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Draft Report

Valuation of Forest Ecosystem Services and Biodiversity in The Western Ghats Case Study in Uttara Kannada

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THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY-INDIA INITIATIVE

FOREST

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Indo-German Biodiversity Programme

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- The Economics of Ecosystems and Biodiversity - India Initiative (TII)
- India Business and Biodiversity Initiative (IBBI)
- Conservation and Sustainable Management of Existing and Potential Coastal and Marine Protected Areas
- Himachal Pradesh Forest Ecosystem Services Project
- Access and Benefit Sharing Partnership Project

Responsible
JR Bhatt, Scientist-G, MoEFCC
Konrad Uebelhoer, Director, Indo-German Biodiversity Programme

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Valuation of Forest Ecosystem Services and Biodiversity in The Western Ghats: Case Study in Uttara Kannada

N H Ravindranath, IISc, Bangalore
Haripriya Gundimeda, IIT, Bombay
Indu K Murthy, IISc, Bangalore

IMPLEMENTING PARTNERS:

INDIAN INSTITUTE OF SCIENCE, BANGALORE
www.iisc.ac.in

INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY
www.iitb.ac.in

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Project Team

Team Leader (Ecological Assessment): Prof. N H Ravindranath, Centre for Sustainable Technologies, Indian Institute of Science, Bangalore

Team Leader (Economic Assessment): Prof. Haripriya Gundimeda, Department of Humanities and Social Sciences, Indian Institute of Technology, Bombay

Project Coordination: Indu K Murthy, Centre for Sustainable Technologies, Indian Institute of Science, Bangalore

Study Team: G T Hegde, Savithri Bhat, Vani Sathyanarayan, Priya Joshi, Vishal Patil, Tashina Esteves, Centre for Sustainable Technologies, Indian Institute of Science P R Bhat, Centre for Ecological Sciences, Indian Institute of Science, Yashashree Garge (Intern), M S University, Baroda, Prantika Das and Soumik Mitra, IIT-Bombay, Swapan Mehra, Iora Ecological Solutions Pvt. Ltd., New Delhi, Dr Vasudeva R, Forestry College, Sirsi, Mr N R Hegde, LIFE

THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY-INDIA INITIATIVE

The Economics of Ecosystems and Biodiversity – India Initiative (TII) aims at making the values of biodiversity and linked ecosystem services explicit for consideration and mainstreaming into developmental planning. TII targets action at the policy making levels, the business decision level and awareness of citizens. TII has prioritized its focus on three ecosystems - forests, inland wetlands, and coastal and marine ecosystems - to ensure that tangible outcomes can be integrated into policy and planning for these ecosystems based on recommendations emerging from TII.

In addition to the existing knowledge, TII envisions establishing new policy-relevant evidences for ecosystems values and their relation to human well-being through field-based primary case studies in each of the three ecosystems. In response to an open call for proposals for conducting field-based case studies in the context of relevant policy or management challenges for conservation and the sustainable use of biodiversity and ecosystem services, over 200 proposals were received. A Scientific and Technical Advisory Group (STAG), comprising eminent ecologists and economists, appraised the proposals and recommended 14 case studies for commissioning under TII.

These studies in forests deal with issues such as hidden ecosystem services of forests, conflicts between humans and wildlife, and the economic consequences of species decline. In wetlands, the studies draw lessons on water resources management, community stewardship and equity, and the economics of hydrological regime changes. In coastal and marine ecosystems, the studies explore the opportunities and economic efficiency of interventions such as eco-labelling, seasonal fishing bans, mangrove regeneration, and the challenge of bycatch in marine fisheries.

The reports of these 12 case studies have been published in this TII series.

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KEY MESSAGES

Recognised as a global biodiversity hotspot and UNESCO World Heritage Site, India's Western Ghats form a watershed for as many as 58 rivers. It is also home to around 50 million people and a large number of endemic plants and animals across six states. Putting an economic value on goods and services silently provided by these giant forests will aid in their conservation.

FINDINGS

- There is a restriction on wood removal in Uttara Kannada. Taking the restriction into account, the value of timber is **₹73,892** (**US$ 1,232**) to **₹95,524** (**US$ 1,592**) per hectare per year.
- Sawmills add a value of **15.5%** and processing adds another **44.5%** to the harvested timber.
- The fuelwood contributed **16%** to **37%** and non-timber forest products (NTFP) contributed **40%** to **63%** of the income among gathering households.
- The demand for NTFP in Uttara Kannada district is estimated at **720 million kgs**, which translates to a value of **₹32,230** (**US$ 537**) per hectare.
- The benefit from carbon sequestration in Uttara Kannada district (7,819 sq km) amounts to **₹7.56 billion** (**US$ 126m**) annually. The benefit is passed on to the global community.
- The value generated by tourism in Dandeli and Anshi Protected Area was **₹11.37 billion** (**US$ 189m**) per year for the year 2014.

RECOMMENDATIONS

- Sustainable harvesting, processing and marketing of Non-Timber Forest Products (NTFPs) has a large potential to generate sustainable income for local communities, which may require information generation on sustainable harvest rates and creating processing infrastructure.
- The economic benefits from tourism should be shared with the local communities through a formal institutional arrangement such as Joint Forest Management.
- Develop certification schemes for the harvest of NTFPs and other raw materials from forests.
- Build capacity of Biodiversity Management Committees and Forest Department at the range and the division levels to understand the economic value of forests and to ensure adequate financial compensation to local communities.

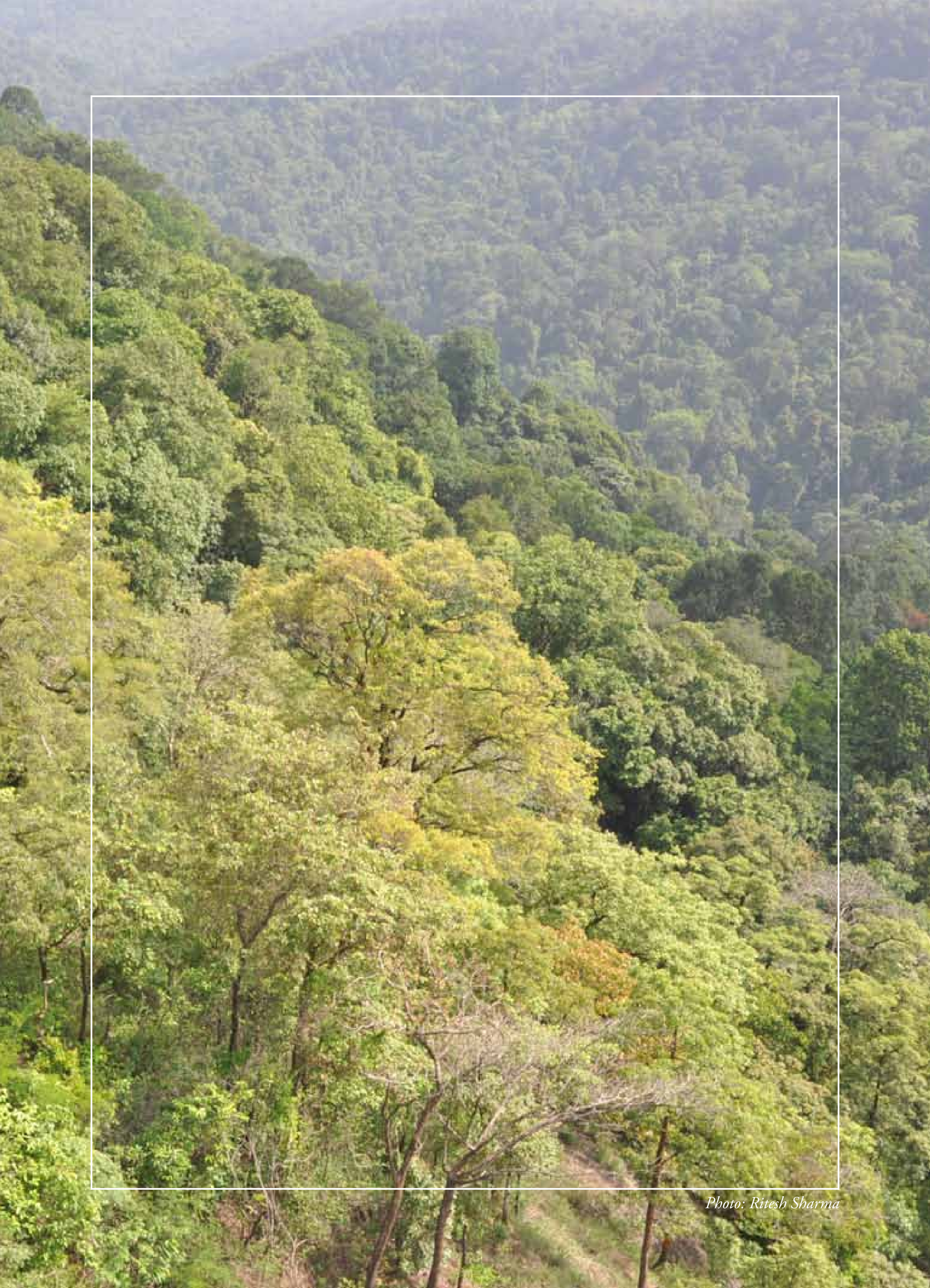

Photo: Ritesh Sharma

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EXECUTIVE SUMMARY

The Economics of Ecosystem Services and Biodiversity (TEEB) in the Forest Ecosystems of Western Ghats: A CASE STUDY

1. Relevance of the Study and Introduction

Forest ecosystems provide valuable ecosystem services for human well-being in the form of provisioning, regulating, supporting and cultural services. These services often are not additively separable and often not produced simultaneously from the same location. Despite the importance of the forest ecosystems they are degraded and lost in most parts of the world including India, the most mega diverse countries of the world. The loss and degradation of forest ecosystems can be attributed to various demographic and socioeconomic pressures along with institutional and policy failures. Further there is difficulty in quantifying the benefits and divergence between private and public benefits and costs leading to its undervaluation, making conservation of pristine ecosystems a non-optimal outcome. It is now widely recognized through initiatives like the global TEEB project (UNEP 2010) that recognizing the economic value of forest biodiversity and ecosystem services, and providing economic incentives can play a significant role in conservation and sustainable management of forest ecosystems. The objective of TEEB was to draw attention to the global economic benefits of nature and to highlight the growing costs of biodiversity loss and ecosystem degradation while highlighting opportunities arising from conservation, restoration, maintenance and sustainable management of ecosystems and biodiversity. TEEB illustrated how recognition, demonstration and capturing of the value of ecosystems and biodiversity in decision making can help better ecosystem management.

Recognizing the importance of valuing the ecosystem services, TEEB-India initiative (TII) has been launched by the Ministry of Environment and Forests and Climate change for the forests, wetlands, coastal and marine ecosystems. This report is part of TII initiative on forest ecosystems for which we considered the region of Western Ghats being the most biodiverse hotspots in India. Despite having the most progressive forest conservation and development legislations, policies and programmes, the forest ecosystems are under severe stress. The reasons for the degradation of valuable ecosystems can be complex and varied including incomplete information and non-recognition of values of the Western Ghats ecosystems. Not recognizing the policy and institutional triggers of the stress can impact the human well-being with differing impacts on various groups. This clearly justifies the need to recognize, demonstrate and capture the ecological and economic values and internalize them in the decision-making. A comprehensive evaluation of the ecosystem services enables visualization of the trade-offs that different groups of people face clearly in addition to guiding efficient resource allocations, providing a hint at the future uncertainties in resource availability, designing biodiversity conservation programs, highlight the distortions from non-recognition of values from ecosystem services.

2. Objectives of the Study

The objective of this report is to assess the ecological and economic values provided by the ecosystem services in Western Ghats for the study region of Uttara Kannada district of Karnataka. Uttara Kannada district is selected as it is representative of the diversity of the Western Ghats.

To illustrate the values the report consider three types of ecosystem services (Provisioning services - Food, fuel, raw materials, manure, medicine and other non-timber forest products), Regulating Services reflecting the ecosystems ecological process (Carbon sequestration), and Cultural Services (Recreational service). The rest of the services could not be considered due to lack of complete information. The report is structured into two parts namely: 1) assessment of the biophysical aspects and ecosystem services and ii) economic valuation of the forest ecosystems. The report concludes with the policy recommendations for the Western Ghats.

3. Biophysical assessment of Biodiversity and Ecosystem Services

The biophysical quantification of biodiversity and some of the key ecosystem services were assessed based on the permanent plots established during 2009-10 by the Indian Institute of Sciences in the forests of Uttara Kannada district of Karnataka part of the Western Ghats. The study was conducted in 9 villages covering three forest types namely evergreen, moist deciduous and dry deciduous forests. The study was conducted during 2014, using the standard field ecological methods and socio-economic surveys. In the sampling sites, the number of tree species in the evergreen forest varied between 16 – 79 per hectare depending on the forest type, with lowest in the dry deciduous and highest in the evergreen forests. The Shannon-Weiner index of trees in the evergreen forest type is estimated at 3.02, followed by 2.9 for the moist deciduous plots and 1.54 for dry deciduous plots. These values compare well with studies such as Singh et al., 1984 and Rai, 1983 for the Western Ghats. The size class distribution of trees with varying diameter classes showed that in all the villages, the number of stems was highest in the lower most diameter class of 0-10 cm, indicating high regeneration status of the forest, despite large dependence of communities on the forests. The following ecosystem services are provided by the forests in the region

- **Food** - In the sampled plots, around 40 different species are used as food or food substitutes in evergreen forests, while in the moist and dry deciduous forest types, 32 and 8 different tree species are used as food, respectively. Few of the dominant species that are specifically used in this region as food and food substitutes or flavouring agents are Garcinia indica (6 kg/household/year), Garcinia cambogea (69 kg/household/year), *Carissa carandas (5 kg/household/year), Artocarpus integrifolia (50 kg/household/year), Mangifera indica (10 kg/household/year),* etc.
- **Timber** - Among the three forest types, highest amount of timber stock is recorded in the moist deciduous forests (184 t/ha), followed by dry deciduous (164 t/ha) and evergreen forests (162 t/ha). Even though local communities use forests for meeting their timber requirements (fencing poles, agricultural implements, furniture, etc.), no data is available, since there is a ban on felling trees in the forests.
- **Fuelwood** - Fuelwood is the main source of energy for cooking in rural areas of the Western Ghats, along with other household and non-agricultural uses. The average quantity of fuelwood available for extraction is highest in the evergreen forest type (146 t/ha), followed by moist deciduous (101 t/ha) and then the dry deciduous forest type (83 t/ha). In most villages, over 90% of the households collect fuelwood from forests and plantations. The quantity of fuelwood collected in the nine sample villages is around 2.5 tonnes per household per year (1.9 to

The objective of this report is to assess the ecological and economic values provided by the ecosystem services in Western Ghats for the study region of Uttara Kannada district of Karnataka.

2.9 t/household/year). The sustainable extraction of timber and fuelwood has been estimated in the range of 0.5 to 0.78 tonnes/hectare/year and for fuelwood it is 1.01 to 1.58 tonnes/hectare/year. For leaf manure, assuming 50% of the leaf litter can be extracted sustainably, the sustainable rate of extraction could be in the range of 2.5 to 7 tonnes/ha/year.

- **Fodder -** Rural households in Western Ghats region largely graze their cattle in forests, plantations, grasslands and croplands. The main sources of fodder or grass for stall feeding are the croplands and grasslands. However, in three of the nine villages, dry grass (1.5 to 3.2 tonnes/household/year) and green grass (0.9 to 4.7 tonnes/household/year) is collected from forests. In addition tree leaves are collected for feeding to livestock. Leaf fodder yielding species in the study area included *Gmelina arborea, Grewia tilifolia, Lagerstromia parvifolia, Schleichera trijuga, Dillenia pentagyna,* etc. Here again, although the above mentioned species are distinctly documented to be fodder species, local communities use lops and tops of many species.
- **Manure:** There is a traditional practice of collecting green and dry leaves from forest as a source of manure for rice and plantation crops. In six of the nine villages, 20 to 85% of the households gathered green leaves (0.7 to 7.9 tonnes/household/year) and dry leaves (1.4 to 3.6 tonnes/household/year) for manure purposes. The main manure yielding species in the forests studied include *Careya arborea, Calycopteris floribunda, Terminalia bellerica, Terminalia chebula, Aporosa lindleyana, Macaranga peltata, Ixora brachiata* and *Grewia tilifolia.* Several studies have been conducted to estimate the litter production in the forests of Western Ghats. These studies have shown the litter production, largely consisting of leaf litter is in the range of 5 to 14 tonnes/hectare/year.
- **Medicinal:** The number of species used for medicinal purposes in the study region range between 91 in evergreen forest type to 30 in dry deciduous forest type. Species used for medicinal purposes include *Actinodaphne hookeri, Calycopteris floribunda, Glycosmis pentaphylla, Knema attenuata, Mappia foetida, Myristica beddomei, Cinnamomum zeylanicum, Emblica officinalis, Terminalia bellerica, Terminalia chebula,* etc. No quantitative estimates of medicinal plant collection could be obtained.
- **Recreational Services:** Uttara Kannada district has several tourist attractions in the forests such as Dandeli-Anshi Tiger Reserve, Attiveri Bird Sanctuary, several waterfalls such as Jogfalls, Unchalli, rocky mountain outcrops (Yana), etc., which attract many tourists providing recreational services and employment to the local communities. A case study of the tiger reserve is presented in a later section.
- **Regulating Services:** Forests provide many regulatory services and only climate regulatory service is assessed due to limitations of time and resource. Carbon regulating service is an important service from the forest ecosystems.

  Biomass + Soil carbon: The carbon regulatory service is estimated as a stock of aboveground biomass, belowground biomass and soil carbon. The carbon stock values ranged from 108 t/ha in dry deciduous forests to 180 t/ha in evergreen forests.

  In addition the report undertook a detailed case study of Garcinia and Honey. *Garcinia* is an important nutritionally valuable tree species used in cooking as well in the form of a cool drink. A case study conducted in five villages showed that that Garcinia accounted for 50 to 80% of the household income of the families gathering the product. The annual income of these families from Garcinia collection was in the range of ₹40,000 to ₹100,000 per household per year. The case study of honey gatherers in four of the five study villages showed that the quantity of honey collected ranged from 1 kg to 30 kg per household per year.

4. Economic Value of the Biodiversity and Ecosystem Services

Timber

The timber produced from forests can be valued using market prices in case of no market imperfections. However if markets are inefficient, the resource is under-priced due to capture of resource rent by other actors other than the owner. Timber and forestland resources enter into value-added calculations in the economy at the point of purchase either as an end product or as an input into another process. In this study the timber has been valued in terms of the surplus value accruing to the extractor or user or an asset after all costs and normal returns have been taken into account. The main value addition takes place at sawmills with a value addition of 15.5% and processing of timber adds further value of 44.5%. Given the restrictions on wood removals in the region, the value of timber per hectare per year in Uttara Kannada has been estimated in the range from 73, 892 – 95,524 ₹/ha (US$ 1190.27- 1,569.31/ha).

Fuel wood is the only source of fuel for most households. Results showed that the fuelwood contributed 16% to 37% of the household income and NTFPs contributed almost 40% to 63% of household annual income

Fuelwood and NTFPs

Fuelwood and non-timber forest products are the other important provisioning services provided by Western Ghats. The value of fuelwood and NTFPs in the study region has been estimated through analyzing the data from 458 households from nine villages of Uttara Kannada district nearer to the ecological sampling sites, which would best capture the people forest dependencies. Three important factors were considered while selecting the villages i.e. vegetation type, extent of disturbance and proximity to the forests. The choice of the villages based on the forest type, distance from the forests and disturbance gives us an opportunity to capture the relation between forests and NTFP dependence. The values have been estimated using household production function.

Fuel wood is the only source of fuel for most of the household and therefore entire fuel wood collected is used for cooking and heating purpose. The results showed that the fuelwood contributed 16% to 37% of the household income and NTFPs contributed almost 40% to 63% of household annual income. From the demand analysis, the annual estimated demand for fuelwood per household has been 12,264 kgs and the demand for firewood for entire Uttara Kannada has been estimated at 2.6 Million tonnes. The average shadow price of fuelwood has been estimated to be ₹3.4 /kg. Considering the benefit to the entire population dependent on fuelwood in Uttara Kannada with a forest area of 7,81,900 hectares, the benefits amount to ₹8,840 million rupees with a per hectare value of ₹11,306 ₹/ha. However, if we assume a sustainable flow wherein approximately 1.05 Million or approximately 1.42t/ha of firewood can be sustainably extracted (based on the ecological study), the value per hectare due to firewood extraction (based on whatever is sustainably extracted is used), the benefits amount to ₹4590/ha. This is a very conservative scenario based on the assumption that whatever is demanded is supplied from forests only through removal of twigs and branches and not through clear felling.

The households collected approximately 3173 kgs of NTFPs annually. The demand for NTFPs has been estimated at 720 million Kgs which gives aper hectare value of ₹32,230 ₹/ha (US$ 519.2/ha). This estimate provides an indicative figure of the use value of forests in Western Ghats in a highly conservative regime.

Forest Carbon

From the biophysical measures, we estimated that the district of Uttar Kannada has a total carbon stock of 183.15 MtC which is equivalent to 672 MtCO2 equivalent with an annual carbon sequestration of 1.12 tC/ha/year. The benefit of carbon sequestered in the forests valued in terms of the avoided social costs is estimated as ₹756 crores (US$ 12.4199 crores) annually equivalent to ₹9673 /ha/year (US$ 11.0563/ha/year) which would accrue to the global community.

Recreational Value

The protected forests in Uttara Kannada benefit the local, regional and national economies through direct money injected into the economy through visitor spending and international funds, job creation in sectors heavily dependent on tourism. The study used travel cost method to estimate the benefits from tourism from a face-to-face survey of 450 tourists (75 groups) visiting Dandeli Sanctuary the second largest sanctuary in Karnataka attracting many national and international tourists. However, this method gives only the use value and not the existence or intrinsic values. during June 2014, The incurred expenditures by tourists are surrogates for the price paid for the site's use. The values to the local economy were generated through the face-to-face interviews of taxi drivers, tour operators, home stays, hotels and restaurants. The study estimated that the total surplus the economy derives per hectare of Dandeli-Anshi Protected Area is around ₹83,337/ha/yr (US$ 1,369/ha/year), assuming an average of 41,175 visits to the Sanctuary in a year. The surplus to the economy from all visitors visiting the Dandeli and Anshi Protected Area is ₹11, 375 million (US$ 187 million) per annum for the year 2014.

However, protected areas might not always generate a win-win scenario as declaring protected areas would impose costs on the local population as they lose access to the park and its resources, which may be disproportionately larger than the benefits incurred. The interaction with local villagers living around Anshi tiger reserve did indicate the costs to the local economy while the benefits are often reaped globally.

5. How much is Forest Ecosystem Worth?

The study revealed that there are important trade-offs faced in the region where 80% of the geographical area is under forests and more importantly when it is diverse Western Ghats ecosystem. It needs to be clarified that the total economic value should be used only to compare two alternate scenarios. In the present case, the comparison should be between the present scenario of flow of benefits in a highly regulated regime vis-à-vis, the alternate scenario in which forest conversion is not regulated and hence the benefits are absent. In Karnataka as a matter of policy of the State Government of Karnataka imposed a complete ban on any green felling and only removal of dead and fallen timber is permitted though mature green trees are available in some of the forests. Locals also have some use restrictions on collection of forest products. The study did not consider the biodiversity value and the option value of the forests due to the paucity of time, which however could be the scope for further research in future. Several studies do exist, but the authors wish to exercise caution in transferring the studies done at an earlier date and also for a different site.

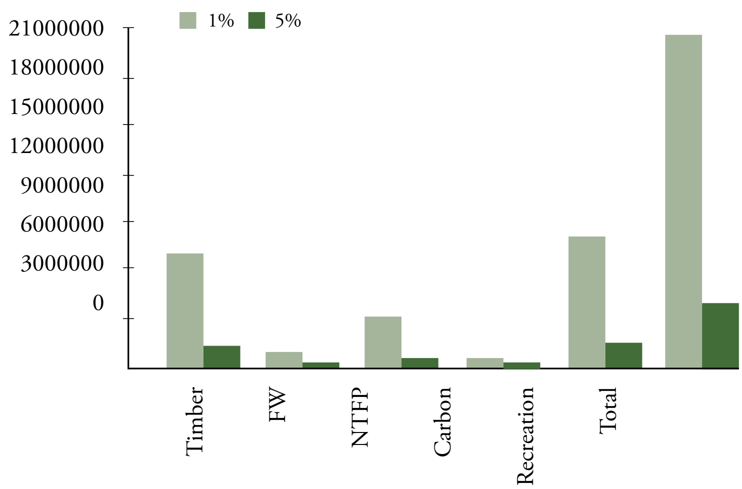
The net present value of the five ecosystem services in the current high protection regime (discounted at 1% and 5%) is expressed in Figure below The net present values show how much would the asset earn during its life span. High discount rate implies that present is more valuable than future and hence would be exploited more and vice versa as there are restrictions on the use of forests. These values do not include extraction from non-forest areas. One can see that the recreational value is high. There would be trade-offs between recreational values and other provisioning services. The study did not include many of the other services provided by forests, particularly those related to water, due to limitation of time.

The contribution of forests seems low but is not so as there is a nexus between the allocation of forests for logging and other uses versus the conservation of forests for protecting biodiversity and ecosystem services. Despite the high protection costs and the income foregone from moratorium on timber exploitation and other access regulations, the forest ecosystems still provide net benefits to the society. The study has considered only a limited set of whole range of ecosystem services and could be extended. However, the extrapolated values from small case s tudy or sample areas to regional or national scales should be viewed with caution and it is better to err on the side of conservation.

6. Policy, Institutional and Financial Options for Conservation and Sustainable Flow of Ecosystem Services

Forests of Western Ghats are critical for biodiversity, watershed services, the economy and livelihoods of communities. Thus there is a need to conserve the forests and biodiversity and ensure sustained flow of economic benefits by using economic incentives. Lot

Net present value of ecosystem services from Uttara Kannada forest ecosystems



of potential exists to explore 'win-win' opportunities to benefit the locals, businesses, global community and the policy maker.

