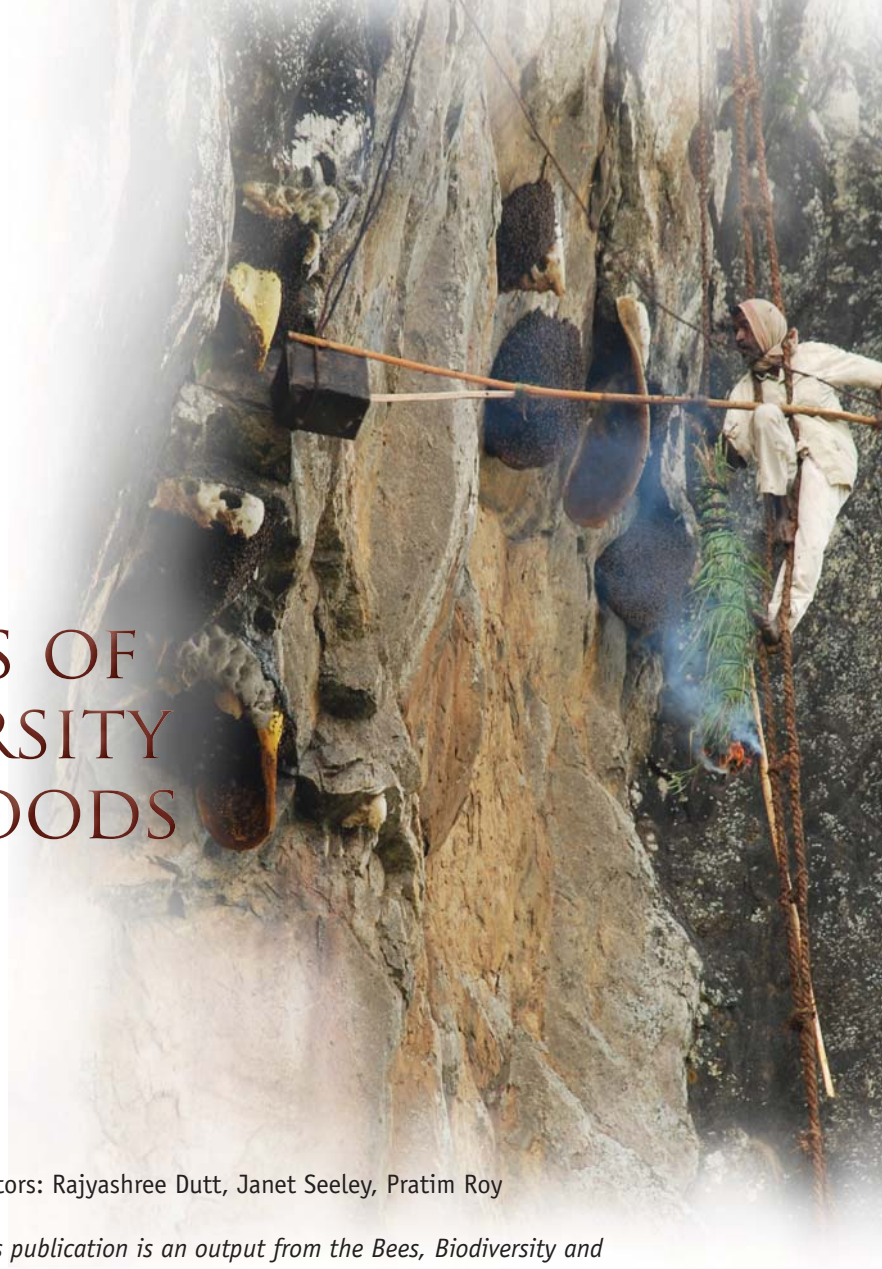
PROCEEDINGS OF THE BIODIVERSITY AND LIVELIHOODS CONFERENCE

26th-28th March 2009
Coonoor, The Nilgiris

DARWIN INITIATIVE



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Editors: Rajyashree Dutt, Janet Seeley, Pratim Roy

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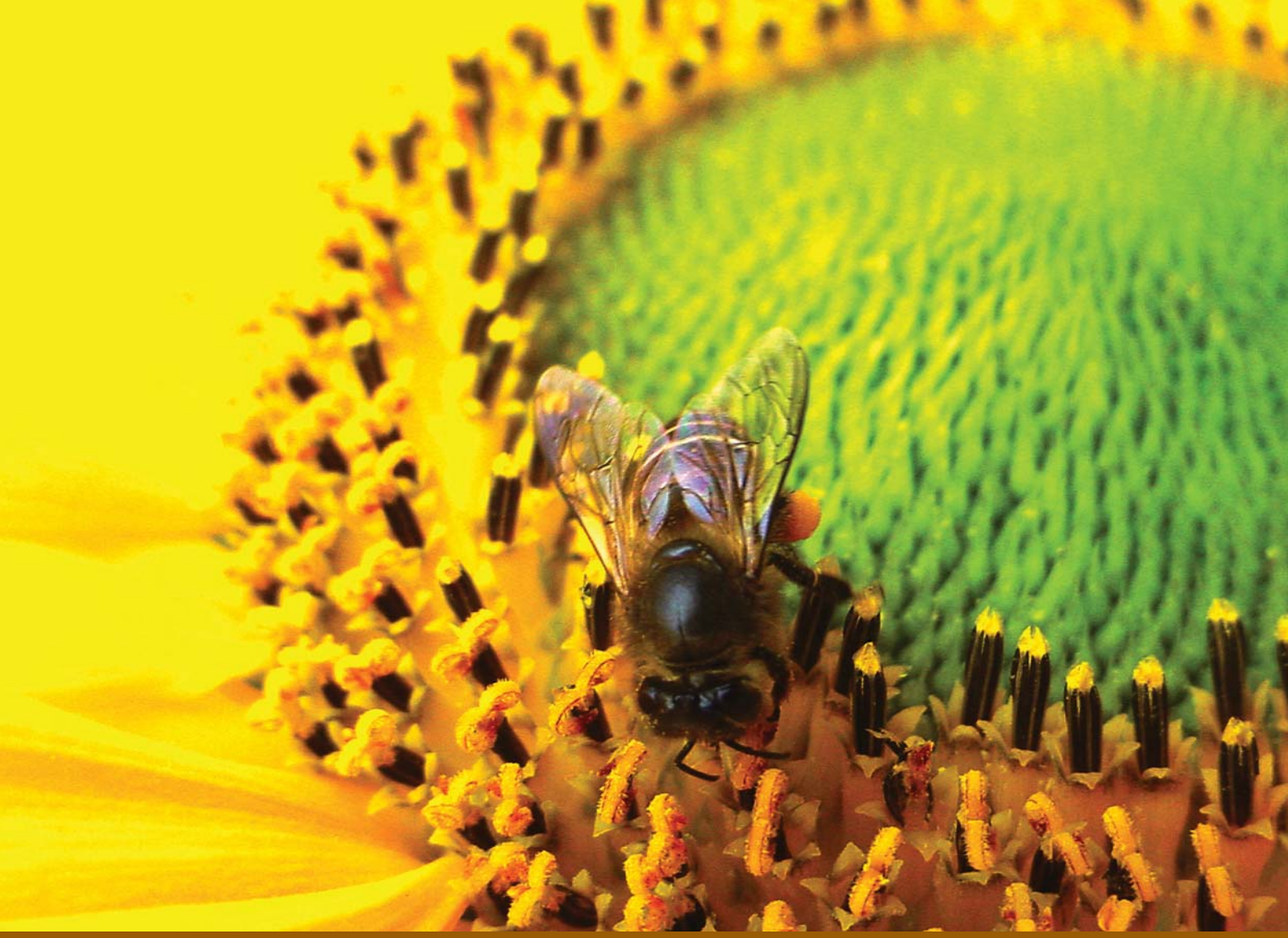
CONTENTS

While some papers had several authors, the names here are of those who presented the papers



PREFACE

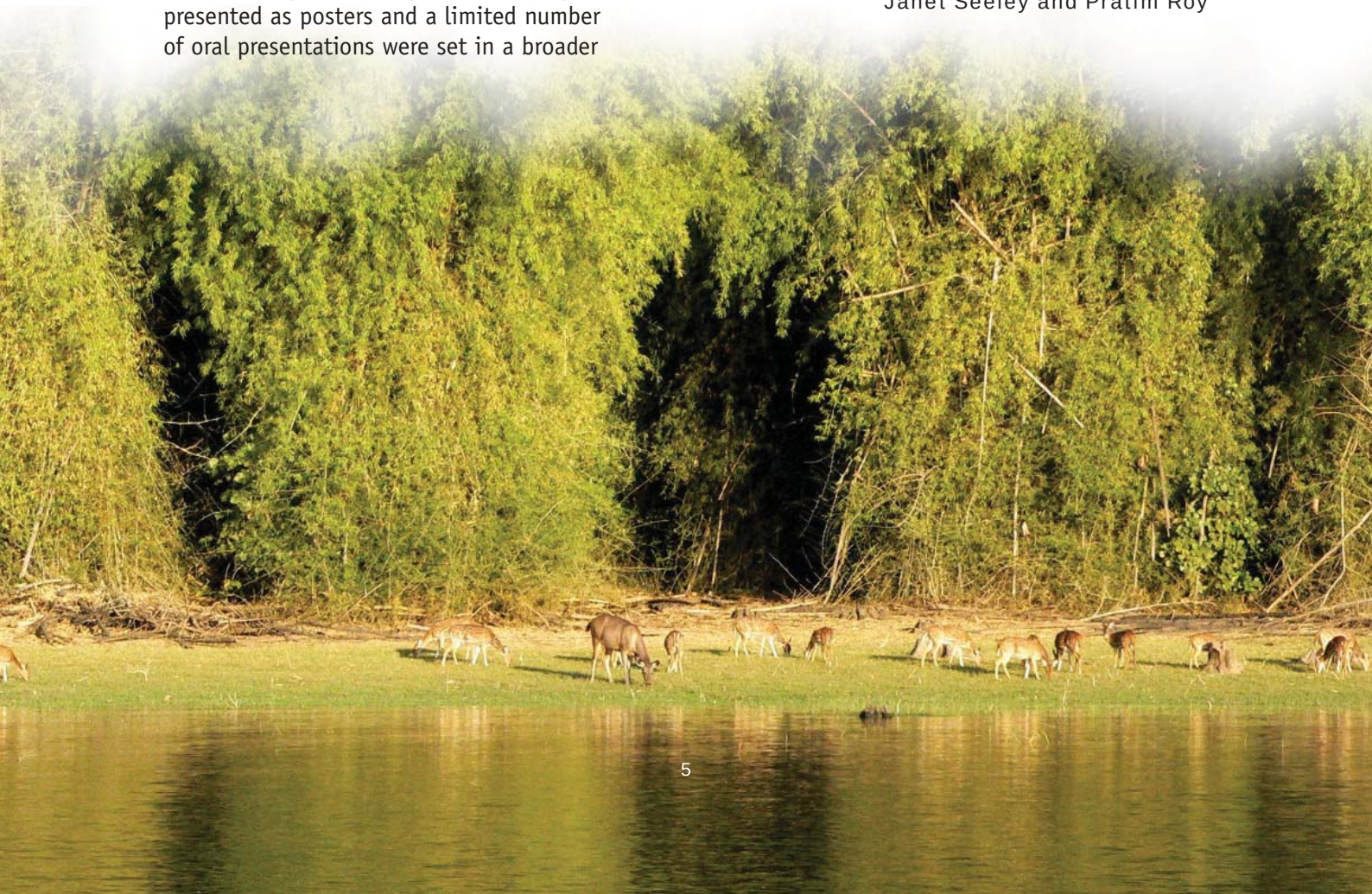
This volume consists of the papers and posters presented during a three day conference on `Biodiversity and Livelihoods' held at the Gateway Hotel, Coonoor, from the 26th-28th March 2009. The conference was held to mark the end of a Darwin Initiative (UK Government) funded project `Bees, Biodiversity and Forest Livelihoods in the Nilgiri Biosphere Reserve'. The conference participants included both national and international academics and policy makers who presented material on different aspects of the topic both in the Nilgiris and more broadly in India.

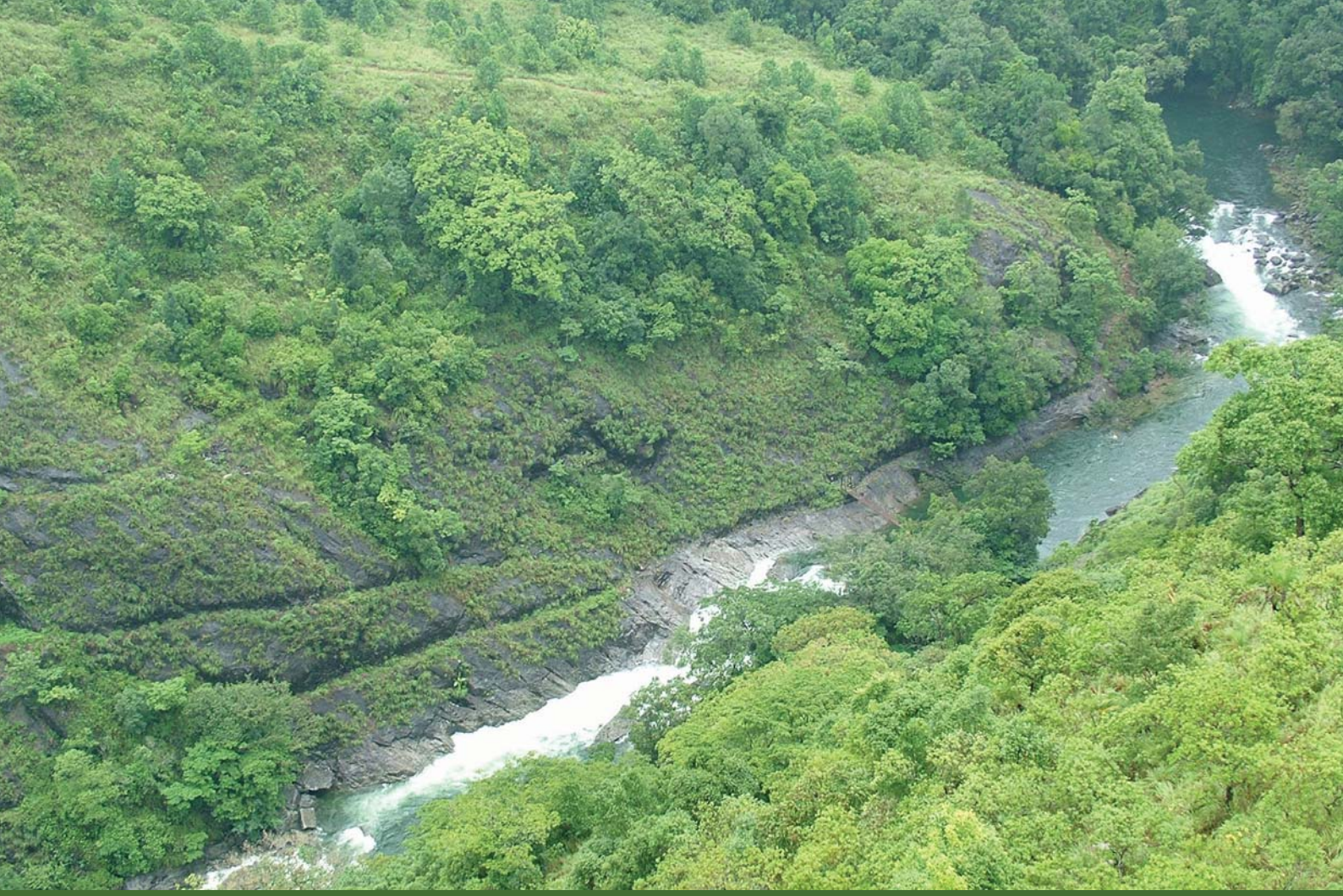
The Bees, Biodiversity and Forest Livelihoods Project, implemented by Keystone Foundation in collaboration with the School of International Development, University of East Anglia, Bees for Development and the Centre for Agri-Environmental Research, University of Reading began in June 2006 and ended in May 2009. The Project sought to elucidate the interdependencies between bees, biodiversity and forest livelihoods in the Nilgiri Biosphere Reserve, Western Ghats, India. The conference was intentionally entitled `Biodiversity and Livelihoods' rather than narrowing the focus to the project `Bees, Biodiversity and Forest Livelihoods' because we wanted to ensure that the range of findings from our project presented as posters and a limited number of oral presentations were set in a broader context. Moreover, many of the findings from the project go beyond a specific focus on bees or indeed `just' forest livelihoods. This is largely because people's lives in the Nilgiri Biosphere Reserve cover a diverse range of activities and an understanding of this is needed to ensure people's interaction with biodiversity (including bees) is placed in context.

The papers in this volume are grouped into five linked themes: placing biodiversity and livelihoods in the Nilgiri Biosphere Reserve history and context; exploring linkages between biodiversity, bees and livelihoods; looking at linkages within biodiversity; examining livelihood linkages and finally `what's driving change?' which focused on broader issues of development and policy in the Niligiri Biosphere Reserve and India more generally.

We are grateful to all the participants for the interesting presentations and lively debate during the conference. We are indebted to the Darwin Initiative for funding. In addition we thank Rajyashree Dutt and Indira Bharadwaj of Write-Arm and Sara and her colleagues from Keystone for organising the conference so efficiently.

Janet Seeley and Pratim Roy





KEYNOTE ADDRESS

Setting the scene for biodiversity conservation linked sustainable livelihood concerns; role of knowledge systems

P S Ramakrishnan

Introduction

Traditional mountain societies such as those of the Western Ghats region being dependent upon land to meet with their livelihood needs, have always used the rich biodiversity (sub-specific, species, ecosystems and landscape level biodiversity) around them as a powerful tool to address their livelihood concerns, the biodiversity playing a key role towards coping with environmental uncertainties that they have to face all the time. In the context of increasing environmental uncertainties, arising from climate change linked global warming and globalization of economies (Bondeau et al., 1997; Dragun and Tisdell, 1999), sustainable conservation and management of biodiversity such as in a 'hot spot' region like the Western Ghats with concerns for human wellbeing is becoming an important issue (Ramakrishnan, 1992a, b). These emerging concerns assume added significance when one realises that the industrialised, living far away from these 'hot spots' of biodiversity, are responsible for rapid land use conversions leading to loss of biodiversity (Indian National Science Academy et al., 2001), a myth which has been shown to have been propagated by all the stakeholders concerned with conservation of biodiversity that includes the scientific community too (Lambin et al., 2001). This is the context in which the 'traditional ecological knowledge' (TEK) of traditional societies becomes relevant. However, in the contemporary context of rapid industrialisation happening all around, TEK oftentimes cannot stand alone; it has to be appropriately lined with text-book based 'formal' knowledge, to arrive at 'hybrid' technologies for addressing sustainability concerns as in the Western Ghat mountain regions, a region that has been undergoing rapid changes both in space and time (Ramakrishnan et al., 2000).

Knowledge systems

'Formal' knowledge derived through a 'hypothetico-deductive' process, arising from a biophysical understanding of ecosystem dynamicity both in space and time, their structural and functional attributes are well studied and elaborated over a period of time (Odum, 1971). This knowledge base has been widely used to address a whole range of ecosystem management related issues, and has often worked well in the context of the industrialised world where a vast majority of the people now remains largely de-linked from nature. Unlike 'formal' knowledge which is derived through a hypothetico-deductive process, TEK is based on community experiences and learning, an area of study which started receiving attention by ethnobiologists concerned with the more obvious economic values attached to species – medicinal and food value of plant species, for example (National Academy of Sciences, 1975; Berlin, 1992; Haldik et al., 1993).

Across the globe, and particularly in a developing world context, confined largely to the uplands live a whole range traditional rural communities who still are dependent upon biodiversity for dealing with their livelihood needs; TEK, for them, is a powerful tool to address sustainability concerns (Ramakrishnan, 2001), an approach that is getting increasing attention in the developed world context too, with implications for addressing resilience and adaptive capacity of socio-ecological systems (Folke et al., 2003).

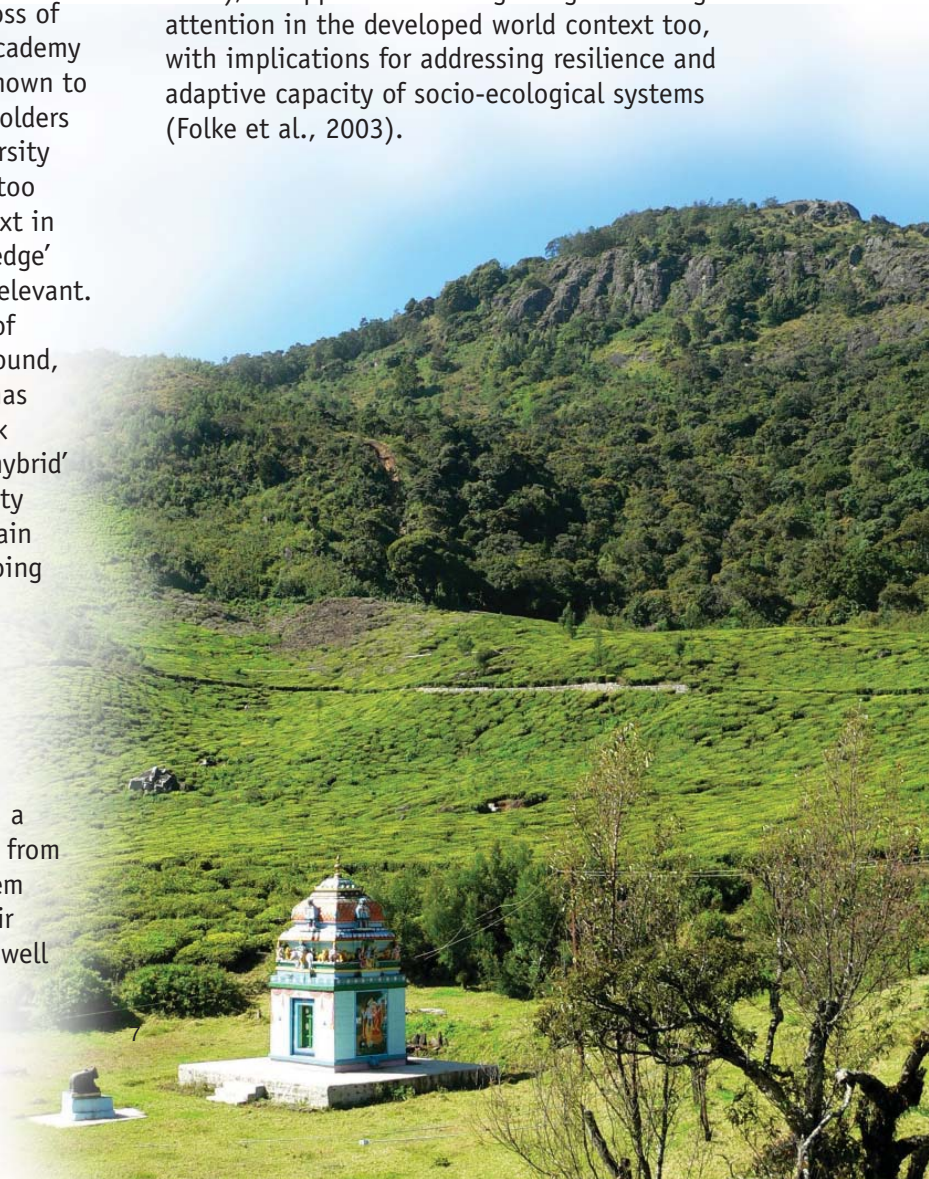
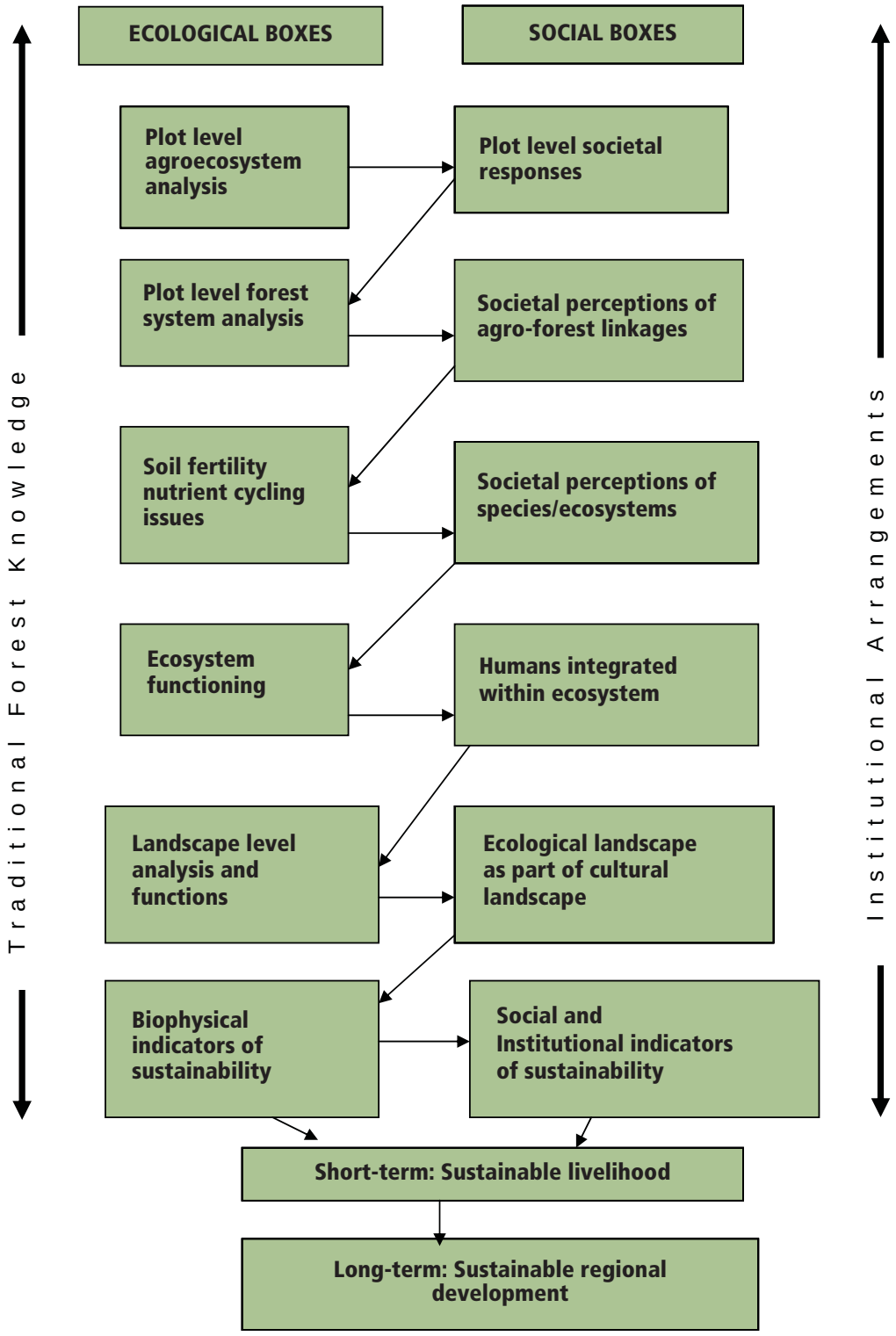


Fig. 1. Traditional Ecological Knowledge (TEK) as the connecting link between ecological and social processes, at varied scalar dimensions – plot, ecosystem to cultural landscape levels, with implications for natural resource conservation linked sustainable livelihood/development of traditional societies



What we are more concerned with here in the context of sustainable biodiversity management linked sustainable developmental concerns is that which operates at the process levels, that connects ecological processes with the social. This could be viewed as being operational at varied scalar dimensions of biodiversity – very traditional societies, being forest dwellers attaching socio-cultural values to identified forested ecosystems leading to the concept of 'sacred groves'. With over 40,000 endogamous groups, and with an estimated 37,000 more structured around the Hindu caste system alone, and with other religious faiths adding on to the richness in cultural diversity in the Indian context, in the Indian context alone we are dealing with a rich variety of culturally valued sacred groves (Ramakrishnan et al., 1998).

From here, socio-ecological evolution could be viewed to have evolved in two directions – (i) reductionism leading to the concept of socially valued 'sacred species' and (ii) expansion leading to the concept of socially valued 'cultural landscapes' with which communities tend to relate themselves as an integral part of their 'village ecosystem'. TEK operating at the process level (linking social with ecological processes) operating at these scalar dimensions determine ecosystem functions such as soil moisture relationships and soil fertility linked nutrient cycling process within ecosystems, with implications for socio-ecological system functioning (Ramakrishnan, 2001; Ramakrishnan et al., 2005). TEK indeed acts as a powerful connecting link between the ecological and the social, in all its scalar dimensions, to understand socio-ecological system functioning at the landscape level with humans well integrated within; in other words, this has implications towards linking conservation linked sustainable livelihood/ development concerns of traditional societies living in the given natural cultural landscape. (Fig. 1)

Apart from the economic and socio-ecological dimensions of TEK, which are tangible dimensions of TEK, the intangible values that communities seek are equally important. As indicated earlier, socio-cultural dimensions (cultural, spiritual and religious belief systems) of mountain people are centred around the concept of sacred species, sacred groves and sacred landscapes, which also denote intangible values linked with biodiversity, apart from the tangible benefits to which they contribute in the given cultural landscape context (Ramakrishnan, 2008a). These can play important roles in biodiversity conservation linked sustainable livelihood/ development of traditional societies such as those living in the mountains. In this effort, one has to move beyond what is often referred to as 'local knowledge', arriving at generalisations applicable across socio-ecological systems on a regional scale, so that TEK can stand on an equal footing with 'formal' knowledge, so that the two could be effectively linked together for 'hybrid' technologies that are relevant for application on a regional scale; this is precisely what we did working with the shifting agricultural landscape in north-east India (Ramakrishnan, 1992a); Linking ecological processes with social processes goes well beyond ethnobiological issues linked with non-timber forest products (NTFPs) (Peters, 1994), an area which has started receiving attention only during the last few decades (Ramakrishnan, 1992a), as illustrated by a few examples:

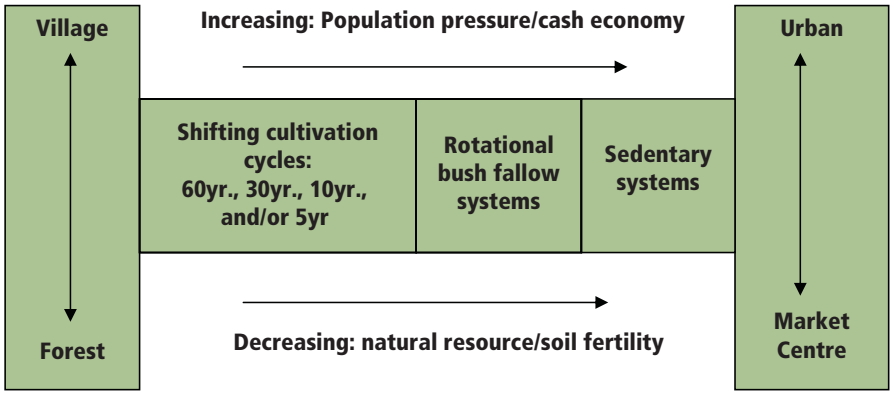
(i) Farmers' choices of mixed crop combinations, with 30-40 units of crop biodiversity along with the associated 50 or 60 units of weed biodiversity on a 2-3 ha plot of land is an effort by the farmer to optimise resource use from an extremely fragile hill slope of the humid tropics, while at the same time trying to cope with environmental uncertainties using biodiversity as an effective tool.

(ii) Under shorter cycle lengths of less than 10 years, biodiversity within the cropping system may drastically decline, but the farmer tends to show a shift towards nutrient-use efficient tuber and vegetable crops at the expense of nutrient-demanding cereals.

(iii) By planting crop species that are nutrient use-efficient on the top of the hill slope and less efficient ones along the nutrient-rich base of the slope, the farmer optimises yield from his mixed cropping system.

(iv) As the cycle length declines below 5 years, farmers often have much reduced crop biodiversity (eg., often a monoculture of

Fig. 2. Evolution in TEK linked with agroecosystems in the landscape, as land use changes in response to population pressure, land degradation and available linkages to market economy closer to an urban landscape (Ramakrishnan, 2001)



potato crop often grown along with a lesser-known food tuber crop such as nitrogen-fixing *Flemingia vestita*, which also helps in stabilising the agroecosystem under low-fertility situations (Fig. 2).

(v) The way the Apatanis, in the Ziro valley in Arunachal Pradesh manage their traditional wet rice cultivation system is a striking example of manipulation of crop biodiversity at the sub-specific level in a settled mono-cropping wet rice cultivation system. Emphasising upon less nutrient-use efficient rice cultivars closer to the village to capitalise upon nutrient-rich soils closer to the village, and more efficient cultivars farther away from the village where the soils are nutrient-poor, the farmer is able to optimise production in the given landscape context, with economic returns close to the 'green revolution' agriculture of Haryana-Punjab, but with an energy use efficiency level of 50-60 (50-60 units as output per unit energy input), which is in contrast to an efficiency level of low 0.5 for 'green revolution' agriculture, and a lower 0.1 for the highly industrialised North American or Japanese agriculture (Kumar and Ramakrishnan, 1990).

It is appropriate at this stage to have a brief consideration of the socio-ecological implications of TEK, in all its varied scalar dimensions about which a mention was made earlier:

(i) Socio-culturally valued ecosystems - Sacred groves and sacred water bodies: which are strictly protected as natural ecosystems; these least disturbed ecosystems, relatively kept free from human activities which could be viewed as learning grounds towards understanding structural and functional attributes of native ecosystems in a situation where the land is already degraded as in Cherrapunji region in north-east India, one of the wettest spots of the world; here in Cherrapunji, Mawsmai sacred grove stands out as an island of biodiversity in an otherwise balded landscaped (Khiewtam and Ramakrishnan, 1989, 1993).

(ii) Socially valued 'sacred species' with ecological keystone value: are very specific tools for restoring/rehabilitating degraded ecological systems, both natural and human-managed. For eg., the shifting agricultural farmer in the northeast India conserves a nitrogen-fixing Nepalese Alder tree *(Alnus nepalensis)* and/or some of the selected Bamboo species which are all socially valued; these species are of keystone value in conserving key nutrients such as N, P and/or K, with implications for restoration of degraded ecosystems/landscapes. (Ramakrishnan, 1992a, b, 2001). That socially valued species have ecological keystone species is a generalisation that we have been able to arrive at a global level. (Ramakrisnnan, 2008a, 2009; Ramakrishnan et al., 1998).

(iii) Human sculptured cultural landscapes: these are natural landscapes that have natural and human-managed ecosystems that are unique to a given community or a set of diverse ethnic groups living together in

the same area. Amongst traditional societies, for eg., the ecological efficiency, as measured through energy input/output analysis (output/input ratio) could be very high, which may not be the case amongst less traditional communities such as the modern societies of diverse sub-sets such as agriculture, animal husbandry and domestic systems; economic efficiency measured using money as a currency could be variable depending upon the general health and wellbeing of the given socio-ecological system (for eg., communities having shifting agriculture under long fallow cycles of more than 10 years could be more efficient than those under shorter cycles of less than 10 years; the high ecological and economic efficiency of the Apatani wet rice sedentary agricultural system could be very high (as noted above) because of efficiency in resource use and its recycling within the rural landscape, compared to many other sedentary systems operating under less favorable socio-ecological situations (Ramakrishnan, 1992a,b). What is to be recognised at this stage is that the urge to be close to 'nature' is not unique only to traditional rural communities, but also finds expression amongst those living in large city centres, an urge to move away from high rise buildings made of only brick and mortar. This urge of urban societies to be close to 'nature' is now getting reflected even amongst the most modern industrial societies, through the concept of 'urban cultural landscapes' that they try to construct around them in the highly urbanised environment in which they live. One could see expressions of this urge to be close to 'nature' in the developing urban context with concerted efforts being made to conserve what is still left as 'green space' as in the urban complexes in India, such as in New Delhi (eg., the 'green' ridge of the Aravalli hill range), and Mumbai (eg., the mangrove wetland ecosystems) conserving the urban complexes in India (Ramakrishnan, 2008a). Indeed, such an effort to bring 'nature' close to extended urban complexes in USA is picking up momentum, through construction and effective management of 'urban greens' and 'urban agriculture', by rapidly developing major NGO movements (Shutkin, 2000).

Biodiversity linked landscape sustainability concerns

With a wide range of agroforestry systems operating in a fragile forested mountain landscape as in the Western Ghat mountain systems, among other considerations food security is an important concern for mountain people. Classifying these complex systems and organising them along a gradient of management intensification is a difficult task; although a loose grouping along such a gradient provides a useful framework for discussing the complexity of the traditional mountain agroecosystem typologies linked landscape functional linkages. In this context, what is developed by Swift et al., (1996) whilst dealing with a whole range of agricultural systems ranging from the casually managed going right up to the most intensely managed agrosystems (Fig. 3), will hold good to our concerns here for mountain landscape management too (Ramakrishnan, 2001). Arising from such a consideration, one could visualise casually managed landscape systems with shifting agriculture as a major land use activity on one extreme, and intensely managed landscape systems with intensely managed annual cropping and/or plantation systems on the other extreme; the Western Ghat mountain region has, a whole range of these landscape systems at varied intensity levels of management (Ramakrishnan et al., 2000).

Of the four theoretical formulations of possible patterns of biodiversity changes under varied management intensity gradients, Curve IV can be seen as the most plausible pattern determining between biodiversity contributing to systems complexity, stability, and resilience linked to productivity (Swift et al. 1996). As discussed by Swift et al. (1996), realising that biodiversity is the key to addressing resilience concerns, working at middle levels of intensity in management (Curve IV) wherein there is a decline in natural and human-managed biodiversity levels seems to be the critical area, for addressing sustainability concerns.

Fig. 3. Biodiversity changes (four patterns) as related to agroecosystem types and intensity of management. Curve I and Curve II represent two extreme possibilities that seem to be unlikely. Curve III is a softer version the ecologists' expectations, whilst Curve IV seems to be more likely and is the most interesting from the point of view of agrobiodiversity conservation (from: Swift, et al., 1996)

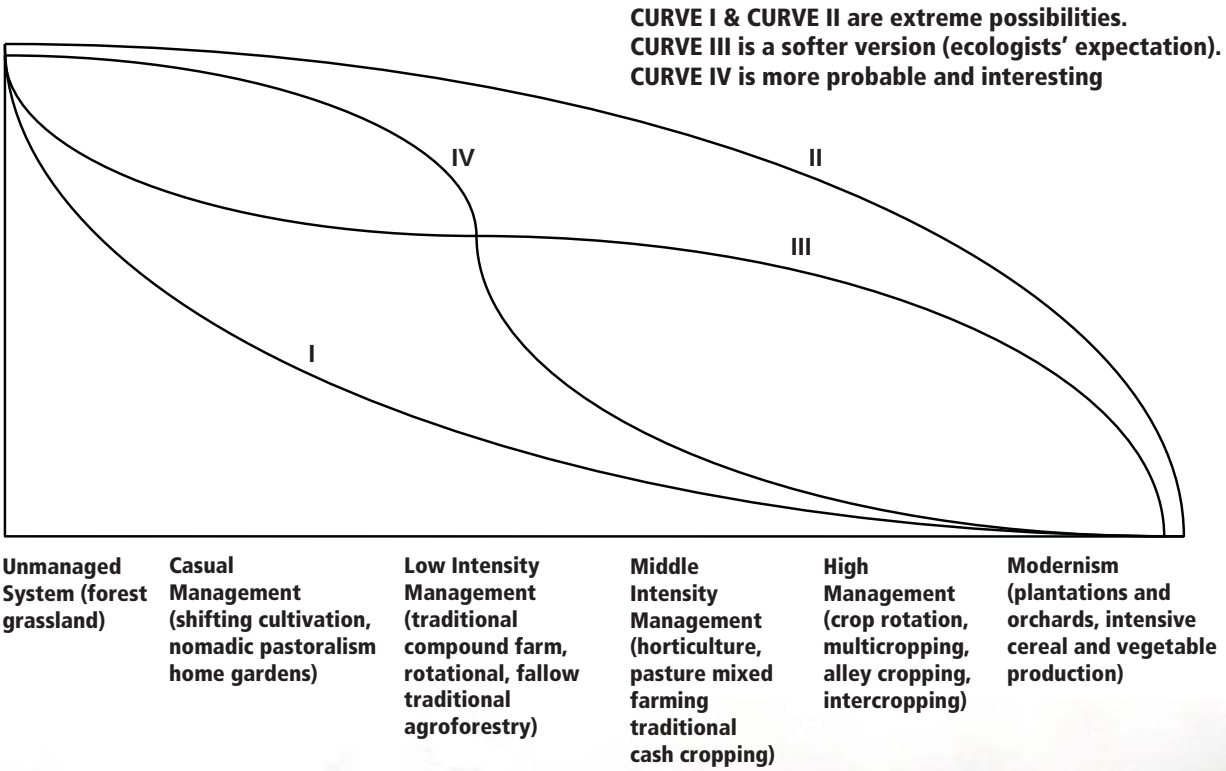
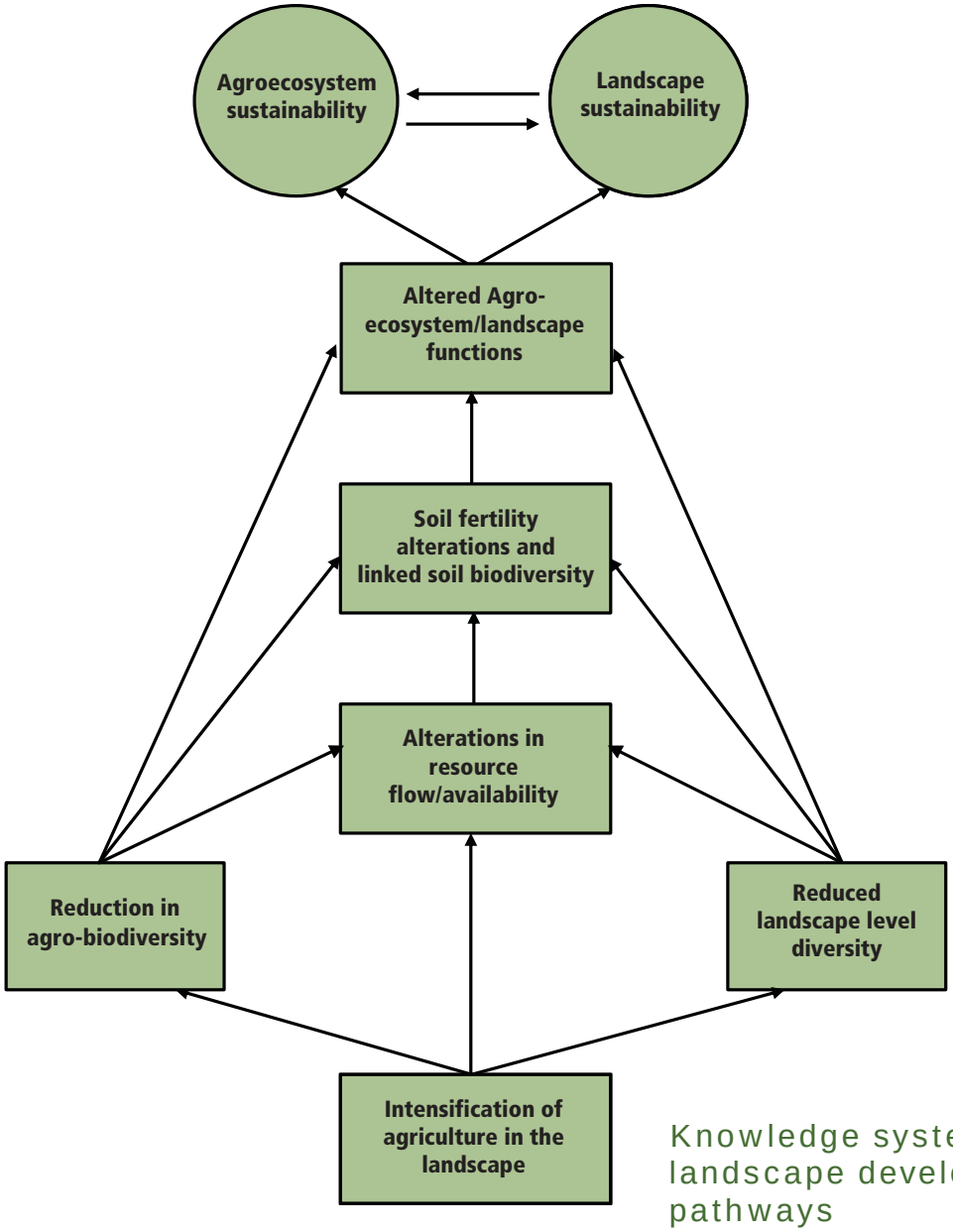


Fig. 4. Intensification of agriculture, biodiversity changes, changing resource flow, aboveground biodiversity impacting upon belowground biodiversity and linked soil fertility alterations in soil fertility levels, altered agroecosystem/landscape functions with sustainability implications (adapted from Swift and Anderson, 1993)



Knowledge systems linked landscape developmental pathways

Biodiversity, no doubt, contributes in a variety of ways towards ecosystem functioning, such as production, decomposition, nutrient cycling dynamics, and thus towards stability and resilience of the system. Working towards community participatory agriculture development possibilities, Swift et al. (1996) considered three distinct sustainable agricultural development pathways that are based on linking different proportionalities of TEK with text-book based formal knowledge. Such an approach is extendable to cover integrated sustainable landscape management too (Fig. 4).

One could consider three broad pathways: (i) the 'incremental pathway' which is all about an incremental build-up largely using TEK (eg., shifting agricultural landscape); (ii) on the other extreme is the 'auto-route', a term based on the simile that to cross a mountain you can use the environmentally friendly long route of going around the mountain, or take the short, less environment friendly approach by having a highway drilled through the mountain to reach the other side faster (eg., a simile linked with energy-intensive and energy subsidised modern land management technologies such as tea/coffee plantation systems in the Western Ghat region); in between the two is the 'contour pathway' where the TEK and formal knowledge inputs are adjusted more or less to equal proportions, depending upon the varied ecological contours that one has to deal with, (eg., a whole range of settled agroforestry systems falling in between the other two noted above widely distributed across the country both in lowland and highland situations).

Landscape conservation linked sustainable livelihood/ development initiatives: Three case studies

The following three conservation linked developmental case studies are illustrative examples of the three different pathways discussed earlier:

Case study 1: The 'incremental pathway' towards a redeveloped shifting agriculture of the rainforest landscape of north-east India

Working upon TEK in the north-eastern hill region of India, it was realised that species that are socially valued invariably has ecological keystone value, implying that such a species would contribute towards ensuring ecosystem integrity, whether it be that of the natural ecosystems or human-managed agroecosystems (Ramakrishnan, 1992a). Thus for eg., a socially valued species such as the Nepalese Alder *(Alnus nepalensis)* was often conserved in the shifting agricultural landscape and had a key function in terms of nitrogen conservation in the ecosystem. Similarly, many bamboo species abundant in the region are also socially valued; a random selection of a few species of bamboos out of many species available in the region was shown to concentrate three major nutrient elements within the system, namely, nitrogen, phosphorus or potassium. Arising from this interesting observation, a global analysis done on socially valued species across different continents suggested that what is socially valued invariably has ecological keystone value (Ramakrishnan, 2001, Ramakrishnan et al., 1998). This broad principle was seen as an effective tool towards sustainable management of both natural and human-managed ecosystems within the shifting agriculture centred landscape, and indeed formed the basis for a redeveloped *jhum* for the whole state of Nagaland. The Nagaland initiative (NEPED and IRR, 1999) was based upon the principle that *jhum* has gone weak and unsustainable because the forest regeneration is not adequate for slashing and burning, and therefore, forest fallow management through human intervention should be the basis for sustainable redevelopment of *jhum*. Over a dozen socially valued fast-growing tree species selected on the basis of interaction with the local communities were used in this effort towards sustainable management of forest fallows which permitted a few years of cropping when the introduced tree saplings do not cast shade at the ground level, and yet these fast growing trees could be harvested under a short rotation.

The strengths of this developmental initiative are:

- **The magnitude of the effort: involvement of all the villages of the state of Nagaland - about 1,200 villages; about 200 experimental plots in farmer's fields for agro-forestry technology redevelopment, with a coverage of about 5,500 ha. of replicated test plots**
- **Farmers have adopted tree-based strengthened *jhum* systems based on agro-forestry principles, for local testing in 870 villages, covering a total area of about 33,000 ha (38 ha per/village x 870 villages); in these plots, local adaptations and innovations for activities such as soil and water management are emphasised**
- **Locally identified edible legume cover crop is cultivated as part of the *jhum* cropping phase of about three to four years, in mixtures as well as a pure cropping system**

- **The Nepalese Alder *(Alnus nepalensis)* tree based TEK which is incorporated both during the cropping and the fallow phases of *jhum,* which is widespread throughout the north-eastern region, but further sharpened by the Angami tribe of Khonoma Village near Kohima, and which fixes up to 120 kg N per ha. per yr., is the starting point and the basis for identifying a number of other tree species, for a redeveloped *jhum***
- **Ten selected tree species for poles for house construction and fuelwood that could be harvested between 5-10 yrs after planting and 20 tree species of value for timber have been identified and introduced into *jhum* plots, to strengthen the *jhum* system, in consultation with local communities**
- **Traditional rainwater harvesting systems and erosion control measures are incorporated into the redeveloped *jhum* practices, where appropriate**
- **Weed control measure through application of salt water, recently in practice with some of the local communities were evaluated; controlling the thatch grass, known in the south-east Asia as 'Alang Alang' *(Imperata cylindrica),* which is extensive in north-east India too was shown to be controlled through dense cropping of cassava**
- **Mixed tree plantations in the *jhum* plots were shown to be superior to monocultures and these are recommended**
- **Agro-forestry related cultivation of non-traditional crops such as tea and oyster mushrooms are considered to be additional possibilities**
- **Improving the yield from the home garden systems through vegetable cultivation is suggested to be another option for cash income; similarly multipurpose bamboo cultivation, including bamboo shoot as a food item has also been suggested**
- **Biodiversity conservation is an agenda for a redeveloped *jhum* system**
- **Land use redevelopment is initiated through participatory extension and dissemination; gender issues are adequately taken care of**
- **VDBs (Village Development Boards) have been constituted on the basis of the local value system, as the vehicles for land use linked development**

However, the major weakness of this initiative has been that detailed in-depth scientific analysis of the outcome has not come out, though review teams have given reports as the work progressed. In the ultimate analysis the key to success of a redeveloped *jhum* system is dependant synchrony between tree growth during two distinct phases, namely, the cropping phase and the fallow phase under a given *jhum* cycle. A supporting land use development activity in the context of *jhum* redevelopment could be the introduction of non-traditional crops like tea and other cash crop systems, for which the traditional home gardens form the appropriate window, which is yet to happen.

In any case, different stakeholders in this initiative had different objectives ranging from sustainable development of shifting agriculture with improved yield from the system, ssustainable forestry, carbon sequestration biodiversity (natural and human-managed) all linked to sustainable livelihood of local communities. In all these efforts, community participation was ensured through Village Development Boards (VDBs) that are ethnicity-specific, based on the value system/s of more than 35 ethnic groups involved in this project. With earlier attempts to impose text-book based technologies turning out to be futile, this is the first time in over 100 years that a community participatory effort proved to be a success, which was also geared towards human security, in a disturbed situation arising from insurgency in the region.

Case study 2: The 'ecologically buffered pathway': Creating buffering mechanisms in the soil sub-system against excessive use of fertilisers in intensively managed tea plantation landscape

Soil organic matter and the linked biological activities as part of soil ecosystem processes are poorly understood and managed in most agroecosystems. As part of the international 'Tropical Soil Biology and Fertility' (TSBF) programme, the South Asian Network (SARNet) has been aiming at understanding sustainable soil fertility management centred around two basic principles (Ramakrishnan et al., 2005): (a) that the capacity to manage soil fertility is dependent on the mechanistic

understanding of the biological processes regulating nutrient flux, organic matter dynamics and soil physical properties, and (b) that the sustainable management of soil fertility must be based on ecosystem/landscape level understanding of processes, integrating soil management concerns of the farmer, his objectives and decisions, in relation to all components of the agoecosystem. In recent times, in the tea growing areas of Western Ghats, serious problems of soil exhaustion had become evident due to intensification of land use. Indeed, the productivity from the tea gardens have been adversely affected in spite of added inorganic fertilisers, including a rapid decline on the lifespan of the tea bush due to soil exhaustion.

Earthworm species were used as keystone species and specific species of this group were used as ecosystem engineers indicative of associated biodiversity, the effort being geared to be indicative of soil health. Because of the diversity of interactions between the mineral soil on the one hand, and organic matter and other soil organisms on the other, under conditions of adequate soil moisture level, earthworms more than any others, bring about fundamental transformations of the work already done by the soil microbes and other soil organisms. Unlike traditional vermiculture, the end results of technology that simply uses mostly epigeic (surface living) earthworms or garbage worms to prepare compost from high quality organic matter like animal dung or from an amendment of waste biomass which involves 'vermi-composting' outside the system, are not often satisfactory under field situations because: (a) being low in C:N ratio, the system demands repeated inputs; (b) they create limited niches not very suitable for organisms that have major activities in the soil profile at different depths, particularly closer to plant roots; (c) one-time application of nutrients are more susceptible to be volatilised, washed out or leached; (d) surface application may decrease plant resistance for pest attack if not managed properly; (e) earthworms often are not able to thrive in agricultural systems under conditions of intense surface activities, with limited capacity to penetrate deeper into the soil. Having said this, vermi-composting is good when organic residues are not readily available locally. This is the context in which the macro-fauna network coordinated by Patrick Lavelle, Laboratoire d'Ecologie des sols Tropicaux, IRD, Bondy, France with support from EEC (European Economic Community) along with B K Senapati of the School of Life Sciences, Sambalpur University, India, with support from the Parry Agro Industries Ltd., succeeded in manipulating soil invertebrates through appropriate soil residue management, using chosen earthworm species as keystone species within the system, (Senapati et al., 2002).

The result of this synergistic interaction between various stakeholders was the development of a patent entitled 'Bio-organic Fertilization for Plantations' or in short as 'FBO', as part of the South Asian Regional Network of the international Tropical Soil Biology and Fertility programme. This led to a range of possibilities for sustainable land use using selected organic residues derived from locally valued and ecologically significant keystone species available at the above ground level. In short, manipulation of organic residues at the aboveground level lead to ensured sustainable soil fertility through in situ management of locally available earthworm species that would ensure appropriate associated soil biodiversity for sustainable soil fertility management.

The net result was a drastic reduction in the use of inorganic fertilisers, with a decline between 30-50%, enhanced tea production, anywhere between 33 to 80%, improved quality of tea, and indeed, improved long-term sustainability of the soil ecosystem. Obviously, what apparently seems to be a sectoral approach to sustainability concerns has had a cascading impact on soil fertility management at the landscape level (Senapati et al., 2002). No doubt, this technology has great relevance for restoring rapidly degrading soil systems under the 'green revolution' agriculture of the Haryana-Punjab region, where excessive use of fertilisers has led to soil exhaustion, with the soil system rapidly losing its productivity, and becoming more and more susceptible to environmental uncertainties.

Case study 3: The 'contour pathway': Sedentary systems of the Central Himalayan region

This pathway falling in between the two pathways discussed above is appropriately adapted to fit into the changing ecological contours at the landscape level, at the same time designed to meet with the social, economic and cultural needs of the farming communities. Working with nature, rather than dominating it, this approach involves working with the background ecosystem, fully in mind. Many agroecosystems types in the 'low' and 'middle' intensity management categories (Fig. 4) will come under scrutiny under this pathway.

Sloping Agricultural Land Technology (SALT)

A whole variety of agroforestry and alley cropping systems come under the 'contour pathway'. For example, in recent times there have been many attempts to design sustainable agricultural systems to meet with the specific needs of the mountain societies, of which 'Sloping Agricultural Land Technology' (SALT) developed by the Mindanao Baptist Rural Life Centre in the southern part of the Phillippines, for mountain agriculture is one of them (Pratap, and Watson, 1994); this is based on planting annual and perennial crops in 3-5 bands between double rows of nitrogen fixing trees and shrubs planted on contours for soil conservation. The objective here was to establish a stable ecosystem that would check soil erosion, ameliorate the chemical and physical properties of the soil and lead to increase in the income of the farmers. This technology could not go far, because: (i) TEK, unfortunately is not the primary basis for selection of species, whether they be crop or tree species; (ii) farmers with uncertain land tenure were unable to accept the technology, a common problem with tree planting in many parts of the tropics; (iii) with land holdings that are too small and fragmented this technology often becomes a spatial misfit; and (iv) with heavy monetary investments called for it often remained out of reach of small farmers. In short, this model often proved to be out of tune with the social dimensions of the problem.

Redeveloped agroforestry systems for tree cover depleted rural landscape of the Indian plains

For the larger plains of India where the biodiversity remains largely depleted, agricultural systems are slowly breaking down and agroforestry developments are seen as the panacea for all the problems of land degradation and declining productivity from the land (Singh et al., 1994). What is important in all these efforts to stabilise agriculture in the rural plains is that socially valued ecological keystone species could be a trigger towards ensuring community participatory efforts with implications for long-term sustainability of such systems. Such ecological keystone species are often linked with many folk tales, music, dance forms, etc., such as in the case of multi-purpose *Prosopis cineraria* in Rajasthan, Oak species *(Quercus spp.)* locally called *'Banjh'* in the Central Himalayan region, etc. Selection of such species for agroforestry would find immediate acceptance from the local communities with implications for sustainability of the models so developed; in such an effort, text-book based formal knowledge inputs could well be integrated too; eg., selection of nutrient-enriching and nitrogen-fixing legumes, and/or species with the right kind of shoot and root architectural designs (Shukla and Ramakrishnan, 1984; Ramakrishnan, 2001) compatible with the crops as part of the agroforestry model.

General considerations

Having been involved with knowledge systems based studies in the area of conservation linked sustainable livelihood/ development for almost four decades now, it is not surprising for this author to witness now, a belief system rapidly emerging which tries to go beyond text-book based formal ecological sciences, and getting more and more involved with community based value systems, as the basis for ecological conservation linked sustainable development. In other words, the path charted out by this author to move from biophysical dimensions of ecosystems to a more integrative socio-ecological systems approach towards taking science to society right down to the 'grass root' level local communities has been seen as an important pathway towards

coping with a whole range of global issues – sustainable food security, conservation and sustainable management of natural resources at large, all with sustainability concerns, renewed interest, not only at the national level, but at the international level too. Indeed, efforts to conserve/redevelop 'cultural landscapes' in our rural landscape in general, but with greater emphasis on biodiversity rich regions where traditional societies live has been gaining ground, as is evident from the earlier discussions, with a number of international initiatives already put in place. To cite a few important ones with their relevance in the Indian context: (i) the 'Globally Important Agricultural Heritage Systems' (GIAHS) of FAO (Ramakrishnan, 2003); (ii) 'Traditional Forest Knowledge for Sustainable Forestry' of IUFRO (Ramakrishnan, 2007); and (iii) the emerging IHDP initiative on 'Knowledge Systems, Societal Learning and Sustainability' (Ramakrishnan, 2008b) are illustrative of these emerging concerns for a knowledge systems approach to sustainable livelihood/development of not only the marginalised rural poor, but also the more modern urban societies. Indeed, there is an intrinsic desire on the part of the humans living not only in the 'developing' rural set up (Ramakrishnan, 2001, 2008a) but also amongst those living in the 'developed' urbanised world too (Shutkin, 2000), to get close to nature through a 'cultural landscape' that they perceive for themselves. What is worth mentioning here is that such a knowledge systems based approach has great relevance too to address issues linked with global human security (Ramakrishnan, 2009). In short, human societies are increasingly getting concerned not only with tangible benefits accruing to them, whilst trying to ensure their eco-cultural identity.

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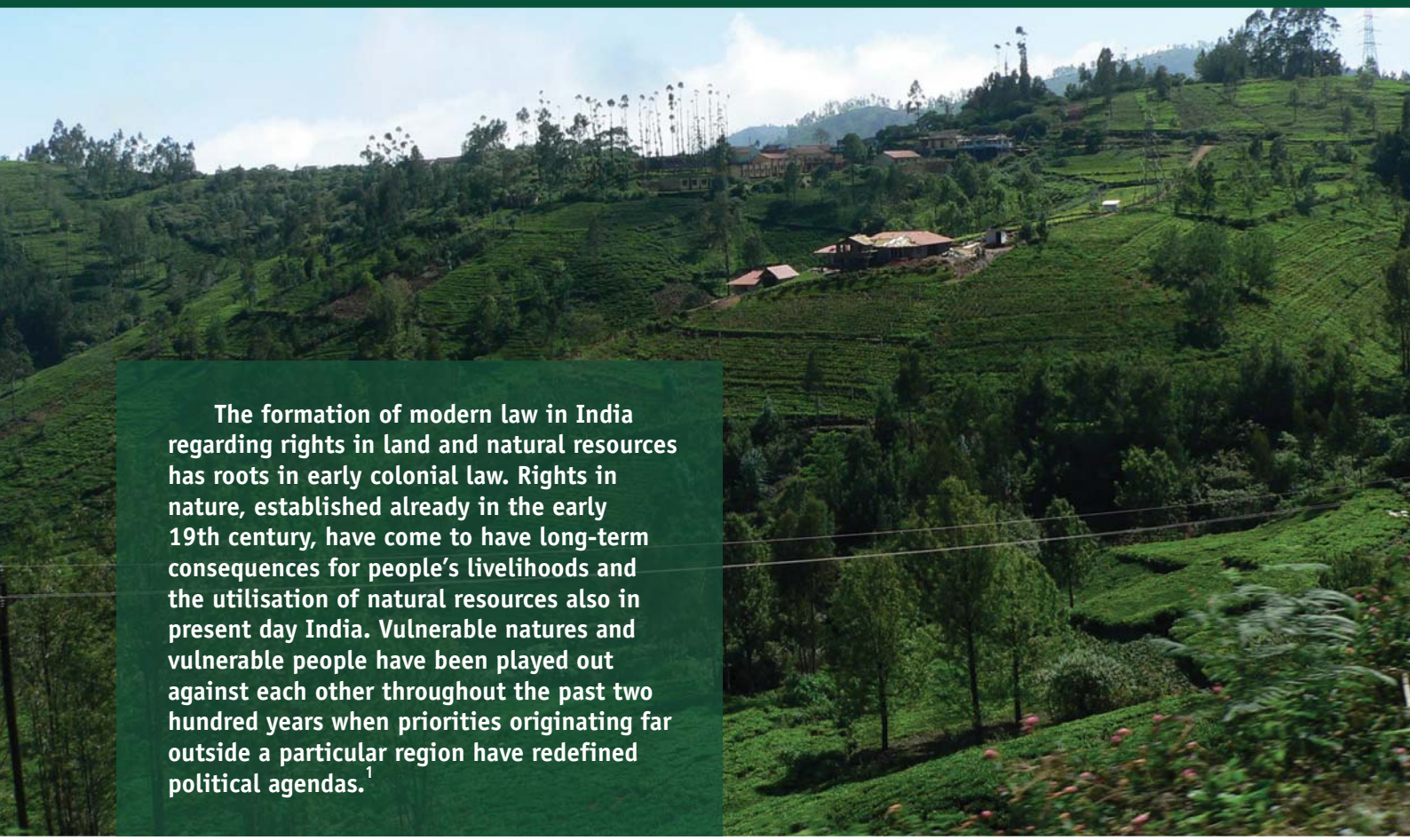
(1)

Nilgiri Biodiversity Reserve - wide history and context

(1A) Battles over Law: The (re-)formation of legal rights to nature in the Nilgiri Hills, early 19th century

Gunnel Cederlöf



The formation of modern law in India regarding rights in land and natural resources has roots in early colonial law. Rights in nature, established already in the early 19th century, have come to have long-term consequences for people's livelihoods and the utilisation of natural resources also in present day India. Vulnerable natures and vulnerable people have been played out against each other throughout the past two hundred years when priorities originating far outside a particular region have redefined political agendas.[1]

This article engages with the formation of legal regulations and codes for the right to access and control land and resources during the British East India Company's conquest and establishment of sovereign rule in the Nilgiri Hills in the early 19th century. The first settlement of right into codes in this limited region was a slow process over a quarter of a century and, in its initial phase, a delayed effect of the Anglo-Mysore War and the following establishment of British control of Malabar and Wynad. After a first period of arbitrary and personalised administration of the hills favouring individual interests, the Madras government stepped in and the land question turned highly sensitive. In the 1830s, different interests within the EIC collided, and existing conflicts within the region, both between and within communities, dating long before European presence were played out in a battle over who had the right to determine land rights and what exactly those rights were.

The British East India Company (EIC) claimed all land in the Nilgiri Hills long before they entered into the territory itself. It was considered part of the Mysore State and, as such, it had fallen into the hands of the British when the Mysore State was conquered in 1799. But since all attention immediately after the war was on getting into actual control of the agrarian plains and setting up revenue administration there, it took two decades before small groups of British officers—one being the collector of Coimbatore, John Sullivan—began

to explore the hills. What they saw made them think of other landscapes, far from India. The Nilgiris looked like highlands in Europe and the people, the 'herders', were perceived as people being one with nature, majestic as the hills, free as the mountain deer, childlike and peaceful as simple peasants 'back home' in England. This would be the perfect place for a sanatorium and for experimenting with European crops. The place and its people were described as the complete opposite of the Hindus of the scorching Indian plains, where heat and Brahmin dominance were thought to have had a devastating effect on people's morals, work ethics, and social and economic life. Soon the watchwords of the time began to resound in the reports from the hills. In the Nilgiris, there was hope for improvement, entrepreneurship, and a healthy life.[2]

Already in these first reports and letters from the hills, the region was described as sealed off from the plains, as an enclave shielded from the civilisations of states and settled societies in the lowlands, and as a place where history long ago had come to a standstill. The perception of the place was that of a landscape which was totally different from the rest of India and the urge of finding a refuge from warfare and disease was so strong that, even though many observers in fact described strong links between hills and plains, and intersecting economies, their conclusions did not include those observations. When comparing the day-to-day correspondence in the Nilgiri administration with the generalised conclusions made in the larger reports and survey, this discrepancy comes out most clearly.[3]

In addition, the general ideas of people held by the travellers to the hills were influenced[4] by the scholarly knowledge of the time, which sought to find explanations for the origin of the human race. Influential scholars of medicine and natural history, like Johann Friedrich Blumenbach (1752–1840) and James Cowles Prichard (1786–1848), outlined in detail the evolution of the different human races, which in a significant way included the 'hill tribes'. Such tribes were often called 'mountaineers' to emphasise the importance of physical elevation and place, and centrally placed in the scheme were the Toda pastoralists of the Nilgiri Hills. Even if the EIC officers in India were not upto date with the latest research, they conformed to views held in the common discussions which were highly influenced by the scholarly debates, argued also in fora like the Royal Asiatic Society and the Ethnological Society in London and in their journals. Ideas of hierarchies within the human race, wherein the Aryans were distinguished from the Dravidians, aboriginals and barbarians, were adopted also by the ethnographical surveyors in the Nilgiris. Prichard, more than Blumenbach, moved on to set up detailed ethnological schemes and to frame his findings in a classical Orientalist discourse. The *'mountaineers'*, he claimed, were *'all the tribes who live remote from cities and cultivated countries, and maintain a savage existence amidst woods and forests.'* According to him, the people of south India constituted a distinct race, different from the Aryan and conquered by them. And just like they had fled from the Aryan race, also the mountaineers in the Nilgiris were claimed to have fled from the states in the south Indian plains and into the hills. Within this historical-cum-racial explanation of hill-plain and caste-tribe relations, non-sedentary societies were explained to be the antithesis of civilization.[4]

Information was also passed in the other direction. There was a strong and mutual dependence between the scholars on the one hand and the 'barefoot' ethnographers in the Nilgiris on the other. Prichard depended exclusively on the reports of Henry Harkness and James Hough—the two most well-known authors of ethnographic reports in the 1820s and 30s—for his conclusions about the Toda, Badaga and Kota communities.[5]

In an important way, such basic and preconceived understanding of the people and place came to have a decisive influence on the administration and bureaucratic rule set up in the Nilgiris during the 1820s–40s. These were the years when new settlements of Europeans and Indians from the plains began to emerge in the hills. The possibilities of setting up small scale workshops and agriculture in a cooler climate, and—not least—getting a freehold of their own attracted new settlers. When the Nilgiris were incorporated into the Coimbatore district administration, the collector John Sullivan together with the Commandant of the hills, Major Crewe, carried on a rather

lax procedure of allowing individuals to build houses and establish their enterprises. The influx of settlers in the centre-most part of the Nilgiri plateau was so significant that, in 1827, Sullivan asked for 'express sanction' for rules restricting the appropriation of land in the region. In a letter to government, he described how this pasture land was increasingly occupied by houses, woods were cut down and large herds of untaxed cattle grazed the land for which the Toda paid taxes. Sullivan wanted the government to ascertain that in the Malnad, the part of the hills where the Toda were in exclusive control, they should be given absolute proprietary rights.[6]

Such correspondence certainly gives support to Sullivan's well established image of being the patron of the Toda and protector of their rights against an aggressive colonial regime. However, looking a little closer at the situation and, rather than making Sullivan into a lead character of Nilgiri history, placing him into the context of legal battles over land that broke out at this point in time will modify such an understanding of early colonial rule in the south Indian hills. Sullivan had private interests in land and shared these interests with many others.[7]

During most of the 1820s, land administration had been in the hands of the Coimbatore district officers while the attention of the Madras government had been given to settling the vast lands in the conquered territories in the plains. Securing land and natural resources in the hills was given a much lower priority and only after members of the government themselves had begun to take a personal interest in the matter—not least by constructing their own houses in the hills—did they realise the consequences of the present administration. Therefore, both district and presidency administrations made claims on the land in the hills, but on very different grounds. Whereas the district administration argued that their expertise from having lived in the area almost a decade should give them the final say in legal matters, the presidency administration could not accept such a challenge to their sovereignty as rulers. Eventually, as conflicts developed, the highest board of the EIC, the Court of Directors in London, voiced concerns about the fundaments of good governance and undisputable principles of proprietary right in India. In these legal disputes, the ethnological classifications of people came to play a major role when rights in land were codified into law.

Land law based in custom

Founding the conquest of territory in legal justice and law codes was crucial for the legitimacy of the growing global empire. Law was seen as a neutral space and an evidence of civilisation, and the new subjects to British rule should be assured that they were treated with the same rights as any other subject within the empire. For the EIC governments in the British territories in India, law was aimed at securing trust among the propertied population while, for the subjects—not least the European subjects—it was a means of safeguarding positions and wealth. In the Nilgiris, Sullivan had been quick to secure nearly 2,000 acres for himself by a government grant. But most other Europeans had trusted Sullivan for his word and had struck deals with the local population when they set up houses and fields.[8]

The disadvantage of lacking a valid document became apparent when conflicts emerged in the early 1830s when the government decided to resettle all land and thereafter put it up for public auction to be granted to the highest bidder. In this way, the government turned what the landholder thought to have secured as a freehold into leasehold. And, as a further disadvantage, the individual who had invested in improving the land could not be sure of reaping the fruits of the investment. Not all landholders were of the high social order representative of the members of the Madras government. Most European landholders in the hills were like Mr W Davis and Mr McNair, who had put their life's savings into small plots of land. The land was their only source of subsistence. They thought of themselves as original proprietors and had purchased the land from the Badaga shifting cultivators in Ketty by order of the Commandant of the Hills. This decision was now overruled by the government and, being made into leasehold, the land lost half its value and could no longer be inherited.[9]

The wrestling between district and government administrations over European smallholdings reflects in a small way the larger conflicting interests that collided in the Nilgiris, which came to have severe consequences for the people native to the hills. Using law as a means of land encroachment was common for British conquest in many parts of the Indian subcontinent. But since the dividing lines in the Nilgiri Hills also cut through the European population, the different interests and principles argued received much attention far outside this limited region and were reported in great detail. This gives us an unusually good opportunity to study the logic and mechanisms of the making of law as it transformed man–land relations and people's livelihood during the establishment of British rule in India.

In spite of disagreements, there were certain legal principles that could never be questioned. The right to land and the freedom to hold property, together with personal security and liberty were indisputable ideological principles in the British debates. These rights were rooted in the legal frame of English common law, going back to Roman law on the British Isles. This custom based law protected both the lord's absolute right in land and the tenants' right to use the commons. As it had its fundaments in the notion of custom, when applied in India, it fitted neatly into the principle of EIC governance in the British territories of respecting native custom in the application of law. As far as possible, local custom and law were to be respected and law codes under British rule were to be adjusted to these laws.

In academic debates, custom has often been seen as the epitome of aboriginal or tribal society, in contrast to British utilitarian and rational ideas of universally applicable law. However, the idea of custom was part and parcel of British land law and, therefore, the practice to adjust legal regulations to regionally specific conditions was not alien to them. The British officers might have misunderstood those conditions, but they were nevertheless keen on establishing native custom of a particular place. Not all agreed to the benefit of such policies but argued that custom would stand in the way of progressive legal reform. Yet in the Nilgiri Hills, to define native custom became a crucial issue for arguing a position in the dispute on land rights.[10]

Two major contradictions stood out: one emphasising the rights vested in land and natural resources, the other arguing for the utility of nature for the sake of the common good. According to common law principles, land belonged to those who were original proprietors, that means those who were the first to set foot on the land and by being aboriginal to the place also had birthright to this land. This implied absolute property in the land, the strongest rights anyone could have. For the district administration and all the private entrepreneurs entering the hills in the 1820s, to establish such rights for people in the Nilgiris became a way to make sure that there were owners from whom they could purchase the land and all the rights vested in it. Thus Sullivan argued at length that the Toda were the original inhabitants of the Nilgiri Hills.[11]

The government's position brought forth the principles of government and sovereignty. It is important to remember that the EIC was first and foremost a global mercantile trading corporation that aimed at securing monopolies. The flip side of monopoly is sovereignty, which took centre stage when the Company began to conquer territory. Consequently, the Madras government argued that whatever rights a subject to their rule might have—and the existence of such rights were by no means denied—they were subordinate to the principle of sovereign rule. It was further the duty of any enlightened government to care for the common good of the subjects, but simultaneously the government kept for themselves the preferential right of defining who those subjects were and what was good for them. When the individuals securing private interests argued that the Toda were aboriginal to the Nilgiris, using ethnographical surveys to prove their point, the government used the same surveys and equally racial conceptions of people to prove the opposite. As the Secretary to Government, H J Chamier explained about the Toda:

These poor men are continually migrating from one part to another, have no fixed habitation, no settled rules of life, no written laws, no taste for agricultural pursuits, no population which presses on their means of subsistence, and no taxes which cannot be paid with the greatest ease; and if there

is any class of people to whom a more free and enlarged intercourse with the inhabitants of the adjoining countries, and with settlers in their own, can be beneficial, it is surely those who will receive knowledge, clothing, and [be] better supplied, in the place of ignorance, nakedness and discomfort.[12]

In the Secretary's view, shared by the members of government, absence of settled cultivation, lack of written codified law, and inability to use land efficiently proved a lack of civilisation among a particular group of people—in this case the Toda 'hill tribe'. Herding buffaloes over extensive grazing fields while lazily resting in the shade was evidence enough to prove their unwillingness to produce revenue for the government that could be converted into progressive reforms for the public. The productivity, not only of the people, but also of the landscape was aimed at improvement and progress. The low stature shola forests, significant because of their high biodiversity and well adjusted to the climate, were seen by the government as useless waste, to be replaced by *eucalyptus*, and the much 'unused' land that was claimed by the Toda was more than they needed for grazing, according to the government. As Chamier argued, they would not be hurt by losing it since the land was evidently not under any population pressure and their subsistence was not under threat. A truly utilitarian position that took note of an economic logic, while disregarding any political and social influence exercised by the Toda in the larger region, which was partly based on their influence over the Malnad lands.[13]

Proving birthright to a particular piece of land followed strictly regulated procedures. In the first instance, this was to be substantiated in a written document—any document, not only *pattas,* was valid proof. If such a document could not be established, habit and usage could in the second instance prove a person's right. The over-riding principle was then that of equity. Not to disrupt people's trust in the government, the exercise of law had to be reasonable and just, also in the eyes of people to whom the law was to be applied. Immediately when the land question began to split the EIC administration, the establishment of the first regulation of the control and access to land in the Nilgiris turned into an elaborate exercise of extensive reinterpretations of the principles of proprietary right and of negotiations on the land itself. This partly explains why it took up to a quarter of a century to establish the first regulation, 'Rights of the Todawars, and Rules for grants of land on the Neilgherries', which, in effect, was a regulation aimed at restricting land rights for a population which never counted higher than 600 individuals.[14]

Two competing extensive production systems

The socio-economic and ritual system of exchange among people native to the Nilgiris was already from the first reports in the 1820s, to be further emphasised in W H R Rivers' magnum opus *The Todas* (1906), described as a closed system of dependence and hierarchy. The Toda was described to have contributed dairy produce, while the Badaga produced agricultural crops, and the Kota, who were artisans, provided the necessary implements. The Toda occupied the dominant position in the social hierarchy, which gave them the right to determine access to usage of land. Their authority was partly manifested in rituals and the giving of *gudu*—a kind of social tribute or gift mostly given by Badaga shifting cultivators as a share of their produce to the Toda, who held authority over the particular piece of land they cultivated. Irula and Kurumba hunters and gatherers were described as not formally included in this social system, but as supplying honey, wax, and other small forest products to the local economy. The system tended to be portrayed as ancient and static.

