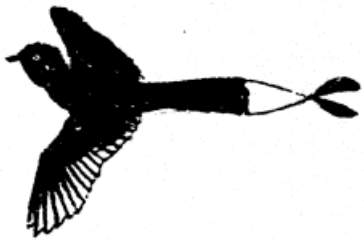

Participatory Local Level Assessment of Life Support Systems

A METHODOLOGY MANUAL

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1. RATIONALE

1.0.1 The ability of earth's ecosystems to provide goods and services to support human existence is under manifold stresses. It is important, as we enter the new millennium, to understand the magnitude of these stresses and the forces that drive them, to communicate this understanding to the citizens of the world, and to help build capacity and appropriate institutions to tackle the challenges before us (Ayensu *et al*, 1999). History tells us that it is not adequate to merely address the key policy makers, key decision makers in the world, for they have a strong tendency to believe that human ingenuity can always substitute for all of nature's services. For instance, soon after the Russian revolution Leon Trotsky declared : “the proper goal of planning is the domination of nature by technology ……. so that raw materials of nature will yield to mankind all that it needs and more besides". The underlying values have been shared by Governments of countries with free enterprise economies as well, so that environmental action has always sprung from broader public concern (Guha, 2000). An assessment of how the world's ecosystems are faring must therefore reach out not only to policy makers, but to the people at large as well. It should especially reach out to the weaker segments of the populations of the developing countries, for these are the people who suffer most from a loss of nature's services. But these victims of environmental degradation are also forced by circumstances to be amongst the most active agents of destruction. The key to saving world's ecosystems therefore lies in developing an understanding of what is happening in partnership with these people and deploying this understanding towards promoting capacity and institutions to undertake positive actions.

1.0.2 Involving such a broader base of people in assessing the state of world's ecosystems calls for engaging in more locality specific assessments. This is because the ecosystems are tremendously variable in space and time and what is relevant to inhabitants of a coral atoll in the South Pacific is very different from what matters to peasants in the Andes. Furthermore neither of these groups of people would be particularly interested in very broad-brush pictures of what is happening to the world's

oceans or mountains. Ultimately, therefore, we should aim to generate concrete, locality-specific assessments that would cover all of the world's ecosystems.

1.0.3 Obviously this is a Herculean task and one must begin with a more limited initiative covering a few, catalytic local level assessments. These local level assessments would also complement the regional and global assessments in forcing one to take a hard look at the quality of data available on the ground; helping one guard against spurious certainties. For instance, it is now becoming clear that the concept of maximum sustainable yield from fish or forest tree populations is beset with many difficulties; yet a global assessment is likely to employ it on a wide scale. Looking at very specific fish populations and their histories would likely help us to appreciate the need for caution. Such is also the case with lists of endangered species. For instance, we found a frog species, *Micrixalus saxicolous*, to be quite abundant along the hill streams in the site of the major case study which forms the basis of this document. At a 1992 meeting of the Indian Subcontinent Reptile and Amphibian Specialist Group of the Species Survival Commission of IUCN this species was listed amongst those "presumed extinct".

1.0.4 The choice of the limited number of specific local level assessments could be made so as to cover as many as possible of the different biogeographic provinces or major ecological regions of the earth; and within these regions different settings in relation to parameters such as human population densities, intensity of inputs into agriculture, and distance from protected areas such as national parks. This would complement well the broad brush global painting with a mosaic of much more detailed local pictures.

2. OBJECTIVES

2.0.1 To assess the status and trends over time and forces driving these trends in the availability of ecosystem goods and services, as well as bads and disservices from the divergent perspectives of people relating differently to the natural world in a representative set of localities.

2.0.2 To inform the regional/global assessments on the state of understanding of the many parameters employed in terms of concrete, ground level data.

2.0.3 To create awareness amongst the public through concrete assessments including scenarios of likely futures and possible response options, to which they can relate themselves, communicated in their own languages.

2.0.4 To appreciate the nature of institutions needed to take positive action in the particular social-economic-political contexts characterizing the different study localities.

2.0.5 To build broad based capacity to assess the ecosystem status, to elaborate appropriate institutions, to plan and implement environment friendly development.

3. CASE STUDIES

India has developed a series of experiences pertinent to local level ecosystem assessments hand-in-hand with the elaboration of institutions of co-management of natural resources such as forest and irrigation and decentralization of institutions of governance down to village level. These have taken the form of Participatory Rural Appraisals accompanying development planning, Panchayat (= Village Council) Level Resource Mapping exercises in the state of Kerala and development of management plans for Village Forest Committees. Following upon these was the initiative of the Foundation for Revitalization of Local Health Traditions to record community level knowledge and practices of use of medicinal herbs as Community Biodiversity Registers (CBRs). This was followed by initiation of broader, biodiversity focussed People's Biodiversity Register (PBR) activities at 10 sites in 4 states of the Western Ghats region as a part of the Western Ghats Biodiversity Network Programme co-ordinated by the Indian Institute of Science (Gadgil *et al*, 1996; Gadgil *et al*, in press). Based on this experience was organised an all-India programme of PBRs as a part of the WWF sponsored Biodiversity Conservation Prioritisation Project. This programme covered a series of 52 villages representing a variety of ecological and socio-economic contexts of the Indian sub-continent (Figure 1). The PBRs involved local level ecosystem assessments along with an understanding of the development aspirations, conservation priorities and elaboration of biodiversity management plans. This exercise does provide an interesting model for local

ecosystem assessments; however it leaves out such significant issues as soil and water and agrobiodiversity. We have therefore undertaken further field work in one of the PBR study sites, namely, Mala and neighbouring villages constituting a watershed contributing to the Swarna river in Karkala taluk of Udupi district in the state of Karnataka (Figure 2). Much of the discussion in this methodology manual is based on the experience of the 52 PBR studies along with the more elaborate work in the Mala cluster.

4. ACTORS

4.0.1 Local level ecosystem assessments should be organized as participatory efforts involving representatives of all segments of society enjoying the goods and services as well as suffering from the bads and disservices flowing from the pertinent ecosystems. At least some of these local people would be familiar with many facets of these ecosystems and would bring in their knowledge to the process. Much of this information especially relating to changes over time may only reside with local people; their active involvement is therefore very important. However most of them are unlikely to be familiar with the broader, systematic framework within which their information needs to be organized. They would also be unfamiliar with important issues such as chemical composition of soils and waters. The assessment would therefore need to involve people with relevant scientific expertise as well; expertise in disciplines such as ecology and environmental chemistry, as well as economics and anthropology. It would be desirable that the technical experts be already familiar with the locality, the society and the culture. This would be achieved if they are associated with one or more neighbouring educational institutions.

4.0.2 The assessment should also involve creation of awareness, and building of capacity and appropriate institutions at the local level. This would be facilitated by the involvement of local NGOs, of farmers' co-operative societies, of governmental agencies concerned with resource management issues such as forest department and institutions of local governance such as village councils.

5. METHODOLOGY

5.1 Choosing Study Localities

5.1.1 Two kinds of considerations governed the choice of the 52 study localities for the PBR exercise over 1996-98. These were (a) the need to represent the whole range of ecological and socio-economic contexts characteristic of the Indian subcontinent, and (b) the need to identify a partner agency working close to the study site and competent to organize a participatory assessment process. In response to these considerations we selected 6 states and 1 union territory as representative of the diversity of the country. These included (fig. 1) (1) Rajasthan representing the desert and semi-arid regions, (2) Himachal Pradesh representing Himalayan hill tracts (3) Bihar representing Gangetic plains and Central Indian hill tracts (4) Assam representing Brahmaputra river valley and northeastern hill tracts (5) Orissa representing east coast and Eastern Ghats and Central Indian hill tracts (6) Karnataka representing the West coast, hill tracts of Western Ghats and the Deccan plateau and (7) Andaman and Nicobar islands in the Bay of Bengal. Through our prior contacts with NGOs interested in issues of environment and development, and in nature conservation and with biology teachers interested in ecological research, we identified for each state / union territory a nodal NGO willing to co-ordinate the activities within the state. In turn these nodal agencies contacted other potential investigating agencies. In consultation with this group we selected a series of study localities, each representing a village or village cluster extending over 20-50 km^2, covering the whole range of ecological, socio-economic variation within the state, as well as contexts such as being away from or proximate to a National Park. At this stage, we did not bring in watershed related considerations, but in organizing the more detailed Mala cluster study we have delineated the study area in terms of a set of watersheds draining into the Swarna river (figure 3).

5.2 Building up Study Teams

5.2.1 The nodal responsibility for the Mala study lies with Dr. K. Prabhakar Achar, Professor of Zoology at an undergraduate educational institution, Sri Bhuvanendra College of Arts and Science at Karkala, located 20 km from the study locality. He

collaborates with Professor K. Krishna who teaches Economics in the same college. Dr. Achar has been engaged in ecological fieldwork in the vicinity of Mala since 1991 and as a consequence had a familiarity with local ecology as well as people. Other expertise in ecology, remote sensing and geographical information systems is provided by members of the Centre for Ecological Sciences at the Indian Institute of Science, Bangalore and in soils and hydrology by civil engineers at Karnataka Regional Engineering College, Surathkal.

5.2.2 This group of technical experts has networked with a number of local people. These include students and teachers of Primary and Middle Schools at Mala who have undertaken an inventory of local plants and animals as a special exercise, and a number of local people particularly knowledgeable in a variety of pertinent issues such as medicinal plants, fisheries and water management for agriculture (Table 1).

Table 1. Knowledgeable people from different local communities, teachers, village council members, physician at Primary Health Centre and others who have contributed substantial amount of information to the Mala cluster study

Sl.No.	Knowledgeable Individuals	Community	Occupation
1	Muniraj Ballal K. B.	Jain	Agriculturist
2	Shankar Joshi	Brahmin	Agriculturist
3	Jayakumar Ballal	Jain	Agriculturist
4	Narayana Barve	Brahmin	Agriculturist
5	Raghuram Phadke	Brahmin	Agriculturist
6	Gunapala	Jain	Agriculturist
7	Venkatesh Ranade	Brahmin	Agriculturist
8	Madhav Marate	Brahmin	Agriculturist
9	Shashidhar	Malekudiya	NTFP collector, Agriculturist
10	Padmayya Gowda	Malekudiya	NTFP collector, Agriculturist

Sl.No.	Knowledgeable Individuals	Community	Occupation
11	Babu Gowda	Malekudiya	Artisan
12	Kunjira Moolya	Moolya	Laborer
13	Dr. Shrinivas Poojari	Poojari	Health Inspector
14	Dr. Ivone Fernandes	Christain	Primary Health Centre Doctor
15	Daju Mera	Mugera	President of village council
16	Sadananda Hegde	Hegde	Member of village council
17	Ramakrishna Maiya	Brahmin	Village Accountant
18	Narayan Dongre	Brahmin	Retd. Headmaster
19	Vasanthi	Brahmin	Headmistress
20	Nagbushan Joshi	Brahmin	Teacher
21	Jayanthi	Shetty	Teacher

5.2.3 The study team has also built rapport with members of the village council and concerned officials such as the Divisional Forest Officer and the Wildlife Warden. It also interacts with locally active rural development NGOs such as Dharmasthala Grameena Abhivriddhi Yojana and Nagarika Seva Trust.

5.2.4 There has been a long process of gradual build up of contacts and links with the local society through a series of individual and group discussions, partnership in programmes such as school nature study project, involvement in social functions such as formal handing over of the PBR report to the Village Council and so on. In other localities where the group of technical experts is making a new entry, rapport with local society will have to be built up through deliberate efforts, identifying local leaders and individuals with extensive knowledge of ecosystem goods and services and getting to work with them.

5.3 Compiling Secondary Data

5.3.1 At an early stage in the study it is necessary to put together all pertinent secondary data such as survey maps indicating land ownership, topographic maps, aerial photographs and satellite imagery, district gazetteers, human and livestock census data, landuse, cropping patterns and crop production statistics, forest working plans, fish landing statistics, statistics relating to commercial and industrial establishments, information maintained by pollution control authorities, rainfall and river flow statistics. It is also necessary to acquire reports and publications of any previous investigations that relate to study locality or other neighbouring areas.

5.4 Ecosystem Goods and Services

5.4.1 A workable definition of ecosystem goods and services could be "those goods and services which undergo relatively little transformation in the hands of people, that is, conversion from the form in which it is provided by nature to the form in which it can be used by people involves relatively little capital investment." Ecosystem goods and services could be available as a result of human modifications of ecosystems including use of industrial goods, such as agriculture or plantations with chemical pesticides as an input, or could be more direct gifts of nature such as wild fruit or fishes. It may require significant and arduous human effort to access certain ecosystem goods such as honey or toddy but the form in which they are tapped from nature would usually be directly of use to humans without the need of any capital-intensive transformation. For the purpose of the present exercise, we would also include in this category simple products which are results of local value-addition not involving any major external input, such as large serving spoons made of coconut shells, since these products illustrate basic links of local people with their ecosystem.

5.4.2 For many ecosystem goods and services, market institutions for exchange do not exist, which means that it is difficult to use price as a proxy for their value as perceived by the user, although valuation can still be attempted through indirect means. Locally collected and used firewood, for example is not exchanged through

markets and hence, not priced from the user's viewpoint, though one could theoretically value this ecosystem good in terms of opportunity costs, for example of the labour involved in the collection, but this would be an outsider perspective.

5.4.3 We may illustrate these definitions further on the basis of some concrete examples of ecosystem versus industrial goods and services

Ecosystem good: Locally available medicinal herb (Relatively little transformation, no well-defined market, labour-intensive collection process)

Industrial good: Commercially produced drug capsule (High degree of transformation, well-defined market, capital-intensive production process)

Ecosystem service: Pleasure and health benefits derived from staying in or visiting a naturally green area (Little transformation, not necessarily priced from user's viewpoint)

Industrial service: Pleasure and health benefits of a gym session (Heavy use of artifacts, definitely priced from user's view-point)

5.4.4 Goods and services are defined with respect to their use-values to an individual, a group of individuals or a community. In almost every case, many of the ecosystem goods and services of an area (in our context, a well-defined watershed) are used by people living outside. They may access these through the market (e.g. a marketed NTFP such as *Garcinia* fruit), by virtue of locational advantages (e.g. watershed benefits in downstream areas) or by physically accessing the ecosystem (e.g. collecting firewood or enjoying scenic beauties). There would also be certain ecosystem goods and services, which yield benefits to a much larger community (beyond those with access through the above means). Forests, for example, provide carbon sequestration benefits to the global community at large with impacts potentially reaching a small island nation or a low lying delta facing threats of submergence thousands of miles away. These benefits will typically have no significance for the local people.