- **Recommendation 1**- *Identify the values to different stakeholder and capture these values accruing to the different stakeholders in the decision-making framework*

Currently there is lack of information and data on the value of forest biodiversity and ecosystem services. The value of forest ecosystem is not recognised in the decision-making framework. Even where values exist, there is severe undervaluation. Failure to recognize the positive externalities provided by ecosystems would lead to distorted policies with detrimental environmental and human consequences.

Implications of distorted policy making can be: 1) conversion of forests to low return non-forestry activities, where the economic returns could be lower than the opportunity cost of retaining the forest ecosystems; 2) lower compensation paid for forest land conversion due to undervaluation; 3) enhanced forest conversion and irreversible loss of forest biodiversity and ecosystem services in the Western Ghats due to undervaluation and 4) Because of undervaluation, the alternate uses of land looks more valuable. Identifying the ecological and economic values makes a strong case for conservation, maintenance, restoration and sustainable management of Western Ghats ecosystem. We need policies aiming individually at each of the ecosystem service as well as targeting the ecosystem as a whole.

- **Recommendation 2** - *Estimate the sustainable extraction rates of timber, fuelwood and NTFPs and set efficient prices*

There is limited information and knowledge on the sustainable rates or modes of extraction of different forest products such as timber, fuelwood, grass and other non-timber forest products. As a result local communities and commercial contractors may be over harvesting many forest products, or even over harvesting in the forests, leading to degradation and loss of the services. This was observed in the case of Garcinia and Cinnamon species, and honey collection in the Western Ghats. Hence, research has to be carried on sustainable methods of extraction of forest products to determine sustainable rates of harvest. These rates may vary from location to location, and thus a potential range of rates of extraction may have to be developed for the Western Ghats region. Here the community traditional knowledge could also be utilized in determining sustainable rates of extraction. The ranges of sustainable rates of extraction should be communicated to the Biodiversity Management Committee's (BMCs) and Joint Forest Management Committees (JFMCs).

The timber should be efficiently priced taking into account the negative externalities. The illegal activities could be curbed through appropriate monitoring and effective enforcement, encouraging farm forestry and species that provide multiple ecosystem services. Alongside conservation of forest ecosystems, policies should address the fuel dependence and provide alternatives or mange the forest sustainably taking into account the fuel requirements of the local communities.

- **Recommendation 3** - *Recognizing demonstrating and capturing of the NTFP values in decision making framework help conserve the Western Ghats forest ecosystems.*

The study has shown that in the Western Ghats region a large number of NTFPs are extracted and used locally and in addition many NTFPs are in commercial demand. The market potential of the NTFPs is not fully understood. Extraction of some of the NTFPs is regulated by the forest department, leading to over-exploitation by the contractors. Due to the absence of markets, the local communities are getting lower prices for the forest products extracted and marketed. Many NTFPs have short shelf-life leading to distress sale at low prices.

The NTFP activity need to be organized in the region and the contribution of the sector needs to be given due priority in the policy making. The market potential of the NTFPs is also not known and the development of markets is required for many species, ensuring sustainable rates of extraction and practices.

At the moment the prices of NTFPs are not

Lack of information about sustainable rates or modes of extraction of forest products may be resulting in over harvesting, leading to degradation and loss of services efficient as there is no information on the demand and supply of these products. There is an opportunity to involve locals in inventorying the information similar to the People's Biodiversity Registers.

The conservation and regeneration of NTFP species is not a priority for many of the species and efforts should be made to ensure that NTFP yielding species are sustained. Many NTFPs have short shelf-life and thus may require storage facility or immediate processing to avoid distress sale or low prices.

Efforts should be made to generate employment through agencies involved in NTFP procurement, processing and sale of NTFPs. To make the sector lucrative, profitable, and sustainable and encourage locals to take up the job of primary collectors of NTFPs along with being leaders in conservation,

Local communities or institutions such as BMCs and JFMCs should have full access to NTFPs and the policy of auctioning and involvement of contractors should be avoided. The state forest departments could charge a fee for the NTFPs gathered.

NTFP management can be linked to the NREGA scheme. More coordinated efforts are required to demonstrate the potential value of NTFPs from the forests in India and their role in poverty alleviation, creation of employment, foods security and income generating opportunities. Government should play an active role in tapping the untapped potential of the NTFPs in Western Ghats and put a break on monoculture plantations. There should be an exclusive policy on NTFPs recognizing their importance to local livelihoods should be in place.

The state forest departments, SBAs, BMCs and JFMCs are not aware of the many values that the forest ecosystem provide and hence do not internalize them in the decision making. The state forest departments and State Biodiversity Authorities (SBAs) should be made aware of the provisions under National Biodiversity Authority (NBA) for full valuation of forest ecosystems, sustainable rates of extraction, approaches and methods for valuation of forest biodiversity and ecosystem services and the need for enforcing these provisions. Simple guidelines and tools need to be developed and disseminated along with periodic training programmes. The BMCs and JFMCs may also have to be trained to adopt the values of ecosystem services estimated for the Western Ghats' region while charging royalty or user fees.

- **Recommendation 4** - *A potential Payment-for-Ecosystem-Services scheme can be developed where in the service that is traded is scenic beauty and the local communities can be involved with minimal damage to the ecosystem.*

The protected areas offer a large potential for ecotourism and for generating economic benefits to the local communities. Right now the potential is unutilized and local communities benefit very little at the moment. Further, there are no clear guidelines for involving local communities and for sharing benefits from eco-tourism. The local communities are not even aware of the existing Ecotourism Guidelines.

A clear ecotourism policy emphasizing minimal impact of tourism on the ecology has to be in place for the region, and not part of the department of tourism policy and the prime sector generating tourism be given complete benefit.

Lot of potential for recreational benefits that can be tapped without disturbing the ecology of the area exists, which would yield high revenues. The benefits of tourism should be shared with local community and local public should be involved in providing direct services to the tourists. This is a potential Payment-for-Ecosystem-Services scheme, wherein the ecosystem services that is traded is scenic beauty, the beneficiaries being the tourists and the supplier of services is the forest department through the local communities.

It is also important to design a compensation mechanism to offset local resource use foregone. Rather than alienating the local community, a clear vision on strategies for tourism, conservation ways with community participation with people and ecosystems at the center need to be evolved rather than unrelated tourism in the region. Provisions should be made to ensure that the local communities are adequately compensated for any loss of access to goods and services from the PAs and avoid conflicts between them and the wildlife.

- **Recommendation 5** - *There is a strong need to provide incentives for industries and corporate for conservation of biodiversity and ecosystem services*

Many large and small-scale industries depend on raw materials from forests and the biodiversity. There are no clear guidelines on enforcing sustainable harvest practices or for ensuring sharing of benefits with local communities. This is not in the interest of either the industry or forest biodiversity in the long-term. In the Western Ghats region, many industries depend on forest for raw materials such as pickle manufacturing units, Garcinia processing units and pharmaceutical units depending on species such as Terminalia chebula, Terminalia bellerica and Emblica officinalis.

1. TEEB for Western Ghats - Background, Issues and Approach

1.1. Introduction and Background

India is one of the mega-diversity countries in the world and around 1.2 billion people co-exist with 7-8% of all recorded species, including over 45,000 species of plants and 91,000 species of animals, of which several are keystone species. India with more than 16% of the global population, and only 2.4% of the world's land area has a daunting challenge with its skewed endowment of natural resources. Further, with only 38 million hectares (Mha) of pasture land (Planning Commission, 2011), supplemented by other fodder resources, India supports one-sixth of the world's livestock population.

Millions of people depend on the natural resources such as forests, wetlands and coastal ecosystems for their livelihoods, particularly important are the 104 million tribals living in and around the forests and depending on them for their income and livelihoods (MoA, 2013). India, with an objective of 'Faster, More Inclusive Growth', according to the 12th Five Year Plan has to ensure the conservation of the biodiversity and health of its diverse ecosystems, while ensuring the growth.

Environmental sustainability is of utmost importance in India and to achieve and sustain higher levels of income and standard of living for all, the overall development with increased opportunities for employment and optimum use of natural resources is critical. Balancing environmental conservation and economic growth is a challenging task and involves huge trade-offs. However, achievement of sustainability is a long-term process and requires investment in human as well as natural capital. India has several constitutional provisions, laws and policies to promote environmental conservation and sustainable use of natural resources. India is a signatory to many international conventions and treaties, related to environmental protection and has taken several initiatives towards their implementation. India has prepared National Biodiversity Targets towards implementation and achievement of Aichi Biodiversity Targets at the national level. The Government of India has also developed a Green National Accounting Framework and applied to limited extent economic instruments for conservation of ecosystems.

In the above context, the Ministry of Environment and Forests, Government of India formally launched a TEEB India Initiative (TII).Consultations in February and September 2011 led to identification of three ecosystems for assessment. The three ecosystems selected for economic valuation include forests, inland wetlands, and marine and coastal ecosystems. A review report on the economic aspects of the three ecosystems was presented as an Initial Assessment and Scoping Report at COP11, Hyderabad, India (October 2012). The report outlined a strategy for ecosystem-based economic valuation.

Forests account for a third of the earth's land area and about 80% of terrestrial biodiversity. Globally, the livelihoods of close to 1.6 billion people are dependent on forests (FPP, 2012). Forests provide multiple supporting, provisioning, regulating and cultural services to human well-being. According to studies reviewed by TEEB (TEEB, 2010), the contribution of forests and other ecosystems to the livelihoods and incomes of the poor rural households is significant. The contribution of forest sector to the national GDP is high in many tropical regions and countries (FAO, 2014). The state and health of the forests, in particular the tropical forests, is crucial for the economy and livelihoods of vast population in tropical countries, the poor in particular. Further, there is a growing recognition of the role forests play in global climate change. Forest resources have an important bearing on the environmental/ecological security and well-being of the country and people (ISFR, 2011). The importance of forests as a natural resource has been recognized by the government of India and therefore large emphasis has been laid on the conservation, restoration and development of forests.

Figure 1: Forest cover of India according to density classes (ISFR, 2013)

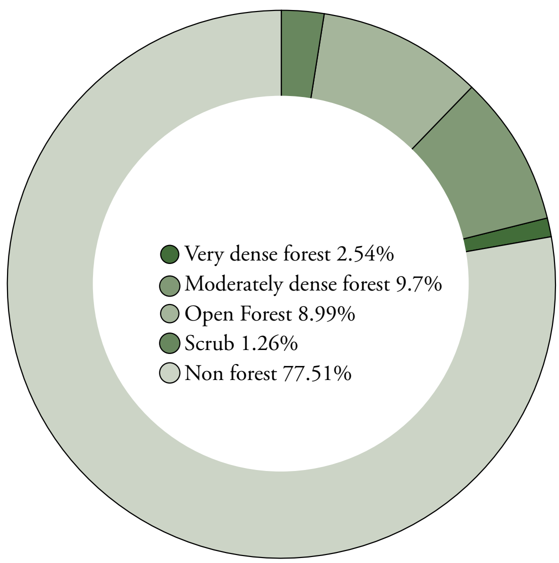


Figure 2: Forest cover of India (ISFR, 2013)

1.2. Area Under Forests in India and Trends in Area Under Forests

The Forest Survey of India (FSI) defines forest as, "all the lands, more than one hectare in area, with a tree canopy density of more than 10%".The area under forests in India is estimated to be 69.79 Mha, accounting for 21.2% of the total geographic area of the country and 200 million live in and around forests, and depend on it for their livelihoods (SFR, 2013). In terms of density classes, about 2.5% is very dense forest, about 10% is moderately dense, about 9% is open forest and scrub accounts for 1.2% of the total geographic area (Figures 1 and 2). In India, many rivers originate in forests. The forest sector contribution to GDP in India, though low (at 1.7% during 2011), could be high for the livelihood of forest dependent communities or poor in general.

Table 1 presents the net area under forests in India during the period 1985-87 to 2009-11. Data in Table 1 shows that the forest area in India is generally stable and consistently increasing since 1995-97.However, a study by Ravindranath et al. (2012) using published data of FSI, has concluded that India is experiencing significant scale forest loss and degradation. Similarly, an assessment by Puyravaud et al. (2010) has shown that there is loss of India's native forests. Gilbert (2012) has also highlighted the controversy over the area under forests in India.

The factors driving change in forest cover in the different States are varied. Factors causing a decrease in forest cover include shifting cultivation in the north-eastern States such as Manipur, Mizoram, Nagaland, and Assam to rotational and planned felling by the Forest Department in Andhra Pradesh and Haryana to encroachments as reported from Andhra Pradesh, Assam, Chhattisgarh, Madhya Pradesh and Maharashtra (FSI, 2013). The factors contributing to increase in forest cover in some of the States such as Gujarat, Delhi, Bihar, Kerala, etc., include conservation and afforestation.

1.3. Threats, Gaps and Challenges in Forest Conservation and Management

In India there are several policies and programmes that have promoted forest conservation and development. However, these have led to constitution of islands of biodiversity (and social exclusion) – the so-called Protected Areas (PAs) – in an ocean of ecological devastation outside of these PAs (WGEEP, 2011). What is needed as advocated by Western Ghats Ecology Expert Panel (WGEEP) is a model of conservation and development compatible with each other encompassing the whole of the Western Ghats region, to replace the prevailing, develop recklessly – conserve thoughtlessly pattern with one of, develop sustainably – conserve thoughtfully'.

Table 1: Net forest area (Mha) under different density classes at different time periods

Forest density class	Year of assessment								
	1985-87	1995-97	1997-99	1999-01	2001-03	2003-05	2005-07	2007-09	2009-11
Dense	36.14	36.73	37.74	41.68	39.06	38.72	40.25	40.42	40.22
Open	28.16	26.61	25.99	25.87	28.78	28.99	28.84	28.78	29.57
Total	64.20	63.34	63.73	27.55	67.83	67.71	69.09	69.20	69.79

Source: *State of Forest Reports – 1987 to 2013.*

According to the report of the High Level Working Group on Western Ghats (2013), there are unprecedented threats to the natural landscape of Western Ghats region by development projects and urban growth as a result of highly interventionist and environmentally damaging activities like mining or polluting industries.

Here, we summarise some of the threats, gaps and challenges in forest conservation and management of forests of India, particularly the Western Ghats from the existing literature on forest ecosystems in India. The same has been elaborated in the TEEB-India Scoping Report.

In India, according to an assessment of forest conversion and loss made by Ravindranath et al. (2012) at the district level, about 63,650 ha was lost annually during the period 2003-05 and 99,850 ha annually during 2005-2007. Further, forests in India are also subjected to degradation due to non-sustainable extraction of fuelwood and Non-Timber Forest Products (NTFPs), over-grazing by livestock, forest fire, fragmentation and encroachment (Afreen et al., 2011). According to ISFR (2013), only 13% of the recorded forest area has no biotic influence. About 11% and 20% of the recorded forest area has high and moderate biotic influence, respectively.

1.3.1. Issues in Conservation and Restoration of Forest Biodiversity and Ecosystem Services

Biodiversity is integral to almost all ecosystem processes, with some species playing key functional roles that are essential for maintaining the value of ecosystems to humans. However, many ecosystem services remain non valued, and decision makers rarely consider biodiversity in policy development, in part because the relationships between biodiversity and the provision of ecosystem services are not directly obvious and hence not appreciated. Some of the potential issues in conservation and restoration of forest biodiversity and ecosystem services were elaborated in the scoping report and a summary of the same is provided below and an attempt is made to address some of these issues in this study:

- Lack of periodic assessments and monitoring that generates knowledge, information and data on the status of biodiversity and ecosystem services and the threats and drivers of degradation and loss
- Lack of awareness on the economic value of biodiversity and ecosystem services requiring due recognition and demonstration of the value of forest ecosystems
- Lack of integration of biodiversity and ecosystem services' concerns in planning and designing of conservation and restoration policies and programmes
- Lack of technical and institutional capacity for conservation and restoration of forest biodiversity and ecosystem services
- Lack of effective institutional arrangements for effective conservation and restoration of biodiversity and ecosystem services.

1.3.2. Existing evidence base on ecosystem services and valuation

While the number of studies based on economic valuation of biodiversity and ecosystem services is growing worldwide, there is still a dearth of similar studies in India. An extensive review is provided in the TEEB Scoping Report (2012). Studies conducted could be categorized as those that valuated provisioning, regulating, supporting and cultural services and there are only a few that have adopted a holistic approach and evaluated multiple ecosystems services. In all, there are about 10 holistic studies covering either a single state or a group of states or the entire country (Gundimeda et al, 2005, 2006, Chopra, 1993, Parikh et al, 2008; Verma et al., 2010., Verma et al., 2007). Provisioning service of forest ecosystems is quantified by several studies (Negi & Semwal, 2010; Joshi & Negi, 2011; Mahapatra & Tewari, 2005; Purushothaman et al., 2000; Narendran et al., 2001; Murthy et al., 2005; Sarmah and Arunachalam, 2011; Appasamy, 1993). There is one study by Kiran and Kaur, 2011, which has quantified the nutrient retention (supporting) service of forests. Badola et al (2010) and Hadker et al (1997) have evaluated the recreation service (cultural) of forest

Biodiversity is integral to almost all ecosystem processes, with some species playing roles essential for maintaining ecosystem value to humans. Still, decision makers rarely consider biodiversity in policy development

The key pressure/threats to forest ecosystems in India include:

- **FOREST CONVERSION:** According to NBAP (2008), about one Mha of forest area has been diverted for implementing about 14,997 developmental projects since the enactment of the Forest Conservation Act in 1980.
- **EXTRACTION OF TIMBER AND NTFPS:** Fuelwood is the dominant source of cooking energy for rural population in India with forests contributing significantly to this. According to ISFR (2011), about 216 Mt of fuelwood is consumed in India of which about 27% is sourced from forests. Domestic demand for timber and fuelwood is well above the sustainable level.
- **LIVESTOCK GRAZING:** Grazing has profound influence on forest vegetation – while light controlled grazing is beneficial, heavy uncontrolled grazing is harmful (ISFR, 2013). Harmful impacts of uncontrolled grazing include death of seedlings, reduced porosity of soil due to compaction resulting in poor aeration and increased run-off and loss of palatable grasses. According to ISFR (2013), incidence of moderate to high grazing pressure is reported for more than 30% of the recorded forest area.
- **FOREST FIRE:** The area estimated to be fire prone by the Forest Survey of India (ISFR, 2013) is about 54% of the recorded forest area of which heavy fires are estimated to affect about 1.3% and moderate and mild fires are estimated to affect about 6.5% and 46%, respectively. The extent of forest area estimated to be experiencing surface fire that affects ground flora and organic matter in the soil is 3.69% and this pole crop and regeneration is affected in an estimated area of 1.42% (ISFR, 2013).
- **MINING:** Mining, particularly open cast mining, has significant impacts on forest and biodiversity of India. Sahu and Dash (2011) estimated the total land area impacted by mining to be 13,546 ha during 2005-06. In the Western Ghats region, iron ore mining activity has resulted in degradation of land and forest area and impacted the water quality in the Bhadra River on account of siltation and contamination of water by the ore (SoE, 2003).
- **FOREST FRAGMENTATION:** Fragmentation decreases habitat through loss of land area, reducing the probability of maintaining effective reproductive units of plant and animal populations. Landscape fragmentation results in less connectivity of habitat to allow natural migration, limiting the adaptive capacity of species and the viability of ecosystems (Vos et al. 2008).Roy et al (2013) have conducted an assessment of, and mapped the extent of forest fragmentation using high-resolution geospatial data on vegetation and a fragmentation index for the entire Indian landscape. According to this study, most of the biodiversity-rich forests, such as evergreen, subtropical broadleaf and temperate broadleaf forests, are relatively intact or have a low degree of fragmentation. But the study also concludes that, certain highly fragmented regions across the Indian landscape harbours a number of endemic species, some of which have medicinal importance requiring conservation.
- **INVASIVE ALIEN SPECIES:** The major forest invasive species include Lantana camara, Eupatorium glandulosum, Parthenium species, Mimosa species, Eichornia crassipes, Mikania micrantha, Ulex europaeus, Prosopis juliflora, Cytisus scoparius, Euphorbia royleana, etc. Highly invasive climbers like Chromolaena and Mikania species have over-run the native vegetation in northeast Himalayan region and the Western Ghats (NBAP, 2008). A study conducted by Forest Survey of India for the State of Forest Report concludes that about 60% of the recorded forest area has moderate to scanty presence of weeds while about 20% of the area has very dense distribution of weeds (ISFR, 2013).
- **ANTHROPOGENIC CLIMATE CHANGE:** The assessment of climate impacts based on projections of the Regional Climate Model of the Hadley Centre and the global dynamic vegetation model IBIS for A1B scenario for the short-term (2021–2050) and long-term (2071–2100) periods showed that at the national level, about 45% of the forested grids are projected to undergo change. This means the future climate is not optimal for the existing forest types and biodiversity leading to forest die-back and change in biodiversity in the long run.

Major threats to Indian forest ecosystems include climate change, mining, and forest fire

FOREST

ecosystems in Corbett Tiger Reserve, Uttarkhand and Borivili National Park, Maharashtra. The regulating service of forest ecosystems have been quantified for a single forest type (Badola et al., 2010), or the entire forests of India (Kadekodi and Ravindranath, 2007; Singh, 2007 and Kumar et al., 2006). Some of the studies which are particularly relevant to the study region are given in Table 2 below.

In addition to the individual research initiatives on Western Ghats, the Government of India constituted two high level committees to take stock of Western Ghats ecosystems, understand the development pressures on the region, and suggest some key implementation plans for Western Ghats. The Kasturi Rangan report identified around 60,000 sq.km of natural landscape (37% of the total geographical area of Western Ghats Region) as ecologically sensitive area and developed the landscape indices (biological richness and forest fragmentation) from the geospatial analysis of IRS LISS-III satellite data and included data on species richness of vegetation, endemicity, ecosystem uniqueness, disturbance indicators, adjacency and patch characteristics. The committee had recommended a prohibitory and regulatory regime in the ecologically sensitive areas for all the activities which destroy and intervene with ecosystem functioning. The committee offered some suggestions to some of the major development versus environmental trade-offs in the region for example, in the case of Gundya hydropower project where the committee suggested that decision should consider the damage to forests in terms of ecological flows in the downstream areas, suggested complete ban on mining, quarrying and sand mining in the region, a strict no to thermal power plants etc. The committee also suggested strengthening of the data monitoring systems, participation and involvement of local communities in decision making, incentivising conservation, encouraging states to take up conservation through grant-in-aid, encouraging PES services within the region etc. The Gadgil's report demarcated area under Western Ghats to be approximately 1,29,037 sq. km. The report emphasized on sustainable development of the region with thoughtful conservation of the ecologically sensitive areas of the Western Ghats. Some of the recommendations relevant to this report include encouraging system of use of positive incentives to encourage continued conservation oriented actions, clear recognition of the damages done to ecologically sensitive areas as a result of various development projects and considering a precautionary approach erring on the side of conservation to the decision making process.

Table 2: Summary of studies relevant to the study region

Forest goods and services	Study year	Area
Provisioning goods and services	2012	Uttar Kannada District
NTFP (including fuelwood)	2002-03	Karnataka
Provisioning services	2013	Tropical wet and semi-Evergreen Forests, Western Ghats
Regulating services	2013	Tropical wet and semi-Evergreen Forests, Western Ghats
Bioprospecting values	2013	Tropical wet and semi-Evergreen Forests, Western Ghats
Supporting services	2013	Tropical wet and semi-Evergreen Forests, Western Ghats
Recreational value	2002-03	Dandeli Wildlife Sanctuary and Karnataka
Carbon storage	2002-03	Karnataka
Medicinal Plants	2002-03	Karnataka
Provisioning services (NTFP)	2005	Periyar Tiger Reserve, Western Ghats
Opportunity cost of biodiversity conservation	2005	Maldari village of Kodagu District, Western Ghats
Net forest resource benefits (grazing, fuelwood and NTFPs)	1999-2000	Uttar Kannada district, Western Ghats
Willingness to relocate outside Dandeli Wildlife Sanctuary		Uttar Kannada District, Western Ghats

Method	Value	Source
Market value (implicit in the subsistence, income and local employment)	₹2,05,388/hectare/yr	Ashwath D N et al. (2012)
Market value (consumptive value)	₹1649.7 crore (Unrecorded value), ₹35.3 crore (recorded value)	Panchmukhi et al. (2008), CSO
Market value	Timber- ₹7,02,146/ha/yr	Verma, M. et al. (2013)
Market value	Bamboo- ₹6261/ha/yr	
Cost adjusted price of fodder	Fodder- ₹24898/ha/yr	
Market value	NWFP- ₹50586/ha/yr	
Market value	Fuelwood- ₹30,268/ha/yr	
Social cost of carbon	Carbon sequestration- ₹29801/ha/yr, Carbon storage- ₹1988221/ha/yr	Verma, M. et al. (2013)
Replacement cost	Pollination and seed dispersal- ₹95844/ha/yr	
	Water recharge- ₹15703/ha/yr	
Species richness	1622164	Verma, M. et al. (2013)
Avoided cost approach	Soil conservation- ₹72707/ha/yr	Verma, M. et al. (2013)
Individual Travel Cost Method	₹37142.86 per Sq km (for Dandeli Wildlife Sanctuary) and ₹21.12 crores (for Karnataka state)	Panchmukhi et al. (2008), CSO
Market value of carbon	₹16659.79 crores	Panchmukhi et al. (2008), CSO
Contingent Valuation Method	0.001% of GSDP for year 2002-03	Panchmukhi et al. (2008), CSO
Use value	Forest dependency varies based on socio-economic characteristics of households and stake of local people over protected forest varies across different socio-economic groups. Poor people are more vulnerable to policy changes on forest management.	Sathyapalan, J. (2005)
Contingent Valuation Method	High opportunity costs for biodiversity conservation. Significant external costs incurred by coffee grower due to wild life conservation accounting for between 7 - 15% of total discounted costs of coffee.	Ninan, K. N., & Sathyapalan, J. (2005)
Market based approach	1256.3 US$/hh (NPV at 8% discount rate, assumed time span- 25 years)	Ninan K.N. (2007)
Contingent Valuation Method	10556.8 US$/hh	Ninan K.N. (2007)

The Ministry of environment and forests has also commissioned a report on revising the NPV rates to compensate for the loss on ecosystem services that occur due to conversion of different class/category of forests for non-forest purposes (Verma et al., 2013). For the wet evergreen forests of Western Ghats region in scenario (2) after adjusting for double counting at discount rate of 4%, the net present values ranged from 44 lakhs for very dense forests to 14.3 for open forests and for semi evergreen forests the estimates ranged from 33.9 to 15.4 lakhs/ha. The study has considered timber, fuelwood, fodder, non-timber forest products, ecotourism, soil conservation, water recharge, pollination, bioprospecting values and is solely based on secondary sources of information and benefit transfer from other studies. For the studies to be more relevant and useful they should take local conditions into consideration. Extrapolation of values from different case studies to regional or national scales should be viewed with caution.