In the case of Rivers, the lack of historical context is the most glaring. At the time of his study, in spite of being published after close to a century of colonial rule and immigration—an influence which had caused dramatic change to the life and livelihood of people in the Nilgiris—he does not make such historical transformation part of his enquiry or observe the fact that he himself also represented British presence in the Nilgiris. In contrast, he claimed that the information he found in the letters of an Italian Jesuit priest from 1603 was 'sufficient to show that there has probably been little change in the Todas and their surroundings in the three centuries which elapsed between his visit and mine'.[15]

The colonial rulers' preference for cultivation over non-sedentary pastoralism is a well researched field in studies of various regions in India. Settled cultivation was the preferred form as it simultaneously implied an intensive use of land and more easily brought people under control by means of revenue settlement. Shifting cultivation, with a mobile population using extensive lands, was targeted for being wasteful and destructive.[16] In the Nilgiris however, in the early 19th century, the conflict between cultivation and pastoralism appeared in a slightly different form. In contrast to generally held views, the British officers saw good prospects for improvement in these cultivators. They were the Badaga—a community constituted of people migrating into the hills over a long period of time. But the Europeans failed to observe their varied past. In the British narratives, the history of the Badaga rapidly turned into a singular and linear story of a cultivating caste from the plains, fleeing from oppressive rulers and warfare into the hills to form a tribe in a dependent relationship to the Toda. Henry Harkness claimed they were *'in every respect the Sudra cultivator of Mysore, [who] … migrated to these hills, together with the other classes of this tribe, about six generations ago'.*[17] True to the ideas held in classical Orientalism, they were portrayed as the entrepreneurial small farmers, representing a superior state of civilisation with dormant skills lacking in the hills, and a knowledge that would create economic improvements only if well guided and their skills utilised in a correct way. Significantly, in the revenue files they were almost never referred to as Badaga but as Burgher.[18] Not until the 1840s are reports beginning to appear wherein this form of cultivation—not only in the Nilgiris but also in other parts of the Madras Presidency—is being targeted as wasteful and blamed for destroying valuable forest and contributing to a negative climate change.[19]

Yet long before the British arrived there are signs of an emerging competition between the two as extensive production systems: shifting cultivation and pastoralism. Archaeological and literary sources indicate a situation wherein, over time, the cultivators had encroached on grazing lands, thus beginning to limit the Toda's sphere of control over land. Most likely, this transformation began during the 18th century. In one of Sullvian's early reports, he claims that only the small region of Malnad and part of the neighbouring Todanad were exclusively under the Toda. He warned of the consequences of Badaga expansion: 'The cultivation and population in their *nauds,* are rapidly increasing, and in a few years, the Bergers if left undisturbed, will occupy all the best descriptions, and many of the inferior soils.' [20]

When Sullivan sent this note to the Madras revenue board, the government had just begun to make restrictions for the procedures of land transfer and the requirement of a land grant was introduced. Simultaneously, the government argued that in spite of their 'custom' to graze cattle on the land, the Toda lost those rights when the land was enclosed. They were 'users'

not 'proprietors' of land. The loss was a loss of a 'privilege' not of a 'right' and it should therefore be compensated in monetary terms. As is evident, cultivation of the soil held priority over grazing. Sullivan protested, arguing that the Toda certainly were proprietors equal to the *mirasidars* in Malabar.[21]

The dispute between district and presidency administrations, more than once breaching the norms of appropriate speech, deepened into a conflict that involved many parties in the 1830s. Apart from the EIC administrators, private entrepreneurs, the Nilambur *raja*, and not least members of the Badaga and Toda settlements primarily in Malnad, were drawn into the legal battle. Seen over a longer period of time, three phases stand out. The first was characterized by strong individuals at the district and regional levels extending European settlement by crude means, the second by legal negotiations in the administrative offices as the presidency administrators took over the initiative on the question of land settlement, and the third by the final establishment of a legal code for rights in 1843 backed by a more powerful state bureaucracy. As the first European settlements appeared in Malnad, the Toda of those *munds* were also the first to respond to the intrusion. Later, when Europeans claimed lands that were under the rotations of shifting cultivators, the Badaga, too, objected to the incoming settlers, while the British immediately mistook the Badaga for landholders.[22]

The settling of land in Ketty in 1833 illustrates well the government logic in practice. In the Ketty valley, a government farm had been established in 1826 on 127 acres of land. Now, in the process of assigning grants to landholders, land used by the government also came up for scrutiny. Four years of investigation brought forth two valid claimants, both Badaga cultivators. Having lost access to this land due to the farm, they were eligible for compensation. When they turned down the new fertile lands offered them, elaborate calculations of the value of their loss were made so that the Badaga could be given monetary compensation instead of land. Each holder's land, its size, rate of revenue and assessment for the five years preceding the establishment of the farm were measured. The statistics resulting from this survey clearly show that these were small plots of land, cultivated under 2–3 years' rotation. Now, long after the fields were gone, no one could clearly establish the exact boundaries of each field any longer. In the end, the government calculated the loss of profit for the land that the Badaga cultivators were assumed to have used, had they had access to it. No land was compensated for more than three years.[23]

At the same time, a similar situation was under investigation for land claimed by the Toda settlement Kandelmund, now used by government as a military cantonment. Since the government did not want to remove the cantonment, they sought an agreement with the Toda where they relinquished all claims. In contrast to the settlement with the Badaga at Ketty, here the government was careful to point out that the Toda were by no means to be considered equal to permanent cultivators:

> *…it would appear that Government consider that lands so assumed are cultivated in perpetuity, but I beg to state that so far from this being the case, lands so taken up are commonly retained for a few months, a year or more as suits the convenience of the parties, but with few exceptions occupied for any considerable time so that such lands on being abandoned revert to the Todas who have the same enjoyment of them for pasturage as formerly.*[24]

It is important to note that, while this officer observed the fact that Toda still held authority over land and land reverted to the Toda after being used for shifting cultivation, he did not recognize any 'loss of profit' during the time when it had been occupied by the cantonment. In spite of both shifting cultivation and pastoralism being non-sedentary production systems, only cultivation was considered to produce a value which deserved compensation when lost.

From the late 1830s until the 1843 regulation, the legal settlement of rights had moved away from the Nilgiris and into the revenue department in Madras. It had become a bureaucratic issue to be solved at the officers' desks. In this regulation, the government made manifest the sovereign rights of government. *'From a consideration of the universally acknowledged rights of the Government in respect to uncultivated lands, as well as to the peculiar circumstances of the case under discussion, we cannot admit the existence of*

any such proprietary right in the soil on the part of the Todas, as can in any way interfere with the right of Government to permit parties willing to pay the full assessment to bring it under the plough.'[25]

The regulation became a landmark in the Todas' right to land and natural resources. From 1843 onwards, they were only left with absolute control over the lands of their settlements and temple grounds. The government's vision for transforming livelihoods in the Nilgiris is also reflected in their decision to reserve the lands immediately surrounding the settlements from purchase. The intention was to influence these pastoralists and turn them away from non-sedentary pastoralism towards settled cultivation. Even the payment of compensation for Toda land was fixed accordingly. First of all, it was compensation for the loss of 'grazing privileges', something that did not account for more than the value of wasteland. Secondly, compensation was not to be given to the Toda directly but to the government that would set up a fund from which the Toda could withdraw money—but only if they were to undertake agricultural operations. Thus this regulation proves beyond doubt that the legal sphere was not a neutral space but an arena for strong and conflicting interests and was a means by which long term transformation of access, usage, livelihoods and rights took place.[26]

Endnotes

[1]*This text is published in Arun Bandopadhyay and Shireen Maswood, Eds, Varieties of Social History: Essays in Memory of Professor Basudeb Chattopadhyay, New Delhi.*

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[5]*Harkness, H., A description of a singular aboriginal race inhabiting the summit of the Neilgherry Hills or the Blue Mountains of Coimbatoor, in the Southern Peninsula of India, London, 1832, Hough, J., Letters on the climate, inhabitants, productions, &c., &c., of the Neilgherries, or, Blue mountains of Coimbatoor, South India, London, 1829.*

[6]*India Office Library (IOL), Madras Board of Revenue Proceedings (MBRP), 3 January 1828, To the President and Members of the Board of Revenue from J. Sullivan, Principal Collector, 2 October 1827.*

[7]*In this particular case, Sullivan had run into a conflict with the successor of Commandant Crewe, Major Kelso, which may have influenced Sullivan's request of limiting European access to land. See also the full-page article 'One Man's Ooty' in The Hindu Magazine 16 January 2005, commemorating Sullivan's 150th death anniversary.*

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[11]*Ibid.*

[12]*IOL, Madras Revenue Consultations (MRC), 1 March 1830: 2603–14, To the President and Members of the Board of Revenue, signed H.J. Chamier, Secr. to Government. IOL, Board's Collections (BC), 16 February (no. 3), 1836, Mr Sullivan's Minute, para 12.*

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[14]*IOL, Madras Despatches (MD), Revenue Department, 27 January 1836, no. 45: 7086–96, Minutes, and 21 June 1843, no.13: 51–92, Rights of the Todawars and Rules for grants of land on the Neilgherries. Cederlöf, G., Landscapes and the law. Environmental politics, regional histories, and contests over nature, New Delhi, 2008. IOL, BC, 16 February (no. 3), 1836, Mr Sullivan's Minute, para 12.*

[15]*Rivers (1873–1919), one of the founders of the British school of anthropology and among the first to emphasize the importance of gathering data through experience in intensive and well-structured fieldwork, explicitly applied an anthropological and scientifically exact method of kinship studies to the Toda. Harkness, H., A description of a singular aboriginal race inhabiting the summit of the Neilgherry Hills or the Blue Mountains of Coimbatoor, in the Southern Peninsula of India, London, 1832, Hough, J., Letters on the climate, inhabitants, productions, &c., &c., of the Neilgherries, or, Blue mountains of Coimbatoor, South India, London, 1829, Mandelbaum, D. G., 'Culture change among the Nilgiri tribes' American Anthropologist Vol. 43 (1), 1941, pp. 19–26, Rivers, W. H. R., The Todas, London, New York, 1906.*

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[19] *Pouchepadass, J., 'British attitudes towards shifting cultivation in colonial South India. A case study of South Canara district 1800–1920', in Nature, culture, imperialism. Essays on the environmental history of South Asia, D. Arnold and R. Guha, eds., New Delhi, 1995, pp, Saravanan, V., 'Colonial commercial forest policy and tribal private forests in Madras Presidency, 1792–1881' Indian Economic and Social History Review Vol. 40 (4), 2003, pp. 403–423.*

[20] *Zagarell, A., 'Gender and Social Organization in the Reliefs of the Nilgiri Hills', in Forager-traders in south and southeast Asia. Long-term histories, K. D. Morrison and L. L. Junker, eds., Cambridge, 2002, pp, Hough, J., Letters on the climate, inhabitants, productions, &c., &c., of the Neilgherries, or, Blue mountains of Coimbatoor, South India, London, 1829. IOL, MRC, 1 February 1830: 1585–93, To The President and the Members of the Board of Revenue, from Pl. Coll. of Coimbatore J. Sullivan, 31 December 1829, paras 20–1. See also Madras Government Gazette, 13 June 1822, A medical report on the Nilgiri mountains, R. Orton, Asst. Surg. Madras, 2 January 1822.*

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[25] *IOL, MD, 21 June 1843, no. 13: 51–92, Rights of the Todawars, and Rules for grants of land on the Neilgherries, para 7.*

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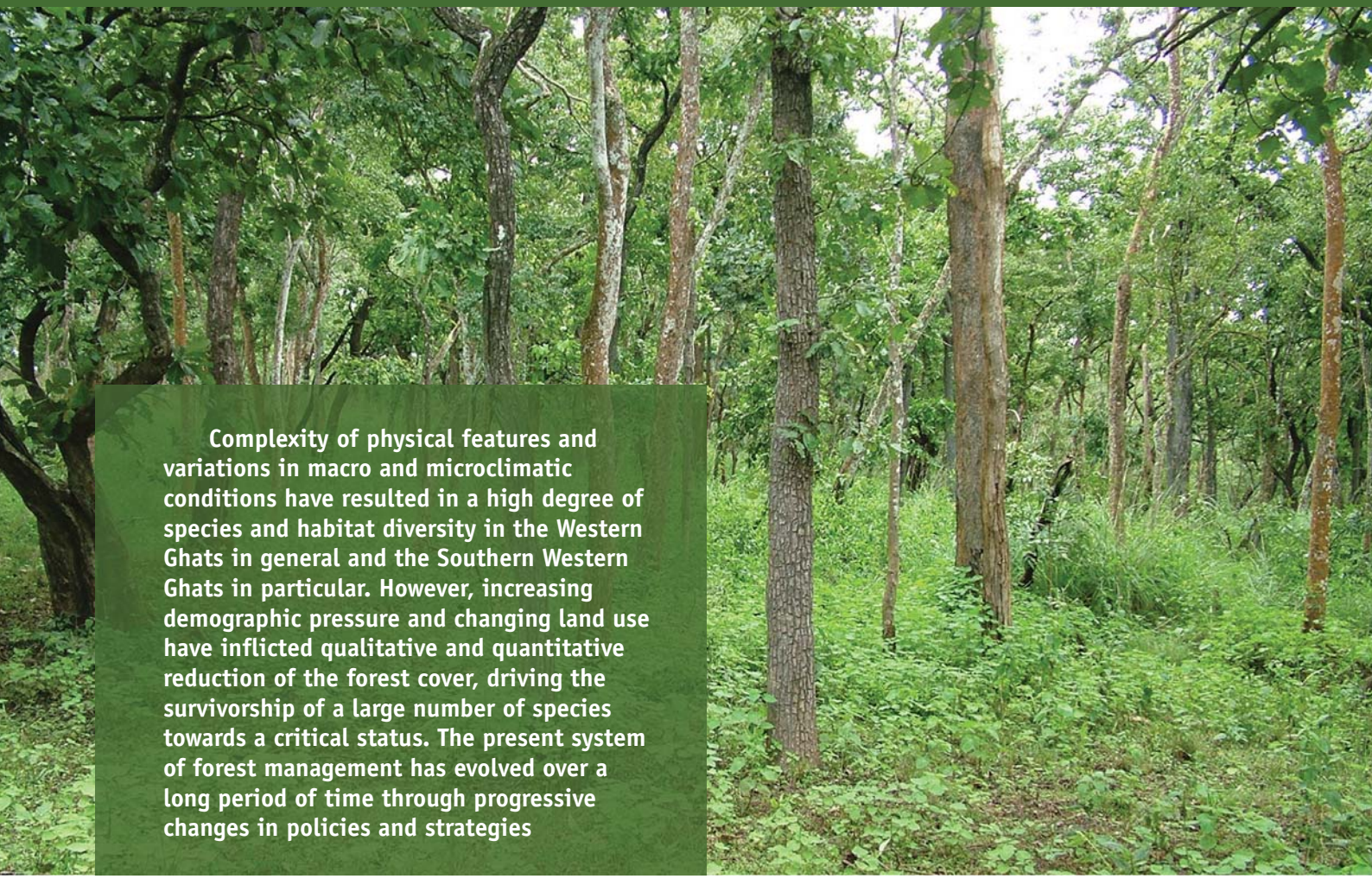
(1B) Analysis of landscape elements for forest management in the Southern Western Ghats, India

B R Ramesh and Rajan Gurukkal



Complexity of physical features and variations in macro and microclimatic conditions have resulted in a high degree of species and habitat diversity in the Western Ghats in general and the Southern Western Ghats in particular. However, increasing demographic pressure and changing land use have inflicted qualitative and quantitative reduction of the forest cover, driving the survivorship of a large number of species towards a critical status. The present system of forest management has evolved over a long period of time through progressive changes in policies and strategies

Until recently the thrust was on revenue generation with less importance given to the conservation of biodiversity and protection of the environment with people's participation. A radical shift in the policy was effected (inspired by international agreements like the Convention of Biological Diversity and the Johannesburg Summit) in the past two decades with participatory management as the key characteristic. The hallmark of these changes was the adoption of an integrated approach to biodiversity conservation with the emergence of new institutional arrangements with incentives for the local people for the joint management of forests. However, some of the existing regulations (e.g., Wildlife Protection Act, 1972) are impeding the effective implementation of participatory forest management. In order to rectify these shortfalls and to address the challenges posed by the heterogeneity in land use and the dynamics fuelled by natural and anthropogenic factors on ecosystem processes, we seek a comprehensive management approach at the landscape level.

The changes in national forest policy and shortfalls in the present management system were highlighted through studies on 'Biodiversity conservation strategy and action plans for Kerala' and 'Rationalisation

of protected area network' conducted by the French Institute of Pondicherry (FIP). The Kerala Forest Department (KFD) has thus entrusted FIP to develop an integrated management plan based on the landscape approach for selected landscape units.

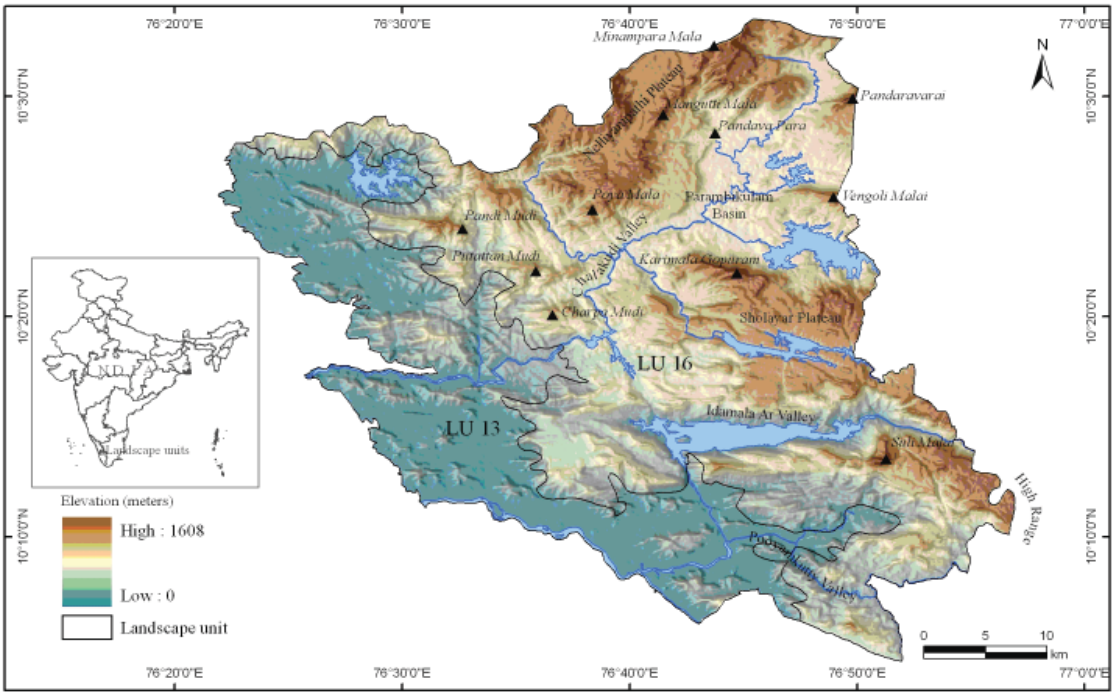
Keeping in view the present management scenario, the overall aim of the landscape approach proposed was to promote conservation of biodiversity at the landscape level and sustainable use of natural resources by communities and other stakeholders, through the development of strategic landscape planning. In order to enhance the capacity of forest managers, the scientific underpinnings of landscape level management and the consequences of spatial heterogeneity on land-management decisions are elucidated.

The study has been designed under the principle of landscape ecology where a landscape is considered as a heterogeneous area composed of a cluster of interacting ecosystems. The structure (type, pattern and spatial arrangements) of ecosystem elements is primarily determined by physical factors (bioclimate, soil, topography, drainage) and modified by human activities. As a result, a complex environment, constrained by socio-economic and cultural factors among others, develops in a landscape. Considering this concept, the landscape approach includes three major parts: (1) division of Kerala, which includes the southern Western Ghats into different landscape units (2) spatial characterisation and analysis of landscape elements, which includes biophysical and human ecological factors (3) strategies to manage the spatially derived management zones and for mitigating the threats that could be detrimental for biodiversity conservation and sustainable development.

Identification of landscape units

Delineation of the landscape units was carried out in the light of hierarchical theory in landscape ecology. A 'top down' approach starting from Peninsular India to the geographical region was first adopted based on the work of R L Singh (India – a regional geography). These geographical units were further classified into geomorphological units based on landforms and soil from National Bureau of Soil Survey and Land Use Planning (NBSS&LUP maps). The potential vegetation cover (using FIP's vegetation maps) was projected on this to derive the third scale classification, which represents the unique landscape units. In Kerala, 19 such units have been identified. Finally, two landscape units (13 and 16) in the western side of the Anamalai region (Nelliyampathi Hills) were selected for the detailed study.

Fig. 5. Landscape units (13 and 16) in the Western Annamalai region of the Western Ghats



Characterisation of biophysical factors in the selected landscapes

The selected landscape units (Fig. 5) for the study lie between 76° 21' 55" – 76° 56' 55" N and 10° 04' 21"– 10° 33' 29" E and include an area of 1837 km² with seven forest administrative units - 3 Protected areas (PAs) and 4 non-PAs. Seven reservoirs spread out in the area highlight the water harness potential of the region. The climate is tropical in nature with a sharp variation in rainfall from northeastern (3,000 to 1,500mm) to southeastern (3,500 to 5,500mm) direction. The length of dry months varies from 2 to 5 months. The presence of young soils (Inceptisols) in association with steep slopes and high rainfall indicates the vulnerability of the study area to soil erosion and siltation of rivers.

The analysis of the land cover and the biological and human ecological matrix reveals the habitat complexities, richness in biological repository and ethnic and cultural values of the area. The land cover and land use map prepared using GIS and satellite data indicates the presence of 72% of natural vegetation and the rest with forest plantations (mostly teak), commercial crops (coffee, tea, cardamom, rubber etc), water bodies and settlements. Among natural vegetation, three primary evergreen forest types (*dipterocarp* type at low elevation and *cullenia* and dry fringe types at medium elevation) cover 22% and dense moist deciduous forests represent merely 3% of the study area. The presence of 47% highly disturbed evergreen to semi-evergreen forests in the form of small fragments and other degraded formations (woodlands, scrubs, thickets, tree savannas and fallows) indicates the prevalence of anthropogenic pressures especially in the fringe areas.

A total of 1,835 species of flowering plants (which account for 39% of the species found in Kerala) have been recorded from different floristic works conducted around the study area. Most of these species have potential value as medicinal, Non Wood Forest Products (NWFP), timber and industrial raw materials. Among these, 437 species are endemic to the Western Ghats. Out of the 60 endemic genera in the Western Ghats, 14 are found in the study area. According to International Union for Conservation of Nature (IUCN) categories 144 species are listed as rare, endangered and threatened.

The stand structural and floristic compositional diversities of vegetation types were studied using 146 sample plots of 0.1ha each. From the sampling plots, 436 woody species were recorded. The most dominant species are *Xylia xylocara* in deciduous forests and *Palaquium ellipticum* in evergreen forests. The multivariate and regression analyses of the database using parameters like density, basal area, species richness, diversity and endemism have showed the qualitative and quantitative changes particularly in phenological (primary and secondary evergreen species and deciduous species proportion) and stand structural (basal area and density) characteristics across different vegetation types as well as along the disturbance gradient of each type.

The vertebral faunal wealth of the landscape unit is evident from the 49 species of mammals, 336 species of birds, 70 species of reptiles, 34 species of amphibians and 81 species of fishes recorded from the area. Among the vertebrate taxa, the maximum species richness is in birds (70% of the species found in Kerala). Among the endemic species of the Western Ghats occurring in the State, the study area possesses 6 (50%) species of mammals, 15 (94%) species of birds, 28 (41%) species of reptiles, 17 (27%) species of amphibians and 43 (71%) species of fishes. According to IUCN, out of the 49 mammals, 15 are among the rare, endangered and threatened categories. Similarly 6 species of birds, 16 species of reptiles, 10 species of amphibian and 28 species of fishes also belong to different IUCN categories.

The distribution and abundance of selected faunal species indicate that species such as elephant, gaur, sambar, Malabar giant squirrel and leopard are widely distributed, while tiger, sloth bear, lion tailed macaque, great Indian hornbill and Nilgiri langur are restricted in distribution either because of anthropogenic pressures or due to habitat alterations. Nilgiri tahr, another endangered species, which inhabit the unique montane grasslands are found to occur in 12 locations.

Human ecological appraisal and forest resource utilisation

Human ecological and stakeholder analysis includes an appraisal of the existing population,

Fig. 6: A typical Muthuvan tribal family

their history of settlement in the study area and the nature of their dependence on the forest for livelihood. The two distinct human ecological situations are the forest dwelling adivasi groups and fringe area non-*adivasi* settlers. The former is constituted of groups such as Kadar, Malasar, Malamalasar, Malayan, Mannan and Muthuvan (Fig. 6). About 90% of the adivasi population reside within the forest territory out of which 70% belong to Muthuvan, Kadar and Malayan tribes. Communities such as Kadar, Malasar, Malamalasar, and majority of the Malayan population are landless or nearly landless. The main sources of income of these communities are from collection and sale of NWFPs, agricultural products, and manual labour. Muthuvan and Mannan practice settled cultivation. The forced shift from slash and burn to settled cultivation has also changed the pattern of labour distribution at inter and intra household levels. The exposure of *adivasi* population to non-*adivasi*, influence of market and increasing control of the state on forests have marginalised and weakened the traditional institutions and forced them to access modern technology. Hence *adivasi* like Mannan, Malayan, Malamalasar, Malasar, and Kadar are in a disintegrated state with very limited remnants of tribal institutional and cultural ties.

The fringe area population is characterised by heterogeneous groups of in-migrant settler households and the market is the most influential factor that patterns their landuse. Their main source of income is either wage labour in corporate plantations or small-scale agriculture. Lemon grass, pepper, tapioca, paddy etc. were the prevalent crops during the early decades of the century. This was subsequently modified to rubber, pineapple and other cash crops. The three prominent landuse patterns in the fringe area are (i) contiguous forest tracts of adjacent forest divisions within and across the state borders, (ii) small to medium sized holdings cultivated with a mix of cash and food crops, and (iii) large plantations of coffee, tea, cardamom and rubber. Some of the fringe area settlements developed over time as a result of encroachment by in-migrant population and resettling of Second World War Army personnel. The increase of accessibility because of road and plantation development has brought encroachers into forested areas such as Injathotti, Thattekkad, Kuttampuzha, Urulanthanni, Pooyamkutty, Pinavoor, Elamblassery and Mamalakkandam. During 1920s, following a steep increase in the price of lemon grass oil, in-migration for cultivating the 'waste lands' with lemon grass caused deforestation and colonisation in the fringes of the Malayattoor forests.

The NWFP collection and marketing, one of the main economic activities of the tribal population is organised through cooperative societies and coordinated by the Federation of Scheduled castes/Scheduled tribes (SC/STs). There are 49 items of forest produce, derived from 47 species of plants and 2 species of animals, collected and marketed from the forests of the landscape during the study period. Among these items, produce from 27 species of plants and 2 species of animals are marketed through cooperatives. The largest consumer of the forest produce is ayurvedic medicine manufacturing units which consume about 33% of the total quantity collected from the area. Among the items marketed through cooperatives 10 are underground parts, 10 fruits or seeds, 2 barks of trees, and 2 are resin. The plants collected and marketed by the private vendors are medicinal herbs where either the entire plant or their tubers and roots are utilised. Among all the items collected only 14 are available throughout the year.

Approximately 236 tons of biomass worth rupees 6 million is extracted from the study area in the form of NWFP by the tribal cooperatives operating in the landscape. The 13 items such as *cheenikka, kattupadavalam, kasthurimanjal, thelli, pathiripoovu, padakkuzhangu, elakka, nannari, koova, marottikkuru, edanappoovu* wild honey and wax contribute to approximately 98% of the total revenue. Out of the 47 plant species of NWFP, 30 are either uprooted or subjected to fatal injuries during normal harvesting. Bark, fruits and resin are the major products obtained from the trees. In case of *Symplocos, Sterculia* and *Cinnamomum* the whole tree is debarked to collect the bark. In case of *Canarium strictum,* the resin is collected by inflicting injuries on the bark of the mature tree. The unsustainable harvesting practices, categorised by a complete removal of local population, destructive harvesting, and early harvesting has drastically reduced the availability of certain resources (e.g., black dammar).

The cooperatives, that are controlling the marketing of NWFP are a failure due to the following reasons (1) the members of the society (tribal collectors) are treated as wageworkers (2) conservation of the resource base and its regeneration is not a concern to the society (3) societies do not invest adequately to improve the quality and capabilities of their human resource (4) the prices offered by the private agents to the collectors are more than the prices offered by the cooperatives resulting in reduction in the market share of the cooperatives (5) underutilisation of opportunities for semi processing and local value addition and (6) collection and marketing of only a limited number of items which are traded in larger quantities, because of a ready market.

Reed is another raw material collected by traditional and modern industries in large quantities from the landscape unit. 82% of the total extraction is done by Hindustan Newsprint Ltd. (HNL) and the remaining is by the Kerala State Bamboo Corporation (KSBC). The average annual extraction of reeds by both these agencies during 2001-2002 to 2003-2004 from the landscape amounts to approximately 25,670 metric tons. The HNL organises their extraction through the contractors and the KSBC directly. From the year 1986 onwards a closure period of three months from July to September is observed in the reed collection. The reed extracted from the landscape unit divisions during the 2002-2003 and 2003-2004 accounted for 35 and 32% of the total annual requirement of the HNL in the respective years.

There are a total of 41 *Vana Samarakshana Samitis* (VSSs) and Eco Development Centre (EDCs) belonging to the *adivasis* and non-*adivasis*. Nine of them are EDCs in the wildlife sanctuaries and 32 are VSSs in territorial divisions out of which 19 are NWFP based tribal VSSs and the remaining 12 are fringe area VSSs. These 41 institutions bring together a total of 9,867 individuals from 3,765 households under Participatory Forest Management (PFM), of which approximately 32% (3,125) belong to *adivasi* communities, 9% (913) to Scheduled castes and the remaining 59% of the members are fringe area non-*adivasi* population.

The total area of forestland earmarked for joint management in the landscape unit is about 550 km^2. Out of this, 95% (520.61 km^2) is allotted for tribal VSSs and the remaining for non-tribal VSSs, i.e., the tribal institutions, while having only 31% of the total population under the PFM have nearly 95% of the total land under the programme. The per capita forestland allocated for fringe area VSSs for joint management is strikingly small as compared to that of the tribal VSSs.

Landscape management plan and institutional mechanism

A review of administrative infrastructure, tools and appraisal of management constraints was carried after analysing the values of landscape units before delineating the management zones. The review of infrastructure indicated that PAs are better equipped in terms of surveillance facilities such as vehicle, arms and ammunitions and other accessories compared to non-PAs. The overall analysis of management constraints (problems/threats) indicated that there are more than 30 issues that influence management of forests in this region. Some of the major issues identified are fire, poaching, cattle grazing, human-wildlife conflicts, illicit distillation, *ganja* cultivation, firewood collection, exotic weeds, etc. In addition to this there are logical issues like lack of funds, staff, political interference, etc. Because of these reasons the management activities are remarkably similar in both PAs and non-PAs.

A review of legal and policy environment pertaining to forests, natural resource management and environment protection was carried out. It could be concluded that even in the context of peoples' participation in the management of forests, instead of decentralisation, centralisation is the theme of policy documents.

Taking into consideration the values, constraints, existing status of forest administrative units in the landscape and the overall objective of this management plan, i.e., biodiversity conservation and sustainable utilisation of resources, two categories of management zones such as value based management zone and constraint based management zone were delineated. For each

management zone, the prevailing threats and mitigatory measures were also suggested. The value based management zones are biodiversity conservation zone, resource zone (teak, bamboo, reed and non-wood forest produce) and soil and water conservation zone. In case of constraint based management zones, all the constraints or management issues hitherto identified have been described with strategies and actions. Spatially, zones have been identified for fire protection and restoration.

Since the landscape is part of one of the centres of species endemism in the Western Ghats, a zone of conservation was delineated so that the whole range of biodiversity is represented and the habitats of critically endangered species are included. The main objective of the zone is to conserve and maintain biological richness with special emphasis on Rare, Endangered and Threatened species, unique habitats such as marshes and swamps and to ensure habitat representativity, ecological integrity and connectivity. The area included in this zone is the primary evergreen and moist deciduous forests in existing PAs and non-PAs. The extent of habitat included under this zone from the non-PAs is more than that of PAs. The focus theme of the strategies and actions are participatory, involving PFM institutions in protection measures, restoration activities, eradication of weeds and monitoring programmes.

The resource (teak, bamboo, reeds and NWFP) zones are designed to extract the resources under the principle of sustainable forestry to meet the local and industrial requirements and to bring ownership in conservation and management among different stakeholders. Teak management zone represents the teak plantations and other zones are characterised by the preponderance of respective key species, for example, different species of bamboo in the bamboo management zone and *Ochlandra travancorica* in the reed management zone. It was emphasised while drawing out the strategies that the extraction of these resources should be carried out only through PFM institutions and a flawless monitoring protocol should be developed and implemented with the help of the local people. Moreover, periodic assessment of the resources should also be carried out by involving local PFM institutions. Regarding the strategies for NWFP management, thrust is on the need for training the local people in collection and value addition of the NWFP.

Soil and water conservation zone is demarcated based on the erosion proneness (slope, type of soil and land cover) of the area and vegetation around the streams. The strategies and actions include restoring the degraded land and avoiding forestry activities other than regeneration on the steep slopes (>200). Moreover a stream bank management policy is recommended.

The constraint based strategies and actions are meant for mitigating the general management problems that are present in other management zones also. However separate and theme based efforts should be taken in the case of illegal activities such as poaching, illicit felling, and *ganja* cultivation with the assistance of PFM institutions. In the case of fire management zone, which is largely represented by degraded areas near the human habitation, a proper fire reporting system and utilisation of modern fire alarm and detection tools have been suggested in addition to the traditional control methods.

The degraded forests in the landscape unit have been delineated as a restoration zone and the major strategy is to restore the area with the help of PFM institutions. Since most of these areas are adjacent to human habitations, the demands of the local people for small timber may also have to be met from these areas. Hence the focus is on restoring these areas to cater to the needs of the local people without compromising on the principles of restoration ecology.

These management prescriptions envisaged in the plan necessitates the involvement of all stakeholders apart from the Forest Department. Since there are multiple claimants for the same resources, conflicting interests exist. In order to resolve these conflicts, the implementation and monitoring mechanism involving all the departments and local level institutions is also suggested.

(1C) Biodiversity and livelihoods in the NBR - what is happening ?

Snehlata Nath and Rev P K Mulley

Abstract

The Nilgiri Biosphere Reserve created in 1986 spurred a great deal of interest and greater concerns on the biodiversity of the region and the livelihoods of indigenous people, groups inhabiting this region. A tentative list of about twenty ethno-linguistically identified groups of people was drawn up. It has always been felt that these groups continued to be marginalised within the emerging socio-economic and political structures straddling across the states of Tamil Nadu, Kerala and Karnataka in South India. A bold initiative of those responsible for the creation of this biosphere lay in the establishment of boundaries transcending politico-administrative units.

Considering the large number of people groups and their habitats in this region it has been a challenge to bring about a new vision of environmental responsibility. The rights of the indigenous communities to manage and control the resources they depend on have their own historical sequence. In terms of sheer numbers these vulnerable groups are small. Except for communities like the Irulas, Paniyas and Kuruchiyars, the rest of the communities number less than 20,000 each. Many of them are food gatherers (if not hunter gatherers). Some small scale cultivation or agriculture was familiar to many of these groups. But the onslaught of monetary economy in the region altered their strategies and degree of interaction with swarming immigrant population.

With the British Expansion came the extraction of forest resources and their commercial exploitation. Now the authenticity of the subsistence livelihoods of these people came to be challenged by an ambitious value system of a new kind of economy. This resulted in an overlap of several spheres of influence between their autonomy and what was propagated as their progress. The world view of these peoples, epitomised in their allegiance to the biodiversity of their environments, has

become exposed to new styles of management from a social, political and administrative point of view. The long time mutual knowledge of each other among these different groups sharing the same environment of biodiversity is therefore what needs to be analysed and applied in the Nilgiri Biosphere Reserve.

Introduction

The Nilgiri Biosphere Reserve created in 1986, spurred a great deal of interest and greater concerns on the biodiversity of the region and the livelihoods of indigenous people, groups inhabiting this region. This paper provides a socio-cultural background to the work undertaken by the`Bees, Biodiversity and Livelihoods' (BBL) project based in the Reserve. It also gives a glimpse of the historical changes in this region which essentially changed land, community and governance dimensions. This has in turn influenced biodiversity and livelihoods of indigenous people of the area. The sites selected in the project tried to capture contrasts of bio geography and the ethnic diversity in the region. Historically, the region has been acknowledged for its complex diversity in the natural regime as well as the specific symbiotic relationship amongst different ethnic groups of the region. The sites selected for this project are represented in Table 1 and the subsequent text discusses the socio-cultural differences and similarities in this area.

Biodiversity, land and community

The Nilgiris, forming a part of the Nilgiris Biosphere Reserve (NBR) in the Western Ghats is home to moist, dry, evergreen and montane (shola) tropical forests. The Western Ghats, and the Nilgiris in particular, harbour a wealth of flora and fauna: mammals, birds, reptiles, amphibians, and fresh water fishes, most of which are endemic to the region. The NBR is 0.15% of India's land area and has 20% of all angiosperms, 15% of all butterflies and 23% of all vertebrates. Of the 285 endemics in the Western Ghats, 156 (55%) are in the NBR (Daniel 1993). The NBR is very rich in plant diversity. About 3,200 species of flowering plants can be seen here of which 132 are endemic to the reserve. Of the 175 species of

Table 1. Sites selected for the Bees, Biodiversity and Livelihoods Project

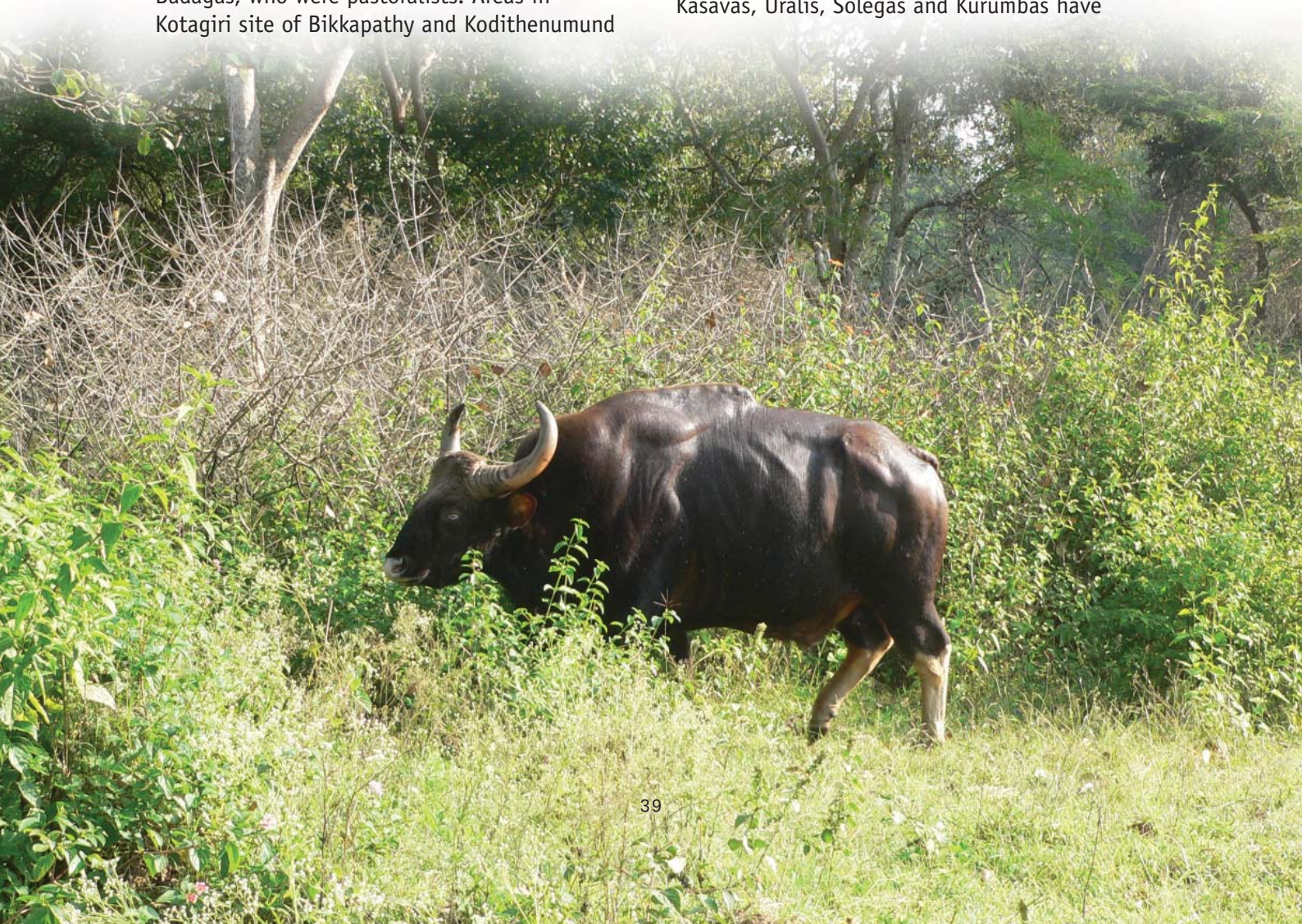
Management Divisions (State)	BBL Location Names	Elevation Range m.a.s.l	Forest Type	Indigenous communities
Chamrajnagar and Satyamanagalam (K&TN)	Chamrajnagar	1000 - 1200	DDF, MDF, Shola, SEG	Sholiga, Irula
Nilgiris North and Coimbatore (TN)	Coonoor	500 - 1400	MDF, DDF	Kurumba, Irula
Nilgiri North (TN)	Kotagiri	1800 - 2200	Shola	Badaga, Toda
Mudumalai and Nilgiri North (TN)	Mudumalai Sigur/	900	DDF, Scrub, MDF	Kattunaicken, Irula, Jenu Kurumba
Nilambur South and Nilambur South (K)	Nilambur	800 - 1200	SEG, MDF, DDF	Cholanaicken, Pathinaicken, Kattunaicken

orchids found here, 8 are endemic. The fauna of the NBR includes over 100 species of mammals, 350 species of birds, 80 species of reptiles and amphibians, 300 species of butterflies and innumerable invertebrates. 31 amphibians and 60 species of reptiles that are endemic to the Western Ghats also occur in the Nilgiri Biosphere Reserve (Daniels, 1996).

The rich flora and fauna has resulted in declaring several areas as protected which include the Nagarhole, Bandipur, Muthanga, Mudumalai, Mukurthi and Silent Valley regions. Besides, areas like the New Amarambalam Reserve Forests are rich repositories of biodiversity (Daniels, 1993). It is said that the Nilgiri *shola* and grassland vegetation complex has not changed significantly for the last 30,000 years (Prabhakar, 1994) but that does not mean that no land use changes have taken place. Over the years there have been commercially generated changes in land use practices, most of them altering the biodiversity of the region.

Before the advent of the British in 1819, land was used for grazing by the Todas and Badagas, who were pastoralists. Areas in Kotagiri site of Bikkapathy and Kodithenumund were pasture lands for the people. Agriculture was done by the Badaga community who grew millets and a variety of cereals. Special importance was given to growing food crops like *Ragi (Eleusine coracana)* and *Ganje* (Barley), which were also exchanged for other goods and services from different communities. Other pre-agriculture communities like Kurumbas, Kattunaiken, Kasava, Jenu Kurumba etc. primarily depended on the lower forests for survival, though they were linked to upper areas for medicinal plants and other forest produce like thatching materials and bamboo.

The corridor zone below the northern slopes of the Nilgiris, along the Moyar river valley, presents a picture of fractured and fragile cultural linkages. This is an area where history, sort of, stood still. The Forest Department named this region Sigur, though, according to epigraphical sources it goes back to about 11th century AD. What happened in this region is not very well known. Despite its close proximity to the Mysore dominion, the ecological and historical changes that have occurred in this buffer zone remain largely unknown. A big question is, did the indigenous people like Kasavas, Uralis, Solegas and Kurumbas have



a relationship of mutual dependence with the Badagas and Toda of the uplands, as indicated in early British documentation? It is true that the Kasavas were looking after more than scores of Badaga pastoral camps in this region, but what determined this historical symbiosis largely remains untraced.

It should be noted that the present day Mudumalai, prior to its conversion into a sanctuary was inhabited by Mountaden Chettis who had fairly extensive cultivation practices. Now there has been an artificial change brought about in the landscape. Consequently not only these Chettis but also the Kurumbas and Kattunaickens, who had shared the same habitat have become refugees in their own land. Therefore the governance of such landscapes could offer more options for a different kind of biodiversity management. With the advent of the British, these relationships and structures changed due to imposed land use alterations and workings in the forests. There was teak, rosewood, other timber logging in the Mudumalai forests from 1857 to 1963 – removing an estimated 4,116,370 cft of timber (Sekar, 2004). This also meant that many indigenous people became logging workers and shifted from their original villages. In 1977, Mudumalai was declared a sanctuary, however, removal of species stopped in 1980 (Sekar, 2004). This continued destruction of the forest and added restrictions of the protected area declaration have only led to further alienation of the people from the land. Similar situations happened in different parts of the NBR. In Nilambur, even today Mundakadavu Kattunaickens are logging workers, maybe earning more money but losing their socio-cultural and forests linkages. Even settlement names like Mel Koop and Kil Koop in Kotagiri area, were derived from a history of logging operations in that area.

With the extent of changes and destruction of the forests, movement of indigenous communities, alienation from land and traditional boundaries has taken place. The forest is not what it used to be – foraging and making a living out of it has become impossible. According to a Badaga proverb, "forest as a foster land has now become a barricaded domain". Here, the changes and existing governance altered the equations

of resource control – from a free access to a monitored, controlled and hierarchical one. Forest governance played a big role in alienating people from their land and forests and making them part of the monetary economy.

Another policy of the then British Government that ruined biodiversity and changed once and for all the *shola*-grassland ecology was the introduction of exotics – wattle and *eucalyptus*. These covered the grassland and colonised large areas quickly which over time made it more and more difficult for the Todas and Badagas to graze herds of buffaloes. Since then the Toda people adapted to a `settled' life with land being `given' by the government. Today they have agricultural land, which they have leased out to plains people and their buffaloes, which they have to maintain for religious/cultural reasons, graze on nearby lands and eat agriculture produce. Badagas adapted to the changes and took up agriculture of potato and other English vegetables and later to tea cultivation. They also became educated and later were absorbed into mainly government jobs – as can be ascertained from one of the field sites – Tuneri in Kotagiri location.

The introduction of other plantation crops like tea in 1839, and its spread after 1869, when it was only 200-300 acres spread, but by 1876 the extent rose to about 7000 acres (Grigg, 1880: 513-4) and by 1940 the extent of tea in Nilgiris was 19,733 acres. After independence the extension really increased and by 1996 it was 63,746 acres (Sekar, 2004). These plantations also attracted labour from the plains and increased in-migration into the area. The establishment of TANTEA by the Forest Department to secure the livelihood of 2,455 repatriated families from Sri Lanka is an important landmark, as it covers a large 3,734 ha of land (Sekar, 2004). These erstwhile forest areas have been home to indigenous people and this influx of a different community also changed the socio-cultural environment forever in the hills.

Pre-agriculture communities and gathering

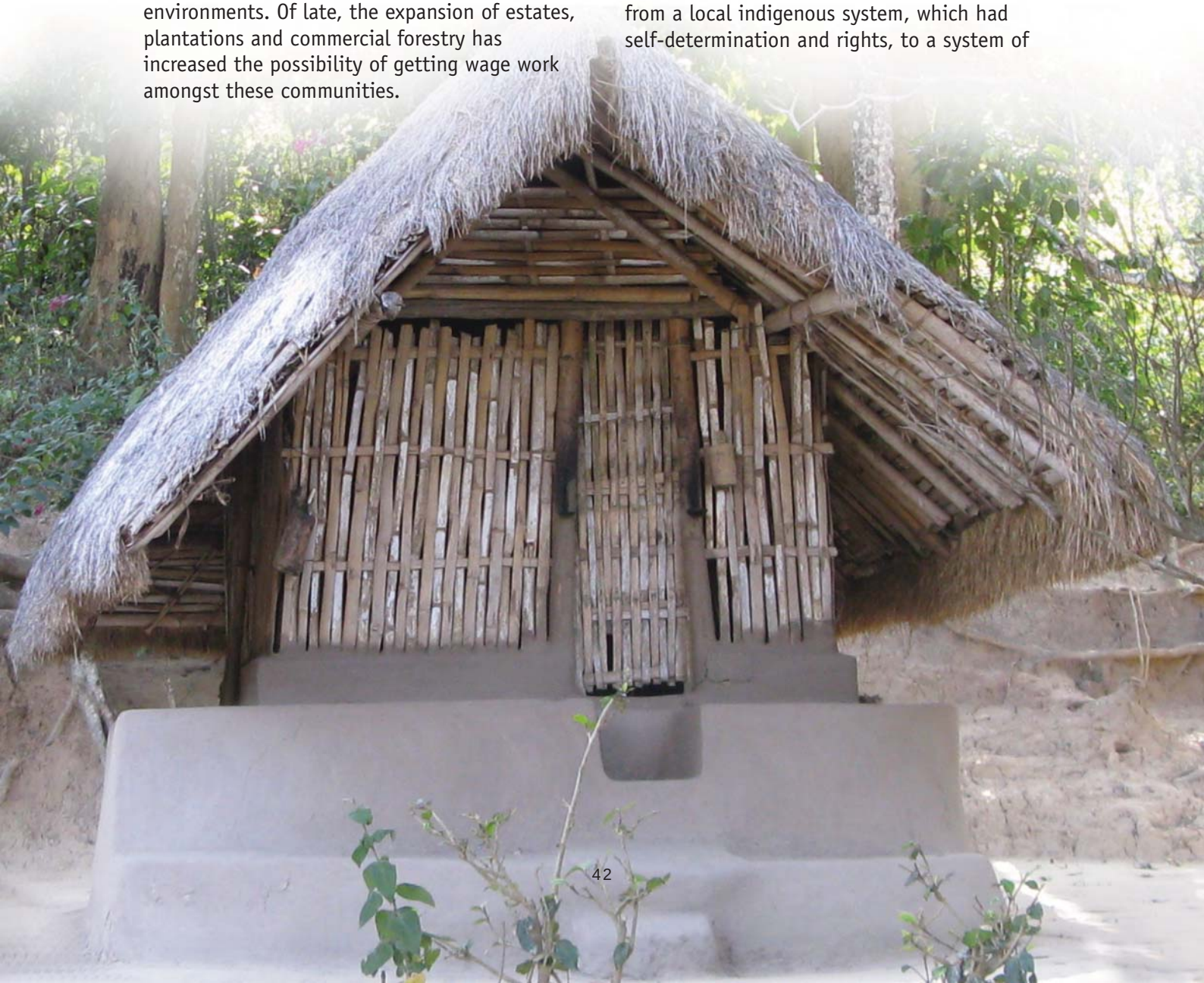
Of the 36 indigenous communities known to reside in NBR, about 14 have been assessed to have been traditionally involved in the collection of honey, although this is of varying significance in the livelihoods of these different communities. 12 of the 14 indigenous communities have been classified as hunter gatherers and it is these communities that are particularly active in wild honey and NTFP collection. The other 2 communities, Todas and Paniyas, are respectively pastoralists and agricultural labourers under their Chetti overlords.

Of the sites selected in this project it is interesting to see the dominant presence of these people. They live in forested areas and have a cultural linkage to the forest, besides a direct livelihood benefit. In older times, even as late as the 1960s, these communities bartered forest produce for grain. The system has now changed and in some cases, like the Nilambur site of Mancheri, the Cholanaickens exchange their forest produce for rice, salt, oil, from the co-operative society. As some of the few hunter-gatherers still following their old way of life, these communities depend most of the time on forest produce both for the market and for their own food and medicine. In other adjacent communities like the Kattunaickens, forest dependence has now reduced significantly as most people opt for wage labour and are beneficiaries of several government and private facilities like hospitals and schools. Likewise, variations exist amongst other communities, depending on location and surrounding environments. Of late, the expansion of estates, plantations and commercial forestry has increased the possibility of getting wage work amongst these communities.

Governance and impacts

The history of bio-diversity management in the Nilgiri Biosphere Reserve has been chequered. Tamil Sangam texts of about two millennia ago refer to Wynaad and also mention that a Chera monarch sub-divided lands for cultivation and granted a sort of tenancy rights to the aboriginals of the area. There is also an 8th Century AD copper plate grant issued by the Ganga ruler, Sri Purusha which mentions Gudalur and the environs as containing lands fit for cultivation of rice and grains, garden lands and forest lands fit for the cultivation of drugs and pepper and fourteen villages. Subsequently, the history of Malabar chiefdoms may also contain a lot of such information on biodiversity management.

A series of historical changes also reflect the governance of the NBR, which moved from a local indigenous system, which had self-determination and rights, to a system of



management and monetary emphasis which was unfamiliar to the local people of the hills. The current governance also continues to be moving on the premise that increased incomes and infrastructure equals development, whereas for these hill and forest systems new approaches may be necessary. In conclusion, it may be said that the importance of the Nilgiri Biosphere Reserve is not only bio-geographical, but also socio-cultural and any intervention needs to take this into consideration. An ancient symbiosis and long time relationship that exists between these communities and their specific niche environments, needs to be kept in mind in the NBR. The drawing of the boundaries for the purpose of governance must be sensitive to socio-cultural dimensions and in this case, especially since it concerns a host of indigenous communities.

Endnotes

[1] *National Bureau of Soil Survey and Land Use Planning*

[2] *Protected Area*

[3] *Non wood forest product*

[4] *International Union for Conservation of Nature*

[5] *Scheduled Castes / Scheduled Tribes*

[6] *Vana Samrakshana Samithi*

[7] *Ecodevelopment Center*

[8] *Participatory Forest Management*

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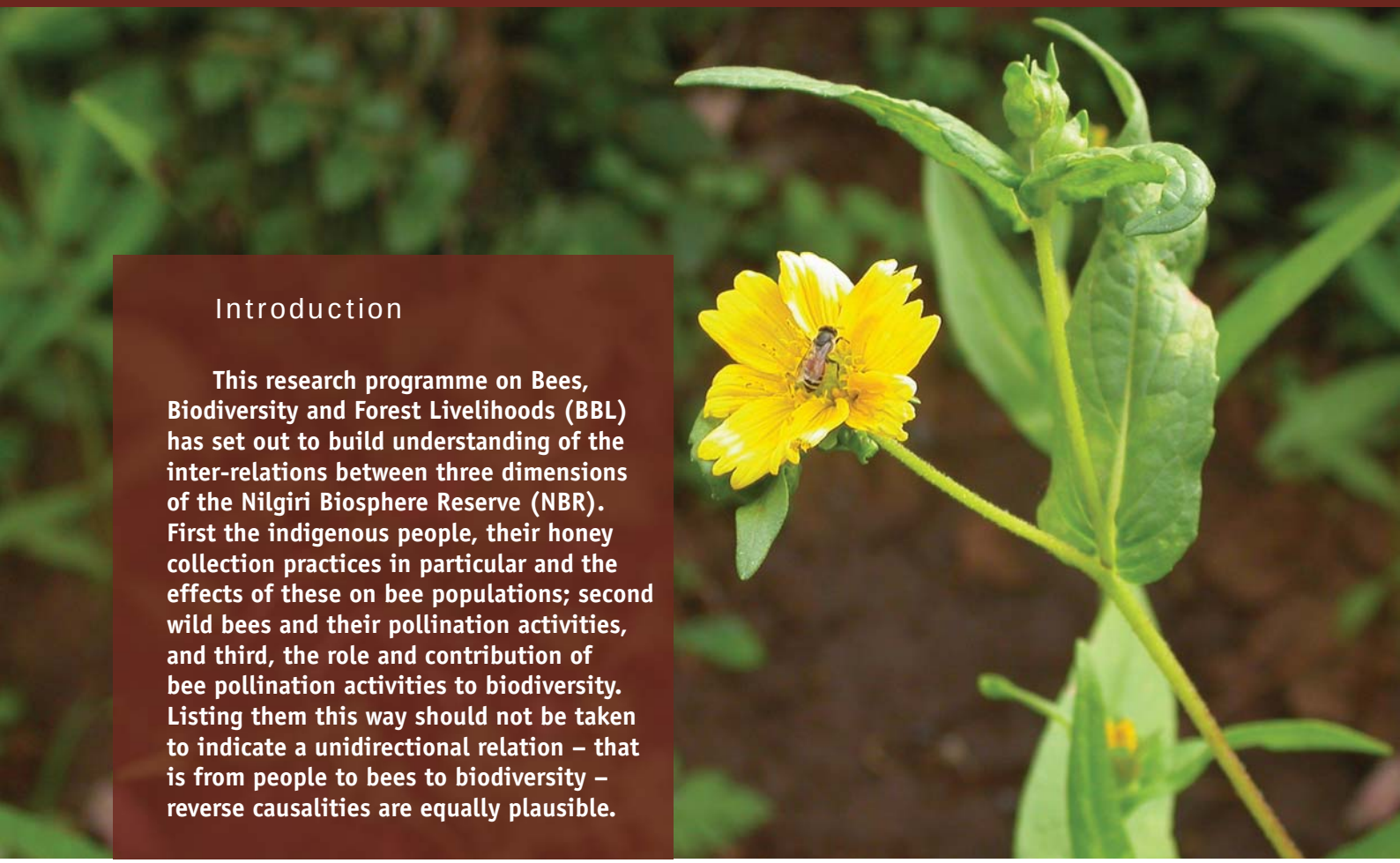
(2)

BIODIVERSITY/BEES/ LIVELIHOOD LINKAGES

(2A) Researching Livelihoods, Bees and Biodiversity Linkages

Adam Pain



Introduction

This research programme on Bees, Biodiversity and Forest Livelihoods (BBL) has set out to build understanding of the inter-relations between three dimensions of the Nilgiri Biosphere Reserve (NBR). First the indigenous people, their honey collection practices in particular and the effects of these on bee populations; second wild bees and their pollination activities, and third, the role and contribution of bee pollination activities to biodiversity. Listing them this way should not be taken to indicate a unidirectional relation – that is from people to bees to biodiversity – reverse causalities are equally plausible.

Previous studies (Keystone Foundation, 2007) have indicated that bees and non-timber forest products (NTFPs) are a resource for indigenous people of the NBR within which the research has been carried out. However the significance, both social and material, and role of these as resources has been far from clear. Equally the bee species from which the honey has been collected have not been scientifically identified or classified, their populations and distribution are unknown and the role in pollination and maintenance of forest biodiversity has not been studied. This research project has therefore attempted to combine participatory livelihood analysis with collection of scientific data about the status of these indigenous bees and their ecology, and the links of this to biodiversity creation and maintenance.

Interdisciplinary research of this nature raises numerous conceptual and methodological challenges as well as practical ones. Part of the issue is the difficulties that interdisciplinary research faces in dealing with qualitative complexity – that is the enormous spatial and temporal variability of ecological systems in the NBR that are in dynamic flux, and the moving non-linear target of socially differentiated livelihood trajectories. Linked to this the knowledge frameworks that drive different disciplinary practices – from biology to ecology

to social anthropology and sociology – are structured with almost mutually incompatible underlying theories, values and methods that challenge, to put it mildly, cross- (let alone inter-) disciplinary research. Different knowledge frameworks lead to different research models in terms of the definition of the problem, understandings of realities and the research methods and data requirements that are used to investigate the issue, although normative science has a tendency to privilege certain knowledge frameworks over others. Even within disciplinary practice debates rage between methods and approach that draw more on normative scientific method (largely deductive in approach and method) and those that challenge or question the positivist tradition of certainty over facts and measurement. On the practical issues, given the resources and time frame of a research project of this nature - and in every sense they have been modest given the task - the question has been how best can one deploy resources and locate activities to even begin to build understanding of these dynamics and deal with the challenges of inter-disciplinary research?

This paper is a preliminary exploration of some of these issues of method and approach as a basis for explaining the case study approach that the research project has followed. It first briefly outlines some of the theoretical challenges, and then discusses some of the issues of working with different knowledge frameworks relevant to the project's research and the debates within them. This leads to a final section on the site selection processes and a discussion of the ways in which data and understanding generated from each of these sites may contribute towards more generalised statements about livelihoods, bees and biodiversity linkages.

Theoretical challenges

This research project is fundamentally about the relations between poor people and natural resource management. It aims specifically to build understanding of the significance of biodiversity to the diversified livelihood activities of poor people and the potential effects of indigenous people's activities on the conservation of natural ecosystems. In this sense it is of direct relevance to the broader policy agenda of linking poverty alleviation with biodiversity conservation. But as Agrawal and Redford (2006) have argued, much of the literature on programmatic interventions e.g., policy responses designed to jointly address poverty alleviation and biodiversity conservation have worked with very limited and simplified understanding of poverty and biodiversity. These assessments have been determined more by what can be measured rather than attempting to investigate the complexity of these dimensions as evidenced by the theoretical literature. Thus poverty has tended to be defined and measured simply in terms of its material dimensions while a focus on income and biodiversity has been characterised in terms of species diversity, often reflected in the presence or absence of indicator species or groups (Agrawal and Redford, op.cit: 29). In addition, these studies have generally paid little attention to history and context and accordingly have offered little scope for generalisation beyond the empirical case study.

As Agrawal and Redford (op.cit: p33) rightfully note, this requires a rethinking of the research agenda. They go on to say:

"What is even more troubling is that if the most widespread and frequently used analytical approaches to understand and document the relationship between poverty alleviation and

biodiversity conservation continue to be used, it may not be possible to throw greater light on this relationship. Case study approaches based on evidence that is collected from a single time period and without careful and systematic consideration of the causal mechanisms at play are ill suited to generate policy relevant insights into the tradeoffs between poverty alleviation and biodiversity conservation."

They conclude that *"new studies will need to focus on the dynamics of the relationships between various measures of poverty and biodiversity, and on how these dynamics are affected by macro-social and political variables such as education, demographic change, levels of unemployment and technological change among others. Without greater attention to change over time, the goal of policy relevant understanding of the relationship between biodiversity and conservation and poverty alleviation is likely to remain chimerical".*

Agrawal and Redford's analysis relates to the assessment of project interventions designed to reconcile poverty and biodiversity objectives but their questions and research agenda are of direct relevance here. While this research has not specifically used instruments of intervention to explore livelihood-biodiversity interlinkages, it has worked within a context where multiple dynamics are at play, including the effects of Keystone programmatic interventions.

This research is fundamentally concerned with exploring cause-effect relations and the interactions in a complex system but it also has to work with considerable theoretical challenges. At a general level there are questions of theory and method related to the question of *"how you know what you think you know"* (Sayer, 1992, 2000). Method is as driven by theory as theory is by method. If these are linked to the challenges generated by complexity theory and chaos in complex systems – and the NBR has to be recognised as an extremely complex system – then certainties about cause-effect relations that are stretched over time and space indicate how difficult it is to know what the variables are and how they interact since measurement at best is only partial.

Uncertainties over biodiversity

Consider for example general ecological theory. There has been a long tradition in

ecology that has worked within a normative framework of ideas of equilibrium and balance, functional order, linear change and homeostatic regulation of systems and stable equilibrium points. These have underpinned succession theory in vegetation, models of population dynamics with their assumptions of definable carrying capacities, maximum sustainable yields and ideal management regimes (Leach et al., 1999). But this normative framework, which still arguably drives much ecological research, is under challenge from an ecological perspective that is concerned more with micro-variability and dynamic changes over space and time, non-equilibrium systems and scale relationships in ecosystem analysis. It also emphasises the importance of history in understanding the present status of ecosystem dynamics, a point that is deeply relevant to the NBR.

If one moves more specifically to defining and measuring biodiversity the issues can be explored more specifically. Following Redford and Richter (1998) and Agrawal and Redford (2006) biological diversity can be characterised in terms of its components, the three dimensions of which can be assessed by attributes of composition, structure and function as outlined in Table 2. This table helps identify how it might be possible to find measures that might indicate potential effects of human activities and use of resources on biodiversity.

But as the table demonstrates and as Agrawal and Redford (op.cit:13) make clear there are multiple dimensions of biodiversity and no one indicator or even several taken together can possibly provide an assessment of biodiversity at even one scale, let alone at another or evidence what the inter-relations might be between different scales. Moreover by selecting and focusing on a single component of the biodiversity – in the case of this research, bee species – it is difficult to argue that this simplification is sufficient to capture the full complexity of biodiversity or be certain of its significance.

Of course there are arguments that can be made, which can less easily be made for more emblematic components of biodiversity such as tigers or other endemic species, about the link between bees and pollination that make the particular case for a critical functional role of bees in pollination and therefore biodiversity maintenance. But to complicate matters further, and as the table indicates, biodiversity in some cases may well be maintained or even encouraged by disturbance regimes[1] that might reduce biodiversity locally but promote it more widely. Thus land clearance and agricultural cropping, both annual and perennial, may support bee populations in terms of pollen and nectar supplies even though it may be detrimental to other aspects of biodiversity.

Table 2. Indicators of Attributes and Components of Biodiversity

Attributes / Components	Composition	Structure	Function
Genetic	Allelic diversity	Heterozygozsity , Heritability	Gene flow, genetic drift, mutation rate, selection intensity
Population / Species	Species abundance, biomass, density	Population Structure, dispersion, and range	Fertility, mortality, survivorship, life history, phenology
Community / Ecosystem	Relative abundance of life forms, proportions of exotic or endemic species	Spatial geometry and arrangement of patch types	Disturbance regimes, nutrient and energy flows, biomass productivity, patch dynamics

Source: Agrawal and Redford, 2006:13

If one moves one step further to explore the specifics of the ecology of *Apis dorsata* given the seasonal migratory behaviour of the species and its relaxed nesting behaviour in terms of nesting sites (at least outside the NBR) building understanding of cause-effect relations on its population dynamics even within the NBR is fraught with methodological and conceptual difficulties. While it is known that there are marked seasonal fluctuations in honey harvested as evidenced from Keystone experience which is probably indicative of fluctuations in production, the causal factors of this are unknown. Here is a case where long term systematic records of *A. dorsata* nest counts within the NBR could provide insights but such data does not exist.

At a relatively late stage in the research, when the question was asked, because it was identified as potentially a crucial link between honey harvesting and *A. dorsata* populations, 'what is the effect of harvesting on *A. dorsata* on nest survival, subsequent honey production and swarming?' it became clear that much of the basic detail on the direct action of harvesting honey on bees is not available. Much depends apparently[2] on the timing of the harvesting in relation to the life cycle of the bees' nest and the method of harvesting, all of which will affect nest survival, recovery, subsequent swarming and so forth. One could assume the worst – that all honey harvesting is destructive but observational evidence does not support this and contextual factors (weather conditions, pollen supplies etc.) might play an equally important role in nest survival and recovery after harvesting. It is conceivable that harvesting through promotion of rebuilding activities could be a stimulant to bee population expansion. In short there are multi-causal dimensions of which we have little understanding.

Uncertainties over livelihoods

Similar questions of method and theory apply to building understanding of livelihoods, and these are developed in a later paper in the conference on Conceptual Issues (Nath, et al.) and in part relate to the issues covered in the next section. Two points are made here.

The first relates to the use of livelihood frameworks and our understanding of livelihoods. There is much about the standardised sustainable livelihoods framework (SLF) and the way in which it has been applied that is entirely consistent with a neo-classical model of utility maximisation by households and assumes a pervasiveness and persistence of liberalised market relations. The idea that poor households having livelihood strategies carries with it assumptions that they have awareness, choice and freedom of movement, that is very far from the reality in which most poor rural household lead their lives (Johnson and Start, 2001). Many of the rural poor live in contexts in which assets are far from fully commoditised and where access to assets depends not on 'free' market relations but much more on dependent social relations. As Whitehead (2002) has noted the whole livelihood framework in its neo classical language and its assumptions of market exchange strips context and relations out of people's lives.It is precisely these dimensions that provide the means by which people handle risk and maintain access

to resources and institutions (de Haan and Zoomers, 2005). For many of the poor it is the maintenance of dependent patron-client relations that provide the means to their survival (Wood, 2003) in a context where the state fails to provide that security or may be the key source of risk.

Second, and linked to this, much of the discussion on poor people, particularly within biodiversity management has tended to treat collections of people as communities (and in the context of the NBR labelled them as 'tribals' or 'adivasis') with assumptions of them being socially undifferentiated and unchanging – the language of 'forest dependent communities' exemplifies this. Comparative field evidence and theory (and as will be seen in the empirical evidence from this research) points to as much social and economic differentiation within many of these groups of people as between them and others and how they have both shared and conflicting interests according to social and economic status. Further, the language and perspectives towards these indigenous groups has tended to see them as either victims or innocents in the face of wider processes of change and ignores their individual capacities to work against domination, challenge or subvert the processes that act on them to find room to manoeuvre. Thus despite the apparent strictness of Forest rules as to what may or may not be done with forest resources, everyday practices, and the studies on the honey market evidence this, indicate many ways around the formal rules. Thus attention to what people do and how they behave, either within, outside or against the rules of the game is essential.

Despite the widespread perspective of seeing these indigenous people as victims, much of the policy and programmatic response to their poverty has focussed more on the symptoms of their poverty – the lack of education or health services – rather than focus on the underlying causes that have contributed to their poverty and marginalisation in the first place. While the origins of the marginalisation of indigenous groups are to be found in deeper history, and part of that is British colonial history and its settler culture in the Nilgiris, closely related to that has been Forest policy and the effect that Forest policy has had in reducing indigenous people's endowments (rights) and entitlements (benefits) from forest resources. In the light of this the recent 2006 Act on Recognition of Forest Rights (The Scheduled Tribes and Other Traditional Forest Dwellers Act, 2006) represents an attempt to redress one structural dimension of the marginalisation of forest indigenous groups and their loss of endowments and rights through previous Forest Acts. What is far from clear though is how (or even if) and to what extent this Act will actually be implemented in practice. Thus the way the State behaves in practice – whether through the laws of central government or the behaviour of State Forestry Departments has a critical bearing on the context in which indigenous people lead their lives and the ways in which they utilise forest resources.

This brings us back to the critical issues of risk and vulnerability. Vulnerability and risk within the standard livelihoods frameworks[3] are largely seen as external factors. In part this is a result of the idea of risk being drawn from the natural resources literature and risks or threats being seen mainly in relation to the occurrence of natural resources disasters – of which the 2005 tsunami in South East Asia is a classic example – and therefore random events (to which some element of probability assessment can or cannot be attached) and external to households. Two issues should be stressed here.

First, it is often the poor who are susceptible to risk from threats associated with natural resource disasters because they tend to live in the most risk prone areas – in areas that can be flooded for example[4]. Second, natural resource disasters (floods, frosts, droughts etc) are not the only sources of risks and for many of the poor a key source of risk and uncertainty is actually caused by markets (commodity and labour) in which they are relatively powerless actors. However in drawing its intellectual origins from the natural resources literature, the idea of vulnerability within the SLF ignores the important factor of human agency or action by others as a significant threat to many. For the poor, risk is a daily feature of life. It is not only just to do with income but also with access to assets (including health) and the ability to deploy what capabilities they have. Uncertainty in the ability of the State to deliver services of health, education and protection is a key risk for many. There is also widespread evidence

(see Ellis and Freeman, 2004 for example) that deliberate action by the government and local authorities can be as much a source of risk. As Geoff Wood has put it (2003):

" the determining condition for poor people is uncertainty. Some societies perform better than others in mitigating this uncertainty. Elsewhere, destructive uncertainty is pervasive. Under these conditions the poor have less control over relationships and events around them. They are obliged to live more in the present and discount the future. Risk management in the present involves loyalty to institutions and organisations that presently work and deliver livelihoods, whatever the longer term cost. Strategic preparation for the future, in terms of personal investment and securing rights backed up by its correlative duties, is continuously postponed for survival and security in the present."

What Wood is emphasising, and this echoes the point made by Whitehead, is that many of the poor are locked in dependent social relations in order to survive in the present. At the heart of these are unequal power relations and, as many have observed, the SLF is particularly weak in addressing issues of power structure.

There are other areas in the SLF that have brought critical comment including the notion of sustainability and the difficulties and value judgements over its assessment and determination. While sustainability may indeed be a desirable objective, the reality is that for many of the poor they lead lives in which "choices" can only be made for the short term and in many ways these are not choices at all. Such choices may well undermine longer-term welfare. In that sense there is no choice and what characterises their life is livelihood insecurity and emphasis in the SLF on emphasising the opportunities and strengths may lead to an underestimation of the constraints and difficulties under which many of the poor lead their daily lives.

The emphasis on history and time needs to be stressed in building understanding of the livelihoods of indigenous groups. Much of the livelihoods research has classically been cross sectional, based on random or stratified sampling, collecting metric data at one particular point in time and through quantitative and statistical manipulations attempting to infer causalities on what are often more arguably correlations around what can be measured. Such methods, based on large or small scale sample surveys have a role but they are also deeply limited and tell us little about the processes of change and differences between households. For these reasons Murray (2002) has argued strongly for the need for livelihoods research to include a retrospective approach – seeking to reconstruct change over time to be complemented with dispersed but intensive research methods of micro-level field investigation. This research has partly responded to this through investigations of household histories which are reported on later in the conference.

Indeed research on chronic poverty – that is poverty which persists over time and across generations (arguably the condition of many of the indigenous groups in the NBR) – has been built out of the quantitative analysis of household panel data which has followed individual and household economic dynamics over time. This has been linked systematically to qualitative data trying to identify the proximate causes or drivers of rising household prosperity or decline through detailed household recollection of sequenced actions and events that have induced change. As da Corta (2009) notes such studies have provided detailed understanding of the character of poverty or its experience but have provided little understanding on the constraints of poor people's agency in constructing strategies, how poverty and vulnerability has been created in the first place or of the deeper processes of poverty creation based on unequal social relations generated through economic, social and political structures. In short there is a need to complement understanding of livelihood trajectories with the understanding of the dynamics of social structure and relations and concepts such as class. But it also requires, as with ecological research, attention to multiple levels. Not only is there a need for both quantitative and qualitative analysis of livelihood change through panel studies but these have to be linked to broader changes in social relations and institutional setting along with their transformation in relation to broader policy and economic trends. Nothing less will do.

This scope of research method and analysis has been beyond the resources of this project and the absence of household panel data, an acute gap in general in the literature of indigenous people and forests, has been partly addressed through the reconstruction of household histories. Equally the attempt to link individual and household changes to broader changes in context – the dynamics of changes in social structures, economic relations and institutional context and how they affect household activities and choices – has been challenging. In part this will be built out of an environmental entitlements analysis (Leach et al., 1999) which will explore changing endowments (rights and resource of indigenous people) and entitlements (the range of benefits derived from environmental good and services) and how these have varied over time and by location. The analysis of the workings of the honey market in part contributes to this investigation as well as an exploration of the changing institutional context, specifically that of Forest Policy and its effects on legal endowments and entitlements of indigenous people.

In summary both the ecological and livelihood dimensions of this research have faced considerable theoretical and methodological challenges: but bringing them together into an interdisciplinary framework has been even more daunting.

Doing interdisciplinary research and negotiating different knowledge frameworks

As Bevan (2007) noted with respect to multi-disciplinary collaboration on poverty research there are multiple barriers. These included the cultures of particular disciplines, the patterns of thought and behaviour of disciplines (disciplinary habitus), the histories of research disciplines and research funding policy and practice. Such barriers undoubtedly exist to an even greater extent in research on poverty-biodiversity linkages. However Bevan focussed specifically on the barrier of "conflicting intellectual assumptions which underpin different social science 'paradigms' or research models" (Bevan, op.cit: 284) arguing that these were "the most interesting and change relevant".

This has not been a research project on building multi-disciplinary research in the project's research area, although the need for such an investigation I think has been self evident from the process of the research. However the analytical framework that Bevan elaborated has been adapted here simply to point out the challenges that exist rather than an attempt to negotiate a way through it. The adaptation (see Table 3) extends to a comparison of social science with science disciplines in the research areas within which the project has been working. It does not cover the style of writing, or 'rhetoric' as Bevan calls it, that is particular to the way in which the disciplines write to analyse and persuade. The point to be made is that the way in which biology and ecological science might think about and characterise interlinkages between people and biodiversity are likely to be very different from those of social science. These are debates which the research has yet to engage in.

Table 3. An Ideal-type depiction of some of the research models on poverty-biodiversity linkages

Question	From social anthropology	Social change	From ecological systems	From biology	From resource economics
Focus: What are we interested in?	Local cultures and meanings; use of resources	Unequal social structures, power, dynamics, access	System and biodiversity resilience	Robust biological models	Institutional Performance
Values: Why?	Agency of poor should be recognised and respected	Redress of inequality and exclusion		Need better knowledge of the biology to inform	Institutions can be made to work better
Ontology: What is the reality we are interested in?	There are different realities associated with different standpoints	Reality exists independent of thoughts but complex, multiply constituted and much unobservable	Reality exists independent of thoughts but complex	One reality exists independent of our thoughts and what is observable is real	One reality exists independent of our thoughts and what is observable is real
Epistemology: How can we know about reality?	Through interpretation of local meanings ..'abductive' research approach	Truth as practical adequacy.. models of mechanisms/ processes through iterative process of conceptualisation / fieldwork	Observe through scientific methods (deductive/ inductive) and can establish truths	Observe through scientific metods (deductive/ inductive) and can establish truths	Use mathematical logic... ***deductive*** and observe it.. surveys .. ***inductive***
Theorising	Hermeneutic interpretation … reflexive	Conceptual frameworks to guide exploratory research, middle range theories	Causal theories through measurement / stat technique	Causal theories through measurement / stat technique	Causal theorizing via mathematical modeling and stat techniques
Research Strategies: How can we establish what is really happening	Data: Ethnography, range of instruments Analysis: interpretation and comparison	Data: Integrated use of surveys, participant observation and protocols Analysis: multiple, discourse analysis	Data: empirical / measurement Analysis: statistical / spatial / multivariate	Data: empirical / measurement Analysis : statistical / spatial / multivariate	Data: secondary Analysis: econometric analysis
Theoretical and empirical conclusions: What kind of conclusions can we draw?	Understanding of people's actions and relationships in cultural context Focus: community?	Identify universal mechanisms / processes; show how they work in different local contexts Focus: interactive .. person, household, community, country	Relations between ecological variables / robust models Focus: the ecological system and its inter-relations	Relations between biological variables / robust models Focus: the biological subject and its inter-relations	Descriptive stats using economic variables Explanatory: identification through regression analysis Focus: Resource / Constitution

Site selection processes

The use of case study sites

The research approach that the project has followed is essentially a case study one with cases selected as points of contrast between different social groups, potential importance of NTFPs in their livelihoods, linked to relative 'remoteness' and different agroecological settings. There is a tradition at least within the sciences of following random selection procedures with random or stratified sampling to avoid systematic bias in the sample and seeking appropriate sample sizes to enable generalisation. As noted in the previous section, data collected from such an approach is largely quantitative. Theorising about causalities is largely based on mathematical modelling and statistical techniques and explanation is provided through the detection of regularities derived through regression analysis. This is not the approach that this project has followed, but and this is emphasised, this is also not a rejection of quantitative methods.