5.4.5 We provide below an indicative list of ecosystem goods/bads and services/disservices, as perceived by various groups of local people of Mala cluster study site (Table 2).

Table 2. Ecosystem goods and services and bads and disservices as reported, by people of Mala study cluster

Ecosystem goods	**Use**	**Locally used**	**Marketed**
Oryza sativa (Paddy)	Food	*	
Mangifera indica (Mango)	Food	*	
Achras sapota	Food	*	
Carica papaya	Food	*	
Artocarpus heterophyllus (Jackfruit)	Food	*	
Musa sp (Banana)	Food	*	
Crabs	Food	*	
Bamboo shoots	Food	*	
Garcinia indica	Food	*	*
Mangifera indica	Food	*	*
Anacardium occidentale (fruit)	Food	*	*
Acacia catechu (fruit)	Food	*	*
Cocus nucifera (fruit)	Food	*	
Hopea ponga	Firewood	*	
Hopea parviflora	Firewood	*	
Terminalia crenulata	Firewood	*	
Terminalia paniculata	Firewood	*	
Calophyllum apetalum	Firewood	*	
Acacia catechu (leaves)	Fuel	*	
Leaf litter	Fuel	*	
Anacardium occidenale (branches)	Fuel	*	
Cocos nucifera (leaves)	Fuel	*	
Tectona grandis (branches)	Fuel	*	
Agri waste	Fuel	*	
Pandanus sp	Mat-making	*	
Calamus sp	Basket-making	*	
Ochalandra sp	Basket-making	*	
Lee indica	Basket-making	*	
Calycopteris floribunda	Basket-making	*	
Desmos lawii	Basket-making	*	
Uvaria narum	Basket-making	*	
Tylophora indica	Basket-making	*	
Hippocratea arnottiana	Basket-making	*	
Pothos scandens	Basket-making	*	

Ecosystem goods	**Use**	**Locally used**	**Marketed**
Vateria indica	Rain-cover making	*	
Garcinia cambogia	Pickles	*	*
Atrocarpus hirsutus	Pickles	*	*
Phyllanthus emblica	Pickles		*
Myristica malabarica	Condiment		*
Cinnamomum verum	Condiment		*
Elettaria cardamomum	Condiment	*	*
Piper nigrum	Condiment	*	*
Vateria indica	Varnish		*
Terminalia chebula	Tanning	*	
Randia dumatorum	Fish poison	*	
Acacia concinna	Detergent	*	*
Sapindus laurifolius	Detergent	*	*
Garcinia morella	Coloring material		*
Areca catechu (stem)	Water transportation	*	
Hevea brasiliensis (latex)	Rubber		*
Acacia catechu	Timber		*
Casuarina equisetifolia	Timber		*
Tectona grandis	Timber		*
Ratsnake	Pest control	*	
Lizard	Control of insects	*	
Red ant	Pollination	*	
Honey bee	Honey	*	
Water	Irrigation, domestic uses, fishing	*	
Grass	Grazing	*	
Medicinal herbs	Medicine	*	*
Caryota urens (Toddy)	Mild intoxicant	*	*
Milk and milk products	Nutrition	*	

Locally value-added ecosystem goods include mats, baskets, large serving spoons made of coconut shells, rain-covers made of *Vateria indica* , milk products and areca plates.

Ecosystem bads :

Ecosystem bads	Dis-use
Wild boar	Nuisance species
Sloth bear	Nuisance species
Civet	Nuisance species
Rat	Nuisance species
Porcupine	Nuisance species
Hare	Nuisance species
Bandicoot	Nuisance species
Gaur	Nuisance species
Bonnet Macaque	Nuisance species
Ticks	Nuisance species
Leeches	Nuisance species
Mites	Crop pest
Caterpillar	Crop pest
Tea mosquito	Crop pest
Stem Borer	Crop pest
Terminal leaf eater	Crop pest
Tree borer	Crop pest
Beetles	Crop pest
Sparrow	Crop pest
White breasted waterhen	Crop pest
Jungle Fowl	Crop pest
Quail/ Partridge	Crop pest
Peafowl	Crop pest

Ecosytem services :

Evergreen forests are origin of streams

Evergreen forests are repository of honeybees

Evergreen forests are asthetically and often, culturally important (for example, when certain spots are associated with sacred beliefs).

Grasslands provide for grazing of livestock

Flowering of rubber plantations increase availability of honey

Plantations check soil erosion due to contour formations

Water streams provide water for irrigation and domestic uses

Ecosystem disservices :

Evergreen forests are repository of nuisance species, pests and vectors. (See above)

Contaminated water streams lead to health problems

5.4.6 To these lists based on discussions with local people may be added other goods/services, bads/disservices visualized from other, outside perspectives. Examples of these include locally possibly relevant issues not visualized by any local people such as pollination as a service, or more globally relevant issues like carbon sequestration by vegetation and maintenance of biodiversity.

5.5 Activities / processes relating to ecosystems

5.5.1 People relate to ecosystems through a series of activities or processes such as using the water of a stream or a well for domestic use or irrigation, grazing cattle on a patch of grassland, selling fuelwood, growing coconuts, being bitten by mosquitoes carrying malarial parasites, having one's goat being eaten by a panther and so on. The ecosystem goods/ services/ bads/ disservices relate to people through such activities /processes. The next step in the assessment should be an inventory of these activities /processes. Table 3 provides for Mala cluster an illustrative list of such activities / processes.

Table 3: Activities and processes which relate the people of Mala study cluster with ecosystem goods/ services/ bads/ disservices.

A. Those (a) which are carried out by local people and (b) which do not need major external input

NTFP collection

Medicinal herb collection

Firewood collection

Collection of wood for making implements

Drawing of water from streams/diverting streams for irrigating agricultural and plantation crops and for domestic uses

Grazing of livestock in grasslands

Collection of cane for basket making

Making charcoal from stems of dead trees

Using leaf litter as manure

Using certain forested areas as picnic spots on festival days (e.g. Ugadi, the New Year)

Fishing from streams

Collecting small fishes, apple snails (Pila) and crabs from agricultural fields

Collection of firewood from river beds

Tapping of toddy from *Caryota urens*

Use of areca stems for transporting water

Use of coconut shells for making large serving spoon

Use of areca shells and rubber and cashew branches as fuel

Basket, mat and rain-cover making

B. Those (a) which are carried out by local people and (b) which need major external input

Maintaining rubber, areca, coconut, cashew and cocoa plantations

Use of areca leaf sheath for plate making

Cultivation of paddy

Dairy activities and sweet making

Trading in NTFP

C. Those which are carried out by outsiders

Trading in NTFP

Enjoying aesthetic values while visiting or passing through the area

Accessing ecosystem goods such as arecanuts and NTFPs or value-added products such as sweets and areca leaf sheath plates through the market

Auctioning of timber from Forest Department plantations by government officials

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5.6 Mapping the peoplescape

5.6.1 Different segments of local human population, men, women, children, peasants, fisherfolk, traders, teachers, bureaucrats are likely to participate in different processes or activities and be affected by different processes linking them to ecosystem goods/services/bads/disservices. The next step in the assessment exercise would be to classify people into groups pursuing a similar set of processes in relation to the ecosystems. Table 4 provides such a categorization of people of Mala cluster with further remarks on the livelihood strategies of the people assigned to different groups. We may term such groupings as user groups.

5.6.2 Such a grouping is an important guide to allocating effort during the course of further investigation. To this end, the next step should be identification of one or more individuals particularly knowledgeable about the local ecosystems from each of these groups. These individuals could then serve as a part of the investigative team collaborating with the technical experts for the purpose of the remaining assessment. Table 1 provides a list of such knowledgeable individuals from the Mala cluster.

Table 4. Major groups of people of Mala cluster defined in terms of their links to the ecosystem

Group	Activities	Processes
Land owners	Maintaining plantations of rubber, areca, coconut etc Paddy cultivation Dairy activities Trading in rubber and arecanut Employing wage labour Hiring toddy tappers Diversion of water from streams for irrigation and domestic purposes Use of areca stems for transporting water Use of leaf litter as manure Collection of crabs, apple snails (Pila) and small fishes from agricultural lands Bees and red ants as pollinators	Use of chemical fertilizers and pesticides Humans and livestock affected by ticks and leeches Crops damaged by nuisance species such as rats Pest control by ratsnake and lizard
Landless labourers	NTFP collection Firewood collection Leaf litter collection Working in agricultural fields Toddy tapping Use of water from streams for domestic purposes	Sloth bear damaging honey combs Flowering of rubber plantations increasing availability of honey
Fishermen	Fishing in streams Use of water from streams for domestic purposes Use of dynamites and fish poisons	
Artisans	Making of mats, baskets and rain covers Sale of these products locally as well as in outside markets Collection of climbers from evergreen forest Collection of wood for making implements Use of water from streams for domestic purposes	
Small scale industrialists	Collection and local purchase of areca leaves Cultivation and purchase of jackfruit Heating and cooling through biogas-powered systems Use of stream water for agricultural, industrial and domestic purposes	

5.7 Mapping the Landscape

5.7.1 The study locality may be viewed as a mosaic of a number of irregular shaped (eg. fields, orchards, grasslands, forests, lakes) or linear elements (eg. streams, roads) of a number of different types. These different types of elements, variously termed ecotope types or landscape element (LSE) types may be discriminated at different spatial scales on many different bases. In the discipline of landscape ecology that has developed especially since satellite imagery became widely available, the individual elements are discriminated on the scale of a few hundred m^2 to few hectares. The basis of discrimination on land is the structure, physiognomy and phenology of the dominant life form, e.g. trees in forest or herbs in grassland. The aquatic elements may be classified on the basis of depth, flow regime and seasonality. Fig. 4 is such a landscape map of the Mala study cluster.

5.7.2 Another relevant basis for the mapping of the landscape is the set of ecosystem goods / services / bads / disservices stemming from the different elements as perceived by the people. Thus elements from which similar ecosystem goods / services / bads / disservices are derived would be clubbed together under the same ecotope type. These two classifications may be largely compatible with each other, with a finer division characterizing the landscape ecology based system. Table 5 shows that this is the case for the Mala cluster with ecosystem goods / service based classification grouping landscape ecology categories under fewer heads.

Table 5. Correspondence between ecotype types defined in terms of landscape ecology and similarity of ecosystem goods/ services/ bads/ disservices

Landscape Ecology Based Classification	Ecosystem goods/ services (use) based classification
Evergreen forest Disturbed evergreen forest Semi-evergreen forest Riparian forest	Evergreen forest/ forest
Scrub Thicket	Scrub
Paddy Field	Agricultural land
Casaurina Plantation Hopea Plantation Arecanut Plantation Coconut Grove Cashew Plantation Rubber Plantation Acacia Plantation	Private Tree Plantation Government Plantation
Stream	Stream
Human Habitation	Human Habitation

5.7.3 Finally another relevant consideration in mapping the landscape is that of ownership and tenure. In Mala cluster, for instance, three major forms of ownership prevail: forest department, land controlled by revenue department but meant for community use and privately owned land. All streams and rivers are government property, some of the tanks are private property. The ownership / tenure considerations are important in governing the access to ecosystem goods and services and should be borne in mind in the course of assessment.

5.8 Assessing Status and Changes

5.8.1 Preparing a checklist of the ecosystem goods and services/ bads and disservices as perceived by local people as well as from other, more global perspectives, grouping people on basis of their links to the ecosystem, identifying knowledgeable individuals and mapping the landscape in terms of elements that furnish similar sets of ecosystem goods / services, bads / disservices completes the foundation for the assessment. The parameters to be assessed belong to two broad categories (a) those with which at least some members of the local community would be familiar, and (b) those which require technical expertise unlikely to be available with any member of local community. In the former case local collaborators would also be in a position to provide some understanding of the changes in these parameters, at least over past two decades and forces driving those changes. In case of parameters demanding technical expertise it would be much more difficult to obtain information relating to changes over time. In that case changes would have to be inferred on the basis of comparisons with other localities representing the presumed earlier state. For instance, local collaborators at Mala are in a position to provide information on current status as well as changes in population of freshwater fish almost all of whom are locally consumed; and most of which have distinctive local names, but have relatively little information on the frog species. The scientific records and literature also provide little information on historical status of frog populations of the region. The only recourse to assess changes over time therefore is to look for, or freshly generate information on status of frogs in other comparable localities of Western Ghats. Of particular relevance would be localities in a similar environmental setting which have had relatively little human intervention. Two such localities are Naravi in Belthangadi taluk and Pilarkanni Udupi taluk. As a part of Mala cluster study it would be worthwhile to investigate the current status of a number of parameters such as frog populations or soil nutrient status in these localities.

5.8.2 Local assessments would employ three kinds of methodologies to generate the required understanding. These would include : (1) mapping and measurements in the field, primarily by technically trained personnel, (2) field visits, jointly by members

of local community and technical experts and (3) discussions at individual, small groups or larger gatherings level by local community members working with technical experts.

6 SOIL AND WATER

6.1 Mapping and Measurement

(i) Topography and hydrology: Topographic survey maps provide the base of all further mapping. The study locality may be demarcated most conveniently on the basis of watershed boundaries. Fig. 3 is such a map of Mala cluster study locality with the stream network. This watershed is a part of the Swarna river basin for which records of flow are available. Rainfall information is also available for a nearby locality. Using this information inferences will be attempted as to any adverse impacts on stream discharges. Some fresh measurements of precipitation using simple rain gauges and stream flow employing a mobile prism - a sufficiently large cylindrical pipe marked with a graduated meter scale are planned to be undertaken over the next year. Also planned are measurements of gravity diversion as well as pumping of water from streams by the farmers.

(ii) Soil erosion, siltation: Measurements in different seasons of turbidity of water in the different streams are planned to yield information on possible levels of soil erosion and siltation.