For any such sustainable model of development and conservation, a study like TEEB for Western Ghats would be extremely helpful. The study is based on ecological data collected from field and backed with the economic data collected through various primary data sources.

1.3.3. Gaps in Valuation of Forest Ecosystem Services and Biodiversity

In India there have been a few studies aimed at assessing economic value of biodiversity and ecosystem services, largely focused on the use value or the marketable products. There are several limitations of the studies conducted so far which limit their use for guiding policy making:

- Inadequate and incomplete coverage of ecosystems/forest areas of the country.
- Focus on one or a few of the ecosystem services arising from a forest ecosystem leading to incomplete valuation and hence not reflecting the total economic value of the forests. The total economic value of forest ecosystems is critical, especially for decisions on conversion of forests to infrastructure projects.
- Macro level valuation at the state or national level, based largely on secondary and international sources of economic value of forest products and services, making them limited in relevance to local situations and policy making. These estimates are further based only on current rates of extraction and not sustainable rates of extraction.
- Limited data on the cost of loss of biodiversity and ecosystem services due to conversion of forestland to non-forest purposes and its implications.
- Absence of empirical data based valuation of biodiversity and ecosystem services.
- Absence of total economic value of biodiversity and ecosystem services, especially in the Western Ghats and in India.
- Lack of standard methods for valuation of biodiversity and ecosystem services, making them incomparable.

1.4. Purpose/scope of the study

Biodiversity and ecosystem services play key role in future economic strategies seeking to promote development and prosperity. Biodiversity — diversity within and among species is related to the production of most ecosystem services (Hooper et al. 2005, Balvanera et al. 2006). When ecosystems are managed for only a limited set of goods and services, such as timber from forests (Nasi and Frost 2009), many other ecosystem services may be overlooked and therefore undervalued. If ecosystems are to be effectively managed and conserved, the value of all ecosystem services, including the externalized costs of their loss, needs to be understood by decision makers. A key role for science is to refine our understanding on how ecosystems function, to establish the links between functions and the provision of ecosystem services, and then to communicate that knowledge effectively to decision makers and the public. Illustrating the importance of biodiversity for ecosystem goods and services valued by people is an increasingly important contemporary approach to influencing conservation policy and complements other arguments for biodiversity conservation (Thompson et al. 2011).Translating the existing body of literature on link between biodiversity and ecosystem services into policy advice is a major challenge (Perrings et al. 2011).

There are many efforts at the national, state and

Biodiversity and ecosystem services play a key role in future economic development strategies. If these ecosystems are to be effectively managed and conserved, the value of all ecosystem services needs to be understood by decision makers

local level to conserve, restore and sustainably manage forests. However, the decline and loss of ecosystem and biodiversity services continues unabated. One of the ways to counter this is to reward best practices by developing markets for ecosystem services and also products and services. Economic valuation of ecosystem services and biodiversity could thus promote ongoing conservation and restoration efforts and also ensure sustained flow of benefits to forest dependent communities. Rewarding local communities with actual value for the products and services from forests would enhance the stake for local communities in protecting and managing the forests, leading to conservation. There is also an emerging need to represent forest biodiversity and ecosystem services in the National Accounts, which is currently limited by lack of information on the economic value of both use and in particular non-use value of forest ecosystem products and services, as evidenced by states such as Himachal Pradesh, Uttarakhand and Sikkim. Economic valuation of biodiversity and ecosystem services is an important step to internalize the values in decision-making process. TEEB thus presents an approach that can help decision-makers recognize, demonstrate and capture the values of ecosystems and biodiversity in decision making.

The Economic Valuation of Biodiversity and Ecosystem Services would help meet the following goals and targets:

- Enable actual valuation of forest biodiversity and ecosystem services and enable comparison with alternate use or land conversion prospects
- Motivate corporates and industries to provide technical support, financial incentives and enable long-term collaboration with local communities
- Enable Biodiversity Management Committees or Joint Forest Management Committees – JFMCs to seek
  - appropriate or actual price for forest products and services
  - compensation for protection or conservation
- Generate information for national/state green accounting
- Identify and create potential opportunities for financing sources for conservation
- Identify the beneficiaries of conservation and the magnitude of the benefits they receive, and thus help design mechanisms to capture some of these benefits and make them available for conservation
- Enable meet some of the AICHI targets thereby contributing to the objectives of the Convention on Biological Diversity.

2. Ecological Assessment of Biodiversity and Ecosystems Services of Western Ghats Forest Ecosystems

2.1. TEEB study in the Western Ghats

The TEEB-Western Ghats study is one effort to address and evaluate the economic benefits of forest biodiversity and ecosystem services. The Western Ghats study will provide local context to valuation, which could potentially be used for policy-making and market development. More importantly, the study will assist in confronting national conservation challenges by providing a policy platform for any reforms that may be needed to achieve higher conservation results by not only recognizing, but also demonstrating, the value of forest biodiversity and ecosystem services. The study intends to help identify the scope for corporate and industrial involvement in realizing the true value of forest biodiversity and ecosystem services, which ultimately leads to conservation and sustained flow of biodiversity and ecosystem services to all stakeholders, particularly local communities. The specific objectives of the study include:

- Assessment and estimation of the status of biodiversity and flow of ecosystem services from selected forest types in the Western Ghats – Bio-physical services
- Estimation of the economic value of biodiversity and ecosystem services in the Western Ghats
  - Evaluating the contribution of ecosystems to the social and economic status of human societies
  - Recognition and demonstration of the importance of monetary and non-monetary benefits of forest ecosystems
- Understanding policy and institutional issues and barriers in the Western Ghats region with respect to forest biodiversity and ecosystem services
  - Suggesting policy, institutional and financial options for providing incentives to promoting conservation and the sustainable flow of economic benefits to local communities.

The report adopts the global TEEB Framework, or the tiered approach, in analyzing and structuring valuation. The tiered approach may be represented by the acronym RDC:

- **Recognize** - Recognizing value in ecosystems, landscapes, species, and other aspects of biodiversity, is an activity of all human societies and communities, and is sometimes sufficient to ensure conservation and sustainable use.
- **Demonstrate** - Demonstrating value in economic

terms is often useful for policymakers and others, such as businesses, in reaching decisions that consider the full costs and benefits of a proposed use of an ecosystem, rather than just those costs or values that enter markets in the form of private goods.

- **Capture** - Capturing value, the final tier of the economic approach, involves the introduction of mechanisms that incorporate the values of ecosystems into decision making, through incentives and price signals. This can include payments for ecosystem services, reforming environmentally harmful subsidies, introducing tax breaks for conservation, or creating new markets for sustainably-produced goods and ecosystem services.

2.2. Approach

The study based in the Western Ghats is an effort to provide an evidence base for the multiple ecosystem services that flow from forest ecosystems and also a demonstration of an approach to the economic valuation of biodiversity and ecosystem services from forest ecosystems. The study is designed to recognize, capture and demonstrate the economic value of forest ecosystems through the approach presented in Figure 3.

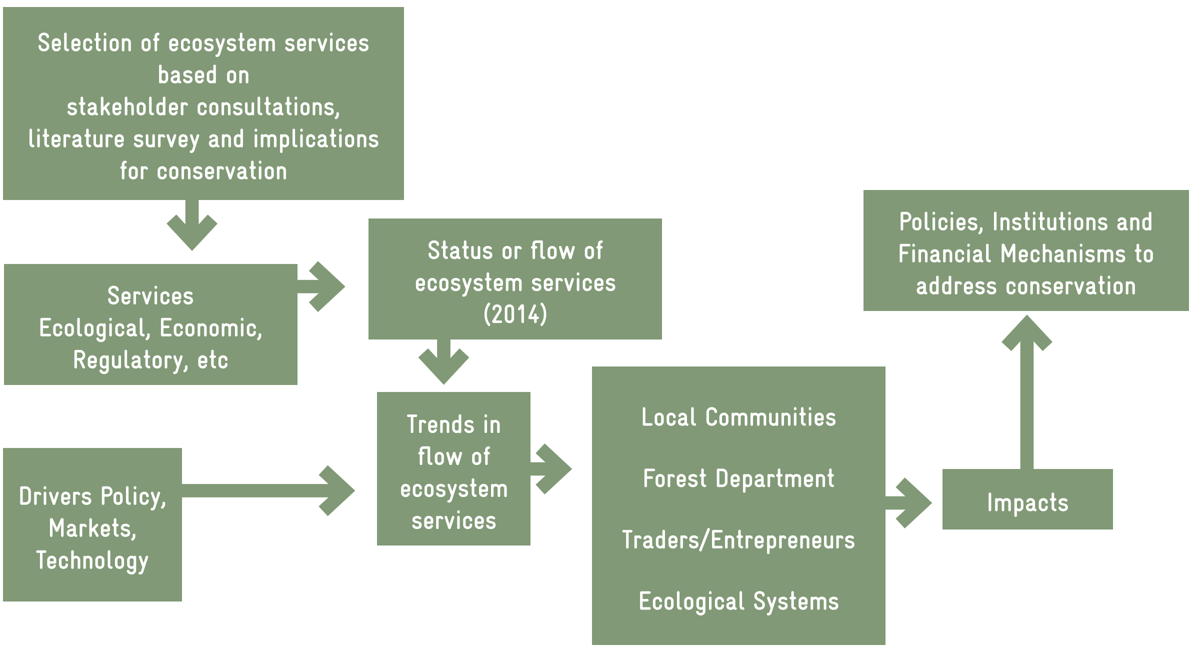
The approach adopted for demonstrating the economics of biodiversity and ecosystem services of forest ecosystems in the Western Ghats involves the following steps: (i) Selecting ecosystem services to be quantified; (ii) assessing the current status of the services as well as the trends in flow of services; (iii) assessing the implications of any such change on various stakeholders and its impacts; and, finally, (iv) formulating recommendations and strategies for addressing the change so as to sustain flow of benefits to all stakeholders whilst ensuring the conservation of forest resources and benefits.

2.2.1. The Western Ghats

The exact total area under the Western Ghats varies due to lack of well-defined boundaries for the Western Ghats. For example, according to Western Ghats Ecology Expert Panel (WGEEP), the total area under Western Ghats is 1,29,037 sq. km, but others put the area anywhere between 1,36,800 sq. km to 260,962 sq. km. About fifty million people inhabit the Western Ghats and the Western Ghats spreads over an area of 1,64,280 sq. km and traverses six states of India, viz. Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu, spanning 188 taluks in 51 districts.

An analysis of the area under forests in the states and districts of the Western Ghats region over a 10-year period, from 2003 to 2013, shows that the area under forests has increased by 7,839 sq. km. However,

Figure 3: Approach to TEEB-Western Ghats assessment



when area under forests in the different density classes is seen, the area under dense forests is reported to have increased but the area under moderately dense forests has decreased by 481 sq km, with area under open forests increasing simultaneously (Table 3).

A close look at the area under various crown density classes in the different districts of the 6 states for the 10-year period of 2003 to 2013 indicates there is a change in forest area under different crown density classes and, in many states, there is a reduction from higher density crown class to lower density crown class across states:

- **Maharashtra:** A net loss of about 79 sq. km area in the very dense and 58 sq. km area in the moderately dense forest categories over the period 2003 to 2013.
- **Gujarat:** A loss in moderately dense forest area of 587 sq. km.
- **Goa:** A loss of 670 sq. km of moderately dense forests in north and south Goa districts.
- **Karnataka:** A loss of only 2 sq. km in the very dense forest category but a loss of 1621 sq. km in the moderately dense forest category in all districts, except Mysore.
- **Kerala:** A reported loss in area under very dense as well as moderately dense forest categories is reported and the loss is 50 and 749 sq. km, respectively over the decade.
- **Tamil Nadu:** About 278 and 103 sq. km loss has been reported for the decade in the very dense and moderately dense forest categories.

The loss in area under very dense and moderately dense forests in some of the districts, (including a loss of 479 sq. km of moderately dense forests in Uttara Kannada) of the 6 Western Ghats' states is a cause of concern as such losses in native forests are irreversible and the biodiversity losses at times are permanent, as the Western Ghats is home to some of the most endangered and threatened species. Such forest losses also have implications for the biomass and carbon stocks, as well as the dependent livelihoods and economies of local communities.

Table 3: Area under forest according to density classes (sq. km) in the Western Ghats districts for the period 2003 to 2013

	Very Dense Forest	Moderately Dense Forest	Open Forest	Total
2003	3096	46838	29534	79468
2005	3949	46086	29685	79720
2009	6322	45977	33124	85423
2011	6370	46001	33267	85638
2013	6844	46357	34106	87307

Source: *State of Forest Report (FSI, 2003, 2005, 2009, 2011 and 2013)*

2.2.2. Importance of the Western Ghats

The Western Ghats is a treasure trove of biodiversity and the water tower of Peninsular India. The great topographic heterogeneity (from sea level to 2695 m at its highest point, the Anaimudi peak) and strong rainfall gradient (annual precipitation of <50 cm in sheltered valleys in the east to >700 cm along west-facing slopes) together give rise to tremendous diversity of life forms and vegetation types, including tropical wet evergreen forest, montane stunted evergreen forest (shola) and grassland, lateritic plateaus, moist deciduous and dry deciduous forests, dry thorn forests, and grasslands. Some of these are critical habitats for plants and animals. The Western Ghats is also home to about 50 million people in the six states it traverses.

The Western Ghats is a hot spot' of biodiversity (Myers et al. 2000) and, at the same time, high human population density and major landscape transformation since the mid-18th century emphasize the urgency of conservation of the Western Ghats and the sustainable use of its resources. A study in the southern region, comprising the states of Karnataka, Kerala and Tamil nadu, showed that between the period 1920–1990, about 40% of the original vegetation cover was lost or converted to another form of land use (Menon and Bawa 1997). It is estimated that not more than about 7% of the area of the Western Ghats is presently under primary vegetation cover, though a much larger area is under secondary forest or some form of tree cover. Nearly 15% of the Ghats is also under the Protected Area system.

The importance of the Western Ghats in terms of its biodiversity can be seen from the known inventory of its plant and animal groups, and the levels of endemism in these taxa (Gunawardene et al. 2007). Nearly 4000 species of flowering plants (27% of the country's total species) are known to inhabit the Ghats. Of 645 species of evergreen trees (>10 cm dbh), about 56% is endemic to the Ghats. Among the lower plant groups, the diversity of bryophytes is impressive, with 850-1000 species; of these, 682 species are mosses, with 28% endemics, and 280 species are liverworts, with 43% endemics.

The Western Ghats also form the major watershed in India, and as many as 58 major Indian rivers originate from it. Forty seven of these rivers flow towards the west, eight rivers flow eastward and three rivers flows outwards. The Godavari, the Krishna, the Cauvery, the Kali, the Bedthi, the Tadri and the Sharavati are major rivers in the region (Tewari, 1995). The Ghats is an important source of water for the entire Peninsular India, as it receives between 2,000 and 8,000 mm of rainfall annually within a short monsoon period and performs important hydrological and watershed functions. Approximately 245 million people live in the peninsular Indian states that receive most of their water supply from rivers originating in the Western Ghats. The great range of the Western Ghats influences the climate of India, particularly the rainfall pattern. Figure 4 presents the varied levels of biological richness while Figure 5 presents the extent of fragmentation in the Western Ghats. As can be seen from Figures 4 and 5, the extent of highest fragmentation largely coincides with regions of high biodiversity richness, indicating pressure on forest resources, with implications for conservation as well as sustained flow of biodiversity and ecosystem services to communities residing in and around these forests.

2.3. Biodiversity and Ecosystem Services Assessment and Methods

The importance of forests as a natural resource has been recognized by the Government of India and therefore large emphasis is laid on the conservation, restoration and development of forests. The forest sector can play a critical role in equitable and inclusive growth, along with protecting natural heritage and ensuring sustainable development (11th Five-Year Plan, MoEF Working Group Report). Forest development provides an opportunity to optimize broad-based development and poverty reduction of forest-dependent communities, as well as helps address global concerns of climate change and the conservation of biological diversity. Along with policy, legislative and administrative reforms, availability of adequate resources for development of forests and forest-dependent communities should contribute towards realizing the new vision based on faster, more broad-based and inclusive growth, which would satisfy needs and aspirations of all sections of the society (11th Five-Year Plan, MoEF Working Group Report) .

The forests of the Western Ghats are rich in biodiversity and there have been descriptive studies dealing with the qualitative aspects of the forests of

Figure 4: Levels of biological richness in the Western Ghats

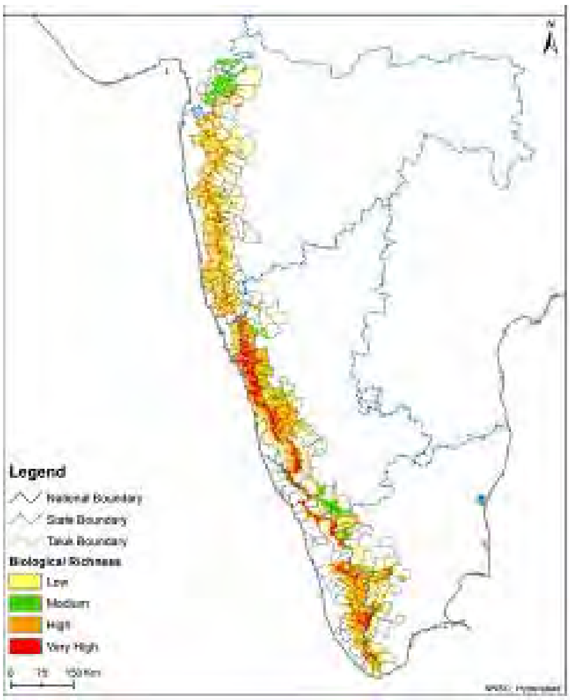
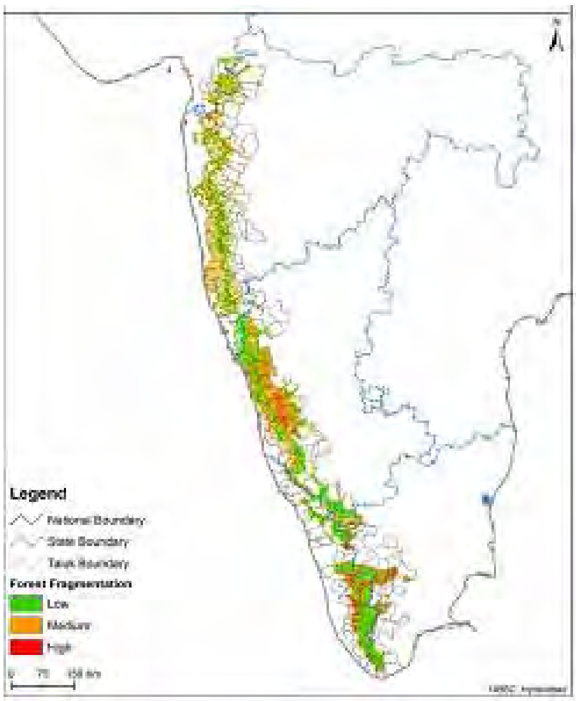


Figure 5: Levels of fragmentation in the Western Ghats



the Western Ghats (Champion and Seth 1968, Rai and Proctor1986, Pascal and Pellisier 1996), but very few studies have attempted quantitative assessment of the status and dynamics of the region (Rai 1983, Bhat et al., 2000a, Pomeroy et al., 2003). The biodiversity rich forests of the Western Ghats are subjected to degradation and loss, despite several progressive conservation and developmental policies and programs. The main hypothesis of this study is that proper economic valuation of biodiversity and ecosystem services and awareness of these values will contribute to the conservation and sustainable use of forests.

The first step towards the valuation of biodiversity and ecosystem services from forests is its recognition, which has been documented by various institutions and individual researchers over the decades. The next step is demonstration of the value of biodiversity and ecosystem services, which is dependent on the forest type, the status of the forest, the current level of dependence on the forests and other climatic and non-climatic factors. To arrive at a value for a resource, it is imperative to quantify the benefits (bio-physical valuation) that accrue from a resource – both use and non-use values, and/or both tangible and intangible benefits.

The first part of the study aims at bio-physical quantification of the provisional and carbon regulatory services as well as the biodiversity status in 1-ha long-term monitoring plots established during 2009-10 by the Centre for Sustainable Technologies, Indian Institute of Science in Uttara Kannada district of Karnataka, part of the Western Ghats. The unique feature of this study is that all the provisional services and carbon regulatory service valuation is based on primary studies and location-specific data. The study involves ecological assessments of evergreen, moist deciduous and dry deciduous forest types.

2.3.1. Study Area

In the Western Ghats region, the Uttara Kannada district in Karnataka is selected for the case study, since forests dominate the geographic area of the district, accounting for 76.3% of the total geographic area. The Western Ghats, which run parallel to the west coast, passes through this district and divides it into two distinct zones — a wide upland country along the Ghats, at an elevation of 675 m above sea level, and a narrow coastal strip. Further, Uttara Kannada was selected because of the availability of past data for understanding and establishing trends in the status of forests and flow of ecosystem services.

Uttara Kannada district, lies between 13° 55' to 15° 31' N lat., 74° 9' to 75° 10' E long. A detailed description of the physical environment of Uttara Kannada district is available in Bhat et al. (2000b). This district is richly endowed with forests and receives an average annual rainfall of 3,500 mm near the coast to more than 5000 mm along the ridge of the hills, mainly from the southwest monsoon, concentrated during the months of June to September.

The vegetation of the district is of the evergreen/semi-evergreen type along the slopes; towards the east of the ridge, it is moist deciduous (Pascal 1982, 1984, 1988). The total geographic area of the district is 1,029,100 ha, of which forests account for 781,900 ha, according to the State of Forest Report 2013, which is about 76% of the total geographic area of the district. Champion and Seth (1968) have classified the forest on the western slope as tropical evergreen and included the forest of the eastern zone in the category of south Indian moist deciduous type. Based on rainfall and vegetation types, the district can be broadly divided into evergreen/semi-evergreen and drier secondary/moist deciduous zones.

The district receives an average annual rainfall of 2,742 mm mainly from the southwest monsoons and it is concentrated during the months of June to September. The district has been divided into five forest divisions to facilitate proper management of forests by the forest department and the area under the different forest types in the five forest divisions of the district is given in Table 4.

The main hypothesis of this study is that proper economic valuation of biodiversity and ecosystem services and awareness of these values will contribute to the conservation and sustainable use of forests

2.3.2. Methodology

In this section, we discuss the forest types selected for establishing the status of biodiversity, the ecosystem services quantified, the sampling strategy and the methods of ecological assessment.

2.3.2.1. Assessment Of Biodiversity

Assessment of biodiversity was carried out in selected forest types of Uttara Kannada district, across a rainfall gradient. The plots selected are the long-term monitoring plots established in evergreen, semi-evergreen, moist and dry deciduous forest types by the Indian Institute of Science during 2009.

- **Selections of plots:** In all, 9 plots – 3 of each forest type, 1 ha each – established during 2009, were revisited for enumeration. Evergreen plots were selected in three locations, namely Ekkambi, Tattikai and Hosur. Moist deciduous plots at Hudelakoppa, Panchavati and Togralli were included, and dry deciduous plots of Malgiand Adikehosur were included for the assessment (Table 5).
- **Plot size and shape:** The plots are square in shape and 100 X 100 m in dimension (Figure 6). Each plot has been sub-divided into sub-plots of 20 X 20 m, for ease of measurement, and the corners of the plot as well as every 20th metre of the plot has a stone planted on the ground as physical marking.
- **Approach:** The nested plot approach adopted for the study and the plot layout for enumeration of trees, shrubs and herbs is given in Figure 7. The size of the plot for trees, shrubs and herbs is given in Table 6.
- **Trees:** Within this 1 ha, all individuals ≥ 10 cm in girth or ≥ 1.5 m in height were classified as 'trees' and enumerated, along with the unique identification number allocated to the individual tree during previous enumerations by use of metal tags on the stem of the trees. Parameters recorded include: name of the individual tree, GBH (Girth at Breast Height) of the tree – 130 cm above ground – height of the tree, and remarks on unique features observed on the tree, such as cuts, termite attacks, signs of fire incidence, or presence of a climber, liana, or other orchids and ferns.
- **Shrubs:** For measurement of shrubs, 10 × 10 metre square plots were laid in a diagonal pattern across the five strips of tree plots within the 1 hectare plot. The

Table 4: Percentage area under different forest types across forest divisions of Uttara Kannada district

Forest division	Area under different forest types (%)			
	Evergreen	Semi-evergreen	Moist deciduous	Dry deciduous
Haliyal	5.37	4.61	48.24	41.78
Yellapur	6.57	13.31	30.09	50.02
Karwar	21.48	38.39	34.75	5.36
Honnavar	18.08	32.13	34.31	5.48
Sirsi	9.20	36.05	25.25	29.47

Source: *Karnataka Forest Department*

- **TROPICAL EVERGREEN**: This forest type is a narrow belt stretching along the Western Ghats and distributed in the high rainfall areas of central and western parts of the district. This forest type generally occurs between elevations 525-925 m and above (Arora, 1963).
- **SEMI-EVERGREEN**: This occurs towards the lower slopes, foot hills and along interior coastal plains. However, there is no clear-cut zonation between the evergreen and semi-evergreen. Degrees of biotic interference and state of soil seem to be the distinguishing factors. Thus, in this study, semi-evergreen forest type is merged with evergreen forest type.
- **MOIST DECIDUOUS**: This forest type is yet again a result of biotic interference and soil type and it replaces the semi-evergreen forest type gradually over the plateau.
- **DRY DECIDUOUS OR SCRUB**: This forest type is found in climatically and topographically homogeneous areas, the reason being biotic disturbance. It forms a small percentage of the lower foot of the eastern slopes, with low rainfall.