In part the reason for not following such an approach responds to the issues raised in the earlier part of the paper about qualitative complexity and uncertainty. There is so much variability, both social and ecological, within the NBR that the research specifically needed to maximise the information that it could gain in order to tease out deeper causalities. Further it needed to select study sites which would tell different stories about potential causal relations between livelihood, bee and biodiversity linkages. What was hoped was that the case study sites would capture the maximum variation that might exist in terms of the role of NTFPs in indigenous livelihoods, thus allowing the building of site specific stories around the potential interactions. Indeed the selection process of sites appears to have been successful – there is one site where indigenous livelihoods are entirely dependent on NTFP income sources (NM[5] – see Table 4) and there are two where NTFP contribute nothing to household incomes (ChB and KT).

A more general comment needs to be made about case study research. First it is not a rejection of large random surveys or questionnaire surveys and the use of quantitative analysis with these. Such research is important and is needed to understand the significance or presence of certain phenomena and how they vary across larger populations or scales. Such approaches provide breadth but they do not provide depth. Given a quantitative

complexity and the theoretical uncertainties discussed above, the need for detailed case studies to build understanding and theory is essential and if we are to make any progress in building understanding of the links between indigenous people and biodiversity, this can only be built out of good case studies.

Site selection process

The project purposively selected case study research sites in order to capture contrasts of biogeography, the distribution and honey collection practices of the major tribal groups as well as respond to practical and strategic considerations of coverage across the three Indian states (Tamil Nadu, Karnataka and Kerala) that are contained with the NBR.[6]

With respect to the biogeography, the selection process drew on available information on the distribution of the seven major vegetation types within the NBR, their distinctive distribution by state and recognition of considerable micro-level variability due to variation in altitude and localised water resources. In terms of biodiversity there appears to be little systematic data on comparative biodiversity richness by vegetation type within the NBR so vegetation type were used as a proxy, on the basis of the wetter regions might be expected to be more biodiversity rich although it is recognized that this is a very crude measure. This was complemented by field observations and assessments by Keystone staff on the indicative presence and relative abundance of bee species by vegetation type. This indicated some degree of association of bee species by vegetation type – for example *Apis cerana* with grassland and *shola* and distinctive bee species mix by vegetation type – which field data should now be able to corroborate or challenge.

Drawing on the known distribution of indigenous groups and their reported honey collection practices (by species of collection) a mapping exercise, again largely drawing on observation and field experience of Keystone field staff allowed an identification of patterning of community by vegetation type by bee species. Finally a comparison was made of the management divisions operated by the three State Forest Departments across the NBR. Management divisions where National Parks are located are areas where in theory honey harvesting activities do not take place and where gaining research permission is also difficult. Logistical issues and questions of accessibility as well as of questions of balance across the states finally reduced the potential 13 divisions across the NBR to seven divisions and from these five research BBL locations, four of which cross the Forest Divisions were identified within which the research sites should be selected.

Finally, within the five locations a process of selection of research sites was initiated. Research sites are defined as places where the following activities were carried out:

- **Studies and sampling of bees and vegetation in one hectare plots**
- **Livelihood studies in villages located near the plots including the assessment of honey collection practices**
- **Additional studies on bee nest densities in the vicinity of the research plots**

Sixteen research sites were selected in total across the five locations (see Table 4). Three ranked criteria were used in their selection. First the distribution of sites had to be proportional to the vegetation cover within the location, second indigenous communities who used the resource of the areas and contained honey collectors had to be located adjacent to the site area (but no closer than 500 m for reasons of disturbance) and third the research plot had to be close to a water source (for bees to visit these areas).

Conclusion

As will be evident this is a paper in progress, written somewhat before the event in that the stories told by the biological and social data and analysis have yet to be put together. That in part is the purpose of this conference. But hopefully the issues that this paper has raised will inform that discussion and contribute to a more open inter-disciplinary discussion that recognises that there are many routes to knowledge and the task is to accept that different knowledge frameworks tell different stories about the same phenomena. We need to listen to them.

Table 4. BBL Location, research sites, adjacent indigenous community and vegetation inside the research plots (vegetation surrounding the research plots)

BBL locations (Forest Divisions and States)	Code	Indigenous community	Altitude m.a.s.l	Vegetation
Chamrajnagar	ChB	Sholiga, Kannadiga	1304	SEG (DDF)[1]
Chamrajnagar and Satyamanagalam MD in Kerala and Tamil Nadu	ChG	Sholiga	1256	SEG (MDF)
	ChK	Irula	1250	SEG (MDF)
	ChP	Sholigas, Kannadiga[2], Badaga[3]	1013	DDF (DDF)
Coonoor	CM	Kurumba	1094	SEG (DDF)
Nilgiri North and Coimbatore, Tamil Nadu	CP	Kurumba	890	SEG (MDF)
	CS	Irula	582	DDF (DDF)
Kotagiri	KB	Toda	1831	Shola (grasslands)
Nilgiri North, Tamil Nadu	KK	Toda, Others[4]	1665	Shola (Cultivation)
	KT	Badaga, Others	1500	Cultivation
Mudumalai/Sigur	SB	Kattunaicken	936	MDF (MDF)
Mudumalai and Nilgiri North, Tamil Nadu	SC	Kasava/Irula	877	DDF (DDF)
	SS	Kasava/Irula/Jenu Kurumba	875	DDF, Riverine (Scrub)
Nilambur	NA	Kattunaicken, Paniyas	198	MDF (SEG)
Nilambur North and South, Kerala	NM	Cholanaicken	258	MDF (MDF)
	NMu	Padinaickens, Paniyas	96	DDF (MDF)

Legend

[1]The vegetation type inside the plot is identified and vegetation adjacent to the plot is given in brackets. SEG - Semi-evergreen, MDF - Moist Deciduous Forest, DDF - Dry Deciduous Forest, EVG – Evergreen, Others - agricultural land;

[2]Kannadigas are the residents of Karnataka state and have been living in the mentioned villages along with indigenous groups.

[3]Badagas are the single largest ethno-linguistic population in the Nilgiri Biosphere Reserve and one site in which they are present has been selected for comparative purposes.

[4]Others refer to those who were settled in the Nilgiri district since the coming of the British or those who have populated the district since the advent of the British. These would also include those who have been recently settled following the ethnic conflict in Sri Lanka.

Endnotes

[1]*See for example the Economist report (November 6th, 2008) which highlighted results from a study that show how structurally complex areca-palm plantations in the Western Ghats retained 90% of the birds associated with the natural forest*

[2]*I am grateful to discussions with Robert Leo and Nicola Bradbear on this point*

[3]*Department for International Development, 1999. See www.eldis.org/vfile/upload/1/document/0901/section2.pdf, accessed 01/03/2009*

[4]*And the riskiness of collecting NTFPs in the NBR should not be underestimated, specifically for wild honey collection and the danger of being killed by elephants*

[5]*See Pain et al., 'What have we learnt about Forest-based Livelihoods in the Project?' for evidence of this*

[6]*See BBL, 2007 for a detailed discussion of the site selection process*

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(2B) Bees of NBR

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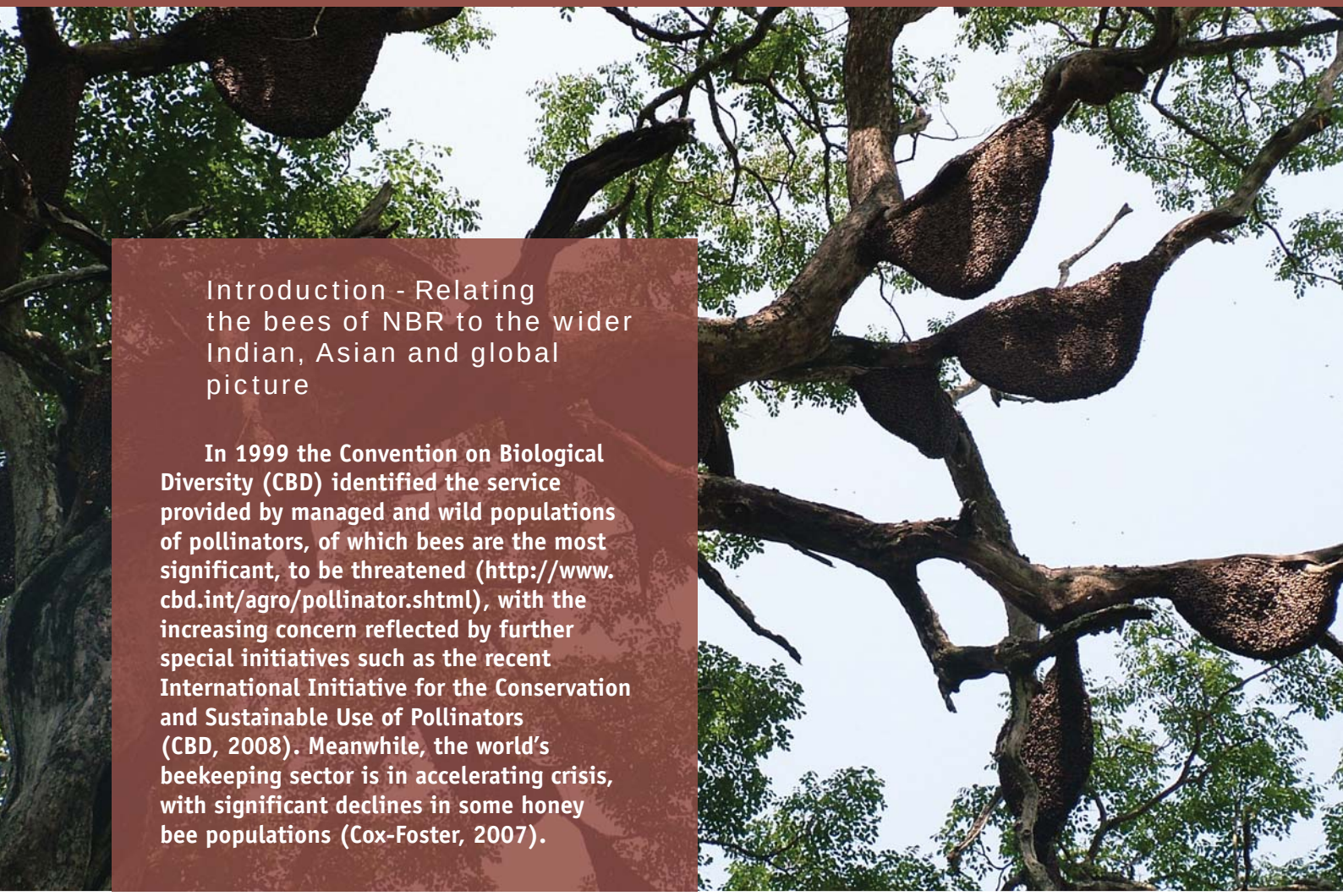

Introduction - Relating the bees of NBR to the wider Indian, Asian and global picture

In 1999 the Convention on Biological Diversity (CBD) identified the service provided by managed and wild populations of pollinators, of which bees are the most significant, to be threatened (http://www.cbd.int/agro/pollinator.shtml), with the increasing concern reflected by further special initiatives such as the recent International Initiative for the Conservation and Sustainable Use of Pollinators (CBD, 2008). Meanwhile, the world's beekeeping sector is in accelerating crisis, with significant declines in some honey bee populations (Cox-Foster, 2007).

This has consequences for the pollination ecology of natural habitat as well as the pollination of crops of which bees are key pollinators, with the total economic value of pollination estimated to be Euros 153 billion, representing 9.5% of the value of the world agricultural production used for human food (Gallai, Salles, Settele and Vaissière, 2009), with consequences also for honey and beeswax production. This Darwin Initiative Project in NBR is timely because the Asian honey bee species that are relatively little known beyond their localities may in the future play a much wider role within the apiculture sector. However, these indigenous honey bee populations are probably already threatened by loss of habitat and excessive hunting pressure (Oldroyd and Wongsiri, 2006). This Project set out to determine basic understandings of the bee species and their populations in NBR.

The vital role of bees in maintaining biodiversity by pollinating flowering plants is rarely observed by non-specialists and not always understood by farmers. Produce such as honey and beeswax that are harvested from bees are valuable, yet the value of this produce is insignificant compared with the role of bees

as pollinators. Nevertheless, throughout human history bees have been kept primarily for their produce. Significant volumes of harvestable products are stored only by species of bees that live socially, and therefore it is bee species with greatest sociality, living in large, permanent colonies, that have been best known and utilised by us as sources of honey, beeswax and other products of bees' nests. (Where there were no species of honey bees or stingless bees, the very tiny stores of honey stored by bumble bees and honey ants have been harvested.) Bees with the necessary honey-storing characteristics belong either to the subfamily Meliponini that contains several genera of stingless bees, or to the single genus *Apis*, the honey bees, and these were the bees studied by the Project.

Diversity of *Apis* in Asia

Bees and flowering plants have evolved during a period of 130 million years to become increasingly dependent upon one another (Engel, 2001). Today there are 20,000-30,000 species of bees of which around 16,000 have been scientifically described (Michener, 2000). Ancestors of honey bees emerged 40 million years ago, with a modern type of open nesting species appearing in south east Asia around 10 million years ago (Engel, 1999). Subsequently species that nested inside cavities appeared, eventually spreading throughout tropical and temperate Asia and into Europe. These European bees became isolated from the Asian species as desert developed in the Middle East, and evolved into the species that we know today as *Apis mellifera*, with an indigenous distribution stretching from the Arctic Circle to South Africa, and with eastern limits of the Ural Mountains in the north and the central deserts of Afghanistan in the south (Ruttner, 1988). The cavity-nesting bees in Asia evolved into *Apis cerana* and the several other cavity nesting species of *Apis* known today. The open nesting species gave rise to the several types of open nesting species existing today, with none of this type outside Asia. Thus, Asia has a diversity of *Apis* species, while Europe and Africa have just one species. However, it is this single species, *Apis mellifera*, upon which the world's industrialised beekeeping sector is based.

Table 5. *Apis* species[1]

Honey bee species whose nests consist of multiple combs (cavity nesting honey bees)	Natural distribution	Exotic distribution
Apis cerana	Asia	Solomon Islands
Apis koschevnikovi	Asia	
Apis mellifera	Europe, Middle East, Africa	Introduced throughout the Americas, Asia, Australasia and Pacific regions
Apis nigrocincta	Asia	
Apis nuluensis	Asia	
Honey bee species whose nests are single combs	**Natural distribution**	**Exotic distribution**
Apis andreniformis	Asia	
Apis binghami	Asia	
Apis breviligula	Asia	
Apis dorsata	Asia	
Apis florea	Asia	Sudan
Apis laboriosa	Asia	

Meliponini stingless bees

This subfamily contains genera of stingless bees found mainly in tropical areas of Africa, America, Asia and Australia. In all of these regions, people have traditionally harvested products from the nests of these highly social bees that live in perennial colonies. Before the introduction of *Apis mellifera* to the Americas and Australasia, stingless bees provided sources of honey, and are still kept and managed by beekeepers in many countries, notably in Central America.

Problems with global apiculture

The world beekeeping industry trades around 1.2 million tonnes of honey per annum, with about half of this exported on to the world market by countries such as Argentina, China and Mexico. This is a globalised industry, based on just a few races of just one species of honey bee (*Apis mellifera*), together with standardised technology that suits this bee. This sector is now in crisis in some countries as bees succumb to diseases, parasites and predators that man has spread around the world while transporting bees from one area to another. In 2007, the media highlighted news that beekeepers throughout the USA were experiencing a

dramatic spate of sudden honey bee colony losses. As often happens, this created media exaggeration ranging from 'Bee AIDS' to the extinction of mankind as a consequence of the loss of honey bees. The condition – now named Colony Collapse Disorder (CCD) has been familiar to beekeepers in Europe during the last ten years or so. No single cause has been identified; rather it is believed that the collapse of colonies arises as a result of the various honey bee pathogens that are now widely distributed (for example the predatory mite *Varroa destructor*), the viruses they carry, the use of neonicotinoid insecticides, combined with the stress caused to bees by intensive, industrialised beekeeping methods (Schacker, 2008).

The effect of this crisis has two outcomes that are relevant to the work of this Project. Firstly, that scientists are having to address concerns for pollination, with fresh research endeavours being made to assess the role of pollinatory bees other than *Apis mellifera* for world crop pollination (Kremen, 2007). Secondly, not only are global volumes of honey threatened by the loss of colonies, but also the quality of honey supplies are affected as world honey markets increasingly screen bee products, especially honey, for the presence of chemical residues. The residues most likely to be present in honey are due to the use of medicines to treat honey bee diseases, introduced during some form of honey bee management, or from environmental pollution. Residues detected in honey have included aminoglycosides, tetracycline, streptomycin, sulphonamides, chloramphenicol, naphthalene and many others. The presence of traces of any residue can have significant consequences, for example, in February 2002, the world honey market was strongly affected by an EU ban on Chinese honey, following the identification of antibiotics in samples of Chinese honey. Since China was Europe's largest supplier of honey, this immediately led to a shortage of honey meeting EU criteria, and world honey prices increased rapidly. This demand for residue-free honey opens opportunities for honey producers in the poorest countries, which also benefit from low labour costs, maybe have excellent resources of bees and habitat for their survival, and where it is often the more poor and remote people of these countries with few other livelihood options, who practise beekeeping. It is in these parts of the world, such as shown well within NBR, that honey bees remain relatively disease free, environments are relatively unpolluted, and people have potential to harvest honey and beeswax that are of excellent quality. Because these products are residue-free, they could achieve good prices on developed markets, assuming they meet the import criteria necessary to gain access. However, these products are being harvested from wild populations of bees, and the sustainability of increased harvest is unknown.

The apiculture sector in Asia

Asian honey bee species

Little is known about the ecology of Asian honey bees, and indeed, it is only comparatively recently that there has been acceptance of the existence of more than three Asian honey bee species: authorities as late as 1988 (Ruttner, 1988) still described only three Asian species. Today at least eight Asian species are recognised, and may be identified according to bee size, nest architecture and known distribution patterns. Globally, little is known about the naturally occurring population densities of any honey bee species. While a number of studies have researched natural forest nesting of Meliponini, summarised in (Kajobe and Roubik, 2006) far less has been done, worldwide to determine the natural nesting density of *Apis* species. Asian honey bees nest in one of two distinct ways, described as **open** or **cavity** nesting, as shown in Table 5, and this has implications for the way they are utilised by humans.

Open nesting species

These species include the so-called giant honey bees (e.g., *Apis dorsata, Apis laboriosa*) that build a large, single comb in the open. This may be suspended down from a cliff (as commonly found in NBR), beneath a tree branch, or human made structures – *Apis dorsata* is commonly seen in urban and peri-urban areas nesting on office buildings, under

bridges and water towers. (Whether such nesting on buildings reflects a lack of natural nesting sites is unknown.) There are also so-called little honey bee species (e.g., *Apis florea, Apis andreniformis*) that also build a single comb, but build it enclosing the branch (rather than just suspended from underneath it).

Colonies of these open nesting species aggregate; for example it is possible to find more than 100 colonies of *Apis dorsata* nesting from the branches of a single tree (Saville, 2002). It has been shown that *Apis dorsata* colonies return annually to the same trees following their migrations (Oldroyd, Osborne, and Mardan, 2000), with the same colonies returning to the same sites (Neumann, Koeniger, Koeniger, Tingek, Kryger, and Moritz, 2000) (Paar, Oldroyd and Kastberger, 2000). Other species of open nesting Apis have been shown also to nest in aggregations, for example *Apis florea* (Rinderer, Oldroyd, de Guzman, Wattanachaiyingchareon and Wongsiri, 2002), and *Apis laboriosa* (Roubik, Sakagami and Kudo, 1985).

Cavity nesting species

These bees (e.g., *Apis cerana, Apis koschevnikovi*) are individually intermediate in size between the large and little honey bees, and nest with multiple combs inside a cavity, which may be a hollow tree, a cave, or a cavity in a wall or in the ground. The acceptance to live inside a closed space means that they can be kept inside a human-made container, otherwise known as a hive. The presence of multiple combs means that those combs containing honey can be removed without harming combs containing brood, and these features make these species (like *Apis mellifera*) appropriate for management, leading to the craft known as beekeeping.

Asian stingless bee species

Stingless bees are social insects living in large, permanent colonies that store honey to survive dearth periods, but generally in smaller volumes than *Apis*. World-wide there are around 50 times more species of stingless bees than *Apis*. While their biology and behaviour resembles honey bees to some extent, they differ in biologically significant ways. All stingless bee species are cavity nesting and therefore can be kept in human made containers.

Use of Asian honey bee species

Before the introduction of *Apis mellifera*, honey and beeswax in Asia were obtained from the indigenous species mentioned above. How bees are utilised by humans depends upon the bees' nesting behaviour: open nesting bee species can be exploited only by honey hunting, while cavity nesting species can be hunted as in honey hunting, or kept in a container owned by a human, i.e., beekeeping.

Honey hunting

Honey hunting is the taking of nest contents of any species of bees, from which are obtained honey, beeswax and maybe bee brood. It is an ancient tradition, providing early humans with a sweet food - honey. The oldest known rock paintings of honey hunting in Asia are in Uttar Pradesh, India (Gordon, 1960), and date from around 6,000 BC. These paintings depict easily recognisable *Apis dorsata* colonies being hunted from cliffs and trees, much as happens today. Mathpal writing in 1984 mentions that the paintings were in rock shelters where *Apis dorsata* were still nesting (Mathpal, 1984). This ancient practice has enabled traditions to develop such that honey, bees and honey hunting occupy a place in many Asian cultures, and these have been well described (Crane, 1997), (Crane, 1999). Honey hunting is not devoid of any management practices, as in some places honey hunters prepare nesting sites for incoming swarms, for example the 'rafter beekeeping' in the *Melaleuca* forests of Vietnam (Chinh, Minh, Thai, and Tan, 1995), beekeepers provide artificial nesting places for *Apis dorsata*: this makes harvesting of the combs convenient and easy. While the beekeeper has ownership and provides some care for the colony, the colony is still living entirely as it would in the wild. Other examples of keeping *Apis dorsata* on rafters have been described from Cambodia (Jump and Waring, 2004), Indonesia (Mulder V., 2001) and in India, in Little Andaman Island (Mahindre, 2000).

Today large volumes of honey are still obtained in Asia from honey hunting. Honey hunting of *Apis laboriosa*, a honey bee species that nests at high altitudes, is practised in the Hindu Kush Himalaya region. Honey hunting of *Apis dorsata* is practised throughout its distribution range: from Pakistan in the West to the Philippines in the East. Honey hunting of cavity nesting *Apis cerana, Apis koschevnikovii, Apis nuluensis* and *Apis nigrocincta,* and the 'little' honey bee species *Apis florea* and *Apis andreniformis* is practised wherever they occur. Indeed, in Nepal and Malaysia tourism based on viewing traditional honey hunting has taken off.

Tending of nests in cavities

This practice describes the ownership by a human of a bee colony that is nesting inside a tree or another cavity, and represents a practice intermediate between honey hunting and beekeeping. It could be described as 'tree beekeeping' or 'bee having'.[2]

Beekeeping

This means keeping bees inside human made containers and confers a number of advantages, such as the possibility for clear ownership, to harvest honey easily and conveniently, to manage the bees to some extent and feed them in dearth periods. All the Asian cavity nesting bee species listed in Table 5 are kept this way, and stingless bees are also kept in hives (variously made from logs, coconut shells, baskets or other local materials) throughout Asia. In temperate areas of Asia, the possibility to manage the temperate zone races of *Apis cerana* (that are much less prone to swarming and absconding than tropical races of the same species), and the lack of open nesting bee species in some of these areas, meant that beekeeping in hives became the most commonly practised form of beekeeping. In tropical areas, where open-nesting species are abundant, both honey hunting and beekeeping in hives are found, although the latter may be considered slightly less common.

Sustainability of apicultural practises

Witnessing honey hunting in many areas of Asia it is common to see large numbers of bees killed with burning brands (Valli, 1998), (Buchmann and Cohn, 2007) and whole colonies destroyed. There is no data available on the population sizes of any Asian honey bee species, and we do not know the impact of honey hunting upon these populations. Efforts have been made to encourage honey hunters to harvest during day time and without destroying the whole colony: i.e., to harvest only comb containing honey and leave comb-containing brood intact, for example, (Mahindre, 1983). However, care in harvesting honey comb is easier to discuss in the classroom than it is to achieve in practice. In many areas, honey hunting has increased with increasing human population, and this combined with a loss of large trees for nesting of bees. The loss of large trees makes it more difficult for bees to find secure nesting places: when they nest in smaller trees, they are easier to locate and to take the combs. We do not know the effect of decreasing tree habitat and increasing human population pressure on honey bee populations, although other authors have concluded that honey hunting of *Apis dorsata* probably is not sustainable (Oldroyd and Wongsiri, 2006). We are not aware of any study to determine the sustainability of honey hunting.

Introduction of *Apis mellifera* to Asia

Until the 1980s, commercial honey and beeswax production in Asia was based exclusively on the honey bee and stingless bee species described above. Throughout the late 19th and 20th centuries, people had endeavoured to introduce European honey bees to various countries in Asia, without success. During the past 30 years or so, beekeeping industries based on *Apis mellifera* have developed in Asia, such that *Apis mellifera* is now present in every Asian country and industries are based on many millions of colonies. However, with *Apis mellifera* in crisis due to CCD in several world regions (and reportedly present in Taiwan[3]), and with the difficulties of keeping these exotic bees in regions where there are several indigenous bee species with numerous associated predators[4] questions must surround the long term sustainability of industries based on exotic *Apis mellifera* in Asia.

The effect of this abundance of *Apis mellifera* colonies on the viability of Asian honey bee species is unknown, although some authors have speculated that there must be competition for forage resources (Verma, 1991).

Table 6. Numbers of *Apis mellifera* colonies in Asia[5]

	1984	1994	2004	2008
Afghanistan	20,000			75,000
Bangladesh	0		present	
Bhutan	0	50	present	
Brunei		0		
Burma	2,000	2,000+	5,000	
Cambodia			present	
China	4,000,000	6,800,000		20,000,000
Hong Kong		100+		
India	3000	80,000		1,750,000 (rough estimate)
Indonesia	1000	31,000		
Laos		present		
Japan	284,000	225,000		180,503
Malaysia	<500	present		
Nepal	2	1,000+	10,000	24,000
Pakistan	1,000	14,000		275,000
Philippines	2,000	6,000		20,000
Singapore		present		
South Korea	280,000	300,000	790,000	
Sri Lanka	4	not permitted		
Thailand	30,000	100,000	300,000	
Vietnam	16,000	70,000	470,000	

Bees and apicultural practises in NBR

NBR represents well the wider Asian apicultural situation, with open-nesting and cavity-nesting honey bees and stingless bees represented, although at the start of this Project they had not to our knowledge been scientifically identified. NBR was believed to be an area still without exotic *Apis mellifera*, although this species has been introduced to other areas of Karnataka, Tamil Nadu and Kerala. Keystone has documented the existing honey hunting and beekeeping practises of the area in several publications, for example (Nath, 1994), (Roy, 1997), (Keystone, 2008), and has also documented many of the flowering plants and NTFPs that may be dependent upon bees (Rehel, et al., 2009). Interestingly, NBR provides examples of different approaches to bee use, from opportunist honey hunting, organised hunting, through 'bee having' as practised by the Toda (ownership and some management of *Apis cerana* nests in trees), to wall and box frame hive beekeeping.

Concerning the sustainability of honey hunting, the situation in NBR is that honey and wax are being harvested from wild colonies of bees, without knowledge of the population sizes, their reproduction rates, and what yields may be borne sustainably, and therefore with unknown consequences for these bee species and other plant and animal species that may be dependent upon them (for pollination or food production), as well as possible consequences for the sustainability of human livelihoods.

The aims of this Project concerning livelihood relevant bee species

We were interested to learn about the presence of bee species and their value both to pollination and more directly within people's livelihoods. In addition, we are interested to gauge whether current levels of honey hunting of these bee species can be considered sustainable or whether any of these species are being harvested at levels that threaten their species' survival. NBR represents one of increasingly fewer places left on earth where research on indigenous populations of honey bees can be done, i.e., areas with neither introduced honey bees nor introduced, exotic predators and diseases, and as far as we know, this is the first attempt to assess both Meliponini and Asian *Apis* species in the same habitats. NBR represents a particularly useful area for this study as hunting of bee colonies is not practised throughout the whole area, with some areas where bees are undisturbed by humans.

Hence the questions that we asked in this project about bees:

- **Which are the livelihood-relevant bees?**
- **How many species are they?**
- **Where are they and how is distribution related to habitat?**
- **How populous are they? Is it possible to estimate population sizes for these species?**
- **What is the bee nest density at each site?**
- **What factors explain variations in bee nest density between sites?**

Results

In summary, this is the information gained during this Project concerning bees and their habitats:

1. **Identification of bee species and the development of a key to their identification**
2. **Genetic analysis of *Apis* spp**
3. **Knowledge of typical numbers of *Apis dorsata* nesting sites (2007)**
4. **Numbers of honey bee and Melipona species at six project sites 2008 and 2009**
5. **Knowledge of insect diversity at 15 sites in relation to landscape and season**
6. **List of foraged plants from 15 sites (12 months, 30 focal patches)**
7. **Floral calendars at 15 sites**
8. **Reference collections of pollen and plant specimens from 15 sites**
9. **Knowledge of bee dependent NTFPs and crops in five locations of NBR**

10. **Typical unit prices and trade of pollinators**
11. **Effect of landscape on pollination, using *Sapindus* (2008) and coffee (2009) as examples**
12. **Plant diversity in four sites**

The first of the above (1-4) relate directly to the bees of NBR, while (5-12) concern bee-related biodiversity in NBR, and are described in a separate Workshop session.

Concerning the identification of bee species and the development of a key to their identification

Methodology

At Project outset, field observations were combined with pan trapping at the 16 Project sites towards an overview of the bee species present. The Project's entomologists have identified most of the bee species. Stingless bees are a particularly difficult group, and the identities of the two stingless species were confirmed by Dr D W Roubik, an authority on this insect group.

Results

The bees of NBR are as shown in Table 7.

Apis mellifera

Colonies of *Apis mellifera* were observed in NBR during the course of the Project when the Indian company Dabur brought 180 colonies of *Apis mellifera* to take advantage of the rare flowering of *'kurunje' Strobolanthes spp* in September 2006. The *Apis mellifera* colonies were observed to be in poor condition and were being fed sugar syrup by the attendant beekeepers. It seemed these *Apis mellifera* were unable to take advantage of the *Strobolanthes,* perhaps due to the cold weather. No samples of *Apis mellifera* were collected or otherwise observed during the project's field work to date and therefore NBR remains as one area in India that does not have permanent stocks of introduced *Apis mellifera* honey bees. *Apis mellifera* cannot persist as feral colonies in Asia, due to the presence of the indigenous Asian honey bee mites.

Bee key

A bee key is being prepared in the software LUCID. This will feature the bees shown in Table 7, and will be illustrated with the bees, their nesting habits and products.

Genetic analysis of NBR's Apis spp

Samples of all the NBR *Apis* species have been sent to two international laboratories (Bieneninstitut Kirchhain, Germany and University of Kansas, USA) for characterisation of mitochondrial DNA. The Project has also collected and sent samples of *Apis cerana* and associated *Varroa* mites – these can be used to research the genetic co evolution of *Apis cerana* and *Varroa* mites.

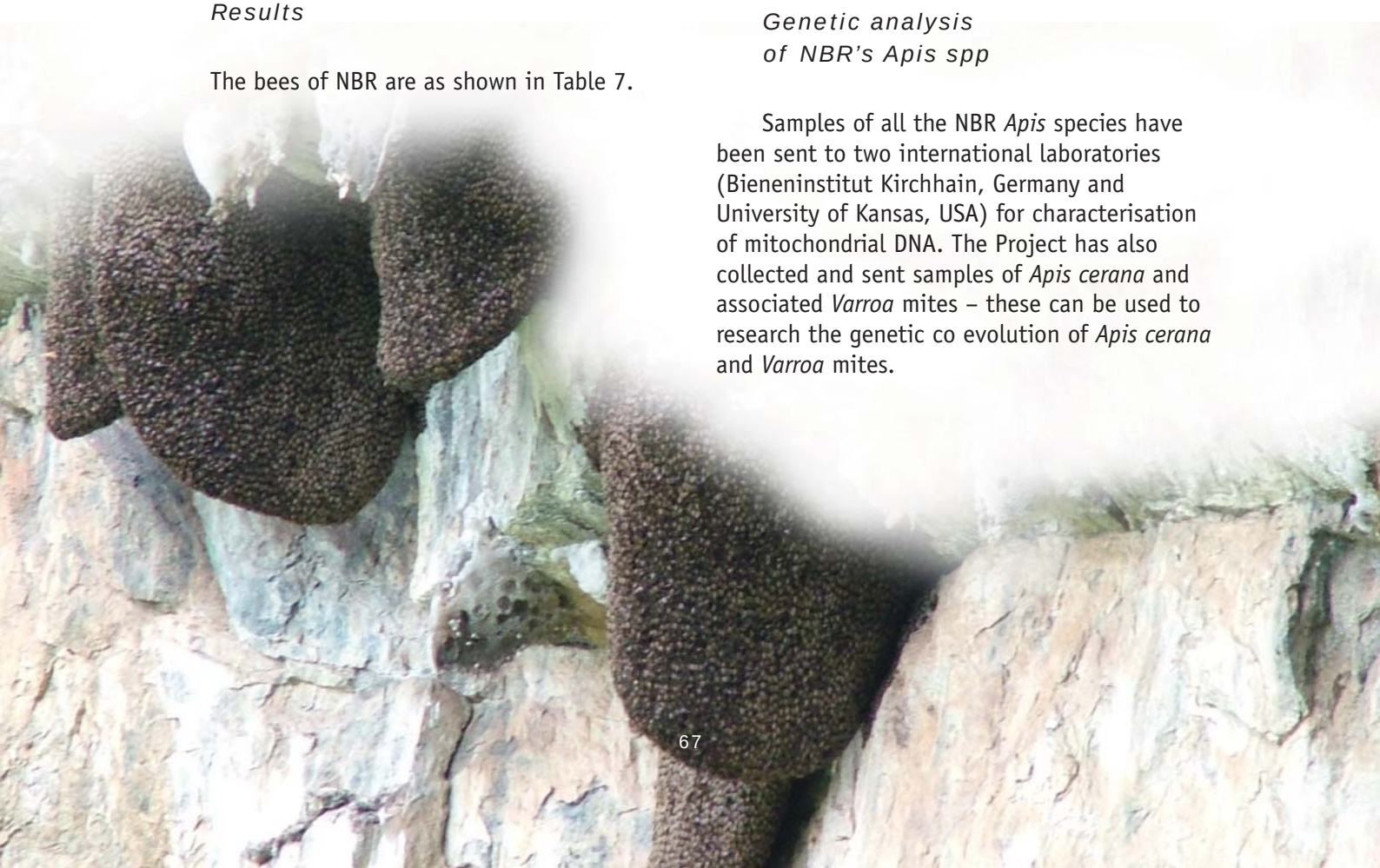

Table 7. Bee species of NBR

	Species	English name	Number of types reported in NBR	Nesting habit	Livelihood relevance
1.	*Apis cerana*	Asian hive bee	3 'types' observed by local people: 'black', 'yellow' and 'red'	Multiple combs, cavity nesting. Nest inside cavities and human-made containers (hives)	Honey, beeswax, pollination
2.	*Apis dorsata*	The 'rock bee', 'cliff bee', 'giant honey bee'	2 'types' observed by local people – these differ in the way the midrib is constructed	Each colony occupies a single comb, in the open (cliff or tree nesting). Sometimes nest in aggregates	Honey, beeswax, pollination
3.	*Apis florea*	Little honey bee	4 'types' observed by local people: *mora kola, nai kola, vangu kolai, kal kolai*	A single comb, in the open (nesting on a branch in shrubby vegetation)	Honey, beeswax, pollination
4.	*Apis mellifera*	European hive bee	One sighting in September 2006 of 180 transient colonies (colonies transported by truck from Himachal) during the project	Each colony has multiple combs, cavity nesting. Nest in human made containers (hives). No feral colonies found in NBR	Not present
5.	*Lepidotrigona ventralis* (Smith, 1857)	Stingless bee	Dammer bee1 of 2 types observed by local people. Identified for the Project by David W Roubik, Senior Scientist, Smithsonian Tropical Research Institute, Panama	Cavity nesting – in hollow tree trunks, or human made container, mud walls	Honey, pollination
6.	*Tetragonula bengalensis* (Cameron, 1897)	Stingless bee	Dammer bee As above	As above	Honey, pollination
7.	*Xylocopa sp.*	Carpenter bee	Identified for the Project by Santhosh Nair, Entomologist	Hollow stems, rotten wood	Pollination
8.	*Ceratina sp.*	Small /dwarf carpenter bee	As above	Nest tunnels in the soft pith plant stems	
9.	*Braunsapis sp.*		As above		
10.	*Amegilla sp.*	Blue-banded bee	As above		Pollination
11.	*Amegilla zonamegilla*	Blue-banded bee	As above		Pollination
12.	*Amegilla anthophoridae*	Blue-banded bee	As above		Pollination
13.	*Lasioglossum sp*	Sweat bee	As above	Nest-earth, rotten wood	Pollination
14.	*Halictus sp.*	Sweat bee	As above		Pollination
15.	*Megachilidae*	Leafcutter bee	Identified for the Project by Santhosh Nair and Stuart Roberts, Entomologist		Pollination

Preliminary results from Dr Deb Smith, University of Kansas

Concerning *Apis florea*

Preliminary results may indicate that the 'red' *Apis florea* ***differ from other samples at a single base in the*** *cytochrome oxidase II* ***gene. These bees seem to be nearly identical to*** *florea* ***samples from Saudi Arabia, and different from the*** *florea* ***samples from Thailand-Laos-Cambodia. The non coding sequence differs a bit (3 bases shorter in India than in Arabia) but four 'oddball' samples match the coding sequence of the Arabian bees.***

The indications are for two big lines within *florea*, ***a western line that extends from Arabia to India, and an East Asian group that includes Thailand, Vietnam, and Cambodia etc. The boundary areas will be interesting.***

Concerning *Apis dorsata*

The samples from NBR have been sequenced along with a large selection of 'giant' bees from Thailand, Malaysia, Borneo, Palawan, Luzon, Pakistan, Andaman Is., Sulawesi, with seven samples from south India-Bangalore and four from NBR. Despite the fact that Sulawesi and Philippine giant bees have been suggested as separate subspecies, the most divergent ones are those from India. They are uniformly quite different from the other locations.

Therefore, we have three groups of bees indicating unusual bees in India: giant bees, *Apis cerana* ***(yellow and black types, and black somewhat different from the black mainland bees of the rest of Asia) and the*** *Apis florea* ***more allied to those of points west, rather than to the*** *Apis florea* ***of Thailand-Cambodia.***

Concerning knowledge of typical numbers of *Apis dorsata* nesting sites (2007 field work)

We are not aware of any other published study in Asia to determine the numbers of *Apis* and Melipona bee colonies in natural habitat, and the Project needed to determine a methodology to undertake this work. The aggregate nesting by colonies of *Apis dorsata* makes it difficult to determine a feasible way to determine the density of colonies in a given area. In NBR *Apis dorsata* commonly nest in aggregations on cliffs, but not exclusively so: it is possible also to find single colonies in trees. The presence of a cliff with bees means that any small area containing a cliff will show a high bee density, while large cliff-free areas will have low densities, yet not all cliffs are populated with bees. The following methodology was followed in 2007:

Methods

Study area

The study was conducted in the dry season of 2007 in six protected areas within NBR: Bandipur National Park (BNP), Nagarhole National Park (NNP), Mudumalai Wildlife Sanctuary (MWS), Sathymangalam Reserve Forest (SRF), Silent Valley National Park (SVP), and Wynaad Wildlife Sanctuary (WWS). Bandipur, Mudumalai and Nagarhole had predominantly moist and dry deciduous forests, whereas Sathymangalam, Silent Valley and Wynaad had a mixture of wet evergreen and deciduous forests.

Colony surveys

The sampling for *Apis dorsata* nests was carried out in the six sites between January and June 2007, the major flowering season for plants (Varghese et al., unpublished data). The study was repeated for Mudumalai during the same season in 2008. After June, *Apis dorsata* leave the area. Variable distance line transects were used to estimate nest densities (Emlen, 1971). The variable width method was used because the habitat type and vegetation structure differed in each site, thereby the probability of detecting nests at different distances from the transect line also differed. Surveys were conducted in the morning hours and a minimum of five hours were taken to complete each transect of 5km. Depending on the area to be covered, the number of days spent in each area varied. In the protected areas of Bandipur, Nagarhole, Silent Valley, Mudumalai and Wynaad a minimum of two transects were done for each range, a management boundary of the Forest Department. Depending on the number of ranges for the protected area, the total length of transect varied (Table 8). By spreading the survey, we tried to cover the length and breadth of the area as against intensively looking for nests in one area. This strategy was adopted to obtain clear baseline information on nest densities. In the Sathyamangalam reserve forest area, honey hunter villages were located based on the volume of honey collected. The five villages that ranked highest in volumes of honey were chosen. Transects were then chosen randomly in different directions from the village into the forests where the honey hunters would go. Three transects of 5 km were walked in the forests around the five honey hunter villages. Distance sampling is a widely used method to assess the density and abundance of populations. We used the line transect to estimate nest densities. A standard survey is conducted along a line of known length and the nests or cluster of nests recorded together with the distance from the transect line.

One fundamental assumption of the method is that all objects on the transect line are detected, and that the probability of detection decreases monotonically with increasing perpendicular distance from the transect line. The detection function can provide estimates of error and reliable estimates of density (Diefenbach, 2007). Therefore, the distance measurements can be used to fit a detection function to the observed distances, and use this fitted function to estimate the proportion of objects missed by the survey. This method is called conventional distance sampling (Buckland S.A., 1993) (Buckland S.A., 2001). If one object in a cluster is detected, then it is assumed that the whole cluster is detected, and the distance to the centre of the cluster is recorded. The data for each study area with the

cluster size and distance from the transect line, was entered into the Distance 4.1 programme and the Akaike Information Criterion. (Akaike, 1974), selected the best-fit model.

The survey was repeated in Mudumalai Wildlife Sanctuary in 2008 using the same transect route, and the density was estimated in the same manner. *Apis dorsata* nests are large and easily visible and the probability of missing nests with increasing distance is probably lower than for cryptic species. Linear transects of different lengths were established in each study area. The length of the transect was estimated with a pedometer. The nests or colonies (cluster of nests) were detected by experienced observers including local honey collectors, and the perpendicular distance of the nest to the transect line, was estimated subjectively by multiple observers (3+).

The length of all the transects in each study area was summed to give the overall transect length. However, since the observers were not standardised between sites, and in some cases, such as Sathyamangalam, the observers were more skilled and the paths taken were not strictly random, the densities only give approximate values and are an indicator of the relative ranking of the different study area with regard to nest densities. As such, it is a valuable tool for management.

Results

Colony numbers in most sites were small with a few nests (Table 9). It was only in Sathymangalam and to a lesser extent in Mudumalai, that nests were aggregated in larger numbers. There was a four-fold difference in nest densities between sites, Sathymangalam Reserve Forest having the highest nest densities (2.1 ha-^{1}) and Silent Valley National Park the lowest (0.02 ha-^{1}). This is because the nests in Sathymangalam were in larger aggregations, sometimes in hundreds. Nest densities in Mudumalai Wildlife Sanctuary were similar in 2007 and 2008 (Table 8).

Table 8. Information pertaining to the study sites and nest densities of *Apis dorsata*

Site	Reserve size (km2)	Transect length (km)	Numbers of *Apis dorsata* colonies	Numbers of trees with colonies	Numbers of *Apis dorsata* colonies on trees	Numbers of cliffs	Numbers of *Apis dorsata* colonies on cliffs
Bandipur NP	874	60	92	14	61	4	31
Mudumalai WLS 2007	321	40	394	19	346	2	47
Mudumalai WLS 2008	321	40	301	32	262	2	39
Nagarhole NP	644	50	249	62	249	0	0
Sathymangalam RF	1360	75	1153	10	18	24	1036
Silent Valley NP	89.5	15	2	2	2	0	0
Wynaad WLS	344	60	181	69	181	0	0

NP = National Park, WLS = Wildlife Sanctuary, RF = Reserve Forest
Where level of protection NP > WLS > RF

Table 9. Results of the conventional distance sampling method

Site	Estimated strip width (m)	Density, of *Apis dorsata* nests ha-1	95% CI		Coefficient of variation
			upper	lower	
Bandipur NP	34	0.34	0.15	0.76	0.41
Mudumalai WLS 2007	47	0.78	0.27	0.49	0.6
Mudumalai WLS 2008	44	0.82	0.41	1.63	0.36
Nagarhole NP	16	1.58	0.98	2.5	0.21
Sathymangalam RF	25	2.1	0.8	5	0.44
Silent Valley NP	30	0.02	0	289	0.86
Wynaad WLS	24	0.56	0.28	1.14	0.36

Table 10. Differences in bee nest densities between sites

Sites	Number of 10m plots	Total area surveyed km^2	Total number of bee colonies	*Apis dorsata*	*Apis cerana*	*Apis florea*	*Trigona sp.*
Appankappu (no cliffs, wet forest)	93	6.52	61	24	14	2	21
Bedaguli (no cliffs, wet forest)	100	11.61	70	46	15	5	4
Kalidhimbam (+ cliffs, dry forest)	103	5.11	93	70	13	5	5
Kurimande (no cliffs, dry forest)	100	9.83	55	11	11	20	13
Bekkapathy Mund	100	to be calculated	10	0	10	0	0
Kodithen Mund	46 (in progress)	to be calculated	6	0	6	0	0

Concerning knowledge of densities of honey bee and Melipona species at 4 sites (2 wet forest, 2 dry forest) 2008 and 2009 field work

Methodology to determine numbers of bee colonies

In 2008 and 2009 we looked at the nest densities of *Apis cerana, Apis dorsata* and *Apis florea* and the Melipona bees, in six sites with different vegetation types in NBR using 100, 10x10m quadrats randomly laid radiating from a hamlet with honey hunters. We assessed plant diversity and abundance using the same quadrats. We also quantified the bee flora in these six sites by estimating the densities of plant species visited by bees in each site and their floral output. [Full details described in draft paper by Thomas, et al.].

Results concerning bee nest densities [Table 10 taken from draft paper: Determinants of bee nest densities by Thomas, et al., 2008]

Discussion of data on bee nest densities

The variation in density of the different bee species at different habitat types is to be expected, and is discussed more fully in the biodiversity papers.

The figures in Table 9 show *Apis dorsata* nest densities between 0.02 and 2.10 nests per hectare, or 2-210 nests per 1km^2. These figures are of the order expected. The data for *Trigona spp*. are within the range expected: for example Roubik, comparing a number of studies, states that stingless bee nests number approximately 150 per square km (100ha) although 'an estimate of 2 to 6 colonies ha-1 seems to apply to larger or detectable colonies' (Roubik DW, 2006). The figures shown in Table 10 (2008 field work) appear to give higher bee nest densities per hectare. This work is still in progress.

Results

A summary of what we have learned so far concerning bees in NBR

For the livelihood relevant bee species: we have created a list of bee species of NBR with a key to their identification. By providing samples to wider studies, we have contributed to knowledge of the origins of these bees. We have knowledge of the numbers of colonies of some of the species in some of the sites, and other areas of NBR. Also knowledge of where the bees are, and their distribution patterns in relation to vegetation. The livelihood studies will contribute considerably to our knowledge of the extent to which these bees are exploited, and new information has been gained from local people concerning bee management, for example from Nilambur, that people clear vegetation towards encouraging the nesting of *Apis dorsata*. Thus NBR represents an area showing all stages of bee management – from opportunist use of nests, through management to encourage wild nesting colonies, 'bee having' of *Apis cerana* colonies in trees by Toda people, and to standard beekeeping of *Apis cerana* in wall and frame hives.

Discussion

Is honey hunting sustainable?

We have learned from this project that all the bee species are hunted, not just *Apis dorsata* as highlighted by most literature on Asian honey hunting.

Honey hunting of these species may be said to be sustainable if the rate at which colonies are harvested is less than the ability of the population to replace those that have been harvested. To calculate the sustainability of the honey hunting it is necessary to know the density of colonies in harvested areas, the species' reproductive rate, species longevity, and survival rates after harvest, the numbers of people involved in honey hunting, and the numbers of colonies harvested. Reproductive success rate will be influenced by the density of the population, other bee populations

competing for resources, predators, forage and nest site resources and variables such as rainfall.

In this Project, knowledge of the nest densities in areas that are known to be without honey hunting can provide valuable indication of the maximum population carrying capacity of the environment. In areas where honey hunting is practised, the nest density will be lower and the rate of reproduction will be higher than in environments that are full to capacity with bees. Therefore, where honey hunting is practised, it is expected that colonies may be reproducing at a higher rate than in 'saturated' areas, and consideration should be given to the dates of the field work and whether recent, small swarms could have been counted in addition to established colonies.

What we still need to know

Concerning honey-hunted bee species, we need to finalise colony counting for 2009, such that we have data for five project sites. We need to consider data from the livelihood studies concerning species hunted and volumes of honey harvested, and endeavour to gauge whether the harvesting rate may be considered sustainable.

Acknowledgments

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Endnotes

[1] *11 species are shown here, as named by (Michener, 2000).*

[2] *A term coined by Eva Crane (pers.comm.).*

[3] *Paul Molga, La mort des abeilles met la planète en danger, Les Echos, 20 August 2007.*

[4] *Honey bees in Jammu and Kashmir State have been infested by the Korean haplotype of Varroa. The impact has been devastating with 80% of the honey bee colonies in the State destroyed during October to December 2005, with irreparable loss to bee farmers. Colonies in the neighbouring States of Himachal Pradesh, Punjab, Rajasthan, Uttaranchal and Uttar Pradesh have also been infested (Khushu, 2006).*

[5] *Data compiled from reports held at Bees for Development, UK.*

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(2C) Pollination of cardamom and coffee in the Western Ghats of Karnataka - Need for conserving bees and bee flora

V V Belavadi and C Parvathi

Abstract

In the Western Ghats of Karnataka, two important commercial crops, viz., coffee and cardamom, are cultivated under the shade of forest tree species. Both these species are predominantly insect pollinated, depending on honey bee populations for successful fruit set. Many of the forest tree species that are retained for shade in cardamom and coffee plantations also serve as good sources of nectar and pollen for the bees in the off seasons and hence help in sustaining their populations throughout the year.

In recent years, there has been a trend towards removal of old forest trees for timber and planting quick growing species like silver oak and *Erythrina*, which no doubt serve as good shade trees for coffee and cardamom but are not good sources of pollen and nectar for bees. This is severely affecting the populations of honey bees and other native pollinators in the zone. Keeping this as the background, a systematic attempt was made to understand the pollination biology of cardamom and coffee, at the Zonal Agricultural Research Station, Mudigere, Karnataka. Additional observations were recorded on the flowering phenology of bee flora in and around cardamom and coffee plantations, and their role in sustaining pollinator populations. In addition, the findings of these studies were passed on to the farmers of the region through a series of training programmes.

Introduction

Green plants are the primary food source for the Earth's living biota and cross-pollination is fundamental to sexual reproduction in plants with its associated adaptive advantages. It is not an exaggeration to say that diversity of plants in a given place depends on the diversity of pollinators. Pollination is an essential ecosystem service that is vital in sustaining natural diversity. According to an estimate the overall mean value per annum of pollination services to global agriculture is $ 200 billion (Richards, 1993). Reduction in the abundance of pollinators or their possible disappearance has concerned many people, and the conservation of pollinators has consequently become an integral part of many biodiversity conservation efforts.

The Western Ghats of India is one of the world's 18 Biodiversity Hot Spots, i.e., a region of high levels of biological diversity under threat of rapid loss (Myers, 1990). It is an island of tropical humid forests at a considerable distance from the large humid forest tracts of Southeast Asia, and harbours a large number of endemic species. Bees constitute an important element in the breeding success of a large majority of plants in the Ghats.

Cardamom *(Elettaria cardamomum)*, the queen of spices, and coffee (*Coffea arabica* and *Coffea canefora*), the king of beverages, are the two commercial crops cultivated within the Western Ghats, under the shade of trees. Both these crops solely or largely depend on bees for pollination and fruit set (Parvathi et al., 1993; Belavadi and Parvathi, 2000; Belavadi et al., 2006). The shade trees, which are usually the original forest tree species, play an important role in conserving populations of bees, providing nesting habitats and sustaining them in periods when neither coffee nor cardamom is in bloom. But, in the recent past there has been a trend towards felling of old forest trees in and around plantations for timber and replacing them with quick growing species like silver oak and *Erythrina*. This has probably resulted in reduction in populations of pollinators which in turn might affect cardamom and coffee production in the region. In the present paper we make an attempt to highlight the dependence of these two important crops on bees and the role played by the shade trees in conserving populations of pollinators.

Material and Methods

Study site: The study was conducted at the Zonal Agricultural Research Station, Mudigere (13° 7′ N and 75° 37′ E; 980 m), University of Agricultural Sciences, Bangalore and in private cardamom and coffee estates close to the station. Observations were recorded on the floral biology of cardamom and coffee, pollinator guild involved in the fruit set and the behaviour of major pollinators.

Studies on cardamom

The plant: The cardamom plant grows in clumps of 20 to 25 pseudostems and its flowers are borne on panicles that arise from the base of these pseudostems. Panicle production commences in December-January. Flowering is between May and October, with peak flowering in July-August. Each panicle may bear 1 to 5 flowers and during peak flowering 25 to 30 flowers are seen radially arranged around each clump.

Floral biology: Observations were recorded on the time of anthesis and pollen dehiscence, flower longevity and duration of flowering.

Pollen viability: In cardamom anthesis occurs around 5 am and dehiscence occurs around 7 am. In order to find out how long the pollen remains viable on the anther lobe, pollen grains were collected from flowers at hourly intervals and put for germination tests in 10% sucrose solution. The germination medium was placed in a cavity slide and a known number of pollen grains (usually 100) was placed in the medium. Observations on the number of germinated pollen grains and the length of pollen tubes were recorded under a stereo binocular microscope after five hours. The pollen germination studies were repeated on five days. On each day pollen grains were collected at hourly intervals commencing from 7 am till 6 pm.

Stigma receptivity: Stigma receptivity studies were conducted in situ. Cardamom flowers were selected and hand pollinated using pollen grains from other flowers. Hand pollination was done at intervals of two hours commencing at 7am and continuing till 7pm. Every time a set of 25 flowers was used and another set of 25 flowers was maintained as control with open pollination. Fruit set observations were recorded at the end of the season.

Behaviour of flower visitors: The foraging behaviour of individual species of flower visitors was recorded by closely observing marked bees. Individual bees were uniquely marked using quick drying paints. Observations were recorded on the peak foraging time in a day and on the number of visits made by individual bees to a given clump, number of flowers visited per clump, number of visits to a single flower and on the time lag between visits.

Flower density: Number of flowers per clump was recorded at fortnightly intervals commencing in the first fortnight of May and continuing till October (n = 25 plants/ observation day). The density of flowers was recorded as low (< 5 flowers); medium (6 to 15 flowers); high (15 to 25 flowers) and very high (>25 flowers).

Flower visitors: We recorded the species of flower visitors and the numbers of each species in different flower density situations, in different months.

Per cent fruit set in cardamom: Number of flowers produced by individual plants was recorded daily throughout the flowering duration commencing from the second week of May till the first week of October. The total flowers produced per clump and the total number of fruits set were recorded individually for ten clumps.

Studies on coffee

The plant: Both *arabica* and *robusta* coffee are perennial shrubs that are pruned to a height of about 1.5 to 2 meters to facilitate easy harvesting. The shrubs are usually planted 2 to 3 meters apart, normally on hill slopes under the shade of forest trees. They begin bearing in about 3 to 4 years, reach full bearing by 12 to 15 years, and may continue up to 100 years or more (Hearer, 1962). Both the species flower after a moisture stress of about 3 months, followed by what is called “blossom shower” usually in the month of March.

The fragrant whitish flowers are borne in clusters in leaf axils. Each flower measures about 10 mm with 7 to 8 mm long corolla tube. Usually there are five stamens attached to the corolla between the lobes, and the anthers are not necessarily close to the stigma. Anthesis occurs during the early morning hours and pollen dehiscence is almost immediate. Nectar is secreted at the base of the corolla and honey bees and several other insects visit coffee flowers to collect both nectar and pollen. Two days after opening, the parts begin to wither and fall, leaving the ovary (Hearer, 1962). Lingering of the withered blossoms on the tree is an indication of non-fertilisation, whereas if the petals fall freely and soon, they have been pollinated and a good crop is to be expected (Krug, 1935).

- **Three days after the blossom showers in the third week of March, all flower buds on four plants each of *arabica* and *robusta* coffee were counted and recorded. Two plants of each species were enclosed in shade-net cages (2 x 2 x 3.5 m) to prevent flower visitors. The remaining two plants were tagged and were left open for bee visits.**

- **Ten plants each of *arabica* and *robusta* were selected and on each of these plants five branches were randomly labeled. All flower buds on these branches were counted and recorded separately. Of the five branches one randomly selected branch was enclosed in a sleeve made of wire mesh (6" dia and 1 m long). Further, five of the wire mesh sleeves were wrapped with a fine muslin cloth. Wire mesh allowed wind movement but prevented insects while the muslin cloth prevented both.**

- **Observations were recorded on all flower visitors on the day of blooming and on the following day in both *arabica* and *robusta* plants. A cumulative total of 78 hours and 30 minutes were spent recording observations on the foraging behaviour of bees and other pollinators.**

Observations were recorded on the number of berries set in all the tagged plants and branches two months after flowering. A total of 5,988 flower buds on 115 branches of arabica and 15,301 flower buds on 97 branches of robusta, were followed till fruit set and maturity.

Flowering phenology of shade trees

Observations were recorded on the species of shade trees in and around coffee and cardamom plantations and their flowering phenology. A floral calendar was prepared for the region using this data to identify species that are useful in sustaining bee populations in times when cardamom and coffee are not in bloom.

Training stakeholders

A series of training programmes was conducted to educate farmers on the importance of bees in cardamom and coffee production and on the need for conserving flora in their estates.

Results and Discussion

Studies on cardamom

Floral biology of cardamom: Flowering in cardamom commenced in May and continued till September. Anthesis occurred between 4.15 and 5.30 am and a flower lasted for a single day. Pollen dehiscence occurred around 7.30 am.

Pollen viability: Observations recorded on the pollen load on stigma at different times of the day showed that there was a progressive increase in the number of pollen grains deposited on the stigma of cardamom flowers as the day progressed (Fig. 7). Pollen grains remained viable throughout the day and germination was around 76.2%. Maximum pollen germination occurred between 9 and 11 am and at 1 pm.

Stigma receptivity: The stigma remained receptive throughout the day. However, maximum germination and elongation of pollen tube occurred around 12 noon, which coincided with peak forager activity. Pollen grains of a cardamom flower when deposited on the stigma of the same flower germinated normally and resulted in fruit set indicating that there is no self incompatibility in cardamom. When bee visits were restricted to different hours of a day maximum fruit set was recorded at 12 noon which did not significantly differ from the flowers that were left for open pollination.

Foraging behaviour of honey bees: Foraging on cardamom by honey bees was observed throughout the day from around 0730 hrs till about 1830 hrs. However, the peak activity of honey bees was between 1100 and 1300 hrs (Fig. 8).

The commencement of foraging activity depended on the temperature. Bees started appearing at cardamom clumps when the temperature was above 21ºC. On an average, a bee visited 12 flowers per clump. Individually marked bees could be easily tracked and the number of flowers visited and time spent were recorded. Individual foragers of *A. cerana* made four to seven trips to a single patch of flowers in a day and the number of flowers visited per trip on each successive trip progressively increased. This could be because in the early hours of the day the quantity of nectar available per flower was higher compared to that in the afternoon hours.

Fig. 7. Number of pollen grains deposited on stigma in different times of a day

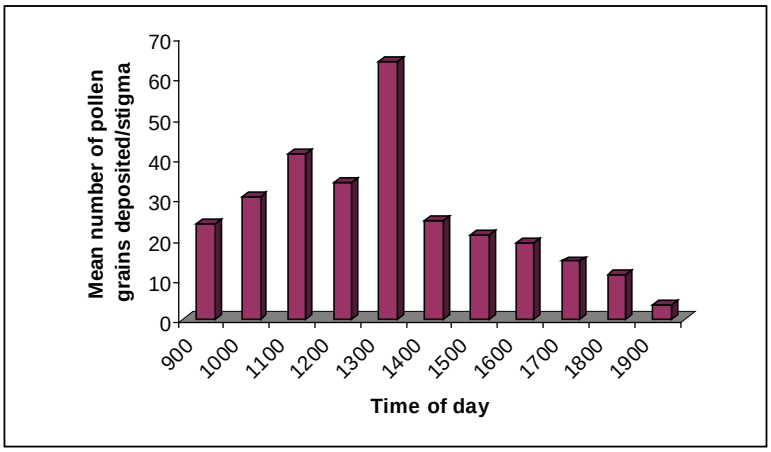
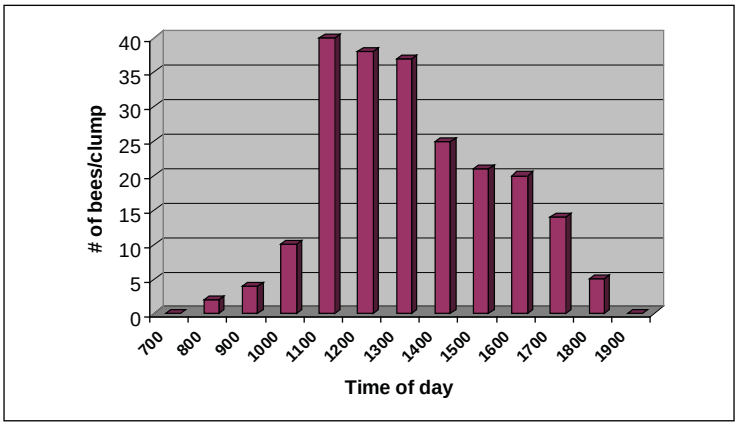


Fig. 8. Foraging activity of *Apis cerana* on cardamom



Proportion of pollen and nectar collectors: In case of both *Apis cerana* and *A. dorsata*, the first bees to arrive at cardamom clumps were pollen collectors. The proportion of pollen collectors was high till around 1000 hrs and the proportion of nectar collectors gradually increased by about 1100 hrs. In the afternoon hours the bees foraged for only nectar (Fig. 9).

Flower density: Flowering commenced in May and continued till October. The flower density varied greatly and significantly differed between months. The flower density was very low to low in the beginning of the flowering season in May, medium to high in June and early July and very high in late July and August. The flower density declined again in September. In May, the flower density ranged from 0 to 3 (x = 2.8), which increased slightly to 7.2 (5.3 to 9.7) in June and to 18.7 (16.4 to 24) in the first fortnight of July. In the second fortnight of July the mean number of flowers was 29.7 (24 to 35) and in August it was 35.5 (32 to 44). The flower density declined in September to 18 (13.2 to 21) and further reduced to 5.2 (4.3 to 6.7) (Fig. 10).

Flower visitors: Flowers of cardamom were visited by seven species of bees, including four species of *Amegilla (*Anthophoridae*), Apis cerana, A. dorsata* and *Pithetis sp. Amegilla spp.* collected only nectar while the honey bees and *Pithetis* collected both nectar and pollen from cardamom flowers.

Species diversity: The species of flower visitors and their abundance differed with the variation in flower density as the flowering season progressed. In May when the flower density was lowest, the only species foraging on cardamom flowers was *Amegilla cingulata*

Fig. 9. Proportion of Pollen and Nectar collectors among *Apis cerana* foragers at different times of a day

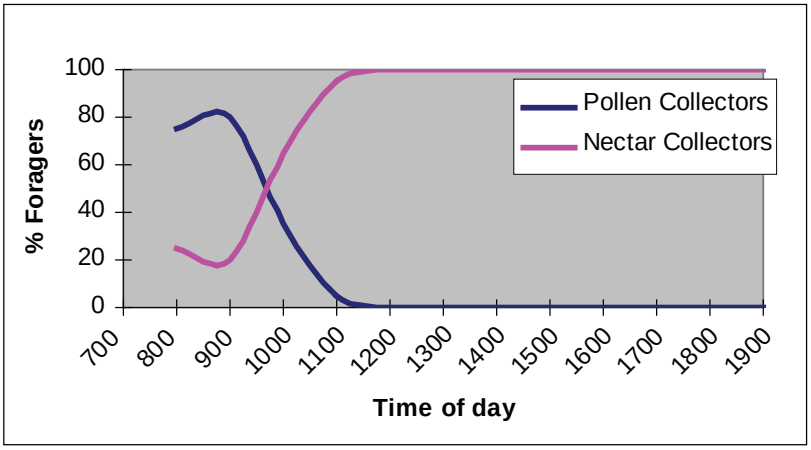
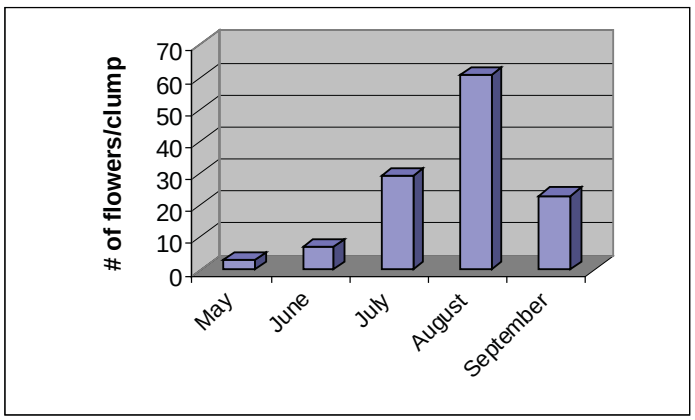


Fig. 10. Variation in flower density in cardamom in different months



(Fabricius). With an increase in flower density (7.2 flowers) in June, four species of *Amegilla* were observed foraging for nectar with over 50% of the forager population comprised of *Amegilla zonata* (Linnaeus). With further increase in flower density in July (18.7 and 29.7 flowers), the populations of *Amegilla* were considerably reduced and *A. cerana* forager population was maximum comprising more than 80% of all foragers. In August with peak flowering and a density of over 30 flowers per clump, *A. dorsata* appeared and dominated the forager population; the other major pollinator was *A. cerana*. With a decline in flower numbers in September, the pollinator diversity reduced, with only *A. cerana* foragers on cardamom flowers and with only *Amegilla insularis* (Smith) in October, when the flower density was lowest.

Role of non-*Apis* bees: It was evident that forager density depended on flower density (Fig 11). In the beginning of the season, when the flower density was low, honeybees were not recruited. This may be due to the fact that under such situations, a bee has to spend more energy in flight between flowers and hence there may not be any recruitment (Waser, 1982; Belavadi et al., 2002). Under very high flower density situation, *A. cerana* was replaced completely by *A. dorsata*. *Apis dorsata* foragers being robust, moved quickly between flowers and spent least time per flower, making nectar unavailable for cerana foragers. *Amegilla spp*. were responsible for fruit set under low flower density situations, when honey bees almost ignored cardamom flowers. The present study has clearly shown the importance of conserving *Apis* and non-*Apis* pollinator populations for maximising cardamom pollination and fruit set.

Per cent fruit set in cardamom: The number of flowers produced per clump varied from 636 to 1654 (x = 1156) and the number of fruits set per clump ranged from 208 to 584 (x = 331). The per cent fruit set was about 31 (Fig. 12). One of the main reasons for low fruit set could be inadequate pollinator populations.

Fig. 11. Relation between flower density and forager population

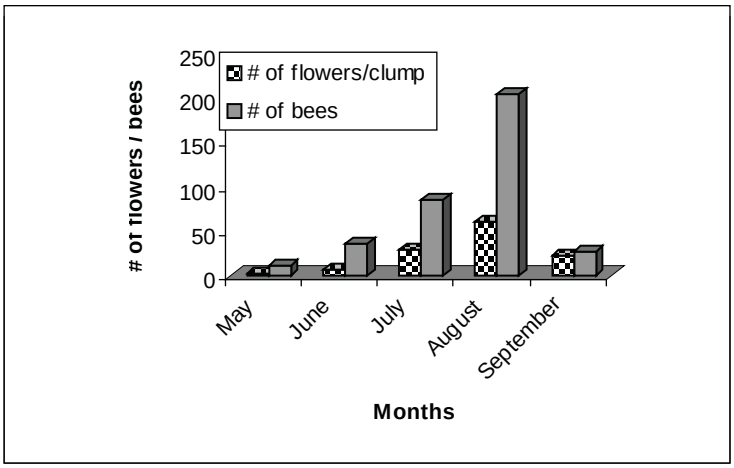
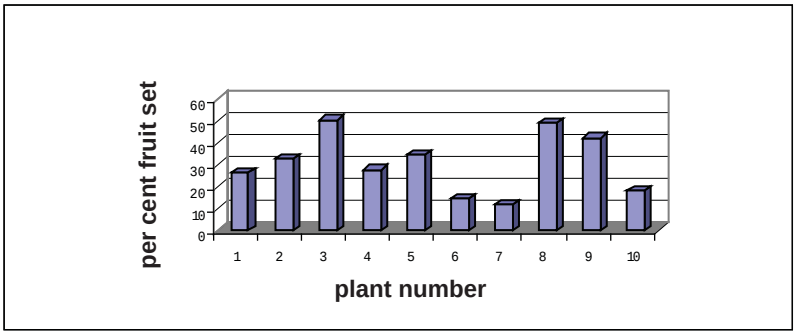


Fig. 12. Per cent fruit set in cardamom



Flower visitors of coffee: Both *arabica* and *robusta* flowers were visited by seven species of bees including *Apis cerana, A. dorsata,* two species of *Amegilla, Pithetis sp. Trigona irridipennis.* and *Xylocopa sp*. Of these *A. cerana* (Fig. 13) was the most dominant species and constituted 73.45 % and 79.1% of all flower visitors on arabica and robusta coffee, respectively (Fig. 14).

The honey bees and *Pithetis* sp. collected both pollen and nectar, *Trigona* collected only pollen and *Amegilla spp*. and *Xylocopa sp*. collected only nectar from the flowers. Visits by *Trigona* were relatively more to *arabica* flowers. The peak forager activity was around 11 am though foraging was observed from around 7 am till 4 pm.

Fig. 13. *Apis cerana* visiting arabica flowers

Fig. 14. Frequency of visits by different species of bees to flowers of *robusta* and *arabica* coffee

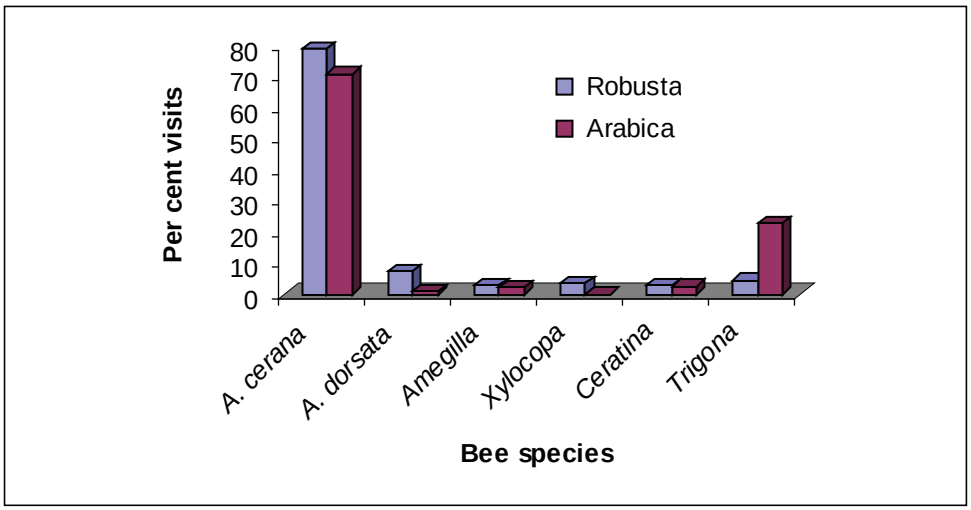


Fig. 15. Effect of bee visitation to flowers on per cent fruit set in *arabica* and *robusta* coffee

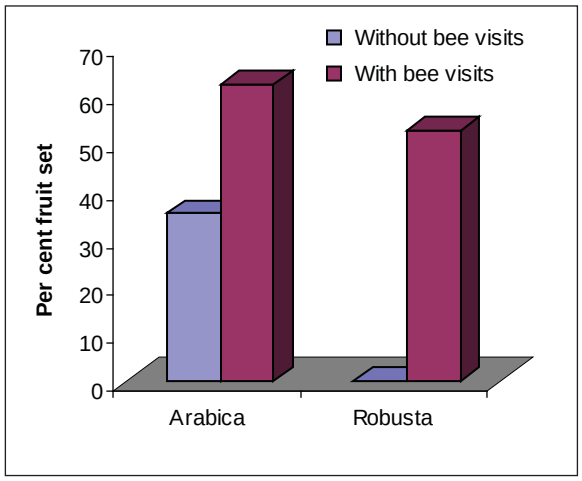
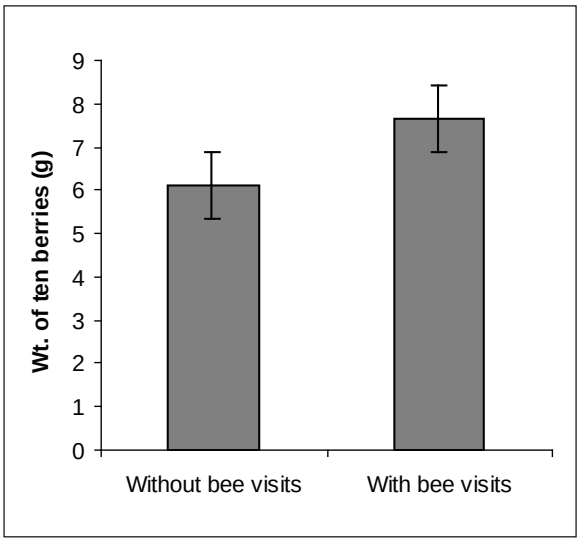


Fig. 16. Effect of bee visitation on weight of berries in *arabica* coffee



Impact of insect visits on fruit set: In *arabica* coffee the fruit set in plants that were allowed insect visits was 62% compared to 35% in caged plants ($t = 2.53$; $p = 0.021$; $n = 10$ plants each) (Fig. 15).

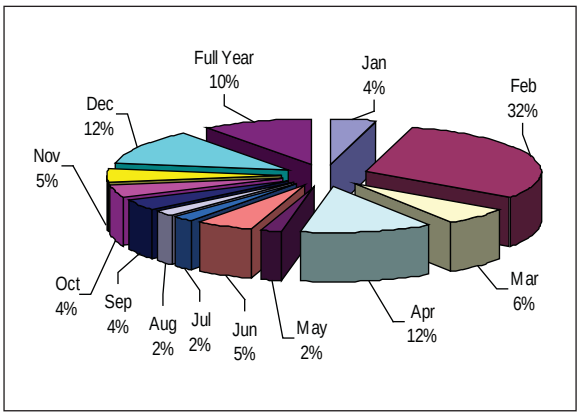
When branches were enclosed in wire mesh sleeves with muslin cloth wrapping, the fruit set was only 21.54% while in branches left open, 44.66% of the flowers set fruits. In branches that were enclosed with wire mesh sleeves, the fruit set was 26.09%. However, there was no significant difference in fruit set between wire mesh sleeve enclosed branches and those that were enclosed with wire mesh sleeves wrapped with muslin cloth. There was absolutely no fruit set in *robusta* plants that were caged while those that were left open for insect visits recorded 52.3% fruit set.

Impact of insect visits on weight of berries: Berry weight taken six months after flowering indicated significant differences between weight of berries from *arabica* plants that were prevented insect visits (6.12 ± 0.74 g/10 berries) compared to those that were allowed insect visits (7.65 ± 0.61 g/10 berries) ($t = 5.01$; $p = 0.05$) (Fig. 16).

The above results clearly indicate that insect visitation plays an important role in fruit set of both cardamom and coffee (be it *arabica* or *robusta*). In *arabica*, in spite of it being self fertile, insect visits increased fruit set by 49.3%. Similarly Roubik (2002) showed that feral colonies of *Apis mellifera* increased fruit yield by 56% in *arabica* coffee in western Panama. He also suggested that bee pollination in arabica coffee increased berry weight, which supports our findings.

Apis cerana being the predominant flower visitor of coffee, our preliminary studies have shown that wild (feral) populations of *A. cerana* are important pollinators of both *arabica* and *robusta* coffee and that by keeping bee colonies or by conserving bee populations, by conserving plant diversity and nesting habitats in and around coffee plantations, we can expect considerable increase in coffee production.

Fig. 17. Flowering phenology of shade plants and other flora in and around cardamom and coffee plantations (Chikmagalur District, Karnataka)



Flowering phenology of shade trees

Flowering phenology of the existing shade trees, shrubs and common herbs in cardamom and coffee plantations were recorded. We have recorded 182 species of plants which have promise as important bee plants for conserving bee populations. Two species of *Schefflera*, viz., *S. venulosa* and *S. wallachiana* have been identified to play an important role in conserving honey bee populations as their flowering is after that of coffee and just prior to flowering in cardamom. A floral calendar was prepared using flowering periods of these plants (Fig. 17).

Conservation of bee plants in the region is important because bees require nesting sites and forage throughout the year (Cardamom and coffee are seasonal). In coffee and cardamom plantations there has been indiscriminate felling of shade trees (for timber) and in most estates the tree species diversity has significantly reduced and there was a need to identify quick growing bee plants that can serve as shade trees and help in conserving bee populations in the off-seasons.

Training stakeholders

The stakeholders are the farmers who cultivate cardamom and coffee within the Western Ghats. Seven training programmes were conducted on various aspects of bee and bee flora conservation. Each programme was for seven days with 28 to 30 participants in each. A total of 200 farmers were trained.