(iii) Soil quality: Systematic soil samples are being collected to represent the different landuse / land cover based ecotope types (fig. 4). These will be analyzed for soil depth, soil texture, soil organic matter, soil carbon, nitrogen and phosphorus and possibly for some important pollutants to be decided upon. Similar soil sample analysis will be carried out from the Naravi and Pilarkaan localities mentioned above for comparative studies. These results may yield information on possible levels of soil degradation.

Soil samples were so far collected from 6 different locations of Mala village. These represent different land use/ land cover classes. One more sample was collected from the scrub near the gaging location of Yennehole river.

In all the locations 3 samples were collected up to a depth of approximately 85cm.

Table 6. Some Soil Properties of Mala Village

Location	Depth (cm)	Dry Density (g/cm^3)	Sp. Gravity	Porosity
Evergreen Forest (Bejjale)	26	1.3	2.08	0.375
	51	1.25	2.065	0.39
	86	1.284	2.15	0.4
Scrub (Kanegundi)	30	1.335	2.25	0.406
	52	1.554	2.23	0.303
	70	1.469	2.16	0.319
Paddy Field (Kasinbail)	40	1.725	2.26	0.33
	58	1.54	2.34	0.38
	70	1.53	2.4	0.38
Arecanut Plantation (Kodange)	30	1.428	2.36	0.39
	56	1.39	2.35	0.408
	70	1.43	2.43	0.41
Coconut Grove (Mata)	30	1.328	2.40	0.446
	56	1.423	2.39	0.4
	75	1.53	2.34	0.346
Cashew Plantation	25	1.324	2.3	0.424
	50	1.429	2.3	0.378
	75	1.409	2.28	0.382
Scrub (Near Yennehole Guaging Station)	20	1.25	2.12	0.41
	53	1.245	2.22	0.439
	80	1.20	2.23	0.46

(iv) Ground water: Measurements of the depth of water table tapped by open wells will be maintained for selected wells in all the subwatersheds of the study locality. This information will be incorporated along with other hydrological information to contribute to an understanding of the watershed function of the study ecosystem.

(v) Water quality: Basic water quality parameters, Biological Oxygen Demand, Chemical Oxygen Demand, Nitrogen and Phosphorous concentrations as well as a few more sophisticated ones such as concentrations of the most intensively used organic pesticides would be measured to understand the extent to which water quality may have deteriorated.

Table 7. Some Water Properties of Mala Village

Sl. No.	Test	Evergreen Forest	Machatte Stream	Open Well	Bore Well	Ambidgundi Stream	Yennehole gauging site
1	pH	7.29	6.8	5.61	7.06	6.6	7.13
2	TDS (ppm)	32	31	34	135	30	41
3	Hardness	24	16	18	96	10	20
4	Calcium (ppm)	2.4	3.2	2.4	26.4	2.4	2.4
5	Magnesium (ppm)	2.187	0.972	1.458	3.645	0.486	1.701
6	Sodium (ppm)	2.07	2.07	0.69	3.22	2.07	1.38
7	Potassium (ppm)	0.156	0.156	0.507	1.326	0.234	0.273
8	Chloride (ppm)	8	9	10	10	9	13
9	Alkalinity	22	18	22	100	16	22
10	Sulphate (ppm)	1.0	2.6	1.0	7.0	2.6	2.6
11	Nitrate (ppm)	0.474	0.1676	1.34	0.18	0.086	0.76
12	Iron (ppm)	0.0256	0.188	0.02	0.88	0.084	0.086
13	Fluoride (ppm)	Nil	Nil	Nil	0.04	Nil	Nil

Sl. No.	Test	Evergreen Forest	Machatte Stream	Open Well	Bore Well	Ambidgundi Stream	Yennehole gauging site
14	Sodium adsorption ratio	0.233	0.26	0.087	0.156	0.32	0.167
15	Electrical conductivity (mmho/cm)	43.3	42.8	45.3	167	39.4	53.1
16	Dissolved oxygen (mg/l)	6.8	6.9	6.0	6.5	6.8	6.9

6.2 Joint Field Visits of Local People and Experts

(i) Topography and hydrology: Figure 5 is a map depicting the local names of all landscape and waterscape features familiar to the people. Such a map facilitates further discussions between experts and local people by providing a commonly understood set of geographical terms; it also contributes to an understanding of the traditional landuse pattern in the study area. Field visits would also contribute to mapping the extent of time for which various streams run dry and in obtaining information on historical changes in levels of flow as well in the various demands for water, including diversion for irrigation purposes.

(ii) Soil erosion, siltation: Figure 6 is a map of joint assessment of soil erosion problems as revealed by exposure of stones and rocks and gully formation. Local people further provide an understanding of the history of these processes as well as forces driving them. They are also helping in mapping the extent and history of siltation in the streams and impact of other processes such as commercial removal of sand.

(iii) Ground water: Joint visits are planned to map current dry and wet season levels in open wells as well as to obtain information on the years during which bore wells were dug and the depth at which water was struck. These visits would also provide information on historical changes in ground water level.

(iv) Water quality: Joint visits are generating an understanding of nature and intensity of use of pesticides in different fields and orchards and their likely impact on water quality. In other localities considerable understanding on a variety of air, water and soil pollution problems could come as a result of such joint visits.

Table 8. Ecosystem goods/ services/ bads/ disservices associated with aquatic bodies in Mala study cluster.

LSE	UG	CATEGORY	USE	COMMON NAME
Water streams	Firewood collector	Firewood	Fuel	Hudenekki
Water streams	Firewood collector	Dead woods floating down	Fuel	
Water streams	Agriculturist	Water	Irrigitaion / domestic	
Water streams	Plantation owner	Water	Irrigitaion / domestic	
Water streams	Fishermen	Fishes	Fishing	
Water streams	All UGs	Water	Domestic	

LSE : Landscape element , UG : User group

Pesticide contaminated water create health problems for all UGs

6.3 Discussions

(i) Topography and hydrology: Individual and group discussions are resulting in a number of insights. One set of these are contributing to an inventory of aesthetically pleasing land and water features, such as rocky promontories, caves, waterfalls and deep pools, places whose beauty people wish to see preserved, their history and prospects. It is also providing an understanding of the history of surface water use, traditional irrigation and water sharing arrangements, the modern developments, including growing demands for water and their implications. For instance, it is reported that perennial crops have now greatly increased in acreage compared to paddy confined to the rainy season. This has led to a higher demand for irrigation water in the dry season. Furthermore, the traditional gravity flow irrigation is now replaced by sprinklers which greatly

reduce the water going back into streams or percolating to underground water table. With increasing use of electric pump sets lifting of water from the streams, as well as from underground water table has also increased. As a result, dry season stream flows have reduced and water table has gone down to an increased depth. People are clearly aware that underground water is a renewable resource and that overuse and reduction in recharge are leading to a depletion of this capital resource. Another significant issue for discussion has been the possibility of electricity generation through microhydel projects and local people have suggested several potentially promising sites. Field visits and flow measurements at these sites are being planned.

(ii) Soil erosion: In a discussion with rubber plantation owners it was claimed that the soil conservation measures, including coverage of ground by a leguminous climber have reduced soil erosion from these areas which were earlier heavily grazed scrubby lands.

(iii) Soil quality: There is a widespread perception that a decline in the use of organic manure accompanied by an increase in the application of chemical fertilizers has led to a serious loss in soil fertility.

(iv) Water quality: There is a widespread perception that extensive use of chemical pesticides has affected water quality and thereby aquatic animals, however chemical fertilizers are not perceived as a problem in this context.

7. LAND USE

7.1 Mapping and Measurement

Figure 4, depicts as described earlier a landscape map, whose elements are different types of ecotopes which reflect different types of land use.

7.2 Joint Fieldwork

7.2.1 Figure 7 is a map depicting major changes in land use and land cover over the last century or so. The field work included an examination of older, natural trees present in an area to infer the nature of vegetation that must have been replaced in recent times, complemented by reporting of changes within the living memory, as

well as on basis of oral histories handed down from earlier generations. Documentary sources such as land settlement records, forest working plans, district gazetteers also aid in the reconstruction of the historical changes in land use and land cover. This reconstruction is the foundation for assessment of changes in ecosystem goods/ services, as also bads/ disservice.

7.2.2 Quoted below is a sketch of Mala ecological history from the first People's Biodiversity Register prepared in 1997.

Ecological History of Mala

Major Historical Benchmarks

The Ecological history of Mala village could be traced back upto 300 years. However, for the recent past the major benchmarks in the ecological history of recent past pertaining to Mala village include the Land Reform Act of 1974, the period of Indian Emergency (1975-77) and the declaration of Kudremukh National Park in 1987. These were recognized by all groups of people.

Historical Social Changes

Pre - 1974 period

The first phase of landscape changes might have been started by the Malekudiyas through shifting cultivation. The Chitpavan Brahmins probably immigrated to Dakshina Kannada District about 300-400 years ago (1600 - 1680 A.D.) as immigrants from the neighboring states of Maharashtra and Goa. They settled along the foothills of Western Ghats in Dakshina Kannada district including Mala Village. An area now called 'Mata', must have been occupied by Lingayaths (Jangamas) who were worshippers of lord 'Shiva', before the arrival of Jains some 300-400 years ago. The presence of Brahmalingeshwara temple across Kadari Hole at Ubharyl, about one kilometer from Mata, supports this view. After settling, Jains must have taken to agriculture and started paddy cultivation; while Chitpavans cleared forest patches at the foothills of Western Ghats and must have started cultivating arecanut and became

horticulturists. Today, not a single Lingayat family is found in Mala village. Forces responsible for their emigration from Mala village in the distant past are unknown.

The relatively recent history shows that the society mainly comprised of various agrarian user groups with the rich landlords at the top and the insecure tenants and labourers at the bottom of the hierarchy related to land. Paddy was the main agricultural crop particularly in the plains of Mala village. In addition, horticultural cash crops such as arecanut, coconut, cashew, pepper etc were also being cultivated in the foothills of the Western Ghats. As a result two main systems of tenancy have flourished in the two agro-economic settings. The Chalageni system of tenancy evolved in the paddy cultivating zone, which may be called subsistence setting. Chalagenis were temporary tenancies and their lease was for a limited term, usually for a year or so, and was liable to be changed or terminated at will by the landlords. Chalageni tenants were quite often exploited by their landlords, since the landlords had the right to raise the rent or evict the tenant, if they refused to pay the enhanced rents. On the other hand, the Moolageni system of tenancy evolved in cash crops growing zone, which can be called commercial setting. Moolageni tenures were quite old and Moolagenigars were considered as proprietary tenants since their rights on land were perpetual. The landlords could neither enhance the rates nor evict the tenants if the rent was paid regularly. Apart from agricultural labour, Malekudiya tribals used to collect forest produce like spices and honey and sell it in the market. Fishing and practice of herbal medicine were also in vogue.

Post Land Reforms (1974) Scenario

The implementation of Land Reforms Act of 1974 had a tremendous impact on agrarian relations and user group pattern, not only in Mala but all over Dakshin Kannada. In the subsistence setting, the traditional, big landlords nearly disappeared from the scene. The hundreds of acres of land they owned partly got divided among family members and partly got sold or transferred to tenants. But hostility between the landlords and tenants continued and the landlords opposed even the fair claims of tenants and fought for resumptions of leased land for self-cultivation both by fair and unfair means.

However, while it was quite tough for Chalagenigars, the moolgeni tenants reaped the benefits of land reforms. The landlords, either evacuated the latter moolgeni tenants by paying suitable compensation, or not.

One of the important outcomes of the implementation of the land reforms in the subsistence setting has been the enormous increase in the number of the marginal and small farmers and corresponding decrease in the number of large farmers. In a way, the Land Reforms Act of 1974 not only unleashed major changes in the agrarian relations and user group pattern, but also brought about changes in every section of the rural society. Of late, some migrants from Kerala settled and started rubber plantations, others engaged in rubber tapping. The various caste groups and their correlation with their occupation started diluting, due to education and economic changes.

Landscape Changes and Driving Forces

The ecological history of Mala village clearly shows that landscape has been continuously changing and so also the forces moulding it, over last several decades and even centuries. Forces that led to landscape change are broadly social, economic, political and cultural. The chronological events of landscape history and the levels of biodiversity are summarized in the Table 9.

It is difficult to estimate the biodiversity levels existent in the earliest phase, some 300 years ago. But intuitively, these must have been much higher. For, people describe how dense and vast forests used to be and they were teeming with wildlife. The landscape would have been a mosaic of successional ecosystems. While Chitpavan Brahmins encroached on slope and riparian forests for arecanut plantations some 300 years ago, the forest department banned the shifting cultivation which allowed some forest restoration. However, the lust for revenue led to departmental and contractual plundering of the majestic evergreen forests for timber and plywood. Later the government gave some forest land on lease for cultivation and these got successively regularized through political pressures. This led to considerable forest encroachment. After this initial phase during the last decade the encroachment of areca cultivation on

forests slowed a bit. The forest department also imposed ban on tree felling and the area was declared as Kudremukh National Park. All these events favored forest restoration in areas that today look forested. The positive picture on the forest front is contrasted by the scrub habitat that is being lost to arecanut and rubber cultivation over the last decade at a fast rate.

The ecosystem people, especially women, have to spend more time and effort to gather increasingly diminishing supplies of fuelwood, fodder and other land based resources for bare survival. The need to collect more green manure due to growth in arecanut cultivation has also resulted in the further loss of biomass support areas like scrub and accentuated soil erosion. The forest department that planted scrub with Casuarina trees earlier has now stopped such plantations altogether. This indeed is a welcome sign as it reduces additional competition pressure on the scrub species.

In addition, the new farming practices have led to the increased use of fertilizers and pesticides and also intensive irrigation. The increasing area of monoculture plantation crops, especially arecanut, coconut, and cashewnut has caused reduction in the output of foodgrains. This all is reducing diversity of local, traditional cultivars and the wild relatives of crop plants. Besides, intensive agriculture might also be affecting several species of lower animals and microorganism in the soil.