Table 5: Forest types and study locations (villages) of assessment of biodiversity and ecosystem services

Evergreen forest type	Moist deciduous forest type	Dry deciduous forest type
Ekkambi	Hudelakoppa	Malgi
Hosur	Panchavati	Adikehosur
Tattikai	Togralli	Chibbalgeri*

** Chibbalgeri forest plot has been converted to a plantation during the recent years and therefore not included in vegetation analysis. But community dependence on forests was assessed in all the 9 villages during 2014.*

girth measurements were taken at breast height using a pair of calibrated Vernier callipers. All individuals ≤ 10 cm in girth and height of ≥1.5 m were classified as shrubs and measured. The diameter or DBH (Diameter at Breast Height) and height of the shrub along with the name of the species were recorded.

- **Herbs:** Herb plots of 1 × 1 meter were laid at the two corners of each shrub plot and all individuals with height ≤ 1.5 cm were enumerated for their numbers according to species.

2.3.2.2. Assessment of Ecosystem Services

The Millennium Ecosystem Assessment (MA, 2005) considers humans as an integral component of the natural ecosystem unlike classical approaches, which differentiate humans as non-natural. The approach also addresses the sustainability of resources and livelihoods by considering human wellbeing a parallel theme to the functioning of the natural ecosystem. Figure 8 outlines ecosystem services from forest ecosystems: provisioning, regulating, cultural and supporting services.

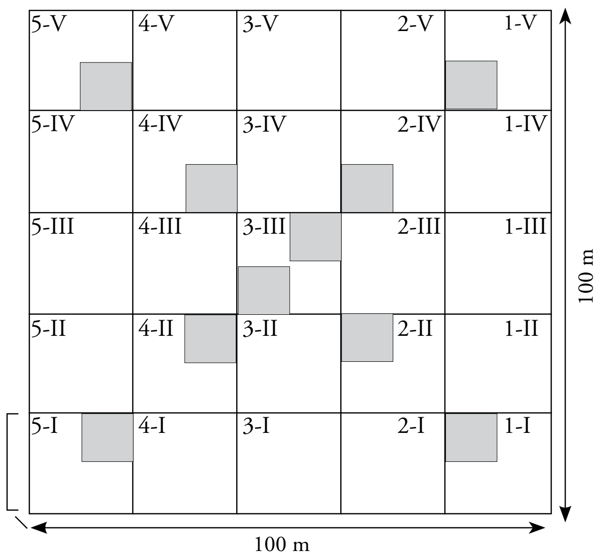
2.3.2.3. Ecosystem Services Studied

Following the Millennium Assessment Framework, the ecosystem services quantified in the current study include provisional services such as timber, fuelwood, food, fodder, medicine and fibre, or broadly, timber and Non-Timber Forest Products (NTFPs), including fuelwood and fodder. The carbon regulatory services were quantified considering aboveground biomass, belowground biomass and soil organic carbon (Table 7). The selection of ecosystem services for the study was limited by the available time and resources.

Provisional Services

Provisional services like timber and fuelwood collection are under the regulation of the forest department and are collected and sold as well as used by local communities. The approach adopted for quantification of provisional services in the forest plots was firstly through inventory of different tree species and their characteristics

Figure 6: Monitoring plot layout



present in the forest plots and secondly through collection of secondary data on the end use of different species – be it timber, fuelwood or NTFPs – from literature and local knowledge.

Assessment of Carbon Regulatory Services

The carbon pools included in this assessment as elaborated earlier are aboveground biomass, belowground biomass and soil organic carbon.

Carbon Pools

In a forest ecosystem there are five carbon pools, namely: aboveground biomass, belowground biomass, dead wood, litter and soil carbon. Ideally, all five have to be estimated. However, due to limitations of time, the current study calculates aboveground biomass based on measurements and estimates belowground biomass using a default. Soil organic carbon is measured and quantified. These are the dominant carbon pools.

Above Ground Biomass

Among the methods for estimating aboveground biomass, the most commonly used method is the 'plot

Table 6: Details of sampling for enumeration of trees, shrubs, herbs and soil

Plant form	Size of the plot
Tree	100 X 100 m
Shrub	10 X 10 m
Herb	1 X 1 m
Soil	30 cm depth

Table 7: Ecosystem services assessed in this study

Provisioning Services	Food, Fodder, Fuelwood, Fibre, Timber, Manure, Medicine
Regulating Services	Climate regulation - Biomass and Soil Carbon
Supporting	Biodiversity
Recreational	Eco-tourism

Figure 7: Nested plot layout

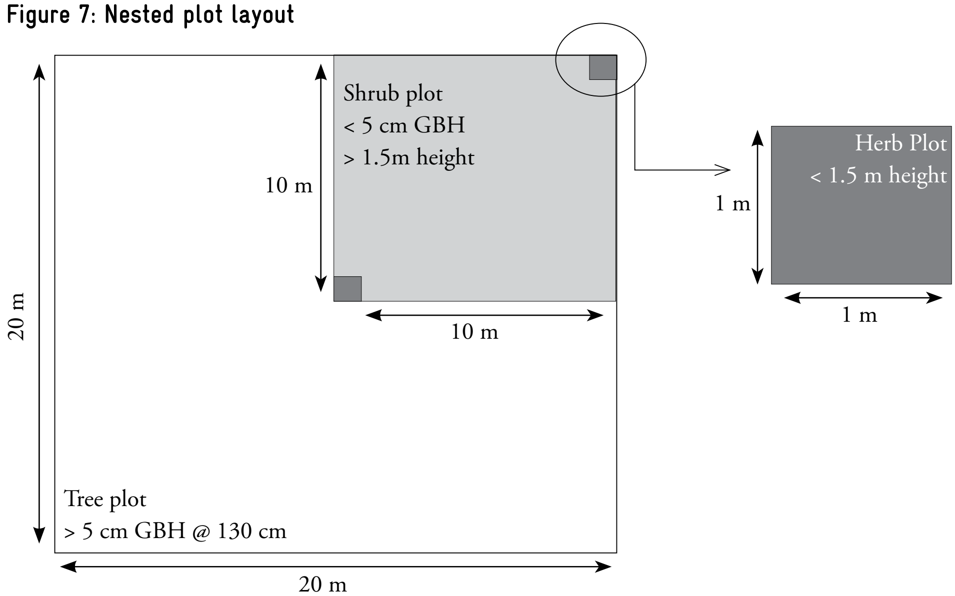


Figure 8: Ecosystem services and benefits obtained (MA, 2005)

Provisioning Services *Products obtained from ecosystems*	Regulating Services *Benefits obtained from regulation of ecosystem processes*	Cultural Services *Non-material benefits obtained from ecosystems*
• Food • Fresh water • Fuelwood • Fibre • Biochemicals • Genetic resources	• Climate regulation • Disease regulation • Water regulation • Water purification • Pollination	• Spiritual and religious • Recreation and ecotourism • Aesthetic • Inspirational • Educational • Sense of place • Cultural heritage
Supporting Services *Services necessary for the production of all other ecosystem services*		
• Soil formation	• Nutrient cycling	• Primary production

method'. Aboveground biomass was estimated using height and DBH data of trees by calculating the basal area (m^2/ha^{-1}) and converting it to biomass following Murali et al. (2005), since species-specific allometric equations are not available for the majority of species found in the study region.

Biomass (in lumes) = 50.66 - 6.52 x (Basal area)

Belowground Biomass

Belowground biomass is estimated based on estimates of aboveground biomass stocks and the use of a default conversion factor of 0.26 (IPCC 2003). Biomass is also an indicator of the productivity of a forest patch.

Aboveground biomass x 0.26 (IPCC Default Factor) = Belowground biomass

Soil Carbon

Soil samples were collected at a depth of 30 cm from the surface within the monitoring plots in different forest types. The steps involved in estimation of soil organic carbon include:

- Collection of the soil samples at a depth of 30 cm from the corners of 10 X 10 m plots laid for shrub enumeration
- Mixing of soil samples collected in replicates to obtain a composite sample

- Estimation of bulk density
- Estimation of organic matter or carbon content present in the soil sample using Walkley and Black method in the laboratory
- Calculation of carbon stock in tonnes of carbon/ hectare using organic matter content, bulk density and depth of soil.

The multiple soil samples collected were combined to give a composite sample. This sample was analysed for soil organic carbon density in the laboratory using the Walkley Black method.

2.4. Bio-Physical Estimates of Biodiversity, Provisional and Regulating Services

Biodiversity, meaning variety of life, is an intrinsic value that is worth protecting, regardless of its value to humans. Biodiversity performs a number of ecological services for humankind that have economic, aesthetic and recreational value. Both points of view (intrinsic and anthropocentric) need not be contradictory, as they are complementary

Biodiversity refers to the number, abundance, and composition of the genotypes, populations, species, functional types, communities, and landscape units in a given system. Biodiversity is both a response variable that is affected by changes in climate, resource availability, and disturbance, as well as a factor, with a potential to influence the rate, magnitude, and direction of ecosystem processes. This chapter focuses on this second aspect – the effects of biodiversity on ecosystem processes and the ecosystem services that humans obtain from them. Ecosystem services are broadly defined as the benefits provided by ecosystems to humans; they contribute to making human life both possible and worth living (Daily 1997; MA 2003). Biodiversity affects numerous ecosystem services, both indirectly and directly. Some ecosystem processes confer direct benefits on humanity, but many of them confer benefits primarily via indirect interactions.

2.4.1. Indicators of Biodiversity

In this section, firstly, plot characteristics including species richness, abundance, size class distribution, basal area and biomass are estimated and presented. Secondly, the provisional services flowing from the different species and the carbon regulatory services – both biomass and soil – are presented.

2.4.1.1. Species Richness

Species richness is the number of different species represented in an ecological community, landscape or region (Colwell Robert, 2009). Table 8 presents the number of species and the number of individuals representing each of the species in the study locations across evergreen, moist and dry deciduous forest types.

Evergreen forest type: The number of tree species in evergreen plots varied between 54 in Ekkambi to 79 species in Tattikai and on an average these evergreen plots had 1978 individuals. In the same plots, the number of shrub species in the total sampled area of 1000 sq. m (10 X 10 m plots, 10 in number) ranged between 23 to 32, averaging around 27 species. Enumeration of herbs in 10 replicates of 1 X 1 sq. m plots within the shrub plots nested in the tree plots indicate a herb density species richness of 24 to 31.

Moist deciduous forest type: Among the moist deciduous plots, the number of species was highest in Togralli (75), followed by Panchavati (61) and Hudelakoppa (55). The shrub species richness varied between 17 to 28 and the herb species richness 25 to 30 in the same plots.

Dry deciduous forest type: Among the two dry deciduous plots Malgi plot had twice the number of tree species as compared to Adikehosur. However the number of shrubs was higher in Adikehosur. The herb species richness was 17 and 21 in Adikehosur and Malgi, respectively.

2.4.1.2. Species Diversity

Ecologists define species diversity on the basis of two factors: (i) the number of species in the community which ecologists usually call species richness and (ii)

Table 8: Species richness and number of individuals per hectare in different forest type locations

Forest type/ Location	Number of species (No. of individuals)		
	Trees	Shrubs	Herbs
Evergreen			
Ekkambi	54 (1610)	32 (405)	31 (107)
Hosur	61 (1389)	23 (116)	25 (85)
Tattikai	79 (2196)	25 (184)	24 (99)
Moist Deciduous			
Hudelakoppa	55 (1622)	18 (75)	25 (87)
Panchavati	61 (1461)	17 (48)	30 (102)
Togralli	75 (1358)	23 (120)	26 (96)
Dry Deciduous			
Malgi	32 (483)	13 (33)	21 (73)
Adikehosur	16 (490)	28 (367)	17 (46)

the relative abundance of species, or species evenness. In this study, the species diversity was calculated using the Shannon Weiner Index for species diversity. The equation for Shannon Wiener diversity index is:

$$H^{'} = \pi \sum \ln \pi$$

where pi is the proportion of individuals found in species I; pi = ni/N, where ni is the number of individuals in species i and N is the total number of individuals in the community.

Table 9 presents the diversity index of trees, shrubs and herbs across the various plots of the three forest types. Among the tree plots, highest diversity was recorded in the Togralli moist deciduous plot while lowest diversity was recorded in the Adikehosur dry deciduous plot. In the shrub plots, the diversity recorded was higher than 2 in all the plots except Malgi wherein the diversity index was as high as 4.51. In the herb plots, the diversity index ranged from 3.08 in Panchavati – a moist deciduous plot ¬¬– to 2.46 in Adikehosur dry deciduous plot. On an average, the diversity index of trees in the evergreen forest type was 3.02, followed by the moist deciduous plots with a Shannon Weiner diversity index of 2.98, and then the dry deciduous plots with 1.54. The shrub diversity was highest in the dry deciduous plots (3.46) followed by the moist and then the dry deciduous forest plots. The herb diversity was however highest in the moist deciduous plots, followed by the evergreen and then the dry deciduous plots.

2.4.1.3. Species Dominance

Species dominance is traditionally expressed as a ratio of the number of individuals belonging to a species, to the total number of individuals in a biological community. The dominant species across the different plots within as well as across forest types differ. Table 10 presents a list of top 10 species considering number of individuals representing that species in each of the plots in the three forest types studied.

It is interesting to note that among the evergreen plots, the top ten species account for about 66 to 80% of the total number of individuals (average – 74%) while in the moist deciduous plots, it is about 66 to 85% (average of 76%) and in the dry deciduous plots, it is greater than 90% in both the plots. *Ixora brachiata* dominates the Ekkambi plot, while in Tattikai, it is *Aporosa lindleyana*, and in Hosur, it is *Memecylon umbellatum*. Among the moist deciduous plots, Hudelakoppa plot is dominated by Aporosa lindleyana, Panchavati by *Terminalia paniculata* and Togralli by *Leea indica*. In both the dry deciduous plots, *Terminalia paniculata* dominates followed by Tectona grandis.

It is also important to note that some of the species recorded in the plots are endemic to the region and they include species such as *Holigarna grahamii* and *Holigarna arnotiana*. Also, it should be noted that the properties of species are more important than species number in influencing climate regulation. Climate regulation is influenced by species properties via effects on sequestration of carbon, fire regime, as well as water and energy exchange.

Table 9: Shannon Weiner diversity index of trees, shrubs and herbs in the study locations across forest types in the Western Ghats

Forest type	Location	Trees	Shrubs	Herbs
Evergreen	Ekkambi	2.93	2.27	2.97
	Hosur	2.84	2.64	2.76
	Tattikai	3.30	2.14	2.78
Moist Deciduous	Hudelakoppa	2.71	2.18	2.70
	Panchavati	2.99	2.62	3.08
	Togralli	3.25	2.54	2.91
Dry Deciduous	Malgi	2.12	4.51	2.55
	Adikehosur	1.01	2.41	2.46

2.4.1.4. Size class (DBH) Distribution of Individuals

Distributing individuals in a study area across diameter (DBH) classes gives an indication of the structure of the population as well as the status of regeneration. In all the plots across all locations and all forest types, the number of individuals was highest in the lowermost DBH class of 0-10 cm with the number in the other diameter classes much lower (Figure 9).

This kind of distribution indicates significant regeneration of species. It is interesting to note that this trend is observed across sites and types, despite human dependence on these forests for various purposes.

2.4.1.5. Basal Area of Trees

Basal area is an indicator of growing stock and biomass production. The basal area of the different plots in the evergreen, moist and dry deciduous forest types is presented in Figure 10. As can be seen, the basal area of the evergreen plots are comparatively higher than that of moist deciduous and the dry deciduous plots, in that order. The average basal area recorded is higher for evergreen plots (39.5 m^2/ha) followed closely by the moist deciduous plots (35.9 m^2/ha). The average basal area of the dry deciduous plots is lowest, at 26.9 m2/ha.

Lower basal area results from indiscriminate logging, lower amounts of precipitation, varying species composition, age of the trees, disturbance and succession stage of the stand. Differences in basal area are mainly related to both the density of individuals and their size.

It is evident from the information presented in this section that the forests of Uttara Kannada district of the Western Ghats are rich in plant biodiversity and have accumulated substantial basal area over the years, an indication of plant growth and biomass availability – both timber and fuelwood to local communities. The observed plant diversity and biomass accumulation despite community dependence on these forests is an indication of community awareness of the importance of maintaining diversity, regeneration and health of these forests.

Table 10: Top ten dominant species in the study plots across different forest types

Evergreen forest type			
Ekkambi		*Tattikai*	
Species	No	Species	No
Ixora brachiata	311	*Aporosa lindleyana*	600
Aporosa lindleyana	241	*Olea dioica*	346
Terminalia paniculata	186	*Psychotria dalzeli*	295
Murraya koenigii	98	*Flacourtia montana*	131
Calycopteris floribunda	87	*Terminalia tomentosa*	108
Randia spinosa	74	*Holigarna arnotiana*	102
Olea dioica	73	*Psychotria flavida*	100
Casaeria tomentosa	70	*Symplocos beddomei*	95
Holigarna grahmii	46	*Symplocos spp*	89
Allophyllus cobbe	39	*Knema attenuata*	68
Others	385	*Others*	1001
Total	1610	Total	2935
Moist deciduous forest type			
Hudelakoppa		*Panchavati*	
Species	No	Species	No
Aporosa lindleyana	289	*Terminalia paniculata*	198
Murraya koenigii	265	*Calycopteris floribunda*	193
Randia spinosa	192	*Randia spinosa*	167
Calycopteris floribunda	158	*Allophyllus cobbe*	156
Allophyllus cobbe	130	*Grewia tilaefolia*	99
Randia uliginosa	121	*Murraya koenigii*	95
Terminalia paniculata	117	*Mallotus philippinenis*	87
Grewia tilaefolia	43	*Lagerstroemia lanceolata*	42
Alseodaphne semecarpifolia	32	*Randia uliginosa*	41
Ervatamia heyneana	28	*Ziziphus rugosa*	39
Others	247	*Others*	344
Total	1622	Total	1461

Contd...

Dry deciduous forest plot			
Malgi		*Adikehosur*	
Species	No	Species	No
Terminalia paniculata	146	*Terminalia paniculata*	373
Tectona grandis	97	*Tectona grandis*	63
Calycopteris floribunda	75	*Terminaia tomentosa*	13
Lagerstroemia lanceolata	65	*Randia uliginosa*	9
Xylia xylocarpa	21	*Anogeissus latifolia*	8
Carea arborea	18	*Diospyros montana*	7
Largerstroemia parviflora	11	*Cassia fistula*	3
Adina codifolia	10	*Xylia xylocarpa*	3
Ervatamia heyneana	5	*Adina cordifolia*	2
Anogeissus latifolia	4	*Lagerstroemia lanceolata*	2
Others	31	*Others*	7
Total	483	Total	490

2.4.2. Quantification of Ecosystem Services From the Sampled Area

Ecosystem goods and services represent the benefits human populations derive, directly or indirectly, from ecosystem functions (Costanza et al. 1997). Some ecosystem services are well known, such as those which are essential for life (e.g. food, clean air and water) or those which improve our quality of life (e.g. recreation and aesthetics). Other services are often taken for granted, such as natural processes (e.g. pollination and flood regulation). In this section we discuss some of the direct ecosystem services that flow from forests to dependent communities. As presented earlier, the services estimated include provisional and carbon regulating services from forest ecosystems. In this section, the various provisional services from forest ecosystems, followed by the regulating service of climate mitigation through carbon sequestration are discussed. Provisioning services encompass a diversity of products that are extracted and utilized by the local communities for self-consumption as well as commercial purposes – in local, regional or national markets.

2.4.2.1. Provisioning Services

These are products directly obtained from forest ecosystems and include the following:

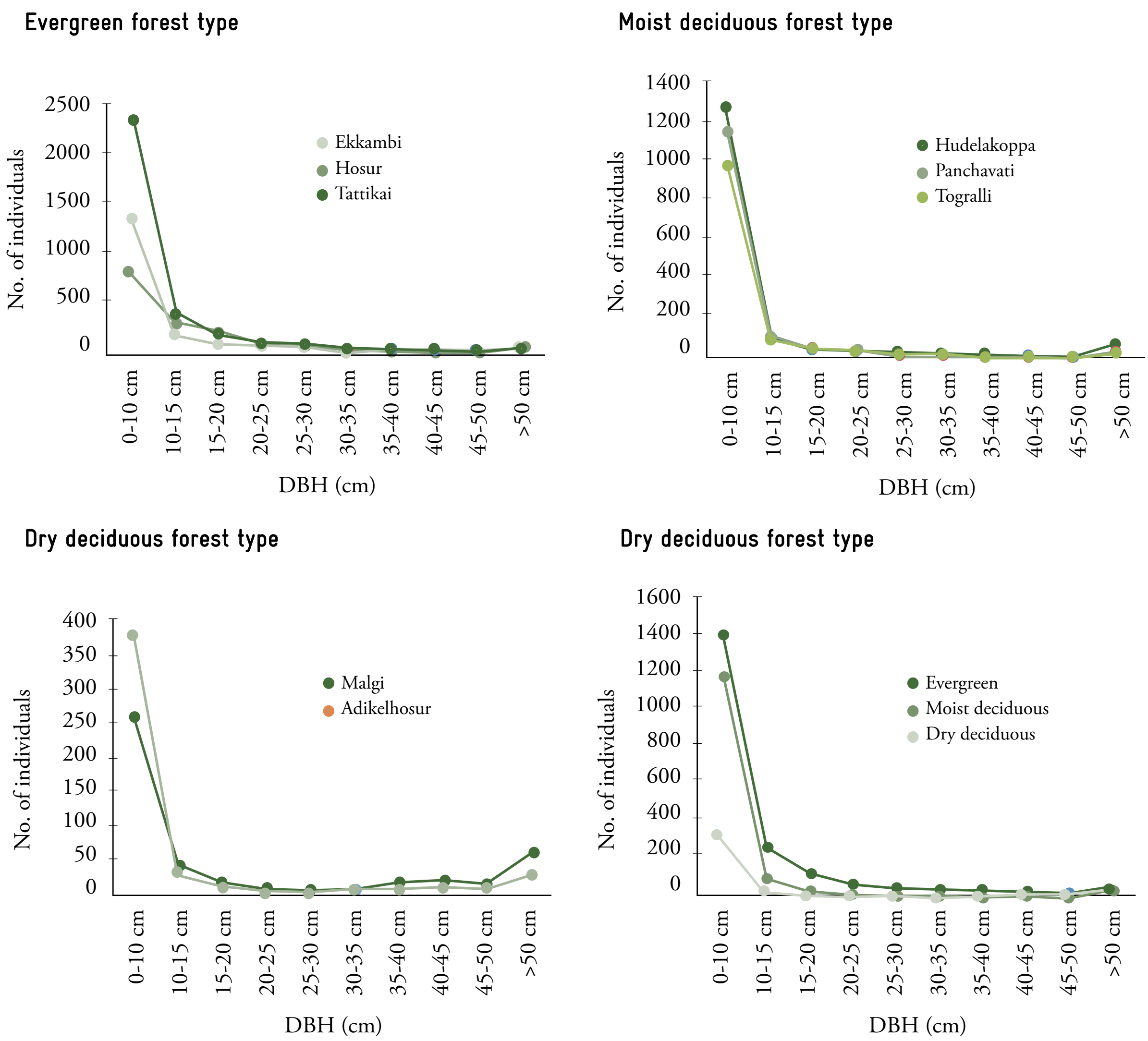
- **Food and fibre:** This includes the vast range of food products derived from plants, animals, and microbes, as well as materials such as wood, bamboo, honey, gum, and many other products derived from ecosystems.
- **Fuel:** Wood, leaves, and other biological materials serve as sources of energy.
- **Genetic resources:** This includes the genes and genetic information used for animal and plant breeding and biotechnology.
- **Biochemicals, natural medicines, and pharmaceuticals:** Many medicines, biocides, food additives such as alginates, and biological materials are derived from ecosystems.
- **Ornamental resources:** Flowers and leaves are used as ornaments, although the value of these resources is often culturally determined.

The present study has generated an evidence base relevant for understanding the significance of many provisional services provided by evergreen, moist and dry deciduous forest types in Uttara Kannada district of the Western Ghats. The various species recorded in the different plots of the different forest types provide multiple benefits. The primary and secondary use for each of the species recorded in the various plots was compiled from local communities and literature. These were previous studies and plant databases provided by different sources and largely restricted to the Western Ghats region.

Food

Many plant parts such as fruits, seeds, flowers and leaves are consumed by local communities. There is a growing awareness of the contribution of NTFPs to household economies, food security, national economies and conservation of biodiversity. NTFPs provide food,

Figure 9: Forest type wise and location wise size class (DBH) distribution of individuals in the study plots of the Western Ghats



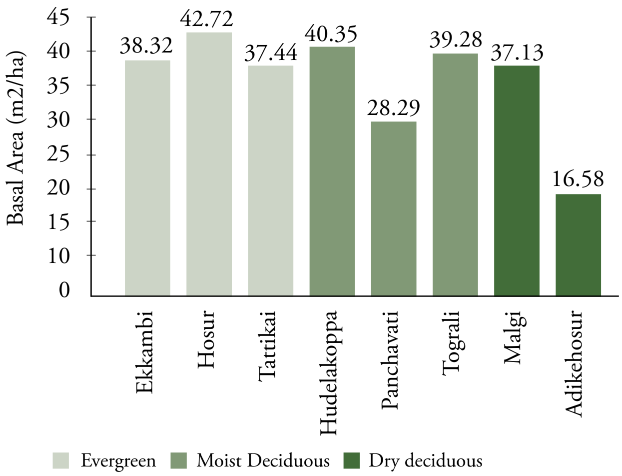
fuelwood, medicines, fibre and cash income to rural households (Okafor et al., 1994). In the developing countries, 80% of the people use forest products for food and personal care (Anon, 2000). In the study area also, several tree species are extracted and used as food or food substitutes. The total number of tree species yielding food products across the three forest types is given in Table 10, and Table 11 provides location-wise number of species that have potential use as food across forest types.

It can be seen from Table 11 that about 40 different tree species are used as food in the evergreen forest type, while in the moist and dry deciduous forest types, 32 and 8 different tree species are used as food, respectively. It is between 14 and 34 tree species across different evergreen forest types (Table 12). Similarly, in the moist deciduous forest type, it varies between 17 and 22 tree species and in the dry deciduous forest type, it is anywhere between 2 to 17 tree species.