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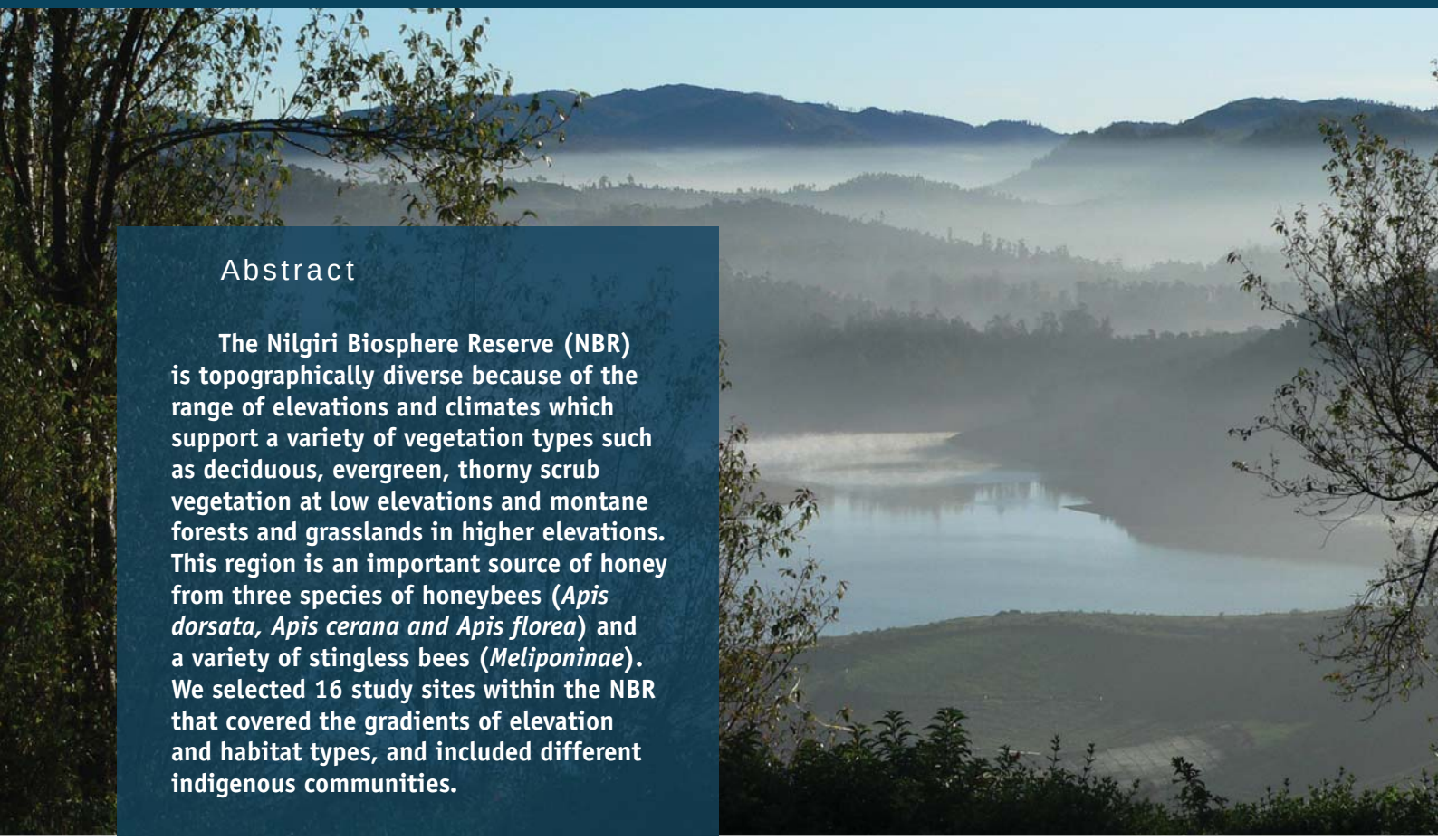
(3)

WHAT'S THE STORY ON BIODIVERSITY LINKAGES ?

(3A) Bees and Biodiversity in the Nilgiri Biosphere Reserve - an overview

Anita Varghese, Pratim Roy, Simon G Potts and Priya Davidar



Abstract

The Nilgiri Biosphere Reserve (NBR) is topographically diverse because of the range of elevations and climates which support a variety of vegetation types such as deciduous, evergreen, thorny scrub vegetation at low elevations and montane forests and grasslands in higher elevations. This region is an important source of honey from three species of honeybees (*Apis dorsata, Apis cerana and Apis florea*) and a variety of stingless bees (*Meliponinae*). We selected 16 study sites within the NBR that covered the gradients of elevation and habitat types, and included different indigenous communities.

Using these sites we investigated the relationship between vegetation structure and diversity and honeybee nest densities, and assessed the inter-dependency of honey and wax harvesting and livelihoods of the forest-based communities. The results identified strong linkages between the biodiversity, of both bees and flowering plants, in local landscapes and livelihoods involving both agriculture and non timber forest products. However, the details of the inter-linkages between biodiversity and livelihoods were diverse and specific to the geographical area, the type of bees and flowering plants present in a particular locality, and the cultural practices of the indigenous people. The findings of this project have identified clear linkages, and established criteria under which these linkages are possible and can be resilient in the face of the larger changes that impact the overall system.

Introduction

Ensuring linkages between various components of biodiversity requires an understanding of these components. One such component of biodiversity of the Nilgiri Biosphere Reserve is the tropical bees of this region. Tropical bees perform an important ecosystem service by pollinating wild and crop plants. However, despite their importance, little is known about their ecology and conservation

status. Tropical bees are probably affected by habitat fragmentation (Aizen and Feinsinger 1994) and have suffered losses in highly degraded habitats (Liow et al., 2001). Studies have shown that less fragmented primary forests are very important in maintaining viable populations of bees (Liow et al., 2001). Loss of bees would result in significant impacts on forest biodiversity, since many species are dependent on bees for pollination.

The forest dwelling communities of the NBR use honey and wax that are produced by four or more known species of social bees. Therefore understanding the ecology of the bee species and their dependence on forest vegetation is critical to understand the dynamics of honey production in this region. The Rock Bee, *Apis dorsata* Fabricius, is an important pollinator of wild and cultivated plants in Asia (Crane, 1999; Devy and Davidar, 2003; Momose et al., 1998). Human beings have harvested honey from wild bees for millennia, and many indigenous communities in the Nilgiri Biosphere Reserve have specialised traditional skills for safely collecting honey from *Apis dorsata* nests.

Products from crops and NTFP may directly rely on animal pollination for their production (e.g., fruits, seeds, pods) or the plant itself may rely on animal pollination for reproduction, even though the product itself may not (e.g., fruits, seeds, nuts, leaves, bark, roots, stems, gums and resins). Non-traded forest produce which may be used directly, such as food, fibre, medicine and construction materials or processed further to yield oils, soap substitutes and other commodities play an important role in the lives of forest dwelling communities. The most important pollinators around the world are bees, but other insects (flies, butterflies, beetles etc.), bats and birds also make significant contributions to biotic pollination (Buchman and Nabhan, 1996).

This paper seeks to understand the linkages between bees and biodiversity within the Nilgiri Biosphere Reserve, Western Ghats, India. As part of the Darwin Initiative funded project titled 'Bees, Biodiversity and Livelihoods' specific biodiversity studies were undertaken to

answer questions linking bees and biodiversity in the NBR. These studies were carried out with the objective of:

- **Assessing the diversity and abundance of bees across the Nilgiri Biosphere Reserve**
- **Recording the visitation patterns of bees to flowers**
- **Characterising the availability of floral resources**
- **Building a methodology for enumerating colonies of livelihood relevant bees**
- **Gathering information on the density and distribution of livelihood relevant bee species across vegetation types of the Nilgiri Biosphere Reserve**
- **Assessing breeding systems, identifying important group of pollinators and estimating natural level of fruit set in livelihood relevant plant species**
- **Providing baseline data on which to develop future research programmes**
- **Generating resources for inclusion in an**

Indigenous Bee Biodiversity Resource Unit

The Setting

Five research locations were chosen in the NBR area where the field work was carried out:

Location 1: Mudumalai, Tamil Nadu

Location 2: Kotagiri, Tamil Nadu

Location 3: Coonoor, Tamil Nadu

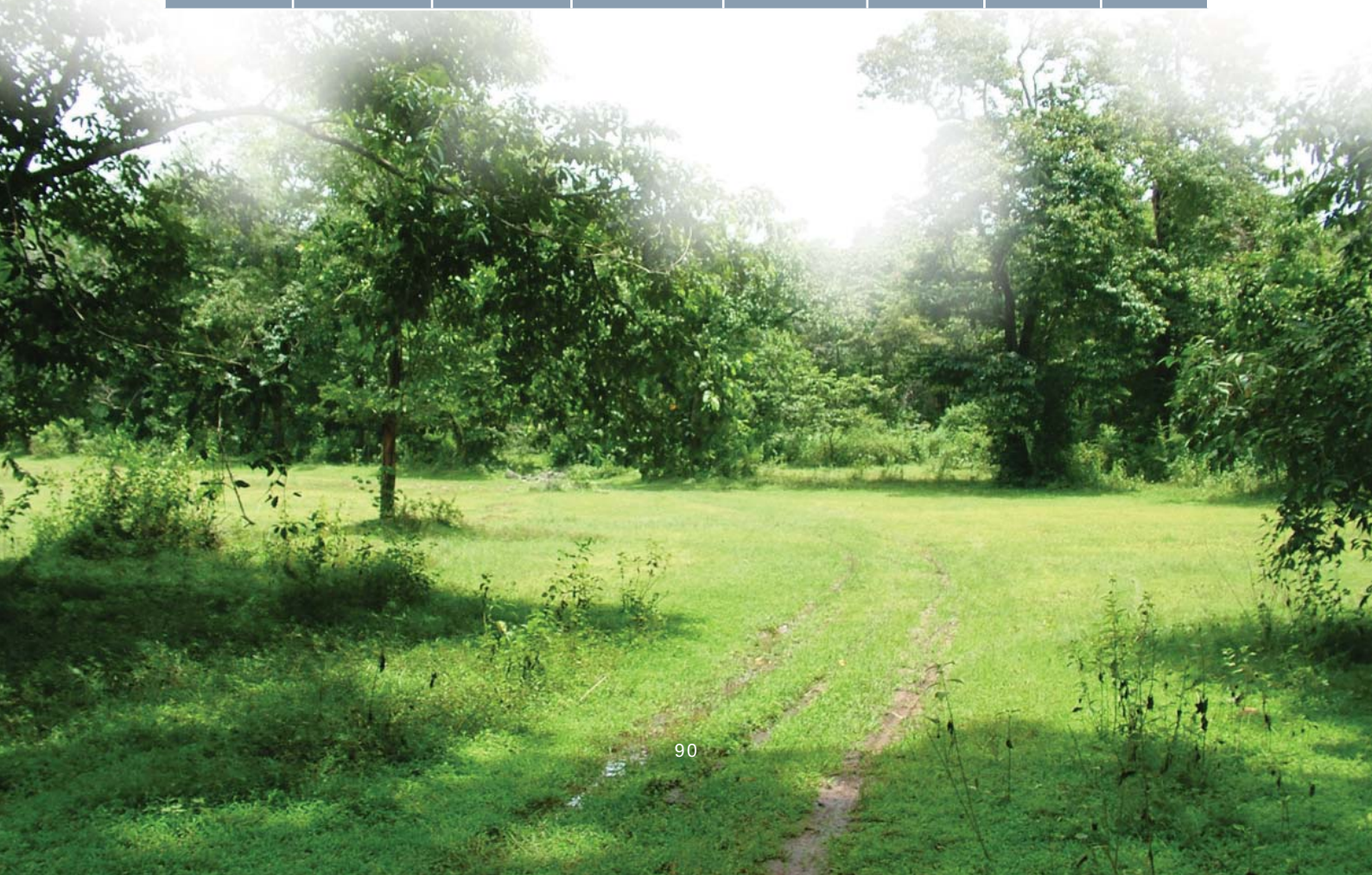
Location 4: Nilambur, Kerala

Location 5: Chamrajnagar, Karnataka

Within each of these five locations, three research sites were established, with the exception of location 5 where four sites were established. Together they formed a total of 16 sites (Refer Map 1). At each of the sites a one hectare plot was laid for pan trap and other biodiversity related studies. There was considerable heterogeneity between sites in terms of the composition of vegetation; higher elevation sites were distinct from the low elevation sites (Thomas et al., 2009). Benne in Sigur was similar to Appankappu in Nilambur while the upper montane sites of Kotagiri were very dissimilar (Thomas et al., 2009).

Table 11. Percentage of vegetation cover within a 3 km radius around the 1 hectare plots

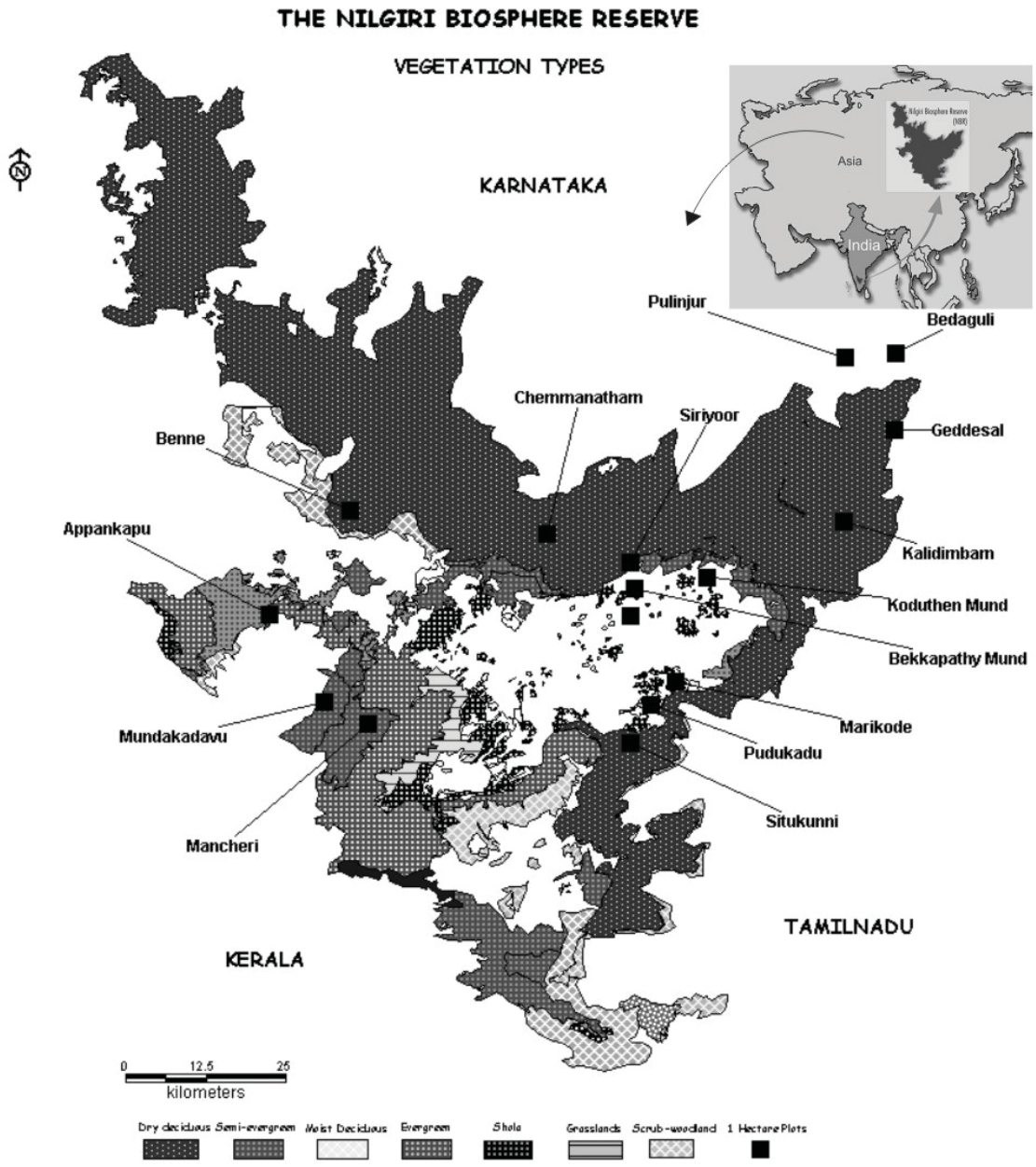
Land cover types	Bedguli-Chamrajnagar	Geddesal-Chamrajnagar	Kalidhimbham-Chamrajnagar	Pulinjur-Chamrajnagar	Marikode-Coonoor	Pudukadu-Coonoor	Situkunni-Coonoor
Dry deciduous	0	12.5	100	100	7.4	0	100
Evergreen	0	55	0	0	0	0	0
Forest Plantation	0	12.5	0	0	0	0	0
Grasslands	45	20	0	0	0	0	0
Mixed agriculture	0	0	0	0	0	0	0
Moist deciduous	0	0	0	0	0	0	0
Scrub	0	0	0	0	0	0	0
Semi evergreen	0		0	0	84.9	74.2	0
Shola	47.5	0	0	0	0	0	0
Tea and coffee plantation	7.5	0	0	0	7.7	25.8	0



Bikkapathymund-Kotagiri	Koduthen mund-Kotagiri	Tunieri-Kotagiri	Benne-Mudumalai	Chemmanatham-Sigur/Mudumalai	Appankapu-Nilambur	Mancheri-Nilambur	Mundakadavu-Nilambur
0	0	0	100	0	0	0	0
0	0	0	0	0	73.3	0	0
11.8	25.3	1.3	0	0	3.5	0	0
0	0	0	0	0	0	0	0
0	0	56.3	0	0	0	0	0
0	0	0	0	0	0	0	100
0	0	0	0	100	0	0	0
0	0	0	0	0	23.1	100	0
24.6	62.6	0	0	0	0	0	0
63.6	12.1	42.9	0	0	0	0	0

The vegetation of the NBR shows considerable fragmentation and one of the primary contributors to this has been the land use changes. On the eastern slopes which are steep, dry deciduous forests give way to the scrub of the lower plains. On the western side of the NBR evergreen and moist deciduous forests are fragmented by rubber, teak and agricultural plantations. On the southern and northern part the NBR there are largely contiguous forest patches; this may be due to the presence of protected areas. The evergreen sholas and grasslands of the upper montane areas are disrupted by plantations of tea, wattle and *Eucalyptus* spp. It is in this highly fragmented landscape that the bees and biodiversity field studies were undertaken.

Map 1. Major vegetation types of the NBR and location of project sites



Source: Thomas et al., 2009

Methods

Over a three year period, the following field studies were conducted:

- **Pan trap and Focal Observation – These methods were implemented in the first year of the project and data about pollinators, livelihood relevant bees and their floral preferences was gathered**
- **Bee Nest Density Estimates using transects and plots – Distribution of livelihood relevant bees and their habitats were intensively studied using these methods**
- **Pollination Studies on three livelihood relevant plants *Coffea arabica, Sapindus emarginatus* and *Mangifera indica* – Extent of bee dependancy on livelihood relevant plants was assessed through these studies. The plant products to be studied were chosen from a database that was prepared for NTFP and crop plants of the NBR**

Findings

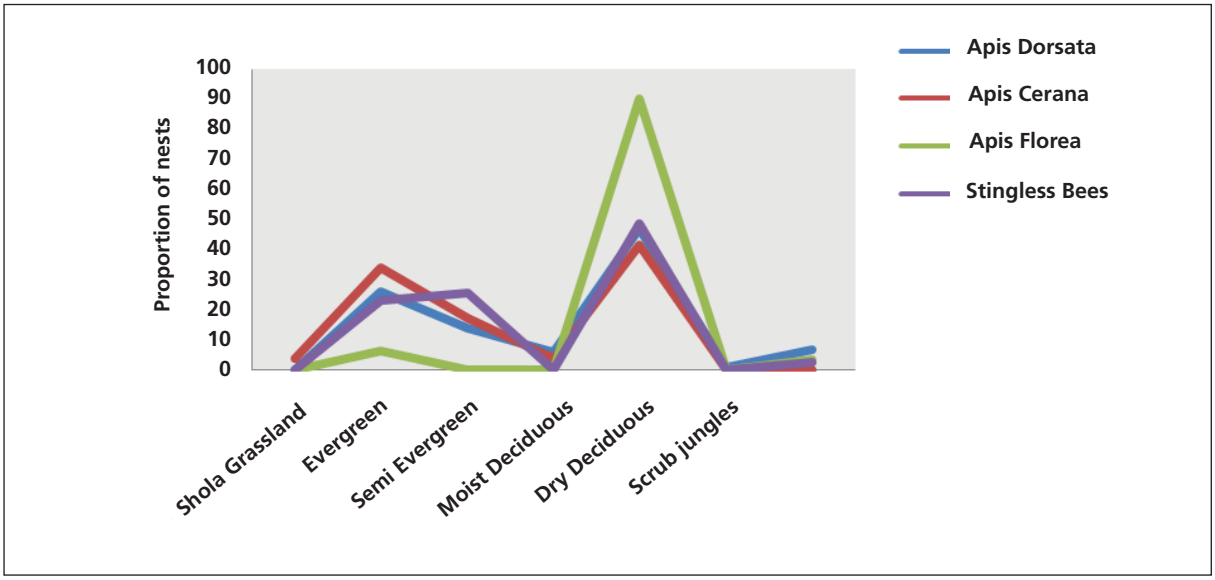
Bee diversity and distribution - Pan traps were used to assess the diversity and abundance of bees across the NBR. We found that Apidae and Halictidae family was found in all sampled areas and at all elevations with diverse vegetation types. The genera *Amgellia* was found mostly in moist deciduous forests. Genus *Apis* was found to be more abundant in farmlands, *Braunsapis, Xylocopa* and species of the family Megachilidae in semi evergreen forests, *Ceratina* and stingless bees in dry deciduous forests, *Halictus* in semi evergreen and dry deciduous and *Lasioglossum* in deciduous and semi evergreen forests.

Floral preferences of social / livelihood relevant bees - Focal observations that were done across the sites along with the pan traps show that bees differ in their selection of flowers, both wild and cultivated. *Apis cerana* were found to visit more plant species than other bee species and tended to visit species that were visited by other bees too. Of the 73 species of flowers observed, 23% were visited only by *Apis cerana* followed by *Apis dorsata* and *Apis florea* (Thomas et al., 2009).

Density of social / livelihood relevant bees in the forests - An assessment was made of the nest densities of four bee taxa: *Apis cerana, Apis dorsata, Apis florea* and stingless bees within four of the research sites. The study shows that bee nest densities differed significantly between species and sites. The largest honeybee *Apis dorsata* had the highest nest densities overall and the values ranged between 8 to 34 nests ha-^{1} (Thomas et al., under review). *Apis florea* were the least common, occurring at the lowest densities. *Apis dorsata* and *Apis cerana* densities did not differ between sites, while *Apis florea* and stingless bee did vary and were more common in the dry forests with an open canopy and shrub cover. The smallest bees, the stingless bee nest densities of 400 to 1300 per km^{2} fall within the estimated range of 15 to 1500 nests per km^{2} (Roubik, 2006).

A sum of all the bee nests within a vegetation type showed that dry deciduous forest types were preferred by social bees, with 90% of the *Apis florea,* 49% of the stingless bee, 47% of *Apis dorsata* and 42% of the *Apis cerana* nests being present. The evergreen vegetation type followed the deciduous in abundance of nests. The least number of nests and species was recorded for the shola grassland type with only *Apis cerana* occurring there. The percentage of nests occurring across vegetation types is represented in the graph below (Fig. 18)

Fig 18. Percentage of bee nests across vegetation types in the NBR



Nesting preferences exhibited by social/livelihood relevant bees in the forests - The studies conducted suggest that several parameters of floral communities and geography or landscape are important determinants of the quality of nesting sites for a range of social bees. *Apis dorsata* were associated with tall trees, cliffs and diverse floral communities, though the latter was only marginally significant. *Apis florea, Apis cerana* and stingless bees all favoured open canopies. *Apis florea* nests were more in areas of higher shrub cover and stingless bees preferred sites with diverse shrub and flower communities.

Studies have shown that *Apis dorsata* preferentially nested on cliffs and large trees in the Nilgiri Biosphere Reserve (Roy et al., under review, Thomas et al., 2009). The cavity nesting bee, *Apis cerana* were more evenly distributed in all the sites and nests were fairly independent of vegetation characteristics, although marginally associated with open canopy. *Apis florea* might be more dependent on vegetation characteristics since they nest on shrubs and thickets. Associations with vegetation parameters suggest a strong preference for open habitats and broken canopy. Stingless bees were also more common in dry forests and the presence of nests was negatively related to tree cover, and positively with plant species richness, suggesting that diverse vegetation was important for this species.

Pollination services from bees - Through our study in the NBR we identified 213 plant species important to local people, a third of which were cultivated and two thirds of which were NTFP. Both groups of plants had a significant proportion of their products which relied directly on pollinators (crops 62% and NTFPs 40%), mainly insects, and even greater proportions of the species themselves required biotic pollination (~80%) even if the harvested products did not rely on pollinators as such (Rehel et al. under review). We can therefore conclude that the majority of products collected from the forests or grown as crops in the NBR strongly rely on the provision of pollinator services.

Pollinators contributed to availability of a wide range of products which are important components of local diets and provide a variety of medicines. Bees and other insects are therefore contributing directly to the nutrition, health and livelihoods of many indigenous people of the NBR. Bees and other insects must therefore be considered a crucial component of biodiversity delivering essential services to society.

Limitations to *Apis dorsata* density and distribution - Studies carried out through this project suggest that predation pressure, in the form of honey hunting, may be less important than the availability of nesting sites in determining population sizes. Harvest pressure was also higher when there were more honey hunters, but there was no association between any of the other variables and harvest pressure.

Traditional knowledge towards sustainable harvests - Honey hunting is an ancient skill (Crane, 1999), and harvesting honey from *Apis dorsata* requires specialised skills and tools, because of the inaccessibility of the nests and the aggressiveness of the bees. The honey hunters of the NBR use traditional tools and techniques, careful not to harvest destructively. When honey is collected from hives on trees, the honey hunters harvest after the honey cells are capped, which is an indicator that the honey is ready. Many of the hunters also leave the colony intact by removing only the honey portion of the comb (Robert Leo, personal observation), especially when nests are found on trees. When honey is harvested from hives, hanging from cliffs, it is not possible to remove all the combs because of the inaccessibility of many of the combs and the defensive nature of the bees (Robert Leo, personal observation). The honey hunter can only remove about 5 combs per hour and the harvest cannot go on longer than 2 to 3 hours at a stretch because of the discomfort of hanging in mid air suspended on a forest vine (Anita Varghese, personal observation). Therefore honey hunting takes place with certain traditional regulatory mechanisms and is also limited by human tolerance.

Discussion

The diverse cultural and biological landscape of the NBR is undergoing rapid change. There are multiple impacts on the ecological fabric of the area. The impacts are largely anthropogenic and have accelerated over the years. The land use cover has seen changes due to the expansion of tea and coffee plantations and conversion to *Eucalyptus*, Wattle, *Cinchona* etc. These plantations were raised on grasslands and in between *shola* patches. Vast areas of the National Park on the Northern and Western part of the NBR are colonised by invasive species like *Lantana* and *Eupatorium*. Large extents of the protected areas are under plantations of teak. The rainfall patterns have been unpredictable and highly disrupted. The summers have been hotter and the winters colder. The multiple impacts of these factors have contributed in a large way to the discontinuity in the landscape. The impacts of these changes are most likely to impact life forms that are directly dependant on natural areas like flora and fauna, rare endangered species and forest dwelling communities. Introduction of alien bee species such as *Apis mellifera* for bee-keeping should be strongly discouraged at the policy level.

There is a need for crucial indicators of the changes and subsequent monitoring of these indicators. We have explored the role of social bees in the ecosystem and now ask to what degree can bees be a good indicator of the biodiversity of the NBR. Their nesting and foraging preferences display a certain amount of specialisation, which may be a prerequisite for their populations and viability. *Apis dorsata* bees show a degree of adaptability and resilience, in spite of the land use change, disruption in floral availability, hunting pressure etc. by its occurrence in diverse landscapes. Their adaptation to urban landscapes is something that has been observed over the years though not documented as part of this project. *Apis cerana*, the generalists have the ability to forage in different landscapes and over different plant species making them a good species for domestication. The majority of NTFP in our study were indigenous to the NBR, while most of the cultivated species have been introduced. The cultivated plants had a greater association with honeybees, which are usually considered as generalist pollinators and can readily use novel floral resources (Itioka et al., 2001; Thomas et al., 2009); honeybees may play an important role in ensuring that newly introduced species are productive and may continue to contribute in the same way if further species are brought to NBR. Of the indigenous plants ~40% of products were reliant on pollinators, whereas more than 60% of crop products need pollination by animals and this suggests that more cultivated products would be sensitive to loss of pollination services than would those obtained from the forests (Rehel et al. under review). *Apis florea* nest in open nests on thorny under storey plants and were also locally rare. The habitat specialisation of this species might contribute to their rarity and their responses to harvests need to be understood better. The stingless bees of the NBR preferred diverse shrub and flower communities.

Using social bees as an indicator of the biodiversity of a region is an approach that needs to be explored further. The species can be monitored with ease especially since they are livelihood relevant and people come in contact with the species more often. A system of monitoring using the community will be a positive way forward in establishing the relationship between bees and biodiversity in the long term. The need for monitoring changes to the ecosystem has become very important and there is a need to put in place mechanisms for biodiversity monitoring over the long term. Some of the questions that such a monitoring programme can address are: How do bees detect variations in the environment and do they adapt and respond to environmental cues such as changes in climatic patterns? To what extent do bees contribute to forest pollination? Can landscapes be managed without bees?

Adaptability and diversification of strategies by both bees and human beings can lead to more stability within the system and opportunities may lie within the traditional knowledge systems. This has been explored through the studies on honey hunting and *Apis dorsata* densities and distributions (Roy et al., under review). There are no specific rules or guidelines for protection, conservation and increasing the population of wild or domestic bees in India as yet. Bee products like wax and

honey, services of pollination, are considered insignificant contributors to the economy or ecology of the state, though culturally important and playing an important role in the subsistence economy.

Where does the stability of the system link itself to the various components of bees, biodiversity and livelihoods? We perhaps need to look at large landscapes, large impact areas of agriculture where bee pollination is crucial for food and cash crops, or a bee sanctuary where the habitat conservation is crucial to the lifestyles of indigenous groups of people for sustenance and livelihood needs.

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(3B) Role of bats in pollination

G Marimuthu

Abstract

We carried out a study on the nectar feeding behaviour of three species of fruit bats – the Indian flying fox *Pteropus giganteus*, fulvous fruit bat *Rousettus leschenaulti*, and the short-nosed fruit bat *Cynopterus sphinx*. Bats visited *Ceiba pentandra* (kapok or silk cotton) trees throughout the nights. Peak visits occurred during pre-midnight hours, coinciding with maximum nectar production and sugar concentration in flowers. *C. sphinx* foraged in the trees at heights of 6-10 m, *R. leschenaulti* at 10–18 m and *P. giganteus* at 15-20 m.

We observed coats of pollen of *C. pentandra* on the ventral parts of all the three species. Out of 60 inflorescences that had only buds, 81% fruit set occurred in 20 uncovered inflorescences, which were visited by both bats and insects. Among the second set of 20 inflorescences that were individually covered with bags to allow only insects to reach the flowers, 56% fruit set occurred. In the third and control set of 20 inflorescences that were completely and individually covered (to which visits of both insects and bats were excluded, but having a provision for ventilation) only 41% fruit set occurred. Thus, it is clear that flowers of *C. pentandra* are pollinated by bats.

Introduction

'Chiroptera', the technical name that refers to bats is a Greek word that means 'hand winged' (Chi = hand; ptera = wing). Their hands are modified in the form of wings. Bats are the only flying mammals. They are active during the night (nocturnal). About 1100 species of bats are available in the world (Mickleburgh et al., 2002), out of which about 120 species are available in the Indian subcontinent (Bates and Harrison, 1997). Chiroptera is divided into two groups: Megachiroptera and Microchiroptera. Megachiropterans are larger in size, feeding upon fruits (e.g. guava, custard apple, mango, sapota, figs, Singapore cherry, etc.) and nectar. So they are commonly known as fruit bats. They live in trees (e.g., banyan, mast or Asoka, tamarind, and *eucalyptus*) and temples. Microchiropterans are smaller in size, feeding upon insects (e.g., moth, beetle, grasshopper, crickets and mosquito). So they are commonly known as insectivorous bats. They live in caves, crevices, temples, trees, tree holes, ruined buildings, under the bridges, etc. In India 13 species of fruit bats and more than 100 species of insect bats are available. Among the 13 species of fruit bats of India, three are very common and distributed through several parts of India. They are:

- **Indian flying fox *Pteropus giganteus*: one of the largest bats in the world, weighing ~1kg, with a wingspan of >1m. During the daytime one may observe them hanging from branches of trees such as banyan, tamarind, eucalyptus, mast, etc.**
- **Fulvous fruit bat *Rousettus leschenaultia*: has a body weight ~90g. Lives in temples**
- **Indian short-nosed fruit bat *Cynopterus sphinx*: lives in small groups inside foliage of creeper plant, *Vernonia scandens*, mast or Asoka tree, and palm tree**

The remaining 10 species of fruit bats live in forests at higher altitudes, and restricted to certain regions of India (Bates and Harrison, 1997).

Nearly 30% of fruit bats are dependent on plants as a source of food, either as fruits or nectar or both. In turn, bats provide pollination and seed dispersal services to at least 140 plant genera (Fujita and Tuttle, 1991). Bat-pollinated flowers exhibit classical syndromes (Heithaus, 1982) such as opening at night, lasting only a single night, whitish colour, permeating strong odour, large quantity of pollen and positioned away from foliage. When selecting food, fruit bats make at least four choices:

- **the kind of foods that are available**
- **how much of each food type is available**
- **where the food is located and**
- **how long the food is available**

Basically there are four flowering strategies: 'big bang' means production of a large number of flowers over a short period, 'steady state' means production of a small number of flowers over an extended period, 'cornucopia' in which a large number of flowers are produced over a month's time, and 'multiple bang' in which several widely spaced, large flower crops are produced annually (Gentry, 1974). These flowering strategies also influence bat-visits. Examples of plants on which bat pollination occurs are *Anacardium occidentale, Adansonia digitata, Barringtonia sp., Bassia latifolia, Bombax ceiba, Careya arborea, Ceiba pentandra, Cullenia exarillata, Duabanga sp., Durio zibethinus, Grevillea robusta, Haplophragma sp., Heterophragma roxberghii, Kigelia pinnata, Manilkara hexandra, Musa spp., Oroxylem indicum, Parkia biglandulosa, Radermachera xylocarpum, Sonneratia spp., and Syzygium cuminii* (Fleming, 1982). Another important role of fruit bats is seed dispersal (e.g., Law and Lean, 1999).

Materials and Methods

We carried a study on five *C. pentandra* trees that were available in and around Madurai (9° 58' N, 78° 10' E). We randomly selected study trees of heights of 5-25 m from a set of 5-100 trees available at three sites. We observed *C. sphinx* and *P. giganteus* foraging on nectar of *C. pentandra*. Observations on *R. leschenaulti* were minimal because they made rare visits to flowers only at a single study tree. We recorded the number of bat visits continuously from 1800 to 0600 h, resulting in 396 h of observation over 33 nights. A bat visit referred to the time interval between arrival and departure of a bat after feeding on nectar of any number of flowers either in one or more

than one inflorescence. We also noted the duration of feeding bouts for each bat. A feeding bout was the time taken by a bat to lap nectar from either only one (for *C. sphinx* and *R. leschenaulti*) or >1 (*P. giganteus*) flower of a single inflorescence. We constructed observation platforms at 15m heights on neighbouring trees, close to the study trees, to observe the bat-visits.

Diffuse illumination from nearby street lamps were useful for the observations. However, in dark areas, we observed bats by using a red-filtered light. We counted number of bat visits with a pushbutton tabulator and timed the duration of feeding bouts using a stopwatch. We captured bats using mist nets as they foraged near trees. In order to collect pollen grains that had adhered tothe ventral body parts of each individual bat (26 *C. sphinx* and 3 *R. leschenaulti*), we used brushes repeatedly dipped in distilled water (Paton and Ford, 1977) and transferred them to 1.5 ml Eppendorf tubes containing 70% ethyl alcohol. Separate brushes and tubes were used to collect pollen grains from different parts of the body of each individual bat. The bats were released at the sites of capture after recording the time of capture, sex, and body mass (to the accuracy of 0.5 g). We marked all captured individuals of *C. sphinx* and *R. leschenaulti* with collars made of elastic rubber rings containing coloured plastic beads (5 mm, 10 colours). Each colour referred to a number from 0 to 9. We loaded each ring with 1–3 beads. Thus, all possible sequential arrangements of the beads provided up to 999 unique tags (Balasingh et al., 1992). In addition, we attached chemiluminescent tags (Mini Knicklicht Cormoron, Munich, Germany) to the collars of 12 *C. sphinx* (3.0 x 25 mm tags) and 3 *R. leschenaulti* (3.0 x 39 mm tags). On any particular night, either only 1 individual of *C. sphinx* or 1 each of *C. sphinx* and *R. leschenaulti* had the tags. The relatively much brighter glow of the larger tag used for *R. leschenaulti* enabled us to distinguish the 2 species. The brightness of the tags lasted 7-10 h. The collar, together with the light tag, weighed <5% of an adult's body mass and we assumed that this additional mass did not affect their foraging behavior (Aldridge and Brigham, 1988). Chemiluminescent tags were useful in our earlier studies, where we observed *C. sphinx* foraging on fruits of custard apple, figs, and nectar from flowers of *Bassia latifolia*, and banana. We transported the pollen samples to the laboratory the following morning, centrifuged them (3,200 rpm for 5 min in Sigma 113 Eppendorf Centrifuge, Sigma, Germany) and discarded the supernatants. We dispersed the sediments uniformly in 1 ml distilled water containing 0.05% Tween 80 and used a hematocytometer to count the number of pollen grains (Dudash, 1991; Kearns and Inouye, 1993). We observed the structure of pollen grains under a microscope (40x) and compared them with pollen grains collected directly from flowers of *C. pentandra*. Because *P. giganteus* flew well above the heights of our mist nets, we could not capture and mark them. We measured the volume of nectar produced by individual flowers of *C. pentandra* at 2-h intervals between 1900 and 0500 h for 20 nights and collected a total of 120 samples. We covered each flower with a nylon-mesh bag prior to the onset of foraging flights of bats to prevent them from visiting these flowers. We collected samples of nectar using 15-ll capillary tubes and transferred them to 1.5-ml Eppendorf tubes. To estimate total sugar present in the nectar, we used 500 µl of sample collected from a single inflorescence. In calorimetric tubes, we mixed 2 ml of nectar samples, 0.05 ml of 80% phenol, and 5 ml of concentrated H_2SO_4 and placed the tubes in a water bath at 25–30°C for 10 min. After the solutions became yellowish orange, we measured their absorbance at 490 nm using a spectrophotometer (Hitachi, Japan). We substituted the nectar samples with distilled water to prepare control samples. We estimated the concentration of sugar in our samples by referring to a standard curve that we constructed earlier (Dubois, et al., 1956). We analysed each sample 3 times. We used 1-way analysis of variance (ANOVA) and Tukey's test to estimate times of peak foraging. We employed the Kolmogorov-Smirnov test to determine whether these data were normally distributed and Levene's test to confirm homogeneity of variances (Sokal and Rohlf, 1995). We used the Mann–Whitney test to compare pollen loads of bats and Spearmann rank correlation to correlate body mass of bats with their pollen loads.

All assumptions were met after transforming the data to natural logarithms.

Values are presented as mean ± SD. In another set of study, we chose 60 inflorescences (with only buds) from four trees. The first set of 20 inflorescences (set 1/control) was covered with transparent polythene bags (40 x 30 cm) containing six holes, each with a diameter of 2 mm to allow only air circulation, but exclude both insect and bat-visits. The second set of 20 inflorescences (set 2) was covered with similar bags containing four holes, each with a diameter of 2 cm to allow insect-visits, but exclude bat-visits. The remaining 20 inflorescences (set 3) were left untouched, and were exposed to both bat and insect-visits. All bags were numbered using 'permanent marker' pen for individual recognition. The bags were gently removed, soon after fruit set. The number of fruits produced from each inflorescence was noted to calculate fruit set index, by dividing the total number of fruits formed with the total number of flowers present in the respective inflorescence. (The fruit set index is 1, if all the flowers developed into fruits, and it is 0 if no fruit was formed from any of the flowers.) The total number of young fruits that ultimately developed into mature pods was also recorded. During the flowering season, *C. pentandra* sheds leaves. As most of the branches had inflorescences at their terminal ends, the flowers were well exposed. A single inflorescence consisted of 12.6 ± 7.4 flowers (n = 60). Anthesis occurred at 1920 to 1930 h (n = 28) and the petals remained open throughout the night. The petals either began to close or the flowers dropped at 0615 to 0630 h (n = 28).

Results

The inflorescences of *C. pentandra* fully opened between 19.00 h and 19.30 h. The inflorescences clustered at terminal branches, and each inflorescence had 4–15 flowers. Because leaves were absent at terminal branches flowers were well exposed. Flowers were creamy white with 5 petals. Staminal filaments and anthers were golden yellow. Majority of flowers were inclined downward and persisted for just one night. Both *C. sphinx* (smallest species) and *P. giganteus* (largest species) visited the flowers for nectar throughout the night. In addition, the intermediate-sized *R. leschenaultia* made infrequent visits only at one site. There was clear spatial partition between their foraging heights. *P. giganteus* foraged at greater heights than *C. sphinx* and there was no overlap between them, when they foraged on nectar at the same trees (n = 72). *R. leschenaulti* foraged at intermediate heights with marginal overlap with *P. giganteus*. *C. sphinx* and *P. giganteus* exhibited their peak foraging visits during pre-midnight hours. However, it appeared 2-3 h earlier in *P. giganteus*, starting with peak number of visits at 2000-2100 h ($F = 60.3$, d.f. = 9,240, $p < 0.001$) followed by a gradual decline. In contrast, *C. sphinx* began to forage at 2000 h, steadily increased to a peak at 2300 h and showed a decline thereafter. *C. sphinx* exhibited a greater number of visits than *P. giganteus* ($U = 142$, $P < 0.01$). The mean number of visits of *C. sphinx* ranged from 6.6 ± 2.6 to 39.3 ± 14.2, whereas they were 2.9 ± 2.1 to 17.3 ± 5.1 for *P. giganteus*. However, the duration of feeding bouts of *P. giganteus* was always longer than that of *C. sphinx*. *Cynopterus sphinx* always foraged solitarily and exhibited 1-2 circular flights before moving closer to flowers. When approaching flowers, all individuals of *C. sphinx* performed 1-3 hovering flights, each lasting,1 s. This usually led to feeding on nectar in two distinct ways. In 437 of 475 observations (92%), bats landed on flowers with partially outstretched wings, inserted their snout into the flowers, and started lapping on nectar. By using the claw of the 1st digit, the bats hooked themselves onto sturdy petals or on buds of inflorescences. During such landings, parts of the ventral regions of bodies and wing membranes of the bats directly touched the anthers of neighboring flowers of the inflorescences. The landings of the bats made terminal branches of trees bend slightly. In the remaining 38 observations, the bats fed on nectar while hovering but without landing on flowers. Feeding while hovering mainly occurred on branches that contained only solitary flowers, and such feeding bouts were much shorter than those with landings. Our observations (n = 61) on chemiluminescent-tagged bats showed that feeding occurred at a particular tree until midnight with intermittent movement to nearby night roosts (in *Cocos nucifera* and *Azadirachta indica* trees). However, we do not rule out the possibility of visits to adjacent feeding trees during these

periods. After midnight, the bats switched to neighboring trees and covered 2–4 trees, with 8–10 visits to a tree per night. During each visit, the bats landed on three inflorescences; within an inflorescence, they lapped on nectar from only one flower. However, when the bats repeatedly visited a particular inflorescence, they fed on nectar from more than one flower during each visit.

In majority of our observations (91%), we noted that *Pteropus giganteus* foraged solitarily. On a few occasions (n = 25) two individuals foraged simultaneously at the same trees. The bats performed at least two wide circular flights before approaching flowers. Unlike *C. sphinx, P. giganteus* neither exhibited hovering flights nor landed directly on inflorescences. Instead, they usually landed either at basal parts of branches containing inflorescences or at their nearest branches, and then approached the flowers with bipedal or quadrupedal movements. The bats were in an inverted posture and used their 1st digit to hold onto nearby flowers or buds to facilitate lapping nectar. Parts of the chins, throats, and chests of the bats were in direct contact with the anthers while they were lapping nectar. The bats fed upon the nectar from almost all flowers of an inflorescence and covered 3-6 inflorescences of a tree during each visit. They neither fed on the whole flowers nor licked pollen directly from anthers (n = 280). Unlike *C. sphinx, P. giganteus* never flew away from the sites of the branches where they fed on nectar. Instead, at the completion of feeding, they hung on, turned their bodies around for a few seconds, licked around their mouths, and always started moving back to the basal part of the branch from where they flew away. The duration of feeding bouts of *P. giganteus* was 12 times longer than that of *C. sphinx*. Similarly, the duration of a visit to the trees was nearly 3 times longer than that of *C. sphinx*. We observed 3 chemiluminescent-tagged individuals of *R. leschenaulti* a total of 18 times in 2 nights. They always landed straight on the inflorescences after a brief hovering. They lapped on nectar for 2.9 ± 0.9s (n = 14) by covering 5-8 inflorescences in a single visit. These visits lasted for 90.0 ± 12.0s (n = 12). Foraging was always solitary, except on one occasion, where three individuals of *R. leschenaulti* jointly chased away a single *P. giganteus* at a height of about 15 m. Even though there were no continuous foraging visits, our observations (n = 18) on light-tagged *R. leschenaulti* showed that they were relatively more active between 2000 and 2100h. We captured 4 bats in the mist nets at this period, all with pollen grains adhering to their ventral abdomen, wings, and heads. During the rest of the night, they never visited the study tree. Nectar production from the flowers of *C. pentandra* showed a peak at 1900h with a volume of 100.0 ± 25.6 µl, followed by a gradual decline. At 0500 h, the nectar production was at a minimum with 8.5 ± 4.9µl. The average volume of nectar produced was 321.0 ± 72.2µl per flower per night. Total sugar concentration in nectar showed a similar pattern. The sugar concentration was maximum at 1900h, with 260 mg/ml; the minimum was 100 mg/ml at 0500h. Nectar often dripped from a few flowers, especially from those that bats had not visited. Such drips were mainly due to the tilted orientation of flowers and were conspicuous between 0200 and 0500h.

We captured a total of 124 individuals of *C. sphinx* in 12 mist-netting sessions. Of them, 40.3% had pollen coats on their bodies. Numbers of bats captured in the mist nets and bats that carried pollen peaked at 2300 and 2400 h. Pollen coats examined on 26 bats were 72% on the ventral abdomen, 20% on wing membranes, and 8% on heads. Males carried significantly more pollen grains (75,000 ± 35,000) on their abdomens than did females (44,000 ± 32,000; Mann–Whitney $U = 119$, $P < 0.05$). However, there were no significant differences in pollen loads of males and females on their wings ($U = 152.5$, $P > 0.05$) and heads ($t = 0.95$, $P > 0.05$). There was also no significant correlation between body mass of bats and their pollen loads (Spearman rank correlation, $r = 0.240$, $P > 0.05$). Observations through the microscope revealed that all pollen grains belonged to *C. pentandra*. Although we did not capture individual *P. giganteus*, we visually observed pollen grains on their chins, throats, and chests.

In the 'bagging' experiments, fruits were formed in all the three sets of inflorescences, after 32.8 ± 3.6 days (n = 60). We observed 81% fruit set from the uncovered inflorescences that were visited by both bats and insects. Fruit set in the inflorescences to which only insects

visited was 56%, whereas it was only 41% in the control set of inflorescences. However, not all the young fruits were converted into mature pods. From the uncovered inflorescences 50% pods were produced. Insect visitation resulted in 22% pods compared to 14% in control. One-way ANOVA ($F_{2,57} = 15.96$, $P < 0.001$) showed that there is a significant difference in the fruit set among set 1 (control), set 2 (only insect-visits), and set 3 (both insect and bat-visits). Further analyses with Tukey multiple comparison test showed that differences between set 1 and set 2 were not significant ($t = 1.77$, $P > 0.05$), but it was significant between set 2 and set 3 ($t = 3.76$, $P < 0.01$) and highly significant between set 1 and set 3 ($t = 5.53$, $P < 0.001$). Out of a total of 355 visits made by *P. giganteus* in the entire study, we observed that on 24 occasions it fed upon the tender fruits of *C. pentandra*. However, *C. sphinx* never fed upon such tender fruits.

Discussion

Our study shows that both *P. giganteus* and *C. sphinx* feed on the nectar of *C. pentandra* with temporal as well as spatial partitioning of their visits to the flowers. Such partitioning avoids interspecific competition in using floral resources (Fischer, 1992; Fleming, 1979; Thomas and Fenton, 1978). Usually, *C. sphinx* forages in groups while feeding on big bang (Gentry, 1974) fruits such as *Ficus* (Elangovan et al., 1999) and flowers such as those of *Bassia latifolia* (Elangovan et al., 2000). In contrast, in our study, bats, including *C. sphinx*, foraged on the nectar of *C. pentandra* solitarily, even though the latter produces big bang flowers (Start and Marshall, 1976). Nevertheless, phyllostomid bats forage in larger groups on the nectar of *C. pentandra*, which usually causes frequent detachments of pistils (Gribel et al., 1999). There was no such destruction in the present study. Intriguingly, in *C. sphinx*, group foraging usually is associated with ex situ feeding, whereas solitary foraging occurs with in situ feeding (Elangovan et al., 1999, 2000) irrespective of whether the fruits and flowers belong to steady-state Elangovan et al., 1999) or big bang phenological patterns. This indicates that the size of the fruits and flowers influences the two kinds of feeding. Thus, *C. sphinx* easily detaches small-sized fruits (*Ficus* - Elangovan et al., 1999) or flowers (*B. latifolia* - Elangovan et al., 2000) from trees and carries them to nearby roosts for feeding ex situ. In contrast, the bats land on relatively large-sized fruits (*Mangifera indica* - Corlett 1998, Singaravelan and Marimuthu, 2008); and flowers (*Musa paradisiacal* - Elangovan et al., 2000; *C. pentandra* - present study) for feeding in situ. Moreover, bats may drop largesized fruits before reaching their feeding roosts (Elangovan et al., 1999) due to an increase in wing loading (Norberg and Rayner, 1987). Similarly, lapping on nectar from a detached flower of *C. pentandra* is not only inconvenient for bats but also prevents feeding repeatedly on nectar from intact flowers. To ensure repeated visits to the flowers, the bats (especially *P. giganteus*) carefully land on and fly away from branches of trees. The landings of *C. sphinx* and *R. leschenaulti* directly on the inflorescences apparently do not cause any loss of nectar, whereas such landings by *P. giganteus* would certainly lead either to total loss of nectar due to violent shaking of nectaries or detachment of entire inflorescences including buds. Similarly, *P. tonganus* in Samoa lands at the top of *C. pentandra* trees and reaches flowers by crawling (Elmqvist et al., 1992). *R. leschenaulti* usually lives in colonies comprising thousands of individuals (Chandrashekaran and Marimuthu 1994). The minimal number of visits by *R. leschenaulti* to *C. pentandra* indicates a low population in the study area, possibly due to lack of substantial day roosts.

The correspondence between the timings of peak nectar secretion and sugar concentration with that of higher numbers of bat visits is in accordance with an earlier study on *C. sphinx* (Elangovan et al., 2000) and nectarivorous phyllostomid bats (Nassar et al., 1997). The volume and sugar concentrations of nectar secreted by the flowers of *C. pentandra* in the present study are in congruence with an earlier report (Gribel et al., 1999) and are within the range of other bat flowers (Faegri and van der Pijl, 1979; Gould, 1978; Helversen and Reyer, 1984; Hopkins, 1984; Lemke, 1985). During the initial feeding on nectar, these bats may acquire energy and water, which are essential after dehydration during the day. Apart from energy (Bertin, 1989), nectar and fruits provide important sources of minerals (Ruby et al., 2000). Barclay (2002) recently reported that

nectar of some bat-visited plants contains significantly higher amounts of calcium than other plants. When bats lap on nectar and groom their fur and wings at night roosts, they probably consume pollen passively. Pollen can be an important source of protein (Law, 1992). The onset of foraging activity of the three pteropodid bats coincides with the timing of opening of the flowers of *C. pentandra* and their nectar production.

Position of inflorescences at terminal branches where leaves are usually absent further facilitates locating the flowers. The loading of the ventral abdomen of *C. sphinx* and *R. leschenaulti* and throats of *P. giganteus* with pollen grains may be because those areas of their bodies directly touch the anthers when the bats lap nectar. Because the pteropodid bats carry pollen grains between trees of *C. pentandra*, they may play a major role in reducing the loss of genetic diversity of this species of tree (Young et al., 1996). Thus, there is good circumstantial evidence that these bats are pollinators of these trees. However, our study relied on low sample sizes of trees. Because it is clear that both *P. giganteus* and *C. sphinx* forage on the nectar of *C. pentandra* with an uninterrupted spatial partitioning, future studies should be carried out on a greater number of trees and should determine numbers of ovules penetrated and settings of fruits and seeds per fruit with reference to upper and lower parts of trees.

Our study with 'bagging' experiments supports a recent report (Singaravelan and Marimuthu, 2004) describing pteropodid bats visiting inflorescences of *C. pentandra*. We demonstrate that both *C. sphinx* and *P. giganteus* were the principal visitors of *C. pentandra*, but *R. leschenaulti*, visited rarely. Usually in mass flowering plants such as *Ficus* species and *Bassia latifolia*, group foraging by bats is common (Elangovan et al., 2000). The significantly greater duration of feeding bouts of *P. giganteus* and its lesser number of feeding visits compared to that of *C. sphinx* facilitate to conserve its energy that is needed to exhibit commuting flights, since flight cost increases with increase in body mass of bats (Speakman and Thomas, 2003). The scanty visits of *R. leschenaulti* suggest that nectar of *C. pentandra* may be one of its less preferable food items. Alternatively, population size of *R. leschenaulti* was low around our study areas. Our study clearly shows that bats such as *P. giganteus* and *C. sphinx* are important pollinators of *C. pentandra*.

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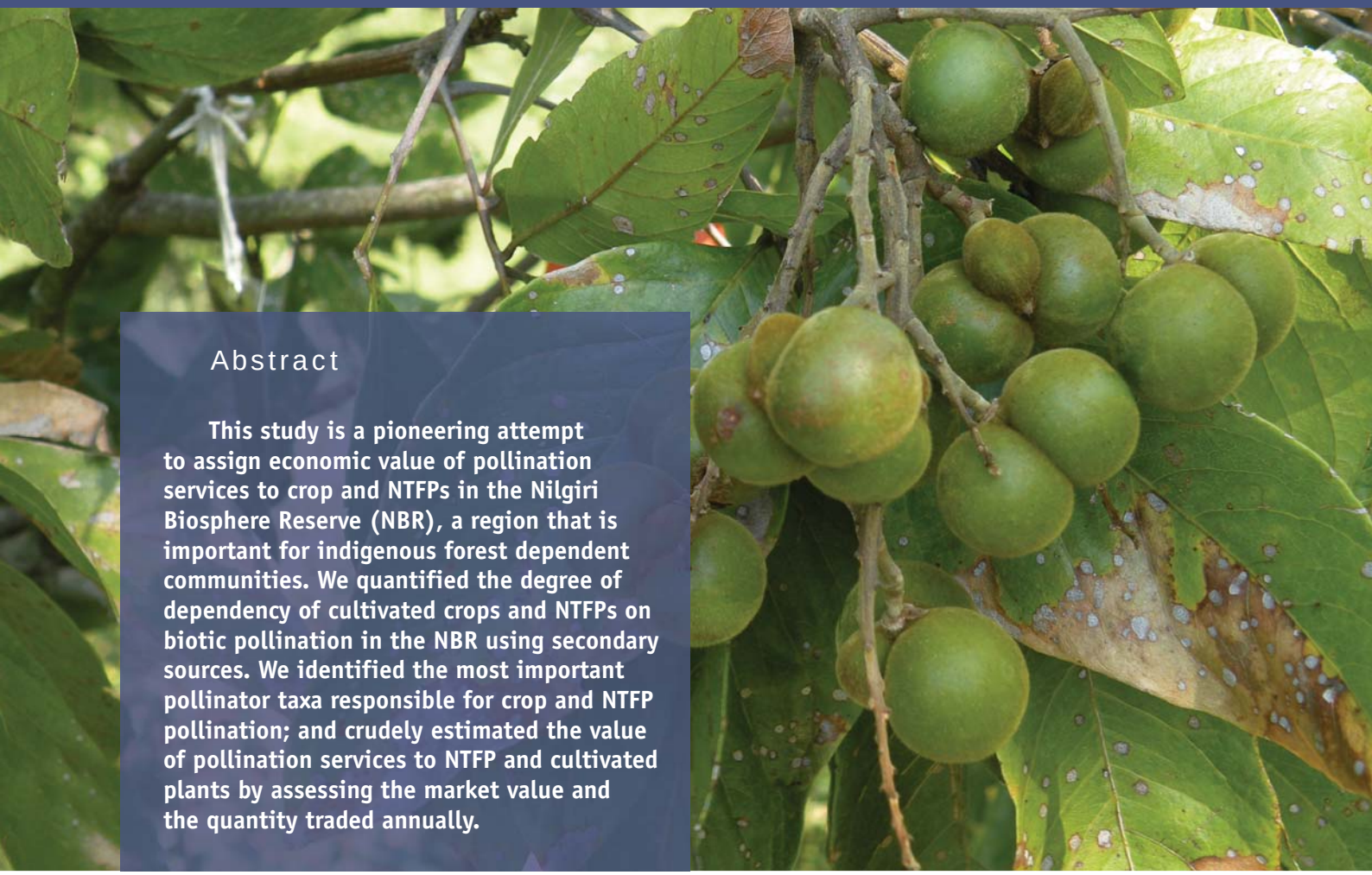
(3C) Pollination services to cultivated and NTFP species in the Nilgiri Biosphere Reserve

Priya Davidar, Shiny Mariam Rehel, Anita Varghese and Simon G Potts



Abstract

This study is a pioneering attempt to assign economic value of pollination services to crop and NTFPs in the Nilgiri Biosphere Reserve (NBR), a region that is important for indigenous forest dependent communities. We quantified the degree of dependency of cultivated crops and NTFPs on biotic pollination in the NBR using secondary sources. We identified the most important pollinator taxa responsible for crop and NTFP pollination; and crudely estimated the value of pollination services to NTFP and cultivated plants by assessing the market value and the quantity traded annually.

Honeybees such as *Apis cerana, A. dorsata, A. florea* and stingless bees were among the pollinator spectrum, and of these *Apis cerana* was the most generalised in flower preferences and nest site requirements. About 80% of 74 cultivated species and 139 NTFP species were biotically pollinated. Social and solitary bees visited over half the species (54%), and diverse insects contributed a significant amount (38%) to pollination services. Products from cultivated plants were more reliant on biotic pollination than products from NTFP. We were able to obtain data on the market value (Rs./kg) and the volume traded for only 82 species. Of these, the fruits and seeds of 64 species were traded. Bees were reported to visit 43 of the 64 species (67%). The total quantity of fruits/seeds produced annually by the 64 species that were visited by pollinators was 534 tons, valued at Rs.2.67 crores. Of these, bee visited plants produced 277 metric tons of fruits/seeds, the total value of which was Rs.1.08 crores annually. Only 13 NTFP species produced 26.2 tons of fruits/seeds annually and the estimated value was Rs.0.05 crores (Rs.5 lakh).

Introduction

Pollinators play an important role in the pollination of economically important plants and wild plants (Allen Wardell et al., 1998, Klein et al., 2007). Bees are considered important pollinators worldwide, but other insects (flies, butterflies, beetles etc.) and bats and birds also make significant contributions to biotic pollination (Buchman and Nabhan, 1996). These pollinators provide an essential ecosystem service by contributing to human nutrition and welfare; however, the extent of this service is poorly understood. Approximately 75% of global crops that are used directly as human food depend, at least in part, on animal mediated pollination (Klein et al., 2007); and the majority of wild plants also require biotic pollination (Kearns et al., 1998; Allen-Wardell et al., 1998). It has been estimated that 84% of 264 crop species in Europe (Williams, 1994) and 70% of 1330 species of tropical crops are pollinator dependent (Roubik, 1995). The value of global pollination services to cultivated crops is estimated to be worth about 153 billion Euros per annum (Gallia et al., 2009). The role of animal pollination in the production of crop plants and NTFPs in the tropics are not well known and the major species involved in pollination have not been adequately studied (Ahmed et al., 2005; Klein et al., 2007).

NTFPs are an important source of livelihood for forest dwelling communities. In the Nilgiri Biosphere Reserve (NBR) there are about 14 different adivasi communities whose livelihoods are intricately linked with the resources of these natural areas (Keystone, 2006, 2007). These adivasi communities harvest and depend on a wide variety of non-timber forest products (NTFP) for subsistence and commercial uses; many of them also practice subsistence agriculture. We have no estimate of the contribution of pollinators to production of non-cultivated plants such as NTFPs that are crucial as a source of livelihood support for local communities (Gallia et al., 2009). It is important to provide quantitative estimates of the services provided by pollinators to NTFPs and other plants that local adivasi communities depend upon for livelihood support. Since pollinators are declining in many places due to global change (Biesmeijer et al., 2006; Natural Research Council, 2006), it is necessary to document their role in providing essential services to indigenous livelihoods (Ahmed et al., 2005, Rehel et al., ms).

In this study we quantified the degree of dependency of cultivated crops and NTFPs on biotic pollination in the NBR, identified the most important pollinator taxa responsible for crop and NTFP pollination; and crudely estimated the value of pollination services to NTFP and cultivated plants that were sold in the market.

Study area

The Nilgiri Biosphere Reserve (NBR) is part of the Western Ghats, a chain of ancient mountain ranges which run parallel to the west coast in the Indian peninsula. It lies between 10° 45' N to 12° N latitudes and 76° E to 77° 15' E longitudes with a total area of 5520 km² spread across the three southern states of Karnataka, Kerala and Tamil Nadu. The steep gradients in elevation and rainfall have created diverse habitats within short distances leading to a wealth of biodiversity.

Methods

Estimation of pollination services

The database was compiled using the species lists of crops and NTFP listed in Manivasakam (2003), Rajendran et al. (2008), and Keystone Foundation (2006, 2007). For each species additional information was collected on the dependency of the plant species on biotic pollination for reproduction and the known pollinators for the species, and whether the species was indigenous to NBR or introduced. The database was analysed by summing counts and calculating percentages for different categories and comparisons between counts for cultivated vs. NTFP species using a X^2 test in Minitab v15 (Rehel et al. ms).

Economic valuation of pollination services

We looked at the market value and weight (kg) of each product extracted annually or cultivated in the NBR. We then multiplied the weight by market value to get an estimate of total value. We then assessed the productive use value of only those species whose fruits/ seeds were traded. The reported pollinators of these species were recorded based on personal observations and from literature. The pollinators were categorised as bees, which included honeybees and solitary bees of the order Hymenoptera, other insects such as flies, butterflies etc. were lumped under insects and diverse insects included species visited by a variety of insect orders. Since we did not have good estimation of the breeding system in these species, we assumed that all the species required pollinators for fruit production. We assessed the total value of pollination services to species in the NBR that produced fruits and seeds, and those contributed by bees. We also assessed the pollination services to NTFP species of the NBR.

Results

Dependence of cultivated plants and NTFP's on biotic pollination

In the database, Rehel et al. (ms) identified 74 cultivated species and 139 NTFP species (Table 12). Bees visited over half the species (54%), among which the contribution of honeybees and solitary bees were similar (Table 12). Diverse insects also contributed a significant amount (38%) to pollination services (Table 12). Overall, 47.9% of the plant products used by local people were dependent on biotic pollination (62.2% of cultivated products and 40.3% of the NTFP products); products from cultivated plants were more reliant on biotic pollination than products from NTFP (X^2=32.51, d.f.=2, p<0.001), but there was no significant difference in the numbers of cultivated and NTFP species reliant on pollination (X^2=5.21, d.f.=2, p=0.074). Irrespective of whether the plant product was dependent upon insect pollination, 80.3% of all the species were biotically pollinated (82.4% for cultivated species and 79.1% for NTFP species).

The honeybees

Analysis of 73 wild and cultivated plants by Thomas et al., (2009) show that *Apis cerana* visited the most plants (54 species, 74%), followed by the stingless bees that visited 30 species (41%) and *Apis florea* (28 species, 38%). *Apis dorsata* visited only 20 species (27%) and seemed to be most narrow in floral preferences (Thomas et al., 2009). All the four honeybees were nest site specialists and only Apis cerana did not show marked preferences for nesting habitats (Thomas et al., ms), suggesting that it was the most generalist of the four honeybees (Table 12).

Table 12. Flower visitation patterns and nest requirements of the four honeybees (Thomas et al., 2009, in prep)

Honeybee	% Recorded visits to wild and cultivated species (n=73)	Nest site specialisation
Apis cerana	74 (54)	Generalist
Apis dorsata	27 (20)	Specialist
Apis florea	38 (28)	Specialist
Stingless bees	41 (30)	Specialist

The plant species that relied on pollinators utilised a wide range of taxa (Table 12). Cultivated plants and NTFPs were most commonly visited by bees and other insects but rarely by birds and bats. Honeybees and solitary bees were the most frequent bee visitors for both cultivated crops and NTFPs, though both taxa are more commonly reported for crops. The overall pollinator community for cultivated plants and NTFP plants were different (X^2=26.62, d.f.=2, p=0.002) (Rehel et al., ms).

Productive use values of 64 species using pollination services

We were able to obtain data on the market value (Rs./kg) and the volume traded for only 82 species. Of these, the fruits and seeds of 64 species were traded. Bees were reported to visit 43 of the 64 species (67%). Diverse insects comprised the next largest group visiting 9 species. Vertebrates such as birds and bats visited four species. The total quantity of fruits/seeds produced annually by the 64 species that were visited by pollinators was 534 tons, valued at Rs.2.67 crores. Of these, bee visited plants produced 277 metric tons of fruits/seeds, the total value of which was Rs.1.08 crores annually (Table 13). Only 13 NTFP species produced fruits/seeds that were traded. Overall these species produced 26.2 tons annually and the estimated value was Rs.0.05 crores (Rs.5 lakh).

Table 13. Likely pollinators of economically important plant species in the NBR

Pollinators	Cultivated	NTFP	Total	%
Bees	54	60	114	54
honey bees	37	20	57	27
Apis cerana	2	5	7	3
Apis dorsata	2	3	5	2
Apis florea	1	2	3	1
Stingless bees	13	4	17	8
Solitary bees	38	10	48	23
Other insects	37	45	82	38
Birds	4	6	10	5
Bats	3	2	5	2

Table 14. The different pollinator groups reported visiting NTFP or cultivated plant species in the NBR whose fruits/seeds were traded

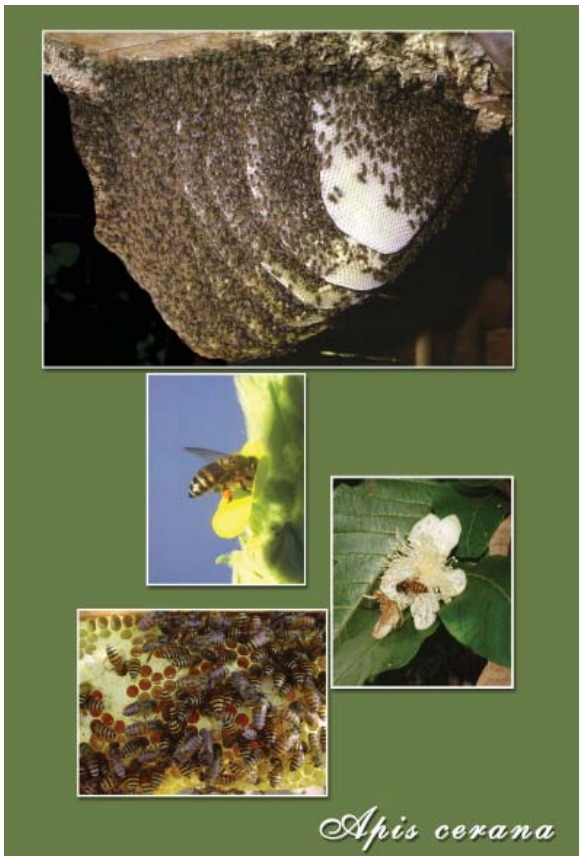
Pollinator category	Number of NTFP/ cultivated plants	Quantity traded per year (metric tons)	Valuation (Rs crore)
Bees	43	277	1.08
Diverse Insects	9	101	0.26
Other Insects	8	105	1.26
Vertebrate	4	51	0.07
Total	64	534	2.67

Discussion

This is a pioneering attempt to assess the dependency of crops and non-timber forest products (NTFP) on biotic pollination in an ecologically important area and value the pollination services to fruit/seed bearing NTFPs and cultivated plants.

Our results indicate that a high proportion of cultivated crops and NTFPs relied directly on pollinators (crops 62% and NTFPs 40%). Insects were the dominant pollinators, among which bees, both social and solitary, contributed to the largest taxa of pollinating insects. Within the NBR we identified 213 plant species important to local people, a third of which were cultivated and two thirds of which were NTFP. Both groups of products were pollinator dependent (Rehel et al., ms) and ~80% required biotic pollination even if the harvested products did not rely on pollinators as such. We can therefore conclude that pollination services are required for the majority of products collected from the forests or grown as crops in the NBR, as for the worlds' crops which also depend, at least in part, on biotic pollination (e.g., Klein et al., 2007).

The productive use value of 64 species producing fruits/seeds that were traded in the NBR was Rs. 2.67 crores. The productive use value of NTFP whose fruits and seeds were collected and traded was about Rs.5 lakh. Therefore the economic value of pollinators in the NBR is significant. Therefore we conclude that pollinators have a significant role in the pollination of economically important species in the NBR and further studies are needed to document, conserve and manage plant-pollinator relationships in the NBR.



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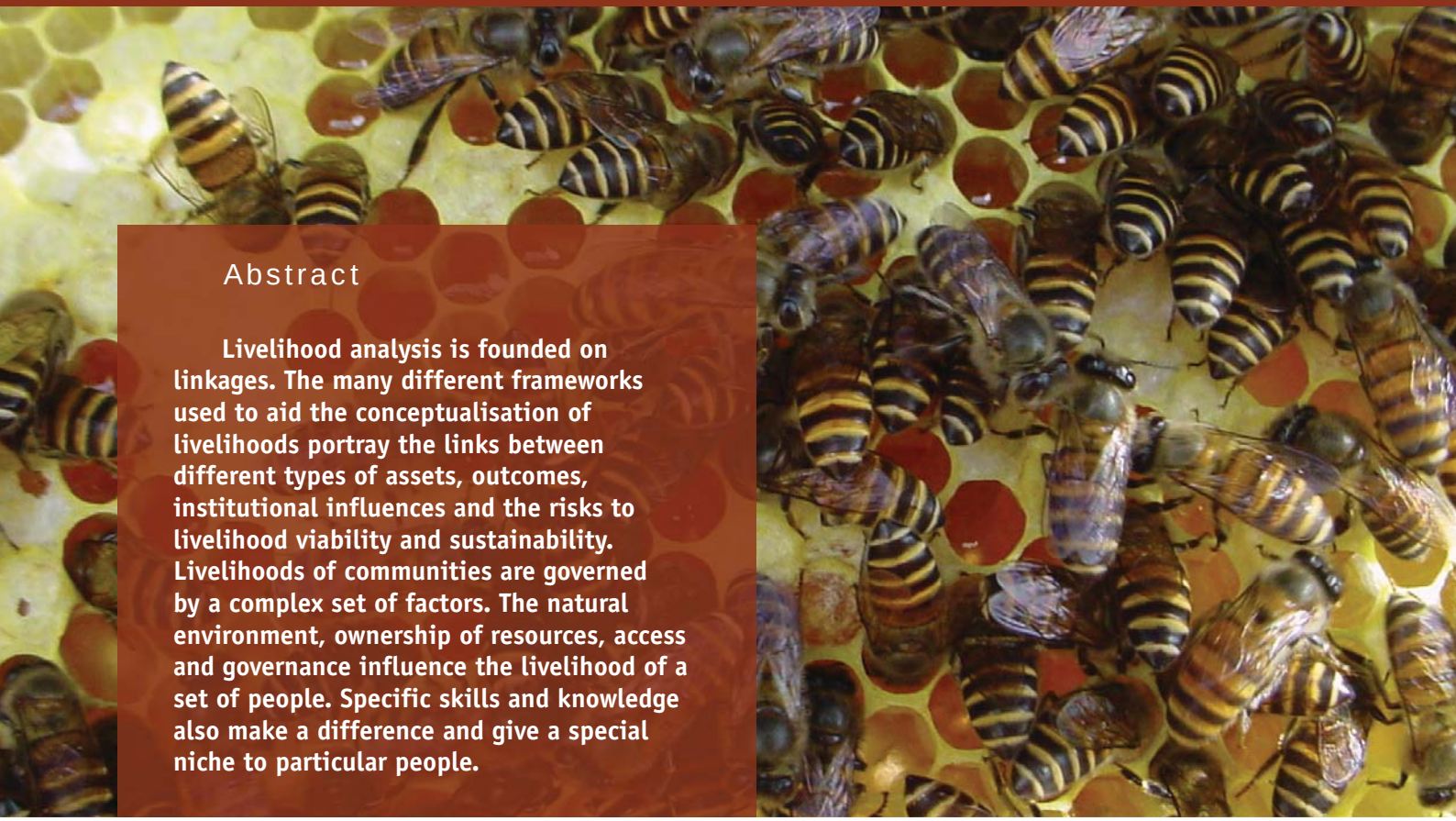
(4)

WHAT'S THE STORY ON LIVELIHOOD LINKAGES ?

(4A) An overview of livelihood linkages of indigenous people in the Nilgiri Biosphere Reserve

Snehlata Nath, Janet Seeley, Adam Pain and Samita Vasudevan



Abstract

Livelihood analysis is founded on linkages. The many different frameworks used to aid the conceptualisation of livelihoods portray the links between different types of assets, outcomes, institutional influences and the risks to livelihood viability and sustainability. Livelihoods of communities are governed by a complex set of factors. The natural environment, ownership of resources, access and governance influence the livelihood of a set of people. Specific skills and knowledge also make a difference and give a special niche to particular people.

Linkages with social structure, culture and traditions, policy and political moves all touch livelihoods and determine the changes over time. Natural resources have, and continue to be viewed as the bedrock of rural livelihoods. Are the linkages between the natural and the social environment so direct and simple? This paper examines forest based livelihoods of indigenous people in the Nilgiri Biosphere Reserve (NBR) and elaborates on the influences of the region. The complexity of why an option is chosen as a livelihood avenue, what changes have happened over time and whether natural resources link only to income generating options are discussed in the paper. In indigenous communities, the role of subsistence use and of natural resources in the overall quality of life need to be given emphasis – does this exist and add to the jigsaw puzzle of livelihood? Is it true that for these communities other socio-cultural factors are also important and it is not a straightforward income–livelihood linkage? We need to look beyond simple links between biodiversity, resource management and production that lead to income based outcomes and question assumptions about `forest-based livelihoods' while we endeavour to understand the dynamic nature of environmental and social change and the complexity of many people's lives.

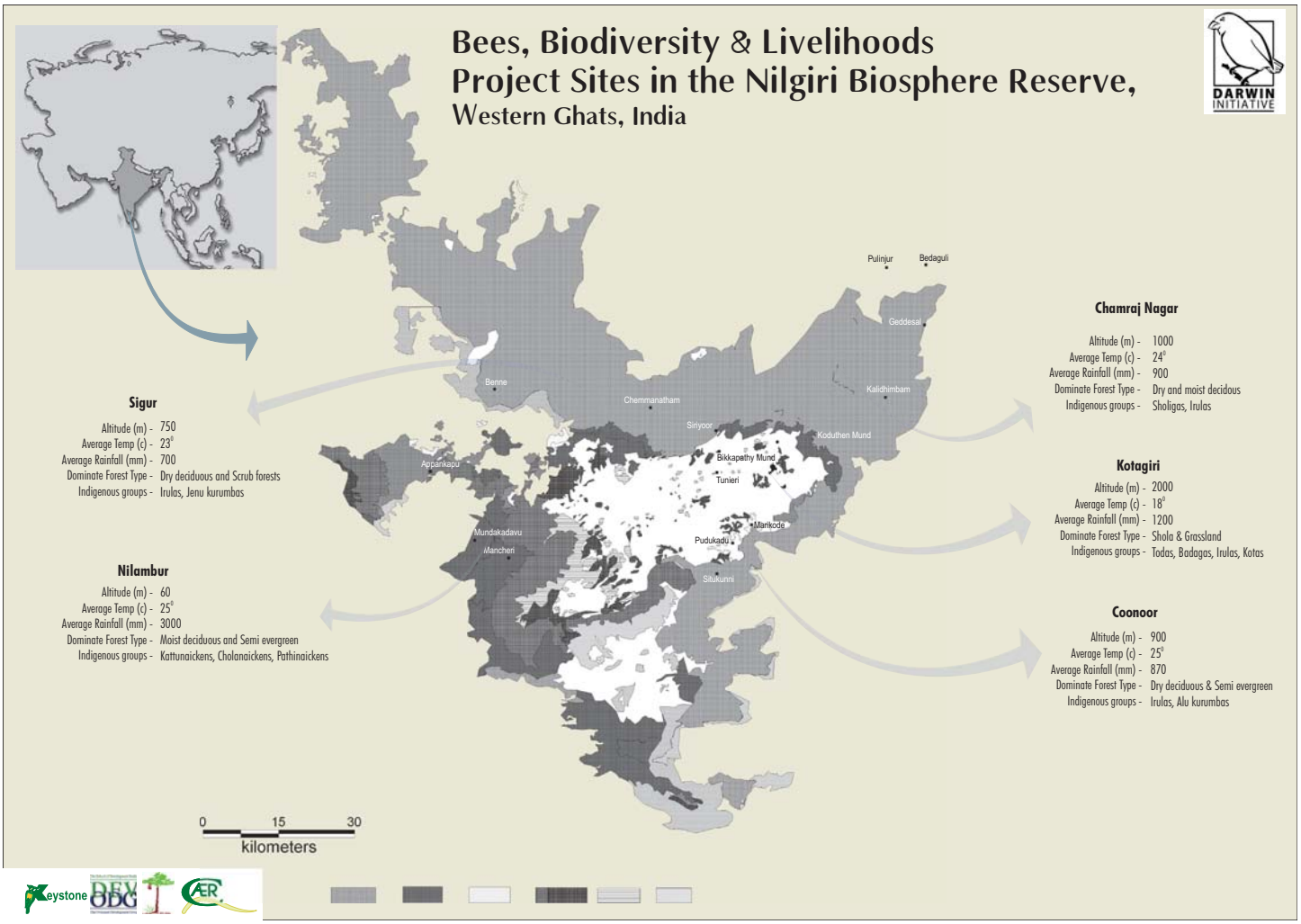
Introduction

The creation of Biosphere Reserves around the world was proposed by UNESCO in 1972 through its Man and Biosphere Programme. This was done to conserve large tracts rich in biodiversity and to promote sustainable use. The emphasis was that people were part of the ecosystem and needed to be integrated in conservation efforts. In India, 12 Biosphere Reserves have been declared but do not have any special legal status. In many cases, these reserves have protected areas and follow those existing legal frameworks. The Nilgiris, an integral part of the Nilgiris Biosphere Reserve (NBR) in the Western Ghats is home to moist, dry, evergreen and montane (*shola*) tropical forests. The Western Ghats, and the Nilgiris in particular, harbour a wealth of flora and fauna: mammals, birds, reptiles, amphibians, and fresh water fishes; much of which are endemic to the region. The NBR is 0.15% of India's land area and has 20% of all angiosperms, 15% of all butterflies and 23% of all vertebrates. Of the 285 endemics in the Western Ghats, 156 (55%) are in the NBR. The rich flora and fauna has resulted in declaring several areas as protected, like the Silent Valley, Mukurti, Mudumalai, Wayanad, Bandipur, Nagarhole National Parks, Tiger Reserves and Sanctuaries.