The current system of offering time bound leases for forest produce exploitation has resulted in overexploitation of forest resources. At the same time, the common lands around habitations have been further rendered poorer in quality due to over exploitation of fuelwood, exploitation of timber and uncontrolled grazing of cattle. With the conversion of kumki land to plantation crops, other scrub patches and accessible reserve forests are gradually beginning to supply biomass needed for agriculture. The ecosystem people, mainly comprising of schedule castes and schedule tribes, who have customarily depended on forest resources and traditional agricultural practices for their livelihood, have been adversely affected by diminishing forests and common lands. Of course , the special welfare schemes provided for them by the Government and NGOs

have been instrumental in improving social and economic conditions, to an extent, but it is not adequate.

Table 9. Major events in the ecological history of Mala cluster of villages

PHASES	BIODIVERSITY ELEMENTS	TIME (years before present)	CHANGE (NATURE AND MAGNITUDE)	DRIVING FORCES (MANAGEMENT/ SOCIAL FACTORS)	IMPACT ON BIODIVERSITY (+VE/ -VE)	IMPACT ON PEOPLE (+VE/ -VE)
I	Natural Forests with maximum Biodiversity Elements (LSEs, species of animals and plants)	>300 yrs bp (=before present)	Mosaics of primary and secondary forests scrub, fallows etc	Malekudiyas Shifting cultivation	Negative	Positive
II	Loss of forest biodiver -sity and increase in agrobiodiversity	300-200 yrs bp	Slope and rivarine forests lost	Chitpavan Brahmins Horticulture Areca Plantation	Negative	Positive
III	Loss of forest biodiver -sity and increase in agrobiodiversity continued	200-100 yrs bp	Intensification and further erosion of riverine forests	Non-Brahmin communities population growth	Negative	Positive
IV	Further erosion of forest biodiversity increase of scrub jungles and thickets	50 yrs bp	Selective felling and degradation of forests	Forest department Timber, Plywood and paper industries	Negative	Positive
V	Fragmentation of agrobiodiversity. No significant change in forest biodiversity		Degradation of forests continued	Land reforms Act of 1974 conflicts between Landlords	Negative	Positive
VI	Afforestation & partial restoration of forest biodiversity	15 yrs bp	Gradual forest restoration. Social forestry declaration KNP	Ban on tree felling Reserve forestry was maintained	Positive	Positive
VII	Loss of Agrobiodiver -sity & intensification of Plantation crops	10 yrs bp	Loss of scrubs, thickets and agricultural lands	Introduction of Rubber Plantation & intensification of Areca plantation	Negative	Positive

7.3 Discussions

7.3.1 During early 1960s the forest department initiated large scale fellings for timber, for example, to meet the demands for railway sleepers, as well as auctioned off extraction of minor forest produce such as cane. This encouraged the invasion of an exotic weed, Eupatorium. A series of other ecosystem transformations followed in a cascade., After the construction of the bridge over Kadarihole and a road to Kudremukh from Karkala via Mala village in the year 1976, there have been radical changes in the land use pattern, as this road rendered accessible a huge and rich forest tract which previously supported subsistence demands of paddy and arecanut cultivators, with only a few produces such as cane baskets reaching the wider market. This historical development furnishes a case study on the effects of a large chunk of largely untouched forest being rendered accessible and getting fragmented by roads.

7.3.2 Many insights have emerged as to people's perceptions of appropriate patterns of land use. For instance, it is felt that excessive levels of conversion of paddy fields to arecanut orchards have been undesirable as this has increased irrigation water demands to unsustainable levels; or that conversion of former village common lands used as grazing grounds to habitation or Casuarina plantations has led to a forced reduction in livestock holding and a decline in organic manure resources.

8. AGRICULTURE AND TREE CROPS

8.1 Measurements carried out in collaboration with farmers

Studies for land under agriculture, i.e. under cultivation of seasonal/ annual crops and tree crops begin with the preparation of a checklist of cultivated plants (both seasonal and perennial) with scientific names, and that of cultivars (Table 10). The former is a straightforward task since the concept of botanical species is well defined. Cultivars however pose some difficulties in case of farmer's as opposed to breeder's varieties. The farmer's varieties tend to be non-uniform - with a great deal of intra-varietal variation, non-stable - with a great deal of variation from generation to generation and non-distinctive - with considerable overlap with other varieties. The problem is relatively less in case of largely self-pollinated plants such as paddy, or vegetatively

propagated crops like many mango varieties, but much more difficult for cross-pollinated crops. It has to be ultimately based primarily on the basis of recognition and naming by local people along with a careful recording of the attributes characterizing them. Table 11 provides such a listing of the cultivars of paddy for Mala cluster.

Table 10. A Checklist of Cultivated Plants of Mala Cluster Study Area

1.	*Anacardium occidentale*	*FR*
2.	*Averrhoa bilimbi*	*FR*
3.	*Averrhoa carambola*	*FR*
4.	*Carica papaya*	*FR*
5.	*Citrus aurantium*	*FR*
6.	*Citrus decumana*	*FR*
7.	*Citrus limetta*	*FR*
8.	*Citrus limon*	*FR*
9.	*Citrus medica*	*FR*
10.	*Coffea arabica*	*FR*
11.	*Mangifera indica*	*FR*
12.	*Passiflora edulis*	*FR*
13.	*Sapindus laurifolius*	*FR*
14.	*Spondias mangifera*	*FR*
15.	*Syzygium hemisphericum*	*FR*
16.	*Syzygium malaccensis*	*FR*
17.	*Tamarindus indica*	*FR*
18.	*Theobroma cacao*	*FR*
19.	*Occimum sanctum*	*MED*
20.	*Occimum basilicum*	*MED*
21.	*Plumbago rosea*	*MED*
22.	*Allamanda cathartica*	*OP*
23.	*Allamanda neriifolia*	*OP*
24.	*Angelonia grandiflora*	*OP*
25.	*Antigonon leptopus*	*OP*
26.	*Asystasia gangetica*	*OP*
27.	*Bambusa vulgaris*	*OP*
28.	*Barleria involucrata*	*OP*
29.	*Barleria prionitis*	*OP*
30.	*Basella rubra*	*OP*
31.	*Bauhinia tomentosa*	*OP*
32.	*Begonia valdensianum*	*OP*
33.	*Bougainvillaea spectabilis*	*OP*
34.	*Breynia nivosa*	*OP*
35.	*Caladium hortulanum*	*OP*
36.	*Canna indica*	*OP*
37.	*Celosia cristata*	*OP*

38.	*Chrysanthemum morifolium*	*OP*
39.	*Chrysothemis pulchella*	*OP*
40.	*Clerodendron calamitosum*	*OP*
41.	*Clerodendron fragrans*	*OP*
42.	*Clerodendron siphonum*	*OP*
43.	*Coleus barbatus*	*OP*
44.	*Coleus blumei*	*OP*
45.	*Coleus rehneltianus*	*OP*
46.	*Cordyline terminalis*	*OP*
47.	*Crossandra unduleafolia*	*OP*
48.	*Croton varigatum*	*OP*
49.	*Epiprenum pinnatum*	*OP*
50.	*Episcia cupreata*	*OP*
51.	*Eranthium bicolour*	*OP*
52.	*Ervatamia coronaria*	*OP*
53.	*Ervatamia corymbosa*	*OP*
54.	*Haemanthus katherinae*	*OP*
55.	*Hedychium coronarium*	*OP*
56.	*Hedychium flavum*	*OP*
57.	*Heliconia rostrata*	*OP*
58.	*Hibiscus mutabilis*	*OP*
59.	*Hibiscus rosa-sinensis*	*OP*
60.	*Hibiscus schizopetalous*	*OP*
61.	*Hydrangea macrophylla*	*OP*
62.	*Ipomoea batatas*	*OP*
63.	*Ixora coccinea*	*OP*
64.	*Ixora macrothyrsa*	*OP*
65.	*Jasminum grandiflorum*	*OP*
66.	*Jasminum officinale*	*OP*
67.	*Jasminum sambac*	*OP*
68.	*Justicia betonica*	*OP*
69.	*Justicia gendarussa*	*OP*
70.	*Kalanchoe blossfeldiana*	*OP*
71.	*Lawsonia inermis*	*OP*
72.	*Magnolia sp.*	*OP*
73.	*Maranta arundinacea*	*OP*
74.	*Michelia champaca*	*OP*
75.	*Mirabilis jalapa*	*OP*
76.	*Nerium odorum*	*OP*
77.	*Nyctanthes arbor-tristis*	*OP*
78.	*Pachystachys lutea*	*OP*
79.	*Pandanus odoratissimus*	*OP*
80.	*Pentas carnea*	*OP*
81.	*Pilea cadierei*	*OP*
82.	*Plumeria acutifoila*	*OP*
83.	*Pogostemon patchouly*	*OP*
84.	*Polyalthia longifolia*	*OP*
85.	*Polyscias crispatum*	*OP*
86.	*Portulaca oleracea*	*OP*

87.	*Quisqualis indicus*	*OP*
88.	*Rosa indica*	*OP*
89.	*Russelia juncea*	*OP*
90.	*Salvia coccinea*	*OP*
91.	*Senecio cineraria*	*OP*
92.	*Sesabania grandiflora*	*OP*
93.	*Tagetes erecta*	*OP*
94.	*Tecoma stans*	*OP*
95.	*Thevetia neriifoila*	*OP*
96.	*Thunbergia alata*	*OP*
97.	*Thunbergia erecta*	*OP*
98.	*Thunbergia fragrans*	*OP*
99.	*Thunbergia grandiflora*	*OP*
100.	*Vernonia sp.*	*OP*
101.	*Wedelia trilobata*	*OP*
102.	*Zinnia elegans*	*OP*
103.	*Curcuma longa*	*SP*
104.	*Elettaria cardomomum*	*SP*
105.	*Mimusops elengi*	*TIM*
106.	*Benicasa hispida*	*VEG*
107.	*Capsicum annuum*	*VEG*
108.	*Capsicum annuum*	*VEG*
109.	*Citrullus vulgaris*	*VEG*
110.	*Coccinia indica*	*VEG*
111.	*Coriandrum sativum*	*VEG*
112.	*Cucumis sativus*	*VEG*
113.	*Cucurbita maxima*	*VEG*
114.	*Lagenaria vulgaris*	*VEG*
115.	*Manihot esculenta*	*VEG*
116.	*Momordica charantia*	*VEG*
117.	*Moringa pterygosperma*	*VEG*
118.	*Solanum melongena*	*VEG*
119.	*Solanum suffruticosum*	*VEG*
120.	*Solanum torvum*	*VEG*
121.	*Solanum tuberosum*	*VEG*
122.	*Trichosanthes anguina*	*VEG*

Legends: *FR: Fruits; MED: Medicine; OP: Ornamental Plant; SP:Spice; TIM: Timber; VEG: Vegitable.*

A Checklist of cultivars of Mala cluster study area

A) Coconut varieties (*Cocos nucifera*):

1) Kundhiri – size of the coconut is small and it yields about hundred coconuts per bunch
2) Gendhaali – colour of the coconut is orange; tender coconuts are prefered for medicine.
3) Sithaali - colour of the coconut is yellow.
4) Padhnenma thingal – Starts yielding at the 18^{th} month.
5) Keththe siyaala - The outer husk of the tender coconut is edible.

B) Arecanut varities (*Areca catechu*):

1) Rama adike - size of the fruit is bigger than normal; tree grows very tall. Fruit is unshelled raw.
2) Mangala
3) Vitla
4) Local
5) Singapore adike – the fruits are very small in size. Nuts are very hard.

C) Jackfruit (*Artocarpus heterophyllus*):

1) Thulve
2) Balke
3) Mundi pelakai
4) Rudhrakshi

D) Pepper (*Piper nigrum*):

1) Panniyoor
2) Mallige sara
3) Local
4) Kari munda
5) Kudhka munchi

E) Jamoon fruit (*Syzygium cuminii*):

1) Sakre jam
2) Pannerle
3) Punjaabi jam : white, red
4) Huli jam

F) Punarpuli (coccum) (*Garcinia indica*):

1) Red
2) Yellow

G) Ginger (*Zingiber officinale*):

1) Agar shunti
2) Kukku shunti
3) Shunti

H) Mango (*Mangifera indica*):

1) Mundappa
2) Gili maavu
3) Neelam
4) Malgova
5) Local
6) Nekkare
7) Aapoos
8) Thothapuri
9) Pairi
10) Gadhdhamaaru
11) Manoranjan
12) Godhavari : gonchal godhi, single

I) Betel (*Piper betel*):

1) Gobbara balli/kolire
2) Mundoli
3) Ambaadi
4) Pancholi

J) Colocasia (*Colocasia sp.*):

1) Kariya sevu
2) Mara sevu
3) Mundi
4) Kaatu sevu

K) Lemon (*Citrus sp*.):

1) Gaja limbe
2) Local limbe
3) Kanchi puli
4) Mahalunga/Madhrampuli
5) Dhodra

L) Banana (*Musa sp.*):

1) Surya baale (yellow)
2) Chandra baale (red)
3) Kadhali/Dhevu baale (2 variety)
4) Poobaare/Rasa baale
5) Kaatu baale
6) Yelakki baale
7) Mysore baale

8) Sahasra kadhali/Munde baare (1000 fruits)
9) Put baare
10) Nendhra
11) Kevandis
12) Shilyanti
13) Onte baale
14) Bhoodh baale

M) Paddy varities (*Oryza sativa*):

1) Hallige
2) Athikaye
3) Kanuve
4) Kajakaayeme
5) Raajakaayeme
6) JB
7) Mogin boldhu
8) Kariyadhadi
9) Gandhasalai
10) Jeerasalai
11) I-R-8
12) Jaya

N) Spondias (*Spondias sp.*):

1) Khaara ambade
2) Godh ambade
3) Ambade

O) Coffee (*Coffea arabica*):

1) Robust
2) Local

Other vegetables and fruits:

1) Haagala
2) Boor peere
3) Southe
4) Mullu southe: Aaane muttu, yelu ire, chikka mullu southe, kudhka southe, kareeta
5) Kumbala : kempu (*Cucurbita maxima*), boodhu (*Benincasa hispida*)
6) Thonde kai
7) Poona kirengu (*Dioscorea*)
8) Thuppa kirengu (*Dioscorea*)
9) Suvarna gadde
10) Palm oil
11) Guava: Without seeds, hybrid.
12) Orange: Nagpur orange
13) Dhodle huli
14) Maaphala

15) Sweet lime
16) Vanilla
17) Clove
18) Egg fruit
19) Pineapple: Moris, local, without prickles
20) Lichi

Flowers:

A) Champaka (*Michelia champaka*):

1) Genda sampige
2) Chini sampige
3) Haladhi sampige

B) Jasmine (*Jasminum sp.*):

1) Jaaji (*Jasminum grandiflorum*)
2) Dhundu mallige
3) Kasthuri mallige
4) Mallige
5) Muththu mallige
6) Mundas mallige

C) Hibiscus: 25 varieties.