Some of the dominant species that are specifically used in this region as food and food substitutes or flavouring agents are *Murraya koenigii, Garcinia indica, Garcinia cambogea, Artocarpus lakoocha, Carissa carandas, Artocarpus integrifolia, Eugenia jambolana, Flacourtia montana, Ziziphus rugosa,* etc.

The number of tree species that are food yielding is given in Table 11. It can be seen that the number of tree species yielding food is higher in evergreen and moist deciduous forest types, with more than 14 tree species. The dry deciduous forests seem to have fewer number of food yielding tree species.

Figure 10: Basal area of trees in study plots of different forest types of the Western Ghats



Timber

Forest is the prime source of timber. This includes wood for making furniture, agricultural implements, fencing poles, and planks for roofs. While green felling is regulated in India following the Supreme Court order, timber continues to be one of the most readily marketable benefits from forests. Although after the National Forest Policy of 1988, forests in India are not specifically managed with the goal of timber production, it is important to recognize that the economic value of timber production from forests of India is significant (Verma, 2013). Hence it is important to quantify the timber yield in the selected plots of the three forest types studied.

The number of timber yielding species is listed in Tables 11 and 12. In all, about 27 species are used for timber purposes (11-24 species across locations) – both structural and fencing poles in the evergreen forest type. Similarly in the moist deciduous forest type, about 21 species (10-17 species) and in the dry deciduous forest type about 9 species (6-8 species) are used as timber. The important timber species in the different plots included *Tectona grandis, Terminalia paniculata, Dalbergia* spp., *Cordia* spp., etc.

The quantity of timber in the different plots

Table 11: Number of species providing provisional ecosystem services in the three forest types of Uttara Kannada district of the Western Ghats

Forest type	Food	Timber	Fuelwood	Fodder	Medicinal	Fibre	Other uses
Evergreen forest	40 (14-34)	27 (11-24)	5 (3-5)	6 (3-5)	91 (38-77)	1	13 (7-25)
Moist deciduous	32 (17-22)	21(10-17)	4 (2-3)	5 (2-5)	84 (45-57)	1	32 (13-22)
Dry deciduous	8 (2-17)	9 (6-8)	1	5 (3-4)	30 (11-25)	1	10 (2-9)

Values in parenthesis indicate the range of tree species and the value outside the parenthesis is a count of unique species across the three representative plots in each forest type.

Table 12: Number of species providing provisional services in the study plots according to different forest types in the Western Ghats

	Evergreen forest			Moist deciduous			Dry deciduous	
	Ekkambi	*Hosur*	*Tattikai*	*Togralli*	*Hudelakoppa*	*Panchavati*	*Malgi*	*Adikehosur*
Food	14	16	34	22	17	17	7	2
Timber	11	19	24	17	10	12	8	6
Fodder	5	4	3	3	2	5	4	3
Fibre	0	0	1	0	1	1	1	1
Medicinal	38	48	77	57	45	48	25	11
Other uses	7	7	25	22	16	13	9	2
Fuelwood – Fallen branches and twigs from all tree species in the forests are used as fuelwood								

is substantial and the same is presented in Table 13. Quantity of timber that is potentially available in the different locations across the three forests was computed by considering only trees with girth >50 cm.

It can be seen from Table 12 that the quantity of timber available ranges from 155 t/ha in Tattikai to 166 t/ha in Ekkambi among the evergreen forest type locations. In the moist deciduous plots, Hudelakoppa has recorded the highest timber quantity of 217 t/ha, followed by Togralli with 191 t/ha and Panchavati with 144 t/ha. In the two dry deciduous plots of Adikehosur and Malgi, the recorded quantity of timber is 120 t/ha and 208 t/ha, respectively. Among the three forest types, highest amount of timber is recorded in the moist deciduous forests (217 t/ha), followed by dry deciduous (208 t/ha) and evergreen forests (166 t/ha).

Fuelwood

Fuelwood is the main source of energy to the rural population in India for cooking, along with other household and non-agricultural uses. NSSO 54th Round data revealed that more than half of the fuelwood requirement of the country is met from forests.

Local communities gather fuelwood irrespective of the species although there are preferences for some over others. Local people collect fallen wood/dry tree branches from the forests for cooking food and heating purposes. It is the most important forest product in the Western Ghats region, as wood is used for processing areca, cardamom, cashew and other agricultural products, including rice. The study showed that twigs and branches of all tree species are used as fuelwood. Local communities do not and cannot distinguish the species from which twigs and branches have fallen, especially when they are dry.

The quantity of wood available as fuelwood was computed considering the total biomass stock of trees in the various plots excluding the quantity estimated as timber (Table 13). Fuelwood quantities available in the various study plots in the three forest types of the Western Ghats are presented in Table 14. The quantity of fuelwood available for extraction in the evergreen forest type locations ranges from 134 t/ha to 164 t/ha, while in the moist deciduous locations it is 91 t/ha to 116 t/ha, and in the dry deciduous locations it is 80 t/ha and 85 t/ha. The average quantity of fuelwood available for extraction is highest in the evergreen forest type (146 t/ha), followed by moist deciduous (101 t/ha) and then the dry deciduous forest type (83 t/ha).

Fodder

Tree leaves and ground herbage (grass) are collected from the forests to feed the livestock as well as spread it on the floor of cattle sheds. In all, there were 6 tree species used for fodder purposes in the evergreen forest type, while in the moist and dry deciduous forest types, the number of tree species used for the same purpose was 5. Fodder yielding tree species in the study plots included *Gmelina arborea, Grewia tilifolia, Lagerstromia parvifolia, Schleichera trijuga, Dillenia pentagyna*, etc. Here again, although

Table 13: Quantity of structural timber and poles available for extraction in the three forest types of Uttara Kannada district of the Western Ghats

Forest type	Location	Quantity of timber (t/ha)	Average quantity of timber (t/ha)
Evergreen	Ekkambi	166	162
	Hosur	165	
	Tattikai	155	
Moist Deciduous	Hudelakoppa	217	184
	Panchavati	144	
	Togralli	191	
Dry deciduous	Malgi	208	164
	Adikehosur	120	

Table 14: Quantity of fuelwood available for extraction in the study locations of the three forest types of the Western Ghats

Forest type	Location	Quantity of fuelwood (t/ha)	Average quantity of fuelwood (t/ha)
Evergreen	Ekkambi	134	146
	Hosur	164	
	Tattikai	140	
Moist deciduous	Hudelakoppa	97	101
	Panchavati	91	
	Togralli	116	
Dry deciduous	Malgi	85	83
	Adikehosur	80	

the above mentioned tree species are distinctly documented to be fodder species, local communities use lops and tops of many tree species.

Medicinal purposes

Approximately 1500 species of vascular plants are used for medicinal proposes by tribal and ethnic groups in India (Handa 1998). Preservation of traditional plant knowledge as a part of the global heritage has been championed by several authors (Lambert et al. 1997, Ayyanar and Ignacimuthu 2005) as well as recognized by the CBD (1992). In the developing world, traditional medicinal uses of plants are often the only or primary healthcare available to people, and thus are of extreme importance in some locations (Ghosh 2003).

The number of species used for medicinal purposes in the study region range between 91 in evergreen forest type to 30 in dry deciduous forest type (Table 10). Table 10 clearly indicates that the forests of the Western Ghats are home to several species that are used for medicinal purposes. Some examples of species used for medicinal purposes include *Actinodaphne hookeri, Glycosmis pentaphylla, Knema attenuata, Mappia foetida, Myristica beddomei, Cinnamomum zeylanicum, Emblica officinalis, Terminalia bellerica,* etc.

Manure

The important manure yielding species in the plots studied include *Careya arborea, Calycopteris floribunda, Terminalia bellerica, Terminalia chebula, Aporosa lindleyana, Macaranga peltata, Ixora brachiata* and *Grewia tilifolia.*

Fibre and other uses

- Species producing fibre include *Grewia tilifolia, Ceiba pentandra* and *Holigarna arnotiana*. The number of species yielding fibre in the study plots is nil or one.
- Species are also used for various other purposes that include extraction of dyes, essential oils, as larvicide, insecticide, ornamental purposes, food plant for larvae, as well as in sericulture and as fish poison. The extract of *Eugenia* spp. is used for termite resistance, the fruit extract of *Gmelina arborea* is used as a polishing fluid, and *Sapindus* spp., also known as soapnut tree, is commercially used for preparation of soaps and other cosmetic products.

It is very clear from the discussion on provisional services that the forests of Uttara Kannada district of the Western Ghats play a key role in the local livelihood and economy. Provisional services provide a strong reason for conservation and sustainable management of forest ecosystems to ensure sustained flow of forest products and services.

2.4.2.2. Regulating Services

These are the benefits obtained from the regulation of ecosystem processes, including air quality maintenance, climate regulation, water regulation, erosion control, water purification and waste treatment, regulation of human diseases, biological control, pollination and storm protection. The regulating services are very critical. However, due to limitations of time and resources, the key water and soil related ecosystem services could not be estimated. The climate regulation service was assessed in the form of carbon sink estimates.

Carbon Stock In Forests

Carbon regulating service is an important service from forest ecosystems. Forests provide several goods and services that are crucial to human survival. Forests constitute one of the world's major carbon sinks, containing about 80% of above-ground terrestrial biospheric carbon and 40% of terrestrial below-ground carbon. Forests play an important role in the global carbon cycle. According to a new report based on empirical evidence from across the country, the net increment in carbon stock of forests in India was approximately 217 million tonnes between 1994 and 2004. In terms of absolute estimates, the carbon stock of forests in India was approximately 6,289 million tonnes

The forests of Uttara Kannada district of the Western Ghats play a key role in the local livelihood and economy. Provisional services provide a strong reason for conservation and sustainable management of forest ecosystems to ensure sustained flow of forest products and services

of carbon in 2004 (MoEF, 2012). Below we discuss the carbon regulating services – Biomass Carbon and Soil Carbon flow from the forests of Uttara Kannada district of the Western Ghats.

Biomass Carbon Stock

In the forest plots of Uttara Kannada district of the Western Ghats, carbon stocks of above ground biomass was estimated using a biomass equation that incorporates basal area of tree species. Using the default IPCC root: shoot ratio of 0.26, the belowground or root biomass was estimated and added to the aboveground biomass to obtain total biomass. Carbon value of biomass was calculated using the IPCC default factor of 0.45.

The carbon regulatory services, estimated for the three distinct forest types (Table 15a) showed that the biomass carbon (above ground + below ground) in dry deciduous forest type (140 t/ha) was lowest when compared to moist deciduous (162 t/ha) and evergreen forest types (175 t/ha). Within the evergreen forest type, the carbon in biomass ranged from 167 t/ha in Tattikai to a high of 187 t/ha in Hosur. In the moist deciduous plots, the range was large, with a high of 178 t/ha recorded in Hudelakoppa to a low of 133 t/ha recorded in Panchavati. Among the two dry deciduous plots, there was a marked difference in carbon stocking, with Malgi recording 166 t/ha and Adikehosur having only 113 t/ha.

Soil Organic Carbon Stock

Forest soil organic carbon is an important component of global carbon cycle, and the changes in its accumulation and decomposition directly affect terrestrial ecosystem carbon storage and the global carbon balance. In the present study, the status of soil organic carbon in different forest plots has been studied. In this study, the soil organic carbon was estimated using the Walkley Black method and the results are presented in Table 15a. The soil organic carbon in the moist deciduous plots was highest at 59±13.7 tC/ha, followed by evergreen (54±14.9tC/ha) and the dry deciduous (42±18.6 tC/ha) forest plots.

The biomass estimates are within the range of values reported by Swamy et al. (2010) for tropical wet evergreen forests of the Western Ghats. These estimates are also within the range of values reported for other primary neotropical forests by Brown et al. 1995, Gerwing and Farias 2000, Chave et al. 2001 and Keller et al. 2001. The carbon estimates of the present study (estimated using a factor of 0.45 from the reported biomass values) are thus within the range and comparable to carbon in other tropical forests (Table 15b). There are variations and these may be attributed to factors such as forest type, growing conditions, non-random sampling, within-site variance, etc. (Francis, 1984; Ku et al., 1981).

2.4.2.3. Cultural Services

Cultural services are tightly bound to human values and behaviour, as well as to human institutions and patterns of social, economic, and political organization. Thus perceptions of cultural services are more likely to differ among individuals and communities than, say, perceptions of the importance of provisional services. These are the non-material benefits people

Table 15a: Biomass (above ground + below ground) and soil carbon stock in the study locations across forest types of Uttara Kannada district of the Western Ghats

Forest type	Location	Carbon (tC/ha)				Total carbon (Biomass + Soil)
		Biomass	*Average*	*Soil*	*Average*	
Evergreen	Ekkambi	171	175	37.21	54±14.9	229
	Hosur	187		73.98		
	Tattikai	167		51.71		
Moist Deciduous	Hudelakoppa	178	162	56.51	59±13.7	221
	Panchavati	133		46.57		
	Togralli	174		73.59		
Dry Deciduous	Malgi	166	140	54.76	42±18.6	182
	Adikehosur	113		28.44		

Forests provide a range of products and services to local communities, the national economy and international trade. These include timber and other forest products, widely referred to as Non-Timber Forest Products

obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. Thus these services are difficult to quantify. However, there is a practice of worship of many tree species and wildlife in the Western Ghats. The presence of 'Sacred Groves' in the Western Ghats is well recorded (Gadgil and Vartak, 1976; Burman, 1992 and Balasubramanyan and Induchoodan, 1996).

2.4.2.4. Supporting Services

Supporting services are those necessary for the production of all other ecosystem services. They differ from provisioning, regulating, and cultural services in that their impacts on people are either indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts on people. Supporting services such as nutrient cycling and pollination are difficult to estimate in a short-term study such as the present study.

2.4.3. Stocks and Flow of Ecosystem Services

A summary of the stocks and annual flows of different ecosystem services is presented in Table 16. Only biodiversity, timber, fuelwood and carbon stock services are presented in Table 16. About 160 to 180 tonnes of timber stock is recorded for the three forest types studied and the fuelwood stock range from 83 tonnes in dry deciduous to 146 tonnes in evergreen forest type.

2.5. Community Dependence on Forests

Forests provide a range of products and services to local communities, the national economy and international trade. These include timber and other forest products, widely referred to as Non-Timber Forest Products. In the previous section, the potential availability of some of the provisional services was presented. Communities depend on many of the provisional services. However, there are regulations in utilizing the forest products and services. For example, extraction of green timber is banned and extraction of some of the NTFPs is regulated. The importance of NTFPs in the economy has always been underplayed because most of the products are largely used for subsistence. A range of NTFPs is collected and used by communities for various purposes

Table 15b:Estimates of carbon across tropical forests

Forests	Location	Total carbon* (tC/ha)	Reference
Moist disturbed open-closed forest	Bangladesh	38-86	Drigo et al., 1988
Tropical rain forests	Cambodia	157-187	Hozumi et al., 1979
Tropical moist dense forests	Cambodia	32-133	FAO, 1971
Tropical moist mixed dipterocarp forests	Sarawak, Malaysia	146-173	FAO, 1972
Tropical moist evergreen-high yield	Sri Lanka	167-234	FAO/UNDP, 1969
Tropical moist evergreen-medium yield	Sri Lanka	164-212	
Tropical moist evergreen-low yield	Sri Lanka	86-180	
Tropical rain forest	W. Ghats, India	206	Rai, 1984
Montane rain forests	New Guinea	227	Edwards et al., 1977
Tropical dry high to low volume closed forests	India	7-36	GOI, 1972
Tropical evergreen forest	Myanmar	5-90	FAO, 1985
Tropical wet evergreen forest	W. Ghats, India	198-264	Bhat et al., 2000a
Tropical evergreen and deciduous forests	W. Ghats, India	113-187	Present Study

**estimated by authors using the IPCC default carbon fraction of 0.45 from the reported biomass values*

Table 16: Bio-physical quantities of ecosystem services

Services	Stock/ flow	Evergreen	Moist Deciduous	Dry Deciduous
Biodiversity (Shannon Wiener Index)	Index	3.02	2.98	1.54
Manure (tonnes/ha)	Flow	5-14		
Timber (tonnes/ha)	Stock	162	184	164
Fuelwood (tonnes/ha)	Stock	146	101	83
Carbon (tonnes of Carbon/ha)	Stock	229	222	182
Food, fodder, medicine – non-timber forest produce (kg/household)	Flow	1261 kg - Includes edible fruits, medicinal plants, honey, gum, structural timber, poles, fodder, etc.		

– food, fibre, fodder, flavor/fragrance, fatty oils, gums, resins, medicinal herbs, religious rituals, structural material, household articles, agricultural implements, etc. NTFPs are of importance to forest-dependent communities for subsistence and as raw material for sale to industry. The dependence of communities and industries on forests of Uttara Kannada district has been assessed by Ravindranath et al., 1997, Murthy et al., 2005 and Bhat et al., 2003. The flow of forest products was assessed by these studies by sampling households in villages that fall within different forest types, using the questionnaire method. Murthy et al. (2005) report that almost all rural households gather products such as fuelwood, medicinal plants etc., for subsistence use and some households are also involved in the collection of commercially valuable products. About 50% of the rural households in the district gathered diverse NTFPs.

A similar study for understanding the dependence of communities on forests was undertaken in all the villages close to the ecological plots in evergreen, moist and dry deciduous forest regions during 2014.

2.5.1. Methodology

A preliminary survey was conducted to gather information on the geographic area of villages, occupation pattern, land and cattle holdings and other socio-economic aspects of the households. A questionnaire survey was conducted to collect information on:

- diversity of NTFPs extracted, the parts of the trees used, their end use as well as the season of collection, and
- quantity of NTFPs gathered per typical trip and quantity collected in a season.

Household survey was conducted in 9 villages spanning 457 households during the period March to May, 2014. The selected villages and the number of households sampled in each of the villages is presented in Table 17. An attempt was made to cover all the households with 100% sampling, but due to unavailability of some of the households, not all households could be surveyed.

The main occupation in these villages is agriculture. The communities depend on forests for different forest products for their consumption and livelihoods. All these villages are located within proximity of 2 to 3 kms from the forests in the study villages. A preliminary survey was conducted to gather basic information about the villages. Further, a questionnaire survey was conducted to collect information on the diversity of NTFPs extracted, the parts used, their end use as well as the season of collection, and quantity of NTFP gathered per typical trip and quantity collected in a season.

2.5.2. Level of Dependence of Households on Forests for Fuelwood, Fodder and Manure Purposes

A diversity of NTFPs is extracted in all the forest zones. Table 18 gives percentages of household dependence on

Table 17: Total number of households and number sampled in study villages

Forest type/ region	Village	Total number of households	Number of households sampled
Evergreen	Ekkambi	110	61
	Hosur	24	22
	Tattikai	21	20
Moist deciduous	Hudelakoppa	41	34
	Panchavati	25	21
	Togralli	55	46
Dry deciduous	Malgi	98	85
	Adikehosur	85	72
	Chibbalgeri	115	96

NTFPs collected by village households include fuelwood, manure, and fodder, with variable levels of dependence and extraction for each village and forest type

NTFPs for fuelwood, fodder and manure purposes in the three forest zones.

2.5.2.1. Fuelwood

The level of dependence of communities on forests for fuelwood purposes is significant in all villages, across all the three forest zones. In the evergreen forest zone, it ranges from 89 to 100%, while in the moist deciduous zone, the level of dependence ranges from 72 to 100%. In the dry deciduous zone, community dependence on forest for fuelwood ranges from 98 to 100% (Table 18).

2.5.2.2. Manure

Manure in the form of green and dry leaves is extracted and used for cattle bedding as well as mulching purposes. Farmers in all the three forest zones collect green and dry leaves for manure purposes. In 5 out of 9 villages, over 40% of the households collect green leaves and in 6 out of 9 villages, over 20% (up to 75%) of farmers collect dry leaves for manure purposes (Table 18). Thus there is a large dependence of households on forests for manure purposes in the Western Ghats region.

2.5.2.3. Fodder

Collection of plant parts for fodder purposes is either in the form of green or dry leaves. In the evergreen forest zone, both green and dry grass is collected only in 2 of the 3 villages (Table 18). The percentage of households depending on forests for green grass is about 34% and 24% in Tattikai and Ekkambi, respectively. Similarly the level of dependence on dry grass in the same villages is 20% and 15%. Local communities graze their livestock in forest and non-forest areas and harvest of green leaves from forests for fodder purposes is limited.

2.5.3. Quantity of Fuelwood, Fodder and Manure Extracted by Gathering Households

Table 19 presents the quantity of fuelwood, fodder and manure extracted by households from the forests adjacent to their villages.

2.5.3.1. Fuelwood

The average quantity of fuelwood gathered in all the villages is about 2 tonnes or more. Among the evergreen villages, in Hosur close to 3 tonnes is gathered as fuelwood, while in Tattikai about 1.9 tonnes is gathered. Among the dry deciduous and moist deciduous villages also, about the same quantity of fuelwood is gathered on an average, although there are slight variations in quantities gathered across villages and households (Table 19).

2.5.3.2. Manure

The highest amount of green leaves is gathered in the villages of evergreen forest zone, about 4 tonnes on an

Table 18: Percentage households collecting NTFPs for fuelwood, manure and fodder purposes

Forest type	Village	Fuelwood	Manure		Fodder	
			Green leaves	*Dry leaves*	*Dry grass*	*Green grass*
Evergreen	Ekkambi	89%	3%	20%	3%	5%
	Hosur	100%	82%	68%	-	-
	Tattikai	100%	85%	75%	65%	35%
Moist deciduous	Hudelakoppa	72%	41%	44%	24%	15%
	Panchavati	100%	48%	29%	-	-
	Togralli	98%	74%	50%	-	-
Dry deciduous	Malgi	98%	7%	-	-	-
	Adikehosur	100%	1%	-	-	-
	Chibbalgeri	99%	-	-	-	-

average per household. The next highest quantity of green leaves is gathered in the dry deciduous villages (2.7 tonnes/household), followed by the moist deciduous villages (1.7 tonnes/household) for manure purposes (Table 18). The quantity of dry leaves extracted and used as manure is also highest in the evergreen villages (2.6 tonnes/household). The quantity of dry leaves gathered ranged between 1.4 tonnes/household/year and 3.5 tonnes/household/year.

2.5.3.3. Fodder

Fodder collection in the form of green and dry grass is practiced only in 2 of the evergreen and one of the dry deciduous villages. The quantity gathered across the two zones is on an average about 2.4 tonnes/household of dry grass and about 3.2 tonnes/household of green grass (Table 18). Rural households normally graze cattle in forests, wastelands and croplands and stall feeding is practiced in a limited manner.

2.5.3.4. NTFPs

In the study villages a diversity of NTFPs are collected. The percentage dependence of households on NTFPs is varied and high on commercially important species such as *Artocarpus integrifolia, Garcinia cambogea* and *Mangifera indica* (Table 20). However, a very large proportion of the forest product is used for subsistence only in majority of the households.

It is clear from the discussion above that households residing in and around the forests of Uttara

Table 19: Quantity of fuelwood, fodder and manure gathered by households in the sample villages (Values are in kg/household/year)

Forest type	Village	Fuelwood	Manure		Fodder	
			Green leaves	*Dry leaves*	*Dry grass*	*Green grass*
Evergreen	Ekkambi	2282	1750	2617	1575	975
	Hosur	2948	3224	1740	-	-
	Tattikai	1945	7894	3560	3283	3940
Moist deciduous	Hudelakoppa	2547	3118	1838	2229	4736
	Panchavati	2692	2725	2425	-	-
	Togralli	2345	3011	1425	-	-
Dry deciduous	Malgi	2465	1883	-	-	-
	Adikehosur	2277	720	-	-	-
	Chibbalgeri	2089	-	-	-	-

Table 20: Quantity of NTFPs collected and percentage of households dependent on NTFPs

NTFPs	Percentage (of the sample) households reporting collection (%)	Quantity collected by gathering households (kg/household)	Average quantity collected/household (kg)
Garcinia Indica	3	43	6.14
Ziziphus rugosa	9	34	3.60
Cordia dichotoma	1	14	3.57
Carissa carandas	1	5	1.67
Bamboo shoot	15	177	5.90
Garcinia cambogea	9	1310	68.95
Artocarpus integrifolia	12	1190	49.58
Mushroom	9	67	3.53
Flacourtia montana	1	14	4.67
Mangifera indica	26	554	10.45

Kannada district of the Western Ghats are dependent on forests for a diversity of products including fuelwood, fodder and manure.

2.6. Trends in Biodiversity and Ecosystem Services

Local communities and the economy depend on forest biodiversity and ecosystem services. Collection and utilisation of forest products and services could have negative or positive implications for forest biodiversity and flow of ecosystem services. In the current study, the trends in biodiversity and some of the ecosystem services could be assessed due to the availability of past data from the same study plots monitored for biodiversity and selected ecosystem services. Here we present the trends in diversity, the number of individuals, basal area and finally biomass and carbon stocks based on comparison of the 2014 values with data generated in 2009-2010 in the same plots monitored during the current study.

Box 1: Garincia Species

Garcinia, popularly known as Kokam, is an important part of lifestyles of people inhabiting the Western Ghats region. Its fruit is used for cooking, as well as in the form of a cool drink to fend off the high summer temperatures and improve digestion; the fruit's butter is also used as a cosmetic and the dry rind from the tree is also used widely. Garcinia is found in the forests of Uttara Kannada mainly in the form of two species, viz., *Garcinia indica* and *Garcinia gummi-gutta*. The two species are commercially and culturally very important in the region and also have high nutritional value.

A case study was conducted in four villages among the *Garcinia* collecting households. The primary occupation of these households is agriculture and areca nut cultivation. Forest is the major source of all *Garcinia* that is collected, with other minor sources being homesteads and small-scale plantations.

Survey of 9 villages showed that 9% of the households gathered Garcinia for household consumption as well as sale. The quantity collected by households ranged from 53 kg to 1,897 kg. A large percentage of the collected quantity is sold and this contributed to from about 4% to as high as 83% of the total household income.

Village	*Quantity of Garcinia collected (Kg/year)*			% HH income from *Garcinia*
	Household use	*Sale*	*Total*	
Areguli	0	400	400	58
Hemagara	0	640	640	83

2.6.1. Biodiveristy

2.6.1.1. Diversity Index

Diversity index is an indication of the number of species and its distribution in space at a given time. The Shannon Wiener diversity index during 2009-10 is lower than that recorded during the 2014 assessment in all the three evergreen plots (Table 21). Among the moist deciduous plots, higher diversity index has been recorded during 2014 in Panchavati and Togralli plots while it is lower than the 2009-10 assessment in Hudelakoppa. Among the dry deciduous plots, Adikehosur has recorded lower diversity while Malgi has higher diversity than the previous assessment of 2009-10. Generally in majority of the forest plots, a marginal reduction in the diversity index is observed (Table 20).