The NBR has a large number of indigenous communities (referred to as '*adivasi*', the term that will be used in this paper), many of them forest dwellers and traditionally hunter gatherers. These distinct ethnic groups have small populations and live in geographical concentrations. Map 2 shows the distribution of these groups over the area of the reserve. The NBR forms home to several *adivasi* communities, including the only surviving hunter-gatherers of the Indian Sub-continent - the Cholanaikans in the New Amarambalam of Nilgiris. Apart from the Todas – a well known pastoral group in the upper Nilgiris - there are others such as Paniyas, Irulas, Kurumbas, Kurichiyans, Mullukurumbans, Adiyans, Alyars, etc.

Given the vegetation and land use of each zone, practices amongst these communities vary. Land distribution, forest dependence and modern developments vary within the Reserve, depending on the accessibility, social affiliations and state policies. However, these societies did not live in isolation but had close cultural and social links amongst them. This formed the 'society' of the Nilgiri Biosphere Reserve, till the advent of the British in 1820

Map 2.



and the opening up of this hilly region, when lands were taken by the state and 'worked' for revenue in different ways. The ancestral domains of *adivasi* people were not a consideration. So from a life where the forest was a large home, most adivasis became 'landless' and unable to stake claim over their lands. The process of land alienation has since only become more intense, with increase in population of migrants and settlers. Further changes in the forests, with the advent of commercial forestry and logging, changed forever the status of the *adivasi's* lifestyle. As an example, a detailed survey done in the Kotagiri/Coonoor region in 1998 by Keystone shows that 39% families are landless, 14% have land which is less than 1 acre and 35% between 1-2 acres. 11.8% have land which is between 2-3 acres. The areas where land alienation has had the largest impact are for the people of Gudalur and Wyanad.

It was in this context that Keystone Foundation established its work with *adivasis* in 1993. This also provides the background to taking up the BBL project 2006-2009 to research and study the linkages of bees, biodiversity and livelihood in the NBR.

Livelihood from the forest

The importance of forests in the livelihoods of indigenous people is considerable as they provide innumerable benefits to them. Kumar (1993) states that in India since long, indigenous people have resided in the forest and have formed their own culture, which is intimately linked with that of the forest. Tiwari (1993) lists out dependence of the forest for the indigenous people in India. Among

the many benefits that the indigenous people accrue, the list includes shelter, fuel, food and drinks, fish, agriculture, forest food, smoke and tobacco, recreation, crafts and industries. Some of the most economically valuable produce in India is *Tendu* leaf, *Sal* seeds, Lac, *Kusum* seeds, Tamarind, *Chironji*, gums, honey, medicinal plants, the value of which runs into thousands of crores. Forests have not only contributed towards providing a home and refuge to the indigenous people but are also instrumental in the economic upliftment of the indigenous people. In fact, the World Bank (2000b) finds that one out of four of the world's poor rely directly or indirectly on forests for their livelihoods. Sunderlin (2005) and Shackleton (2003) both find that cash income is generated from NTFPs due to the extension of the market system to more remote areas. Such income meets household needs like paying school fees, health care or investing in agriculture which contributes towards livelihoods.

Socioeconomic research reveals that NTFPs become important in the livelihoods of many poor households who live in or near forests, especially in the tropics. Many of these studies find that the livelihoods of poor households still depend on NTFPs from fallow and natural forest relatively more than the other groups (Tickin, 2004, Ambrose-Oji, 2003, Roderick and Hirsch, 2000 and Belcher and Kusters, 2004). Moreover, findings show that NTFPs and their related activities provide a platform for their livelihood during lean seasons when possibilities are limited and the opportunity cost of labour is low (Springate-Baginski et al., 2007). With this scenario in mind the importance of NTFPs in the Nilgiri Biosphere Reserve needs to be examined. Here NTFP collection is a seasonal activity, which gets importance on the basis of amount of the product available, a favourable season and high yields, and the presence of an assured buyer. Amongst the NTFPs, honey plays a significant role as profits are high in a good season. The product is usually high in demand and finds an easy market. Varying in intensity across the NBR, NTFP collection contributes between 20-80% of gross income amongst *adivasis*. On an average a contribution of 20% per annum is common. In certain sites studied, like the Cholanaickens and Kattunaickens in Nilambur locations, NTFP collection is high. This is due

to the diversity in the forest for available products, the policies of the Forest Department which are pro-collection and the regular presence of a buyer in the form of the Society or its agent. In other areas like locations in Coonoor and Kotagiri, NTFP collection forms a low priority livelihood option with wage labor being easily available.

Agriculture and wage labour

The poor have less land and hence are dependent on forests for a greater share of their total income. If common property rights to forests were restricted, the rise in poverty could not be ameliorated simply by increasing the reward in occupations in which some of the poor are engaged (Chakravarthy and Reddy, 1999). In the NBR, land amongst *adivasis* is a rare asset and whatever is available is usually highly degraded having high slopes and being rainfed. Those with marginal lands cannot depend on it for major returns, profits or even

a full year's stock of grain for the household. Rainfed agriculture on steep mountain slopes cannot sustain a family, unless supplemented by wage labour and forest gathering. Besides, the inputs required for initial land work is very high and no family can afford it without taking loans or accessing government schemes and subsidies. The location of their villages, usually very close to forest areas, also makes the lands victims of crop raiding by wild animals.

However, as per (Sunderlin et al., 2001) the proportion of overall household income (whether through use or exchange) from forest resources tends to decline with respect to the transition stages from hunting and gathering to swidden cultivation and sedentary agriculture at the forest frontier. But they also mention that important exceptions to the overall pattern are known to exist. Some hunters and gatherers have gotten substantial cash incomes from forest products dating back to centuries. And conversely, in recent times, there are remote locations where use values predominate. This, they say, is a reflection not just of increased income opportunities in agriculture and other domains, but also of decreased availability of types of forest resources that might have been abundant in the past.

The changing political and economic circumstances are also demonstrated to be creating forest-based income opportunities that did not exist before. Currently, the choice of wage labour appears as the most reliable option for most *adivasis*. Landless families have no option but to work as estate, farm, forest or road workers. In a number of cases, across the NBR, it is a common sight to see *adivasi* people working on other people's land for wages ranging from Rs.100-150 per day, while their own lands are barren. The number of women going for regular work is much higher than the men, due to the nature of work in the plantation industry. Most *adivasis* work for 3-4 days a week, earning between Rs.400-600. Only in the case of Mundakadavu in Nilambur, timber logging earns higher per day income for shorter hours of work. This work is very difficult and not many people can take it up.

Subsistence and cultural significance of forests

NTFPs in the NBR are also used by the *adivasis* for different purposes in the subsistence of their livelihood strategy. In excessively dry periods many families leave the village and reside by the river, fishing and foraging in the forest for different tubers and small game. This activity varies in different locations – but is a common thread amongst most *adivasis*. The making of baskets, ropes and houses; festivals and rituals need time and space in the forest – the presence of several sacred groves and burial sites in the forest provide enough evidence towards this relationship. Amongst the communities of the NBR, this aspect is important and is reflected in their everyday life and environment. The Toda, Kurumbas, Cholanaickens and Kattunaickens all have this relationship as an integral part of their social, cultural and often subsistence life. Often, this takes precedence over their economic dependence on the forests. In subsistence economies, forests can provide many essential products and services for the life of local people such as "food, utensils, clothing, shelter, medicines and objects of spiritual or cultural significance" (Wong, 2000, pp. 3–4). The majority of NTFPs for the purposes of for example fuel, diet, medicine, forage and fibre are used by collectors and their family members while some may also be produced for sale or barter (Arnold et al., 2001; Davidson-Hunt et al., 2001; Hegde and Enters 2000; Sunderlin et al., 2005). In the NBR also, *adivasis* use forest resources for medicine, building their houses and for food. The livelihood importance of forests and trees is closely linked to their cultural significance. Sacred groves, a tradition of protecting patches of forests dedicated to deities and/or ancestral spirits by many Indian communities means that they provide a safe refuge to several endangered and threatened species of flora and fauna (Malhotra et al., 2001).

Discussion

In the NBR, it is seen that the choices made by the people between these livelihood options could depend on a variety of factors. This includes aspects of availability and reliability. Often wage labour fulfills that role, enabling the *adivasi* to choose this option. Besides, in most parts of the NBR, wage rates are higher vis-à-vis other areas, owing to the plantation land use and economy.

Seasonality plays another important role in the choice of work, demarcating different times during the year for activities. Both agriculture and NTFPs are seasonal and compete for time. Those with land and those more interested in agriculture do not prefer to go to the forest. Some families have a preference for NTFP collection, especially honey and do not take up agriculture operations during that time. This preference is also based on the location of the villages and the community type. Kurumbas, Cholanaickens, Kathnaickens are traditionally hunter gatherers, while the Irulas are primarily cultivators.

In this context the role of the market must be mentioned, as a deciding factor between options. If the trader or co-operative society assures the gatherer of the market by placing demand, people are ready to go for harvest. In certain areas like Coonoor and Sigur these market forces are often absent, thus reducing options for people to collect NTFPs. *Adivasis* collect NTFPs, especially honey, for commercial purposes. In most cases, honey is sold to Marketing Co-operative societies, LAMPS or to traders and middlemen. Agents of these societies are also located in strategic places to procure the produce. After these purchases, honey is sold to big companies like Himalaya and Dabur. Ayurvedic units and manufacturers of herbal medicine in Kerala also buy this honey in large quantities. The interesting features are:

- **though the collection is considered illegal, marketing avenues are located just outside the forest areas. Some of these are state run businesses.**
- **no processing, value addition is done on a significant scale within the NBR (except in Keystone). All profits are therefore channelised outside to wholesalers, large companies and private entrepreneurs.**
- **variable rates are given to honey collectors and no standards are set on quality and properties of the honey being purchased. The worst quality honey can also find a market.**
- **the boundaries of collection and marketing are porous between the states, making it impossible to estimate how much honey comes from a certain zone.**
- **there is a general movement to sell in Kerala – as the state has liberal policies with regard to NTFP collection and a marketing system of societies in place.**

For the *adivasis*, a low rate for their produce, irregularities in weighing and maintaining records, billing etc. reduce the income from NTFP collection. This is coupled with the fact that price fixation of NTFPs is ad hoc and regulated by a consumer's market, which wants to pay the lowest price. This makes returns from NTFPs low for the gatherer and the forest becomes an unviable economic option for livelihood.

Another important aspect amongst these communities for selecting a particular livelihood option also depends on the time to be allocated for social engagements, festivals, birth and death ceremonies, marriages and ancestral worship. These engagements are crucial for the *adivasis* and often render it difficult for them to join work or `a job' on a permanent basis.

Vulnerability and risks

An aspect that influences all natural resource livelihood options concerns climatic factors. In recent years, these have been showing an erratic trend with seasons of rain, storms, excessively long dry periods affecting both agriculture and forest collection options. These climatic factors make many *adivasi* families go for wage labour, thus passing on the risks and vulnerabilities to big land owners, who have a bigger safety net and have access to more manipulated resources like irrigation and seed capital. NTFP collection is also rife with issues concerning overall forest degradation, the reduction in produce/ harvests, forest fires and access rights to forest collection. In Sigur area, a ban was imposed by the Forest Department, due to wildlife considerations, denying *adivasis* access to NTFP collection and sale. In the overall scenario, it seems that the *adivasi* has to work harder to get some cash returns from selling the produce. Besides natural factors, aspects related to indebtedness could be caused by a host of reasons like illness, ceremonies or fines. A cycle of indebtedness amongst families forces them to choose certain reliable wage options, with earnings being used to repay old debts.

Transforming structures and processes

In the NBR there is a marked change in the livelihood of *adivasis* fuelled by different processes and interventions from the state, NGOs and private sector. Government interventions, development programmes and markets, have all contributed to change amongst these communities. In the past decade, there has been more attention given to the health and education needs of these communities and special schemes have been designed to increase income generating options. There is a new concept of space. Traditional *adivasi* villages are widespread with houses and home-gardens around. There are very few such villages in the NBR now. Most people have been settled in line houses, which is a design selected by the government to 'provide all facilities at one place'. This has also been administered in areas where people have been relocated from Protected Areas and settled in colonies outside the boundary. This total dependence on government for managing their settlements has killed the spirit of the independent *adivasi*, and made them move from self sufficiency to dependence. A combination of these factors has also eroded the local governance and leadership within the community.

Who determines food sovereignty? Again, the change in the land, society and governance has changed the food habits of the people of this region. With slash-burn agriculture and hunting made illegal, they do not get either the grains or the proteins, which they got earlier. Most families now depend on the highly subsidised ration rice (Re.1 per kg. in Tamil Nadu), which is part of the public distribution system. The health and nutritional status of these people, especially women, is known to be poor. Problems ranging from anemia, sickle cell anemia, general debility and child bearing problems are common ailments in the community.

Though change is inevitable and will be moulded by a host of events and processes, the aspect of providing `free deals' or major subsidies needs more examination. The recent distribution of free television to each *adivasi* home by the present government in Tamil Nadu seems to change the use of time. More people are seen in front of their TV sets today – a use of time not earlier conceived amongst hunter-gatherer communities. It becomes essential to examine the issue related to livelihood and changing perceptions amongst communities to what is their own well being, welfare and relationship to nature.

Conclusion

Considering the importance of forests to the *adivasis* in myriad ways and its diversity in household livelihoods, the framework provided by Bebbington (1999) would be useful in livelihood analysis in such cases. The framework looks at rural livelihood and poverty without linking them automatically to agriculture or natural resources analysis. To arrive at this, Bebbington argues that it is essential to have

a broad understanding of the resources people need to access to constitute what is their livelihoods, especially where it shifts from being based directly on natural resources to livelihoods based on a range of assets, income sources and product and labour markets. In the framework, livelihood is conceptualised in terms of access to the five capitals of physical, social, natural, human and cultural. The notion of access according to him is of how people deal with poverty in a material sense, but also their perceptions of well being and poverty in relation to their livelihood choices and strategies and the capacities that they possess both to add to their quality of life and also enhance their capabilities to confront the social conditions that produce poverty. Acknowledged is also that people's assets are largely determined by the structure and logic at work in economic and political spheres. An aspect to be added in this analysis is the environmental sphere, as this is playing a crucial role in present days. The erratic nature of climate influences natural resource behaviour which in turn impacts both agriculture and forest collection. Livelihoods of *adivasis* in the NBR comprise a number of options. More directly, the choices depend on history and location, access to land, forest biodiversity, access to reliable sources of income like wage labour. Socially and culturally the choices also depend on community allegiance, festivals and rituals.

Byron and Arnold (1999) explain that the existing literature on people - those who depend, use and protect the forest and the various types of their relationship with the forest has not been adequately studied and documented. They argue that while the number of forest users or dependents is important, it is the nature of the relationship that needs to be understood, as it is not homogenous but diverse. A similar condition can be seen in the Nilgiris and a holistic understanding of what are the drivers of change, will determine livelihood dynamics and the intricate changing relationship between man and nature.

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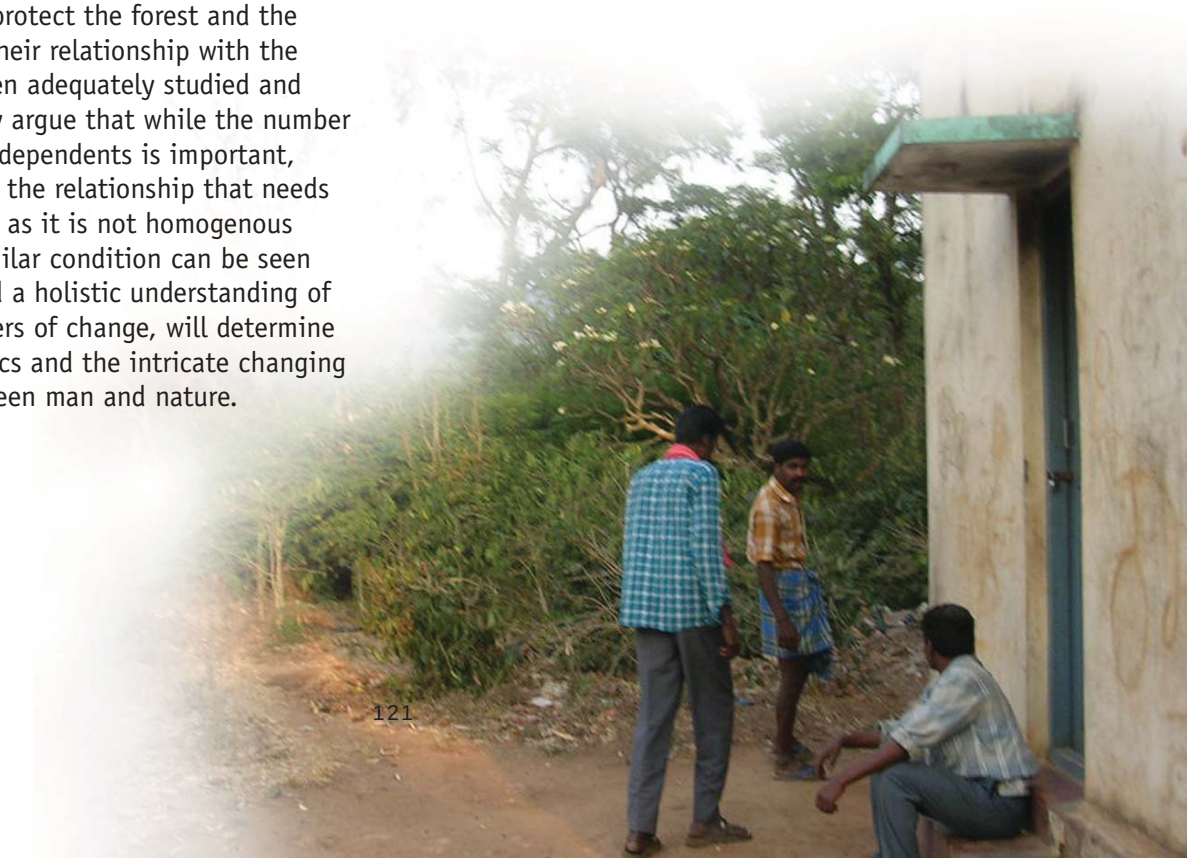
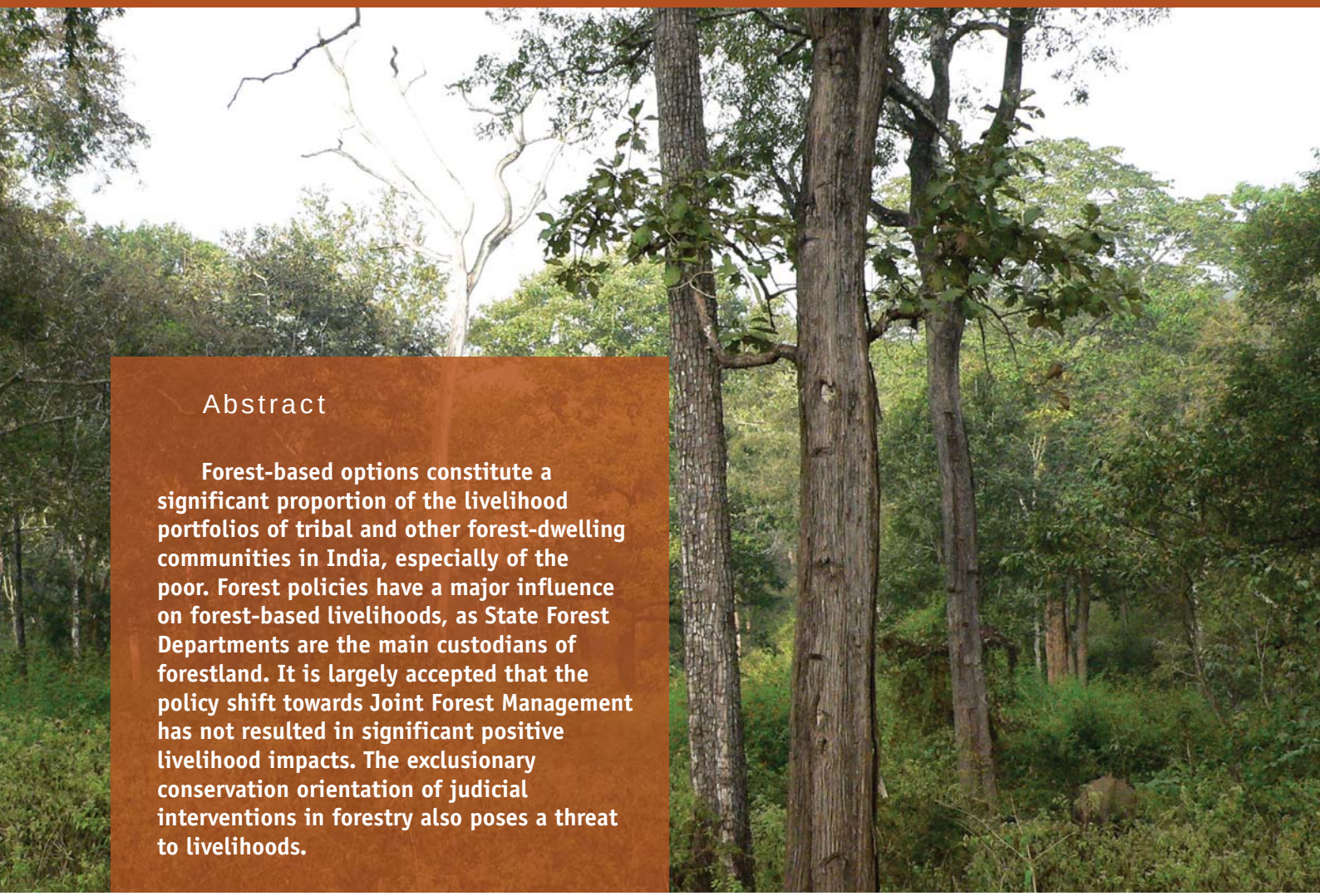


(4B) Forests and livelihoods in India

Rajesh Ramakrishnan



Abstract

Forest-based options constitute a significant proportion of the livelihood portfolios of tribal and other forest-dwelling communities in India, especially of the poor. Forest policies have a major influence on forest-based livelihoods, as State Forest Departments are the main custodians of forestland. It is largely accepted that the policy shift towards Joint Forest Management has not resulted in significant positive livelihood impacts. The exclusionary conservation orientation of judicial interventions in forestry also poses a threat to livelihoods.

The Forest Rights Act, an outcome of political mobilisation by forest dwellers, focuses on tenurial security. With its provision for recognition of community management rights, it attempts to move forest management away from the existing state-centric frame. However the immediate challenge is to get the Act implemented in letter and spirit as it faces resistance from the forestry establishment. The thrust of most policy advocacy is towards improved community linkages with markets, strengthening of community institutions and re-orienting state forestry institutions in order to improve livelihoods. But concerns remain about the outcomes of integration with markets - the possibility of privatisation of common resources, increased commodification of forest produce, ecologically unsustainable modes of forest produce collection, and changes in social structure and values, and gender relations. Community institutions and their interaction with markets therefore need to be carefully designed.

1.0 Introduction

This paper, largely based on a review of existing literature and informed by the author's own experiences in implementation and research projects, focuses on forests as livelihood resources and the impact of law and policy that mediates community and household access to them. Forest-based options constitute a significant proportion of the livelihood portfolios of tribal and other forest-dwelling communities in India, especially of poor households within them. Forest laws and policies have a major influence on forest-based livelihoods, as State Forest Departments are the main custodians of forestland. The contest over tenurial rights between state agencies and local communities is therefore the main focus of this paper and not so much household and community livelihood strategies using forest resources under existing tenurial conditions. Livelihood approaches are actor-centred, putting people first, and therefore recognise that in the real contexts in which people live, there is both co-existence and contest of various interpretations of social value. Early livelihood approaches drew attention to the politics of value in development, and emphasis was placed on the need to understand how people's livelihoods are contingent upon a secure command over assets (Arce, 2003). From this perspective too, a focus on the contest over tenurial rights seems appropriate.

When Joint Forest Management (JFM) was introduced in 1990, it was envisaged that the state would play a hand-holding role, enabling communities to manage forests on their own eventually, and improving livelihoods substantially. This paper presents evidence to show that the anticipated shift towards genuine devolution and participation did not occur under JFM, and therefore positive livelihood impacts of JFM are very limited. The main reason for this lack of transition is the continued custodial mindset, and the continued definition of forest management objectives by State Forest Departments. JFM is based on an ad-hoc policy arrangement where State Forest Departments are not really accountable to communities, who have no tenure over the forests, but have responsibilities towards protection in return for usufruct rights, as defined and allowed by the former.

The paper then discusses the livelihood-threatening conservation orientation of the spurt of judicial activism on conservation of forests witnessed in the nineties. The Supreme Court directed the definition of forests according to the dictionary and thereby subject/ed all `forests' to management by Forest Departments under the purview of the Forest Conservation Act. This brought under the spotlight an old problem that had remained unresolved: the lack of due legal process in defining forestlands and settling rights of forest dwellers. The Court's orders converted thousands of forest dwellers into

`encroachers' and the Ministry of Environment and Forests ordered evictions under the guise of implementing the Court's directives. Massive countrywide resistance by forest dwellers and their organisations culminated in the drafting of a new legislation aimed at recognising and vesting rights over occupation and use of land and providing a framework for recognition of such rights. The legislation went a step further and also provided for community rights to manage forests.

The paper discusses the features and promises of the legislation, as well as its present status. The opposition to the legislation, won in the teeth of opposition from the forestry establishment and a section of wildlife conservationists, is dogging its implementation and it is still an open question whether and where it will be implemented in letter and spirit. Only when it is implemented will it be possible to assess whether a new model of community forestry will be inaugurated. For this, a number of conditions that have been identified by the common pool resources and new institutional economics literature will have to be satisfied[1].

Policy advocacy has focussed on the complementary inputs to clear definition of tenure. The paper discusses many of these inputs being suggested. In particular, the World Bank, in its 2006 report *Unlocking Opportunities for Forest-dependent People* has advocated improved community linkages with markets, strengthening of community institutions and re-orienting state forestry institutions in order to improve livelihoods. The assumption here is that the sole aim of communities is to strengthen linkages with the market and thereby improve income streams. **Such a homogenous view of communities is at odds with reality where we find a wide diversity of land uses and livelihoods aimed at both use value and exchange value.** Linkages with the market generate new positives as well as negatives. Wasteful uses of human labour and extensive uses of forest resources are replaced by efficient and intensive methods of production, and incentives are created for sustainable production. But merely left to the market in a *laissez faire* manner, the negatives may outweigh the positives. **Common forest and forestland resources may get privatised, older traditions of reciprocity and social welfare may break down and be replaced by an ethic of individual accumulation, forest-based production may get increasingly commodified and based only on the production of exchange values, and**

gender relations may be irreversibly altered in favour of men as their hold over economic matters tightens. There is also the danger of forest-based production becoming ecologically unsustainable. The paper outlines the experience of much of India's Northeast, which unlike the rest of India has strong community tenure over forests.

Section 2 provides a short overview of forest-based livelihoods, with definitions and quantitative estimates, problems with estimates and summarises results of key case studies from a few Indian states. Section 3 provides a brief sketch of forest management and its legal framework in the colonial period, as well as its impact on local livelihoods. The impact on livelihoods of the two main paradigms of forest management in the first four decades after independence, production forestry and the turn towards conservation, are examined in Section 4. Section 5 argues that Joint Forest Management, the flagship participatory forest management programme of the forestry establishment, has failed to have significant positive livelihood impact on forest dwellers. The custodial mindset of the forest bureaucracy has been demonstrated in attempts to undermine pre-existing community forest management institutions and extend the writ of Forest Departments. Section 6 briefly scans judicial activism in forest management and the impact it has had on forest management and forest dwellers' livelihoods. The Forest Rights Act was a response to judicial activism, and Section 7 traces its emergence, what it promises for forest management and forest livelihoods, ambiguities in the Act and concerns over its implementation. Section 8 summarises and comments on the World Bank's recommendations for pro-livelihood reforms in the forest sector. Section 9 examines the social and ecological effects of close market linkages on traditional forest-based livelihood systems, largely with evidence from North-East India. Section 10 draws the threads together and provides the conclusion that along with tenurial security, communities' interaction with markets need to be carefully structured and effectively supported by the state so that the terms of interaction do not become livelihood-threatening and resource-depleting.

2.0 Forests and livelihoods: Definitions and estimates

Forest-dwelling communities in India depend on forests for a number of products and environmental services. These include land for agriculture, water, domestic fuelwood and construction timber, agricultural inputs, grazing and fodder resources, inputs for artisanal work, labour opportunities, and a large variety of non-timber forest produce (NTFP). But forest products and services, notably raw timber and non-timber products like medicinal plants and herbs, gums and fuelwood, are also consumed by urban and peri-urban communities. Environmental services provided by forests, such as water conservation and prevention of soil erosion have wide-scale benefits, extending well beyond the boundaries of forests. The flow of forest products to distant rural, peri-urban and urban markets is linked to the labour of forest-dwelling communities either as wage labour for contractors and traders or as petty commodity production-gathering, occasional local value-addition and sale. But a market for environmental services is yet to develop. Therefore forest dwellers' dependence on forests is both for subsistence and for local processing and sale.

We can therefore define forest-dwellers as those individuals, at least a part of whose livelihoods depend on the administrative land-use category called forestland. Three distinct economic activities are performed by forest-dwellers in relation to forestland. (a) Subsistence production: This includes subsistence agriculture, free grazing and collection of NTFP like bamboo, small timber, fuelwood, fodder, forest foods and medicinal herbs for own consumption. (b) Petty commodity production: This includes cultivation for the purpose of sale and collection of NTFP for sale. The petty commodity producer uses own labour for extraction, processing, sorting, grading and transport of produce to buyers. (c) Wage labour: This includes casual labour on forestland for the Forest Department and its contractors. Needless to say, these distinctions are only analytical. All three are seasonal activities and may be performed by the same person in a single cycle of activity that caters to both subsistence and exchange.

Box 1.
Estimates of dependence on forests

An estimated 147 million people live in villages in and near forests (FSI, 2000, cited in Springate-Baginski and Blaikie, 2007). But a much larger number is dependent on forests. 70% of India's rural population depends on fuelwood to meet domestic energy needs, and it can be assumed that much of this is sourced from forests. Half of the 89 million *adivasi* ***population lives in forest fringe areas and has close economic and cultural links with forests (World Bank, 2006). Women perform most forest-related activities such as fuelwood and fodder collection, NTFP collection and supervision of grazing. It is estimated that 60 to 70% of NTFP, fuelwood and fodder gatherers are women (Gera, 2001 and Kalpavriksh, 2003, cited in Springate-Baginski and Blaikie,*** *op. cit.*).

One estimate is that about 275 million poor rural people in India, or 27% of the total population, depend on forests for at least a part of their subsistence and cash livelihoods. (See Box 1 for details). However, statistical estimates are not exact as the definition of `dependence' is complex and open to interpretation. The level and type of household dependence is highly variable. But poorer households are clearly more dependent. Households involved in shifting cultivation or long-rotation forest fallows cultivation may be highly dependent on food from these forms of subsistence cultivation. Settled agricultural households may have moderate dependence for supplementary grazing resources and NTFP collection for sale. Wealthier households may depend on forests only for ecological services like hydrological moderation for continued water availability in summer. Poorer households with limited access to on-farm fodder supplies tend to keep flocks of small ruminants that are grazed on forest and common lands. NTFP collection and sale offers a safety net in times of stress and especially in the lean season when other labour opportunities are few (Springate-Baginski and Blaikie, *op. cit.;* see Box 2 for summaries of studies of forest-dependent livelihoods).

Box 2.
Studies of forest livelihoods in India

In a study of six villages in four districts of Jharkhand, it was found that forests were mainly used for seasonal subsistence, and also as a safety net to augment poor agriculture performance. The per capita forest area in all the study villages was equal to the state average and slightly below the national average. *Adivasis* ***accounted for 80 to 100% of the population in five of these study villages. All communities used the forest, but primarily for subsistence fuelwood and fodder. Fuelwood from the forest supplied an average of 86% of energy needs and fodder from the forest met 55% of the needs of domestic livestock. An average household used between 6 and 10 poles every three years for construction needs. NTFP was used mainly for subsistence. Some villages reported periodic sales of a few NTFPs in local markets, but respondents could not recall the quantity collected or sold. The low level of commercial sales of NTFP could be attributed to poor market access due to bad roads, low and isolated production levels, and low awareness of markets outside local trading areas (World Bank, 2006).***

A study of eight villages in four districts of Assam also found that forests offered an important safety net for smallholder communities. Communities used the forest primarily for subsistence fuelwood and fodder. Two of the districts had per capita forest area well above the state average and two had per capita area well below the state average. The quality of forests was observed to be worse than that in Jharkhand. Fuelwood from forests met an average of 79% of energy needs, fodder provided about 64% of the needs of domestic livestock. Both bamboo and poles, but largely the former, played an important role in domestic construction. Most communities, and mainly women from the communities, were engaged in collection of NTFP. Exploitation by middlemen, low local value addition and consequent poor financial returns, as well as lack of information about markets for specific products were cited as the reasons for poor incentives for commercial sales (World Bank, *op. cit.****).***

A study of 40 villages in two districts of Andhra Pradesh (68% of the village population on average being tribal) found that forest degradation and curtailed forest access have reduced the availability of food from the forest that tribal populations depend on in the post-sowing monsoon period and after the *kharif* ***harvest is exhausted. Many tribal households are caught in a debt trap as they have to borrow to buy food. Impoverished villagers choose between migration and unsustainable fuelwood harvesting to survive (Alsop et al., 2002, cited in World Bank,*** *op. cit.****).***

A study of 550 households in forest fringe villages in Jhabua district of Madhya Pradesh examined, among other parameters, the variation across permanent income quartiles of income from natural resources from the commons. While the lowest two quartiles got about 7.8% of their income from natural resources, this fell only marginally to 7.33 and 7.01% in the two highest quartiles. The income from natural resources (subsistence use monetised and cash from sale) from the commons was composed of, in order of magnitude, fuelwood, NTFP, fodder and poles. The share of fuelwood in income from natural resources declines as household income increases, due to the use of other sources like LPG and because the opportunity cost of time spent collecting fuelwood becoming high. A similar pattern is seen for income from NTFP, again due to the opportunity cost of time spent in collection. The share of fodder income increases with household income as richer families own more livestock resources (Narayan et al., 2005, cited in World Bank, *op. cit.****).***

In a study of 10 villages with Forest Protection Committees in three districts of south-western West Bengal, it was found that mean contribution from forest sources is 11.18% of household income, but it is 32.1% for poor and landless households and only 14.9% for medium-rich households. *Sal* ***leaves,*** *sabai* ***grass and fuelwood are the main contributors to livelihoods). A study of 30 villages in three districts of Orissa, between 20 and 25% of total household income was derived from forests, with a much higher proportion for poorer households. Fuelwood,*** *mahua* ***flowers and fruit,*** *kendu* ***leaves, leaf plates and other forest foods accounted for all household forest income (Springate-Baginski and Blaikie et al., 2007b).***

3.0 Law and livelihoods in the Colonial Period

The main impact of colonialism on India's forests was the centralisation of their management and the extinction of claims for livelihoods by local communities. The overarching objective was revenue maximisation, and this was enshrined in law, policy and the structure of forest administration itself. Until the mid-nineteenth century, Britain's inexhaustible need for timber for ship-building, iron-smelting and for the expansion of a railway network in India, as well as conversion of forest to agricultural land for revenue maximisation, led to uncontrolled deforestation. The Indian Imperial Forest Service was set up in 1864 to `manage' forests to ensure steady supplies of timber. The Forest Act of 1865 and the Act of 1878 enshrined the aim of eliminating all customary usage by communities by categorising all forests into three. (See Box 3)

Box 3.
Reserved/Protected/Village forests

In `reserved' forests, customary rights were to be `settled', either converted to `privileges' to be exercised elsewhere or extinguished completely. In `protected' forests, rights and privileges were recorded, but not settled, valuable species were reserved for the government and practices like grazing labelled as damaging and liable to restriction. The third category of `village forests' were never implemented as communities were suspicious of the provision of first reserving these forests.

Colonial forestry adversely affected traditional management and conservation systems of communities, denied them customary rights to forests and forest products, and tried to eliminate shifting cultivation practices. The onus of proving pre-existing individual and community rights was on the latter, and they were unlettered in the property and legal systems and the language of colonial administration. Consequently, large proportions of communities saw their rights converted to privileges that could be withdrawn at the will of the government or extinguished completely (Singh, 1986; Guha, R. Early environmentalists in India: some historical precursors. Foundation Day lecture, 15 June 1993. Delhi: SPWD, 1993.)

'Scientific forest management' legitimised a virtual state take-over of uncultivated commons from user communities. 'Forest estate' was defined as land under any standing forest or as any land recorded as forest in any government record, irrespective of whether it had or ever had any forest cover. Areas called 'wastes' because of their poor revenue potential, but used by communities as grazing resources, were taken over by Forest Departments, and planted with non-browsable species. Huge areas were declared state forests without any vegetation surveys. Complex local land tenures and common property resource management regimes were revised in favour of the state (Springate-Baginski and Blaikie et al., 2007). However, the overwhelming dependence of communities on forests led to several rebellions[2]. In several places, rebellions and accumulation of grievances forced the colonial government to retreat strategically and accommodate some local livelihood needs[3].

The history of assemblage of the forest estate in the colonial period accompanied by the disempowerment of local communities laid the foundation for post-colonial forest management policy that similarly overlooked local claims. **This led to a chain of livelihood consequences and reactions from forest communities that continues till the present day.**

4.0 Law and policy after Independence: Production forestry and conservation

The colonial Forest Act of 1927 continued to be in effect for the first three decades after independence and its thrust was production of timber for national needs. There were three

distinctive ways in which production forestry affected livelihoods. First, the assemblage of the forest estate was through the same process of marginalisation of local livelihood rights and claims. Second, the emphasis on production was so pronounced that policymakers overtly advocated clear felling of natural forests and replantation with commercially useful species. Third, and as a corollary to the emphasis on production, there were all-out attempts to extinguish local livelihood rights.

Resistance to the production forestry paradigm by forest dwellers mounted in the seventies, even as global concerns over deforestation resonated with concerns of the urban intelligentsia over rampant deforestation and loss of biodiversity for `development' projects. The state responded to concerns over deforestation through a central legislation to curtail the diversion of forestlands for non-forest purposes. However, this move towards conservation of forests also went against livelihood interests of forest dwellers as the very definition of forestlands was controversial due to faulty methods of settlement and classification of lands. Forest dwellers often found themselves called as `encroachers' on their own land due to these faulty procedures and the new legislation prevented the true status of the lands from being recognised.

Between 1951 and 1988, the 'net' state forest estate was expanded by 26 million hectares. (For the situation today, see Box 4). This was done largely through 'vesting' the non-private lands of former princely states and of *zamindars* as state forests, including community forests for local use set aside by the British (Saxena, 1999). In many of these areas, the procedure for enquiring into and settling local people's rights was not followed; nationalisation was done through summary notifications, without surveys and settlements. These wrongly classified lands had a wide diversity of communal property use and management systems by communities, recognised by custom. The livelihoods affected included those of shifting cultivators, hunter-gatherers, forest-based settled cultivators, nomadic pastoralists, and tenant cultivators of *zamindars*[4] .

Box 4.
Recorded forest area

The recorded forest area today covers about 76.96 million hectares or 23.57% of the country's area. Of this, 51.6% is reserve forest, much of it not finally notified after settlement of rights; 30.8% is protected forest, and the remaining 17.6% consists of 'unclassed forest'- not legally notified but simply recorded in government records as `forest'. This includes about 10 million hectares of community shifting cultivation lands in north-eastern India. Not all recorded forest area is under forest cover either. The Forest Survey of India estimates forest cover of 67.71 million hectares, of which 48 million hectares is considered 'good forest' (Springate-Baginski et al., 2008).

With the conversion of these lands into state forests, local management for local livelihoods was replaced by a uniform, centralised management system for sustained yield of timber and other commercially valuable produce for revenues of the state (Sarin, 2005). The attempt to curtail customary use also continued after independence, as illustrated by the case of *nistar* lands (See Box 5).

Box 5. *Nistar* ***lands***

In Madhya Pradesh, *nistar* ***lands that were earlier under the control of*** *Malguzars* ***or*** *Zamindars****, or under the control of the Revenue Department in*** *ryotwari* ***villages, were declared Undemarcated Protected Forests in 1958. The Protected Forest Act, 1960, converted*** *nistar* ***into a facility provided by the Forest Department even as community forests that stood on*** *nistar* ***lands passed into the hands of the Department (Ekta Parishad, n.d.).***

The Forest Policy Resolution of 1952 pledged forests to the "national interest", including defence, communication, industry and a maximum annual income in perpetuity for the states. State governments treated forests as an exploitable resource to earn revenue.

In 1976, the National Commission on Agriculture recommended that all natural mixed forests be clear-felled and replanted with economically useful species, an idea that the Government of India also sought to operationalise through a World Bank loan to replace 40,000 hectares of mixed forests in tribal Bastar with pine for the pulpwood industry (Sundar et al., 2001; Pathak, 1994). The Commission also recommended complete separation of forests from forest-dwellers' requirements and social forestry on village common lands as a source of meeting people's requirements. Social forestry projects, a precursor to joint forest management, attracted heavy donor investment. While they were advertised as projects to fulfil "people's needs" of fuelwood and small timber, their results were very different. The Forest Department (which had to recoup its investment) and the rural elites of village *panchayats* gave a commercial orientation to the projects by cultivating quick growing species like eucalyptus and casuarina, and thereafter selling the fuelwood and light timber to the nearby urban markets. The profits were never used for re-plantation. The poor got some wage labour during the plantation but thereafter were denied access to the *panchayat* land for fuelwood and fodder needs (Pathak, 1994).

Protests mounted in the 1970s against the ecological consequences of large-scale deforestation, notably those against a proposed hydro-electric project in the Silent Valley in Kerala and the Chipko movement in the Himalayas. **Conservation became an element of State policy in response to movements, reminiscent of the colonial state's response to protests and uprisings.** Control over forests was further centralised by shifting forestry from the State list to the Concurrent List, thereby giving the Union Government a greater say in the management of forests. The Ministry of Environment and Forests was formed in 1985 by shifting the Department of Forests out from the Ministry of Agriculture and merging it with

the Department of Environment. The story of its formation illustrates the struggle between an ideology of environmental preservation articulated by the Department of Environment and the older ideology of revenue maximisation espoused by the Department of Forests (Pathak, 1994).

In a bid to stop large-scale de-reservation of reserved forests, diversion of forestland in the States for non-forest purposes, clear felling of forests, and leasing of forests to individuals and corporations, the Forest Conservation Act, (FCA) 1980 and an Amendment in 1988 were enacted, making it mandatory for States to seek prior Central concurrence. One of the non-forest purposes targeted by the FCA and Amendment was regularisation of `encroachments' by State Governments, which provided ruling parties in the States substantial opportunities for political patronage.

Increasing concerns over the environmental impact of deforestation and people's movements protesting against the loss of forest-based livelihoods led to a reversal of statement of priorities in the National Forest Policy of 1988[5]. This Policy was an uneasy combination of livelihood and social objectives with conservation goals and `scientific' management. Along with the new objectives was also listed "increasing the productivity of forests to meet essential needs". Forest management plans were required to conform to the Policy and be approved by the Government. Scientific and technical inputs to improve productivity were emphasised. Rights and concessions were to be related to "carrying capacity" of forests, which was left undefined. While it was agreed that the domestic requirements of tribals and the poor had to be the "first charge on forest produce", they were to buy these from depots at "reasonable" rates. Grazing was to be controlled through levy of "adequate" grazing fees (MoEF, 1988). The objectives of the Policy, which is not legally binding on the Central or State Governments are often in conflict with provisions of laws. The ambiguously worded Policy is therefore amenable to widely varying interpretations, and can easily be read against the necessities of forest-dwellers, as has happened in recent judicial interventions.

5.0 Joint Forest Management and contests over forest resources

The Joint Forest Management circular of June 1990 has been the single largest attempt by the Central Government at participatory forestry. But results on the ground suggest that despite all the trappings of participation, the programme demonstrates the continued dominance of the forest bureaucracy. Further, the rhetoric of devolution and participation has been used to undermine community forest management institutions and extend the control of Departments over forest resources.

In a nutshell, JFM is an informal contract between the Forest Department and an identified village JFM Committee to protect a clearly demarcated area of forestland from encroachment, fire, felling and grazing. In return, the Committee is promised entitlements on forest usufructs from the protected patch, a share of the proceeds of intermediate and final harvests of timber by the Department, wage employment for silvicultural operations, and financial assistance from the Department for village amenities. All these entitlements are subject to satisfactory performance of its duties by the JFM Committee, as judged by the representatives of the Department (MoEF, 1990). The list of various prohibited and restricted activities that the circular lays out provides an insight into the forest administration's anxieties: ownership or lease right over forest land, grazing on the protected land, agriculture and cutting of trees before the stage of harvesting. The circular advocates the drawing up of a Working Scheme for the protected area to be approved by the State Governments and to be prepared with the participation of the community. It provides for State Forest Departments to terminate the informal contract without compensation on grounds of non-performance, and explicitly warns against "commercial or other interests" taking advantage of the programme (*ibid*.). Since 1990, JFM has gone on to become the flagship programme of the forest establishment in India, with programmes in 27 states, covering more than 17.3 million hectares of forest land or 27 percent of the forest area, with more than 85,000 JFM Committees formed (World Bank, 2006).

Box 6. Adverse Impact of JFM on Livelihoods

Restrictions on use of forestland imposed by forest protection groups often have an inequitable impact. While office-bearers and active members of JFM Committees may be less dependent on the forestland under protection, women from poorest sections of the same village may be highly dependent on the protected patches for fuelwood for own use and sale and for fodder resources. Women are often forced into situations of confrontation or have to walk greater distances and negotiate greater hazards to gather forest products (Sarin et al., 1996). In many states, Forest Departments have used JFM for plantation on disputed lands, thereby extending the Department's control over them as forestland (Sarin, 2005).

State	Impact on Livelihoods
West Bengal	Harassment from Department officials has reduced, especially for the poor, as they collect forest produce The time taken to collect forest products has reduced substantially Department working plans not modified to suit people's needs Community involvement used to further the Department's objectives Only a third of the village communities have received net income from Department marketing of timber products This income has been meagre
Orissa	Had about 8,000 self-initiated forest protection groups predating JFM protecting about 2 million hectares of forest, their conversion into JFM Committees has rendered most of them inactive Department officials have provided inadequate support and self-initiated groups resent the 50 percent share in final timber harvest that JFM promises A third of households in Self-Initiated Forest Protection Group reported reduced cultivation because of restrictions imposed
Andhra Pradesh	WB support generated temporary wage labour opportunities, but once these ceased, there was little incentive for Vana Samrakshana Samities to continue their activities Poor households faced reduced availability of fuel and fodder and restrictions on grazing Poorest were forced to sell their cattle Restrictions imposed on shifting cultivation have adversely affected income and food security of poor households Villages have been played off against each other, for e.g, by allotting land used for shifting cultivation by one village to a neighbouring village for plantation and protection

Source: Springate-Baginski and Blaikie et al., 2007b

JFM has, to some extent, changed the hitherto adversarial relationship between State Forest Departments and forest dwelling communities. Communities have seen improvement in resource use rights, have developed a sense of ownership, and JFM is seen to have contributed to improved forest cover. However, a number of studies have confirmed the very limited impact that JFM has had on livelihoods. In some cases, the impact has even been adverse as promised shares of benefits have not materialised, community groups have been utilised to further Forest Department objectives, and customary uses of forests, especially by the poor and by women, have been curtailed, sometimes by deliberately instigating forest protection groups against users (See Box 6 for examples).

Other studies have examined the perceptions of forest dwellers about JFM several years into the implementation of the programme and have found that communities view the programme with suspicion, see it as non-transparent and controlled by Forest Departments in consultation with a few individuals in villages (See Box 7).

The main reason for the failure of JFM to evolve into a genuinely participatory form of forest management is the continuation of a custodial mindset in the forestry establishment. The imbalance between authority and responsibilities of Forest Departments and communities that is written into JFM guidelines is evident in the JFM process.

Box 7. Perceptions of JFM

Forest dwellers in Jharkhand have expressed several concerns about the implementation of JFM. These include lack of involvement of the tribal population in JFM meetings and activities, and the lack of awareness by villagers about JFM guidelines, rules and regulations. There is deep suspicion about sharing of information, sharing of benefits, and maintenance of meeting minutes, records and accounts. There is a perception that JFM rules neglect existing and prudent uses of natural resources, local knowledge and cultural contexts. JFM is viewed as a non-participatory process, especially in the way micro-plans are formulated. But perhaps most damningly, there is a perception of lack of consultation with *adivasis* ***in the process of JFM formation and planning, and exacerbation of tensions between tribal and non-tribal people, among tribal people, and between JFM and non-JFM villages (World Bank, 2006).***

In a study of 40 JFM villages in Madhya Pradesh, it was found that only half of the Committee members attended meetings regularly, mainly due to lack of advance information and lack of time to participate. More than two-thirds of the respondents had no awareness of the availability of funds through JFM, the amount of funds available, and what they were spent on (Alsop et al., 2002).

A study of 21 JFM Committees in 6 ranges of the Harda Forest Division in Madhya Pradesh revealed that while there was great enthusiasm for JFM in the initial years, there was little sense of ownership or responsibility for forests 10 to 12 years into the programme. There had been little active people's participation in the formation of Committees and members of the Executive Committees had been handpicked by the Forest Department, meetings were not held regularly and women's participation was especially poor. Voluntary forest protection by villagers in rotation had given way to a system of paid watchers of the Department. A decade of JFM had not altered a hierarchical and unequal relationship between the state and local people, and it was only the activism of a mass organisation of *adivasis* ***that had challenged these paternalistic interactions (Vira, 2005).***

New JFM Committees created have confused and undermined pre-existing institutions like self-initiated forest protection groups in Orissa and *van panchayats* in Uttaranchal (Sarin et al., 2003). Income sharing with communities has been very limited. In Gujarat and Orissa, lands protected by Committees have been leased to paper companies. In Gujarat, Madhya Pradesh and Rajasthan, Forest Departments have unilaterally revised JFM orders, reducing the benefits due to villagers in return for protection (Sarin, 2005).

6.0 Judicial interventions and livelihood impacts

Over the last twelve years, the Supreme Court has been intervening in forest management in response to Public Interest Litigation (PIL)[6]. These interventions have rightfully focussed attention on the lapses of the forest bureaucracy in the states in checking rampant deforestation and diversion of forestland. However, the proposed solution of the Court is to further centralise forest management through what it perceives as `scientific' working plans overseen by the Union Ministry of Environment and Forests. With the confusion and disputes over forest settlement and people's rights, judicial intervention has adversely affected forest-based livelihoods.

In response to the PIL, the Court expanded the meaning of `forest' in the Forest Conservation Act, hitherto understood as reserve forest, to all forests as defined by the dictionary, irrespective of their ownership. All `forests' thus defined would have to be managed only in accordance with working plans prepared by Forest Departments and approved by the Ministry of Environment and Forests. It also redefined what constituted "non-forest purposes" to include mining, and operation of sawmills. It almost completely banned tree felling in three whole states and parts of four other states in the north-eastern states. It ordered saw mills to close down not only where a complete ban was directed but even within a 100 km radius of Arunachal Pradesh's state boundary. Finally, it banned any transportation of timber out of the north-east states. The Court ordered all non-forestry activities anywhere in the country that had not received explicit approval from the central government to cease immediately. It also suspended tree felling everywhere, except in accordance with working plans approved by the Ministry of Environment and Forests[7] (Rosencranz and Lele, 2008).

Box 8.
Livelihood impact of the Court's orders

In Meghalaya, logging of privately owned forests provided substantial household income and enabled household investment in education of children. The ban on timber has affected not only forest owners and contractors, but also farmers and woodcutters for whom forests are not the primary basis of subsistence. Depressed wages, rising unemployment and increased drop-out rates from schools and colleges have been reported as consequences of the timber ban. Further, the ban has also resulted in ecologically harmful practices like burning trees and removing charcoal and removing and selling the bark of trees (Nongbri, 2004).

The Court's actions had mixed outcomes. It jolted awake State Governments to take the Forest Conservation Act seriously, and provided more and transparent access to decision-making in forestry by admitting various interlocutory applications. But in terms of forest governance and livelihoods, it had serious negative impacts (See Box 8: the example of Meghalaya). Various community lands with diverse tenurial status and livelihood functions have been erroneously called `forests' and brought under the purview of the Forest Conservation Act. This has diluted or erased community rights by giving unfettered discretionary powers to forest departments. The Court's orders have placed undue faith in forest working plans, which have traditionally had revenue maximisation, and not livelihood and conservation objectives (Sarin, 2005).

7.0
The Forest Rights Act

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, (referred to as the Forest Rights Act or FRA) is a remarkable legislation that owes its drafting and passage to sustained activism by forest dwellers and civil society organisations acting against the threat of eviction from forestlands. The FRA provides a framework for recognition of individual and community rights over forests and promises much for forest management and forest-based livelihoods. However, the legislation has several ambiguities. A greater concern is implementation as State Governments seem to be either delaying implementation or departing from the letter and spirit of the FRA.

The Godavarman case resulted in a sharp division between the forestry establishment on the one hand, and forest-dwellers and civil society organisations championing their cause, on the other. At the centre was the new definition of forests that the Supreme Court had put forth in the Godavarman case. The Ministry of Environment and Forests summarily declared all those who were in occupation of recorded forest area as 'encroachers', though these included people whose rights were not settled, or where there were disputed claims over the land between forest and revenue departments. The Ministry's May 2002 order asked all State Forest Departments to evict in a time-bound manner, 'encroachers' from 12,50,000 hectares of land estimated as under encroachment. By August, the Ministry claimed to have freed 152,000 hectares of 'encroachments'. These violent evictions were contested by communities and civil society organisations[8].

Much earlier, in 1989, the Commissioner for Scheduled Castes and Tribes had drawn the attention of the Ministry of Environment and Forests to problems arising from incomplete land settlement and disputes. The Ministry, in 1990, issued a set of six circulars that established a framework for dealing with these problems, including review of encroachments on forestland, review of disputed claims over forestland arising out of forest settlement, and disputes regarding titles/leases/grants involving forestland. However, the Ministry showed little interest in implementing the circulars, but chose to focus on its JFM strategy which was also initiated the same year. In 2002, forest-dwelling communities and their representative organisations, began pressing for the implementation of the 1990 circulars while resisting Forest Departments' eviction attempts. It was soon realised that relying on the forestry establishment to implement circulars that it had neglected for over a decade was futile.

Instead, organisations began mass campaigns and educated political parties on the need for a new legislation to establish the rights of forest dwellers. The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 [Forest Rights Act or FRA hereafter] was finally passed in the teeth of stiff resistance from the forestry establishment and conservation lobbies[9]. Significantly, the Act was drafted under the leadership of the Ministry of Tribal Affairs.

The FRA aims *"to recognise and vest the forest rights and occupation in forest land of forest-dwelling Scheduled Tribes and other traditional forest dwellers who have been residing in such forests for generations but whose rights could not be recorded; to provide for a framework for recording the forest rights so vested and the nature of evidence required for such recognition and vesting in respect of forest land"*. The Act broadly provides for two sets of rights - land rights, both private and common, and community rights over forest resources. The former include the *"right to hold and live in forest land under individual or common occupation for habitation or for self cultivation for livelihood"*. The latter include rights for collective management of community forest resources, rights over common property resources such as produce of water bodies, grazing rights for both settled and nomadic communities, rights over habitat for primitive tribal groups, and ownership rights over NTFP (Springate-Baginski et al., 2008).

The FRA promises greater livelihood security and reduced vulnerability through freedom from harassment, rent-seeking, destruction of assets and extortion by forest staff, improved income through an improved range of rights to control and manage forests and secure access to forest produce, and recognition of cultivation rights over land through its conversion to revenue land, which also enables legal titles and consequent access to formal credit and development inputs from government departments (*ibid*.).

While the FRA promises to do a lot for livelihoods of forest dwellers, a number of grey areas remain. Only forest-dwelling Scheduled Tribes are eligible, which means that tribes who have not been scheduled will be excluded. The latter may constitute up to 50% of forest-dwelling tribes. Second, only those who primarily reside in and depend on the forest are eligible, this may exclude a large number of forest-dependent poor who may not be residing in forests. Other traditional forest-dwellers, as defined in the Act, will have to prove residence of over three generations of 25 years each to be eligible for rights under the Act. Third, the Act promises rights of ownership, access to collect, use and dispose of minor forest produce which has been traditionally collected within or outside village boundaries. The minor forest produce defined in the Act are currently governed by a plethora of state-level legislation and rules that regulate collection, transport and marketing. Many states have already created monopoly corporations that effectively make them the owners of the produce. It is unclear how ownership over minor forest produce will effectively be transferred to communities. Fourth, the Act empowers the *Gram Sabha* to be the authority to initiate the process for determining the nature and extent of individual and community rights. But the *Gram Sabha* is ambiguously defined both in the Act and in the Rules. Fifth, the relation between the Act and other legislation that governs forests is unclear. While the Act supersedes other legislation for the purpose of recognition of rights, it is a moot question whether other legislations regulate the exercise of these rights, since Section 13 says that the provisions of the Act shall be "in addition and not in derogation of the provisions of any other law for the time being in force" (Springate-Baginski et al., 2008).

Box 9.
The case of Critical Wildlife Habitats

The FRA provides for formation of Critical Wildlife Habitats through modification of forest dwellers' rights in them so as to preserve threatened species or habitats. The FRA provides for a transparent, consultative and fact-based process of identifying Critical Wildlife Habitats only after rights have been settled in the protected area. However, the Ministry of Environment and Forests issued its own guidelines for Critical Wildlife Habitats even before the Act came into force. Critical Tiger Habitats have been notified without the informed consent of *Gram Sabhas* ***(Springate-Baginski et al., 2008). In general, there have been attempts by forest and wildlife conservation lobbies to declare all existing Protected Areas as Critical Wildlife Habitats. Quite clearly, a section of conservationists and forest bureaucrats believe that as many wildlife habitats as possible should be `rescued' from the domain of the Act and kept under the control of the forest bureaucracy. Supporters of the Act point out that while conservationists have attempted to subvert the Act, they are not seen to raise their voices against ecological destruction caused by large-scale industrial and infrastructure projects.***

Given the resistance of the forestry establishment to the drafting of the FRA, and some of the early hurdles placed before it in implementation, the immediate question is whether the Act will actually be implemented in letter and spirit, with complementary changes in other laws and policies. (A case in point is that of Critical Wildlife Habitats, see Box 9).

A noteworthy point is that the Act was passed as a `non-money' one. There are no resources dedicated for the many supporting activities that are necessary for successful implementation of the FRA – awareness raising and information/education resources, clarification of responsibilities of various stakeholders, and monitoring of the process to ensure that it is timely and fair. This means that only those State Governments that are very pro-active, or where they are forced to be active by pressure from below, will actually take systematic steps towards implementation. Pressure from below essentially means organised efforts of forest dwellers, which is most likely in places where traditional ties with the forest are still strong, and where self-initiated forest management efforts have been extant. There have been concerns over whether sufficient numbers of `honest brokers' exist who can competently and sensitively interpret the provisions of the FRA to communities everywhere. There is a hiatus between the approaches of NGOs who emphasise community resource governance and may miss out on community heterogeneity and equity concerns, and the approaches of social movements who emphasise equity issues and may miss out on resource management aspects (Kashwan and Lobo, 2008). Concerns have also been expressed whether the FRA's central assumptions hold, that forest-dwelling communities everywhere have a deep bond with forests and will conserve them if tenurial security improves, and that *Gram Sabhas* are living institutions to initiate the claims process competently and without being swayed by the influence of elites (Ramnath, 2008). Given the wide variation in livelihood and life situations and world views of tribal communities all over India, it has been asked whether the FRA is over-generalised and with an overly technical-administrative perception of the status of tribes (*ibid*.). Some of these concerns are likely to be substantiated as regional-level empirical studies get under way, but underlying perspectives of these studies also matter. For example, Southern Rajasthan has a complex pattern of interaction of economically heterogenous communities with private, forest and non-forest commons, and the issue of 'encroachment' needs careful study. (Kashwan and Lobo, *op. cit.*).

At this point in time, claims submitted in most states are for individual land rights, mainly for cultivation. There are very few reported claims for community rights over forest resources. It is as yet too early to say whether the FRA will herald a new paradigm

of community forest management that is different from the JFM model that is still strongly supported by the forest bureaucracy[10]. The Campaign for Survival and Dignity, in a statement issued in January 2009, noted several glaring violations of the letter and spirit of the FRA during implementation: imposition by State Government of additional evidence requirement to back land claims, arbitrary influencing of the functioning of statutory committees under the FRA by State Forest Departments, imposition of arbitrary deadlines for submission of claims, declaration of Critical Wildlife Habitats without following due procedures under the FRA, and encouraging only individual and not collective claims (See Box 10 for details).

While the eventual fate of the FRA is yet to be known, that of a similar past legislation, the *Panchayat* (Extension to Scheduled Areas) Act (PESA hereafter) is well known. Despite, or perhaps because of, being a very radical legislation that empowers tribal communities to revive their traditional hamlet or village-level institutions of self-governance and to own and manage NTFP, PESA remains more or less a dead letter[11].

Box 10. Implementation of the Forest Rights Act: Issues of concern

While the FRA clearly lays down the evidence that is required to back a claim for individual or community rights, it is found that some State Governments are imposing various additional requirements.

Whereas the process of claim-making is to start at the level of the *Gram Sabha* ***and then to be scrutinised by committees at sub-divisional and district level, in most states it is found that Forest Departments are exercising a virtual veto over the claim-making process, that higher level committees function in a non-transparent and non-accountable manner while dealing with claims submitted by*** *Gram Sabhas*.

Whereas *Gram Sabhas* ***can be and must be held at hamlet or revenue village level to make the process participatory, accessible and transparent, almost all states are calling*** *Gram Sabhas* ***at the level of the*** *panchayat*, ***involving multiple villages.***

While the FRA Rules only state that claims must be filed within a period of three months after the *Gram Sabha* ***calls for them, and*** *Gram Sabhas* ***may extend deadlines, State Governments are themselves declaring deadlines after which no claims will be entertained.***

JFM Committees, which are usually composed of people under the control of the Forest Department, are being set up against the FRA claims process. Either JFM Committees are themselves being made Forest Rights Committees (instead of having the latter elected by *Gram Sabhas****) or, JFM Committees are being used to sabotage the claims process.***

The Ministry of Environment and Forests is planning to notify Critical Wildlife Habitats without following the evidence-based and transparent procedures laid down in the FRA, and at the same time is also diverting forest land for infrastructure and industrial projects, though the FRA prohibits any displacement of people before their individual and community rights are settled.

Both the Centre and the States treat the FRA as though it is only about individual rights, the rights of communities to manage and conserve forests have been completely ignored and not publicised.

Source: CSD, 2009

8.0 Options for enhancing livelihoods of forest communities

There is a growing acceptance of the limited success of the JFM model of participatory forestry to deliver livelihood benefits for forest communities. The World Bank, for instance, is of the opinion that JFM is weighted in favour of State Forest Departments' control over planning, management, investment, harvesting and marketing. This keeps forest communities trapped in a regime of using forest products for subsistence and as a safety net. The role envisaged for State Forest Departments is to focus more on core business functions like technical advisory service delivery, facilitation of partnership with communities and the private sector, and monitoring of forests (See Box 11 for details).

The Bank also suggests development of a comprehensive forest sector strategy with a vision for community forestry, including a comprehensive review of supply and demand for major forest products, long-term trends relative to forest sustainability and forest health, and guidance for investment programmes. This requires better information on supply and demand forecasts for key forest products, secondary processing capacity and market demand, pressures on the forest, livelihood issues and economic analysis of policy options. As more forests are allocated to communities through new models of tenure, the concept of a top-down working model to control decisions in forests will become less relevant. Therefore working plans will have to evolve into broader strategic documents to guide, rather than control, field-level management in community forests. The new working plan approach will need better information on communities, rural development priorities, biodiversity values and options for forest management to meet local needs; how resource supply will meet subsistence and market demand and how supply could be modified through management inputs to meet future requirements. More economic analysis would be required on forest management strategies to inform micro-planning and implementation. Working plans would have to be integrated with community micro-plans, and the latter would have to be guided by operational manuals that address broader rural development and livelihood activities such as livestock, grazing, energy, agro-forestry and agriculture intensification (World Bank, 2006).

All these changes need new and more flexible institutional models in place of large State Forest Departments where staff are nevertheless overburdened with multiple responsibilities. The Bank recommends a partnership model involving forest departments, communities, private forestry consultants, *panchayats* and community support organisations. The right mix of incentives needs to be designed to get the private sector to invest in production and marketing through outgrower and contract schemes. New models of service delivery are needed for rural development services to forest dwelling communities. Advisory bodies for forestry are needed at the state level and state-level community forestry federations or associations need to be developed. Multi-stakeholder networks need to be created where information, best practices and training material are made available based on demand assessment (*ibid.*).

The Bank's vision is a combination of providing quasi-property rights to communities and increasing access to markets. In advocating this, the Bank uncritically accepts a monolithic vision of `forests' despite there being ample evidence of multiple land uses. The report also pre-supposes that the sole aim of all communities is to access markets and increase income, whereas in reality there is a wide diversity of livelihood systems supported by different land uses. The possible contradictions between forest management for economic benefits and ecological aspects of forest conservation do not find mention anywhere. The mobilisation around the Forest Rights Bill and its eventual passage into an Act has, in reality, overtaken the market advocacy of the Bank. It is not clear how receptive the Ministry of Environment and Forests has been to the vision offered by the Bank, it appears that MoEF has stood by the JFM model.

Box 11. The World Bank's recommendations for forest-based livelihoods

- *Forests have huge untapped economic potential, and communities can benefit from these if the Central and State Governments undertake a phased reform programme targeted at (i) stronger forest rights and responsibilities for forest communities (ii) more effective management systems targeted at community forestry (iii) improved access to more efficient market systems for major and minor forest products, (iv) more effective and flexible institutions and capacities, and increased developmental focus on communities to broaden livelihood opportunities.*

- *In order to achieve more secure tenure and management rights for forest dwellers, the Bank suggests that using a participatory process, policy-makers should lay out a new community forest management framework with stronger forest resource tenure for communities.*

    - *Where historic forest resource rights exist, they should be clearly acknowledged in policy, codified in law and recorded on maps.*

    - *Where no rights exist, reforms should be guided by other global experiences as in China, for instance, granting tenure over resource rights for a fixed term, giving the community specific contractual rights and responsibilities over the forest. Or the Latin American and Canadian model of 20 to 25 year tenure, renewable and extended in five-year increments, based on the community meeting clear performance standards. The harvesting and transit permit regime on selected forest products needs to be reformed.*

- *Resource assessment and monitoring systems need to be improved by letting communities assume greater responsibility for basic forest inventory, developing increased GIS mapping capacities in forest departments and having community-based local monitoring with good baseline data, clear management responsibilities, simple indicators and achievable performance targets. Research and development needs to be refocused, at both state and national levels, on timber and NTFP that meet community needs, rather than plantations and traditional commercial timber species.*

- *The Bank recommends that communities and farmers wanting to sell commercial forest products outside of local markets should have the option of using contract sales or outgrower schemes rather that the existing state institutions. Complementary changes in forest legislations and agricultural produce marketing legislations need to be carried out. Potential revenue losses to state governments and forest departments can be addressed by developing alternative sources of revenue, such as better collection of downstream sales or income taxes. At the same time, the market power of communities must be strengthened by strengthening producer organisations at the community level, and marketing federations of producer organisations at the state level, allowing both to develop independent of forest department control. The federations need facilitation to strengthen their market position, establish storage, build capacities for value addition and sustainable harvesting methods, and encourage communities to directly sell consolidated lots of forest produce to large processing or marketing firms through auctions or contract agreements. Extension and technical services with a focus on agro-forestry, non-traditional timber species and NTFP need to be strengthened by forest departments in partnership with the private sector. Mechanisms for gathering and sharing market intelligence within government and with communities need to be strengthened.*

Source: World Bank, 2006

9.0 Social and ecological effects of transformation of traditional livelihood systems

Linkages with the market and commercialisation lead to an overall change in the approach to production, from one based on the satisfaction of relatively fixed self-consumption needs, to one based on the maximisation of income. The relatively wasteful use of human labour in earlier production systems aimed at self-consumption is overcome. In place of earlier extensive methods of production, dependent on use of large forest areas and relying on natural regeneration methods, intensification of production through producing more from smaller areas and smaller amounts of labour time takes place in order to meet external demand. While the maximisation of income becomes the overarching orientation of production, the ability to maximise income is unevenly distributed within communities. Those with better market connections and ability to leverage capital, usually but not always the elites of the old community, do better. Class divisions tend to get more pronounced and as older forms of reciprocity that led to collective welfare die out, more disadvantaged households tend to lose out. Gender relations within communities undergo changes, as men increasingly take charge of economic affairs (Nathan and Kelkar, 2004b).

In the North-east, while small-scale and localised sale of NTFP remain in women's hands, the more important income-generating timber sale is controlled by men. Even in formally matrilineal communities like the Khasi, there is a big shift in control over household income. The growing proportion of self-acquired property, as against ancestral property, that is the outcome of timber production and sale, leads to increasing control of property overall by men. The increase in men's say in family economic matters is also associated with their continuing control over village and community affairs. Gender relations within households also undergo changes along with the change in production orientation. Traditional gender division of responsibilities, where women are responsible for household food security, become more accentuated. Women try to maximise the income they can earn, even through low-return labour-intensive activities like collecting, carrying and selling headloads of fuelwood (Nathan, 2004).

Box 12.
The impact of timber trade in north-east India

Privatisation of forestland

Before the growth of timber trade in the north-east, there was limited private ownership of agricultural land. Swidden or shifting cultivation plots reverted back to village commons, and large areas of uncultivated village land remained as village commons. There were also lands between villages that remained under the control of traditional chiefs. But with the growth of timber trade, forest use was transformed from swidden alone as timber could be sold or converted to charcoal and sold. The ability to use forestland for these new purposes was not restricted by the extent of family labour, as in the case of swidden, but by the amount of capital that a family could access. Village headmen and their families, with their economic connections and political influence, could register vast areas of inter-village and uncultivated village land as their own private land. Plantations sprung up as high-value timber trees could command prices sufficient to cover the costs of fencing.

Class inequalities

As a result of the privatisation of forest ownership, the Khasi Hills have a large class of farmers who own forests - families of headmen own large tracts, while many small farmers have patches with only a few trees. Besides these forest owners, there are timber traders or contractors, often local persons who have learnt trading by working as employees of other contractors. There are also sawmill owners, who also usually own some forest, take leases on other forests and buy timber from the market. Sawmill owners are also usually village headmen, with good external contacts, who are able to raise capital.

Impact on forests and forest management

Timber sale became the most stable source of household income, more so than agriculture. Incomes were substantial and led to upgradation of houses, purchase of consumer durables and increased investment in quality education. The impact on forests was very negative. Most timber sales were by leasing forests for a fixed period. This only led to clear-felling at the end of the lease period, the contractor had no incentive to invest in replanting. Over time, there was a move towards regeneration and sustainable harvesting, and this was reflected in a decline in leasing and a shift towards logging by owners. But there is also a tendency towards over-harvesting by individual owners as income from harvesting accrues to the individual owner while the individual bears only a small part of the effects of logging in terms of environmental services that are foregone. Logging was eventually stopped by an order of the Supreme Court.

Source: Nathan, 2004

9.1
Impact of timber trade

The transition from communal to private property is illustrated in North-East India, where forests are largely owned by communities, clans or families[12] . The growth in timber trade resulted in the privatisation of forestland, increase in class inequalities, and a tendency to deforestation (See Box 12 for details).

9.2
Impact of NTFP commercialisation

The privatisation of forests among the Khasi and the Naga also has an indirect impact on NTFP. Earlier, there were rules of access and harvesting that were developed in a system of collection primarily for self-consumption[13]. The scenario changed with the emergence of large, non-local markets and accessibility through road construction. Many NTFP species were subjected to over-exploitation. Many were cultivated in private gardens (See Box 13 for details).

Box 13. NTFP commercialisation in north-eastern India

With greater proximity to markets through growth of road networks, NTFP became one of the main sources of cash with which to buy non-local goods - cloth, implements, education and entertainment. The result was that many NTFP species became threatened with over-exploitation. Rules prohibiting the extraction of NTFP for sale broke down in the face of the dual pressure of external market demand and the internal need for cash income. The rule of restricting access to members of the relevant community, clan or village remains, but there is no effective regulation of rates of harvesting, leading to competitive over-harvesting.

In this changed scenario, if harvesting is to be made sustainable, it needs a certain investment of labour and other resources. However this investment is not forthcoming, if the income from NTFP will be shared among all members of the community, while the investment of labour or resources is to be undertaken by one person or family. The combination of competitive over-harvesting and lack of investment in sustaining the productivity of the resource leads to the depletion of NTFP on common properties.

One response of families and communities to this has been to bring the trees into home gardens or private orchards carved out of the commons. Studies of Meghalaya show that most NTFP sold in the market come from gardens and not from forests as such. Similar worldwide studies show that increased commercialisation of NTFP is likely to lead to a breakdown of common property systems and a trend towards individual private property. Those NTFP which yield a higher return are domesticated, while those with lower and uncertain returns are not.
The resultant cultivation of NTFP results in high population densities of the desired species and low biodiversity.

Source: Nathan, 2004

10.0 Conclusion and way forward

Forest-based livelihoods constitute a significant proportion of the livelihood portfolios of tribal and other forest-dwelling communities in India, and especially of poorer households in these communities. The legacy of colonial rule has been the centralisation of control over forestland in the hands of the state and the marginalisation of forest-dwellers and forest-based livelihoods. Forest law and the institution of the Forest Service and Forest Departments have been the main instruments of centralised control. Post-independence forest policy more or less followed in the footsteps of its colonial predecessor and resulted in the assembling of a massive forest estate without settling the rights of forest dwellers or recognising their livelihood claims on forests. Tenure and tenurial security have been the central issues for forest dwellers with respect to livelihood from forests.

Mobilisation by forest dwellers around these issues and by citizens concerned over widespread deforestation for `development' led to the framing of a new National Forest Policy in 1988 that provided importance to forest dwellers and their livelihoods. The vehicle chosen by the forestry establishment to operationalise the new forest policy was Joint Forest Management. However almost two decades of JFM have not translated into genuine devolution, participatory management and positive livelihood impacts. This is primarily due to the continued custodial mindset of the forestry establishment and the ad-hoc nature of JFM, which has done little to provide security of tenure to forest-dwelling communities. Judicial activism over the last twelve years to contain deforestation by further centralising forest management in the hands of the forest bureaucracy brought tenure and livelihood insecurity issues to the fore, in particular, the long-standing problem of lack of due legal process in the settling of forest dwellers' rights while assembling India's forest estate.

Once again, mobilisation by forest dwellers and civil society organisations led to the passage of a path-breaking legislation, the Forest Rights Act, which seeks to provide a framework and a methodology to settle the individual and collective rights of forest dwellers. The FRA tackles tenurial security head-on and with its provision for recognition of community management rights, attempts to move forest management away from the existing state-centric frame. However the immediate challenge is to get the FRA implemented, as the forest bureaucracy in the states, wildlife conservation lobbies, and State Governments in general are attempting to deviate from the letter and spirit of the Act. With the space that it provides for community agency, the FRA threatens business-as-usual models of paternalistic governance.

Only after the FRA is sincerely implemented will it be possible to focus on issues complementary to secure tenure that will have a significant impact on community management and livelihoods. Policy advocates have emphasised, apart from tenurial reform, improved community linkages with markets, strengthening of community institutions and re-orienting state forestry institutions in order to improve livelihoods. But community linkages with markets as a panacea needs critical reassessment, as communities in reality have a wide diversity of land uses and livelihoods aimed both at use value and exchange value. The intrusion of the market into traditional management systems undoubtedly reduces inefficiency in resource use, and enables an intensification of resource use beyond that caused by local demand for self-consumption. But as the experience of North-East India, where state control of forestland is weak and forests are largely managed individually and communally, shows, there are several issues of concern when traditional livelihood systems undergo transformations after integration with markets. Some of these are: privatisation of common resources, increased commodification of forest produce, ecologically unsustainable modes of forest produce collection, and changes in social structure and values, and in gender relations. The formation and strengthening of private property gives rise to class inequalities and increased patriarchal control, and loss of assured access to land. Membership of the community is no longer synonymous with access to critical productive resources. There is also a decline in earlier forms of reciprocity as social welfare (Nathan and Kelkar, 2004a).

In the face of these transitions, conscious attempts need to be made for new forms of distribution of land and other productive resources, private-public interaction and public human welfare systems. If successful, these can result in more equal forms of gender relations, less unequal development and better human welfare alongside privatisation. While the market is likely to destroy the traditional community, conscious interventions can re-create the community. The nature of intra-community interaction would change from the earlier kinship-based reciprocity and redistribution welfare systems to a new form of citizen-based social welfare system, combining state and community-based mechanisms (Nathan and Kelkar, 2004b)[14].