Livestock:

A) Poultry:

1) Manjole
2) Uriye
3) Praddige
4) Korange
5) Karbale
6) Hybrid

B) Dogs:

1) Kaalu
2) Maire
3) Mangale
4) Thoudu
5) Mudhol honda

C) Honey Bee:

1) Thodde
2) Periya
3) Maduve
4) Kolcha : Pundi kolcha, Thatti kolcha
5) Mujanti

Table 11. Cultivars of Paddy grown currently or in recent past in the Mala cluster study area

Sl. No.	Traditional Paddy Variety	Sowing Time
1	Kayame	June
2	Kavlukayame	June
3	Rajakayame	June
4	Thonnuru	June
5	Dhodre	February
6	Bolliari-small	June
7	Hambuge	June
8	Athikare	June
9	Gandhasale	June
10	Jeerasale	June
11	Peetisale	June
12	Maskathi	June
13	Suggi kayame	October; February
14	Karthi kayame	June
15	Kutti kayame	June
16	Hallige	June
17	Kanuve	June
18	Kage JB	October
19	Kattu mundai	June-October
20	Gaddu kayame	June
21	Kaje kayame	
22	Kumera	June
23	Kariyadhadi	June
24	Sooranje	
25	Boli ari-big	June
26	Sonpakutti	October-February
27	Sona bidhe	October

The second step is a classification of the different cropping mixes under which cultivated plants are grown, ranging from highly diverse home gardens to extensive paddy fields under a single modern breeder's variety. The number of classes to be recognised will have to be decided upon primarily in terms of convenience. The third step is then a variety of measurements for representative fields of each class of cropping mix. These would include : (a) Diversity of cultivated plants, (b) Diversity of pests, diseases, weeds, (c) Diversity of other non-cultivated plants and animals associated with the crops, (d) Inputs into cultivation including labour, specially purchased seeds, manure, fertilizers and

pesticides (e) Levels of biomass production (f) Levels of economically valuable products and by-products of cultivation. In addition, of course, there would be soil and water related measurements mentioned above.

8.2 Discussions

These would focus on how patterns and practices of cultivation have changed over time, and how these have affected the ecosystem goods and services; bads and disservices. People in Mala cluster have expressed a number of concerns, including (i) non-sustainable use of irrigation water (ii) Loss of soil fertility under continued application of chemical fertilizers (iii) death of many non-target organisms due to applications of pesticides. However, there seems to be little concern with loss of diversity of cultivars. There were many cultivars of paddy; there was little such variation in other important crops such as arecanut and coconut . Since paddy is the least paying of the crops and is losing out to other crops, there seems to be little interest in the maintenance of its cultivars, though people do recall that the traditional cultivars had better flavour and taste, although lower levels of yields. A very interesting on-going effort in Mala cluster is that of revival of organic agriculture led by one of the largest land-owners, Mr. Muniraj Ballal.

`Brahma Srushti' and `Vishwamitra Srushti':

Local people talk of creation of two worlds or Srushtis, that of Brahma, the god of creation and of Vishwamitra, a sage. The usual cultivated varieties of plants have been regarded as the `Brahma Srushti'. The wild relatives of cultivated plants, including wild pepper, wild mango, wild jack-fruit, wild cardamom, wild nutmeg etc. have been considered as `Vishwamitra Srushti', and there have greater genetic vigour and could be cross-pollinated/ grafted with the cultivated varieties to rejuvenate and revitalize the cultivated varieties from time to time.

Table 12. Ecosystem goods/ services/ bads/ disservices associated with cultivated lands of Mala study cluster

Ecosystem goods

LSE	UG	COMMON NAME	CATEGORY	USE	M/L/B
Private tree plantations	Firewood collector	Areca (leaves)	Firewood	Fuel	L
Private tree plantations	Firewood collector	Coconut (leaves)	Firewood	Fuel	L
Private tree plantations	Firewood collector	Cashew (branches)	Firewood	Fuel	L
Private tree plantations	Firewood collector	Rubber (branches)	Firewood	Fuel	L
Private tree plantations	Firewood collector		Leaf litter	Fuel	L
Private tree plantations	Agriculturist	Areca (stems)	Stems	Water transportation	L
Private tree plantations	Plantation owner / Outsider	Rubber	Plantation crop	Commercial product	M
Private tree plantations	Plantation owner / Outsider	Areca nut	Plantation crop	Commercial product / Local consumption	B
Private tree plantations	Plantation owner	Coconut	Plantation crop	Local consumption	L
Private tree plantations	Plantation owner / Outsider	Cashew	Plantation crop	Commercial product / local consumption	B
Private tree plantations	Plantation owner / Outsider	Pepper	Plantation crop	Commercial product / local consumption	B
Private tree plantations	Plantation owner / Outsider	Cocoa	Plantation crop	Commercial product / local consumption	B
Private tree plantations / habitations	Toddy tapper / Plantation owner	Toddy (from Caryota)		Mild intoxicant	B
Private tree plantations	Folk artist	Coconut leaves		Ornament	L
Agricultural land	Firewood collector	Agri-waste		Fuel	L
Agricultural land	Agriculturist	Paddy	Crop	Local consumption	L

LSE	UG	COMMON NAME	CATEGORY	USE	M/L/B
Agricultural land / Habitations	Agriculturist	Sapota	Crop	Local consumption	L
Agricultural land/ Habitations	Agriculturist	Mango	Crop	Local consumption	L
Agricultural land/ Habitations	Agriculturist	Papaya	Crop	Local consumption	L
Agricultural land / Habitations	Agriculturist	Jackfruit	Crop	Local consumption	L
Agricultural land/ Habitations	Agriculturist	Banana	Crop	Local consumption	L
Agricultural land	Agriculturist	Crabs Apple snails	Crustacean Molluscs	Local consumption	L
Agricultural land	Agriculturist	Morantai (Cat fishes)	Fishes	Local consumption	L
Private tree plantaions	Outsiders	Areca plates	VA product	Commercial product	M
Private tree plantations	Outsiders	Rubber sheets	VA product	Commercial product	M
Private tree plantations	Outsiders / All local UGs	Large serving spoons (Coconut shells)	VA product	Commercial product	B

M = Marketed, L = Locally used, B = Both marketed and locally used, VA = Value-added, LSE = Landscape Element (use-based), UG = User Group

Ecosystem services

LSE	UG	Service
Private tree plantation	Agriculturist / Plantation owner	Check on soil erosion (due to contours)
Private tree plantation	Honey collector	Flowering of plantation crops leads to increased availability of honey

Ecosystem bads

LSE	UG	Common name	Dis-use
Agricultural land / Plantation	Agriculturist / Plantation owner	Rat	Nuisance
Agricultural land / Plantation	Agriculturist / Plantation owner	Hare	Nuisance
Agricultural land / Plantation	Agriculturist / Plantation owner	Bandicoot	Nuisance
Agricultural land / Plantation	Agriculturist / Plantation owner	Bonnet macaque	Nuisance
Agricultural land / Plantation	Agriculturist / Plantation owner	Mite	Crop pest
Agricultural land / Plantation	Agriculturist / Plantation owner	Caterpillar	Crop pest
Agricultural land / Plantation	Agriculturist / Plantation owner	Stem borer	Crop pest
Agricultural land / Plantation	Agriculturist / Plantation owner	Beetles	Crop pest
Agricultural land / Plantation	Agriculturist / Plantation owner	Tree borer	Crop pest
Agricultural land / Plantation	Agriculturist / Plantation owner	Terminal leaf eater	Crop pest
Agricultural land	Agriculturist	Sparrow	Crop pest
Agricultural land	Agriculturist	Peafowl	Crop pest
Agricultural land	Agriculturist	Quail / Partidge	Crop pest
Agricultural land / Plantation	All UGs	Ticks	Nuisance

(Plantation refers to private tree plantations)

Ecosystem disservices :

Agricultural lands and private tree plantations are repository of nuisance species and pests (See above).

9. FORESTS

While from an ecological perspective we may discriminate several types of ecotopes with natural or human impacted forest vegetation, the local people treat this as a single type. They however recognize within the broad forest category different habitat preferences – for instance, that some genera like *Gymnacranthera* and *Pandanus* are restricted to swamps, others to streamsides, others to hill tops, and so on. The government

forest department, on the other hand, treats all land under its legal control, regardless of whether it is under grassland, Casuarina plantation or natural forest as forest.

9.1 Measurements

Apart from soil and water related parameters mentioned earlier, the scientific measurements would focus on standing biomass, harvests and biodiversity. Methods of biodiversity measurements would be considered below under section 14. Standing biomass may be measured through quadrats or plotless methods such as point centred quarter method. In the latter method a series of transects are laid from randomly chosen starting points along random directions of compass with a sampling point fixed at some predetermined interval, such as 100 meters. At this sampling point distance, girth and height of trees nearest to the point in each of the four quarters are measured; a tree being defined as a plant with a diameter of 10cm or more at a height of 130cm. Standard textbooks on eoclogical methodology provide other details including computational formulae. Other measurements such as leaf litter and regeneration may also be undertaken.

Table 13. Ecosystem goods/ services/ bads/ disservices associated with forest lands of Mala study cluster

Ecosystem goods

LSE	UG	COMMON NAME	SCIENTIFIC NAME	CATEGORY	USE	M/L/ B
Evergreen forest	NTFP collector	Manthapuli	*Garcinia cambogia*	NTFP	Pickles	M
Evergreen forest	NTFP collector	Bherundi	*Garcinia indica*	NTFP	Food	B
Evergreen forest	NTFP collector	Vatehuli	*Artocarpus lakoocha*	NTFP	Pickles	B
Evergreen forest	NTFP collector	Rampatre	*Myristica malabarica*	NTFP	Condiment	M
Evergreen forest	NTFP collector	Dalchini	*Cinnamomum verum*	NTFP	Condiment	M
Evergreen forest	NTFP collector	Dhupa	*Vateria indica*	NTFP	Varnish	M
Evergreen forest	NTFP collector	Norekai	*Sapindus laurifolius*	NTFP	Detergent	B
Evergreen forest	NTFP collector	Yelakki	*Ellateria cardomomum*	NTFP	Condiment	B
Evergreen forest	NTFP collector	Karimenasu	*Piper nigrum*	NTFP	Condiment	B
Evergreen forest	NTFP collector	Mavu	*Mangifera indica*	NTFP	Food	B
Evergreen forest	NTFP collector	Alale	*Terminalia chebula*	NTFP	Tanning	L

LSE	UG	COMMON NAME	SCIENTIFIC NAME	CATEGORY	USE	M/L/ B
Evergreen forest	NTFP collector	Mundaga	*Pandanus*	NTFP	Mat making	L
Evergreen forest	NTFP collector	Bettha	*Calamus*	NTFP	Basket making	L
Evergreen forest	NTFP collector	Vate	*Ochalandra*	NTFP	Basket making	L
Evergreen forest	Firewood collector	Honne	*Callophyllum apetalum*	Firewood	Fuel	L
Evergreen forest	Agriculturalist			Leaf liiter	Manure	L
Evergreen forest	Agriculturalist	Ratsnake	*Ptyas sp.*	Reptile	Pest control (Predator)	
Evergreen forest	Fishermen	Karekai	*Randia dumatorum*	Bush	Fish poison	L
Evergreen forest	Honey/beewax collector			Honey and beewax		L
Evergreen forest	Basket makers	Nedil	*Lea indica*	Climbers	Basket makers	B
Evergreen forest	Basket makers	Renjir	*Calycopteris floribunda*	Climbers	Basket makers	B
Evergreen forest	Basket makers	Ithalbooru	*Desmos lawii*	Climbers	Basket makers	B
Evergreen forest	Basket makers	Pandil	*Uvaria narum*	Climbers	Basket makers	B
Evergreen forest	Basket makers	Perbooru	*Tylophora indica*	Climbers	Basket makers	B
Evergreen forest	Basket makers	Madir	*Hippocratia arnottiana*	Climbers	Basket makers	B
Evergreen forest	Basket makers	Arkadabooru	*Pothos scandens*	Climbers	Basket makers	B
Evergreen forest	Artisans			Stems of dead trees	Used as charcoal	L
Evergreen forest	Folk artists	Kiskara	*Ixora coccinea*	Flower	Coloring material	L
Scrubland/ Thickets	NTFP collector	Sheegakai	*Acacia concinna*	NTFP	Detergent	B
Scrubland/ Thickets	NTFP collector	Soapnut	*Sapindus laurifolium*	NTFP	Detergent	B
Scrubland/ Thickets	Artisans/ carpenters	Cashew (tree)	*Anacardium occidentale*	Wood	Implements	L
Scrubland/ Thickets	Artisans/ carpenters	Korajji	*Ixora brachiata*	Wood	Implements	L
Scrubland/ Thickets	Artisans/ carpenters	Matthi	*Terminalia paniculata*	Wood	Implements	L
Government plantations	Basket makers	Cane	*Calamus sp.*		Basket making	B
Government plantations	Firewood collector	Cashew (branches)	*Anacardium occidentale*	Firewood	Fuel	L
Government plantations	Firewood collector	Acacia (branches)	*Acacia auriculiformes*	Firewood	Fuel	L
Government plantations	Firewood collector	Teak (branches)	*Tectona grandis*	Firewood	Fuel	L
Government plantations	Firewood collector	Casuarina (branches)		Firewood	Fuel	L
Government plantations	Forest Dept officials	Acacia	*Acacia aurifuliformes*	Wood	Sale by auction	M
Government plantations	Forest Dept officials	Casuarina	*Casuarina equiserifolia*	Wood	Sale by auction	M
Government plantations	Forest Dept officials	Teak	*Tectona grandis*	Wood	Sale by auction	M

Value-added products based on ecosystem goods derived from forests used by outsiders include mats, baskets and rain-covers.