2.6.1.2. Number of Trees

Plots enumerated during 2009 shows differences in the number of tree individuals recorded in the tree plots. A positive change is an indication of regeneration while a negative change is an indication of the loss of individuals due to natural death or anthropogenic disturbances such as removal by the local communities for use as fencing poles, fuelwood, etc. Table 21 presents the tree species density of the different study plots across forest types. As can be seen, among the evergreen study locations, a loss has been recorded in only Hosur while in the other 2 locations; there has been recruitment of trees resulting in an increase in the total number of individuals per hectare. In the moist deciduous plots, two of the three locations have recorded a loss in the number of individuals while in the dry deciduous forest type, Malgi shows recruitment and Adikehosur shows loss in individuals. There is no clear trend on the loss or recruitment of trees. It varies from village to village.

2.6.1.3. Basal area, Biomass and Carbon

Among the eight plots across the three forest types, a loss in basal area and biomass stock is recorded in only one of the moist deciduous plots, namely Panchavati (Table 22). In all the other seven plots, an increase in basal area ranging from 0.8 to 2.5 m^2/ha over a period of 5 years is recorded. The trend in basal area translates

Box 2: Honey Collection

Honey collection is practiced in many of the villages of Uttara Kannada district. Honey not only benefits the rural poor nutritionally and economically but also creates a sense of awareness about the importance of forests and their conservation due to their dependence on it. A case study of five villages that primarily depend on agriculture as their main source of livelihood and on honey collection from the surrounding forests as a secondary source of income for their livelihoods was conducted. Honey collection is being practiced traditionally in the study villages.

Collection of honey is from forests and, according to the collectors, there has been a decline in availability of honey over the last few decades. The average amount of honey collected from the forests in the study villages ranged from as low as 30 kg for subsistence use by household to about 8,200 kg by traders. About 2 to 3% of the honey collected is usually for household use and the rest is sold to contractors or private traders. For individual collectors, honey collection contributes to about 20 to 60% of the household income. Honey collection also gives an important by-product in the form of wax, which is sold at a price of ₹150 per kg in the local markets. The wax generated from honey collection is around 500 kg annually. Honey is like an insurance policy to communities practicing collection.

With continuous increase in demand for honey in the market, collectors express concerns about fulfilling future demands. Main threats perceived by them include fire damage, poisoning of bees by smoke and lack of training amongst collectors. They suggest sustainable ways of harvest, including harvest at the right time with minimum damage to brood along with following a tender mechanism for extraction. Apart from this, monitoring of harvest of produce, protection of host trees, capacity building programs and creation of alternate livelihoods are suggested options by the collectors, in times of crop failures.

Villages	Main occupation	Quantity of honey collected (Kg)			% household income from honey
		Household consumption	*Sale*	*Total*	
Kelase	Honey	30	30	8230	66
Audal	Agriculture	30	10	40	20.8
Shanavalli	Agriculture	2	1500	1502	20
Hutkhand	Agriculture	1	2500	2501	NA
Yellapur	Spice Trade	0	4128	4128	NA

Table 21: Change in diversity Index and number of individuals in the study plots of Uttara Kannada district of the Western Ghats from 2009 to 2014

Forest type	Location	Shannon Wiener diversity index (H`)		Number of individuals (trees/ha)		
		2009	2014	2009	2014	Change
Evergreen	Ekkambi	3.15	2.93	1131	1610	479
	Hosur	2.85	2.84	1457	1389	-68
	Tattikai	3.34	3.30	2184	2935	751
Moist deciduous	Hudelakoppa	2.77	2.71	1288	1622	334
	Panchavati	2.96	2.99	1573	1461	-112
	Togralli	3.13	3.25	1388	1358	-30
Dry deciduous	Malgi	2.11	2.12	451	483	32
	Adikehosur	1.12	0.96	525	490	-35

Box 3: Cinnamon Collection and Trends in Availability

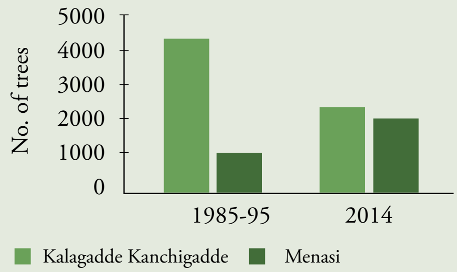
Cinnamon is one of the most important spice varieties. Out of the two species mainly found in the Western Ghats, Cinnamon malabathrum and Cinnamomum zeylanica, the latter is widely used and is in great market demand nationally and internationally. It is found abundantly in the evergreen forests of Uttara Karnataka district.

A case study of Cinnamon collection and trade was conducted in 11 villages of Uttara Kannada district. The spice collectors interviewed in this study depend on Cinnamon collection and trade as an important source of their income and livelihoods. Cinnamon is collected primarily from the natural forest. The collectors usually get a free pass to collect Cinnamon from the forests. Other sources include betta lands and homesteads. A few households in the villages of Kalagadde-Kanchigadde, Kabkuli, Kalagadde and Katnpal have private plantations of Cinnamon on a small-scale, while in villages of Sonaginamane and Taddalase, naturally established dense plantations of Cinnamon are found. About 28% of households have planted Cinnamon on their private lands as a tertiary crop.

The primary occupation in the study villages is agriculture. The quantity of Cinnamon collected per household ranges from about 2 kg to about 32 kgs. The average annual income of households in these villages ranges from ₹60,000 to ₹3,50,000. Cinnamon collection and sale contributes from about 1% to almost 50% of the annual household income in some of the villages. In four of the study villages (Sonaginamane, Kalagadde-Kanchigadde, Menasi and Badagigadde), Cinnamon is used daily for cooking purposes, while few households also use the spice for medicinal purposes.

A case study analysing the trends in the availability of Cinnamon was conducted in Kalagadde-Kanchigadde and Menasi villages. The number of Cinnamon trees in the two villages have declined considerably. The reasons for decline include increase in price (₹20 in 1985 to ₹600 in 2014), leading to over exploitation and unsustainable harvest. Also, the yield per tree has reduced considerably from 6 to 8 kg to about 4 to 5 kg over a 20-year period. Apart from this, variations in temperature and rainfall are also considered to have affected the productivity and yield of Cinnamon in the past few years.

Village	Quantity of Cinnamon collected (Kg)	% household income from Cinnamon	Total income from Cinnamon (₹)
Bhagvat pal	10.0	3.33	5000
Bekemat	7.8	3	5382
Kalagadde-Kanchigadde	11.8	6	7316
Kabkuli	5.0	1	3500
Kalagadde	10.0	12	7500
Katnpal	7.0	4	4081
Nellallimata	2.0	0.3	1200
Halagebile	8.0	1	4000
Handimane	10.0	2	6420
Taddalase	32.5	49	21937
Sonaginamane	10.0	1	5000



to biomass and carbon accumulation, or loss, in the case of Panchavati. The average increase in carbon across the three forest types ranges from 4.2 tC/ha or a 0.8% increase in carbon per hectare per year in moist deciduous forests to about 1 tC/ha/year in the evergreen and dry deciduous forest types.

It is interesting to note that even though there is a reduction in the number of trees in four villages (Table 21), biomass and carbon stock declined only in one village (Table 22), namely Panchavati. This indicates biomass growth in the standing trees have compensated for the loss in the number of trees/ha. Thus, on the whole in the Western Ghats forests of Uttara Kannada district, forest biomass and carbon stocks have increased, despite dependence on the forests for many products and services.

Table 22: Comparison of basal area, total biomass and carbon in the study plots of Uttara Kannada district of the Western Ghats during 2009 and 2014

Forest type	Location	Basal area (m^2/ha)			Total biomass (t/ha)			Carbon (tC/ha)		
		2009	2014	Change	2009	2014	Change	2009	2014	Change
Evergreen	Ekkambi	36.52	38.32	1.8	364	379	15.1	164	171	6.8
	Hosur	40.93	42.72	1.8	401	415	13.9	180	187	6.2
	Tattikai	36.66	37.44	0.8	365	372	6.3	164	167	2.8
Moist deciduous	Hudelakoppa	37.82	40.35	2.5	374	396	21.4	168	178	9.6
	Panchavati	28.83	28.29	-0.5	301	296	-5.0	136	133	-2.3
	Togralli	38.55	39.28	0.7	381	387	6.3	171	174	2.8
Dry deciduous	Malgi	35.96	37.13	1.2	359	369	10.1	162	166	4.5
	Adikehosur	15.34	16.58	1.2	241	252	11.3	108	113	5.1

2.6.2. Ecosystem Services

There is no change in the number of species providing ecosystem services in all the plots studied across the three broad forest types of Uttara Kannada district of the Western Ghats. However, there are changes in the climate mitigation regulating service provided by the forest ecosystems, as there is a gain in most villages. As indicated in Table 21, there is an overall net gain in sequestered carbon over the 5-year period in the all the three forest types of Uttara Kannada.

Thus it could be concluded that in the Western Ghats region, monitoring of eight village forest plots over a period of 5 years showed no change in the species diversity index, in additon to which the carbon stock has increased during these years.

2.7. Potential Sustainable Rates of Extraction

In the earlier sections, the extent of provisional services availability and the current level of dependence of local communities on forests were presented. In this section, an attempt is made to estimate the potential sustainable rates of extraction of fuelwood and timber. There are no scientific or published sustainable rates of extraction of timber, fuelwood and different NTFPs. Since the potential sustainable rates of extraction of timber and fuelwood are required for estimating the economic flow of provisional services, the estimates are provided in Table 23 and the method adopted is given as a footnote to the table.

The potential sustainable rate of timber extraction is in the range of about 0.5 to 0.72 t/ha/year for moist deciduous and evergreen forest types, respectively. Similarly, potential fuelwood rates of extraction are in the range of 1.07 to 1.68 t/ha/year for the same forest types. Table 23 also provides the total potential sustainable extraction quantity for timber and fuelwood. It is assumed that most of the NTFPs are extracted sustainably. Litter consisting of largely leaf litter production is in the range of 5 to 14 t/ha/year.

Table 23: Potential sustainable extraction rates of timber, fuelwood and litter in different forest types of Uttara Kannada district of the Western Ghats

Services	Forest type	Potential sustainable extraction rate in tonnes/ha/year	Total potential sustainable rate of extraction for the total area under forest types (tonnes/year)
Timber	Evergreen	0.72	2,39,853
	Moist deciduous	0.46	1,32,763
	Dry deciduous	0.63	1,46,327
Fuelwood	Evergreen	1.68	4,86,975
	Moist deciduous	1.07	2,69,550
	Dry deciduous	1.47	2,97,088
Litter*		5-14	-

Notes: *Of the total annual biomass production Mean Annual Increment, one-third of the NPP is allocated to timber or stems and the remaining two-thirds to fuelwood (Ravindranath et al., 2000)*
In this study, Mean Annual Increment is considered as the upper limit of sustainable rates of extraction.
**Based on studies conducted in the region (Mohan Kumar and Deepu, 1992; Bhat, 1990 and Pragasan and Parthasarathy, 2005)*

FOREST

3. Economic Assessment of Biodiversity and Ecosystem Services of Forest Ecosystems in Western Ghats, India

3.1. Introduction

Forest ecosystems provide valuable ecosystem services for human well-being (see for example, MA 2005, TEEB 2010). Ecosystem services, coined by the Millennium ecosystem assessment (MA, 2005), are classified into four broad categories: provisioning, regulating, supporting and cultural services. The most important distinction, which TEEB adopts in comparison to MA, is that it does not consider supporting services such as nutrient recycling and flood chain dynamics, which according to TEEB is a subset of ecological process (see TEEB, Chapter-1, Ecological and Economic Foundations). Specifically, provisioning services such as food, fresh water and fuel may be produced or managed intentionally for the purpose of meeting human needs. Regulating services indirectly contribute to health and safety through regulation of climate and disease, air and water purification, and prevention of soil erosion. Cultural services provide nonmaterial benefits such as spiritual enhancement, cognitive development and recreation, and supporting services include production of oxygen and soil formation necessary for the maintenance of all other services. However, many of these may not be additively separable as the ability to provide these ecosystem services depends on the intermediate functions and processes and how well the ecosystem is maintained. Some of the ecosystem services may not be produced simultaneously at a single location. For example, fuelwood and carbon sequestration cannot be achieved simultaneously. Timber production reduces the non-timber forest products or genetic diversity. Reduction in the ecosystem service of a particular type may impact provision of other service more than proportionately. For example, the quantity and quality of water available for human use depends on the complex interaction between vegetative cover, soils, wetlands, microorganisms and other ecosystem components (Daily, 1997). Damaging or altering any of the ecosystem components may alter the ecosystem function of water purification and thus the human welfare. The impacts on human welfare also vary spatially and temporally. Thus viewing ecosystems in terms of ecosystem services enables visualization of the trade-offs that different groups of people face much more clearly.

Forest ecosystems worldwide, in tropical regions, and in particular the Western Ghats, are under threat, which has major implications for human well-being. The drivers of these risks are complex and varied. The main drivers include population change, demand for food production, industrial growth, mining, agriculture, real estate, consumption patterns, changes in life style. Along with these direct drivers, market and policy failures are the other prime reasons for the forest loss. There are hidden incentives that encourage forest land conversion. Also, many of the ecological functions of forests are non-marketed, thereby giving an impression that they have zero prices and hence zero economic value. Because of this incomplete knowledge of the exact contribution of ecosystems to human well-being, any decision to convert forests from its current use to another does not take into consideration the consequences and the costs of our action. This justifies the need to recognize, demonstrate and capture the economic values provided by forests and internalize them in the decision-making.

Valuation of ecosystem services is important for different reasons. The benefits provided by Western Ghats are often not quantified, and hence they are underestimated in policy making. A comprehensive analysis of the value of ecosystem services considering the local context is very important. An economic value of the ecosystem services of Western Ghats that can capture the trade-offs between ecosystem service provision, biodiversity conservation, agricultural production, or other uses of land, is necessary to support land-use decisions.

The objective of this section is to analyze the economic value of the bundle of ecosystem services provided by the Western Ghats in Karnataka, India. The study considered three types of ecosystem services: Provisioning Services (food, fuel, raw materials, non-timber forest products), Regulating Services (reflecting the ecosystems' ecological processes, including carbon sequestration), and Cultural Services (recreational service). The study could not consider the supporting services and all the services at this stage due to lack of complete information. The details of the study area were given at the beginning of this report. The focus of analysis is the Uttara Kannada District of the Western Ghats. The area has been selected because the ecosystems in this area are representative of the diversity of the Western Ghats. In Uttara Kannada, 80% of the geographical area is covered with forests. The district has mainly five ecological zones – coastal, evergreen, semi-evergreen, and moist deciduous and dry deciduous forests. A variety of crops are cultivated in roughly 13% of its land area, which includes rice, coconut, areca nut; spices like pepper, cardamom, ginger and nutmeg; cocoa, cashew and fruit trees, like Mango, Jack, Garcinia, Sapota, Banana, Pineapple; and other vegetables. Uttara Kannada is especially popular among tourists for the natural attractions as well as for religious practices. The region has several rivers, waterfalls and pilgrim places. Though all major ecosystem service values were not considered, in future they can be included.

3.2. Value of Forest Ecosystem

The Western Ghats forest ecosystems are extremely valuable as they provide a bundle of ecosystem services like biodiversity conservation, recreation, improving air quality, recharge of ground water aquifers, etc. The values here can be intrinsic, economic, cultural and aesthetic, and often these values complement instead of substitute each other. While not undermining other values, the focus here is on economic values, the values that contribute to the human welfare. The basic premise behind valuation is that the individual's economic welfare is maximized through the use of the goods and services provided by forest ecosystems. These economic values are all based on the notion of willingness to pay, which vary among individuals depending on their self-interests. Hence, the economic values are anthropocentric and hence instrumental values. Instrumental values allow the comparisons across different trade-offs. For example, a forest managed for timber will have low values for carbon and similarly forests protected for the purpose of biodiversity conservation will have low values for timber. The values reflect only the current choices given a multitude of socio-ecological conditions such as the distribution of income and wealth, the state of the natural environment, production technologies, and expectations about the future (Barbier et al., 2008)

The economic valuation of forest resources is important as most of the policy decisions are based on various economic criteria. The TEEB (2010) study indicates different purposes of valuing ecosystem services: (1) forest ecosystems, despite providing multiple values, are undervalued and non-priced, which leads to distortions in efficient resource allocations; (2) for some biodiversity goods and services it is important to understand and appreciate the alternatives and alternate land uses; (3) suggesting future uncertainties in resource availability; (4) designing biodiversity conservation programs and for the development of green accounts (see TEEB 2010, MA 2005). Demonstrating the economic values can highlight the extent of these distortions, the distribution of costs and benefits of conservation, as well as enable design of mechanisms which would capture the benefits from forests.

Ecosystems through ecosystem processes and functions provide economic benefits for human well-being. The benefits are the output while the ecosystem processes and functions are the inputs. The total (output) value of forest ecosystems has often been conceptualized as the sum of different use values (direct, indirect and option) and non-use values (existence and bequest values) of the communities (Krutilla, 1967, Pearce 1993, Costanza et al., 1998, and the extensive literature following that). The use values can be categorised into direct consumptive values (reduction in quantity available for others due to use) and direct non-consumptive values (no reduction in the quantity). Examples of consumptive use values are the provisioning services provided by the forest ecosystems like food, fibre, water, and non-timber forest products, while the non-consumptive use values are the cultural and recreational services of MA classification. The indirect use values are those that are used as an input to the other production processes but are not final goods. These include some of the supporting and regulating services provided by forests. The use values (both direct and indirect) can be used now or could have a potential to use later (Option value). The second category of value, the non-use value, stems from the fact that individuals would in general have an intrinsic value of natural elements (e.g. spiritual values, cultural values) for their mere existence or would like to pass the natural capital as an asset to the future generations (Bequest value). This category of values falls under the cultural values of MA assessment. The last category of values are difficult to assess but can be valued using non-monetary tools. The diagrammatic representation is given in Figure 11.

While there is no debate on the fact that ecosystems have value, the debate is on the use of monetary valuation techniques. The total economic value is based on a preference-based valuation approach, which is based on the subjective preferences of individuals. Different valuation approaches – market based and non-market based, as well revealed non-market based and stated non-marked based preferences – are available to value ecosystem services. Sometimes, one can use participatory valuation approaches or resort to benefit transfers (see Wittmer and Gundimeda, TEEB D2, chapter 3). Table 24 indicates the valuation approaches that could be used to derive economic values.

3.3. Estimates of forest economic values

3.3.1. Value of Timber from Forests in Western Ghats

The forestry sector in Uttar Kannada district is very important, as 75.98% of geographical area of the district is under forests (India State of Forest Report, 2013). The district has a total forest cover of about 10,291 sq. km. The per capita forest and tree cover availability in the district is about 0.54 ha. Amongst all the districts under Western Ghats region, the forestry and logging sector[1] of Uttara Kannada district contributed about 3.7% of Karnataka's Gross District Income (at constant prices) in 2008-09 (Figure 12). Timber production values are well-recorded by the forest departments and reflected in national accounts.

Forest resources can be valued for the land as a resources and for the flow of services that it generates (e.g. standing timber). Cultivated forests are produced

Figure 11: Total Economic Value of Ecosystem Goods and Services

assets while the natural forests are treated as non-produced assets Due to the enforcement of the Forest Conservation Act (1980, 1981 and 2003) and the National Forest Policy, forests in India are not exclusively managed for timber production; hence arises the nexus between the allocation of forests for logging versus the conservation of forests for biodiversity protection and ecosystem services. According to the Forest Survey Report (2013), Uttar Kannada district witnessed no change in forest cover, mainly due to stringent ban on green felling of trees, with only the removal of dead and fallen timber permitted, though mature green trees are available in some of the forests. Thus in the Western Ghats, the trade-offs are clearly illustrated.

Table 24: Valuation approaches for ecosystem goods and services

Group	Methods	Summary	Statistical analysis	Which services valued
1. Direct market prices	Market prices	Observe market prices	Simple	Provisioning services
2. Market alternative	i. Replacement costs	Finding a man-made solution as an alternative to the ecosystem service	Simple	Pollination, water purification
	ii. Damage cost avoided	How much spending was avoided because of ecosystem service provided?	Simple	Damage mitigation, carbon sequestration
	iii. Production function	How much is the value-added by the ecosystem service based on its input to production process?	Complex	Water purification, freshwater availability, provisioning services
3. Surrogate markets	i. Hedonic Price Method	Consider housing market and the extra amount paid for higher environment quality	Very complex	Use values only, recreation and leisure, air quality
	ii. Travel Cost Method	Cost of visiting a site: travel costs (fares, car, use etc.) and also value of leisure time expended	Complex	Use values only, recreation and leisure
4. Stated preference	i. Contingent Valuation Method	Given a 'menu' of options with differing levels of ecosystem services and differing costs, which is preferred?	Very complex	All services
5. Participatory	i. Participatory Environment Valuation	Asking members of a community to determine the importance of a non-marketed ecosystem service relative to goods or services that are marketed	Simple	All services
6. Benefit transfer	i. Benefit transfer (mean value, adjusted mean value, benefit function)	'Borrowing' or transferring a value from an existing study to provide a ballpark estimate for current decision	Can be simple, can be complex	Whatever services were valued in the original study

Source: *Wittmer and Gundimeda, TEEB (2012), chapter 3*

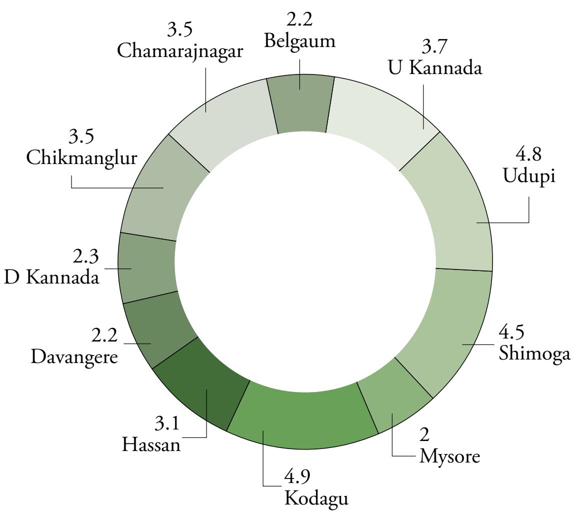
3.3.1.1. Valuation of Timber Resources

Value of timber as an ecosystem good is usually evaluated using four methods: stumpage value method, consumption value method, net present value (NPV) method, and valuation after allowing for management cost. Timber produced from forests can be easily valued as it is marketed. In case of no market imperfections, using market prices is the ideal scenario. However, in case of inefficient markets, economic rents often are captured by others (the intermediaries), instead of the owners – in this case the forests. Inefficiencies may arise because of the non-commercial uses of timber, timber privileges, or under-pricing of the resource. Timber for commercial use is mainly in the form of round wood, sawn wood, and pulpwood, while the non-commercial purposes are for the use by locals. These can be in the form of privileges granted for timber, for the purpose of construction, renovation, extension or repair of houses; grant of bamboos, small timber and jungle wood, for the purpose of making agricultural implements, or for agricultural purposes; and for grant of dry firewood. Usually, there is no right to forest produce of any kind, except Malnad privilege rights, which are available only in respect of certain areas, as provided by the Karnataka Forest Manual.

Thus the timber and forest land resources enter into value-added calculations in the economy at the point of purchase either as an end product or as an input into another process. In the process, the resource log can potentially pass through a number of processes before it is finally consumed as an end product. A tree, for instance, may initially be sold as a sawn log to a saw mill, then as sawn wood to a furniture manufacturer, and then to consumers at the retail level. Fuelwood, poles, etc., may be consumed by the same user who acquire them. When a tree is converted into a log, it has value added to it. At each stage, the value addition is distributed, accruing as income to some other actor in the economy.

Since there is a value build-up for each link, a breakdown of the different relevant activities that may generate cost or revenue is required. A basic structure relevant for the study region is given in Figure 14. The timber originates from different sources, processed, and transported to the depots or dealers. The auctioned timber is then transported to the sawmills, from where the timber is shaped, sized and sold to different end users, like carpenters and furniture dealers. The final product is transported to the final customer.

Figure 12: Percentage contribution of forestry and logging sector to Gross District Income of districts under Western Ghats region (as identified by the Western Ghats Ecology Expert Panel) in Karnataka at constant prices 2008-09



Source: *Directorate of Economics and Statistics, Bangalore 2010-11*

3.3.1.2. Suppliers of Timber

Timber is sourced from forests, government plantations, private plantations and non-forest lands. The key resources required for them are land, labour, good quality environment and technology. There are several inputs required for producing the final product, including seeding, weeding, planting, cleaning, thinning, pruning and final harvesting. These management costs depend on the source of timber. For natural forests these costs are low, while for private plantations or agro forestry this may be high. The timber available to cater to the demand is approximately 2.3 million cubic meters. Various kinds of timber, from dead and fallen trees and teak poles, are removed by the contractors approved by the Forest Department and brought to the Government timber depots. However, only 0.03–0.04 million cubic meters per year (1.5% of the total timber supplied) is extracted from forests by the forest department and the Karnataka forest supply industrial corporation (KFSIC), according to EMPRI, 2009. Timber may also be sourced from small scale agro forestry, individual trees outside of forests, private forests, malki land[2] (Figure 6),

[1] *Forestry and logging sector comprises of timber production and extraction of fuelwood and non-wood forest products from forests.*

Betta lands[3] and imports from neighboring places like Gujarat, Kandla, Tuticorin, Cochin, Goa, Chennai and Andaman and Nicobar Islands. The inter-state imports amount to 0.86 million cubic metres per year (EMPRI, 2009). However, some of the wood is also sold in nearby markets, making it difficult to estimate the exact amount of timber consumed within Karnataka. Some of the timer is imported from Myanmar, Gabon, Malaysia, Germany, Tanzania, Brazil, Russia, Benin, Indonesia, Italy, Ghana and other African countries (ITTO, 2012).`The average quantity of timber imports between 2006-09 from the Mangalore port, the primary port for timber imports in Karnataka, was estimated to be 0.159 million cubic metres per year.