Community institutions and their interaction with markets therefore need to be carefully designed so that the outcomes of the latter are not greater social stratification and ecological and economic impoverishment. The role of the state here is crucial, ironically, the same state that seems to be impeding the progress of the FRA today. But the very experience of the drafting and passage of the FRA shows that forest management and forest livelihoods are not just the domain of experts and technocrats, but are intensely political subjects where the affected forest-dwelling populations are increasingly capable of making their voices heard. There is reason for hope that the state will eventually respond.

Endnotes

[1]*Some of these conditions include: well-defined boundaries to the resource, the ability to exclude non-stakeholders from using the resource, exclusive claim to the benefit stream arising from management of the resource, clearly identifiable stakeholders who are relatively economically and socially homogeneous, the organisation of stakeholders into institutions with clear regulations governing access to the resource and intensity of use of the resource and with a clear authority structure to enforce regulations, equity in distribution of benefits, appropriate technical and capital investment for improvement in productivity.*

[2]*The Great Bhil Rebellion of 1857-60, the revolts led by Tantia Bhil, the Alirajpur Bhil Rebellion of 1881 (Rahul, n.d.), and the Gudem-Rampa rebellion (Arnold, 1982) are examples. Other examples include the Chotanagpur uprisings in 1893, Bastar in 1910,*

Midnapur in 1920, and Kumaon and Garhwal in 1915-20. In other cases, continuous pressure on Baiga and Gond shifting cultivators to `settle' them resulted in their getting incorporated into the labour force of the forest department (Rangarajan, 1996).

[3]Van panchayats *were conceded in Kumaon and Garhwal to allow community self-management for livelihood needs. The Punjab Forest Grievance Committee recommended the creation of Forest Co-operative Societies in Kangra, reserved forest area was significantly reduced in Bastar, and independent panchayats were created to manage forests in the Madras Presidency. The* Mundari Khundkatti *system of the Mundas was recognised, where original families settled in the village enjoy ancestral rights over the village area, including the right to clear forest land to settle male heirs. Many tribal areas were declared agency areas with special administrative arrangements, which provided some protection from extinguishments of customary rights.* Nistari *forests and* nistar *rights for household subsistence consumption were recognised (Springate-Baginski and Blaikie et al., 2007).*

[4]*For example, revenue land settlements carried out during the 1970s in Orissa did not survey hilly lands steeper than 10 degrees because of the expense involved. Nevertheless, these lands were declared as state-owned forests or `wastelands'. These lands were predominantly inhabited by* adivasis *and used for shifting cultivation (Sarin, 2005).*

[5]*Prior to this, the forest bureaucracy made one more attempt to re-establish old-style custodialism. In 1981, the forestry establishment attempted to tighten control once again through a Draft Forest Bill that sought to further curtail customary access. The Bill's intention to declare customary forest uses as cognisable offences and further strengthen the administrative and judicial powers of Forest Departments were seen as draconian. Criticism from NGOs and mass demonstrations in some forest areas finally led to the Bill being shelved (Pathak, 1994).*

[6]*The case began with a Public Interest Litigation filed by Godavarman Thirumulpad in 1995 against illicit felling in his ancestral forest estate that had been taken over by the Forest Department after independence. The Court clubbed this PIL with another similar case and expanded its remit to forest management in the whole country.*

[7]*The Court order in the Godavarman case has also been used by the Gujarat Forest Department to disallow JFM groups permission for thinning and other intermediate operations. People approaching the Department have been told to get permission from the Forest Development Agency regional office in Bhopal, which in turn has issued orders to the effect that JFM groups could be given such permission as long as it does not violate Supreme Court orders. State Forest Department officials are unwilling to vouch for this (Prakash Kashwan, personal communication).*

[8]*Many organisations rallied under a common banner, the Campaign for Survival and Dignity. There were also independent mobilisations by Ekta Parishad, DISHA, and the National Forum of Forest People and Forest workers.*

[9]*Details of the process by which the legislation became a reality can be read at Springate-Baginski et al. (2008)*

[10]*For example, even the recently introduced Compensatory Afforestation Fund Bill, 2008 provides for all compensatory afforestation when forestland is diverted for non-forestry purposes, to be carried out through the Central Government's Green India campaign, where JFM Committees are tasked with the actual afforestation activity.*

[11]*PESA originated in a successful legal challenge mounted by tribal groups against the extension of the 73rd Amendment of the Constitution – establishing* Panchayats *as a three-tier system of governance at district and sub-district levels – to tribal areas governed by the Fifth Schedule of the Constitution. Thereafter, the Government of India constituted a Committee of Members of Parliament and experts headed by the Congress MP, Dilip Singh Bhuria, a tribal. The Committee's recommendations culminated in PESA. PESA provides a radical mandate for local self-governance in tribal majority areas as recorded in the Fifth Schedule of the Indian Constitution. PESA makes the* Gram Sabha *(the body of adult voters of a self-defined tribal village community) competent to safeguard and preserve the traditions and customs of people, their cultural identity, community resources, and the customary mode of dispute-resolution. According to the provisions of PESA, the* Gram Sabha *is conferred ownership right over NTFP either directly or through the* Gram Panchayat. *The provision in PESA for conferment of ownership over NTFP on* Gram Sabhas *in Scheduled Areas led to a severe reaction from the Ministry of Environment and Forests. Asked by the Ministry of Welfare and the Ministry of Rural Areas to initiate action on PESA, the Ministry of Environment and Forests formed an Expert Committee with a majority of foresters on it. The Committee warned against conferment of ownership, citing the possibility of destructive harvesting, financial inadequacy of Panchayats for sustainable harvesting, intra- and inter-tribe inequalities. It recommended usufructory rights over NTFP for all* Gram Sabhas, *in both Scheduled and non-Scheduled Areas; and sharing of net proceeds from sale of important state-regulated NTFPs, in different proportions, with the* Gram Sabha *and with the gatherers. It also classified bamboo and cane as timber, and not as NTFP. In defence of its interpretation of PESA, the forest bureaucracy said that the Indian Forest Act had conferred state ownership over forestland and PESA does not override it. PESA faces legal challenges in some States and is hardly being implemented by State Governments (Ramakrishnan, 2002).*

[12]*Forests under the control of State Forest Departments range from 8 to 40 percent of forest area. The Autonomous District Councils, created under the Sixth Schedule of the Constitution, nominally have ownership or management rights over forests, but in actual fact these rights are exercised by villages and families.*

[13]*For whatever is planted, local systems accept the right of the planter to the tree and its produce, but the latter has to be established by the personal presence of the planter. Trees of absentee planters would be harvested by others. Whatever is not planted can be collected by anyone belonging to the relevant community, clan or village. Communities also had rules or informal norms about the time when harvesting could be done. Many community rules also specify that any collection for sale is not allowed, or requires the prior permission of the clan or village (Nathan, 2004).*

[14]*An example of this is the leasing of degraded forestland to the poorest sections in villages who depend more on common land than others in the village; this has been tried out by the International Fund for Agricultural Development project of Leasehold Forestry in Nepal. The returns from plantation accrue to the entire group. Such a relatively homogenous group can set up rules about labour contribution and sharing of income and resources, monitor the observance of rules and impose sanctions for infringement. It may also be necessary to combine group access with family labour, so that tasks like social fencing may be done at group level, whereas the major labour of tending plots and extracting products could be family based. Thereby the group organisation could be used to establish user rights, while family labour would be the basis of income distribution (Nathan and Kelkar, 2004b).*

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(4C) What have we learnt about forest-based livelihoods in the Bees, Biodiversity and Livelihoods Project?

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Abstract

The NBR needs to be considered as both a social and economic resource of households that live in and around it. Drawing from the evidence of the household studies this paper will investigate the significance of the forest, and Non Timber Forest Products (NTFPs) in particular, as a household resource, and how it varies between individuals, households, social groups and locations.

With respect to the forest as a social and cultural resource the paper reflects on the role of the forest, and different forest `products' in people's lives showing how seemingly similar people, from the same `community' may view a resource, or for example a social activity to gather a forest product (such as honey hunting), in very different ways. Differences in background, experience as well as gender and age, result in different perceptions of the social value of the forest and NTFPs.

On the economic role, based on an assessment of household income portfolios, it will be shown that the contribution of NTFPs in general and honey in particular to household income is highly variable and differentiated both by site and by differences between households within sites. There are a few sites e.g., Mancheri in Nilambur in Kerala where all household income is drawn from NTFP collection. However even here household income on average obtained from honey does not amount to more than 20% of total gross household income. In most other locations NTFP derived income is 20% or less of gross household income and honey derived income a quarter of this or less. Factors that appear to affect the role of NTFPs in household income include both supply considerations as well as the availability of different economic opportunities. This is discussed in terms of overall differences between sites and how these interact with household specific factors.

Introduction

The involvement of rural communities living close to forests in protection, management and use was enshrined in the National Forest Policy in India in 1988. That Policy stated that `the rights and concessions from forests should primarily be for the bona fide use of communities living within and around forest areas'. Since then much has been published exploring the nature of the use of forest resources by people living close to forests (Reddy and Chakravarty 1999, Shaanker et al., 2004, Rai and Uhl, 2004, Rasul et al., 2008 among others). These various studies establish that non-timber forest products (NTFPs), as well as timber, are an important source of livelihood for many people in India. For example, Rasul et al., 2008: 780, reviewing a range of different studies, conclude that forest-based small enterprises provide half the income of about 25% of India's rural labour force. Forest products not only provide income but are also important for subsistence and as a safety net during seasonal food shortages (Shiva, 2001). The cultural, spiritual and social significance of forests for many people has also been described (Gadgil, 1992, Tewari and Campbell, 1995, Ramanujam and Kadamban, 2001, Mahapatra and Tewari 2004, among others). Our purpose in this paper is to document the findings from the 'Bees, Biodiversity and Livelihoods Project' on forest livelihoods in the Nilgiris to try to unpack how 'forest dependent' the people are in the areas studied.

Background

This project, in the Nilgiri Biosphere Reserve (NBR), Western Ghats, India investigated the interdependencies between bees, biodiversity and forest livelihoods. As a part of this project we studied the place of indigenous bees in local livelihoods and the value, in the broadest sense (economic, social and cultural) of the forests in local livelihoods.

The project purposely selected case study sites in order to capture contrasts of biogeography, the distribution and honey collecting practices of the major tribal groups, as well as respond to practical and strategic considerations of coverage across the three Indian states (Tamil Nadu, Karnataka and Kerala) that are contained within the Nilgiri Biosphere Reserve. We worked in five locations in an attempt to capture key differences and variability. The site selection methodology is described in detail elsewhere, but for the

purposes of this paper we summarise the characteristics of the five locations and 16 research sites within them.

Of the 36 indigenous communities[1] known to reside in NBR, about 14 have been assessed to have been traditionally involved in the collection of honey although this is of varying significance in the livelihoods of these different communities. 12 of the 14 indigenous communities have been classified as hunter gatherers and it is these communities that are particularly active in wild honey collection. The other two communities, Todas and Paniyas, are respectively pastoralists and agriculturalists. The distribution of indigenous people, as well as vegetation type and elevation was taken into account in site selection. Each location (broad area or region in which the site was situated) were given distinctive names (Project Location[2] Names) for the purposes of this project. These details are summarised in Table 15, along with the major vegetation types contained within each of the project locations and the indigenous communities found within these.

Within the five locations, sixteen sites were chosen, each with a village or settlement. These are identified by different codes shown in Table 16.

Table 15. Characteristics of Project Locations

Management divisions (State)	Project location names	Elevation range m.a.s.l	Forest type	Indigenous communities
Chamrajnagar and Satyamanagalam (K&TN)	Chamrajnagar	1000 -1200	DDF, MDF, Shola, SEG	Sholiga, Irula
Nilgiris North and Coimbatore (TN)	Coonoor	500-1400	MDF, DDF	Kurumba,
Nilgiris North (TN)	Kotagiri	1800 -2200	Shola	Badaga, Toda
Mudumalai and Nilgiri North (TN)	Mudumalai Sigur	900	DDF, Scrub, MDF	Kattunaicken, Irula, Kasava, Jenu Kurumba
Nilambur South and Nilambur South (K)	Nilambur	800 -1200	SEG, MDF, DDF	Cholanaicken, Pathinaicken

Legend:
SEG - Semi-evergreen, MDF – Moist Deciduous Forest, DDF - Dry Deciduous
State K = Karnataka, TN = Tamil Nadu, K = Kerala

Table 16. Project locations, sites, adjacent indigenous community and vegetation type

Locations	Site code	Indigenous community	Vegetation
Chamrajnagar	ChB	Sholiga, Kannadiga	SEG/DDF
	ChG	Sholiga	SEG/MDF
	ChK	Irula	SEG/MDF
	ChP	Sholigas, Kannadiga* Badaga**	DDF/DDF
Coonoor	CM	Kurumba	SEG/MDF
	CP	Kurumba	SEG/MDF
	CS	Irula	DDF
Kotagiri	KB	Toda	Shola and grasslands
	KK	Toda, Others***	Shola and cultivation
	KT	Badaga, Others	Cultivation
Mudumalai / Sigur	SB	Kattunaicken	MDF
	SC	Kasava/Irula	DDF
	SS	Kasava/Irula/Jenu Kurumba	DDF and Riverine/scrub
Nilambur	NA	Kattunaicken, Paniyas	MDF/SEG
	NM	Cholanaicken	MDF
	NMu	Padinaickens, Paniyas	DDF/MDF

Legend
* Kannadigas are residents of Karnataka state and have been living in the mentioned villages along with indigenous groups.

** Badagas are the single largest ethno-linguistic population in the Nilgiri Biosphere Reserve and one site has been selected in which they are present for comparative purposes.

*** Others refer to those who were settled in the Nilgiri district since the coming of the British or those who have populated the district since the advent of the British. These would also include those who have been recently settled following the ethnic conflict in Sri Lanka.

Methods

Four different methods were used for the collection of data on forest livelihoods: mapping of settlements, general interviews using a checklist, in-depth interviews to gather household histories and a honey market study. A research assistant and a field assistant familiar with the research area collected the information. All but one of the ten research staff were men and six of these men were members of indigenous communities.

In each site a map of each settlement was drawn showing the dwellings and main physical features. The dwellings were numbered and these numbers used for systematic data collection from each place. Using a checklist the research team then collected information on specific topics through discussions with household members (a formal questionnaire was not used). Data was collected on: the history of the area, of both the people and biodiversity; the social structure in the area and the demographic composition of the individual household, socio-economic status of settlement and individual households; occupation or other things people do to make a living; people's relationship with the forests (including dependence, wildlife/NTFP); landuse/animal husbandry; culture and religion (particularly as it relates to natural resources; Forest or other Government policy which might influence people's lives; interaction with institutions, such as government and non-government organisations; general infrastructure and natural resource distribution (geography of the area); overall well-being (health and sickness) in the household; risks and uncertainties that people face. This information was tabulated in a matrix for each site. Households for in-depth study, to collect the household histories, were purposively chosen to represent people heavily engaged in honey hunting and NTFP collection and those who were not. The intention was to build up detailed portraits of households. The life histories of the adults (usually a man and a woman, where available) in the households were documented and day to day activities in the households were described. In addition an attempt was made to record significant events during the period of study, including any engagement household members may have with people in authority (including the Forest Department). Sixty nine life histories were collected from the five different locations.

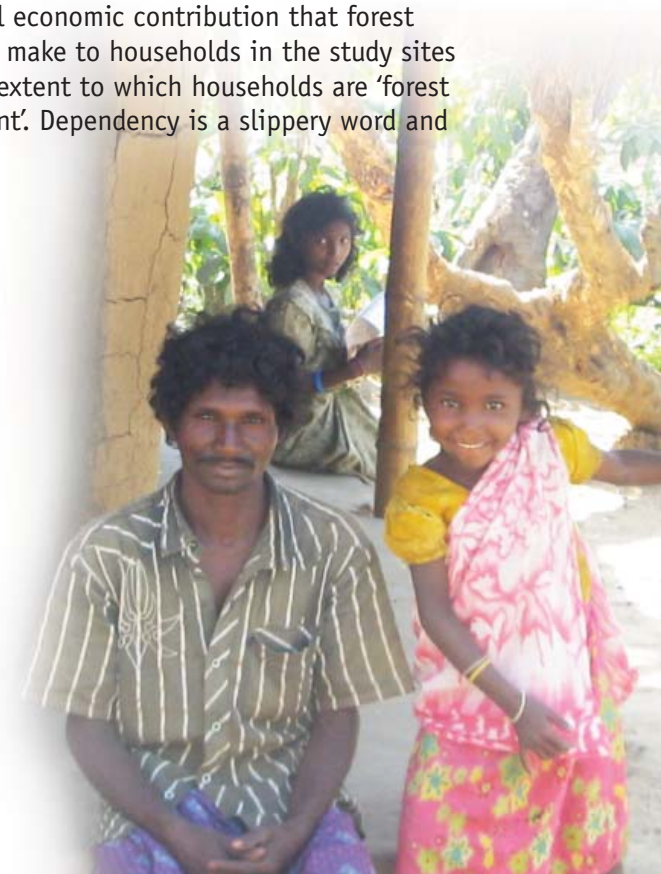
In addition, a honey marketing study was undertaken to find out how much honey was being exchanged informally and commercially in each settlement and who was involved in these transactions.

All data was coded manually by theme for analysis.

The next section of the paper investigates the contribution that the collection and sale of NTFPs in general and honey in particular make to household income in the case study sites before turning, in the following section, to other ways in which forests may be important in people's livelihoods. It should be noted that fauna are not included in the present analysis, the contribution of fish/small animals will be included in a future version of this paper.

The economic role of NTFPs and honey in households

The assumption that is often made about social groups that live in forests and in the Nilgiris are that these are 'forest dependent' communities, as noted above. Forest dependence as has been noted has complex dimensions with spiritual, social and economic aspects. Here we are concerned with the potential economic contribution that forest products make to households in the study sites and the extent to which households are 'forest dependent'. Dependency is a slippery word and



must be handled with care. It could be taken to mean that income from forest products constitutes a major part of household income in cash or in kind, without which households could not survive. Equally it could be a small percent of household income (again in cash or kind) but as household income is low anyhow, its absence could, for example, push the household below the food security line. Accordingly the idea of 'dependency' which is an evaluative term is deliberately avoided and we focus here on the concrete measure of income without drawing inferences as to whether this means dependency or not.

As always, assessment of household income in rural economies is an inexact science for reasons of method (based for example on recall and the difficulties associated with that and measurement, particularly if there is an 'in kind' component) and questions of reliability (willingness and ability of informants to give accurate data). The data that is presented here can be regarded as a best estimate. It has been collected at all sites (with the exception of Mancheri[3] in Nilambur) on the basis of household interviews using seasonal calendars to determine primary activities during that time. Since most income generating activities of most households are based on either activities in the informal sector or casual employment, precision cannot be expected. Estimates of income from the collection of NTFPs, for example, have been assessed based on an aggregation of the number of harvesting trips made per month, estimates of the average weight or volume of product collected per trip and the reported price paid per kg for the product. These are then estimates of gross income and do not take account of income in kind for products consumed within the household. In particular no assessment has been made of the in-kind value of firewood collected by most households from the forest although in two sites cash income from firewood is included.

Three questions structure the summary analysis of household income and its sources and can be posed as follows:

- **What proportion of household income in the study sites is derived from NTFP sources and honey[4] in particular and how does this vary between sites?**
- **How does this contribution of NTFP and honey sourced income vary between households within and between sites?**
- **What factors might explain the variability in the contribution of NTFP and honey sourced income between sites and between households within a site?**

Table 17. Mean annual household income (Rs.)[1] by site (N = number of households) and proportion of income derived by source

Site (N)	Mean annual income (IRS)	% Income from wage work[2]	% Income from agriculture	% Income from NTFPs including honey	% Income from honey
Chamrajnagar					
- ChB (10)	60000	1.00	0	0	0
- ChG (38)	36970	0.21	0.23	0.53	0.10
- ChK (20)	34407	0.16	0.19	0.65	0.13
- ChP (23)	36787	0.76	0.06	0.23	0.23
Coonoor					
- CM (7)	21214	0.82	0.04	0.14	0.07
- CP (21)	44981	0.93	0.01	0.07	0.02
- CS (6)	25333	0.76	0	0.23	0.03
Kotagiri					
- KB (9)	39289	0.31	0.29	0.40	0.04
- KK (8)	53525	0.35	0.55	0.10	0.02
- KT (21)	75707	0.41	0.52	0	0
Sigur					
- SB (44)	34995	0.64 [+0.07]	0.03	0.25	0.11
- SC (39)	41665	0.70 [+0.14]	0.09	0.07	0.02
- SS (42)	40667	0.65 [+0.05]	0.18	0.14	0.02
Nilambur					
- NA (16)	46945	0.81	0	0.19	0.04
- NM*	60000*	0.00	0	1.00	0.34
- NMu (30)	56950	0.97	0	0.03	0.01

[1]For sake of clarity Standard Deviation values are omitted but they are high in all cases indicating considerable variability between households.

[2] Income from wage work includes wage labour (the major source), pension payments and in the case of the Sigur sites the additional income from salaried work is given in brackets. Note that there has been rounding up and down of figures.

* In the case of Mancheri this indicates a maximum income that would be possible given NTFP collection activities; in practice it is likely to be less than this.

What proportion of household income in the study sites is derived from NTFP sources and honey in particular and how does this vary between sites?

Table 17 summarises the data on mean household income determined for each site and the proportions of income coming from wage work, agriculture, NTFPs and honey.

A number of observations can be made drawing from this data set.

First, there is enormous variability between sites both with respect to the mean annual household income, the major sources of that income and the contribution of NTFPs to income. That in itself invites extreme caution about making generalised statements about the role of NTFPs to the income of households that live in or near forests. With a median value of about Rs.41,000 (US$ 820) these are poor villages. Even the highest income sites (KT, NM, NMu and ChB) only manage a mean household income of Rs.60 – 75,000 (US$1200 – 1500) while the poorest villages (CM and CS) have mean household incomes of Rs.21,200 – 25,000 (US$ 425 – 500).

Second, in only three (20%) of the sixteen sites (ChG, ChK and NM) is the contribution of NTFPs more than 50% of mean household annual income and in only one of these (NM) is it the only source of income. In nine (56%) of the sites NTFP income contributes 20% or less of household income and in two of these (ChB and KT) NTFPs contribute no income. Note should be made that four sites have a mean annual household income in excess of Rs.55,000. One of these sites is NM where income is exclusively based on NTFP sources although this is based on estimation. The other three sites are NMu, ChB and KT and these are also the three sites where the contribution from NTFP income is least (respectively 0.03, 0 and 0 of mean annual household income) raising the interesting question of what the relation might be between overall levels of income and the contribution made by NTFPs. This is returned to later.

Third, it is evident from the data that honey is not a major source of income. For those sites with NTFP income (14 of them), the contribution of honey ranges from 0.02% to a maximum of 34% of mean household income in NM. Indeed in 11 of these 14 sites (78%) it is less than 10% of mean site household income. In only one site, ChP, is honey the only source of NTFP income and even here it is only 23% of household income. This relatively small contribution is hardly surprising given, as with most NTFP collection, the seasonal nature of honey collection (over approximately a three month period). Further it is also clear that honey is far from being the most economically important NTFP that is collected. In only two sites (CM and ChP) does it contribute 50% or more of NTFP income. In 50% of the sites with NTFP income sources it contributes 20% or less of NTFP derived income. Nevertheless its value as an income source is not to be underestimated and it is the only NTFP to be named at each site. As the data in Table 18 shows, in 7 of the 14 sites with NTFP income it ranks as the top NTFP income source and in another 5 as the second most important income source.

In summary two points are worth stressing. First, the enormous variation between sites with respect to the contribution of NTFP sourced income to mean household income and second, the relatively low percentage of income derived from NTFPs in most sites. Note that these comments take no account of the variability of income from a given NTFP income source between years (and hence the reliability of it as an income source) and honey harvesting is known to show considerable variation between years.

Table 18. Ranking of NTFP income sources contribution to NTFP sourced income by site

Site	First Ranked NTFP income	Second Ranked NTFP income	Third Ranked NTFP income
- ChG	Gooseberry	Honey	Phoenix
- ChK	Gooseberry	Honey	Phoenix
- ChP	Honey	-	-
- CM	Honey	*Canarium*	*Shikaki*
- CP	Kapok	Firewood	Honey
- CS	Firewood	Honey	*Nelli*
- KB	Dung	Honey	-
- KK	Honey	Dung	-
- SB	Honey	Wild Coffee	Lichen
- SC	Honey	Passam	Phoenix
- SS	Tamarind	Lichen	Honey
- NA	Cheenika	Honey	Nutmeg
- NM*	Honey	Black Dammer	Ginger
- NMu (30)	Honey	Cheenika	Nellikka

How does the contribution of NTFP and honey sourced income vary between households within and between sites?

The second question to be considered is how the contribution of NTFP income varies between households. This question is important because it is often considered that NTFP and common pool resources in general are of particular importance to the poorest households. For the basis of this analysis the households in each site have been ranked by income and divided into thirds (terciles) with mean incomes for each of the terciles and the contribution of NTFPs and honey to mean income assessed. The data is summarised in Table 19.

A number of summary statements can be drawn from this data.

A first observation would be to note the differences in mean income between the bottom and upper terciles of households in each site. In most sites the mean income of the upper tercile is at least twice that of the lower tercile. To consider these as economically undifferentiated households or to call them all equally poor is simply incorrect.

Second, two distinct patterns of NTFP income contributions to household income can be observed. In one cluster of sites (CM, CP, KK, SS, NA for example) and these are all sites where the overall contribution of NTFP income to mean site income is less than 20%, the overall contribution of NTFP income to household income is greatest in the poorest tercile and declines with increasing income. NTFP income contributes from 8 to 61% of mean household income for the bottom tercile in these cases.

Table 19. Mean household income (IRS) and the contribution of NTFPs and honey to that income by income tercile by site

Site (N)	Bottom Income Tercile			Middle Income Tercile			Upper income Tercile		
	Mean Inc[1].	% NTFP	% Honey	Mean Inc.	% NTFP	% Honey	Mean Inc.	% NTFP	% Honey
Chamraj Nagar									
- ChB (10)	N/A								
- ChG (38)	22375	0.44	0.06	37333	0.57	0.10	51230	0.60	0.10
- ChK (20)	23571	0.38	0.20	34106	0.73	0.05	44550	0.70	0.14
- ChP (23)	27375	0.11	0.11	33500	0.16	0.16	49075	0.22	0.22
Coonoor									
- CM (7)	9050	0.17	0.06	22476	0.13	0.07	31500	0.13	0.06
- CP (21)	28686	0.09	0.03	43043	0.09	0.02	63214	0.06	0.005
- CS (6)	18000	0.61	0	25000	0	0	33000	0.21	0.08
Kotagiri									
- KB (9)	24333	0.16	0.08	38133	0.31	0.02	55400	0.40	0.04
- KK (8)	35200	0.14	0.08	56400	0	0	69933	0	0
- KT (21)	33400	0	0	66149	0	0	127571	0	0
Sigur									
- SB (44)	12247	0	0	38514	0.13	0.09	54460	0.41	0.16
- SC (39)	25086	0.08	0.05	40567	0.06	0.02	62462	0.02	0.005
- SS (42)	22071	0.19	0.02	42428	0.16	0.01	55528	0.10	0.02
Nilambur									
- NA (16)	25815	0.35	0.03	44766	0.17	0.05	70688	0.15	0.03
- NM*	N/A								
- NMu (30)	39503	0.03	0.01	62400	0	0	68947	0.06	0.03

[1]For clarity SD values have not been presented. As with the data in Table 15 they are also high.

There is however a second cluster of sites (ChG, ChK, ChP, KB and SB) and these are the sites where the overall contribution of NTFP income is more than 23% where the contribution of NTFP to mean tercile income increases from bottom to middle to upper mean income tercile, consistent with the findings of Agrawal (2001). For example in ChK the contribution of NTFP income to mean tercile income increases from 44 to 57 to 60% for the bottom, middle and upper terciles. It should be noted that this is not only an increase in a percentage contribution to mean income but also an increase in the absolute amount, given the increase in mean income as one rises through the terciles. For the example (ChK) NTFP income contributes Rs.9,845, 21,280 and 30,738 to mean tercile incomes of Rs.22,375, 37,333 and 51,230 for the bottom, middle and upper terciles of income respectively. It is evident therefore that in the NTFP 'rich' sites, the better off you are, the greater the contribution that NTFP income is likely to make to your overall income. This is clearly not a case where NTFPs particularly benefit the poorest households.

Does the contribution of honey to mean tercile income follow these two distinctive patterns? Is the contribution of honey to mean tercile income greatest in the 'NTFP' poor sites for the bottom tercile but least for this group in the NTFP 'rich' sites? In the NTFP poor sites the contribution of honey to total mean tercile income does not amount to more than 8% of mean income and there are no consistent differences between tercile groups across sites. In the NTFP rich sites there are three sites (SB and ChG and ChP) where the contribution from honey is least for the bottom income tercile but there are also two (ChK and KB) where the poorest tercile obtain a greater percent of income and absolute amount of income from honey than the middle and upper income tercile groups.

In summary, there are complex patterns of difference between and within sites on the economic contribution that NTFPs in general and honey in particular make to household income. We turn now to explore some of the factors that might underlie these patterns.

What factors might explain the variability in the contribution of NTFP and honey sourced income between sites and between households within a site?

The data does not lend itself to detailed statistical analysis and nor does correlation or regression analysis indicate causality. Attention is drawn here to three potential determining factors that may contribute to the patterns of spatial variability of the role of NTFP income in the site households.

The first is site or location factors (such as agro-ecology, potential bee nesting sites etc.) that might determine the availability of NTFP and honey sources. These are essentially supply issues but of course confounded by the impact of collection pressure and it is unknown what the balance is between supply and demand factors influencing actual NTFP harvest.

Only for honey is it potentially possible to begin the answer to this question and the analysis of bee nest density (an indicator of supply) is not yet complete. Hopefully this will indicate for selected sites what proportion of bees nests are potentially being harvested. For the present, data can be presented on the harvesting of honey and how this varies by site (Table 20) but there are limits to how this can be interpreted.

With the exception of one site (NA) there appears to be a correspondence, as one might hope, between the reported volume of honey collected and the contribution of honey to household income. For those sites where income from honey contributes less than 10% of household income, honey volumes harvested are consistently less than 500 kg per season. For those sites where honey provides more than 10% of income, honey volumes collected are in the order of 1,000 kg or more. The one exception of NA is where the estimate 2,000 – 3,500 kg of honey harvested is not matched by the contribution of honey to household income providing an estimated 4%. There is at present no explanation for this although this may be related to the higher wage rates for labour in Kerala.

Table 20. Estimates by site of honey harvesting from *A. dorsata*

Site	No. bee sites	Distance km	Colony No	No. trips	Harvest kg per trip	Harvest kg per season	No. groups	Minimum harvest kgs	Maximum harvest kgs
Chamrajnagar									
Bedaguli*	?	?	?						
Geddesal	8	1-10	840-1260	8 -12	30-40	100-400	5-6	500	2400
Kalidimbam	7	1-3	60-65	4-12	30-40	100-500	3	300	1500
Pulinjur*	12	12-30	430-550	4-10	45-50	100-500	4-5	400	2000
Coonoor									
Marikode*	6	3-28	10-20	3-4	0-40	0-100	3	40	300
Pudukadu	6	1-8	30-40	4-5	0-30	20-100	2	40	200
Situkunni	6	1-6+	11-60	4-5	0-30	30-150	2	60	300
Kotagiri									
Bikkapathy M	4[1]	1-4	40-50	5-10	0-10	10-40	2	20	80
Koduthen M	6[1]	1-2[2]	7-8	5-10	1-2	10-12	6	20	40
Tunieri	0								0
Sigur									
Benne	10	2-10	215-265	10-12	20-30	100-450	4-5	400	2250
Chemmanatham	4	2-7	40-55	10-20	15-30	120-200	2	250	400
Siriyoor	6	0.1-4	30-40	4-12	12-20	100-180	2	200	360
Nilambur									
Appankapu	6	1-5	200-300	8-10	20-25	200-300	10-14	2000	3500
Mancheri	4	5-15	70-100	?	?	150-250	5	750	1250
Mundakadavu	3	1 - 10	15-20	?	?	100-200	3	400	1000

[1] *A cerana* and *A florae;* [2] One man travels 70 km to his wife's home to collect 30 kg *A. dorsata* honey

A second factor to consider is the availability of other sources of income. The fact that three of the four sites (the exception is NM which has an exclusively NTFP based economy) with the highest mean household incomes have the lowest contribution from NTFP income (Table 21) is indicative and indeed there is a negative correlation factor of -0.53 between income level and proportion of income contributed by NTFP. This suggests that with rising income, NTFP income contributes a declining share to mean household income. This is not to say which is cause or effect and the correlation is confounded by legal factors (for example the banning of NTFP collection in CB). Nevertheless as other research indicates (see for example Hegde et al., 1996) NTFP is a relatively low return activity and it is probable that with increasing availability of reliable wage labour opportunities either in the forest through labour on timber harvesting as in NMu or for labour work on tea or coffee estates, the attractiveness of NTFP as an income source may well decline.

Thirdly, there are idiosyncratic or household specific effects that may affect the contribution that NTFP income makes to particular household

income. These can include that lack of available male labour of the right age (which would exclude a household from collecting harvesting *Apis dorsata* honey) to the complete absence of male labour or household age. Indeed it is clear (Table 22) that only a proportion of households in each site reported being engaged in the active collection of *A. dorsata* honey although more are likely to have collected honey from *A. cerana* and *A. florea*.

We now turn to the social and cultural significance of NTFPS and honey in study households.

The social and cultural role of NTFPs and honey in households

Nearly all the people interviewed who mentioned that they gathered NTFPs, including honey, to make an income also stated that some was retained for domestic use. However, there were particular items that some people only collected for domestic use, such as *Apis florea* honey which was valued for its medicinal content. Some herbs, and the bark of particular trees, were gathered for home-based treatments of ailments. Certain tubers, bamboo shoots, wild green vegetables, fibre, and small animals were also gathered for the home and not for sale.

It is impossible to quantify the collection undertaken for household use for any NTFP since in many cases small amounts are taken from harvests that are intended for sale. Biswal (2009) who undertook a study in one of the Project villages, was told that one household kept, for use at home, five to eight kilos from the several hundred kilos of phoenix grass they had collected for sale to make brooms; but this type of precision is unusual. Few people provided information on quantities collected for their own use.

Table 21. Sites ranked by percent of income from honey against mean annual household income.

Site (N)	Mean annual income (Rs)	% Non NTFP income	% income from NTFPs	% income from honey
- NM*	60000*	0	1.00	0.34
- ChK (20)	34407	0.35	0.65	0.13
- SB (44)	34995	0.74	0.25	0.11
- ChG (38)	36970	0.44	0.53	0.10
- CM (7)	21214	0.86	0.14	0.07
- KB (9)	39289	0.60	0.40	0.04
- NA (16)	46945	0.81	0.19	0.04
- ChP (23)	36787	0.82	0.23	0.03
- CS (6)	25333	0.76	0.23	0.03
- CP (21)	44981	0.94	0.07	0.02
- KK (8)	53525	0.90	0.10	0.02
- SC (39)	41665	0.93	0.07	0.02
- SS (42)	40667	0.88	0.14	0.02
- NMu (30)	56950	0.97	0.03	0.01
- ChB (10)	60000	0	0	0
- KT (21)	75707	0.93	0	0

Table 22. Number of households harvesting honey at each site

Site	N	No. households harvesting honey	Site	N	No. households harvesting honey
ChB	55	(10)*	KB	9	3
ChG	48	44	KK	8	2
ChK	55	20	KT	51	0
ChP	52	24	SB	51	18
CM	7	4	SC	44	5
CP	34	5	SS	52	7
CS	10	2	NA	54	17
			NM	12	8
			NMu	29	5

* From *A. cerana* and *A. florea*.

A man in village KB told us that his first priority after collecting honey was `home consumption', another in the same village said that any honey they managed to collect was consumed at home. Bees wax was also used for domestic purposes. It is apparent that during honey hunting, either from cliffs or trees, that a benefit of the hunt is the consumption of honey often at the site of collection. Stories were told of the camaraderie around the hunt and the enjoyment in sharing some of the honey when the collection was over. Another benefit of honey collection, that was mentioned as being only for domestic use, was the gathering of the bee larvae to make what one man described as `bee larvae curry'. He described how his wife would wait for him at night in a safe place (because he did not want to leave her alone in the house at night) while he was collecting honey. She would be close to where he was and when he had finished they would go home and cook the curry at once.

Honey hunters, all men, described how they learnt the skill from their father or an uncle when they were at the age of seven or eight starting with *Apis cerana* or *Apis florea*, which they did not have to climb to collect, so that they would overcome their fear of stings. These accounts were usually told with great pride, not only in describing the feat of collecting honey but also in explaining the importance to their culture of what was done. As is clear from the information on the economic significance of honey which for many households was not large, the social and cultural importance may often have been of more importance for some than the economic return. Older men and women spoke wistfully of times when honey was plentiful and hunting yielded rich returns.

Not everyone who had tried to collect honey relished the role. One man from village NMu recounted the following:

In the first week of May 2005, he was coming back from the forest after collecting Apis cerana *honey, carrying the honey carefully. Suddenly three bees attacked him, so he put the bucket down. He was very afraid. After the bee attack he never went near a bee colony. The honey hunting team normally takes somebody with it as a caretaker to watch for animals. So now he goes with the team as caretaker not as a honey taker!*

The importance of the `caretaker role' is illustrated in the life histories by the number of people who mention either losing a relative to elephant or bear attack or being attacked themselves. A man (V) from NA village gave this account:

One morning in 2006 V went with his son (who was under the age of 10) to collect an NTFP called padakkizhngu. *They left the village at 8/8.30 am. The boy was walking behind his father at a distance of about 100 metres. They*

were climbing up a hill through shrubs so they were not able to see each other. Suddenly V saw something moving and thought it was a wild boar. The animal came straight at him before he could make any movement or sound. It was a bear which caught on to one of his legs and kept biting him for two to four minutes. V had a roll of rope with him so he tried to hit the bear with that and it let go.

He goes on to describe how his son tried to stab the bear and then ran home as his father lost consciousness. Eventually V was found by villagers who came to look for him. He was disabled by the incident and can no longer work.

Therefore it is not surprising that those people living close to the forest, who collect NTFPs and fuelwood whether for sale or their own consumption, speak of the forest with reverence. The Cholanaickan people from Nilambur talk of the gods in the forest who protect them but can bring harm to others if they try to take forest produce. However, it was not only indigenous people who valued the forest in this way. In one case an in-migrant to village SB, who was not from one of the indigenous communities, told the interviewer that even though he did not collect NTFPs the forest was `a very precious thing' which he feared was disappearing. Another man who worked away from the forest to earn his living said that he valued the forest as a place to walk in and find peace when he was home.

These anecdotal references to the social and cultural significance of the forest provide some insight into the value placed on the forest by some of the people in our study. Of course, this was not the case for all. For some people in places where cultivation was the main source of livelihood and little, if anything, was gathered from the forest (as in village KT) people made no reference to the social, cultural or economic value of the forest. Biswal (2009: 46) was told by one family that they would rather borrow money from neighbours than collect tubers and wild vegetables from the forest when food was scarce.

Conclusion

The forest makes an important contribution to many people's livelihoods in the Nilgiris. However, it is apparent that it would be inaccurate to describe many of the people in the study villages as `forest dependent'. People were engaged in a great range of livelihood activities: cultivation, agricultural wage labour, tea picking, rubber and coffee plantation work, embroidery work (among the Todas), as well as tasks related to the forest like work on Forest Department plantations or as watchers. Many people pursued diverse livelihood activities - they might cultivate and collect some honey during the season and when that ended they may turn to wage labour or some farm occupation while collecting fuelwood and perhaps some herbs or mushrooms from the

forest when available. People living in villages where lucrative alternatives to forest produce collection exist, such as cultivation (village KT) or timber felling and processing (NM), expressed no interest in NTFPs at all.

It is apparent that livelihoods are dynamic and as new opportunities emerge, either through migration or new enterprises or industries in the Nilgiris people's dependence on the forest to provide timber for their houses, fuelwood for cooking and NTFPs for a range of domestic purposes will change. Belcher and Schreckenberg (2007) have recently criticised commentators who view the commercialisation of NTFPs as being an opportunity for species conservation as well as improving livelihoods, a view expressed by Rai and Uhl (2004), among many others. What our findings suggest is that for many communities living close to the forest the challenge is not to counter commercialisation as a threat to conservation, but to address a waning interest in the forest as a resource. Neglect may be a greater threat than over-exploitation.

Endnotes

[1] *These include the Aalu Kurumbas, Paalu Kurumbas, Jenu Kurumbas, Kattunaickans, Sholegas, Betta Kurumba, Urali Kurumba, Kaadu Kurumbas, Kadars, Cholanaicken, Pathinaickens, Mudugas, Adiyans, Arnadans, Paniyans, Kurichiyans, Mullukurumbans, Malaivedans, Panjari/Badava Yeravas, Tani Yeravas, Karimpalans, Pathiyans, Malapulayans, Mala Kudiyas, Muduvas, Todas, Kotas, Irulas/Kasabas, Mala Malasar, Malapanikkars, Malamuthans, Thaccanaadans. Badagas, Wynaadan Chetti and Manthadan Chetti.*

[2] *Thus a distinction is been made between Management* ***Divisions*** *of the NBR, the project* ***Locations*** *composed by the project out of the Management Divisions and as places for research site selection, within which the Project carried out research activities.*

[3] *In Mancheri given the mobility of households and the fluid nature of residence, it was difficult to get consistent or meaningful household data and group data was collected on seasonal activities.*

[4] *The contribution of bees wax to income is not discussed here, partly for reasons of space but also because the data on bees wax sales is less systematic.*

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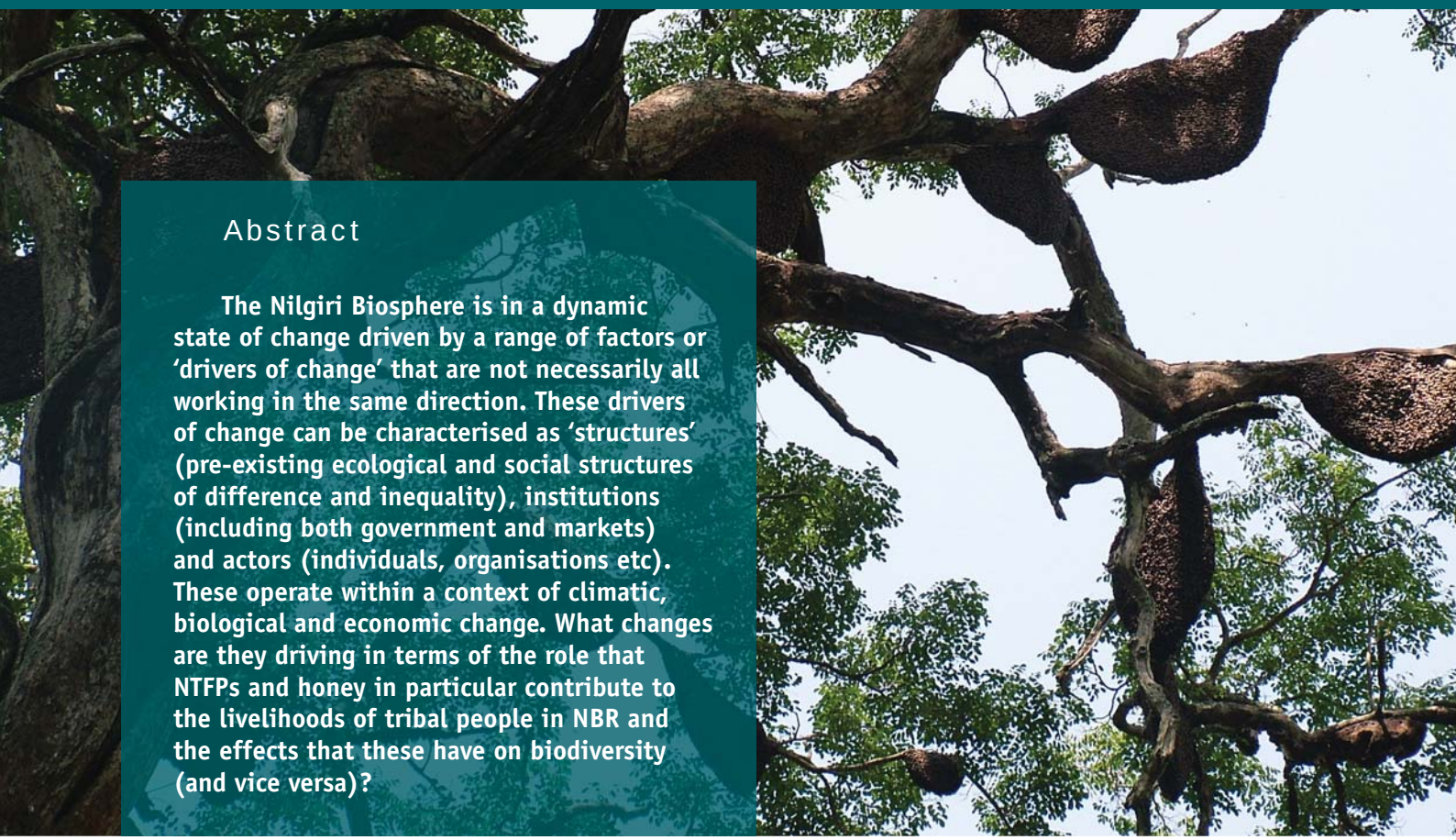
(5)

WHAT'S DRIVING CHANGE ?

(5A) What is driving change in the Nilgiri Biosphere Reserve and what effects might such change have on the role of NTFP in the livelihoods of indigenous people?

Adam Pain



Abstract

The Nilgiri Biosphere is in a dynamic state of change driven by a range of factors or 'drivers of change' that are not necessarily all working in the same direction. These drivers of change can be characterised as 'structures' (pre-existing ecological and social structures of difference and inequality), institutions (including both government and markets) and actors (individuals, organisations etc). These operate within a context of climatic, biological and economic change. What changes are they driving in terms of the role that NTFPs and honey in particular contribute to the livelihoods of tribal people in NBR and the effects that these have on biodiversity (and vice versa)?

This paper will focus on three particular drivers. The first driver to be considered is that of government and the way in which the different state Forest Departments interpret and implement Forest Policy in the NBR and what effects these have. The second is the role of markets in NTFPs and the honey market in particular. Drawing from a study on the honey market undertaken under the BBL project the paper will first discuss the evidence for a highly fragmented honey market indicated by differential prices between locations. It will then explore the extent to which this is due to complex market regulation, both formal and informal and the effects that this has on honey collection practices. The third driver to be considered briefly in the conclusion, drawing from the livelihood studies of the project, is that of general economic change and the influence of rising education and economic opportunities on the use that households make of NTFPs.

Introduction

The concept of 'Drivers of Change' draws from work developed for the UK Department of International Development (DFID) and developed for it by Oxford Policy Management (2003). The 'drivers of change' framework centres around three interactive core components – structural features (natural, economic and social structure), institutions

(the rules of the game and central to the framework) and agents (individuals and organisations). 'Drivers' are changes that can be influences of processes, that may take place in any one of these components and which may have spillover effects. A significant emphasis of the 'drivers of change' framework is that it focuses on understanding how things actually are (rather than what needs to be done) and using this for the starting point to consider how change can be brought about. The purpose here is to use such an approach to investigate the linkages between social and economic processes of change and natural resource access and use.

One aspect that is not considered here, and it is acknowledged it is a significant gap, is the process of long term change in the biological resources of the NBR driven both by the effects of climatic change as well as by interactions between the use of resources of the NBR and the impacts that these have on biodiversity. Specifically it would appear that there is simply insufficient knowledge at present to build any historically grounded discussion on bee population dynamics, identify any trends with respect to this, identify the variables associated with such change and what their likely consequences will be with respect to both bee populations and the role that they play with respect to pollination and biodiversity maintenance.

This discussion as an initial exploration of a 'drivers of change' perspective focuses on just three potential drivers, and even within these, given the space, this is a selective analysis. They all are potential sources of variability in relation to effective demand and collection of NTFPs but say nothing about supply determinants (and variability) or how demand may affect supply. The first issue to be considered is that of long term institutional change (understood as the rules, both formal and informal that govern how people behave – in this particular case the legal environment in relation to the use of forest resources and the role of the state) and the effect that these will have on the use of the NBR. The second is the role of markets and again the institutions of markets and how these may or may not contribute both to the extraction of forest products and the welfare of those who collect these products. Markets and the development of liberalised markets are commonly perceived to be a key driver of poverty change but the way that markets work in practice is often very different from this liberalised model. The third dimension to be considered is long term rural and economic change. The NBR does not exist as an island and the role that it plays in household economies is critically influenced by wider processes of change.

The role of the State

This is not the place for a review of the long history of forest policy and legislation in India since the first Forest Act of 1865 under the British Colonial India and their continuity into Indian independence which is well covered in the literature[1]. The effects of forest policy and legislation on the removal of historic rights (endowments) and legal entitlements to the use of forest resources have also been well documented. It is also clear that the capacity of the State to enforce legislation has been variable and there has been a long history of contention between forest users and Forest Departments with many indigenous users managing through patterns of resistance and subterfuge to maintain *de facto* entitlements. The shift in thinking which downgraded the historical production emphasis of national forest policy and prioritised ecological protection and the meeting of the needs of the local forest population led to the 1988 National Forest Policy although significantly this policy remained as policy and was not buttressed with legislative support. Nevertheless a more general shifting towards more participatory processes in forest management driven both by international shifts in forest policy objectives as well as activism within India has contributed to the emergence of more participatory forms of management of forest resources although the degree to which State Forest Departments have moved beyond the sharing of management rights over forests and devolved effective authority is highly variable.

For the purposes of this project the recent Forest Rights Act (The Scheduled Tribes and Traditional Forest Dwellers [Recognition of Forest Rights], Act, 2006) is of particular significance given its attempt to resolve the

historical injustice whereby the local rights of indigenous forest inhabitants and their use of forest resources were systematically reduced and removed through the assertion of state control. The Act's recognition of rights of traditional forest dwellers to make claims on forest land held before December 13th 2005, to access and use non-timber forest products (NTFPs) and grazing land within the forests and to also manage and conserve forest resources is a significant step forward in restoring the authority of indigenous people of the management and use of their resources. While there is much to commend about the principle of the Act, there are also deep concerns with respect to the modalities of its implementation and the extent to which it will be possible to restore those rights, and the consequences of this, given both differences in policy and attitudes of State Forest Departments and underlying structural social inequalities between indigenous people and others[2].

Springate-Baginski et al., (2007) make clear in their discussion on the implementation of Joint Forest Management (JFM), that the State control of forests and the rise of the powerful Forest Department institution and its culture has been far from universal or omnipotent – in parts of India local resistance and forms of informal management of forests have persisted despite formal policy. Their case studies on the nature of implementation of JFM shows that is has been diverse and context specific and it is difficult to talk generically of JFM practice. In part this arises, as David Mosse (2004) has argued, from the way in which policy gets interpreted in practice – it is highly variable and depends on the local constellations of power and interests and how policy and law are actually interpreted.

What this indicates is a need to systematically analyse how forest policy is actually interpreted in practice both by State Forest Department and by District Forest officials, including staff on the ground. This would include a systematic analysis of the State Forest Policy documentation (and its comparison with Federal Policy), detailed field level investigation of how State Forest Policy is actually implemented by Forest officials – both at the District Forest Officer (DFO) level and at the more local level and on the daily interaction between forest users and Forest officials. Equally, attention would have to be given to understanding the three states that share the NBR between them because they not only have rather different forest ecologies but are also characterised by rather different political regimes with potential effects on welfare outcomes for the indigenous people. In this sense a systematic investigation of the three Forest Departments as institutions within their state context would have been an important investigation to undertake.

Within the scope of this study, such a systematic investigation has not been possible. What field evidence shows is that there is considerable variation between the states in terms of the rules and regulations with respect to forest use, the ways in which these are applied and differences also with states according to the ways in which rules are applied in practice and how they affect the endowments and entitlements of indigenous people with respect to forest resources. Non-timber forest products remain in a deeply ambiguous and highly variable legal position.

For example in the case of Karnataka there is no specific policy or laws or regulations that directly regulate NTFP collection, processing and sale. However within the Karnataka Forest Act of 1963 minor forest products (MFPs)[3] are defined as 'forest produce other than timber, sandal wood, firewood, charcoals, bamboos and minerals, and includes forest produce such as myrobolans, barks, fibres, flosses, gums, resin, dyes, grass, leaves, roots, fruits, seeds, creepers, reeds, moss, lichens, wood-oil, honey, wax, lac, wild animals, wild birds, horns, hides, bones, tusks etc.' There are certainly some rules on the extraction of NTFPs in the Karnataka Forest Manual and the collection of 45 items is allowed from leased forest areas although these are required to be sold through the LAMPS[4] at a price set by them.

The Tamil Nadu Forest Department allowed 23 items of NTFPs for collection from leased forest areas, which does not include honey in the list of allowable items. The price is fixed by the Tamil Nadu Forest Department. In the state of Kerala, the Forest Department allows the collection of 100 NTFPs by the Tribal Services Cooperative Societies (TSCS) from leased forest areas. The price fixation mechanism operating

here is through Kerala Minor Forest Products committee. Honey and wax collection in the state is not banned but it is regulated through Cooperative Societies.

The highly variable and unclear legal status of honey collection has a number of effects. The first is that it gives rise to a honey market that is highly fragmented as evidenced by differential prices between locations, a point that is explored in more detail below. Second and related the honey market is highly regulated but regulated in diverse and complex ways, both formal and informal (although the blending of formal and informal challenges the notion of these being clear contrasts). In the case of Kerala where honey collection is legal, sales have to be made through Village Community Councils at a price determined by them. However there is some degree of competition between the VCC and the older Cooperative Structures which offer lower prices. In Tamil Nadu where honey collection is banned in law, practice varies according to site. In ChG where the DFO tacitly accepts honey collection, this is effectively regulated through a Village Forestry Committee (VFC) connected to Keystone enforced by a powerful village leader and forms of informal taxation that effectively restrict private sales. In SB illegal cross-state movement for 'legal' sale in Kerala occurs although much of the sale is to a few traders who pay below market prices but then trade it on to 'legal' buyers elsewhere. In the other two Tamil Nadu sites, Keystone is a key buyer of the relatively small honey production from these sites. In Karnataka, where honey collection is illegal because of the location of the villages in a reserve, the major route for honey sales is through traders who then trade it on to 'legal' buyers or to commercial buyers.

This murky environment obviously allows ample opportunities for individuals to find ways round the formal rules. But, and this is a third effect, it also allows ample opportunity for Forest officials to act as gatekeepers and extract private benefits from themselves as an interview from one village (see Box 14) where honey collection is officially banned illustrates.

Box 14. Payment of honey to Forest officials

The Forest officials coming in contact with the honey hunters are the anti poaching watcher, watcher, the forest guard, the forester and the ranger. The first three patrol the forests and come through the village at least once a day. They take some honey from the honey hunters occasionally. The honey hunters are unable to remember how much they actually give them. They also have to give honey to the ranger's office once a year, each group giving around 5 to 10 kilograms. A rough estimate of the honey flowing to the Forest officials must be around 50 kilograms a year (Source: interview with forest guard).

Source: James and Rajar, 2008.

In summary, the legal context within which indigenous people lead their lives is extremely uncertain. What the policies and law actually say and what happens in practice is clearly highly variable depending on how the specific State Forest Department interprets national legislation, the field practice of Forest officials and the relationships that are built between Forest officials and indigenous people. While this is not to downplay the significance of legislation and changing formal rights as important factors in indigenous people's lives and potentially of long term significance, perhaps the more important point that emerges is the context of risk and uncertainty in which indigenous people live their lives, given the unpredictability of the way in which the state and its representatives at various levels actually behaves towards them in relation to the access and use of forest resources.

Studies on the ways in which the honey market works develop these points further.

Understanding markets – the case of the honey market in the NBR

Thinking about markets

The term 'market' is widely used essentially as a metaphor for mechanism and 'marketing' is widely used as a synonym for market. This both emphasises and prioritises aspects of 'competitive' pricing which are assumed to arise mechanistically out of forces of supply and demand. There are however many aspects of markets that are dependent on other 'extra-market' conditions, including history, institutions, and non-economic processes. Some features of markets, such as entry and exit reflect both mechanisms and institutions. As Gasper and Apthorpe observe (1996):

"Positions which proceed as if 'market' denoted mechanisms only are misleading; they make a machine of the ghost. Arguing as if market were institution only, makes a ghost of the machine"

Ignoring the institutional dimensions of markets abstracts markets from their context, idealises how markets should work and ignores the performance of markets in practice in relation to the institutional structures in which they are embedded. As Harriss-White argues (2003b:481):

"Economic markets are vehicles for the exercise of forms of social authority, the origins of which lies outside markets and which operate outside markets as well as inside them. ... Markets do not perform 'subject to' institutions, they are bundles of institutions and are nested in others."

Understanding the honey market therefore requires looking at both the mechanisms and institutions within which the honey market operates. The honey market effectively straddles the formal and the informal and, as noted above, transforms the harvested honey from its status as semi-illegal in collection to a sort of legal existence in its sale. The 'informal' can be characterised as being that which is not formally recorded in official statistics. It is often assumed that the informal, which as a label also carries meanings of being 'not legal', also carries with it the status of not being regulated by the State. But it should not be assumed that it is not regulated and there are many non-State means of regulation operating in the informal sector. As Harriss-White (2003a) has argued with respect to the 88% of the Indian economy that lies outside the formal economy, there are key structures of regulation (ethnicity, religion, age, gender and geography) that characterise the way in which profit or 'surplus is accumulated, distributed, saved and invested' in markets.

Understanding the institutional dimensions of markets requires different conceptual and analytical approaches from that of idealising 'supply' and 'demand' and focusing just on the mechanisms of the market. Attention has to be paid to power relations and patterns of exchange and their regulation. The dominant conceptual approach to understanding markets is that of New Institutional Economics. This focuses on information and transaction costs in its analysis of contractual relations among households, farms and firms. It is largely abstract and pays little attention to contexts of time or place. (Harriss-White, 2003b:491-492). There are three other major approaches to the study of markets – economic sociology, the politics of markets and the social structure of accumulation – all of which give weight to both history and geography in different ways[5]. With respect to the 'social structure of accumulation', which the following analysis of the honey market in the NBR draws on, this requires a particular focus on the informal or non-state regulative structures that operate although, as will be seen, these interact in complex ways with the incomplete and complex regulation that the three states seek to enforce.

The honey market in the NBR

Table 23 summarises by site the legal status of honey collection and the actual practices of honey collection in the face of its legal status. What this summary information points to is a complexity of legal status and actual practice. Only in two sites (ChB and KT) where honey collection is reportedly not legal, was honey collection not reported, although it should be remembered that these are two sites where mean annual household income is

amongst the highest of the sites. In all sites where honey collection did not have legal status some degree of honey collection was reported.

The terms legal or illegal, formal or informal are problematic. The Darwin sites could be categorised into one of the three trade types – formal, permitted and informal. Informal trade is characterised as honey collection and trade through private traders (and so not billed or recorded) in locations where it is banned by law and is not (officially) allowed by the Forest officials. This kind of a trade can be seen on the Karnataka part of NBR. By 'informal' trade we refer to honey trade with private traders and the flow is through informal channels of trade not regulated or recorded by the state. Honey trade in Tamil Nadu is not allowed by law but it is permitted by the Forest officials. This is also essentially informal trade but honey collection

Table 23. Legal status of honey collection and the actual practices by site (Sites that are in italics were selected for detailed study)

Locations / legal status	Site code	Actual practice of honey collection
Chamrajnagar		
- informal	ChB	Collection is banned and collection not reported
- formal	*ChG*	*Collection is banned in Tamil Nadu, but the Village Forest Council (VFC) collects honey from harvesters & other NTFPs*
- formal	ChK	Collection is banned in Tamil Nadu, but the Village Forest Council (VFC) collects honey from harvesters & other NTFPs
- informal	*ChP*	*Collection is banned but collection reported*
Coonoor		
- formal	*CM*	*Honey is sold to "Green Shop" Keystone in Coonoor - both honey as well as beeswax. Occasionally sold to other local shops as well*
- informal	CP	The honey is sold to shops on the Coonoor- Mettupalayam highway
- informal	CS	Sold to local traders, tourists and occasionally to Keystone's centre
Kotagiri		
- informal	*KB*	*Honey is collected mostly for personal consumption*
- informal	KK	*Cerana* honey collected for consumption but not regularly
- informal	KT	None of the households are engaged in HH
Mudumalai/Sigur		
- informal	*SB*	*The product is sold within the village, tourists and local customers or to Kallur cooperative society in Kerala*
- informal	SC	Honey collection is banned. It is collected and sold to local traders or the numerous resorts adjacent to the Mudumalai sanctuary
- informal	SS	Honey is sold to the cooperative society. Society has a captive market as selling outside is illegal
Nilambur		
- formal	*NA*	*Honey is sold to the cooperative society. Society has a captive market as selling outside is illegal*
- formal	NM	Honey is sold to the society. Bees wax is also sold to the society. Society has a captive market as selling outside is illegal
- formal	NMu	Honey is sold to the society and to the local traders. Bees wax is also sold to the society for Rs.120/kg. Society has a captive market as selling outside is illegal

Table 24: Six study sites for investigating the honey market, the contribution of honey income to household and the estimated volume of honey harvest

Site	Legal status	% Income from NTFPs	% Income from honey	Estimated range of honey harvest (kg)
Tamil Nadu				
ChG	Legal	0.53	0.10	500 - 2400
SB	Non-legal	0.25	0.11	400 - 2250
CM	Legal	0.14	0.07	40 - 300
KB	Non-legal	0.40	0.04	20 - 80
Karnataka				
ChP	Non-legal	0.23	0.23	400 - 2000
Kerala				
NA	Legal	0.19	0.04	2000 - 3500

and trade happens with the knowledge of the Forest officials and so can be considered as 'permitted' trade, but it is not documented. But 'permitted' trade can also be formal and in such cases it is billed and recorded. Thus in Tamil Nadu there is some formal trade with organisations like Keystone which is billed and in Kerala (where honey collection and trade is permitted by law) there is formal trade with the cooperative societies. These overlapping categories therefore have to be handled with care; for simplicity the terms formal and informal are used here but the limits of this categorisation should be appreciated.

For a more detailed study on the honey market, six of these sites (three where honey collection is formal, three where it is not) were selected[6] for a more detailed investigation of the workings of the honey market looking at market structures, value chains and honey volumes. Drawing from Pain et al., (2009) the summary characteristics of these sites with respect to the role of honey in household income is presented in Table 24 along with the estimated range of honey collection.

A summary of estimates, drawn from the honey market study, of the 2007 honey sales and the proportion that was sold through organisations, private traders and sold directly to customers by the honey collectors is presented in Table 25. Somewhat reassuringly the estimates of honey volumes recorded for each site based on the market study are consistent with the separate estimates derived from honey collectors reported in Table 24.

Table 25. Summary estimates of 2007 honey sales (kg) by site and buyer

State	Site	Estimated* honey (kg) sales 2007	% sale through organisation	% sale through traders	% sale private
Tamil Nadu	ChG	2770	97	0	3
	SB	3300	38 (illegal?)	59	3
	CM	120	76	0	24
	KB	270	63	7	30
Karnataka	ChP	4250	37 (illegal?)	58	5
Kerala	NA	2000	95	4	1

* Numbers rounded up/down

A number of observations can be made. In the sites of high honey volume (2000 kg or more) and where honey has a legal status (ChG and NA) most of the honey is sold to formal organisations. In the third site with legal status (CM) with sales of only 270 kg again sale to an organisation accounts for 76% of sales while 24% of sales are through private buyers. In all three of these sites there is almost no trade through private traders.

In the three sites where honey collection and trade is not sanctioned (SB, KB and ChP) in the low volume site (KB) again the majority of the honey is sold through an organisation (Keystone) which appears to be effectively allowed but again with a significant proportion of the honey sold privately. In the high volume sites (and note the volume of sales here is significantly greater than the legal high volume sites) the majority of the sale is through private traders but still a significant proportion is sold through legal organisations. What is happening here is that honey is being traded across state borders: in the case of SB within Tamil Nadu a proportion of the honey is sold in a cooperative society in Kerala. In the case of ChP in Karnataka, honey finds its way across the Tamil Nadu border to be sold to a Keystone centre.

What these contrasts between sites show very clearly is how attempts by the state at various levels to regulate collection and trade, particularly given the lack of consistency of regulations across State Forest Departments, are not effective and are unenforceable. They lead to action by honey collectors to circumvent the regulations.

But how do prices vary between states and by the point of sale?

The data presented in Table 26 points to considerable consistency across sites with respect to prices for sales to organisations and with honey collectors gaining some 65-80% of the final retail value. Private sales can provide the honey collector with a price some 60% greater than sales to private traders or organisations although the volume of private sales is limited. In the two locations where private traders handle the bulk of the honey sales prices paid to the collectors are some 5-10% lower than those that a collector might have obtained from an organisation and gives the collector between 40-80% of final sale priced depending on location.

What this points to is the ability of private traders where honey collection is not legal to be able to set prices. Indeed it is in the two sites SB and ChP with a high volume of honey and where private traders handle the bulk of sales, selling on to commercial buyers that there is a degree of monopoly control by two traders with considerable purchasing power. In the other two sites where the traders operate, the traders have a limited market and buy enough honey just to cater to the local

Table 26. Price paid to honey collectors according to first point of sale and as a percent of final retail price

State	Site	Organisations		Private traders		Private sales	
		Collector Price Rs/kg	As % of final sale	Collector Price Rs/kg	As % of final sale	Collector Price Rs/kg	As % of final sale
Tamil Nadu	ChG	60	80 - 100	-	-	100	100
	SB	60 - 70	65	60 - 65	40 - 85	70	100
	CM	75	65 - 75	-	-	200	100
	KB*	85	45	250	50 - 80	195	100
Karnataka	ChP	60	65 - 75	50 - 55	45 - 75	75	100
Kerala	NA	60 - 65	60	70	55 - 65	100	100

* note the honey sold in KB is from *Apis cerana*; in all other sites it is *A. dorsata*

demand. In the former case, the traders procure honey at a price that is lower than the price offered by the institutional buyer and in the latter case the traders procure honey at a price that is higher than that of the institutional buyers. Traders do not operate in ChG because of the presence of a strong village level leader. The absence of traders in CM is apparently because of the presence of Keystone. The institutional buyers decide the procurement price for a particular year at the beginning of the year and do not revise it until the end of the year; the traders fix their price after the institutional buyers have fixed theirs and of course have the option of revising it depending on the supply.

The traders in ChP and NA provide credit in the form of reportedly interest free advance payments to the honey hunters. In NA, the honey being sold to traders is limited in quantity and is procured only from a few honey hunters, considered reliable by the trader. The traders also pay a price higher than the society. In ChP, the trader giving advance payments pays less than the society for the honey he buys. He buys honey from any honey hunter in the village but extends credit only selectively. In both the sites, the provision of credit serves as an incentive for the honey hunter to trade with the trader. Box 15 summarises the practice of one key trader in Coonor and is indicative of more widespread practices of traders reported in the study.

In summary it would be difficult to argue that there is an open and competitive market for honey in the NBR. Where honey trade is legal, officially established organisations control the bulk of the market, creating a condition where multiple sellers have essentially only one buyer or an example of imperfect competition or monopsony. As the only purchaser this has the effect of the buyer effectively setting the terms to its suppliers. But the effect of this official monopsony and its variability between the three states gives rise to effectively monopsonic private trade as well which, because of its ambiguous status, is able to be even harsher in the setting of terms. The loser is the honey collector since monopsony leads to a redistribution of welfare gains from their effort to the purchaser.

Box 15. Traders credit practices: a case study

The most prominent trader of honey in the Coonoor region before the entry of Keystone used to procure most of the honey. After the entry of Keystone he started acting as an agent of honey collection, collecting honey from honey hunters at a rate of reportedly Rs.30-40 per kilo and supplying it to Keystone at Rs.75 per kilo. However with increasing awareness of Keystone's prices honey hunters started supplying honey directly to it.

This led to a change in the trader's strategy. Reportedly with the help of Forest officials he locates honey colonies in the forests. He organizes honey hunters into various groups and provides them with financial assistance. He makes a group of five people and gives those bidis, food and expenses for honey hunting and they collect the honey. If the honey is sold for Rs.8,000 in total, and the advance expenses provided amount to Rs.2,000, the profit of Rs.6,000 is divided equally between the trader and collectors (giving them less than 40% of the final sale price).

The honey hunters claimed that the trader also gives small amounts of money as loans. He does not charge interest but he buys various NTFP products from them at a price lower than the market rate. The various products bought from them are coffee, silk cotton, pepper, honey, soap nut etc. (based on interview with honey hunters).

Source: James and Rajar, 2008

Markets and Risk

In discussions on how markets function and their relationship to formal and informal regulation, the recognition of markets as a source of risk to the poor is often ignored. For the poor, markets are often the key source of risk (Dercon, 2001) due to price fluctuations and price setting. Uncertainty over prices and their variability on a seasonal and longer-term basis particularly are a key source of uncertainty. The neo-classical position is that markets effectively act to spread risk across people and distance. However, much of this is premised on a rather idealised view of how markets actually work. Dercon (2004) who would clearly position himself within the paradigm of mainstream 'neoclassical' economic theory has focused particularly on where the free market model simply does not work:

"The normal prescriptions of basic neoclassical economics, to let the markets work freely without interference, have weak foundations in the presence of risk and uncertainty, since it would require that competitive markets should exist that would allow anyone to insure themselves against all contingencies. While even in developing countries some insurance markets exist, their scale and functioning seem far removed from the idealised construct suggesting widespread market failure."[p2]

The pervasiveness of risk and its downside – potential vulnerability to food insecurity or poverty for example, is not just a dimension of poverty – it is in itself a cause of poverty (Dercon, 2001). Risk and shocks can have permanent effects on income, nutrition and human capital formation. There is considerable comparative evidence that the presence of high risk in relation to markets and market prices combined with limited assets and therefore protection against price fluctuations can have a major influence on the choice of crops and technology. Asset-poor households will often choose lower risk activities that have lower returns (subsistence crops or sub-optimal levels of inputs and management for example) that will result in more secure but lower mean incomes, thus contributing to a persistence of income poverty (Rosenzweig and Bingswanger, 1993; Dercon, 1996).

This raises an interesting question to which there are various possible answers. Could it be that NTFP collection, and honey collection in particular as relatively low risk activities and as we have seen relatively low return activities, are an income poverty trap which, given the way in which the markets for them are regulated, perpetuate? On the one hand it could be argued that the seasonal nature of NTFP collection and the diverse resources of NTFPs offer a degree of social protection by which the poor are at least able to secure the basic means to living. But forest dependence will keep them poor and it is significant that as household income rises on the cross site comparisons then the contribution of forest derived income falls (see Pain et al., 2009).

If on the other hand price rises, and an analysis of long term price trends in NTFPs and terms of trade would be most useful here, it is not evident that the poorest of the indigenous people would necessarily benefit from this. Again evidence from the study sites where NTFP incomes provided a significant proportion of household income is supportive of such an interpretation.

Dercon's analysis of markets and risk leads to a robust set of arguments with respect to public action for social protection on an economic rationale that it is also good for growth and can contribute to broader equity and efficiency. But it also widens the scope of our understanding of risk to address not only risk to income but also risk in terms of being able access to assets, risks associated with an uncertain policy and institutional environment and risks associated with the ability to transform income into well being through achieving consumption, health or education goals through uncertain public provision of health or education. All these dimensions appear to be present for the indigenous groups in the NBR, and particularly for the poorest of them.

Conclusion: Rural change and livelihood trajectories

While the focus of the argument in this paper so far has been on the role of the State and markets in relation to access and use of forest resources, one must not ignore wider

changes in the rural economy around the NBR which may act to draw people away from deriving significant parts of their household income and subsistence from forests. Again evidence from cross site comparisons indicates that this is already happening. In part it is being driven by improved access to public goods – access to education and health – for indigenous groups, in part by improved communication. As commented in earlier paper (Pain et al., 2009) forest dependence may be in long term decline, the implication of which for biodiversity maintenance are unclear. State practices and markets may be reinforcing this trajectory.

Endnotes

[1] *See Guha, (1983) and a recent summary review by Springate-Baginski et al., 2007.*

[2] *See for example a recent discussion on this issue in Frontline, 26, issue 5, Feb. 28- March 13th 2009, 'Rights and Forests'; http://www.frontline.in/sotires/20090313260508800.htm accessed March 10th. 2009.*

[3] *The persistence of the term Minor Forest Products.*

[4] *LAMPS – Large and Multipurpose Society*

[5] *"Economic sociology focuses upon networks, labour markets, corporations and the state. The politics of markets requires analysis of the state as participant and regulator, of collective institutions, of assets and their relations to tactics of competition or collusion, of the social power in which markets are embedded – and in relation to the others. The 'social structure of accumulation' school has focused on regulation of each stage of transfer of property rights in the process of production, distribution and consumption" (2003b: 492)*

[6] *This section draws extensively from James and Rajar, 2008.*

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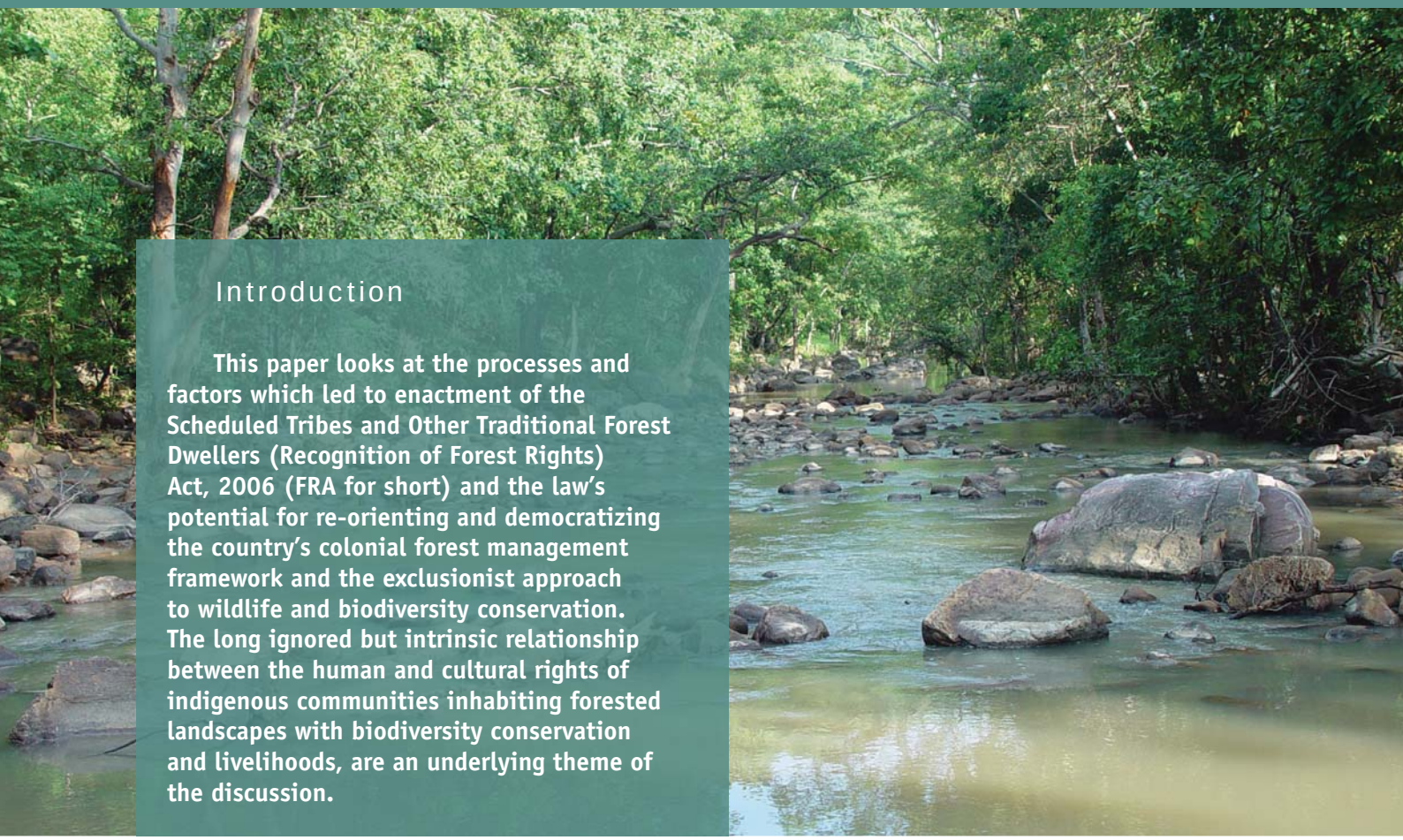
(5B)

Biodiversity, livelihoods and the Scheduled Tribes and other traditional forest dwellers (Recognition of Forest Rights) Act

Madhu Sarin



Introduction

This paper looks at the processes and factors which led to enactment of the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (FRA for short) and the law's potential for re-orienting and democratizing the country's colonial forest management framework and the exclusionist approach to wildlife and biodiversity conservation. The long ignored but intrinsic relationship between the human and cultural rights of indigenous communities inhabiting forested landscapes with biodiversity conservation and livelihoods, are an underlying theme of the discussion.

Key Dimensions of the FRA

"AND WHEREAS the forest rights on ancestral lands and their habitat were not adequately recognized in the consolidation of State forests during the colonial period as well as in independent India resulting in historical injustice to the forest dwelling Scheduled Tribes and other traditional forest dwellers who are integral to the very survival and sustainability of the forest ecosystems;" (Preamble of the FRA, 2006 - emphasis added)

The FRA represents a milestone in Indian legislative history with Parliament acknowledging in the Preamble of the Act the historical injustice done to India's tribal and other traditional forest dwelling communities (OTFDs) due to non-recognition of their pre-existing rights on ancestral lands during the consolidation of state forests. The preamble also declares that rights recognised under the Act include "responsibilities and **authority** for sustainable use, conservation of biodiversity and maintenance of ecological balance" to strengthen the conservation regime while ensuring livelihood and food security.

For the first time since the advent of colonial rule, this lays the foundation for democratisation of forest governance by making right holding and empowered Scheduled Tribes (STs) and OTFDs primary actors in combining conservation with livelihood and food security. For the millions treated as thieves and law breakers for using their ancestral lands and forest resources, it implies restitution of their citizenship rights and a right to live with dignity.

With 60% of the country's recorded forest area falling in 187 tribal majority districts spread over only 33% of the country's geographical territory, the Act implicitly also challenges the classification of constitutionally protected tribal lands as state forests.