L = Locally used

M = Marketed

B = Both locally used and marketed

LSE = Landscape element category (use based)

UG = User group

Ecosystem services:

Evergreen forests are origin of streams

Evergreen forests are repository of honeybees

Evergreen forest are of aesthetic and cultural value, especially at sacred spots, such as *Brahmasthanam* in Mala village.

Ecosystem bads:

(All the bads refer to evergreen forest)

Common name	**UG**	**Dis-use**
Wild Boar	Agriculturist / Plantation owner	Nuisance
Sloth Bear	Agriculturist / Plantation owner	Nuisance
Civet	Agriculturist / Plantation owner	Nuisance
Rat	Agriculturist / Plantation owner	Nuisance
Porcupine	Agriculturist / Plantation owner	Nuisance
Hare	Agriculturist / Plantation owner	Nuisance
Gaur	Agriculturist / Plantation owner	Nuisance
Bonnet Macaque	Agriculturist / Plantation owner	Nuisance
Mite	Agriculturist / Plantation owner	Crop pest
Caterpillar	Agriculturist / Plantation owner	Crop pest

Common name	UG	Dis-use
Stem borer	Agriculturist / Plantation owner	Crop pest
Terminal leaf eater	Agriculturist / Plantation owner	Crop pest
Tree borer	Agriculturist / Plantation owner	Crop pest
Beetle	Agriculturist / Plantation owner	Crop pest
Jungle fowl	Agriculturist / Plantation owner	Crop pest
Pea fowl	Agriculturist / Plantation owner	Crop pest
Quail / Patridge	Agriculturist / Plantation owner	Crop pest
Ticks	All UGs	Nuisance
Leeches	All UGs	Nuisance

Ecosystem disservices :

Evergreen forests are repositories of nuisance species, pests and vectors (See above).

9.2 Joint Field Visits

Information in official records of the harvest from forests, as well as management regime is often incomplete and inaccurate. Moreover such records are not readily accessible. Forest produce harvests, an important component of ecosystem goods and services are therefore best estimated through joint field visits with local people many of whom either work as forest labourers or collect forest produce for self-consumption as well as sale. The joint field visits may also be used to reconstruct the history of vegetation and of flow of ecosystem goods/ services/ bads/ disservices from particular forest patches.

9.3 Discussions

9.3.1 Discussions have produced a wealth of information on flows of ecosystem goods/ services/ bads/ disservices from the forest ecotopes. A significant historical event in this context was the large scale felling of trees for railway sleepers in mid 1960's. An important species being so felled was *Poeciloneuron*, whose resin renders

it susceptible to fire. Apparently there was a major crown fire during this operation leading to large scale death of forest tree populations and drastically changing the forest composition. A tribal hamlet in upper forest reaches reports, that it has required many decades after this fire for the streams to their locality to resume normal dry season flows.

9.3.2 A second major event reported was the commercial exploitation of canes (rattan) around the same time. Cane of several *Calamus* species had traditionally been very abundant in this forest and extensively used locally. It was marketed to a limited extent as baskets woven by some artisanal households. In particular cane harvests during 1960s included harvests of the top portion of rhizome along with the basal segment of the stem to produce walking sticks with hooked tops. This new practice reportedly totally decimated the very abundant cane stocks. However, in a recent welcome development the forest department has reintroduced cane species in several places within the newly declared national park.

9.3.3 This phase of exploitation and opening up of the canopy coincided with the invasion of the exotic composite weed *Eupatorium odoratum (=Chromolaena odorata*). This weed has profoundly affected the understory herbs and shrubs as well as trees regeneration and eliminated the sources of many minor forest produce as well as grazing for cattle.

9.3.4 These discussions also bring out that people have a basic appreciation of the idea that harvests from forests beyond a limit would lead to drastic depletions in the forest stock. They also understand successional processes, remarking that reduction of grazing and fire on grasslands enclosed by forest have led to a progressive change in the vegetation from grassland to shrubby growth to woodland.

10. FORESTRY PLANTATIONS

10.1 Measurements

Soil, water, biomass, harvests and biodiversity would be quantitatively assessed in case of the forestry plantations such as *Casuarina equisetifolia*, and *Acacia auriculiformis* following methods similar to these discussed for forests above.

10.2 Joint Field Visits

These are very useful in recording the history of forestry plantations, especially in terms of flow of ecosystem goods/ services – bads/ disservices from these locales. These exotic species plantations do not permit any undergrowth and thereby exclude grazing. They do not provide any leafy matter useful as green manure. Local communities therefore view these as responsible for substantial loss of ecosystem goods/ services earlier accessible to them.

10.3 Discussion

Forestry plantations have largely come up on lands that were earlier maintained as community grazing lands. During the period 1970s, there was a spurt of encroachment on these lands for cultivation and habitation both by the local inhabitants and immigrants. One of the official reactions was the handover of authority over such lands to Forest Department which brought them under plantations of exotic species which would resist grazing pressure.

11. GRASSLANDS

All the grasslands under the temperature, rainfall, soil conditions prevalent at Mala cluster study site are secondary, created either as a result of (a) shifting cultivation practiced earlier and discontinued around the end of the 19^{th} century; these occur on upper hill slopes, or (b) deliberate clearance of forest around settled cultivation and habitation in the valley or lower hill slopes to create grazing resources for the cattle.

11.1 Measurements

Soil and water related measurements are to be carried out by appropriate methods as discussed earlier. Biomass may be estimated at the end of the growing season, coincident with cessation of rains around November through harvest of 1m x 1m sampling plots distributed randomly in a representative set of grassland patches. Biodiversity will be estimated through methods discussed further in section 14.

11.2 Joint Field Visits

Joint visits provide inputs on histories of particular grasslands and the flows of ecosystems goods/ services and bads/ disservices.

Table 14. Ecosystem goods/ services/ bads/ disservices associated with grasslands of Mala study cluster

LSE	UG	CATEGORY	USE	COMMON NAME	M/L/B
Grassland	NTFP collector	NTFP	Pickles	Emblica	L
Grassland	Animal husbandry	Grass	Fodder		

L = Locally used

M = Marketed

B = Both locally used and marketed

LSE = Landscape element category (use based)

UG = User group

11.3 Discussions

People identify grasslands as an ecotype tope that has been especially eroded in recent decades, and whose ecosystem goods and services are now in great scarcity. This is traced to two causes: (a) rapid decimation of common property resources as traditional community organization and practices have changed due to a variety of forces of modernization, and (b) antipathy of forest authorities towards cattle and fire; two agents responsible for maintenance of grasslands.

12. DOMESTIC ANIMALS

Cattle, dogs and chicken are the three species maintained under domestication by a significant proportion of people since many generations. Buffalo, goat and pig have been introduced in the last few decades.

12.1 Measurements

Survey of randomly selected households from the different groups of people can provide estimates of biomass, productivity and the variety of goods and services furnished by domestic animals. There are no definable land races amongst the traditionally maintained domesticated animal populations. Therefore, while their range of variability may be noted, no investigation of land race diversity is called for.

12.2 Joint Field Visits

History of change in holding of domestic animals, availability of food resources to these animals, change in their productivity, diseases, predation by wild animals and the various goods and services provided by them can be ascertained through discussions involving visits to households and grazing lands. These also bring out some special insights: modern breeds of chicken are purchased only for meat and never maintained for any length of time since all chicken are kept as free range chicken feeding on their own. Moreover, cockfights are a favourite pastime and traditional chicken are selectively bred as fighting cocks. People talk of a pale mutant form of cattle “Kabetis” as a special sacred breed; in fact these appear not to be true breed, nor are there any attempts to deliberately breed for them.

12.3 Discussions

Free grazing cattle, primarily serving to convert natural vegetation into manure for agriculture was traditionally a significant link between natural and managed ecosystems. This link is now under considerable stress due to encroachment of common grazing grounds and deterioration of grazing resources in the forest because of the invasion by *Eupatorium*.

13. FISH

The aquatic ecosystems of Mala are primarily hill streams and some small artificial tanks and wells. Fish are neither especially abundant nor diverse in these waterbodies, yet they have been significantly depleted.

13.1 Measurements

Fish populations may be sampled using hook and line, cast nets, gill nets, baited traps or sweeps of rectangular nets. They may also be sampled in conjunction with fishing by people for their own purpose.

13.2 Joint Field Visits

History of changes in fish fauna in particular water bodies and forces driving these changes are well documented through joint visits. Also of relevance was the visit to a stretch of river protected through personal effort by a farmer who owns neighbouring lands.

13.3 Discussions

Discussions have led to many insights into the history of fish populations. Large scale road construction activity taken up in 1970's has led to ready availability of dynamite. This has been used in destructive fishing leading to a serious depletion in fish populations, now estimated to be around 25% of the earlier level.

14. BIODIVERSITY

Biodiversity is an issue somewhat different from water, agriculture, forest, livestock or fish. While specific components of biodiversity are significant as sources of ecosystem goods/ services – bads/ disservices, biodiversity per se does not constitute such goods or services. Nevertheless status and trends in biodiversity per se are of substantial interest. But nobody has so far succeeded in carrying out an all taxa biodiversity inventory, let alone go down to the yet lower level of genetic diversity except to a very limited extent. So the measurement of biodiversity will have to focus on some specific components alone. For logistic reasons, we suggest the following upto species level: (a) angiosperms

(b) butterflies (c) birds (d) fishes (e) molluscs. At the family level: (f) aquatic insects. At the level of varieties, cultivars, land races, we suggest (a) cultivated plants (b) domestic animals.

14.1 Measurement

14.1.1 For local level assessments it is sufficient to record presence/ absence without attempting to estimate abundances. The spatial units for the measurements should be individual elements within the landscape e.g. a forest patch, rubber plantation or a stretch of a stream. The attempt would then be to come up with a checklist of occurrence of relevant family/ species/ cultivar within the patch.

14.1.2 For this purpose we need some standardized methodology. A species list generated from an all out search of an area is the most frequently used method to survey the species diversity. However, a practical problem associated with all such efforts is the lack of knowledge of the number of species which are present but have been "missed". Can one estimate the number of species which have been "missed" in this effort? An answer to this question will facilitate the evaluation of the "completeness" of the species list and hence the necessity for further sampling effort.

In an attempt to come up with a simple methodology to answer this question we undertook sampling exercises aimed at generating species lists for trees with three observers in four different habitats in Mala village. We present here the details of the sampling and data analysis methodology. The results of the analysis are also presented. Each of the 3 observers spent an equal amount of time (T_{obs}, in minutes) in each habitat while performing an all out search to prepare a list of observed species, spotting A, B and C sets of species respectively. Let N_{obs} be the cumulative number of species seen by the observers at the end of their sampling effort and N_{tot} be the total of number of species that are present in the area. The latter quantity needs to be estimated. Let P_i be the probability that the observer I will `spot' a tree species. This quantity could also be understood as the efficiency of the observer. Now, the aim of

the exercise described below is to estimate N_{tot} from the observed data. For the analysis the data is divided into the following seven categories:

- Species seen by all three observers, $A \cap B \cap C$
- Species seen by only two of the observers ($A \cap B \cap \overline{C}$, $A \cap C \cap \overline{B}$ and $B \cap C \cap \overline{A}$)
- Species seen by only one observer ($A \cap \overline{B} \cap \overline{C}$, $B \cap \overline{A} \cap \overline{C}$ and $C \cap \overline{B} \cap \overline{A}$)

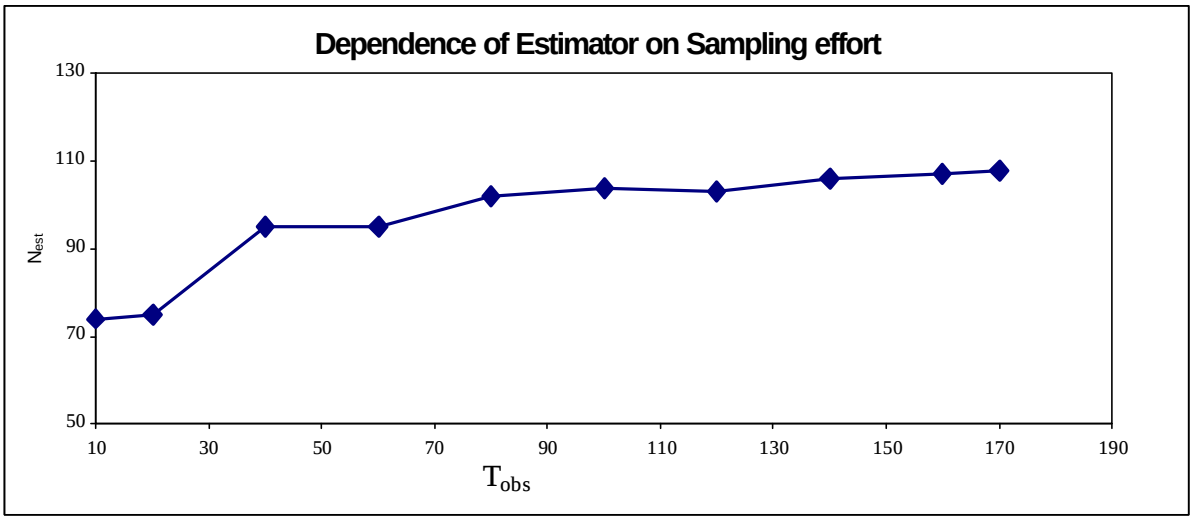
14.1.3 The values of these seven categories can be estimated as following:

- Estimate of species seen by all three observers is, $(p_1p_2p_3)N_{tot}$
- Estimates of species seen by only two observers are: $p_1p_2(1-p_3)N_{tot}$, $p_1p_3(1-p_2)N_{tot}$ and $p_2p_3(1-p_1)N_{tot}$ respectively.
- Estimates of species seen by only one observer are: $p_1(1-p_2)(1-p_3)N_{tot}$, $p_2(1-p_1)(1-p_3)N_{tot}$ and $p_3(1-p_1)(1-p_2)N_{tot}$ respectively.