Agro forestry plays an important role in the Western Ghats. According to the Forest Survey of India report in 2013, approximately 7,465 sq. km of land (10.3% of the geographical area of the Western Ghats) is under agro forestry, with a growing stock of 69.2 million cubic metres. To sum up, the sources of supply through various channels to meet the growing demand are given in Figure 14, while outturn of timber from malki land in Uttara Kannada district is depicted in Figure 15.

3.3.1.3. Extraction Methods Used

Due to ban on clear felling, no extraction of green timber has taken place since 1983, and only salvaging of dead and fallen timber and firewood is carried out on a limited scale within the department. Thinning of Teak plantations, with a view to improving the status of stands, is also carried out, but no proper records exist. Felling of marked trees in coupes, logging and dressing are done by local labour or imported labour. Usually felling of marked trees is done by axes and saws and logging is done by crosscut saws. After the trees are marked and felled, logs are prepared out of them. The prepared timber is removed by means of trucks to various timber depots.

The harvesting of the forest products is the responsibility of the Karnataka State Forest Industries Corporation (KSFIC). The main objective of the corporation is to harvest forest produce for supply to pulpwood and rayon industries vis-à-vis creating employment potential, in the forms of processing wood, manufacturing furniture, and wood based construction materials. One of the main responsibilities is to eliminate forest contractors in the whole chain of operations, including logging for timber and the processing and marketing of forest produce. The corporation conducts logging works in the Forest Division of Shimoga, Dharwad, Sirsi, Mysore, Bangalore and Mangalore, and extracts firewood from Shimoga, Dharwad, Mysore, Bangalore, Mangalore and Sirsi. It also operates sawmills in Shimoga and Dandeli. The output after extraction is logs, pulpwood, fuelwood, charcoal, and we assume that no part is wasted.

3.3.1.4. Transportation from the Source to Depots

The logs are then loaded on trucks and transported to the depots. *Acacia auriculiformis* plantations are clear felled to meet the fuelwood requirement of the local people. Departmental elephants are sometimes used for dragging timber and poles in inaccessible and difficult parts of forests to places from where the logs can be carted in trucks. The cost for extraction and transportation of timber varies from ₹2000 to 3000 per m^3. The work is done by the department or through the Karnataka State Forest Industries Corporation (KSFIC).

3.3.1.5. Timber Dealers and Depots

The timber from various sources reaches the government depots in Kanara circle of Uttara Kannada district stated at Haliyal division (comprising of Dandeli, Bhagavati, Kulgi, Barchi depots), Honnavar division (Idagundi, Katgal, Kabinnahakkal depots), Karwar division (Kadra, Hattikeri depots), Sirsi division (Chipgi, Manmane depots) and Yellapur divisions (Kirwatti, Mundgod depots). The major types of timber which come to the depot include teak, rosewood, Jamba, Matti, Kindal, Nandi, Dindal, Dhaman, Honni, Karimuttal, acacia and other jungle wood species, etc. There is no sandalwood depot in the circle. The logs are classified as per the standard classification norms and stacked in the depots. Figure 16 provides figures for the forest division timber outturn at the depot range in Uttara Kannada for year 2012-13.

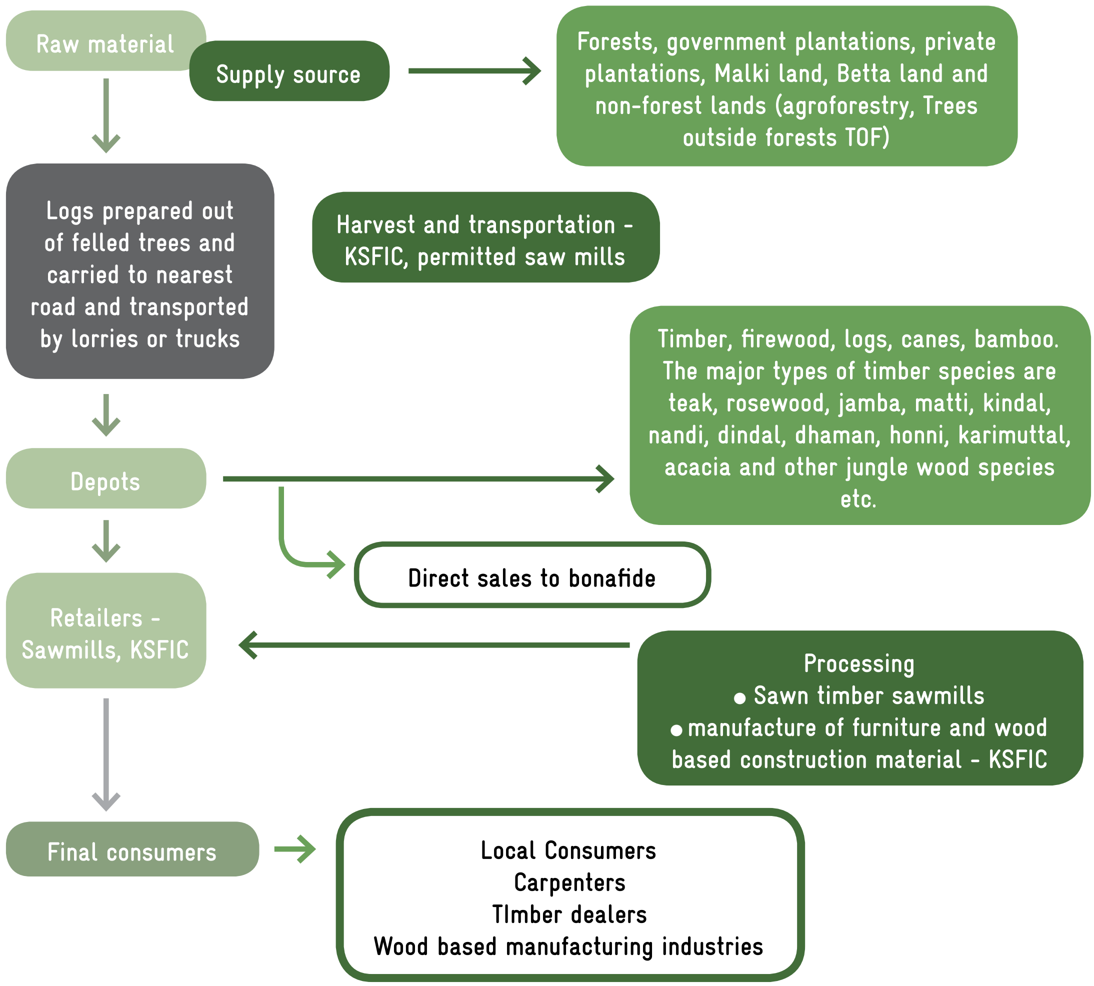
Depot Sales Proceedings

Usually, there are four sales in a year, in the months

[2] Malki land usually refers to thickly wooded areas that are not yet brought under cultivation or plantations but having the characteristics of forests. Malki land is an important source of timber in Karnataka. Krishnapur, Gavli, Bheemgod areas of Belgaum district and Kadamane estate of Hassan district and other such areas with wide stretches of malki lands.

[3] Betta lands are the strips or patches of tree land on the hill slopes adjoining the areca orchards owned by the government, where local communities have customary rights for mulching, animal bedding, collecting grasses and leaves and fuelwood, and for non-commercial purposes.

Figure 14: Value Chain of timber in Karnataka



of March, May, September and December. However, in cases of heavy accumulation of produce, special sales are also conducted after obtaining sale date and approval from the higher authorities. One month prior to the sale date, sale notification is published in major national newspapers and also in the State Gazette to give wider exposure. The sale notification is also circulated to major timber purchasers of the state and outside the state. The sale notification includes information on approximate quantity of species wise timber, firewood and poles available at each depot.

The buyers are timber dealers and general public from local as well as neighboring localities. The bidders come from various regions of Karnataka, as well as from other states, like Andhra Pradesh, Kerala, etc. From the depots, timber is supplied to Government departments and public at retail price, fixed and revised from time to time. Timber left after meeting these supplies is auctioned periodically. The depot conducts 3-4 sales every year and earns revenue of approximately ₹6-8 crores (US$ 966,496–1,288,661) per year.

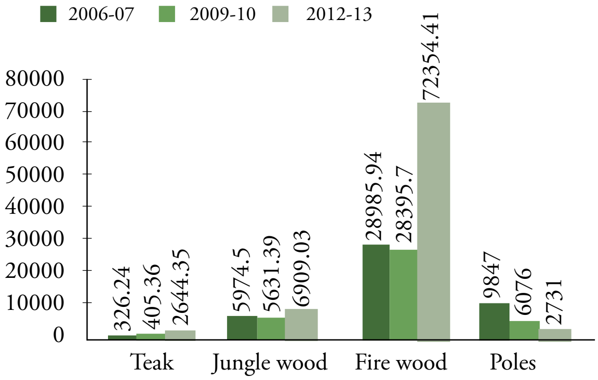
The depots usually do not do additional processing. The price of timber charged varies with species quality and dimensions (see Appendix 1).

Timber Retailers: Saw Mills

Saw mills are important stakeholders in the timber value chain. They form the crucial link between the timber supply source and the end users. Usually saw mills sell sawn timber after processing, thereby creating value addition. As in 2012-13, there were total 105 saw mills in Uttara Kannada.

Figure 17 gives division-wise number of private sawmills permitted to extract timber in Uttara Kannada.

Figure 15: Quantity of timber, jungle wood, firewood & poles produced from Malki land in Uttara Kannada district



Source: *Forest Department, Karnataka 2012-13*
Note: *Quantity of timber, jungle wood and firewood is in m³ and poles is in numbers*

Dandeli Wild Life division was found to have no private saw mills. The sawmills are permitted to extract timber from the forests and malki land up to certain permit limit granted by the forest department based on the working plans.

The saw mills also process the logs into different shapes and sizes depending on the requirement of the customers. Sawmills have to invest in machinery to process the logs, Sawmills buy timber in lots with variations in quality and dimensions of the logs. The sale is customized based on the requirements and sold per cubic feet or cubic inch, and poles are sold per piece; any remaining timber is sold as fuelwood and the wastage is sold as chips and saw dust. In order to understand the exact operation of sawmills, we carried out a survey of various sawmills in the Karwar town of Uttara Kannada district.

We gathered technical, financial and economic information from sawmills. Details on volume and costs of raw materials sourced and purchased were also gathered. In addition, a section on business practices was included to assess the profitability of timber business. This gave an idea about costs and net profit margins of the saw mills per standard volume along the supply chain (see Box 1 for the survey results).

Final Customers

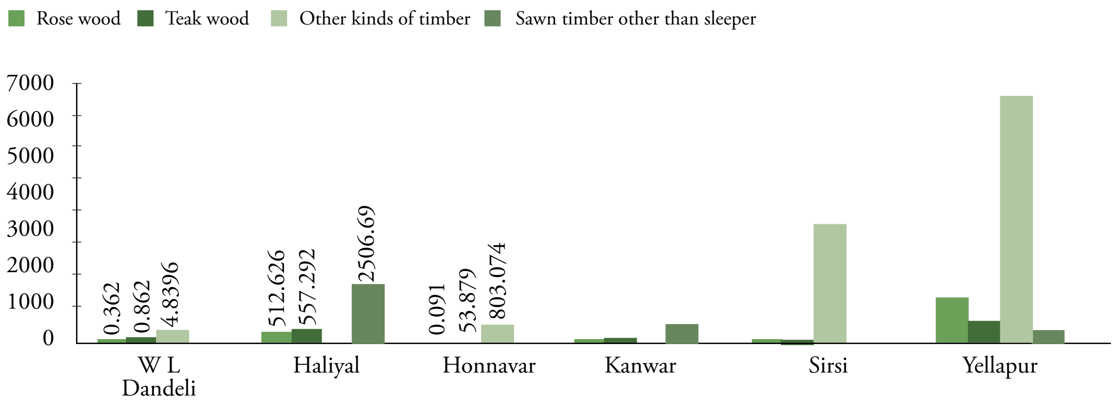
Timber from sawmills is bought by the construction industry or carpenters or big furniture houses who transform them into various value-added products. It has been extremely difficult to get further data on costs and revenues, as the products are highly customized to order, varying from small articles to big articles. The price includes skill factor as well.

3.3.1.6. Assessing the Value Addition for Timber

It is apparent that the value of a log as an immediate end product that can be used directly is different from that of a log which undergoes processing and transforms itself into a customised product for the end user. There is value addition at each and every stage and since our main intention is to demonstrate the value to different stakeholders in the economy, it is the total value and not just the producer prices which are more relevant. Ideally, observable market prices should be used to value timber resources, and the ideal sources of these prices are values observed in markets in which each asset traded is completely homogeneous.

We can view the value of timber in terms of the

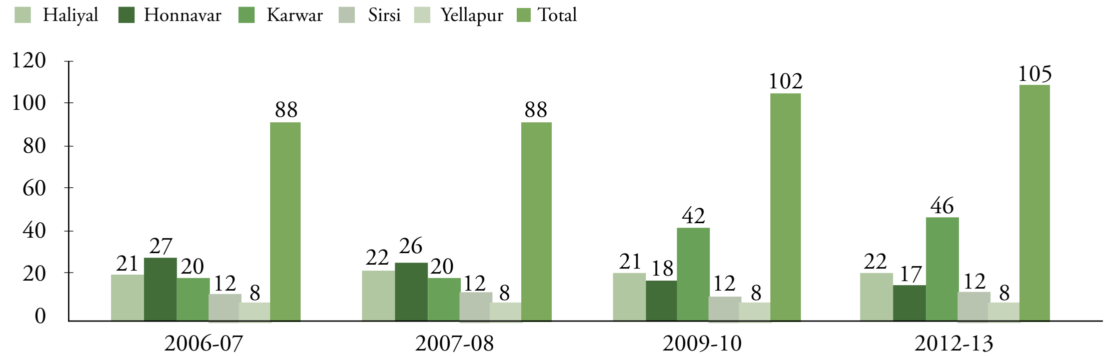
Figure 16: Division-wise outturn of timber (in m³) at Depot/Range from forests in Uttara Kannada in 2012-13



Source: *Forest Department, Karnataka 2012-13*

FOREST

Figure 17: Division-wise number of private saw mills permitted to extract timber by forest department in Uttara Kannada



Source: *Annual Administrative Report, Karnataka Forest Department*

surplus value accruing to the extractor or user or an asset calculated after all costs and normal returns have been taken into account. In the context of the environmental assets, the surplus value is referred to as the resource rent, which can be calculated directly using stumpage prices. In the case of the stumpage price of timber, the cost of managing the timber and the normal returns to capital are not deducted. However, as we did not have information on the costs of producing timber, we used an approximate percentage. Usually the producers hire workers to clear fell the trees and then transport them to the forest depot. From the depot the timber is competitively auctioned and the buyer bears the costs of transportation out of the depot. The price paid by the buyer at forest depot is the net economic benefit to the producers of timber. The price of wood also depends on the quality and species sold. Hence, the figure that we report here is the weighted price of timber, the weights computed in proportion to the quantity harvested.

As the study objective is to understand the real contribution of timber resource to the economy and the value as an asset (the potential value) if left untouched in the forest, the incremental value added at each stage was used, i.e. the contribution at the point of entry plus further value added at different stages till it leaves the retailer for use by the customer. This is done by deducting the user cost of the resource from the gross operating surplus of the suppliers of timber (forest departments, Malki land producers and farmers selling timber as part of agro forestry). For the value of timber at the point of entry into the market, payments for the purchase of raw materials or supplies, principal payments, and depreciation are not included in value-added for the activity under consideration. When it enters the market there is value added in the transportation and extraction sector. However, we did not have information on the operating costs of the transportation sector. So the estimates we got are the gross value additions. Similar deductions were made for calculating the value-added for successive activities – from harvesting to subsequent downstream processing. A sawmill consuming sawn logs cannot be credited with the value-added of producing the log itself. As demonstrated, the log value-added was already calculated at its point of purchase. The market price also includes the cost of transportation and extraction, which need to be deducted to reflect the net value of the timber per unit. To calculate the total value-added derived from timber resources, the above approach is applied for each activity or product of which they are a part until their purchase by consumers as an end-product (or by another sector as an intermediate product or input).

However, if the stand is in forest, the value is captured by its stumpage value. While calculating the asset value of the resource, the valuation of timber resources is undertaken on the standing timber. All the standing timber stock is being valued as if it is used solely as timber, without considering the other ecosystems they provide. Therefore, the value derived in this report (see Figure 19 for detail) is an asset value of timber resources when they are being removed and used as timber products.

Based on the net primary productivity (see Table 23, section 2.8) of forests in Western Ghats, the annual timber available is 2.4 million cubic metres (1.16 t/ha). Based on the FSI estimate, the mean annual increment is assumed to be around 15 million cubic metres. The forest depots auction timber four times annually; the highest bidder's price is the purchase price and the prices vary across the species. For example, the cost

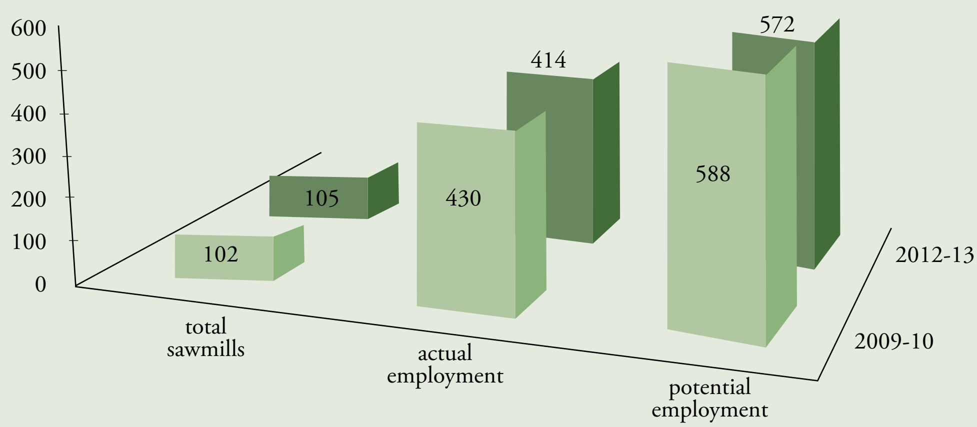
Box 4: Operational Analysis of Sawmills

The surveyed sawmills were engaged in timber business for about 30 to 70 years. Timber business is the main source of income from them. The timber is mainly procured from forests, Malki land, and imports from nearby places. The major timber species sold by these sawmills include Nilgiri, Bilkambi, Teak, Jalli, Acacia, Kindal, Honne, Jungle wood, Bharanagi, Matti, Halasu, Mango and Nerale, which they purchased from government timber depots or malki land.

The operating costs of sawmills comprise machinery costs, transportation costs, loading and unloading charges and labour charges. The surveyed sawmills generate an employment for about 28 individuals paying an approximate wage of ₹27.8 lakhs per annum. We also find that there is wide difference between potential employment and actual employment generated (Figure 18). The difference between actual and potential employment prospects was 158 in 2009-10 and 2012-13. Thus, it is possible to increase welfare by generating adequate employment opportunities through providing better wages and other employment benefits.

The average quantity of timber purchased by the surveyed sawmills (in total) is 405.31 cubic metres, and the average purchasing price of timber is about ₹23,908.07 per m^3 (inclusive of costs). Cost of transportation ranged between ₹45-800 per m^3. The saw mills have to incur fixed costs in terms of machinery cost (blade cost), ranging between ₹20000-50000 per year, depending upon the size of operation. The average quantity sold by sawmills is 266.47 cubic metres. The average selling price of timber without processing is ₹28,021 per m^3 and the survey results show that sawmills sell timber only at 15.46% profit margin. Timber purchased is also processed into cut sizes and rippers and sold to bonafide customers, temples, furniture retailers, other retailers for industrial purposes and farmers. The cost of processing usually ranges between 10-30% of the cost. The average cost of processing is about ₹4,113.82 per m^3. Processing of timber in form of sawn timber leads to value addition of about 10-30%.

Figure 18: Potential and actual employment in Uttara Kannada District, Uttara Kannada



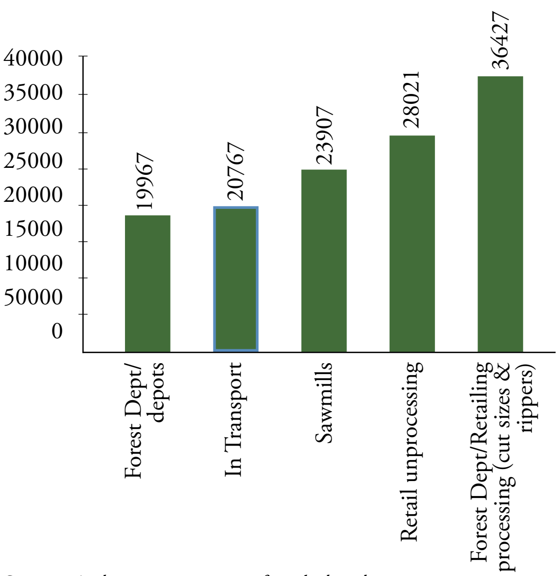
of Dalbergia latifolia (Sissum) is ₹7,70,332/m^3 (US$ 12,655.4/m^3), Tectona grandis (Teak) is ₹1,22,657/m^3 (US$ 2,015.06/m^3), Terminalia paniculata(Kindal) is ₹16,477/m^3 (US$ 270.692/m^3), Terminalia elliptica (Matti) is ₹17,789/m^3 (US$ 292.246/m^3) and Pterocarpus marsupium (Honne) is ₹39,811/m^3 (US$ 654.033/m^3) (at 2013 prices). There is variability in prices depending on the diameter of the logs as well, which makes it more complicated to assign unit price for timber. The main consumers are sawmills, retailers, other states, house constructors, etc. The main value addition takes place at sawmills, who buy timber at a weighted average price of ₹23,907/m^3 (US$ 392.755/m^3) and sell at a weighted average price of ₹27,605/m^3 (US$ 453.507/m^3) leading to a value addition of 15.46%. Processing of timber leads to further value addition of 44.5%. As the wood produced from Western Ghats due to restrictions is very small in comparison to the global demand, we can safely assume that the timber markets are competitive and hence there is no consumer surplus. Whatever is reaped is the producer surplus which is the net benefit accruing to the producer of wood as a whole. Hence the value of net benefit is taken as the producer surplus or the economic value of timber resources. Here the producer surplus along the chain of production has been summed up. Thus, based on the current scenario of selective and sustainable harvesting regime, the value of timber per hectare per year in Uttara Kannada is estimated to range from 73,892–95,524 ₹/ha/yr (US$ 1,190.27–1,569.31/ha/yr). The values under regulated harvested regime seem to bevery low compared to the study on estimation of NPV rates by Verma et al. (2013), where the Western Ghats forests commanded a value of ₹7,02,146 ha/year for timber. However, this study assumes a very strict harvesting scenario as per the existing policies and hence Western Ghats have higher value for other ecological services than that of timber.

3.3.1.7. Policies for Sustainable Management of Forest Resources

The study tried to gather the perceptions of different stakeholders regarding the key issues surrounding the supply of timber (Table 25 represents the summary). None of the stakeholders actually felt that excess felling of timber is presently leading to environmental and forest degradation. The respondents are aware of the future consequences of resource unavailability caused due to over-extraction. However, no efforts were made by them to protect the forests and the environment. Half of the respondents felt that extraction was done only from fallen trees or standing deadwood, while the remaining 50% were of the view that sufficient planting processes are not taking place and forests should be expanded in partnership with local communities. The survey recorded mixed reactions regarding the status of timber availability. All the respondents felt that the availability of timber is declining from both forests and on Malki land; 50% of the respondents felt that the extent of decline is to the tune of 50%, while the remaining 50% of respondents observed a 20-25% decline in timber availability. The income from timber business is declining up to 60%, as the demand for timber products has declined in comparison to past 5 years, since wood products are now replaced with substitutes like cement, aluminum, etc. Moreover, 84% of sawmill owners are of the view that several policies have been initiated by the government to curtail excessive exploitation of timber resources. Policies such as ban on green felling, promoting timber plantations only on government owned land, restriction on sawing all trees on Malki land were in place. However, 16% of the respondents were of the view that too many restrictions by government on felling of trees is affecting their earnings.

Some of the policies that could lead to sustainable management of timber resources could be curbing illegal activities through appropriate monitoring and effective enforcement. Further replacing the species in natural forests should be prioritized and multi-diverse species should be planted instead of mono-culture species. The conservation targets can be easily met due to availability of close substitutes like aluminum and cement. In Western Ghats, due to the diversity in species, policies should be in place for a very strict conservation regime and to strictly observe sustainable management of timber. The timber should be better priced so as to ensure profitable returns to traders as well as to take into account the negative externalities. Farm forestry can be encouraged and individual farmers can be allowed to grow commercial species of high value. Forest industries should be given special impetus. The local farmers can be encouraged and the forest industries sector could be more competitive. The village forest committees can provide good alternatives in this respect but better incentives need to be in place to grow and save forests.

Figure 19: Graphical representation of value addition (₹/m³) at different links of value chain



Source: *Authors representation of results based on survey outcomes*

Table 25: Stakeholder perceptions on timber extraction, opportunities generated and impact on environment

Perception	Responses
Extraction done only from fallen trees or standing deadwood	50%
Sufficient planting processes are not taking place and forests should be expanded	50%
Availability of timber is declining from both forests and Malki land	100%
a. Extent of decline is to the tune of 60-80 %	50%
b. Extent of decline is to the tune of 20-25%	50%
Income decline from timber business due to availability of close substitutes like cement, aluminum etc.	100%
Policies initiated by govt. to curtail excessive exploitation of timber resources	84%
Too many restrictions by government on felling of trees is affecting their earnings	16%
Excess felling leading to environmental degradation	0%
Awareness of future consequences of resource unavailability due to over extraction	100%
Efforts taken to protect the forests	0%

3.3.2. Value of Fuelwood and Non-Timber Forest Products (NTFP) from the Western Ghats

The dependence of humans on non-timber forest products has been well-documented since prehistoric times. The non-timber forest products can be edible and non-edible products like foods, fuel, nuts, berries, honey, mushrooms, medicinal plants, spices, fibres, resins, grass, ornamental plants, oils, specialty wood products and other extracts from trees other than timber originating from forests. People living in the fringes and within the forests are highly dependent on the collection of NTFPs for subsistence, employment and cash income. Often, they play a crucial role in providing food security to the rural people. The number of products available from NTFP is staggering. The studies carried out in Western Ghats indicate that about 130 species of NTFP are used to varying extents by villagers in Uttara Kannada district (Hegde et al. 2000). These range from bamboos, canes, medicinal plants, honey from beekeeping, fodder, fuelwood for domestic and commercial use, litter, leaves for mulching, fruits, etc. However, the economic value of non-timber forest products is often underestimated, as most of them are used for subsistence consumption and are rarely sold in the markets. Sustainable extraction of NTFPs can augment rural incomes and contribute enormously to the state domestic product of Karnataka. A key feature of NTFP-based economy is that it is possible to exploit these products without damaging the ecosystems, in the case of sustainable extraction, and hence can provide incentives for conservation. Highlighting the contribution of NTFPs to the local and then to the regional and national economies is cumbersome due to the difficulty in tracking their collection and use, and the sale of parts and products of different species.