Two other dimensions distinguish the FRA. First, unlike the plethora of existing laws and constitutional provisions for safeguarding tribal rights and cultures, about which their intended beneficiaries remain largely unaware to date, the FRA is the outcome of a prolonged struggle and mobilisation by an informal alliance of grassroots movements, rights activists, academics and professionals. This alliance successfully engaged Members of Parliament, state legislatures and political parties in lobbying for the law after brutal evictions from forest lands had made forest rights a major national political issue. A demand driven law is more likely to be implemented, and implemented properly, than top down laws framed by benevolent lawmakers.

Second, in belated recognition of the country's forest areas also being the homelands of tribal and other forest dwelling communities whose welfare and rights have been sacrificed at the altar of conservation, the nodal agency for the law is the Ministry of Tribal Affairs (MoTA) and not the Ministry of Environment and Forests (MoEF). This has ended MoEF and forest departments' exclusive hegemony on 'forest' lands, potentially liberating forest dwelling communities from the unfettered control over their lives and livelihoods by a powerful and oppressive forestry establishment.

Responses to the FRA

The FRA has been widely welcomed by practically all political parties, tribal MPs cutting across party lines, tribal rights activists and by renowned anthropologists, social scientists and historians. They see it as a belated attempt to undo a historic wrong to tribal and other forest dwelling communities which began during colonial rule and which, ironically, has continued with greater ruthlessness after independence. This is not to say that all provisions of the FRA have received unqualified support from this constituency.

The initial response of wildlife conservationists, forest officers and the urban elite, on the other hand, was near hysterical. With the loss of all tigers from the Sariska Tiger Reserve, they actively used the specter of vanishing tigers and selective misreporting of the initially tabled Bill's provisions to create opposition to the Bill. The media quickly converted this into a 'tiger versus tribal' issue as if the matter involved a simple choice between one or the other – the latter involving the fundamental rights of 8% of India's marginalised tribal population – over **80 million people**. Accused of pandering to 'vote bank' politics, the Bill was projected as the intended privatisation of 'national' forests through their distribution to a minority of the population. The unblinking attack on the rights of the weakest without a murmur of protest about the massive ecological and biodiversity destruction caused by commercial interests, mining, dams and official forest management practices was particularly striking.

But the conservationists' and foresters' protests did not go unchallenged. While pushing for ever more stringent and coercive forest and wildlife conservation strategies, more recently with the backing of judicial pronouncements, they had turned a blind eye to the acute distress and crisis of survival these were generating in the country's forested tribal areas. The polarised debate between tribal rights activists and wildlife conservationists brought the country's approach to forest and wildlife conservation, of it's being in total violation of the constitutional protection provided to the resource rights of tribal communities, and its

horrendous impact on their lives, livelihoods and cultures, in the domain of wider civil society scrutiny, perhaps for the first time.

Origins of the FRA

The FRA was the outcome of over three years of grassroots mobilisation and active lobbying by a loose federation of scores of *adivasi* organisations from 11 states under the umbrella of the 'Campaign for Survival and Dignity'. The Campaign was born out of outrage at the large scale and brutal evictions of alleged 'encroachers' from forest lands by state Forest Departments. These evictions were triggered by a May 2002 order of MoEF asking all state governments to evict alleged 'encroachers' from forest lands by September 30, 2002. Although based on a misinterpretation of a Supreme Court order, between May 2002 and August 2004, about a million impoverished forest dwellers were evicted from 1,52,000 ha of forest land. And the means used were inhuman and patently illegal – minimal *adivasi* huts were trampled by elephants, burnt or otherwise razed to the ground; crops and fields burnt during a drought year in areas reporting starvation deaths, together with beatings, arrests, abuse of women and in some cases, killings. In remote tribal areas classified as state forests, the writ of Forest Department staff prevails with little challenge or oversight.

The Campaign's initial demands were straightforward. It wanted the illegal and brutal evictions stopped till MoEF's guidelines issued on September 18, 1990 were implemented. These guidelines were meant to resolve serious tenurial conflicts and disputed claims plaguing tribal lands declared state 'forests' without following the due process of law. Based on recommendations of the then Commissioner of Scheduled Castes and Scheduled Tribes to the President of India, the September 1990 guidelines had been approved by the cabinet and state forest ministers. MoEF, however, had implemented only one of the 6 guidelines – the one concerning alleged "encroachers" on forest land. The rest, dealing with disputed land and forest rights, were left gathering dust. Intriguingly, while MoEF's JFM guidelines of June 1, 1990 attracted massive donor funding, the September guidelines issued 3 months later, and dealing with the far more critical issues of rights and tenure, were more or less ignored.

The recognition and settlement of rights of pre-existing inhabitants and users is required even under the Indian Forest Act (IFA), 1927 and the Wildlife Protection Act (WPA), 1972. This has simply not been done for large areas declared state forests or wildlife reserves and is a patent violation of the law. As many of the areas are scheduled under Schedule V of the constitution, any major policy initiative affecting tribals requires consultation with the SC/ST Commissioner. Leave aside consultation, MoEF had not even informed the SC/ST Commissioner about its May 2002 evictions order.

With the Campaign bringing the blatant violations of forest dwellers' rights in the name of forest and wildlife conservation under public gaze, even the most extreme tiger conservation proponents could not publicly justify the ongoing illegal brutality and most retracted from their initial extreme position against the draft law. Conceding the need to recognise ancestral tribal rights in forests, they insisted

that at least wildlife sanctuaries and national parks must be kept out of the law's purview to enable creation of 'inviolate areas' for wildlife by relocating the people living in them. While claiming to be against forcible relocation even from Protected Areas, they have continued asserting that co-existence between wildlife (particularly tigers) and tribals is not possible. The demand for urgent creation of inviolate habitats for wildlife with the deployment of adequate guards and guns has persisted.

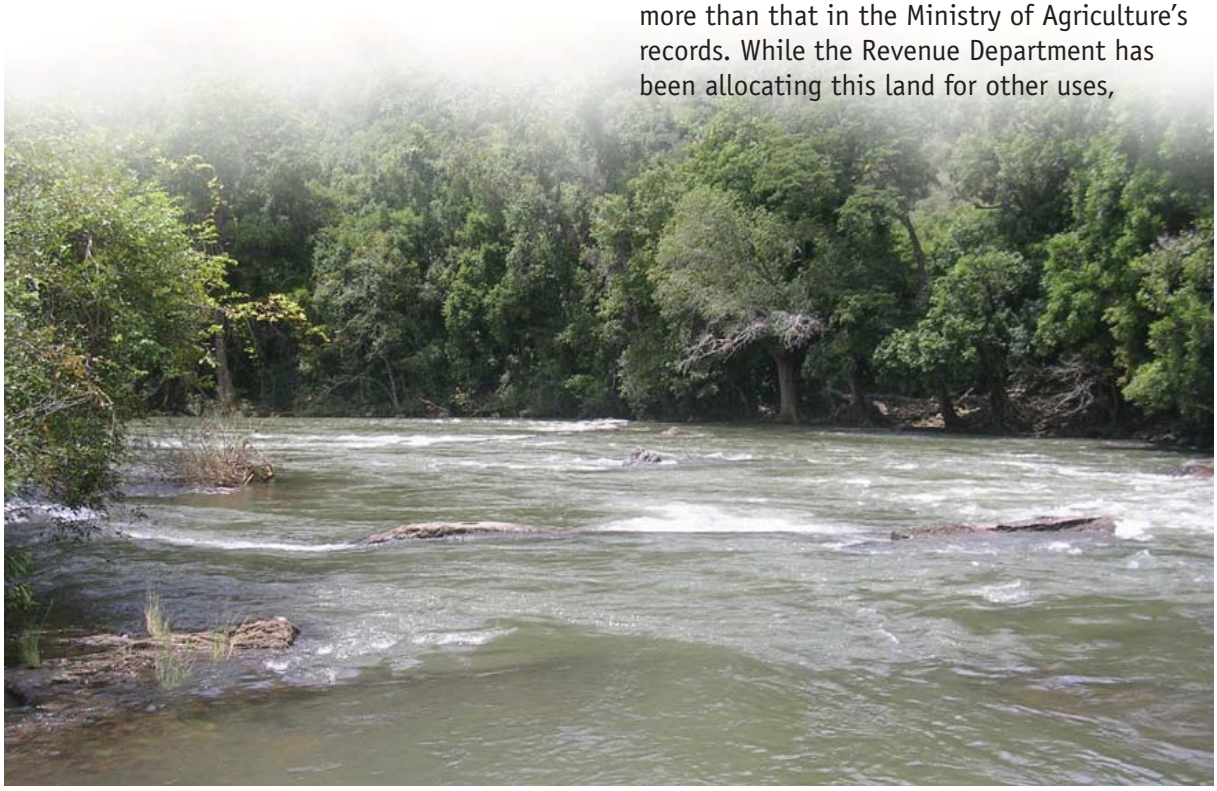
Subsequent interactions between a wider constituency of conservation scientists, wildlife biologists involved in empirical research, and tribal rights activists led to a more nuanced discussion of the underlying issues. This made it clear that the wider constituency of even conservationists are not against the recognition of forest dwellers rights and consider the existing official approach to forest and wildlife conservation neither scientific nor just. Many were shocked on being made aware of the poor quality of official data about the country's forests on which official policies are based and the ongoing brutalities heaped on forest dwellers.

So what are the critical issues related to forest and wildlife conservation which the FRA highlighted and attempts to address?

Need to deconstruct and rationalise legal classification of forests and democratise forest governance

The larger issue is the unsound processes by which about 23% of the country's area has been classified or 'recorded' as 'forest' and brought under the purview of the Forest Conservation Act, 1980 (FCA). According to the 2003 State of Forests report (FSI, 2005:5), 51.6% of this forest area consists of Reserve Forest and 30.8% of Protected Forest. As much as 17.6% of it consists of **unclassed forests under diverse owners and tenures which is not even legally notified as forest** (FSI, 2005:5). A large part of this is shifting cultivation land in the North East governed by customary tenures protected by Schedule VI or other provisions of the Constitution. Even in the case of the areas stated to be Reserve or Protected Forests, the required legal process of settling the rights of their existing users has yet to be completed in most tribal areas in central India, despite these being governed by Schedule V of the Constitution.

Further, the condition of government land records is so dismal that the area recorded as forest by MoEF is 9.13 million hectares more than that in the Ministry of Agriculture's records. While the Revenue Department has been allocating this land for other uses,



including through giving *pattas* and leases to the landless, the Forest Department treats these as illegal violations of the FCA. In the states of Madhya Pradesh and Chhattisgarh alone, 1,900,000 hectares of land are disputed between the Revenue and Forest Departments, with much of it under cultivation by a million, predominantly tribal families (Garg, 2005).

Historical (mis)-classification of diverse types of land as 'forest'

A brief look at how the national forest estate has been assembled will help understand the 3 major roots of the problem: 1) a lot of the country's notified or 'recorded' forest land has been so classified, without following the due process of law, often in violation of constitutional provisions for safeguarding tribal welfare and rights; 2) significant areas of this land never had, or should not have (from the point of view of conserving their natural biodiversity[1]) or are ecologically **incapable** of supporting forests, and 3) centralized and uni-functional tree-focused forest management has been superimposed on these lands, irrespective of their pre-existing biodiversity, multi-functional uses, customary tenures and rights, thereby dis-enfranchising their residents of their basic citizenship and livelihood rights.

During colonial rule, while good forests were selectively reserved for commercial exploitation, large areas of other common lands were arbitrarily declared state forests through blanket notifications without any vegetational or socio-economic surveys. Rather than identifying forests, the objective was to assert state ownership over non-private lands. All uncultivated lands, including those under permanent snow and alpine pastures in British Kumaon, for example, were declared state owned 'District Protected Forests' through a blanket notification in 1893. Under the Assam Forest Regulation (AFR), 1891, vast areas of land considered to be 'at the disposal of the government' were categorised as 'unclassed state forests' despite these having little woody growth even at that time (Upadhyay and Jain, 2004). **The legal designation of such lands as state forests has not been reviewed till today.**

During the survey and settlement of revenue villages, however, significant areas were recorded as *nistari, gramya, khesra*, etc. forests for meeting the villagers' *bona fide* needs. In undivided Madhya Pradesh, for example, at the time of independence, 9,478,000 hectares consisted of such common lands and forests in which the villagers had extensive recorded common property rights (Garg, 2005).

After independence, instead of enabling indigenous forest dwelling communities to claim restitution of their lands forcibly appropriated during colonial rule[2], India did the opposite. Contrary to the general impression of massive diversion of forest land to other uses since independence, the net area of state forest land increased by 26 million ha between 1951 and 1988 (from 41 million hectares to 67 million hectares), largely as reserve forests (RFs) in which there are limited or no rights (Saxena 1995 & 1999[3]) . This was done by 'vesting' in the state diverse categories of non-private land of the ex-princely states and *zamindars* by a stroke of the pen without surveying their vegetation/ecological status, and declaring them reserve, protected or 'deemed' state forests irrespective of their existing users or uses.

As this expansion of the national forest estate was mostly done using the Indian Forest Act (IFA), 1927, it is useful to look at its key provisions. Chapter II to V of IFA clearly provide that no forest or land should be so notified unless the existing rights of individuals and communities have been fully enquired into and taken into account. Sections 3 and 29 allow only lands that are government property or where government has some proprietary rights to be declared PF or RF. Sections 7 and 29 require an inquiry into pre-existing rights of villagers before such declaration. Sections 6, 21 and 31 specify that a vernacular notification of intent is essential. All these sections were violated in the creation of new reserve and protected forests in most tribal areas after independence.

In Orissa and Madhya Pradesh, the addition of section 20A through an amendment to the IFA was used to circumvent the requirement of settling pre-existing rights by declaring the vested forest lands as 'deemed' Reserve

or Protected Forests. However, in each case it was mentioned that such declaration (as Reserve or Protected Forests) shall be subject to recognising the existing land rights and usage customs of individuals and communities.

In the above process, village forests and common lands, with extensive recorded rights, were simply 'vested' in the State and handed over to either the Revenue or Forest Department fairly arbitrarily.

Owing to both practical difficulties in taking into account the different types of land tenure records at the time of the 'vesting' of private forests in the state, as well as the fact that in many cases there were no proper land survey records (especially in the erstwhile Princely states), the forest settlements in them, in particular, have been far from being complete. In many tribal areas, these are yet to be undertaken even 60 years after independence[4]. The rights of *podu* (shifting) cultivators as well as settled cultivators on land with slopes above 10 degrees were simply ignored in both Orissa and AP[5]. Despite this, over time, state Forest Departments have *de facto* extinguished the pre-existing rights of forest dwellers and established their exclusive legal jurisdiction over such 'forest' lands.

While *zamindari* abolition freed tenant cultivators in the plains from landlord oppression, declaration of zamindari forests as state forests often illegally deprived them of their forest rights[6]. In poorly surveyed hilly forested landscapes, it threw millions of predominantly tribal forest dwellers in the clutches of a far more oppressive *zamindar* – the Forest Department, by declaring even their unsurveyed cultivated lands and settlements as state forests. In the process, large numbers of the most vulnerable Scheduled Tribes (STs) and other forest dwellers were disenfranchised of their customary resource rights without even their knowledge and labeled 'encroachers' and thieves on their ancestral lands. Even in areas with good record of rights, there was near wholesale reclassification of legally recognised community lands and forests into 'national' forests, a fact which has escaped serious questioning to date.

On the one hand, the tribal majority 'excluded' and 'partially excluded' areas under colonial rule were scheduled under the Vth and VIth Schedules of the Constitution, providing for their special administration for safeguarding tribal resource rights and cultures. On the other hand, large parts of the Schedule V areas were declared state forests under the colonial Indian Forest Act. Due to the poor recording of *adivasis'* customary rights and tenures, tribal majority areas bore the brunt of the post-Independence statisation spree. 74% of the land in Orissa's Scheduled areas, for example, has been declared state property, either as forest or revenue wasteland, while 23% of the Scheduled Tribes are landless and over 40% of them own less than 2.5 acres.

To summarise, through the 'vesting' of the non-private lands of Princely states and intermediary tenure holders in the state after independence, lands with a complex diversity of customary and legal common property tenures and land uses were converted either into revenue 'wastelands' or state forest lands and brought under centralised management by large bureaucracies. Forest boundaries were arbitrarily defined with poor co-relation with the ecological characteristics of the land; even legally recognised rights were eroded, diluted or extinguished often without following due legal process, and community resources reclassified as 'national' forests. The requirement under section 4 of the IFA while declaring state intention to reserve an area as forest, that a settlement officer be appointed to settle the claims of its pre-existing occupants and users, was often dispensed with. Many of these lands have still not been surveyed with the land and forest rights of their pre-existing occupants and users remaining unrecognised. In many cases, these lands are yet to be finally notified as forests under sections 20 and 29 of the IFA. Because of this, their legal status as state 'forests' is open to challenge (Sarin, 2005). Further, the restrictive and coercive provisions of the IFA, FCA and WPA are in direct violation of the Constitutional and statutory protection of tribal rights.

1952 Forest policy and commercial forest exploitation

Following large scale re-classification of community lands and forests as 'national' forests, the 1952 National Forest Policy reflected a contempt for local rights and livelihoods by stating that **"the accident of a village being situated close to a forest does not prejudice the right of the country as a whole to receive benefits of a national asset."** (cited in Saxena, 1999).

The post-independence policy of commercial forest exploitation for industry and urban markets changed the nature of the forest itself through replacement of natural vegetation by commercial plantations. This further reduced forest based communities' access to forest resources while simultaneously destroying rich biodiversity under the rubric of 'scientific' forest management. During the 1970s, even important NTFPs were nationalised. In 1976, by when most natural forests had been exhausted, the National Commission on Agriculture (NCA) announced that "Production of industrial wood would have to be the *raison d'etre* for the existence of forests." As pointed out by Saxena (1999), **"the entire thrust of forestry during the first four decades after Independence was towards the production of a uniform industrial cropping system, created after clear felling and ruthless cutting back of all growth, except of the species chosen for dominance".** Forest Development Corporations set up for raising commercial plantations turned themselves (in the words of Dr. Salim Ali and Mrs. Indira Gandhi) into Forest Destruction Corporations and clear felled huge tracts of rich natural forests without ensuring their replacement. Forest based industries were made available bamboo, or huge trees for pulpwood, at throwaway prices and promptly exhausted these resources. Forest Departments did not spare even the sacred groves protected by communities since generations. Plywood industry was provided access to giant wild mango trees, which yielded fruit famous for pickles worth hundreds of rupees every year for local communities, for as little as sixty rupees (Gadgil, 2008).

While seriously undermining their livelihood systems, this brought local communities in perpetual conflict with Forest Departments. A wave of protests in Uttarakhand (the *Chipko* movement), Bastar, Jharkhand and other areas against commercial felling and replacement of natural forests by commercial monocultural plantations swept the country during the 1970s.

Centralisation of control with growing environmental concerns

Growing environmental concerns from the 1970s led to 2 new Central laws:

The Wildlife (Protection) Act (WPA), 1972, which requires all legal and customary rights in national parks to be extinguished while severely restricting them in wildlife sanctuaries.

Besides importing the alien exclusionary approach to wildlife conservation, the WPA is

remarkable for the unfettered powers it vests in wildlife authorities to declare any area a protected area (PA) without any process of public consultation, or giving the people likely to lose their rights an opportunity to file their objections. PA managers are empowered to stop the exercise of rights from the day of the preliminary notification by providing alternatives till rights are settled. With little awareness among forest dwellers about provisions of the law, the inaccessibility of judicial recompense for the average non-literate villagers living in such areas, combined with the immense powers and authority enjoyed by forest officials, there has been *de facto* illegal extinguishing of even legally recorded rights in most PAs from the day of the initial notification. Even notional alternatives have not been provided for the loss of rights despite the final settlement of rights yet to be completed in over 60% of the protected areas. In any case, the WPA provides for settling only 'recorded' rights despite the fact that in most tribal areas, where PAs are concentrated, few customary rights are recorded. It is next to impossible for the affected people to seek any legal remedy as all decisions related to PAs must now be approved by the Supreme Court and the National Board of Wildlife.

The Forest Conservation Act (FCA), 1980, enacted after forests had been moved from the State to the Concurrent list in 1976, which made central government permission mandatory for diverting even small parcels of forest land to non-forest uses irrespective of the diversity of contexts across the country.

The FCA froze legal land use for lands categorised as 'forests' through the highly deficient processes described above. Initially considered applicable only to finally notified reserve forests, over time the FCA's mandate has been extended even to lands with preliminary notifications where rights are yet to be settled, in addition to **'any area recorded as forest in the government records'** despite the notoriously poor quality of government records. The word 'forest' has been used generically in them for recording even community grazing and other common lands and customary community lands. Although the FCA has nothing to do with the settlement of rights, it brought even the slow and inefficient forest survey and settlement processes in different states to a near halt. Even the recognition of existing rights started being treated as diversion of forest land to non-forest uses requiring central clearance and compensatory afforestation (CA). In so doing, the FCA effectively converted several million long standing forest dwellers as illegal occupants of their ancestral lands.

The Forest Advisory Committee (FAC) constituted by MoEF for diversion of forest land under the FCA has no accountability to the local people whose lands and forests it is empowered to permit for diversion. Extension of the FCA's ambit to non-notified lands and forests irrespective of ownership has empowered the FAC and MoEF to **deprive people of their rights over community/common lands classified or recorded as 'forest land' without due legal process without even informing them, leave aside seeking their consent or compensating them.**

Impact of the Godavarman PIL

Matters were further complicated by the Supreme Court order of December 1996 under the Godavarman PIL which extended application of the FCA even to all lands conforming to the **dictionary definition of forest,** irrespective of ownership. All such 'forest lands' now have to be managed in accordance with working plans/ schemes prepared by FDs and approved by the MoEF.

State Forest Departments have been identifying such 'forest like lands' to bring them under their management control with little discussion about the legal processes to be followed, the livelihood impacts on people dependent on such lands or how their legal rights under other existing laws or constitutional provisions are to be dealt with. Under the Santhal Parganas Tenancy Act (SPTA), 1949, for example, traditional village heads are legally empowered to settle scrub village forest lands in the name of *ryots*. The interim court order has effectively overruled this without the state legislature amending the law[7]. The situation is even more contradictory in the North Eastern states where community rights and customary tenures in land recoded

as 'unclassed state forest' enjoy constitutional protection.

Proactive Interlocutory Applications (IAs) filed by the *Amicus Curiae* in the case have led to further interim court orders with drastic impacts on the rights and livelihoods of impoverished tribal and other forest dwellers. Besides staying regularisation of even eligible pre-1980 'encroachments' (Order dated 23.11.2001) and de-reservation of forest land or protected areas, irrespective of whether these have been finally notified after due settlement of rights (Order dated 13.11.2000 in WP(C) 337/95), the Court has also stayed the "removal of dead, diseased, dying or wind fallen trees, drift wood and grasses, etc" from all National Parks (NP) and Wild Life Sanctuaries (WLS) (Order dated 14.2.2000). MoEF and the Central Empowered Committee (CEC) constituted by the court interpreted this to mean that "no rights can now be exercised" in PAs and have banned the collection and sale of all non-timber forest produce (NTFP) from them. This is despite people having legally admitted rights in many finally notified PAs.

In one stroke, between 3 to 4 million of the poorest forest dwellers living inside PAs since long before their notification as forests or PAs have been deprived of their basic citizenship rights and access to critical livelihood resources without due legal process or any scientific studies substantiating that all such collection is harmful to wildlife habitats or biodiversity. In Orissa's infamous 'starvation deaths' forest belt, some PA managers have been refusing permission for *gram sabha* meetings for information dissemination, entry of health workers and in one case, even the delivery of public distribution system (PDS) rations to villages inside PAs. Impoverished tribals are being driven to giving their children in bondage and resorting to large scale distress migration. While the Court's focus on holding the executive accountable for protecting forests and wildlife may be laudable, its orders have totally overlooked, and in fact reinforced, the even more grave failures of the executive in enforcing the constitutional protection for tribal rights and governance systems in the same areas. The affected PA dwellers have had little representation in the ongoing court proceedings with next to no opportunity to be heard. Dominated by strong supporters of an exclusionary approach to conservation which has lost favour in most parts of the world, the CEC assisting the Court has no representation of either the constitutional authority or the ministry responsible for tribal affairs. (Sarin, 2005a)

The bringing of community lands with diverse tenures and livelihood functions under the FCA's purview has confused their management objectives, diluted or erased legal and constitutionally protected community rights, created jurisdictional conflicts between forest and revenue departments, *panchayats* and traditional community institutions, while being difficult to enforce. As pointed out by the CEC itself in its recommendations to the Court on dealing with 'encroachments' on 'forest' lands, **"In respect of deemed forest area, unclassed forest and areas recorded as forest in Government records, which are not legally constituted forests, the provisions under which an offence can be booked are not clear"** (CEC, 2002).

The result is that large areas of the country's so called 'forests' are not forests at all. Huge areas under cultivation by forest dwellers as well as their villages have been trapped in the official legal category of 'forest' land requiring central permission and compensatory afforestation (and now even the payment of 'Net Present Value' of several lakhs of Rupees per hectare under a Supreme Court order) for legal recognition of their non-forest nature. While drastically curtailing the *adivasis'* land and forest rights, the ever increasing stringency of forest and wildlife legislation has rendered most of their livelihood systems illegal, leaving them vulnerable to daily exploitation by an unaccountable bureaucracy. Despite enactment of the *Panchayats* (Extension to the Scheduled Areas) Act, 1996 (PESA), Forest Departments have refused to permit *gram sabhas* to manage their customary forests in accordance with their customs and traditions, arguing that PESA's mandate does not extend to forest land. They have similarly stalled transferring ownership of minor forest produce (MFPs) to them arguing that PESA has not defined MFPs.

How will the FRA impact forest conservation?

Through de-notification of cultivated and inhabited lands as forests following recognition of land rights under the FRA, while the right holders will be freed from the clutches of the forest bureaucracy, there should be no impact on forest conservation as such lands do not have any forests on them – a fact highlighted by MoEF itself in an affidavit submitted to the Supreme Court in July 2004.

In addition, the FRA provides for the recognition of several community/common property rights. These include rights over MFPs and the right and **authority** to manage customary community forests. Through its open and transparent *gram sabha* based, de-bureaucratised process of enquiring into claimed rights, the FRA provides space to village communities to reclaim their community lands and resources wrongly classified as 'national forests' after independence. This should finally enable democratic decentralisation of forest governance in the country through restoring management of community forest resources for local needs in the hands of community institutions and *gram sabhas*. While such forest lands will remain protected under the FCA, the **authority** to protect, conserve and manage them will shift from the Forest Department to the community. MoEF will also need to seek the consent of right holding communities for diverting such community forests to non-forest uses.

The argument that right holders will destroy forests restored to them begs the question whether state forest management has been effective in protecting the country's forests. Because of its admitted inability to protect forests without community support, MoEF initiated the ongoing joint forest management (JFM) programme from 1990. Due to the FDs' continuing stranglehold on the constitution and functioning of JFM committees, these tend to function for only as long as external funds can be pumped into them. In contrast, thousands of forest dependent villages in Orissa, Jharkhand, Gujarat, Rajasthan and other states have been regenerating and protecting their forests, often from the Forest Department, entirely through their own efforts. Vested with legal rights and management authority for sustainable use provided by the FRA, their incentives for improving their efforts will only increase. Uttarakhand already provides the precedent of decades old *Van Panchayat* forests managed by villagers which are as good, if not in better condition than the reserve forests under the FD's control. A recent study has found that the costs of FD managed forests are seven times of those managed by *Van Panchayats* for similar quality forests, questioning the rationale of continued state management (Somanathan et al., 2009). Community forests 'handed over' to forest user groups in Nepal have similarly regenerated dramatically. It is about time that India also abandons its colonial forest management framework in favour of a more democratic one.

Yes, systems of capacity building and other support for communities will need to be developed and in some cases, community systems may fail. But the same applies equally, if not more, to state managed forests. Overall, there is little evidence from existing experience to suggest that community managed forests will not do better than existing management by state bureaucracies. It will be cheaper, will strengthen local livelihoods and incomes and conserve biodiversity through creating space for the use of local indigenous knowledge driven by local priorities.

The FRA and wildlife conservation

The most contentious debate over the FRA has been over its likely impact on PAs and wildlife. The non-consultative process of PA notification and effective extinguishing of the rights of the people living within or dependent on them without due legal process has not only jeopardised the already fragile livelihoods of the affected people, but has also alienated them from the very objective of wildlife conservation. As pointed out by the Tiger Task Force report, small islands of artificially created wilderness surrounded by angry, impoverished and hostile people deprived of their rights and pushed out of their habitats have no future. This is particularly so when they see outsiders, including wildlife conservationists, profiting from their misery through commercial tourism, hotels and such activities.

The viewpoint that co-existence between wildlife (particularly tigers) and tribals is not possible is a-historical as both have co-existed for centuries. It is true that today, in many areas they compete for survival and subsistence. But this is because the habitats of **both** have shrunk because of economic processes driven by non-tribal, including the conservationists' own lifestyles. Tribals have suffered as much as tigers and other wildlife from the shrinkage of their habitats caused by large dams, mines and industry. The conservationists' solution of creating inviolate spaces for wildlife by throwing out the tribals is to punish one victim to save the other. Ironically, while there is a red list of endangered wild life species, there is no equivalent list of endangered tribes. Some of India's pre-agricultural tribes are as, if not more, endangered as the country's wildlife.

Further, according to many conservation scientists and biologists, there is little empirical evidence supporting the necessity of creating inviolate areas where humans have co-existed with wildlife due to their low consumption lifestyles.

As pointed out by Ram Chandra Guha, the tiger conservationists' arguments are unapologetically **authoritarian**. It is implied that it is 'they' who will decide which and how much area should be made inviolate, and consequently, the number of people to be removed from their habitats. This is irrespective of whether they have the biological or ecological knowledge for taking such decisions. The boundaries of India's existing protected areas have been demarcated quite arbitrarily with an estimated population of 3 to 4 million people living inside them and probably more wildlife outside than inside the PAs. Most conservationists clearly lack an appreciation of the complex historical and cultural links between tribal communities and their forested habitats and the horrific record of forcible displacement, both with and without resettlement, in independent India.

In any case, where the government itself has failed to recognise people's rights required by law and the Constitution, there can be no justification for arguing that such rights should not be recognised simply because the area has subsequently been declared a wildlife reserve. Irrespective of their love for the tiger or other wildlife species, conservationists have no right to demand that the rights of other Indian citizens should be violated.

A groundswell of criticism and opposition is building up even internationally against large international conservation organisations for promoting the concept of creating 'wilderness areas for wildlife' in different countries. It is always the ancestral habitats of indigenous people, whether in Africa, Latin America or Asia that are selected as wilderness areas. With 12% of the world's area, a total area exceeding the whole of Africa, already under protection, tens of millions of indigenous communities have been converted into 'conservation refugees', thrown out of their ancestral habitats and

living miserable lives in slums and shanties. Some have started calling themselves 'enemies of conservation'. It needs to be remembered that creation of the first 'wilderness area' in the USA, from where we have imported the concept, was begun in 1864 with the military expulsion of Miwok and Ahwahnee Indians from their 4000 year old settlements in Yosemite Valley. Similar treatment was meted out to the native Indians living in what is now known as the Yellowstone National Park.

Indian wildlife conservation cannot be based on perpetuating this legacy of cultural (if not physical) genocide of our indigenous communities who have shaped and been shaped by, the ecological landscapes they have co-inhabited with wildlife. We need to move towards evolving site specific conservation strategies, based on the best available indigenous and scientific knowledge, through transparent and consultative processes involving all concerned parties, particularly the local communities. With rights and entitlements to benefits secured under the FRA, the forest dwellers living in our protected areas can potentially become the best guardians of the country's wildlife. Both conservationists and rights activists need to invest greater energy in protecting the country's forests and biodiversity, and the habitats of both tribals and wildlife, from the real threats of mining, dams and other destructive processes. Since October 1980, MoEF has cleared the diversion of over 1 million hectares of forests for such activities, with the pace of diversion having increased dramatically during recent years.

Endnotes

[1] *Large areas of natural grassland ecosystems have been destroyed by the plantation of exotic tree species in them due to their being classified as forest land and handed over to tree focused FDs (Sarin, 2005).*

[2] *South Africa, for example, passed a law after the end of Apartheid which enabled indigenous African communities to claim restitution of their lands forcibly appropriated during Apartheid.*

[3] *Although 4.3 million hectares of forest land was diverted to non-forest use between independence and 1980, this was only a fraction of the 26 mha declared to be state forest after independence, often without due legal process.*

[4] *Settlement officers for settling the rights of tribals in over 100,000 ha notified as RF under section 4 of the IFA decades ago have been appointed in Andhra Pradesh only recently. The Orissa Forest Department is being unable to provide forest maps to* Gram Sabhas *during implementation of the FRA as these simply don't exist.*

[5] *See Kumar, K., 2008 for an excellent investigation of the process of disenfranchisement of shifting cultivators in Orissa.*

[6] *See Ghosh, 2007 for how the forest rights of tenants in South West Bengal were illegally extinguished.*

[7] *For examples of illegal cancellation of land titles based on the Court's 1996 order in Jharkhand and Maharashtra, see Sarin, 2003.*

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Discussions

Welcome and introduction

Pratim welcomed all the participants to the conference. Keystone Foundation is an eco-development group which has been working for the past 15 years on issues of honey, honey hunters and indigenous people in the Nilgiris. This project, Bees, Biodiversity and Forest Livelihoods funded by the Darwin Initiative, gave Keystone the opportunity to expand its horizons of knowledge, work in partnership with people from different disciplines, get into new realms of knowledge and share its knowledge with this diverse group. Dr Janet Seeley, as leader of the project also welcomed the participants and hoped that this conference would encourage sharing of information and debate across disciplines, reflecting the ethos of the project.

Keynote address

P S Ramakrishnan

C R Sathyanarayanan said there are a number of communities in the Western Ghats who still practice shifting cultivation as a low profile activity for themselves as multi-cropping is fundamental for their survival.

P S Ramakrishnan said multi-cropping, not only in space but also in time, is being increasingly recognised as one of the solutions for sustainable agriculture. Many traditional systems are multi-cropping systems with multiple units of biodiversity, and each one had an important role. But traditional ecological knowledge is not static; it is a very dynamic system; people themselves change over time.

(1) NBR-wide history and context

Gunnel Cederlöf

C R Sathyanarayanan said the Nilgiris has been well documented from the angle of social anthropology, but we get a romantic view that the ethnic communities with their unique customs and practices lived in harmony with mutual interdependence. For the first time, through this research paper we get a new picture founded on historical documents and colonial revenue records. In the early 19th century under the British East India Company's rule the Todas and Badagas had to consistently battle in the courts with the British administration against land grabbing attempts and injustice committed by early British settlers, entrepreneurs, and colonial administrators.

Today the livelihood of the Todas is largely based on potato and tea cultivation. During the 1890s about 2,000 acres of land have been secured to the Toda community as a whole by a Government Order as Toda *patta* lands. Now the population of the Toda has increased resulting in certain clans having comparatively more land than others. The government has allowed about one-third of the lands to come under cultivation leading to a chaotic situation among them.

Gunnel Cederlöf described what happened after 1843. What happened before 1843 was to set the legal framework. The British needed a bottom line on which they could establish colonial rule with sovereign control. They wanted to restrict Toda claims to land so Toda were diminished into being graziers. They were given grazing rights on which they were taxed at one-fifth of the revenue for cultivation lands. They wanted to establish grants, leading to *pattas*, so that land could be auctioned to the highest bidder, so they set the baseline for access to land in the hills for the first regulation of land in 1843. Subsequent legal regulations depended on this one. The waste land rules which came a decade later meant control of the land that was not under permanent cultivation i.e., the grazing land and the land under shifting cultivation. This affected the Badaga as well as the Toda communities. The "Toda *pattas*" were the land titles that were different from other land grants because they were not individual but joint *patta* based in a Toda settlement. The law is not universal; different people have different rights depending on who they were classified to be. The law is not neutral; it is subject to interpretation.

The colonial archives are huge. Not all the documents were authored by British or Europeans; many were by Indians. If one is looking for the truth one should remember that every document has a bias which has to be understood before one can understand what the document conveys.

The Toda-Badaga interrelated system was probably changing at the time when the British moved in. It appears that cultivation had been slowly taking over and there were conflicts between two extensive production systems and influences from the surrounding regions.

B R Ramesh

B R Ramesh clarified that no landuse change investigation had been done. That would be the next phase of his research. He also said that he had used bio-climatic parameters to classify the forest types, not the existing agro-climatic zones which are used for classification of agricultural areas.

The present forest management system is not working. Working plans are for territorial divisions, geared more towards production forestry with little emphasis on conservation. Management areas may cut across many eco-systems and many landscapes, but the same set of management protocols is applied uniformly. That is why in his study the areas were divided into different landscape units based on natural phenomena. For each landscape, landscape units have been reclassified based on different factors considering the richness, diversity of vegetation, distribution of animals and the socio economic situation of the communities.

K C Malhotra said the approach was very different from the watershed approach he was familiar with because the watershed development had to overcome political boundaries. He felt that these exercises were excellent science, but the people had been left out.

C R Sathyanarayan asked about the landscape units in Kerala. Indira Gandhi, Perambikulam and Chinnar are all adjoining sanctuaries, within which there are hundreds of *adivasi* settlements and many tea estates. The first two have been notified as Critical Tiger Habitats, so there will be resettlement and eviction in these areas whereas Chinnar will follow a different management plan for conservation, working with the people. There is a contradiction in the basic management planning.

There are hundreds of settlements in areas which have recently been notified as sanctuaries. Traditional millet cultivation here has given way to cash crop cultivation like lemon grass oil, cardamom and spices by developing home gardens. Bio-cultural diversity has been destroyed. Sustenance now is based on food supply from outside. What kind of conservation strategy is this if it leads to total loss of livelihood of humans who are now supported by Public Distribution System rice?

Anita Varghese said that the study presented by Dr Ramesh was unique because it was the first time that the state mechanism, the Kerala Forest Department, brought together a really strongly founded ecological institute like the French Institute together with the School of Social Sciences with a consultative process which took into account all the *Vana Samrakshana Samitis* (local forest committees) that were there in that area. So it was a very powerful report and management plan.

B R Ramesh clarified that his presentation was in two parts. One was gap analysis based on the biological aspects which showed gaps in conservation. The other was the landscape analysis which involved biological as well as human aspects. First forests or landscape were scientifically classified and then the human aspect introduced. The study had modified the natural landscape for different human uses so people were not excluded. In fact they suggested in a book they had written on the subject that there should be participatory forest management including the local people.

Rev P K Mulley

C R Sathyanarayan said several indigenous communities have been omitted for political reasons from the list of communities in the NBR.

Priya Davidar was interested in the relationship of the Todas with biodiversity. They now lease out their lands for cultivation. Todas and buffaloes do not damage the rare endangered species whereas livestock and other external factors destroy habitat leading to species decline. We need to identify situations where the positive impact tends to be destroyed by external factors.

Adam Pain felt that though the technical definition of biodiversity was clear, how it was assessed and who assessed it were areas of debate.

Snehlata Nath wondered whether governance takes into account that there is biodiversity, there are traditional livelihoods, ancestral domains, a system of management of biodiversity. Governments probably have different priorities.

Madhu Sarin said that when the British made laws, at least there was negotiation although it was an alien power trying to exert its sovereign rights on colonised territory. But even 60 years after Independence laws are used in a manner which is totally non-consultative. They look only at one aspect, whether economic development or conservation, but people don't count.

Adam Pain said that Madhu's point was about the privileging of particular knowledge systems, where law gets privileged, where science gets privileged or particular knowledge about science becomes dominant over other forms of knowledge. Where do indigenous knowledge systems stand in relation to the knowledge of law or the knowledge of science and to what extent are they balanced.

(2) Biodiversity/bees/ livelihoods linkages

Adam Pain

Priya Davidar said ecological theory is very complex. Research has shown that biodiversity is highly structured. Non-equilibrium dynamics does play a role but on the whole there has been very little empirical support for non-equilibrium systems. Models show that a certain degree of perturbation and disturbance are part of ecological systems but most ecological systems have a threshold and cannot withstand too large a disturbance. Humans have been part of the ecological systems over the past million years or so and have colonised different forest types at different times in the past. For example, the rain forests were the last to be colonised so they are less resistant to perturbation than dry forests which have been colonised for a longer period of time. So there is a lot of evolution also involved in this.

Pankaj Sheksaria asked Adam, since he had said that three years was not enough to do this kind of work, as a group of individuals trying to influence policy how would they economise on their resources and research? Decisions have to be made, but there is a constraint of time and resources; there will never be enough information so how would decisions be taken with the available knowledge and resources?

Adam Pain said that the bigger question behind that is what drives policy? Is it evidence or are there wider considerations? Who uses that evidence? Policy, by and large is about creating solutions but who defines the problem? And that again leads us back into different knowledge frameworks. For people who live in the forest their problem may be forest regulations for which they would offer a very particular set of solutions. An ecologist's solution is better management regimes defined in terms of problems. We have to accept that policy is always imperfect.

Rajiv Srivastava traced the historical background of forestry in India. In 1861 forestry was systematised and the initial concept was conservation, but within two decades forestry entered another phase which was the destruction of the forest through lumber operations. So the backbone of the forest in India was totally broken. After 1950, there was a phase of social forestry, trying to repair the destruction of the forest after the UNESCO charter declared that 33% of the forest has to be under green cover. After Independence, national policy had not addressed the sustainability and livelihoods of tribal people. Now the issues of biodiversity conservation and the linkages with the livelihood status of tribal people are being taken up by the government. People are talking about it. Even the Forest Department is beginning to feel that without the cooperation of the local people and tribal people in particular, they cannot achieve the targets.

There are other issues. Each site is different. Even within the NBR the problems differ from one area to the other. So how best can we incorporate and develop research technologies and linkages? Should the focus be on poverty alleviation or biodiversity conservation? There is more pressure on the forest because biodiversity and livelihoods have to be maintained. Many factors have to be considered from the anthropological, sociological and psychological angles.

Archana Sivaramakrishnan asked whether frictions between various epistemologies resulted in various understandings coming up from say community knowledge and scientific knowledge.

Adam Pain clarified that he was talking about conflicts between formal knowledge systems, not between formal and informal.

Pratim Roy asked Adam, in a project of three years or a project on a topic like this which has got inter-linkages and multi-disciplinary subjects, how do we know and question how things work and get those frameworks and those templates right? Do we try and train people to think differently or in different cultural contexts?

Adam Pain explained that much of what we do in science is very normative. We work with concepts and theories which we don't really question and much of our method is repetitive. In short term projects like this we must be very realistic about what capacity building actually means. It's about techniques, methods, approaches. But we need to be much more critical of the normative models that we work with. That requires a different set of analytical tools and conceptual thinking which you do not get over a short term input. It is about the ability to challenge particularly when one is working in more complex situations, with multi-disciplinarities. Within biodiversity research much of the discussion on biodiversity management comes from particular knowledge frameworks. An important outcome of this project should be developing our thinking of how we do research on biodiversity and livelihood linkages, ensuring a much more plural approach to doing research that is not dominated by one particular discipline or institutional framework.

K C Malhotra said that the research that we are doing here is multi-disciplined and each discipline has its own way of looking at it and that is where we have to build some common understanding.

Madhu Sarin commented on the report of the Steering Committee of the 11th Five Year Plan which said that we need to recognise that ecosystems are too complex and too inter-related, that any one intervention can have totally unpredictable outcomes. Policies towards honey differ in each state in the NBR. How do those rules impact people's behaviour and therefore their incentive for either sustainable or unsustainable harvesting or management and why can it not change to a system where there is collaborative decision making? Budgets convert everything into a monetary problem and then again the budgets go to one department which has total control to the exclusion of other knowledge systems.

Soligas are shifting cultivators and have been totally banned from using fire within the sanctuary within their customary traditional habitat but it is the controlled use of fire which enables them to maintain a much higher level of biodiversity. Today the whole sanctuary has been taken over by the invasive `weed' lantana. We must be prepared to try out flexible regimes and a trial and error approach where the people who are living there and have the most intimate knowledge have a major say as they are major partners.

Vanya Orr added that the Todas also used their traditional knowledge and ritualised the sustainability of their ecology. The priest stood on the top of the hills and controlled the fire burning which was a light burn which never did any harm to deep rooting or hibernating plants. Now, because there is no controlled light burning we have deep burning which really destroys so much.

Rajiv Srivastava responded to their comments. 50-70 years ago shifting cultivation was not such a problem because the population pressure was not much and there was more forest. It affected around 50-54% of forest, but now it is going much beyond that. It is a very complicated issue. Forest fire is definitely detrimental to the area because it stops the process of humus formation. More than 99% of the forest fires in India are man made. No doubt the forest fire is good for certain species because they open the dormancy, but with fire lantana becomes much more invasive because if the seeds which have fallen on the ground get a gentle burn it opens the dormancy and it spreads much faster. But the problem is because of the recurrent fire the grasslands which sustain the herbivore population are sinking because of the lantana. So we have to prevent forest fires and we have to eradicate the lantana simultaneously otherwise much more damage will be caused to the biodiversity.

R Vijaykumar said that the government on the one hand is trying to create a zone where the tiger is preserved. On the other it is trying to promote livelihoods, trying to conserve the biodiversity and the natural resources on which the lives of the people are sustained locally. So there is a contradiction.

V V Belavadi

V V Belavadi confirmed that the coffee and cardamom plantations were not organic.

Rajiv Srivastava referred to the comment that 50% nectar was wasted due to long tongue and short tongue but nature has created its own way of managing things so nothing is wasted. There will be competition between the insects and bats which the paper does not highlight. The study needs to look at which are the competitors. What about the predators? What is their role? Some exotic predators also exist. What are they?

The concept of the exotic is only 40-50 years old. Before that even the planters were giving respect to the local indigenous species. This acted as a germplasm bank outside the forest, so now we have to work out how we can restore this germplasm bank.

Nicola Bradbear

C R Sathyanarayanan said there is a loss of knowledge about honey hunting and other skills among the indigenous communities. What is Keystone's long term strategy to face this situation?

Rajiv Srivastava was not aware that there was so much diversity in his area. The work done through genetic engineering was very interesting. Had there been any invasion of exotics in the Nilgiris? What was the role of *lantana camera, parthenium* and other exotic plants on bee colonies? Were there any predators?

Foresters were working out phytogeographical zones but they should also work out phylogeographical zones which Nicola's paper had highlighted. He also wanted information on whether there was any competition with other pollinators and what was the impact on their colony sites. Did harvesting vary in different species? The number of colonies had to be counted each

year for monitoring because they did not know if harvesting was sustainable. Was there is an increase or decrease in the size of the colony? Why?

Vanya Orr wanted to know what the relationship was between the different bee species.

Nicola Bradbear said different species occupy different habitats and have different biology and behaviour and occupy different niches within the ecology. They are not in competition.

K C Malhotra said we must delineate more carefully the kind of species on which each one of the bee species is mainly dependent as the main source of nectar to help management. Graphs showing at what time the population grows and when might be optimal to harvest and how much, will not work. Each settlement where people are dependent on the forest will have to take the decision so it depends upon the home range of the particular settlement. We need a more decentralised way of thinking of the sustainability curve. One mega curve for the entire area will not do. There is a lot of scope of indigenous knowledge building here in terms of how much to harvest, when to harvest, how many colonies to be left. Various communities here, indigenous or otherwise who gather honey use different tools and technology. We must analyse very carefully whether they are destructive and if so the quantum of destruction and introduce the nondestructive method of honey gathering which was developed in Wardha.

Adam Pain asked whether it was at all possible to know what the bee population is. It's a moving target with many variables associated with populations. The graph is a classic carrying capacity argument which runs through much of forest management policy that we know what sustainable harvest is. Will we ever know what a sustainable harvest is? We have to recognise that many of these conceptual models are no more than models and yet we apply them as if they are true and then give grants or take decisions based on them.

Nicola Bradbear explained that it was possible to count how many colonies are on a cliff. We know from science that the same *dorsata* colonies return to the same spot, right next to where they nested the year before.

Adam Pain argued that there are different methods for estimating nest density but if we measure different scales we get different stories so how can we know what the population is? Why don't we have systematic data on how local populations have assessed change and density? Different knowledge systems have different forms of recording. That needs to be much more systematically explored.

Nicola Bradbear clarified that honey from hives can be perfect quality. Bees do get sick. The Thai *sacbrood* virus comes in a cycle of every seven years and kills some *cerana* colonies. The Indian government tells people they should keep European honey bees but importing bees brings with it many problems.

Many organisations have projects to increase market chains for honey so there are projects where they are giving honey hunters modern equipment so they can go and harvest more honey at more times of year. There are eco-tourism projects where they are taking tourists to see honey hunting so the honey hunting takes place out of season. They say that you can harvest the combs without killing the bees but it is very hard not to damage the bees when you do it. You have to be careful of these well meaning organisations.

R Vijaykumar asked, from the governmental point of view as an intervention how do we handle fragile ecosystems? There is a lot of co-evolution. There is evidence of how the population seems to have adapted to the environment and the environment has adjusted itself to human interaction in the area. Therefore there is a need to intervene intelligently. There is a complexity in understanding biodiversity. The nature of the ecology is being altered now. There have been interventions of all kinds in this area from the pre-British times and during the British times and then subsequently through the ages, through the Forest Act and then the subsequent introduction of exotics in these areas. The people have had to develop ideas on where they should get their livelihoods and found the best available means to do it.

From our point of view how do we improve capabilities while handling such fragile ecosystems like we find in the Nilgiris area. When government comes in it comes in a very ham fisted fashion because we come with money and then we want something done. We have an annual plan, we have a schedule for spending the money so our systems are uneconomic. It is a different kind of system that is trying to adjust to some other activity which is not working in the same timeframe or objectives. So there is a need for developing some kind of local natural resource institutions that can handle such complexity, that can allow local people to innovate, to develop ideas, to learn from what they are doing and then to develop solutions where government or other agencies and research institutions are able to come and make suggestions on what are the consequences of particular actions and make study-centered research thereafter.

(3)
What's the story on biodiversity linkages?

G Marimuthu

Pankaj Sheksaria asked if there was any quantification of damage caused by fruit bats. Is there high incidence of orchard owners or farmers actually killing fruit bats?

G Marimuthu clarified that bats are killed but not because of the damage they cause but for food.

Vanya Orr asked if there has been a study of the balance between the fruit produced through pollination by bats compared to the destruction by them?

Anita Varghese asked if there was effective seed dispersal of valuable species by bats and what was the value of pollination.

G Marimuthu said seed dispersal is one of the major beneficial roles but so far his study has not extended to it. For damage a quantitative analysis had been done by putting a market value on the quantity of fruits damaged. He did not have the data but from the literature had gleaned that there are about 500 products made available from bat pollinated plants.

K C Malhotra was concerned that if we said bats are vermin there would be a serious problem because the role that bats play in dispersal, in pollination has not been studied so the balance must be found.

G Marimuthu said that of the thirteen species one has now been shifted to Schedule 1 of the Wildlife Protection Act of India; of the remaining twelve only three visit orchards and damage commercial fruits.

Anita Varghese

Anita Varghese commented that in this project their set theories had been challenged. They thought that bees indicated a pristine habitat. But they saw that *apis cerana* seemed to be adapting, helping the exotics for their own survival.

She clarified that the valuation presented was a valuation of soapnut and 200 NTFP species which were used by the communities, not the value of the biodiversity which is used by the people of the NBR.

Adam Pain wondered how one assessed value and to what did one give weight in terms of measurements? It comes back to knowledge frameworks. Metric measure of money had been chosen and for many aspects for biodiversity that measure could not be used.

Anita Varghese said crop production is managed and we can predict yields but how do we define this in terms of forest produce where there is no guarantee on the yield.

Nicola Bradbear said that in Europe and the US with honey bee colonies on the decline people were trying to persuade governments to put money into bee research so they have put a monetary value on bees. Where honey bee populations have declined they have put money into looking at what other pollinators are there in the environment and coming out with good findings.

K C Malhotra said that in the natural scenario several plants need pollinators so it is important to learn in a given landscape or ecosystem, who are the pollinators and then identify threats, their populations etc. In the northern plains of India today, during the winter crop, pollination services are being provided by nomads who move with beehives in lorries.

Pankaj Sheksaria asked if one could give up on the philosophical and the qualitative arguments and considerations. In such a rapidly changing value system how do we look beyond just reducing everything to either economics or figures? Can we draw a balance between the two?

K C Malhotra said that he had learnt that it was possible to combine both. Where numbers were required he gave them numbers, where philosophy was required he dealt with that.

Snehlata Nath said there was no point in telling policy makers that these were forest dependent communities, honey hunting was important for them, bees play an important role in tropical forests. We have to prove it and give numbers and analysis.

Pratim Roy said people were not willing to change so quickly and things like biodiversity, environment, marginalised communities, forest people were not in the radar of decision makers at all. So we have to be innovative to bring it to centre stage.

(4)
What's the story on livelihoods linkages?

Snehlata Nath
Janet Seeley

Anita Varghese said we rank NTFP income sources contribution based on income, but sometimes the time the produce is available is more important than how much it fetches. Those factors also drive NTFP harvesting.

Janet Seeley added that it is not regular income in the pocket because sometimes there may be no point in collecting NTFP at the wrong time of year.

K C Malhotra said that, except for man-animal conflict the fauna does not appear in the paper at all.

Janet Seeley clarified that in Non Timber Forest Products they had not counted animals as well but there was certainly some information on animals. It was work in progress; a lot of it had not been analysed yet.

Somnath Sen asked how one could do individualistic research which is typically implemented at the household level versus a communitarian approach to research. This was a particular challenge because in the Nilgiris context where there are diverse tribal as well as non *adivasi* groups, where the group character is more pronounced, a lot of cultural awareness is needed. Many of the Keystone staff members are from these ethnic groups and able to understand.

Methodologically it is not easy to look at livelihoods and measure it neatly, given its different complications and ramifications. One point data has its own problems. Ideally we would like to look at some of these things over a period of time. The Sustainable Rural Livelihoods Framework is difficult to use for livelihoods and poverty measurement in contexts where the traditional understanding of what communities are, what nature is, what government is, is not very clear and evolved. In India, government work is centered around poverty and the politics of that. So we need to say what our research tells us in terms of the condition of the people. Livelihoods are played out in the context of power and power structures including economic structures.

Much of the data is still coming in but it seems clear that biodiversity and economic value seem to be related but mediated by a number of factors such as the situation of the household and location and other factors which are still being researched. Biodiversity and social and cultural values are very closely linked. These linkages are established; the challenge is to put some sort of qualitative and quantitative indicators to say how strong or weak they are, how they get intermediated by structures such as household on the one hand at the micro level and by larger forces on the other.

How at the household, community level are risk and associated vulnerabilities perceived? An interesting finding was that you alienate people so much because their own place has now become somebody else's that conservation and biodiversity derived from that comes under threat because you lose a whole constituency and their interest.

There are some issues that need to be looked at further as Keystone's future work.

If we look at biodiversity being a wealth or capital it is not always converted into a flow of goods and services. Therefore measuring or appreciating it becomes difficult.

What kind of indicators are we looking at when we say value or well-being?

In research situations try and find diverse locations where you compare biodiversity to levels of poverty or non-economic well-being and then try and understand what explains those.

In NTFP and honey we measure prevalence and salience. What percentage of that does it form? But we are unable to measure what kind of other values it has. When we measure any product from a biodiversity related attribute we might want to go more in depth and take measurements not just in terms of economics but also other attributes of importance.

Unless we look at other attributes of households it will be very difficult for us to say what kind of lives they lead as livelihoods are a subset of that. We need to see the connections between biodiversity and health, for example. A lot of household related factors and cultural aspects determine to what extent and who uses NTFPs.

R Vijaykumar said that in other areas also there were critical factors in people's livelihoods such as average landholding, how they take decisions on what they grow. For livelihoods the old definition of DFID has incorporated all the factors including health. He was not sure that Janet Seeley's presentation said that dependence was diversification of risk. Even if people were not so dependent on the forest, at least in terms of income calculation often the forest is a resource.

P S Ramakrishnan said he was confused by the distinction being made between forest dependence and biodiversity dependence because to him biodiversity dependence was automatically forest dependence.

Madhu Sarin asked whether the dependence on forests had gone down because the forest had been destroyed and converted into plantations? The intertwining of the biodiversity and cultural landscapes has been transformed over time and is related to the progressive deprivation of access and rights over resources and that is today shaping people's relationship with those resources and therefore the links with livelihoods.

Vanya Orr reminded the group that nobody had mentioned traditional knowledge and its importance as a value. There are extraordinary interconnections between people and landscape, people and forest and people and animals that we have lost because we work only on an intellectual basis.

K C Malhotra said that if one were trying to make an inference of dependence, the tables mentioned firewood as an important NTFP because it is sold. But the people depend solely on the forest for firewood, construction material, implements, etc., but that did not add to the dependency level. Animal holding also require grazing and fodder. If these were added, the level of dependency would have looked very different. Methodologically he did not agree that one could make a judgment only on the economic value. Livelihood is overall. There was also a methodological difficulty in that we were dealing with 16 sites with different communities. The data had to be disaggregated on a community basis and inter-site variations as well as variations within communities had to be looked into. He felt that there had been robust data collection but some of the inferences we were moving towards were premature.

Adam Pain clarified that the paper said "Dependency is a slippery word and must be handled with care." We focus on the concrete measure of income. There is an important question of income in kind or the subsistence component. That is not so amenable to analysis but it would certainly be part of the overall analysis of the programme.

These were case studies, not samples. They were simply interviewing the households in each location; that is why there was considerable variation. There are definitely major differences between locations which were not fully understood yet, as they had not got to that next stage of analysis.

Janet Seeley added that the second part of the paper was based on rapid analysis as the data was received only two days before the conference. What there was in the life histories and village data were snippets. One of the key things that needs to come out more is the bias in all our data. There is no absolute truth, it is always mediated by who you are and where you are. The timeline is also mediated by people's sense of time. Whether it is biodiversity or people the factors are the same – all the data is mediated by the subjectivity and the positionality of the people involved in the collection.

Priya Davidar wondered whether the research had looked at the educational levels of the households and what they collected.

Adam Pain replied that there was some information on education and it was not systematic. When they looked at individual households this aspect would be looked at along with age etc.

Snehlata Nath said they had collected data, whether historical or land use change or governance issues, health issues. Now they had to look at it in a more holistic way in terms of both biodiversity and governance and policies and other things. There was a lot of traditional knowledge involved and documented and covered by the case studies.

Nicola Bradbear said we need to capture that beeswax is a cash commodity. For every ten kilos of honey harvested there is one kilo of wax so we are talking about tons of beeswax which has significant financial value.

Janet Seeley agreed, saying that there is very limited information on beeswax in the data. This needs more work.

Somnath Sen said that the NBR which is prone to biases of different kinds is a good case to think about how to use traditional methods of research and build them into more ethnographic participatory methods and combine them to respond to particular situations.

What kind of presentations do we need? The key validation should be to do small exercises with the communities whom Keystone had researched.

There is a lot of material on the relation of tribal communities to bee keeping and biodiversity. How do we use this mine of case studies and stories to understand well-being of communities in respect of biodiversity? Can this data dovetail into district level data? If we cannot relate to the government data structures then we cannot talk to the government through its language and classifications.

(5)
What's driving change?

Adam Pain

K C Malhotra said the framework has identified the drivers who have influenced the processes of change. The structures, institutions and the agents have been expanded and linked to the most powerful player in the process, the government, state and central.

However, in a study of this kind to understand change one needs at least two points for comparison. Records do not exist so the Keystone team says it cannot comment substantially on what has happened to the biodiversity of this area. We know changes have occurred. Prof Prabhakar was able to document changes that have occurred in biodiversity of the Nilgiris flora by using the working plans of the Forest Department which are expected to be revised every ten years. The other method is the Recall method which is extensively used where there are no written records. Drawing on the memory of the older members of the community it is possible to reconstruct a scenario going back at least 50/60 years.

Pankaj Sheksaria was concerned that in the context of what is driving change, there are some very powerful changes at the global level which involve a huge extraction and movement of resources and finance. These processes have huge localised impacts on people and spaces, including a particular landscape like NBR.

Madhu Sarin

K C Malhotra said that the Tribal Rights Act is now being implemented. Honey is included in the list of NTFPs so they will have ownership and the right to dispose. There is a very large number of claimants, primarily from tribal people. 59% of the land in Tripura goes under forest land. As a result the forest area will get fragmented, as the rights fall in between the forest area. Therefore with only a fraction of the original land available to the Department, implementing Joint Forest Management will be difficult.

It has been observed that villagers and tribal people in particular are not aware of their rights. What has happened to many of their rights after the area was declared a biosphere reserve? We must list these rights for all the groups. If they know their rights they can access them for development. In the Nilgiris the younger generation is more aware. In discussions for change the *panchayat* must be brought in as all government schemes have to come in through the *panchayat*.

C R Sathyanarayanan said there is a scheme for the development of basic amenities in forest villages started in the 10th Five Year Plan for which there is a sizeable allocation of money. Southern states which have hundreds of settlements are missing because this list was formed during the colonial period so they cannot access any benefits.

Madhu Sarin clarified that the Forest Rights Act says that forest villages are the settlements which have been established inside the forest by the Forest Department of any state for forestry operations or which were converted into forest villages through the forest reservation process and include land for cultivation and other uses permitted by the government. They can now claim rights to conversion into revenue land.

Pankaj Sheksaria brought up the issue of discontent, including Naxalism, among the tribal people across India. One way to mollify them was to immediately implement the Forest Rights Act to prevent further attacks. Was that correct?

B J Krishnan added his comments to the factors that are driving change. The law as a driving force is very important. He said we are here because of the Convention on Biological Diversity. The first biosphere in India was constituted in September 1986 under the UNESCO Programme on Man and the Biosphere even before the Wildlife Protection Act came into force. At the national level we have the 1927 Forest Act, 1972 Wildlife Protection Act and the Conservation Act. These Acts are in conflict with each other. The 1927 Forest Act and 1972 Wildlife Protection Act do not allow people into the forest as against the CBD which is more people friendly. CBD is not about conservation alone; it is about conservation across the board, both at the global and at the national level. Before the Forest Rights Act we have the National Environment Policy Statement which specifically refers to the historical injustice done to the indigenous people.

This project of Keystone is about access to biodiversity areas. People do not have access to the biodiversity because of the 1927 Government of India Act, 1882 Tamil Nadu Act and the Wildlife Protection Act. These Acts are still there. On the other hand we have the Forest Rights Act which is in addition to these Acts. So, hypothetically if there is a conflict between these two sets of instruments, the earlier Acts will prevail.

There are other problems at the local level as locals do not know how to implement the Forest

Rights Act. For example, they do not know how to set up a *gram sabha*. But we should try to implement the Act, despite these difficulties, because something is better than nothing and the Act came into being after a long struggle.

Anita Varghese said that the tribal people are not responsible for the diminishing natural resources. There is a responsible way of collection that traditional communities share and exhibit.

Madhu Sarin said that under the Constitution it is everybody's responsibility to protect the environment. Why should only these people be made responsible? Does that mean that the others are not responsible? Many villages are protecting the forest anyway, sometimes against the Forest Department itself. We need to focus on being the right holding person and how that changes your attitude towards the forest against being someone who is being managed.

Anita Varghese said when they replaced 'forest dependent' with 'forest dwelling' in their writing it might mean something else now in the light of this Act. So this would be something they would have to watch out for in the project and in their analyses.

Somnath Sen pointed out that a very fundamental driver of change in the NBR context is the politics outside of the NBR. What happens across the border in Karnataka, Kerala and most importantly within their front yard of Chennai, often determines things like power, and other resources. This is a boon in disguise as well. There may be a big global change which might wipe out everything so worrying about a small honey market may be just a small blip compared to this mammoth thing like climate or political change.

Pratim Roy said Keystone is still operating at a very small scale in the NBR with a set of communities who are living in a highly natural resource rich area. How do we upscale this to make a bigger impact? How do we have networks in other parts of the country? How do we use this experience with others and learn from their experiences? Are we still in an island? Are we still not being able to "mainstream" our efforts and experiences to a broader framework? There are many things still to do.

Janet Seeley said one of the challenges is that this is a very small project with a very big agenda with a number of stakeholders. We have only just scratched the surface. In this project we have tried to bring biodiversity and people together to show interlinkages and we hope others can build on our work. The discussion at this conference has been stimulating because people from so many different backgrounds have come together; this has been a valuable contribution to debates around biodiversity and livelihoods.

poster session at the conference

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CONFERENCE PROGRAMME

Biodiversity and Livelihoods Conference
26th-28th March 2009,
Coonoor, The Nilgiris

Programme
26th March 2008

Time	Session	Presenters
	Arrival and lunch	
2.00-2.30	Welcome and introduction to the conference Chair - Pratim Roy	Pratim Roy/Janet Seeley
2.30-3.00	Setting the scene on the importance of the topic - overview presentation on interface between biodiversity and livelihoods	P S Ramakrishnan
3.00-3.30	Tea	
3.30-6.00	**NBR - wide history and context** *Chair* - ***Adam Pain*** *Discussant* - ***C R Sathyanarayanan***	
	Guest paper "Battles over Law: The (re-) formation of legal rights to nature in the Nilgiri Hills, early 19th century"	Gunnel Cederlöf
	Guest paper "Analysis of landscape elements for forest management in the southern Western Ghats, India"	B R Ramesh
	Project paper "Biodiversity and Livelihoods in the NBR – what is happening?"	Rev P K Mulley
6.00-7.00	Poster presentations	Facilitated by Anita Varghese
7.00-9.00	Reception and dinner	

Biodiversity and Livelihoods Conference
26th-28th March 2009,
Coonoor, The Nilgiris

Programme
27th March 2008

Time	Session	Presenters
9.00-12.30 (with a break for tea)	**Biodiversity/bees/livelihoods linkages** *Chair* - ***R Vijayakumar, IAS*** *Discussant* - ***Rajiv K Srivastava, IFS***	
	Conceptual overview paper "Researching Livelihoods, Bees and Biodiversity Linkages"	Adam Pain
	Guest paper "Pollination of cardamom and coffee in the Western Ghats - need for conserving bees and bee flora "	V V Belavadi
	"Bees of NBR"	Nicola Bradbear
12.30-2.00	Lunch and posters presentations	Facilitated by Sumin George Thomas
2.00-5.30	**What's the story on biodiversity linkages?** *Chair* - ***K C Malhotra*** *Discussant* - ***P S Ramakrishnan***	
	"Bees and biodiversity in the Nilgiri Biosphere Reserve - an overview"	Anita Varghese
	Guest paper "Role of bats in pollination"	G Marimuthu
	"Pollination services to cultivated and NTFP species in the Nilgiri Biosphere Reserve"	Priya Davidar
5.30-7.00	Poster presentations	Facilitated by Saneesh
7.00-9.00	Reception and dinner	

Biodiversity and Livelihoods Conference
26th-28th March 2009,
Coonoor, The Nilgiris

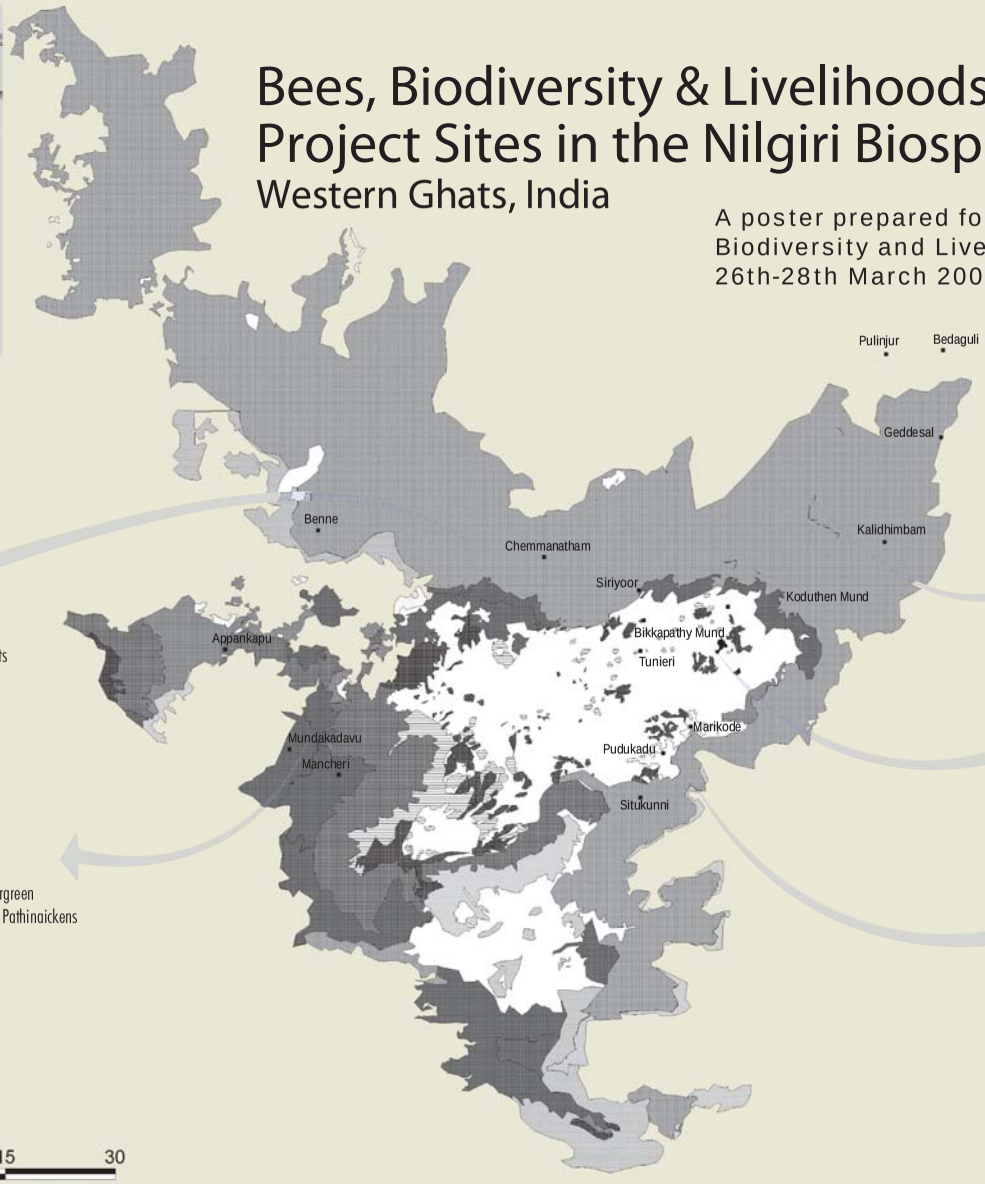
Programme
28th March 2008

Time	Session	Presenters
9.00-9.45	"Biodiversity Informatics in Sustainable Resources Management: Challenges and Potentials"	V Chavan
9.45-12.45 (with a break for tea)	**What's the story on livelihoods linkages?** *Chair* - ***Nicola Bradbear*** *Discussant* - ***Somnath Sen***	
	Overview "An overview of livelihood linkages of indegenous people in the Nilgiri Biosphere Reserve"	Snehlata Nath
	"What have we learnt about forest based livelihoods in the Bees, Biodiversity and Livelihoods project ?	Janet Seeley
12.45-2.15	Lunch and poster presentations	Facilitated by Shiny Mariam Rehel
2.15-4.45	**What's driving change?** *Chair* - ***Somnath Sen*** *Discussant* - ***K C Malhotra***	
	Overview - "What is driving change in the Nilgiri Biosphere Reserve and what effects might such change have on the role of NTFP in the livelihoods of indegenous people?"	Adam Pain
	"Biodiversity, livelihoods and the Scheduled Tribes and other traditional forest dwellers (Recognition of Forest Rights) Act"	Madhu Sarin
4.45-5.30	Summing up - Drawing it all together - summary of the outputs from the conference and way forward	Pratim Roy / Janet Seeley
Evening and next day	Departure	

Bees, Biodiversity & Livelihoods Project Sites in the Nilgiri Biosphere Reserve,

Western Ghats, India

A poster prepared for the
Biodiversity and Livelihoods Conference
26th-28th March 2009, Coonoor, The Nilgiris



Sigur

Altitude (m) - 750
Average Temp (c) - 23°
Average Rainfall (mm) - 700
Dominate Forest Type - Dry deciduous and Scrub forests
Indigenous groups - Irulas, Jenu kurumbas

Nilambur

Altitude (m) - 60
Average Temp (c) - 25°
Average Rainfall (mm) - 3000
Dominate Forest Type - Moist deciduous and Semi evergreen
Indigenous groups - Kattunaickens, Cholanaickens, Pathinaickens

Chamraj Nagar

Altitude (m) - 1000
Average Temp (c) - 24°
Average Rainfall (mm) - 900
Dominate Forest Type - Dry and moist decidous
Indigenous groups - Sholigas, Irulas

Kotagiri

Altitude (m) - 2000
Average Temp (c) - 18°
Average Rainfall (mm) - 1200
Dominate Forest Type - Shola & Grassland
Indigenous groups - Todas, Badagas, Irulas, Kotas

Coonoor

Altitude (m) - 900
Average Temp (c) - 25°
Average Rainfall (mm) - 870
Dominate Forest Type - Dry deciduous & Semi evergreen
Indigenous groups - Irulas, Alu kurumbas

Contribution of non timber forest products to livelihoods: a study from Nilgiri Biosphere Reserve

Samita Vasudevan
and Rajib Biswal

A poster prepared for the Biodiversity and Livelihoods Conference

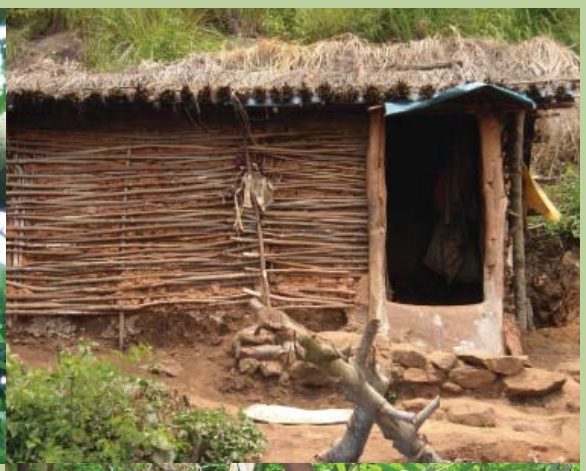
26th-28th March 2009,
Coonoor, The Nilgiris

Aim

The broad aim of the study was to critically analyse the contribution of Non-timber forest products (NTFP) to rural livelihoods in the NBR from a gender perspective.

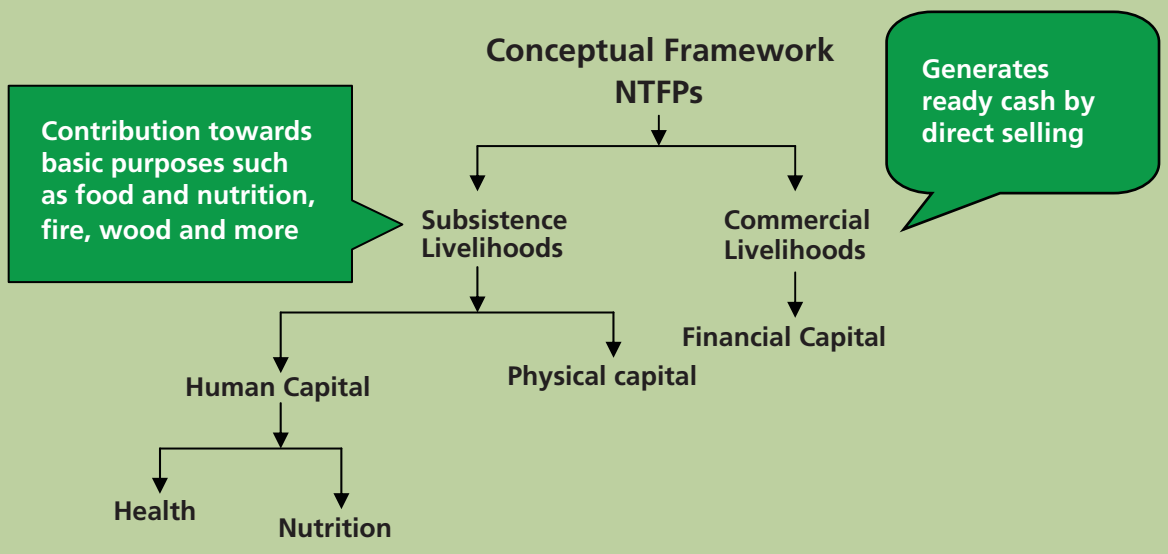
Nilgiri Biosphere Reserve

The Nilgiri Biosphere Reserve (NBR) of India, established in 1987 was proposed by UNESCO through its Man and Biosphere Program. It is part of one of the mega biodiversity hotspots of the world. The 5520 sq Km region is the junction point of three Southern States of India – Kerala, Karnataka and Tamil Nadu. Of the 36 indigenous communities known to reside in NBR, 12 of them have been classified as hunter gatherers



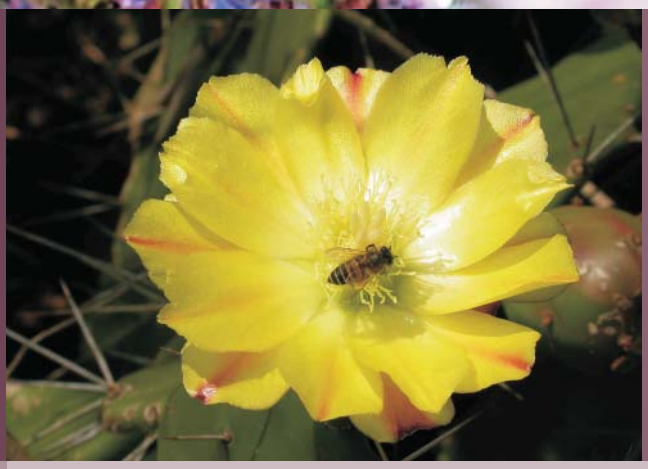
Findings

- Intake of mushrooms, leafy vegetables and fruits as part of daily diet, contributes to health and nutrition
- Usage of bamboos and phoenix leaves as construction material to make ladders for honey hunting and thatching the roof and for similar purposes.
- Collective gathering of NTFPs builds up social capital
- Contribution of honey, *Phyllanthus emblica, Syzygium cumini* and many more NTFPs to direct cash income
- Involvement of men and women in the collection of both subsistence and commercial NTFPs
- Knowledge regarding medicinal plants is higher among elderly people than younger generation.