14.1.4 We have four unknown parameters, p_1,p_2,p_3 and N_{tot} to be estimated from seven data points estimates for which can be calculated as shown above. A χ^2 fit can now be performed on the data to extract the best estimates of these four unknown parameters. χ^2 is defined as $\chi^2 = \sum(obs_i\text{-}est_i)^2/ (est_i)$ where, obs_i is the observed value of any of the seven categories and est_i is the associated estimate. The best estimates of these parameters are those that correspond to the minimum value of χ^2. A numerical procedure was implemented to minimize χ^2. The results of this analysis, indicating the best estimate of N_{tot}, for the four different habitat patches surveyed are presented below.

	Evergreen	**Scrub**	**Semi-evergreen(1)**	**Semi-evergreen (2)**
χ^2	9.58	6.96	4.18	11.08
N_{tot}(est)	76	58	108	86
N_{obs}	66	52	98	74
T_{obs}(in min)	90	60	170	80

Figure 8



T(obs)	N(est)
10	74
20	75
40	95
60	95
80	102
100	104
120	103
140	106
160	107
170	108

Note: An estimator for N_{tot} should be independent of the sampling effort. The above figure (for data from semievergreen (1)) shows that except for very small sampling efforts our estimator for N_{tot} fulfills this requirement.

14.1.5 Using this methodology for the Mala study sites we have some preliminary data on flowering plants, butterflies, birds, aquatic insects and fish. Our interest is to interpret this data to obtain an understanding of how the biological communities are being impacted by ongoing interventions, and how to manage the interventions so as to do as well as we could from a biodiversity perspective. One possible approach to this is through assigning values to individual taxa, as well as assemblages from a

conservation perspective. We quote below relevant portions of a study of birds of Western Ghats which attempts to do this (Pramod et al 199).

14.2 Valuing Bird Taxa

14.2.1 We need to evaluate the bird species pools characterising the various habitat types. This is best based on an evaluation of the individual member species of the pool. This would be an exercise of quantifying the effort that the society might be willing to devote to ensure continued persistence of any given species. This would depend on a variety of attributes of the species. They belong to three major categories; rarity, extent of threat of extinction and utility. In general, rarer the species, the more threatened the species, the greater the utility of the species, the greater the effort that would be merited to ensure its continued persistence.

14.2.2 We may then assign to any particular species a conservation value reflecting this effort, such that the value would increase with rarity, extent of threat and utility. The actual values could either be ranks along a scale or a specific number. We propose to leave out attempts to quantify utility of bird species and assign quantitative values ranging between 0 and 1 on the basis of 7 attributes relating to rarity and extent of threat. Four of these values relate to the geographical range: G1, over the entire world divided into 6 zoogeographic regions; G2 over the oriental region divided into 9 subregions; G3 over the Indian subregion divided into 8 provinces; and G4 over the Malabar (Western Ghats plus West coast) province divided into 4 sections. The conservation value for a taxon by geographic range is given as:

$$G = (N-a)/(N-1)$$

where `N' is the number of subdivisions at a given level and `a' is the number of subdivisions from which the taxon is known. This ensures that the more restricted the range on any of these scales, the greater would the conservation value be. The conservation value of each taxon by habitat preference was computed as :

$$H = (N-a)/(N-1)$$

where `N', is the total number of bird habitat types over the Western Ghats region and `a' the number of habitats favoured by a given taxon. This ensures that the more limited the habitat range of a species, the greater would the value be. The conservation value of a taxon reflecting its taxonomic distinctness was calculated as :

$$T = 1/(a * b)$$

where a is the number of species known in the family to which the taxon belongs and b is the number of races under the species. Rarity is thus sought to be captured in terms of narrowness of geographical range, narrowness of habitat preference and limitations on number of related taxa. The conservation value by degree of endangerment was assigned as:

$$E = p$$

where p is the proportion of endangered taxa in the family to which the taxon belongs. This methodology has been discussed earlier in some detail by Daniels et.al.

14.2.3 Admittedly these attempts to capture rarity and endangerment in terms of broad patterns of geographical distribution, habitat preferences, taxonomic position and number of related taxa recorded as threatened are crude. Nevertheless they are based on information which is available for all bird species of Western Ghats, indeed of the whole country, and therefore permit of an evaluation exercise which is reasonably objective and accessible for verification by all who may be interested. This overcomes problems which plague other more subjective exercises, including the listing of threatened species in IUCN sponsored red data books. Thus the peafowl (*Pavo cristatus*), the Nigiri Wood Pigeon (*Columba eliphistonii*), lesser adjutant stork (*Leptoptilos javanicus)* and the redfaced malkoha (*Phaenicophaeus pyrrhocepahlus)* are the 4 Western Ghats species included in the list of endangered species. However of these four the peafowl is widely distributed in India with many

pockets of local abundance thanks to religious beliefs and the lesser adjutant stork is locally quite common in its appropriate habitat.

Distribution of Conservation Values

14.2.4 The 212 species encountered by us over the 132 transects are a subset of the 586 species of the Western Ghats. We have computed for the set of 586 species of Western Ghats conservation values for each of these 7 parameters, and a composite conservation value (CCV) as the sum of four values, namely the mean of the four values derived from geographical distribution and the other three values related to habitat preference, taxonomic uniqueness and degree of endangerment. This the CCV ranges between 0.66 for the Indian jungle crow, widespread, habitat generalist, a member of a speciose family with many races and of a family in little danger of extinction to 2.77 for crab plover, a wader with a restricted geographical distribution, narrow habitat preferences, and the only species in the family Dromadidae. The cumulative frequency distribution rises rapidly at either end, with about 520 species in the middle accounting for the values between 1.11 to 1.94. The bottom 22 and top 21 species with composite values substantially higher or lower than the majority are then of special interest. Fifteen out of these are birds of aquatic habitats, egrets, cormorants, cranes or skuas. Since our focus is on terrestrial habitats, we may take a closer look at the other species. The terrestrial species with highest conservation value include thrushes, babblers, woodpeckers, trogon, characteristic of forest habitats with narrow ranges at least at the subspecies level; and gallinaceous birds (quails, junglefowls etc.) that are extensively hunted and thereby threatened. The species with the lowest conservation values include passerines, swallows, hawks and falcons with a broad range of habitat tolerance and a wide geographical distribution, many of whom have adapted to human presence.

14.2.5 It is also of interest to examine the distribution of the composite conservation value amongst the broader groups of birds at family/subfamily level. Two groups of water birds herons and curlews, and one group of terrestrial birds hawks and vultures have significantly low composite conservation values. These have all very broad

geographical distributions. Although the hawks and vultures have a significantly higher value in terms of endangerment, and curlews and sandpipers significantly higher value because of their more limited habitat preference, their CCVs are still significantly lower than the general population.

14.2.6 Three groups namely thrushes and chats, pheasants and quails and babblers and laughing thrushes have significantly higher CCVs. These they owe in all three cases to more restricted geographical distributions, and in the case of pheasants and quails also to significantly higher degree of endangerment. Three other groups of birds are notable for relatively high values along some of the dimensions of conservation value, though their CCV is not significantly higher. These include ducks and geese and pigeons and doves that have significantly high values in terms of endangerment, and woodpeckers that have significantly higher values in terms of restricted geographical distribution. Virakkala *et al* have suggested the use of woodpeckers as indicators of the health of forest habitats of Finland. For the terrestial habitats of Western Ghats the babblers would evidently be an appropriate choice as the group with the highest CCV.

Valuing habitats

14.2.7 Having thus quantified the conservation value at the species level, we can proceed to assign values to habitats on the basis of species they harbour. Most of the earlier exercises of this nature have primarily relied on species richness. An important advance in this context has been the use of taxonomic information as suggested Vane Wright and his co-workers. Our concept of mean composite conservation value is another attempt in this direction. It is notable that the two habitat types with lowest mean CCV, gardens and scrub savanna are also richest in the number of species whereas more natural habitats like shola-grassland and evergreen forest harbour comparatively lower number of rarer species which have a high conservation importance. This is because the former habitats are highly heterogeneous spatially and are colonised by a large number of opportunistic species with wide geographical distributions and broad habitat tolerances. It then appears appropriate not to base

conservation decisions on simple species richness, strengthening the case for using a measure such as the mean composite conservation value. The mean CCV for shola-grassland is significantly higher than all other values, that of evergreen and semi-evergreen forests significantly higher than that of scrub- savanna and habitation,and that of deciduous forests significantly higher than that of gardens (all statistically significant at $p < 0.05$). The differences between evergreen forests, semi-evergreen or deciduous forests and monoculture tree plantations are not significant. A caveat is however in order here. All the localities surveyed by us are a highly intricate mosaic of several of these habitat types. In particular, the monoculture tree plantations surveyed are of small extent and tend to abut on patches of evergreen and, deciduous forests. Their bird communities though often poorer in total number of species, are made up of many elements from neighbouring forest habitats. This may be the reason why their mean CCV is not significantly lower in comparison with evergreen and deciduous forest types.

Exploring conservation values for ecotope types

14.2.8 Sixteen ecotope or landscape element types were identified in the Mala cluster. Fifteen of these were sampled for birds, butterflies and aquatic macroinvertebrates (Table 15). Representative patch of each landscape element type was visited between November 1999 and March 2000 to prepare a comprehensive checklist for birds, butterflies and aquatic macroinvertebrates. Both sighting records and indirect evidences (calls for birds) were used to prepare the checklists. Kick netting and all out search method were employed to sample aquatic macroinvertebrates.

Table 15. Ecotope Types of Mala cluster and taxa sampled.

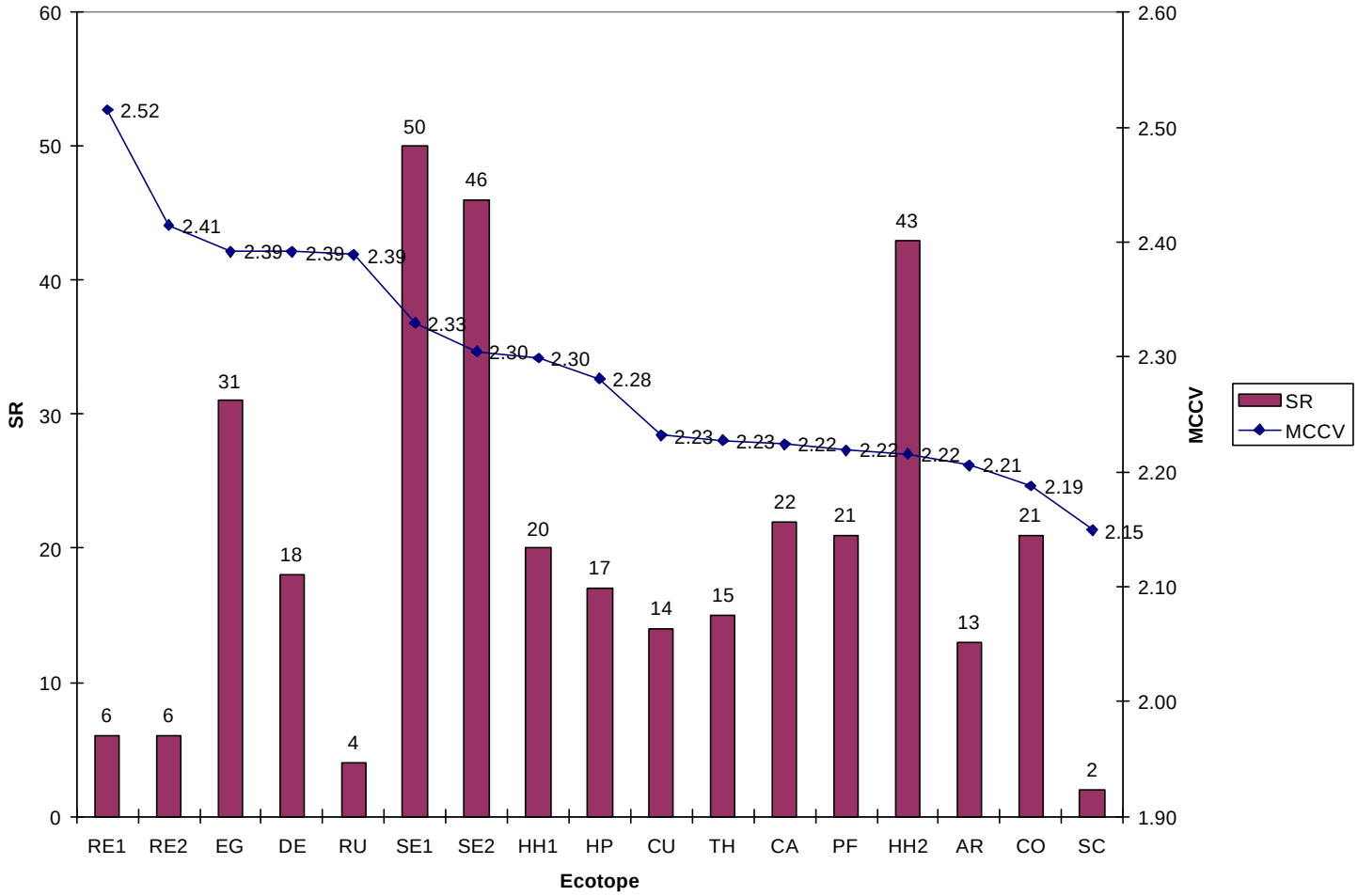
Ecotope Type	Birds	Butterflies	Aquatic Macroinvertebrates
Evergreen	+	+	
Semi evergreen	+	+	
Riparian	+	+	
Scrub	+	+	
Thicket	+	+	
Grassland	+	+	
Paddy field	+	+	
Casaurina plantation	+	+	
Hopea plantation	+	+	
Arecanut garden	+	+	
Coconut grove	+	+	
Cashew plantation	+	+	
Rubber plantation	+	+	
Acacia plantation	-	-	
Human habitation	+	+	
Streams			+

14.3 Birds:

14.3.1 A total of 127 bird species was recorded from Mala cluster, of these 106 were recorded during sampling of various ecotope elements. Remaining 21 species were observed while travelling through the landscape. Checklists of birds were used to calculate Mean Composite Conservation Value (MCCV) for the birds recorded in each ecotope type. Bird species encountered while travelling were not used to calculate MCCV. Composite Conservation Value (CCV), has been calculated as the sum of four conservation values, namely, mean of three geographical distribution (global, oriental and Indian), taxonomic uniqueness, habitat threat and habitat preference (Pramod *et.al*. 1999). Landscape elements of Mala cluster are then prioritized for their conservation importance on the basis of the mean of CCV of each landscape element. The preliminary results of such an exercise is shown in Figure 9.

MCCV of natural ecotopes is higher than that of the man-modified ecotopes. Riparian evergreen forests have higher MCCV among the natural vegetation types followed by evergreen and semi evergreen forests.

Figure 9 : Species richness (SR) and Mean Composite Conservation Value (MCCV) for ecotopes sampled for birds in Mala



Legends: RE: *Riparian Evergreen*; EG: *Evergreen*; DE: *Disturbed Evergreen*; RU: *Rubber Plantation*; SE: *Semi Evergreen*; HH: *Human Habitation*; HP: *Hopea Plantation*; CU: *Cashew Nut Plantation*; TH: *Thicket*; CA: *Casaurina Plantation*; PF*: Paddy Field*; AR: *Arecanut garden*; CO: *Coconut grove*; SC: *Scrub*,.

As is evident from the figure, species richness does not necessarily reflect the conservation importance of a landscape element. For example the MCCV of semi evergreen forests with 50 bird species is less than that of riparian evergreen forests with just 6 species. This is because the computation of CCV takes into consideration important ecological attributes such as geographic range (endemic versus widespread) and habitat use (specialist versus generalist). In this case riparian evergreen forests

with Western Ghat endemic birds such as Bluewinged Parakeet, Small Sunbird and a habitat specialist- Malabar Whistling Thrush pulls up the MCCV even in the presence of some wide spread and generalist species such as Golden Backed Three-toed Woodpecker and Pond Heron. On the other hand, patches with high species richness such as semi evergreen forests and human habitation have low MCCV even in the presence of some common endemic species such as Bluewinged Parakeet. This is because the rest of the birds are either with wide geographic range or are habitat generalists with low CCV.

14.3.2 Use of MCCV of birds to prioritize a patch may not be always reliable as exemplified by the case of rubber plantation in Mala cluster. The MCCV of rubber plantation is on par with that of the evergreen forest. This high MCCV of rubber plantation is due to presence of very few species, for example Bluewinged Parakeet, Small Sunbird and Racket-tailed Drongo, with high CCV. The presence of forest birds in the plantation is due to its spatial proximity with patches of high conservation value such as evergreen forests. These forest birds may be using the plantation transiently while moving into other patches. The significance of man modified landscape elements with high MCCV, such as rubber plantation can be reliably understood only after repeated sampling.

14.4 Butterflies:

14.4.1 A checklist of 185 field identifiable butterfly species was prepared, of which 100 species have so far been actually recorded from the study area. The species were assigned to different ecotope types based on our earlier field observations in the Western Ghats. Of the 185 species, 154 are from the semi evergreen forests and 121 from the evergreen forests. Plantations and human habitations have less than 30 species that they can sustain on their own (Table 16).

Table 16. Family-wise species richness of butterflies in different ecotope types of Mala cluster.

FAMILIES	EVG	SEVG	SCR	SAV	HUH	PAF	CASH	CASS	RUB	COC
PAPILIONIDAE	16	16	0	5	7	3	0	0	0	1
PIERIDAE	11	18	18	6	4	2	1	0	0	1
NYMPHALIDAE	44	55	17	13	12	7	3	2	2	6
LYCAENIDAE	30	40	14	4	5	3	1	0	0	1
HESPERIIDAE	20	25	6	5	1	1	0	0	0	1
TOTAL	**121**	**154**	**55**	**33**	**29**	**16**	**5**	**2**	**2**	**10**

Legend: EVG: *Evergreen*; SEVG: *Semi evergreen*; SCR: *Scrub*; SAV: *Savanna*; HUH: *Human habitation*; PAF: *Paddy field*; CASH: *Cashew nut*; CASS: *Casaurina*; RUB: *Rubber*; COC: *Coconut.*

14.5 Aquatic Macroinvertebrates

14.5.1 Six streams flowing through ecotopes like evergreen, semievergreen forests and human habitations were sampled for aquatic macroinvertebrates. Nineteen aquatic insect families and two families of fresh water molluscs were recorded during the study period. Insect fauna was composed of mayflies (Ephemereoptera), dragon and damselflies (Odonata), stoneflies (Plecoptera), aquatic bugs (Hemiptera), caddiesflies (Trichoptera), beetles (Coleoptera) and flies (Diptera). The presence of insect families like *Leptophlebiidae, Potamanthidae* (Ephemeroptera), *Perlidae* (Plecoptera), *Chlorocyphidae, Euphidae* (Odonata) is indicative of the unpolluted nature of the streams of Mala cluster. It is worth noting that a mayfly family rare to Western Ghats – *Potamanthidae* was recorded from the stream flowing through Sri Brahmanath, a scared grove. The three fresh water molluscan species recorded from these streams are *Thiara scabra*, *Sulcospira huegeli* (Fam: Thiaridae) and *Lamellidens marginalis* (Fam: Unionidae).

14.6 Discussions

14.6.1 Since there is no historical data available on changes in biodiversity levels, the only source of information is accounts by knowledgeable individuals. One of the most knowledgeable of these is Mr. Kunjira Moolya, who reports either disappearance, or drastic decline in the populations of following plant species: Kabale, Nare, Kaadu Karuvolu, Adka baare (*Xeromphis uliginosa*), Kaat Peeray and the following fish species: Peruvolu (*Tor kudri*), Murante, Vaateharolu, Heekote,

Baale meenu (*Wallago attu*), Mugudu (*Clarius batrachus*), Poomeenu, Puriyol (*Anguilla bengalensis*), Manjol sede, Madenji (*Channa orientalis*).

14.6.2 A number of traditional practices of protection of sacred animals, plants, groves and tanks have played a role in maintenance of biodiversity. Discussions have provided significant understanding of various forces impacting these practices and their future. For instance, a section of immigrants to the village in the last thirty years are Christians from the neighbouring state of Kerala. They do not observe the traditional taboo on hunting of gaur (*Bos gaurus*), an animal related to cattle who are venerated by Hindus.

15. HEALTH

15.0.1 Health status and health care have undergone drastic changes over the last fifty years, primarily because of (1) Elimination of serious diseases such as smallpox and malaria, and (2) Replacement of local health care systems grounded in herbal medicines by modern allopathic system. Where traditional health care continues to be practiced as in places like Mala, it is affected by decreasing availability of medicinal plants and animals. Another major change is the increasing use of pesticides whose poisonous effects in high dosages are noticeable, though there is no understanding of any possible effects in low doses. Herbal treatment of livestock diseases may continue as well, even more than human diseases as in Mala.

15.1 Measurements

15.1.1 If possible measurements may be directed towards estimation of pollutants such as pesticides in water and food, as well as in air. Measurements may also be undertaken of vector populations such as mosquitoes.

15.2 Joint Field Visits

15.2.1 Joint visits have been useful in assessing depletion of medicinally useful plants and animals from different ecotope elements; as also in assessing the role of traditional conservation practices in maintenance of biodiversity.

15.3 Discussions

15.3.1 Discussions with herbal medicinemen, as well as allopathic medical practitioners and other community members suggest that potential health effects of pesticides in water and food are of concern to some people. These discussions also brought out the history of the outbreak of a relatively new viral disease, Kyasanur Forest Disease (KFD) in some neighbouring areas. Locally this disease is known as monkey disease since it kills primates. Apparently the outbreak of this disease is linked to increasing incidence of tick bites to people. This increase in tick bites is related to increasing infestation of cattle by ticks, in turn caused by spread of the weed Eupatorium in forests subjected to overexploitation.

16. SCENARIO

16.0.1 Local level assessments furnish a very rich set of data on historical trends and forces driving these trends. People are in a position to visualize the future as an extrapolation of these trends and to project scenarios of what may happen in coming years. What they are unable to incorporate are possible consequences of radically new technologies. With this limitation, they responded when asked to construct the following three sets of scenarios: (i) Business as usual, (ii) Worst that may happen (iii) Best that they can hope for.

A Conservationist Scenario

If a conservationist approach is adopted by returning to the cultivation of traditional crop varieties, cutting down the Acacia and Casuarina plants from the hill tops and permitting the grasslands to regenerate; by planting wild plants such as *Artocarpus hirsutus, Artocarpus heterophyllus, Mangifera indica, Dillenia pentagyna, Garcina cambogia, Terminalia bellirica* etc. instead of practicing monoculture cultivation; by regulating the digging of more and more open wells and bore wells and equitable sharing of available sources of water; by controlled burining of grasslands for regeneration of grass in the subsequent year etc., the future scenario is likely to improve the life of people of Mala.

These are best generated through leisurely interviews person to person, or in small or larger groups representing the various segments of population, women and men,

different age groups. These should cover all the sectors, one by one: soil, water (streams, tanks, ground water), land use, agriculture, tree crops, forests (natural evergreen forest, scrub land, forestry plantations), grasslands (grasslands in midst of forest, village commons), livestock, fish, biodiversity, health. Many different perspectives, often conflicting will emerge. Space should be provided to allow them to emerge, without the investigators injecting any of their own biases in recording the scenarios.

17. VALUES AND ASPIRATIONS

17.0.1 A second series of similar interviews would focus on values people assign to various environmental resources and processes and what they aspire to see as maintained and changed. There are three major themes: (a) Kinds of living organisms, species, cultivars, (b) Ecotope types, specific localities (c) Processes such as recharge or withdrawal from ground water, free range grazing by cattle, dry season forest fires, use of pesticides.

17.1 Kinds of organisms

17.1.1 The discussions on kinds of living organisms people value should begin with a complete inventory of the types recognised; categories such as trees, grasses, birds (which may include bats or even flying squirrels), fish (which may include shrimp), individual species of plants, birds etc, and any varieties within species (particularly in case of cultivated plants and domesticated animals). This should be followed by those that they value positively, in order of priority, as well as those that they consider undesirable, again, in order of priority. This should be supplemented by a discussion on any culturally conditioned values relating to these organisms; e.g. while bonnet macaque is considered a great nuisance because of their destructions of field and orchards, they are considered sacred and are not killed because of their association with Lord Rama. The final set of discussions should pertain to what steps at either conservation or elimination of any of these species they would like to see initiated, and how these steps may be compatible, or incompatible with their other aspirations. For instance, a farmer may wish to see several traditional cultivars of paddy

maintained on farm, but may not wish to do so on his own farm which he wants to convert to arecanut plantation which is a more lucrative use of land.

17.2 Localities

17.2.1 The next theme for a whole series of discussions would pertain to the localities, their current pattern of use and biological communities they harbour, their value, and the preference for the kinds of use they should be put to and the kinds of biological communities they should be managed to harbour. The map of local names of all topographic elements provides the point of reference for this discussion (Fig. 5).

17.2.2 A variety of perspectives may emerge. For instance, some farmers are unhappy at the ongoing conversion of paddy fields into arecanut orchards and would like to ban such changes in land use. However, this would tend to freeze the social and economic divisions, since most paddy fields are owned by poorer farmers from communities with a lower social status, and because paddy yields far lower financial returns than arecanut cultivation. The paddy field owners would therefore like to promote such conversions. Others would like to see grasslands enclosed by forests maintained since these provide grazing for wild herbivores such as Gaur, who otherwise tend to raid crops.

17.3 Ecological processes

17.3.1 The last series of discussions would pertain to a series of important ecological processes, such as encroachment on village commons for habitation, encroachment on forests for cultivations, tapping of ground water by borewells, dynamiting and other destructive methods of fishing, promotion or suppression of fire in forest areas, free range grazing by cattle. Perspectives should be generated on the manner in which people view the consequences of these processes in various localities, and their preferences as to how these processes should be managed and how such management relates to their other aspirations. For instance, in a discussion involving members of the Panchayat (= Village Council), some felt that the Panchayat should demarcate

areas in which no further bore wells should be dug; others disagreed. On the other hand, they were unanimous that fishing using dynamite should be banned.

18. CONFLICTS AND CONSENSUS

18.0.1 An exhaustive documentation of the varying perspectives of the people relating to management of species, localities and ecological processes would bring out instances of congruencies as well as divergences. The next step is to document these and then hold group discussions either to confirm congruencies, or more significantly, to see whether the divergences can be narrowed down and some perspectives acceptable to all parties achieved. If there are some irreconcilable divergences, then it should be recorded that the proponents agree to disagree. This exercise would set the stage for a statement of broadly what the community members would like to see happen in terms of the local biodiversity, the various ecotopes and the key ecological processes.

19. RESPONSE OPTIONS

19.0.1 The concluding step of the assessment would be a series of discussions at individual, small group and finally the entire village assembly level of the options available to translate what community members would thus like to see happen into practice. These options would relate to actions that may be taken by individuals (e.g. farmers deciding to continue cultivation of a traditional cultivar of paddy in a small plot on his own land), groups of people (e.g. members of Moghera community deciding to abandon the tradition of ritual communal hunts twice a year), government functionaries (e.g. village agricultural extension workers deciding to draw people's attention to toxic effects of certain pesticides), local institutions (e.g. local farmers' co-operative deciding to promote drip instead of sprinkler system of irrigation), formal governmental institutions at local level (e.g. local village council deciding to ban use of dynamite in any water body within village boundary) or governmental institutions at state level (e.g. agriculture department deciding to give special reward to people for maintaining traditional crop cultivars on their farm etc). The options may also include policy changes that may be recommended at various levels, e.g. at local government level on tapping of

ground water through bore wells, or at state government level on sharing of revenue obtained through levying collection changes on commercial harvests of medicinal plants.

20. FOLLOW UP AND OUTREACH

20.0.1 Finally there should be an attempt to put into operation as many of the response options arrived at as possible, at local, state and national level by sharing the findings of the assessment exercises, both in local languages, and in English through a variety of channels. These channels could include local level discussions such as meetings of farmers' co-operatives, village council or annual school day; special exhibitions arranged at annual village festival, articles in local, state and national level newspapers, discussions at special state level meetings such as Wild Life Week celebrations, material put on web page etc.

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