Dependency of Cultivated Plants and Non Timber Forest Products on Pollinators

Shiny Mariam Rehel, Anita Varghese, Nicola Bradbear, Priya Davidar, Stuart Roberts, Pratim Roy and Simon G. Potts



A poster prepared for the Biodiversity and Livelihoods Conference

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Introduction

Biodiversity supplies multiple goods and services to society and is critical for the support of livelihoods across the globe. Products from crops and NTFP may directly rely on animal pollination for their production (e.g. fruits, seeds, pods) or the plant itself may rely on animal pollination for reproduction, even the though the product itself may not (e.g. bark, roots, stems etc.). Approximately 75 percent of global crops that are used directly as human food depend, at least in part, on animal mediated pollination (Klein et al. 2007); and the majority of wild plants also require biotic pollination (Allen-Wardell et al. 1998, Kearns et al., 1998).

The most important pollinators around the world are bees, but other insects (flies, butterflies, beetles etc.), bats and birds also make significant contributions to biotic pollination (Buchman and Nabhan, 1996). These pollinators provide an essential ecosystem service by contributing to human nutrition and welfare. It is estimated that globally pollination services to cultivated crops are worth 153 billion Euros per annum, yet we have no similar estimate of the contribution to non-cultivated plants from which NTFP are derived (Gallia et al., 2009). Given the central role of pollinators in supporting livelihoods, and the fact that in many places around the world pollinators are under increasing threat from global change (Biesmeijer et al., 2006, Natural Research Council 2006).

To understand the linkages between biodiversity and NTFP and crops we use the NBR in India as a model system to explore the role of pollinators in relation to crops and NTFP. Specifically we aim to: (1) quantify the degree of dependency of cultivated crops and NTFP on biotic pollination; (2) test whether indigenous

plants are more pollinator dependent than introduced plants; (3) identify the most important pollinator taxa responsible for crop and NTFP pollination; and (4) describe the plant part and use of the products dependent upon animal pollination.

Methods

A database for the NBR was compiled using the species lists of crops and NTFP listed in various publications of Keystone Foundation (2006, 2007), Manivasakam (2003) and Rajendran et al. (2008). For each species additional information was included for the type of product(s) used by local people, what the product(s) are used for, whether they are traded, the dependency of the product on biotic pollination for production, the dependency of the plant species on biotic pollination for reproduction, the known pollinators for the species, and whether the species is indigenous to NBR or introduced. The database was analysed by summing counts and calculating percentages for different categories and comparisons between counts for cultivated vs. NTFP species and indigenous vs. introduced species tested using a X^2 test in Minitab v15

Results

For the NBR, in our database, we identified 74 cultivated species and 139 NTFP species. Overall 47.9 percent of the plant products used by local people were dependent on biotic pollination (62.2% of cultivated products and 40.3% of the NTFP products); products from cultivated plants were more reliant on biotic pollination than products from NTFP (X^2=32.51, d.f.=2, p<0.001; Fig. 1 (a).

Figure 1 (a)

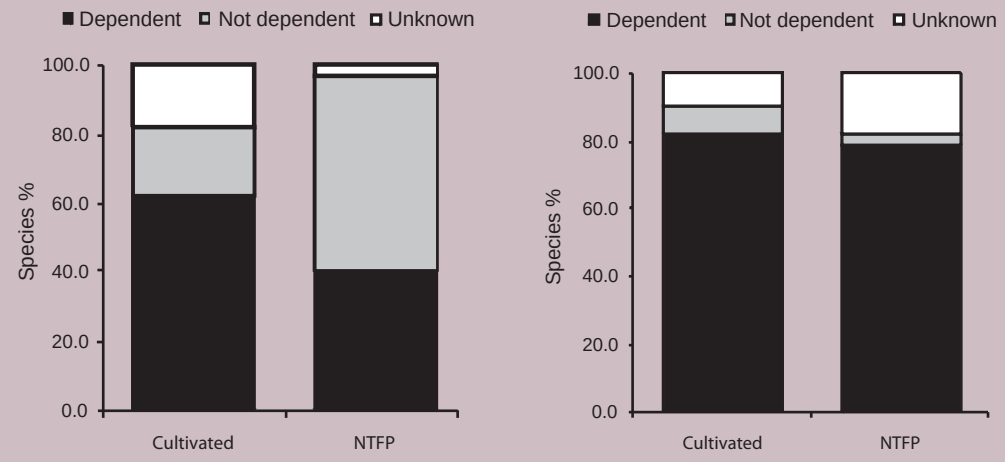
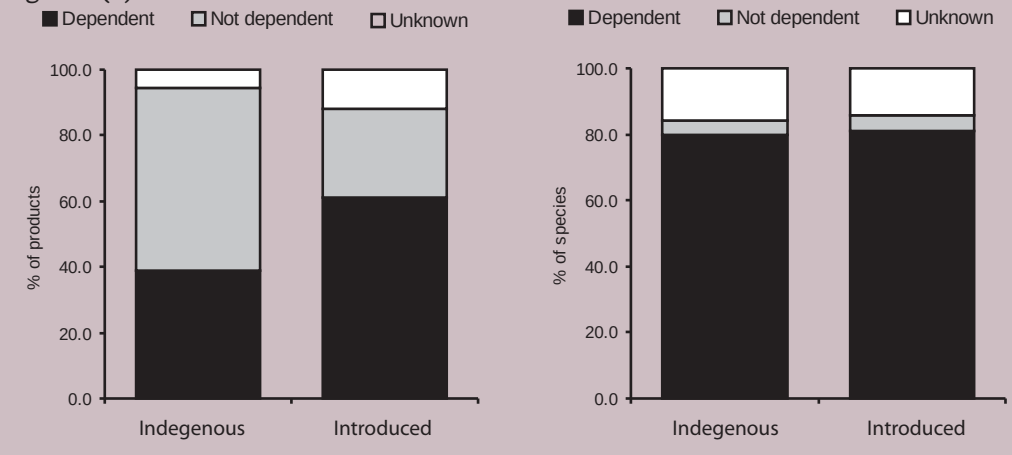


Figure 2 (a)



Irrespective of whether the plant product was dependent upon insect pollination, 80.3% of all the species were biotically pollinated (Fig. 1b; 82.4 5 for cultivated species and 79.1% for NTFP species), but there was no significant difference in the numbers of cultivated and NTFP species reliant on pollination (X^2=5.21, d.f. =2, p=0.074).

Figure 1 (a) The proportions of cultivated and NTFP products dependent upon biotic pollination; (b) the proportions of cultivated and NTFP species dependent upon biotic pollination.

In our study, 128 of the plants were indigenous to the NBR and 85 were introduced, and most of the NTFPs were indigenous to the area (117/139 species) while most of the cultivated species were introduced (63/74 species). Of the indigenous plants, 39.1% of products and 79.7% of species were dependent on biotic pollination, whereas of introduced plants 61.2 % of products and 81.2 % of species were dependent on biotic pollination. (Fig. 2a). Introduced plant products were on the whole more pollinator dependent than indigenous products (X^2=17.10, d.f. =2, p<0.001) while indigenous and cultivated species were equally reliant on pollinators (X^2=0.09, d.f. =2, p=0.955).

Figure 2 (a) The proportions of indigenous and introduced products dependent upon biotic pollination; (b) the proportions of indigenous and introduced species dependent upon biotic pollination.

Cultivated plants and NTFPs were most commonly visited by bees and other insects but rarely by birds and bats. Honeybees and solitary bees were the most frequent bee visitors for both cultivated crops and NTFPs, though both taxa are more commonly reported for crops. The overall pollinator community for cultivated plants and NTFP plants were different (X^2=26.62, d.f. =2, p=0.002). Indigenous and introduced plants were fairly similar in the spectrum of pollinating taxa associated with them (X^2=16.97, d.f.=2, p=0.049), again being dominated by bees and other insects, however introduced plants appear to be more often associated with honeybees and solitary bees than indigenous plants.

Table 27. Type of product collected or harvested from plant species depending upon biotic pollination

Product	Cultivated	NTFP
Fruit	33	46
Seed	13	4
Nut	3	0
Pod	2	0
Bark	0	14
Shoot/stem	0	1
Leaf	6	32
Flower	4	1
Gum/resin	0	1
Bulb/root/tuber	4	8
Rhizome	1	11
Whole plant	0	4
Total	66	122

Table 28. Use of products collected or harvested from plant species depending upon biotic pollination

Use	Cultivated	NTFP
Food	56	45
Medicine	0	56
Perfume	1	0
Construction	0	1
Fibre	1	3
Fumigation	0	0
Oils	3	1
Soap	0	3
Total	61	109

The types of products collected or harvested from pollinator dependent plants are diverse. The types of products collected or harvested from pollinator dependent plants are diverse (Table 27) and include: fruits, seeds, nuts, pods, bark, shoots, stems, leaves, flowers, gum or resin, bulbs, roots, tubers, or rhizomes and the whole plant. Fruits were the most common cultivated product harvested (33/66), while fruits (46/122) and leaves (32/122) were the most commonly collected NTFP.

Most pollinator-dependent crops were used for food (Table 28: 56/61), whereas NTFP yielded a wider array of use for products, the most common of which were for food (45/109) and medicine (56/109). Nearly all cultivated products reliant on biotic pollination were traded (52/61) while only about half of NTFP were commonly traded (65/110).

Conclusion

Within the NBR we identified 213 plant species, a third of which were cultivated and two-thirds of which were NTFP. Both groups of plants (crops 62% and NTFP 40%) had a significant proportion of their products which relied directly on pollinators. We can therefore conclude that the majority of products collected from the forests or grown as crops in the NBR strongly rely on the provision of pollinator services. Similarly a high proportion of the world's crops also depend, at least in part, on biotic pollination (e.g., Klein et al., 2007).

The majority of NTFP in our study were indigenous to the NBR, while most of the cultivated species have been introduced. The cultivated plants had a greater association with honeybees, which are usually considered as generalist pollinators and can readily use novel floral resources (Itioka et al., 2001, Thomas et al., 2009); honeybees may play an important role in ensuring that newly introduced species are productive and may continue to contribute in the same way if further species are brought to NBR. Of the indigenous plants, 40% of products were reliant on pollinators, whereas more than 60% of crop products need pollination by animals. This suggests that more cultivated products would be sensitive to loss of pollination services than would those obtained from the forests.

Given that in most regions of the world pollinator declines have been observed, and that land use changes and climate change is impacting on NBR, it is essential to understand the conservation needs of bees in the NBR and ensure that suitable forage and nesting resources are made available now and into the future. Only by managing bee habitats can the provision of pollinator related products be ensured and the livelihoods of indigenous people be protected.

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Honey bee densities in forest types across the Nilgiri Biosphere Reserve, Western Ghats, India

Sumin George Thomas,
Priya Davidar, Anita Varghese,
Saneesh C S, Sudhakar K
and Mahadesha B

A poster prepared for the
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26th-28th March 2009, Coonoor,
The Nilgiris

Abstract

The nest densities of four bee species: *Apis cerana, Apis dorsata, Apis florea* and *Trigona* spp. in four sites within the Nilgiri Biosphere Reserve, India were assessed. The sites covered a gradient of wet evergreen through to dry deciduous woodland and each had an indigenous village at its centre. Within each sites, approximately 100 plots of 10 x 10m dimension were randomly placed in the forests at different distances from the focal village and a vegetation inventory was used to assess species richness and densities of trees (≥10 cm dbh =diameter at breast height), basal area, height, and % tree and shrub cover. Each plot was searched intensively for bee nests with experienced honey hunters from the focal village, and nests identified and recorded. The sites varied significantly in vegetation parameters. Overall nest densities were highest for *Apis dorsata*, more even across sites for *Apis cerana*, while *Apis florea* and *Trigona* nests were more common in the dry open canopy forest of Kurimandai. Nest densities of all species of bees were correlated with one or more vegetation parameters. Apis dorsata was associated with tall trees and diverse vegetation, though the latter was only marginally significant. *Apis florea, Apis cerana* and *Trigona spp*. all favoured open canopies. *Apis florea* nests were associated with higher shrub cover and Trigona spp. preferred sites with a richer plant assemblage. Our study suggests that vegetation parameters significantly influenced nesting sites for a range of social bees.

Introduction

The ecological diversity of the Nilgiris Biosphere Reserve provides an appropriate foraging and nesting substrates for four major honey producing bees, *Apis dorsata, Apis cerana, Apis florea* and *Trigona* spp, and are found in abundance in NBR. Decisions regarding nesting sites can affect the fitness of social bees (Seeley and Buhrman, 2001). For honeybees, food limitation,

nest site availability and nest predation could be important variables constraining population size (Eltz et al., 2002). Food limitation probably plays a primary role in nest site selection among social insects (Deslippe and Savolainen 1994), and nest densities in stingless bees varied 20-fold at the landscape level in relation with floral resources (Eltz et. al., 2002).

The availability and quality of nesting sites is also an important constraint in determining population size. Bees exhibit a variety of nesting habits: miners dig tunnels in bare ground; masons line pre-existing cavities (e.g., pithy stems, small rock cavities or abandoned insect burrows) with glandular secretions or leaf material; carpenters excavate dead wood; and social nesters (e.g., *Apis, Bombus* and stingless bees) construct their nests inside larger cavities in or on trees and rocks. *Apis mellifera* chose nest-sites based on two parameters: cavity size and entrance size (Lindauer 1961, Seeley 1977, Seeley and Buhrman, 2001). Larger cavities allow large colonies to develop and small entrances reduce chances of predation (Seeley and Buhrman, 2001). Studies in Northern Europe have suggested that species richness and abundance of bees was related to plant species richness and abundance of nest sites (Tscharntke et al., 1998).

Studies on tropical honeybees have indicated that factors that influence nest site location could differ among species. Some taxa appear to be more constrained by nest site availability than others. *Apis dorsata* usually nest on large trees and cliffs in southern India (Roy et al., under review, Seeley et al., 1982, Thomas et al., under review), and the availability of such sites might constrain nest densities. Stingless bees have permanent nests on large trees and in the ground (Roubik, 2006) and Inoue et al., 1993) have experimentally shown that colony number increased with the addition of artificial nests for *Trigona minangkabau* in Sumatra. Stingless bees have also shown preferences for certain species of trees. Studies in S. E. Asia have suggested that the abundance of large trees of particular species was an important correlate of stingless bee abundances (Eltz et al. 2003; Liow et al., 2001; Samejima et al., 2004). In a hyper diverse forest in Sarawak, figs appear to be their favoured species, although in most forests they were generalists (Roubik, 2006).

Study area: The Nilgiri Biosphere Reserve (NBR) is part of the Western Ghats chain of mountains of the Indian peninsula, and lies between 10º 45′ N to 12º N and 76º E to 77º 15′ E with a total area of 5520 km^2 spread across the three southern states of Karnataka, Kerala and Tamil Nadu. Altitude varies from 250m to 2650m, and at least four of the major rivers of south India originate in this region - the Bhavani, Moyar, Kabini and Chaliyar rivers. The intensity of the rainfall brought by the South West and North East monsoon winds differ across topographic and altitudinal gradients (Lengerke, 1989). The western ranges of the NBR receive higher precipitation (up to 4600 mm) while the eastern parts are part of the rain shadow, receiving less than 800 mm rainfall annually (Prabhakar, 1994). Most of the precipitation is during the South West monsoon from the months of June to August. The eastern and northern parts often suffer from drought, though they receive some rainfall from October to November during the North East monsoon.

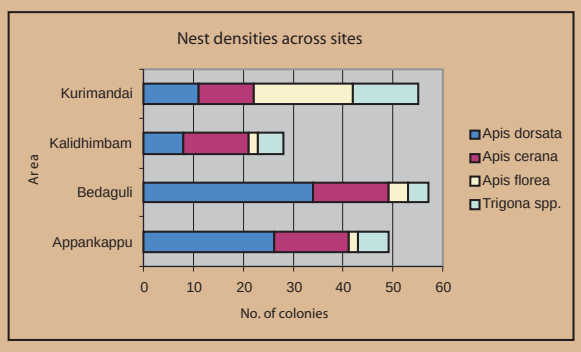
This range of topography and climate has resulted in sharp gradients of vegetation composition and most of the major vegetation types of peninsular India occur in the NBR (Champion and Seth, 1968). Many of the indigenous communities in the Nilgiris are dependent upon honey from the forests to supplement household income (Keystone Foundation, 2007).

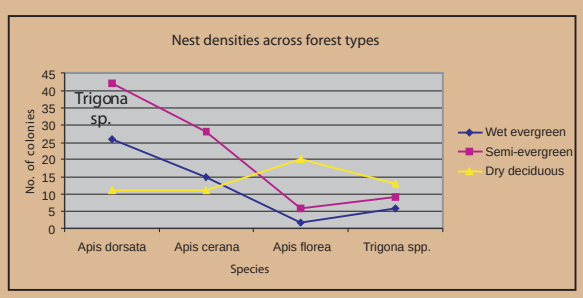
Four sites were chosen in two regions: Nilambur and Chamraj Nagar that differ in land use patterns and vegetation characteristics, to capture the diversity of forest types of the NBR. The Nilambur region is in the wetter part of the NBR and the forest is a mixed evergreen-deciduous type, whereas the Chamraj Nagar region is in the drier eastern part of the NBR and the vegetation ranges from dry deciduous to evergreen and *shola* montane grasslands. Within each region, the study sites were selected based on different indigenous communities that depend upon honey to supplement their income. In the Nilambur region, the sampling was centered on Appankappu (11º 27′ N, 76º 17′ E, 300m asl), which is the hamlet of the Kattunaickens. In the Chamraj Nagar region which lies further east, Bedaguli hamlet (11º49′N, 77º 11′ E, 1355m asl) populated by the Sholigas was taken as the center, Kalidhimbam hamlet (11º 38´ N, 77º 06´E. 1183m asl) which lies north of Bedaguli is populated by the Irulas followed by Kurimandai site which lies close to Pulinjur hamlet (11º 49´N, 77º 06´E, 925m asl) and is a Soliga village. Plots in Nilambur were surveyed in April 2008 and Chamraj Nagar in June and August 2008 respectively. Kurimandai is a dry forest in the Chamraj Nagar region where the others are wet evergreen and semi-evergreen forests.

Results

Bee nest densities ha-[1] differed significantly overall, and between sites. *Apis dorsata* had the highest nest density across all sites and *Apis florea* the lowest. *Apis dorsata* nest densities were highest in Bedaguli and lowest in Kalidhimbam, but the differences between sites was not significant. Kalidhimbam differed from the other sites in having a cliff face close by with nesting bees. *Apis cerana* had similar levels of nest densities between sites. Nest densities differed significantly for *Apis florea* and *Trigona spp*. Both species had highest densities in Kurimandai whereas nest densities in the other sites were low.

Results also indicate that *Apis dorsata* nests and vegetation characteristics of the plots indicated that nest occurrence was significantly correlated with mean height of trees but weakly correlated with plant species richness. Nests of *Apis cerana* were weakly and negatively associated with percentage tree cover but not with any other vegetation parameter. Nests of *Apis florea* were negatively associated with percentage tree cover and positively with percentage shrub cover indicating that this species preferred open forests with a good undergrowth. Nests of *Trigona spp*. were positively related with species richness and negatively with percentage tree cover indicating that these species preferred a diverse forest with an open canopy.





Discussion

Our study shows that bee nest densities differed significantly between species and sites. The largest honeybee *Apis dorsata* had the highest nest densities overall and the values ranged between 8 to 34 nests ha-[1]. In this study nest densities were towards the higher side probably because these study sites were chosen on the basis of the presence of traditional honey hunter groups, who depend on the presence of stable honey sources. Kalidhimbam had the lowest density of *Apis dorsata* nests, probably because large trees were not available (maximum tree height =14m), and there was a cliff face close by with large number of *Apis dorsata* nests. It is surprising that the largest bee *Apis dorsata* had the highest nest densities overall. This could be due to foraging success or due to lower levels of nest predation. *A. dorsata* can probably access resources further away than its conspecifics, and be less dependent upon variation in floral abundances in space *Apis dorsata* nesting sites are not easily accessible to non-flying predators, and they might suffer lower levels of nest predation.

The cavity nesting bee, *Apis cerana* was more evenly distributed in all the sites and nests were fairly independent of vegetation characteristics, although marginally associated with open canopy. As all four sites were covered with forest vegetation, availability of suitable nesting cavities is probably not a constraint. These results suggest that *Apis cerana* is the most generalist and adaptable in terms of habitat requirements. This factor in combination with its non-migratory behaviour makes it a preferred species for domestication. *Apis florea* might be more dependent on vegetation characteristics since they nest on shrubs and thickets. Associations with vegetation parameters suggest a strong preference for open habitats and broken canopy. Kurimandai, which is a dry open site, is favourable for *Apis florea*. *Trigona spp*. was also more common in the dry forest of Kurimandai, and the presence of nests was negatively related to tree cover, and positively with plant species richness, suggesting that diverse vegetation was important for this species. However, more studies are needed to understand the factors influencing nest densities of the stingless bees in southern India. The lower densities of the three smaller honeybees across all sites could be because they nest at lower heights than *Apis dorsata* and might be more susceptible to nest predation. *Apis dorsata* nests are apparent, but inaccessible and guarded by fierce workers.

Sites	N	*Apis dorsata*	*Apis cerana*	*Apis florea*	*Trigona spp.*
Overall density (mean ± SE, nests ha-1)	396	19±5	13±2	7±2	11±2
Appankappu	93	26±13	15±4	2±2	6±5
Bedaguli	100	34±13	15±4	4±2	4±2
Kalidhimbam	103	8±4	13±4	2±1	5±3
Kurimandai	100	11±5	11±3	20±5	13±4

Apis cerana nests are easily found but difficult to destroy by large predators because of the small entrance and *Apis florea* are difficult to find but easy to destroy.

Conclusion

Our study suggests that several key vegetation characteristics are important in nest site location of *Apis dorsata, Apis florea* and *Trigona spp*. whereas *Apis cerana,* which was more evenly distributed, may be more flexible in terms of nesting requirements. Overall nest site availability could be an important constraint for most tropical honeybees and intensive deforestation and/or poor management of Asian forests (Laurance, 2007) could adversely affect honeybee populations by reducing the quality of potential nesting sites by removing tall trees (preferred by *Apis dorsata*), reducing scrub coverage (favouring *Apis florea*), and reducing plant diversity (associated with *Trigona spp.*). Protection and effective management of tropical forests is therefore imperative for the conservation of honey bees.

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Bee diversity and floral preferences in the Nilgiri Biosphere Reserve Western Ghats, India

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Introduction

Insects pollinate 70% of the angiospermic plants worldwide. The insect pollination was likely begun with gymnospermous taxa in the Jurassic period and the presence of *Brachycera* flies in the Jurassic, coupled with *Archaefructus*, suggests that insect pollination may have occurred early in angiosperm evolution. Before the Jurassic period, insect pollinators probably did not play a significant role early on in angiosperm evolution, although they were likely to have had a selective role for bisexual flowers later on. This was based on the absence of efficient or reliable pollinators in the fossil record of the Early Cretaceous period. Insect pollinators like Coleoptera, Lepidoptera, and Hymenoptera were more diverse and specialised in the Cretaceous and Tertiary period (Ren, 1998), so that 'fine-tuning' of angiosperms occurred in the same period.

The order hymenoptera comprises of bees, wasps, ants and sawflies. Hymenoptera possess both sucking and biting mouthparts. This was a requirement for the evolution of 'beeness' because bees suck liquid nectar and use jaws in nest construction. Bees evolved from the particular sort wasps known as sphecoid wasps. The differences between sphecoid wasps and bees are in their morphology and behaviour. Female sphecoids hunts insect prey which they paralyse by injecting venom with their stings. Bees provide pollen as a protein-rich food for their young ones rather than insect prey. The adult females possess specially modified structures on their legs and bodies to trap and carry the pollen grains (Christopher O'Toole and Anthony Raw, 2004). Bees are

important pollinators of natural vegetation and agricultural ecosystems in terms of benefits to humans. The loss of these pollination services would have adverse consequences for food production and for the maintenance of biodiversity (Allen Wardell et al., 1998; Klein et al., 2006). The honey and wax produced by the honey bees economically benefit the indigenous community. There are approximately 20,000 bee species found worldwide. Few bees are solitary; others live in colonies. Solitary bees construct their own nest and collect their own food. Social bees live in colonies; worker bees do all the work in the colony and the queen lays eggs. In the present study the focus was on bee diversity and floral relationship.

Material and methods

Study area

The Nilgiri Biosphere Reserve (NBR) is part of the Western Ghats, a chain of ancient mountain ranges which run parallel to west coast in Indian peninsula. It lies between 10º 45' N to 12 N latitudes and 76º E to 77º 15' E longitudes with a total area of 5520 km spread across the three southern states of Karnataka, Kerala and Tamil Nadu. The NBR with only 0.15% of India's land area contains 20% of angiosperms, 15% of all butterflies and 23% of all invertebrates that are found in India (Daniels, 1996). The study was conducted in 5 sites across the NBR. From each site 3 to 4 one hectare study plots were chosen.

Methodology

There were 15 one hectare study plots set out for the pantrap collection in the NBR. In each plot, 15 pantraps were set out in 5 clusters of 3 (1 blue, 1 yellow and 1 white pan). Pantraps are small coloured bowls which attract insects. The coloured pantraps were filled with soap water to drown the insects that approach the pan trap. Different insects are attracted to different colours. The collections were made once in a month from January to December 2007. The collections were stored in 70% of ethyl alcohol in the refrigerator. All the bee specimens were pinned and identified. Within each plot, two 20m x 10m patches were marked out which were representative of the local habitat and included patches of flowering plants. In these patches observations were made for foraging patterns of social bees: *Apis cerana, Apis dorsata, Apis florea*, and *Trigona spp*. Observations were made three times per day i.e., 09:00-10:00, 11:00-12:00, and 15:00-16:00 hrs to encompass the main periods of bee foraging. Half an hour was spent at every interval at each patch. The researcher walked at random through the patch and recorded the number of visits by social bees to all the flowers. Therefore the total observation time per site on 6 patches (1200m^2) was 9 hours for a month.

Result

The total number of bees collected in the pan traps were 241 individuals. Three families of bees were found in the collection such as *Apidae* (132 individuals), *Halictidae* (101 individuals) and *Megachilidae* (8 individuals). *Apidaewere* found more abundant in collection with 8 genera viz. *Amegilla* (14 individuals), *Apis* (55 individuals), *Braunsapis* (14 individuals), *Ceratina* (32 individuals), *Trigona* (11 individuals) and *Xylocopa* (6 individuals). The second abundant collection were *Halicitidae* with 4 genera viz. *Halictus* (37 individuals), *Lasioglossum* (53 individuals), *Nomia* (1 individual) and unidentified (10 individuals) then followed by *Megachilidae* with 8 individuals. The family *Apidae* consists of social bees. *Halictidae* and *Megachilidae* consists of the solitary bees but some have the behavoiur of social bees. It shows the presence of the *Apidae* family is found in all types of vegetation where as the genera *Amgellia* was found in moist deciduous forest, *Apis* was found in agriculture plot, *Braunsapis* was found in semi evergreen forest, *Ceratina* was found in dry deciduous forest, *Trigona* was found in dry deciduous forest and *Xylocopa* was found in semi evergreen forest. *Halictidae* family is found all types of vegetation where the genera *Halictus* was found in semi evergreen and dry deciduous forest, *Lasioglossum* was found in deciduous and semi evergreen forest. *Megachilidae* were found in Semi evergreen patches. The bees were attracted to white colour more than blue and yellow colours. The members of *Apidae*

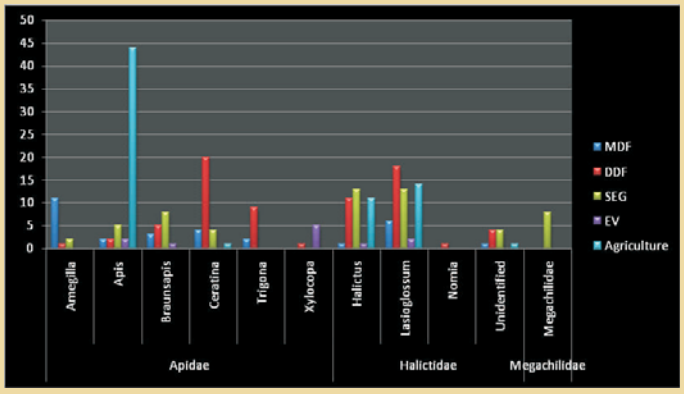
were found 40% in white, 33% in blue pantrap and 27% in yellow pantrap. It indicates that during study period blue and yellow colour flowering was less but the collections of insects in the pantrap were high. At the same period white colour flowering was more but the insect preference for the pantrap were less. *Halictidae* family was found 39% in blue pantrap, 36% in white pantrap and 25% in yellow pantrap. This indicates while blue and yellow colour flowering were less but the pan collection were high. *Megachilidae* family was found 62% in blue pantrap, 25% in white pantrap and 13% in collections. This indicates when blue flowering were less the insect in the pan collection were high.

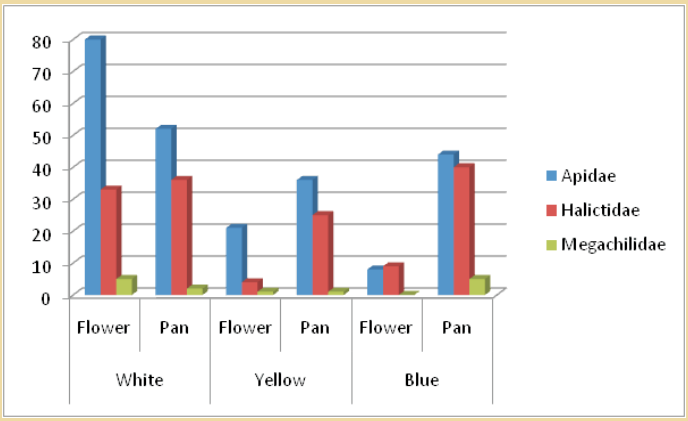
Bee visitation frequencies

The analysis of bee visits to the 73 species of plants indicated that 45% of plant species were visited by just one species of bee, 37% by two species, and 18% by more than two species. This indicates that plants are specialised to particular speciesof bees. The most frequent bee visitor was *Apis cerana* that visited 74% of plant species; *Trigona spp*. visited 41% of plant species; *Apis florea* visited 38% of plant species and *Apis dorsata* only 27% of plant species. The single species visits were mostly by *Apis cerana* (17 species) and the *Trigona spp*. (13 species). *Apis florea* had no single species visits and *Apis dorsata* had three indicating that while the bees are generalists, some are more broadly generalist than others. Among multiple bee visits, all bee species were similarly represented with *Apis cerana* on 13 species and the other bee species on 10-11 species.

Conclusion

It was found that bees were attracted to white colour more than blue and yellow colour. The hypothesis was the white and blue colour pantrap were more attractive compared to yellow pantrap. It also shows that collection of insects were low during peak flowering. Bees also differ in their selection of flowers, and *Apis cerana* was found to visit more plant species than other bee species. Of the 73 species of flowers observed 23% were visited only by *Apis cerana*. *Apis dorsata* and





Site	Location	Latitude	Altitude (m.a.s.l)	Vegetation
APANKAPPU	NILAMBUR	11°46'	198	SEG
MUNDAKADAVU	NILAMBUR	11°34'	96	DDF
MANJERI	NILAMBUR	11°30'	258	MDF
TUNIERI	KOTAGIRI	11°46'	1500	AGRICULTURE
BIKKAPATHYMUND	KOTAGIRI	11°49'	1831	SHOLA
KODUTHENMUND	KOTAGIRI	11°51'	1665	SHOLA
BENNE	SIGUR	11°60'	936	MDF
CHEMMANATHAM	SIGUR	11°57'	877	DDF
PUDUKADU	COONOOR	11°33'	890	SEG
SITUKUNNI	COONOOR	11°28'	582	DDF
MARIKODE	COONOOR	11°36'	1094	SEG
BEDAGULI	CHAMRAJ NAGAR	11°82'	1304	EV
GEDESSAL	CHAMRAJ NAGAR	11°72'	1250	SEG
KALIDIMBAM	CHAMRAJ NAGAR	11°60'	1256	DDF
KURIMANDAI	CHAMRAJ NAGAR	11°82'	1013	DDF

SEG : Semi Evergreen Forest, DDF: Dry Deciduous Forest, MDF: Moist Deciduous Forest

Apis florea were more generalists and tended to visit species that were visited by the other bees too. Flower size and shape probably plays a major role in attracting or limiting bee visits (Fenster et al., 2004). It also indicates that each species had vegetation preferences between the locations.

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The limitless expanse of the Giant Rock Bee - An ecological perspective from the Blue Mountains

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Indigenous bees of the mountainous Nilgiri Biosphere Reserve (NBR) are known to play an important role in local livelihoods, yet they have not been scientifically identified or classified, their populations and distributions are relatively unknown, and their vital role in pollination and the maintenance of forest biodiversity is less understood.

Giant bee, *Apis dorsata* is the major source of honey in India. Out of total honey production from all the species of bees in India, about 69% honey comes from *Apis dorsata*. These bees migrate periodically and nests can be found in the same area year after year.

In the dry deciduous forests type of the NBR, larger concentrations of *Apis dorsata* nests are found on cliffs and is a preferred nesting habitat for this bee species. Cliffs maybe safer from predators in contrast to the short trees in dry deciduous forests that are more accessible.

In moist deciduous and semi evergreen forests of the NBR, the trees are relatively tall and branch outward, hence are favourable to *Apis dorsata* nesting. On an average a single tree was observed with more than 50 combs. Cliffs are not a regular feature of moist deciduous forests and the *Apis dorsata* were found on tall trees.

Apis dorsata migrate locally in response to seasonally varying floral resources (Dyer and Seely, 1994). Lowland dipterocarp dominated rain forests in S. E. Asia have irregular and

unpredictable general flowering events every few years (Ashton et al., 1988) and *Apis dorsata* responded to mass flowering by a seasonal migration and rapid expansion of population size (Itioka et al., 2001). *Apis dorsata* migrated locally in the Nilgiri Biosphere Reserve in southern India (Leo, 2008)) possibly in response to food limitation. *Apis dorsata* tended to have broader preferences for flower types than *Apis cerana* and *Apis florea* in the Nilgiri Biosphere Reserve (Thomas et al., 2008)), and therefore probably less constrained by the quality of floral resources.

To better understand the nesting behaviour of *Apis dorsata* in contrasting landscapes with different levels of protection and exploitation and also at the levels of forest types and relevance to livelihood options in the NBR the following analysis was undertaken based on field work done in 2007.

A landscape level analysis

We assessed densities of *Apis dorsata* nests in five areas in the Nilgiri Biosphere Reserve: three were National Parks with a high degree of protection where collection of forest products is banned; one was a Wildlife Sanctuary where collection of forest products such as honey for household use is permitted; and one was a Reserve Forest where limited commercial extraction is permitted. We predicted that *A. dorsata* nest densities in the landscape would be related to the availability of nesting sites, such as cliff faces, and would differ with regard to the level of prohibition of honey harvesting, i. e. increasing levels of forest protection.

Methods: Variable distance line transects were used to estimate nest densities. The variable width method was used because the habitat type and vegetation structure differed in each site, thereby the probability of detecting nests at different distances from the transect line also differed. The study areas were Nagarhole, Silent Valley and Bandipur National parks, Mudumalai Wildlife Sanctuary and Sathyamangalam Reserve Forests.

Categorisation of harvesting pressure and levels of protection

A measure of harvest pressure on colonies was obtained by recording the number of nests that were harvested along each transect. This measure was converted to density estimates of harvest pressure by dividing by the area sampled in each site. We developed an indicator of 'honey hunting pressure' by estimating the number of specialised honey hunters in each site. Honey hunting is an expert skill and indigenous communities in each region differed in their method of harvesting honey. Based on household data from each region (Snehlata Nath, personal communication), we estimated the number of honey hunters in each region and rated them on a scale of 1 to 6, from 1 being the site with the fewest honey hunting groups to 6, having the most honey hunting groups. In addition, the protected areas were assigned a numerical indicator of the level of protection. Reserve Forests that had a low level of protection were given a value of 1, Wildlife Sanctuaries, 2 and National Parks, 3.

Data analyses

Assessment with regard to whether nest density was associated with harvest pressure, indicators of honey hunter abundance, levels of protection and availability of cliffs in the different sites. Nest densities, cliffs, harvest pressure, honey hunter groups and levels of protection were independent variables. The variations of colony sizes on trees and cliffs were analysed.

Results

Colony sizes in most sites were small with a few nests per colony. It was only in Sathyamangalam and to a lesser extent in Mudumalai, that nests were aggregated in larger numbers.

There was a four-fold difference in nest densities between sites. Sathyamangalam Reserve Forest having the highest nest densities (2.1 ha^{-1}) and Silent Valley National Park the

lowest (0.02 ha-^{1}). This is because the nests in Sathyamangalam were in larger aggregations, sometimes in the hundreds.

Harvest pressure was generally low, with the highest levels of harvest being in Sathyamangalam. The nest densities at the landscape level were positively associated with harvest pressure, the number of honey hunter groups, and negatively with protected area status.

This is mainly because Sathyamangalam had higher nest densities, and number of honey hunter groups. If the analysis is conducted without the Sathyamangalam data, the results show a positive but not significant association with harvest pressure, but no association with the number of honey hunter groups and levels of protection.

The only data, which is significant and consistent even excluding Sathyamangalam, is that the percentage of nests on cliffs was associated with the number of cliffs, and harvest pressure was negatively associated with levels of protection. (Table 29).

In a later study that was conducted in four sites within Nilambur and Chamraj Nagar, the largest honeybee *Apis dorsata* had the highest nest densities overall and the values ranged between 8 to 34 nests ha-^{1}. The dry forests of Kalidhimbam had the lowest density of *Apis dorsata* nests, probably because large trees were not available (maximum tree height =14m).

The largest bee *Apis dorsata* has the highest nest densities overall and this could be due to foraging success or due to lower levels of nest predation. Bee size has been related to foraging distance (Greenleaf et al., 2007) and *Apis dorsata* can probably access resources further away than its conspecifics, and be less dependent upon variation in floral abundances in space. They are also able to track temporal variations in resource availability (Itioka et al. 2001). *Apis dorsata* nesting sites are not easily accessible to non-flying predators, and they might suffer lower levels of nest predation.

Seeley et al. (1982) document the defensive strategies of *Apis cerana, Apis dorsata* and *Apis florea* in Thailand. *Apis dorsata* nests are apparent, but inaccessible and guarded by fierce workers. *Apis cerana* nests are easily found but difficult to destroy by large predators because of the small entrance and *Apis florea* are difficult to find but easy to destroy.

Overall nest site availability could be an important constraint for most tropical honeybees and intensive deforestation and/or poor management of Asian forests (Laurance, 2007) could adversely affect honeybee populations by reducing the quality of potential nesting sites by removing tall trees (preferred by *Apis dorsata*). A list of tall trees that were preferred by *Apis dorsata* in the study sites are as listed: Species *Adina cordifolia, Anogeissus latifolia, Bombax ceiba, Cullenia exarillata, Dalbergia latifolia, Erythrina sp. Eucalyptus grandis, Ficus bengalensis, Ficus sp., Ficus tsjakela, Grewia tilifolia, Elaeocarpus spp., Lagerstromia macrocarpa, Mangifera indica, Melia azedarach, Myrtigynia parviflora, Persea macrantha, Pterocarpus marsupium, Schleichera oleosa, Spondias indica, Sterculia villosa, Syzygium cuminii, Tectona grandis, Terminalia alata, Terminalia arjuna, Terminalia bellerica, Terminalia crenulata, Toona sp.*

Conclusion

The giant rock bee *Apis dorsata* has been hunted for its honey for millennia. It is migratory and highly adaptable. Our findings, indicating the importance of particular nesting trees, may have profound implications for the conservation and management of *Apis dorsata* at the landscape scale. *Apis dorsata* colonies migrate over distances of 100 km (Koeniger and Koeniger, 1980) and return to their original nest site (Paar et al., 2000). Particular nesting sites such as large trees and cliffs are used year after year, and the loss of such trees and cliff faces may limit nest densities in the wild. Tall trees are more frequent in primary unlogged forests and intensive logging over the geographical range of *Apis dorsata* in Asia removes many potential nesting sites (Laurance, 2007). They are found to be nesting in urban landscapes and have the strangest of nesting sites, below water tanks, below bridges, under balconies etc. These choices they make need to be better understood and in that may lie the indicators to the changes in habitat and landscape that are driving these choices. Can the rock bees rock forever?

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Table 29. *Apis dorsata* nest densities across study areas

Site	Reserve size (km^2)	Transect length (km)	Nest sightings	Cliffs	Colony size (Mean ± SD)		Harvest density (km^2)	Honey hunter groups
					Tree	Cliff		
v	874	60	91	4	4.4±6	7.8±7	0	3
Mudumalai WLS 2007	321	40	220	2	18.2±26	47*	0.044	2
Mudumalai WLS 2008	321	40	217	2	8±15	13±11	0.000	2
Nagarhole NP	644	50	238	0	4±7	0	0.012	4
Sathyamangalam RF	1360	75	1238	24	9±23	48±95[a]	0.192	6
Silent Valley NP	89.5	15	2	0	1	0	0.000	1
Wynaad WLS	344	60	181	0	2±4	0	0.019	5

***one sample point, a Mann Whitney U test= $p<0.05$**

Honey hunting patterns in the Nilgiri Biosphere Reserve

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Introduction

The Nilgiri Biosphere Reserve has a tradition of honey harvesting from the Giant Rock bee - *Apis dorsata*. The dense forests and steep escarpments provide natural nesting places for these bees. The honey hunters of the Nilgiri Biosphere Reserve are renowned for their bravery and skill. Numerous *adivasi* groups hunt honey and each has their own specialised methods. The Alu Kurumbas in the eastern and southern parts of the NBR are renowned for scaling high cliffs whereas most Irulas, Cholanaickens, Kattunaikans are adept in harvesting from tall trees.

Methods

The information presented was collected through interviews with honey collectors of Chamarajnagar, Coonoor, Kotagiri, Nilambur and Sigur regions. Information regarding their traditions, practices, culture and belief with regard to honey hunting were enumerated through life histories and informal interviews. 1077 households were part of this study (+145 individuals of Mancheeri, Nilambur) broadly and 69 households were interviewed to make life

histories. Honey hunting of *Apis dorsata* was described in more detail though other honey bee species were also covered. The information is also based on field observations.

Findings

Honey Hunting Patterns across NBR

Honey in NBR is harvested through various means and methods. People, tools, methods and beliefs between areas are similar in different ways yet unique to many communities and regions.

- **Hunts from trees and rocks**

1. Chamarajnagar: Trees - *Karavadhi* (*Persea macrantha* - Geddesal), *Vagai* (*Pterocarpus marsupium* and Karitta (Geddesal). Honey cliffs - Geddesal - Konoorugiri, Pulinjur - Bedarayanagiri, Chikkayyanagiri and Baregudde

2. Nilambur: *Cheeni* (*Tetrameles nudiflora*), *Kudukka* (*Sterculia spp.*)and *Thanni* (*Terminalia bellerica*) *Mathi* (*Terminalia spp.*)

Honey cliffs: Thalivarai is one of the honey cliffs in Nilambur

3. Sigur: Trees *Eucalyptus spp, Mathi (Terminalia spp.) Thanni (Terminalia bellerica)*

4. Kotagiri: (Study area was upper Kotagiri) Collection was limited to Toda community who were collecting honey only from *Apis cerana* nesting in tree cavities. The tree species in which *Apis cerana* nesting is found: *Naaval (Syzigium cumini), Kobu (Glochidion neilgherrense), Paarsh* (*Isonandra perrottetiana*) and *Pelozd* (*Neolitsea scrobiculata*)

5. Coonoor: Trees - *Arainthumaram, Kilinchi maram (Toona ciliate), Koontha panai* (*Caryoto urens*) and *Aala maram* (*Ficus sp.*) tree

Honey cliffs: Kadasakkal parai, Kuirkathikalparai, Ooraiparai, Masholai and on railway bridge

- **Honey hunters of five sites are hunting *Apis dorsata, Apis cerana, Apis florea* and Stingless Bees.**

Apis dorsata honey is collected by men, except for one woman in Bedaguli. It is collected by hanging down of rope ladders on cliffs and climbing bamboo ladders on tall trees. A wide range of tools and techniques is used by different communities.*Apis cerana* honey is collected by men and women in all five areas. Hereditary trees for *Apis cerana* are managed by Toda community in Kotagiri area. *Apis cerana* bees are smoked away and the combs are harvested by hand.

Apis florea is collected by men, women and children in all five areas. People don't use any tools for the collection of *Apis florea*. Children learn honey hunting by collecting *Apis cerana* and *Apis florea*. Since the amount from an *Apis florea* is very little (maximum 350 gm) and belief of medicinal property in the honey does not encourage the sale of this honey.

Stingless bee honey is collected by hand by men, women and children from the forest. Tree cavities and rock cavities are the nesting place for stingless bees.

- **Hunting tools used all over NBR**

1) To climb: Bamboo pole/ladder
- Rope ladder with various climbers, lianas and trees' bark is used.
- Small steps cut into the tree trunk
- Bamboo pole to climb a small tree in turn to climb the taller honey tree.
- Coir rope is used to climb honey branch of the tree.
- sometimes people climb bare feet, with no supporting tool.

Tool to cut the comb: Iron knife and wooden knife are used. Sholigas of Pulinjur use only wooden knife. Knife made out of bamboo is also used to cut the comb from trees.

2) Honey basket: to receive honey comb portion from the main comb- people use baskets made out of vines, bamboo and cane. The inner parts of these baskets are covered with the leaves of *Curcuma spp*. Preparation of baskets was one of the activity they did in the evening before the night hunt. In these days oil tins and aluminum vessels are substituted for convenience.

3) Rope to bring the honey down from the honey tree or rock: People use ropes made out of wild climbers and bark of trees like *Vakka (Sterculia villos), Biskoti kodi (Derris benthamii*)and *Ullathi* (*Debregeasia longifolia*). This can be kept for two to three years.

Smoker: Smokers are used to remove honey bees from the comb, before honey is removed from honey comb. A good honey hunter carefully selects only smoke producing plants to make the smoker. Plants like *Strobilanthus spp*. *Cassia fistula* are used in Nilambur and, *Lantana, Eupatorium, Pongamia pinnata, Syzigium spp*. in Chamarajnagar.

- **Hunting group formation and hunting**

Group honey hunting is done only when there are more than two or three combs on a tree.

In a group there are around 5-6 members. Most of them are relatives. In the case of rock honey hunting, groups are formed on trust to save the life of the main honey hunter. In tree honey hunting the group formation is based on family relationship, because they don't want to share the sales profit with others. Family members are also selected as they can freely communicate with each other, including showing anger. There is a fixed member in a group with a leader. There are at least two hunters and others are helpers. Leader decides when to harvest honey, where to use the rope and ladder and the position of all the members.

- **Hunting time**

Apis cerana, Apis florea and Stingless Bees are hunted in the daylight. However, most honey hunters collect *Apis dorsata* at night. AD is not hunted close to full moon nights. The hunting of combs starts from 6.30pm to 05.30 am and depends on the number of combs. They leave village by around 10 am to prepare the smoker, ladder, baskets, wooden knife.

- **Honey trees/Rocks - Rights and hereditary ownership**

Amongst most communities in the five locations studied, there is hereditary ownership of honey trees and cliffs. Once the right is created or given by the ancestor no body in that area will touch that honey tree or cliff.

There is a medicine (black magic) prepared with leaves and bark taken from the forest to attract honey bees to one particular tree. Once the tree is attracted by *Apis dorsata* bees that tree will always be under the owner ship of the honey hunter who took the initiative. Normally other honey hunters respect this ownership and they never hunt from those trees. Even then there are incidents of stealing. In order to avoid this there is black magic/ medicine prepared by *poojari* (village priest). Once these medicines are kept thieves won't be able to approach trees or if they try very serious incidents can happen, even loss of life.

People in Nilambur, the Kattunaikan and Cholanaickan use similar methods to attract honey bees to an intended tree). Honey hunters who wish to attract honey bees choose a tree which honey bees may prefer.

Cholanaickens learn honey hunting skills from their parents. At an early age, children accompany the hunters when honey harvesting and also during collection of NTFP. By about the age of 20, a young man is skilled to climb any tree and safely harvest honey from an *Apis dorsata* colony.

Features of a honey tree: A tree which is well branched and strong. A tree that stands in open space but with little disturbance from the wind: the bees can not build combs against wind,

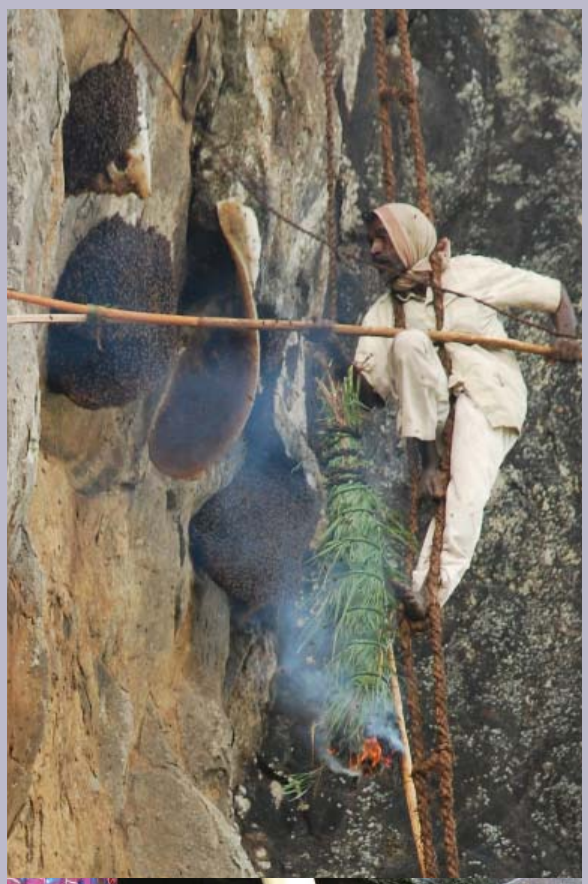
A tree with branches that faces west. People say that bees like the evening light,

A riverine tree: some *Apis dorsata* makes nests on the banks of the stream or river.

If a honey hunter find these qualities on a tree he starts clearing the undergrowth and small trees around that tree to be seen by the bees. That clearing will provide them good air circulation.

While most groups collect honey from smaller cliffs or trees, it is the Kurumba who scale the high cliffs. This perhaps explains the Kurumbas' minute care in choosing the group while others have now allowed a degree of relaxation to creep into this very important exercise. The formation of the group conventionally consisted of members from the same village, usually related through blood ties. The main hunters' brother-in-law forms the crux of the operation as he holds the rope ladder on which the hunter decends. A group once formed usually remains unchanged for several seasons. A member returns to his group irrespective of his present occupation elsewhere. Once a colony is sighted they constantly check the condition of the comb on their forest forays and only when the time is ripe, the group starts the hunt.

A Toda bee keeper, at the end of November-end of monsoon, makes a journey into the Shola¬ wood land to clean up cavities and seal the entrances for the bees. These are called cap stones. *Apis cerana* ***bees occupy the cavities by the end of November. These bees accept the housing provided by the Toda. Later, in February and March, when the honey is ripe only the honey combs are collected and usually taken home for sharing with family. The nesting trees are not disturbed by gathering of fire wood and other requirements for domestic life, even if a tree dies.***



Dry bamboos are largely selected by Stingless bee spp. for nesting and many of these `bamboo hives' are cut from the forest and kept in Kattunaikan settlements.

- **Superstitions and beliefs**

Harvesting specified cliffs and leaving rest untouched

Hunting under the veil of darkness

Praying to sprits for blessings

Formation of groups on a traditional basis

Precise material for making equipments. If iron is used to cut the comb honey will not come back to the same tree in the next year. This way they leave some bees wax or the base of the comb on the tree that same areas are found being used.

How much money do bees make for us? - A case of *Sapindus trifoliatus*

Shiny Mariam Rehel, Geeta Nayak, Sudhakar K, Priya T A, Saneesh C S, Mahadesha B, Aradukuttan T, Rasingam L and Priya Davidar

A poster prepared for the Biodiversity and Livelihoods Conference

26th-28th March 2009, Coonoor, The Nilgiris

Study area and experimental sites

The Nilgiri Biosphere Reserve (NBR) is part of the Western Ghats, a chain of ancient mountain ranges which run parallel to west coast in Indian peninsula. It lies between 10° 45' N to 12° N latitudes and 76° E to 77° 15' E longitudes with a total area of 5520 km^2 spread across the three southern states of Karnataka, Kerala and Tamil Nadu. The western ranges of the NBR receive higher precipitation (up to 4600 mm) while the eastern parts are part of the rain shadow, receiving less than 800 mm rainfall annually (Prabhakar, 1994).

The study sites were selected in Bangalapadgai and Samaigudal. The two sites lie in the North Eastern Slopes of the NBR. The area was covered by secondary forests interspersed with disturbed semi evergreen forests, small scale mixed farming and plantations. The elevation of the sites was about 1060m and an average rainfall of 700mm.

The study species, *Sapindus trifoliatus,* commonly called the Indian Soapnut tree is one of the main NTFP resources for the local people. A deciduous tree, flowers in terminal and axillary panicles, rusty, fruits 3 lobed velvety smooth, united completely. Leaflets softly pubescent beneath shining above. Fruiting December-January, Flowering November -December. The soap produced from the fruit is mild, used to wash jewellery and silks and traded extensively in India. The tree occurs in the plains from the coast to 750 (1000)m. dominant in the deciduous belt upto 600m. Peninsular India. Southern regions of the

Western and Eastern Ghats. Deer, squirrels and rodents have been observed foraging on the fruit.

Methods

The pollination study was carried out from October to November 2008 at Bangalapaidgai and Samaigudal. Five plants of *Sapindus trifoliatus* located within the village boundary were selected from each site. The trees were tagged with numbered tags. The pollinator visitation patterns and information on fruit set with and without pollinators was assessed for each tree.

Pollinator exclusion experiments

To assess the importance of pollinators for seed set, inflorescences were selected on each tree and the number of closed flower buds was counted. Open flowers and young fruits were manually removed. The closed flower buds on the selected inflorescences were counted and the inflorescence tagged. One set of inflorescences were left open for pollinator visitation and an equivalent number were enclosed in mesh bags for assessing fruit set without pollinators. The fruit initiation was recorded and the fruit set was monitored once in fifteen days.

The importance of pollinators for fruit set was assessed by the formula:
Pollinator importance index: Fruit set in open pollinated flowers-fruit set in bagged flowers.
Pollinator visitation frequencies.

Three inflorescences were chosen randomly from each tree and the flowers were observed for periods of 15 minutes. The observation was done during peak flowering time. All visitors to the inflorescence that came into contact with the reproductive parts of the flower were recorded and the species or taxon noted. The 15 minute observation periods were interspersed randomly through the day between 8 to 16 hours.

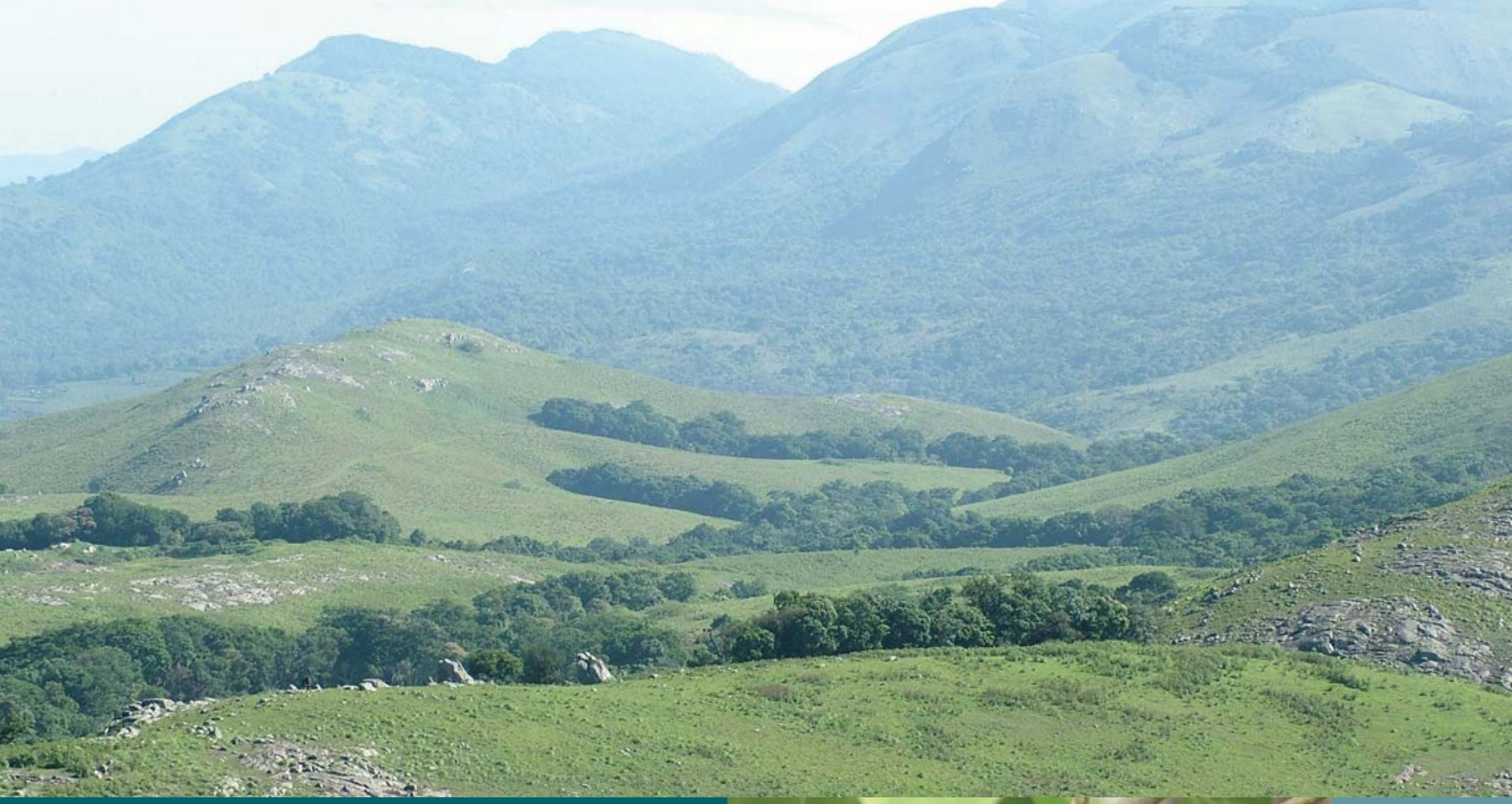
Market value		
Species name	**Typical Unit Price/kg INR**	**Approximate volume produced in kgs**
Sapindus trifoliatus	**6**	**2000**

Pollinator group	Number of pollinator visits per 15 minutes (Mean ± SD)		T Test, df	p
	Banglapadigai	Semmaigudi		
Honeybees	7 ± 6.7	7.8 ± 7	-1.03, 339	ns
Other insects	2.2 ± 2	3.3 ± 3.6	-2.54, 205	0.01

Total number of visits by bees and other pollinators in the two sites. There were significant differences in the visitation rates of honeybees and other pollinators in Banglapadigai (T test=6.25, df=203, p<0.0001) and Semmaigudi (T test=6.63, df=341, p<0.0001).

Total number of visits: 548
honeybees: 341
Other pollinators: 207
% honeybee visits (62%)
Percentage honeybee visits in Banglapadigai: 62% (127 out of 205)
Percentage honeybee visits in Sammaigudel: 62% (214 out of 343)
Proportion of honeybee visits consistent between sites.
2000 kg at Rs. 6 per kg = Rs. 12000-
Sapindus is completely pollinator dependent.
honeybees Rs. 7440- for the whole region

There were no significant differences in the average visits per hour by pollinators (excluding *Apis dorsata*) in both sites.
Wilcoxon Signed Rank test =0.539, ns.



Honey from the hills.. an ecological detail on the honey bees of Chamrajnagar

Sumin George Thomas
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Chamrajnagar is the southernmost district of Karnataka. Chamarajanagar district borders the state of Tamil Nadu and Kerala. Specifically, it borders Mysore district of Karnataka to the west and north, Mandya and Bangalore districts of Karnataka to the north-east, Dharmapuri district of Tamil Nadu to the east, Salem and Erode districts of Tamil Nadu to the south-east, Nilgiris district of Tamil Nadu to the south and Wayanad district of Kerala to the south-west. Most of the district lies in the leeward region of the Nilgiris and consists of mainly semi-arid rain-dependent flatlands along with forested hills.

The major forest types of the forested areas of the area scrub, deciduous, riparian, evergreen, *sholas* and grasslands. Coffee plantations also cover considerable areas of the region. The average altitude ranges from 900-1500 meters. The average rainfall ranges from 900-1800mm. The Biligiri Rangan Temple Wildlife Sanctuary is spread over an area of 539 sq.kms. Biogeographically, the sanctuary is unique. It is located between 11° and 12° N and the ridges of the hills run in the north-south direction. It is a projection of the Western Ghats in a north-easterly direction and meets the splintered hills of the Eastern Ghats at 78° E. This unique extension of Western Ghats constitutes a live bridge between the Eastern and Western Ghats with the sanctuary located almost in the middle of this bridge. Thus, the biota of BRT sanctuary can be expected to be predominantly of Western Ghats in nature with significant proportion of eastern elements as well.

The Soligas are the major inhabitants of the area. These hunter-gatherers are mainly located in the Karnataka part of the NBR, bordering between Bandipur and Biligiri Rangan Betta. Small numbers of them also live in Theppakadu (within Mudumalai Sanctuary) of the Nilgiris. This area is covered with forests, which is their largest resource base for livelihood and sustenance. The main collection in the whole zone is of honey, gooseberry (*Phyllanthus spp*.), *eecham* (*Phoenix spp*.) and lichen. They also practice shifting cultivation growing *ragi* (*Eleusine coracana*), which is their staple diet. They are now settled in villages undertaking seasonal agriculture, slowly joining the mainstream, supported by several government and NGO initiatives.

Honey bees are revered for their extraordinary capacity of generating sweet honey. *Adivasis* consider bees to be a superior being bringing fertility to the land. The honey hunter takes great care in ensuring that no harm befalls the bees. Bees are supposed to be pure creatures. This sense of purity awards them respect from harvesters who make every effort to ensure that bees do not take offence at the hunter – an important consideration why the honey hunter undergoes such penance before setting out into the forest.

Honey bees of the forests of Chamrajnagar

The Giant Rock Bee (Apis dorsata)

The giant rock bee, *Apis dorsata* is among the largest, most productive and dangerous bees known to man. The Giant Bee forms a large comb of up to two meters across and almost one and a half meters in height. Thousands of bees cling to the hive, containing up to 20 kgs of honey in some cases. Due to the weight of the comb, bees build them using strong support and in open spaces. They also prefer to build their combs in the same spot, year after year. Thus, the chosen sites are easily identified by man but rarely accessible to other predators of honey.

The bees generally choose an overhang in sheer rock faces, strong branches of a tall tree and steep escarpments with upto a hundred or more colonies in the vicinity. The bee is considered highly fierce if provoked and has been known to cause deaths also. It migrates over long distances to areas of abundant nectar flow. It has great strength and capacity to forage over large distances with some records of up to 1000 meters and even more.

Apis dorsata colonies are known to hold a population between 40,000-50,000 bees in a single comb, with a large number of worker bees in addition to drones and the queen bee. Worker bees cover the comb as a curtain for protection and maintenance of optimum temperature.

Much of their activities in a nesting place can be documented but little is known on migration patterns. Though they have been known to migrate between 50km to 250km, yet much of this information is based on informal sources and the bee occasionally springs surprises that shakes established scientific knowledge. These bees are migratory in nature, and move large distances to areas with abundant nectar flow in different seasons. Efforts to domesticate the bee have been tried, but have not been very successful. The economic importance of the bee in India is very high as it contributes almost two-thirds of the total production of honey to the industry.

The Asian Honey Bee (Apis cerana Fabricius)

Being indigenous from Afghanistan to Japan and China, *Apis cerana* exhibits a number of races and sub-races, which differ widely in productivity, behaviour and body size. Feral (wild) colonies nest in cavities of trees, rocks, stone walls and other dark enclosed places, building several parallel combs. Honey for rearing of brood is stored in the upper part of central combs while pollen and brood are stored below. Surplus honey is stored in the outer combs.

Apis cerana often absconds (leaves) the nest in case of severe disturbance or lack of food. Their temper is gentle to moderately aggressive, with a distinct positive correlation between colony size and aggressiveness. Beekeeping with *Apis cerana* in simple hives has

been practiced in India for at least 2000 years. It is a valuable pollinator with a foraging range of 800 meters.

The Little Honey Bee (Apis florea Fabricius)

The small single comb nests of *Apis florea* is often found in dense, shrub vegetation, in cavities of trees and rocks or under roofs of palm leaves. Workers form a multi-layered protective blanket covering the comb. Sticky plant resins are used on the branch supporting the comb, to protect the colony from ants.

Honey is stored in the upper part of the comb while pollen, brood and drone cells are stored below. Honey usually sells at better prices than honey from *Apis cerana* and *Apis dorsata*, due to reputed medicinal properties. The annual yield from a colony is about 1-3 kgs. Honey can easily be harvested, without destroying the colony by applying a little smoke. If disturbed, the bees desert the comb, but often return within a short time. It is a valuable pollinator with a foraging range of up to 500 meters.

Stingless Bees (Trigona spp. and Melipona spp.)

They are the smallest among the honey-yielding bees. They are often called stingless bees because they do not sting but bite. Their nests are built in trunks of trees, logs, wall crevices or under the roofs of dwellings. The bees are easily hived and seldom abscond their nest.

Stingless bees gather propolis (plant resins) and use it together with wax, to construct their nest. In the nest, there is a group of separate cells for brood rearing and another group of larger "sacs" for storage of pollen and honey. The dark and bitter honey is valued for its medicinal properties. Information on honey yields range from 20 grams to 1kg per colony per year. They are valuable pollinators of small herbs and shrubs.

Honey hunting as an activity is deep-rooted within *adivasi* people. The activity symbolises a binding element amongst them, as elaborate rituals and ceremonies bring together members of the community into a communal display of goodwill. Mutual ties are intensified because of the relatively large number of people who set out for the hunts are related and from the same village. This togetherness is unidirectional as it focuses towards ensuring safety of the group that sets out into the forest.

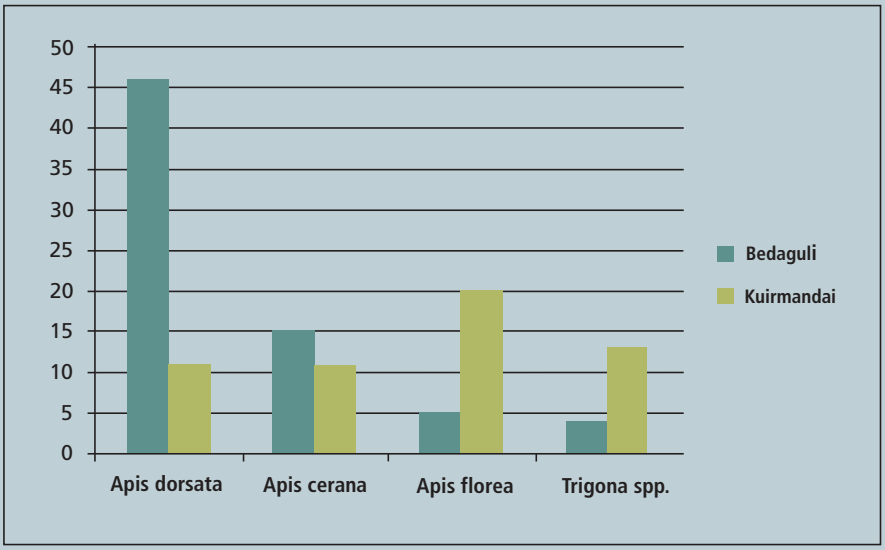
The colonies were found on trees and the tree species that form nesting substrates for honey bees are as given below:

Bee Species	Kurimandai	Bedaguli
Apis dorsata	*Mangifera indica, Terminalia bellerica, Syzygium cuminii, Bombax ceiba*	*Elaeocarpus spp., Ficus spp., Syzygium cuminii, Mangifera indica, Percea macrantha*
Apis cerana	*Tectona grandis, Anogeissus latifolia*	*Elaeocarpus spp., Syzygium cuminii, Percea macrantha, Ptercarpus marsupium, Canarium strictum*
Apis florea	*Bambusa spp., Lianas*	*Anogeissus latifolia, Phyllanthus acidus*
Trigona spp.	*Tectona grandis, Pterocarpus marsupium*	*Syzygium spp., Grewia tilifolia, Pterocarpus marsupium*

Pantraps:
Pan trapping of insects was done in study sites across the Nilgiris Biosphere Reserve in 2007 of which Bedaguli and Kurimandai were two sites. This study was conducted to assess the bee diversity across forest types and landscapes. The bee diversity in the two sites are as given below:

Order	Family	Genera
Hymenoptera	*Apidae*	*Amegilla, Apis, Braunsapis, Ceratina, Xylocopa*
	Halictidae	*Halictus, Lasioglossus*

Density of bee colonies in the two sites



From surveys done in the forests of Chamrajnagar

Surveys were done in 2008 in the dry forests of Kurimandai and in the evergreen forests of Bedaguli in the Chamrajnagar division to estimate the nest densities of the four honey bees. Its variations across forest types and climatic gradients were studied. The graph given below shows the variations in the nest densities of honey bee species in the two areas.

Conclusion

Bees are valuable. A major role is played by bees is that of pollination. This means better yields in agricultural and horticultural crops, i.e. more food produced in the same area. The effect of sufficient pollination on natural vegetation is even more important. It is a way to secure floral diversity which makes ecosystems less vulnerable. More vegetation increases the carrying capacity of the area and allows associated life forms to evolve. Changes in the flora and fauna affect the population and presence of bees. Large, strong colonies are found in areas of high floral availability throughout the year, i.e., with a high diversity in vegetation. There is an urgent need to address threats that are associated with loss of habitats that support bees, as an intricate web is woven around many factors like forests, landscapes, bees and people.

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CAN ECOTOURISM BE AN ALTERNATE SOURCE OF LIVELIHOOD FOR FOREST TRIBES?

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A Study in Chinnar Wildlife Sanctuary, Idukki District, Kerala:

In the Kerala state of south India, 14 Wildlife Sanctuaries and National Parks have been identified and promoted as eco-tourism destinations, including the Chinnar Wildlife Sanctuary.

Under the World Bank assisted Kerala Forestry Project, Eco-Development Programme was initiated in eleven tribal (i.e. Scheduled Tribes) settlements encompassed within the Chinnar Wildlife Sanctuary in 1998.

In 2003, Ecotourism was identified as an important activity for income generation under the Eco-Development Programme in four of the eleven settlements, namely, Champakad, Alampatti, Eachampatti and Palappatti, which are inhabited by the Hill Pulayan tribal community. The Hill Pulayans are hunter-gatherers by tradition; daily wage laborers at present.

The Muduvan tribal community lives in the remaining seven settlements falling within the Sanctuary. The Muduvans are shifting cultivators by tradition; presently lemon-grass oil distillation forms their primary source of income.

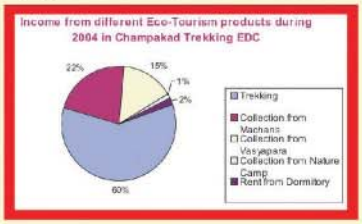
As per the Eco-development Programme, all the Ecotourism activities are to be carried out by the Eco Development Committees i.e. EDCs of respective settlements. Trekking, bird watching, nature trails etc. are developed and operationalised through the institution of Eco-Development Committees (EDCs).

Objectives of the Ecotourism project in the Chinnar Wildlife Sanctuary, as stated in the Ecotourism project records, are,

- To generate income for members of the EDCs through Ecotourism.
- To provide opportunities to tourists for experiencing and learning about nature.
- To educate local communities about conservation and its benefits and
- To evolve a model for community managed Ecotourism

Why Ecotourism was initiated in Chinnar Wildlife Sanctuary

- To reduce the dependence of local communities on forest resources and traditional subsistence activities, such as, millet cultivation, animal husbandry, food gathering and so on
- To divert the Hill Pulayans from providing assistance to elephant poachers and sandal wood smugglers in the Sanctuary area and generate a regular source of income for the Hill Pulayan youth and men
- To use the Trekking Guides of Ecotourism project in 'forest conservation' works as well



Focus of the present study

- Extent of participation of local communities in Ecotourism.
- Sustainability of Ecotourism as an alternate source of livelihood.

Settlement chosen for study:

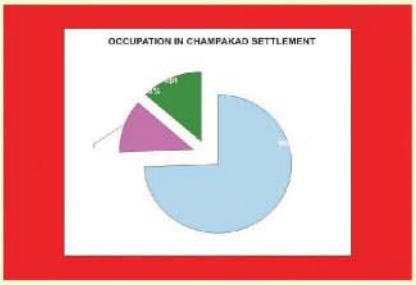
Champakad Hill Pulayan settlement with a population of 212 (58 households).

Period of field work:

May 2004 & May- June 2005.

Observations of the study:

- Ecotourism is operated like a tourism activity of the Forest Department with the hidden objective of forest protection.
- About 74.38% of the potential working population is dependent on seasonal wage labour; involved in road laying, check dams constructions and repairs, making boundaries to prevent forest fires, etc. Remaining 25% are 'employed' as Trekking Guides under Ecotourism and used primarily in forest protection and conservation activities. The positive aspect of the whole exercise is that it provides employment and income to a portion of the Hill Pulayans who are devoid of livelihood opportunities due to their location in a rain shadow area, and that too encompassed within a Wildlife Sanctuary, where subsistence activities are totally curtailed!
- Though in documents, Ecotourism is claimed as a sustainable activity, in real terms, from the point of view of the Adivasi people who are living there and taking part in it, it does not appear to be sustainable. If the flow of tourists is reduced or stopped due to external factors, it jeopardizes the livelihood of dependent communities. With its limited income generating potential and employing only a section of people in its initiatives, Ecotourism can form only as a secondary source of income.
- Harsh living conditions exist in Champakad; No irrigation facilities and no cultivation takes place. The sustainable option, according to the Hill Pulayans is, traditional millet cultivation (for their own food security) combined with animal husbandry and cash crops cultivation.



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Linking Biodiversity to Ecosystem Services in the Nilgiri Biosphere Reserve

Background

Our project aims to understand spatial and mechanistic links between natural habitats, biodiversity and ecosystem services. Biodiversity-ecosystem service relationships can provide tremendous impetus to conservation and have seen numerous advances in recent years; but there is still a long way to go in terms of understanding linking mechanisms and spatial congruence.

This poster describes a few ideas that we plan to pursue in the context of understanding biodiversity-ecosystem service linkages in the Nilgiri Biosphere Reserve and similar systems in the Anamalai Hills. This landscape, with its rich biodiversity as well as long history of diverse landuse is an ideal setup within which to explore these issues.

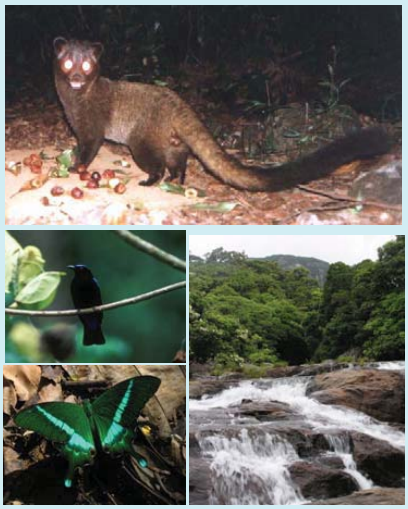

Photo credits: Divya Muddappa, S.U. Saravanakumar, M.O. Anand

Project objectives

1. To understand spatial patterns of biodiversity across heterogeneous multi-use landscapes in the Nilgiri Biosphere Reserve

2. To understand links between biodiversity and ecosystem services in terms of
   - ***Functional links*** and the mechanisms that relate biodiversity to ecosystem services
   - ***Spatial links*** in terms of spatial congruence between biodiversity and ecosystem services

Assessing functional links

Do more diverse biological communities also provision better ecosystem services?

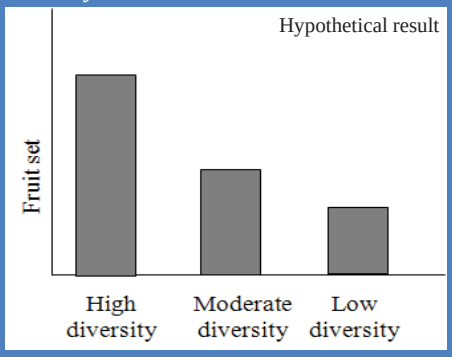

Figure: Hypothetical scenarios where, by comparing pollination services at sites with high, moderate, and low pollinator diversity, one could ask if mode diverse pollinator communities result in better crop pollination.

How do ecosystem services respond when species are lost or replaced in a deterministic manner?

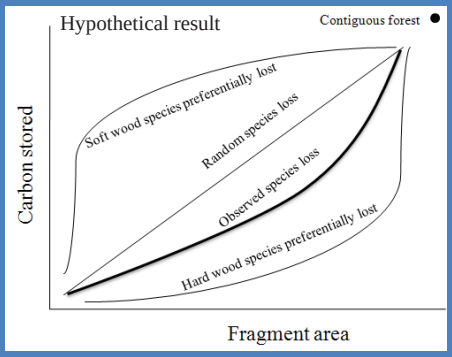

Figure: Hypothetical scenarios when tree species are lost from a community as a result of fragmentation, species possessing specific traits (high wood density, longevity) are likely to be more susceptible. Loss of few species could have disproportionately high impacts on ecosystem services such as carbon storage.

Assessing spatial links

What is the spatial overlap between biodiversity and ecosystem services?

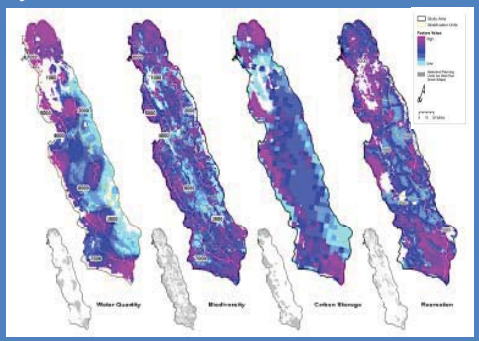

Figure: An example from California [Chan et al. 2006 PLOS Biology 4(11) e379] is illustrated where biodiversity and ecosystem services were mapped across the landscape. By doing this, one could assess spatial congruence by asking to what extent priority areas for biodiversity conservation overlap with those for ecosystem service conservation.

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