Many studies have highlighted the importance that NTFPs play in the rural livelihoods (Chopra, 1993). In an attempt to quantify the value of ecosystem goods and services in Uttara Kannada, Ashwath et al. (2012) found that valuation of provisioning goods and services from forest ecosystems is about ₹2,05,388/hectare/year (US$ 3,294.83/ha/year), which is implicit in the subsistence, income and local employment. The study accounted for timber, NTFP, bamboo, canes, food, medicinal plants, honey from bee keeping, fodder, fuelwood for domestic and commercial usage, litter, mulching leaves, inland fishing, domestic water use, industrial water use, water for power generation, irrigation services, ecological water, oxygen provision and wild fruits. The use of NTFPs may make a substantial contribution to livelihood strategies of rural people in providing building materials, fodder and wild food. This contribution is especially important for poorer sections of the community, who might be able to benefit from policies designed to maximize the values of NTFPs. Tejaswi (2008), focusing on livelihood security of tribal communities in the Western Ghats region, indicates that 55% employment was generated by the wage sector followed by NTFP collection (26%) and other sectors (19%). NTFP generated an average annual income of ₹14,244 per household (US$ 228.50 per household). Panchmukhi et al. (2008) estimated that about 86% of NTFPs are unrecorded in State Domestic Product (SDP) originating from forestry and logging sector, and this unrecorded value of NTFPs constituted about 1.45% of SDP of Karnataka in 2002-

03. Ninan (2007) estimated the NPV of net forest resource benefits (i.e. grazing, fuelwood and NTFPs) in the Uttara Kannada district at around 1256.3 US$/household at 1999-2000 prices.

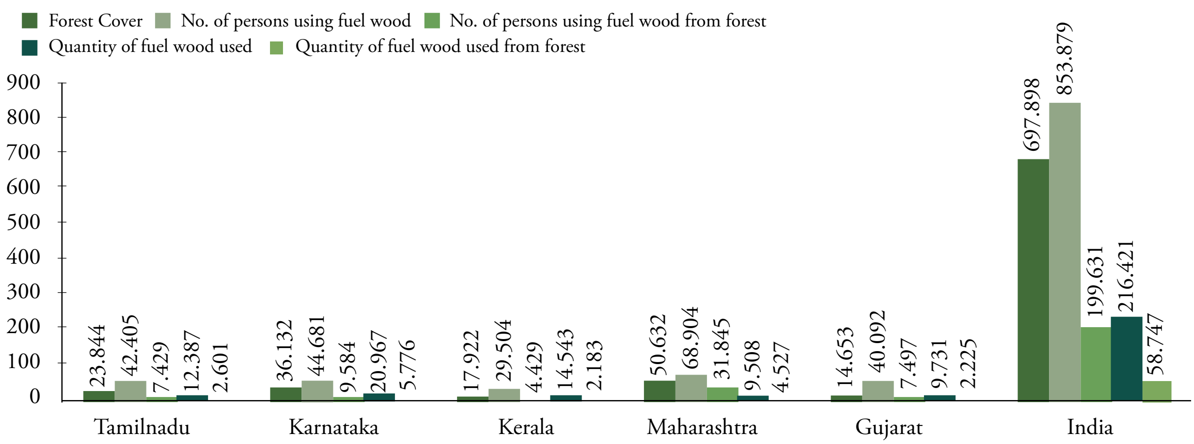
Quantification of NTFPs can be made using either forest area or household as a unit. The first type entails mapping the ethno-botanical studies with the market price of the NTFPs, while the second one looks at the usage of various products and their valuation at the household level. Both are relatively complex as each species has a range of products and different uses, most of which do not have a market price, being used as substitutes for other products. If market prices exist then valuation is relatively straight forward. However, markets for many of the NTFPs are non-existent and it is impossible to get their prices. Even where market prices can be estimated, there is very little publicly available information on the quantities harvested, consumed and sold, and the costs incurred in collecting the products. As a result one has to resort to often more complicated analytical tools to estimate the value of NTFPs. Lack of systematic monitoring and information systems on NTFPs also means that the necessary data has to be collected from costly household surveys.

Fuelwood collected from forest fringes is an important source of domestic energy for rural areas. Availability and accessibility to local forests is the prime determinant of fuelwood consumption by households. Fuelwood dependence and the value to the local economy is well established, so while not as complex to calculate as NTFPs, there are few statistics showing the extent of dependence on fuelwood. Figure 20 and 21 shows fuelwood consumption and dependence of households for the five states coming under Western Ghats. The figure shows that the percentage of quantities of fuelwood used from forest is highest in Maharashtra (47.61%), with the highest forest cover of 50,632 sq. km., and second highest in Karnataka (27.55%), with second highest forest cover of 36,132 sq. km. Of the total fuelwood used in Karnataka, 21% comes from the forests. As per 2011 Census, fuelwood is the primary source of energy for cooking and heating in Uttara Kannada district for both rural and urban areas. About 78.6% of the rural households of the district use firewood for cooking, while 0.87% of household use crop residue and cow dung, and only 14.7% of the households use LPG.

3.3.2.1. Valuing the contribution of NTFPs and Fuelwood to the Households

The data for this analysis came from nine villages of Uttara Kannada District of Karnataka nearer to the ecological sampling sites, which would best capture the people-forest dependencies. Three important factors were considered while selecting the villages: vegetation type, extent of disturbance and proximity to the forests. The premise is that villagers living within forest area have high dependence on NTFPs for subsistence, and those living on fringes depend on the NTFPs for sale. The choice of the villages based on the forest type, distance from the forests and disturbance gives us an opportunity to capture the relation between forests and NTFP dependence. Based on these sites, we extrapolated the results for the entire Uttara Kannada district.

Figure 20: Fuelwood used in Western Ghats States 2011



Source: *Authors representation of data from www.indiastat.com*

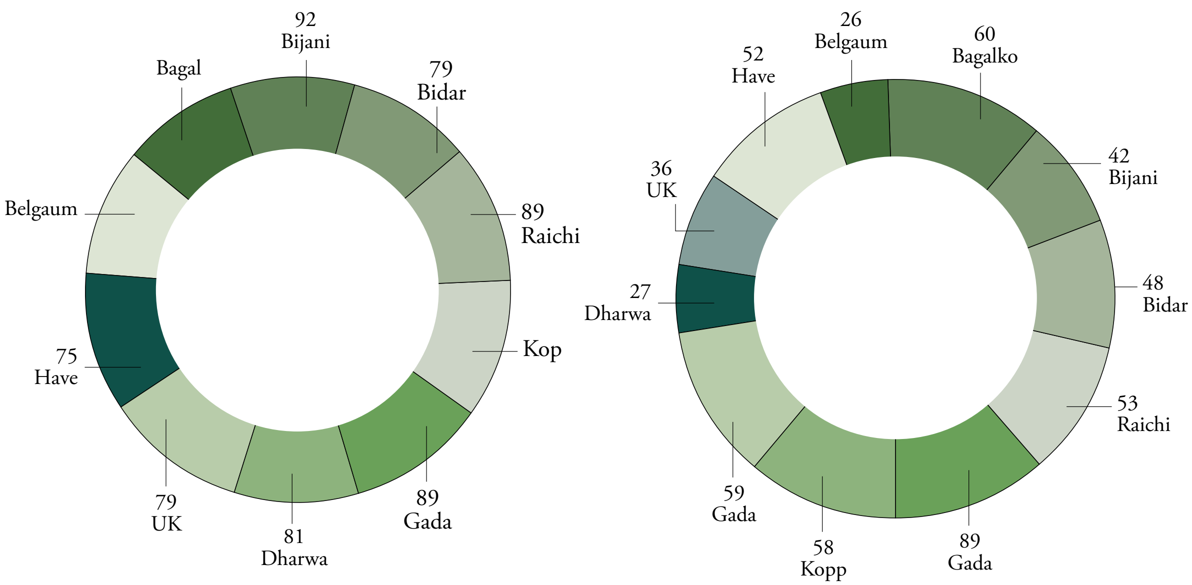
The study found that rural people still extract and depend on NTFPs for their subsistence like food, medicines and building materials. Further, in the study area we also found that there is lot of scope for creating NTFP-related jobs. This is especially important in Western Ghats, which can offer huge potential for NTFP production, along with delivering other ecosystem services.

In order to assess the value of fuelwood, fodder and non-timber forest products for the forest-dependent population and to extrapolate for the rest of the Western Ghats region, this study modelled the demand using the household production function. The household production function approach gives an understanding of household behavior. The household production function is based on theory that an individual household tries to produce utility maximizing bundle of goods through combining the time endowments of its members with other variable and fixed inputs, including in this case available forest resources (Sill et al., 2003). We find that this method is applicable here as the villages are agrarian, living on the forest margin, engaged in agriculture and collecting NTFPs and fuelwood. Complete markets for agricultural products exist while incomplete markets exist for NTFPs and fuelwood. The households take a decision on how much time to allocate between collecting fuelwood, NTFPs, agriculture, rearing livestock, as well as other opportunities and time constraints that they have. The decision is also driven by the amount of endowments that they have, like land, access to forests, income opportunities and household size. In the study villages, NTFP and fuelwood collection is done only in public lands, i.e. forests, and the households do not produce them in their own lands. The only variable input in the forest product collection is the household time. In the study area, most of the forest products collected are for personal consumption or for use as input in agriculture (dry leaves for mulching, etc.).

The household model has the following implications for our analysis. The household allocates the time for NTFP and fuelwood collection up to the point at which the marginal costs equal the marginal benefits from collecting the forest products. The shadow value of time spent collecting forest products equals the marginal utility of income generated from other activities like agricultural production, which in our case is the shadow value of income.

As in rural areas the labour markets are incomplete, the shadow wage can be estimated as the value of the marginal product of labour (Kohlin and Parks, 2001). Sills et al. (2003) argue that if multiple markets are incomplete, as is the case with the study area, it is important to obtain reduced form models, wherein household behavior is modeled as a function of socioeconomic and environmental characteristics reflecting preferences, technology and input endowments, rather than prices. Collection of NTFPs

Figure 21: Percentage of (a) Rural and (b) Urban Households using firewood for cooking in Karnataka (based on census 2011)



and fuelwood is a function of different exogenous factors like the household size, income from NTFPs, socio-cultural factors (education and caste), household wealth (landholdings, livestock), household income, regional variables like forest area, distance to the forest, presence of substitutes, etc.

3.3.2.2. Selection of Sample Villages

Data was collected through a survey of 9 villages of 458 households during the months March to May, 2014. These villages are characterized by large populations dependent on the forests for NTFPs in the four forest zones of evergreen, semi-evergreen, moist deciduous and dry deciduous in the Uttara Kannada District of Karnataka. The selected villages are Kelgin Sarkuli from Siddapur Taluka (20 households); Hudelakoppa (32 households), Ekkambi (56 households) and Hosur (22 households) from Sirsi Taluka; Togaralli (45 households), Janageri (21 households) and Malgi (83 households) from Mundagod Taluka; and Chibbalageri (107 households), Adikehosur (72 households) from Haliyal Taluka (brief over view of villages given in Figure 22). All these villagers engage mainly in agriculture and casual labour activities. The main occupation of all these villagers is agriculture and casual labour. Dependence of population on forest produce depends on the availability and accessibility of such products. The villagers use household labour for collecting the forest products. All these villages are located within proximity of 2 to 5 km from the forests and have very limited opportunities for labour.

A preliminary survey was conducted to gather basic information about the villages. Further, a questionnaire survey was conducted to collect information on the diversity of NTFPs extracted, the parts used, their end use as well as the season of collection, and quantity of NTFP gathered per typical trip and quantity collected in a season. The household schedules mainly consist of information on the socio-economic characteristics of households, status of fuelwood and NTFP consumption, collection in terms of quantity collected, time taken to collect, frequency of NTFP collection, etc. Out of 458 households surveyed only, 275 reported to collect NTFPs. Typically, the households surveyed use several different NTFPs to meet their everyday needs. The main NTFPs collected by households are fuelwood, green leaves, dry leaves, fodder, bamboo shoot, poles and fruits, such as mango, Garcinia Indica (Kokum), Jackfruit, Garcinia gumi-gutta (Uppagge), Carrissa, Blueberry, Koulikai, Mullohunno, Vaate, Soapnut, Rugusa, Sampigai Hannu, etc.

3.3.2.3. Key Findings of the Survey and the Empirical Model

From the survey, it was observed that the range of the products collected varied between households depe nding on the local and external contextual conditions, such as availability of the resources, the presence of substitutes, labour to collect, the income, family size. Not all the households are engaged in NTFP collection. The survey indicated that whether villagers are actively involved in collecting NTFPs depends on whether they are staying in the fringes of evergreen forests or dry deciduous forests. The households collected NTFP and fuelwood from forests mainly for subsistence and are not engaged in any type of sale of NTFPs (including fuelwood) in local market. Households are mainly involved in seasonal collection and maintain their stocks throughout the year. Fuelwood is the only source of fuel for most of the household and therefore entire fuelwood collection is used for cooking and heating purpose. Apart from fuelwood only few households use Kerosene as alternate fuel, which they get from Public Distribution System (PDS). As far as selling of NTFP is concerned, only few households are engaged in selling other NTFP products such as Uppage, dry leaves, Gooseberry, Borlumoggu, Rugosa, Vaate and Sham bamboo. The collection of NTFPs and fuelwood contributes substantially to the household income. Table 26 shows that the contribution of fuelwood ranges from 16 to 37% of household income in different villages. The evergreen has highest dependence, while dry deciduous has relatively less dependence. Similar is the case with NTFPs: in villages 1 and 2 the percentage contribution of NTFPs is almost 63% and 40% of their annual income. It may be pointed out here that income is also an approximation by the households as they try to recall the multiple sources of earning that they have.

Value of Fuelwood

Fuelwood is often transported using head loads by foot. Thus the distance to the firewood source, the effort (measure of labour input which is measured as the number of hours spent in collecting fuelwood) put in collecting the firewood, number of members in the house (a measure of labour supply) and the size of the landholdings and livestock possessed can be some important factors in determining the quantity of firewood collected from forests. For details on methodology refer to Appendix 2.

Our results (refer to Table 26) indicated that large households collected more forest products (fuelwood) than smaller households. Clearly availability of labour

Figure 22: Key aspects of the study villages

Kelign Sarkuli (20hh)

- Taluk: Siddapur
- Geographical area: 85928 ha
- Population: 40,000
- Forest area and type: 68245 ha, Evergreen forests
- Proximity to forests: 2 km
- Main occupation: Agricuture and casual labour
- Main crops: Paddy, coconut, pineapple, cashew, arecanut (major crop grown in the valleys in between forests), others-pepper, vanilla
- NTFPs collected: fuelwood, green leaf, dry leaf, fodder, mango, poles, garcinia indica, jackfruit, uppagge

a. Hudelakoppa (30hh), b. Ekkambi (56hh), c. Hossur (22hh)

- Taluk: Sirsi
- Geographical area: 132233 ha
- Population: 117,000
- Forest area and type: 103583, a. Moist deciduous, b & c. Evergreen
- Proximity to forests: a & b 2 km, c 1 km
- Main occupation: Agricuture and casual labour
- Main crops: Paddy, Cardamom and vanilla. Arecanut is the primary crop grown in the villages that suround the town, making it one of the major trading centers
- NTFPs collected: fuelwood, green leaf, dry leaf, fodder, bamboo shoot, mango, uppagge

a. Togaralli (45hh), b. Janegari (21hh), c. Malgi (83hh)

- Taluk: Mundgod
- Geographical area: 66809 ha
- Population: 107,499
- Forest area and type: 50503 ha, a & b Moist deciduous, c. Dry deciduous
- Proximity to forests: a. 2 km, b. 3 km, c 5 km
- Main occupation: Agricuture and casual labour
- Main crops: Arecanut is the primary crop. Cardamom, paddy.
- NTFPs collected: fuelwood, green leaf, dry leaf, fruits (not much in quantity)

a. Chibbalageri (107 hh), b. Adikehosur (72 hh)

- Taluk: Haliyal
- Geographical area: 84746 ha
- Population: 20652
- Forest area and type: 59847 ha, a & b Dry deciduous
- Proximity to forests: a & b 3 km
- Main occupation: Agricuture and casual labour
- Main crops: Arecanut is the primary crop. Cardamom, paddy, coconut
- NTFPs collected: fuelwood

is one key determinant of fuelwood collection. Higher opportunity cost of time translates to lower collection, meaning that the poorer households depended more on fuelwood collection. Higher frequency of fuelwood collection with lower collection per trip means that distance plays a major role in fuelwood collection. People living off at a distance tend to collect large quantities and stock them up while those staying nearer collect lower quantities but more frequently. Households who possessed more land collected more fuelwood. This reflects the fact that other factors like tradition, culture, preference, etc., play a major role in fuelwood collection. The demand curve derived for fuelwood is given in Figure 23. We found a negative relationship between fuelwood collected and the opportunity cost of time. If the opportunity cost is low demand is high.

From the demand analysis, the annual estimated demand for fuelwood per household has been 12,264 kgs. Uttara Kannada has 2,28,877 rural households and 95,643 urban households. The dependence on fuelwood in rural areas is 79%, in urban area 36%. The survey indicated that all the households collected fuelwood and none of them bought. Based on this the demand for firewood in Uttara Kannada district alone is 2.6 million tonnes. Ideally the local market price of fuelwood is most suited to use. However, 100% of the villagers surveyed in the region are dependent on fuelwood collected from forests and none of them reported any market transactions. In such cases, the imputed values from neighboring markets may be used (the existing studies impute a value of ₹3/kg) but the study chose to use shadow price, as the markets for fuelwood in the region are extremely thin and unrepresentative. On an average households spent 65 days in collecting the fuelwood. The shadow price of fuelwood is computed as mean value of quantity of firewood collected, the mean hours spent collecting the firewood times the marginal product of labour. The mean opportunity cost per day estimated in the model is ₹390/day. Based on this the shadow price of fuelwood is estimated to be 4.49 ₹/kg. However, if the existing NREGA wage rate for Karnataka of ₹204 per day is considered, the shadow price of fuelwood is estimated to be ₹2.32/kg. Considering the benefit to the entire population dependent on fuelwood in Uttara Kannada with a forest area of 7,81,900 hectares, the benefits amount to ₹8,840 million rupees (assuming an average of 3.4 ₹/kg (mid point of 2.32–4.49 ₹/kg), with a per hectare value of 11,306 ₹/ha. However, if we assume a sustainable flow wherein approximately 10,53,613 tonnes (sum of total potential sustainable extraction across forest types

FOREST

Table 26: Village-wise annual fuelwood and NTFP collection and proportion of annual income (at household level)

Village	Mean Fuelwood collected (Kg)	Mean NTFP collected (Kg)	Mean NTFP value	Mean annual income (in ₹)	% share of Fuelwood in annual income	% share of NTFP in annual income
Kelagina Sarkuli	1945	3856	25664	62500	16 %	63 %
Hudelkoppa	2547	5528	10879	36765	25 %	40 %
Ekkambi	2282	697	1722	53688	16 %	4 %
Togaralli	2345	3115	1722	5529	17 %	13 %
Janageri	2692	1995	3601	34524	28 %	12 %
Malagi	2465	137	254	56765	18 %	0.051 %
Hosur	2948	3894	13325	52727	37 %	45 %
Chibbalageri	2089	0.04	1.85	54167	16 %	0.002
Adikehosur	2277	No NTFP collection		47917	18 %	-
Total	2330	1261	3489.6	52207	19 %	10 %

Source: *Author's compilation of survey results*

from Table 23) or approximately 1.42 t/ha of firewood can be sustainably extracted (based on the ecological study), the value per hectare due to firewood extraction (based on the knowledge that whatever is sustainably extracted is used), the benefits amount to ₹4590/ha. This sustainable yield is a very conservative scenario. We assumed that whatever is demanded is supplied from forests only through removal of twigs and branches and not through clear felling.

Value of NTFPs

Household demographics affect NTFP collection patterns. NTFP collection is positively related to measures of wealth. The coefficient on agricultural wealth also has a positive sign, although not significant. The positive correlation with wealth may reflect the fact that these NTFPs are not necessities for day-to-day survival like fuelwood, but rather add some variety to consumption possibilities (see Table 27 for the results).

The households were asked to impute prices on the NTFPs they collected for consumption, and hence are lower bounds. The villagers staying nearer to the forests depended more on the NTFPs, and in fact even those households which have land are involved in collecting the NTFPs. The contribution of NTFPs to household income ranges from 0.5 to 7% per NTFP collected (if households collect more NTFPs, the contribution is substantial and they usually collect more than one NTFP) depending on how actively the households are engaged in NTFP collection. For the households engaged in the sale of NTFPs like uppage, kokum and honey, the contribution is quite substantial, which increases value addition to the economy (see Boxes 2 and 3).

The estimated collection is 3,173 kg/household. Assuming that the 1.02 million populations in rural areas consume NTFPs from forests, the derived demand for collecting NTFPs is 720 million kilograms (based on Tobit estimation). The mean price is ₹35 per kg (US$ 0.56/kg) across all types. Extrapolating these estimates to the entire Uttara Kannada district based on the econometric model (Tobit estimation) gives a per hectare value of 32,230 ₹/ha (US$ 519.17/ha). This estimate provides an indicative figure of the use value of forests in Western Ghats in a protected area management regime.

The survey was based on recall and it is very likely that for the products collected regularly accurate responses could have been recorded in comparison to those collected occasionally. Another key issue is that the price of NTFPs is not efficient market price, but instead reflects local prices as quoted by the household. Further, no adjustment for time costs were made, as the only input we assumed in this case is time, and there is lot of debate on whether to deduct these time costs.

3.3.2.4. Conclusion and Policy Implications

The study revealed a very high fuelwood dependence in local communities living closer to the forests. Easy accessibility, absence of fuelwood substitutes and cultural practice contribute to this high dependence. The fuel is mostly collected from agricultural fields,

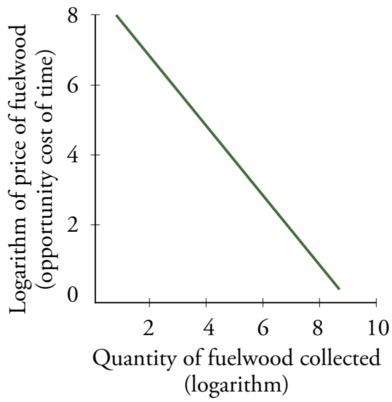
Table 27: Results of the regression analysis of NTFP collection from the survey results

Dependent variable – quantity Fuelwood collected per trip Ordinary least squares estimation	Observations – 458 R-squared – 0.66 F (13,261) = 47.42
	Coefficient
Constant	-1.17 (0.88)
Household size	1.31 (9.31)
Opportunity cost of time	-0.83 (-20.17)
Average expenditure per month	0.76 (6.43)
Frequency of collection	-0.18 (-2.59)
Value of the land possessed	0.05 (0.96)
Village dummies	**Coefficient**
Hudelkoppa	0.46 (1.62)
Ekkambi	0.13 (0.38)
Togaralli	-.079 (-0.32)
Janageri	0.58 (2.34)
Malagi	0.29 (1.23)
Hosur	0.27 (1.05)
Chibbalageri	-.018 (-0.08)
Adikehosur	.041 (0.16)

Note: *Figures in parenthesis indicate the t-statistics*

forests, plantations, bottomlands, road side plantations. This also shows that in rural forested areas it is difficult to replace the fuelwood and buying the commercial fuels will impose a burden on these communities especially the poor. On the other hand, heavy dependence on fuelwood may also contribute to the forest degradation along with other factors. The trade-offs here are apparent. The policies need to address this delicate balance of providing energy security to rural poor versus conserving the forest resources. Thus there should be more plantations of the fuelwood species to take care of the energy needs of the communities. The forest departments in the Western Ghats region take an active role in afforesting its forest and non-forest lands, distributing seedlings to the farmers, promoting agro-forestry, and involve local people in protection, planning and management of forests. Still the efforts are not sufficient as the forests are being degraded. As trees are lopped by the community for the firewood needs, it might impact other services provided by forests. Alongside conservation, policies should address the fuel dependence and provide alternatives or manage the forest sustainably taking into account the fuel requirements of the local communities.

Figure 23: Demand curve of fuelwood



The results show that NTFP offers very good opportunities for informal job creation. The activity is unorganized in the region as a result of which information on actual quantity collected, consumed, sold and the dynamics of market price could not be assessed. It is important to maintain inventoried information on the NTFP yielding species, the number, and potential quantity produced, collection for self-consumption, sale and commercialization aspects of the species for implementing NTFP policies. At the moment the prices of NTFPs are not efficient as there is no information on the demand and supply of these products. There is an opportunity to involve locals in inventorying the information similar to the People's Biodiversity Registers.

Further, the contribution of this sector has been neglected in the policy making. The right over the forest resource lies with the state government. But rights of use can be given to certain communities or groups to exploit the NTFPs. Most of the products which are of high commercial value are regulated by the state government through the village forest committees or the forest department. For most of the commercialized species the rights to harvest NTFPs are auctioned and the winning bidder or contractor according to locals is an effluent business person who has complete control over the trading and marketing of the extracted NTFP for the entire range. The contractors hire local people to harvest. As the lease is given for a period of only 2 years, the contractors do not ensure sustainable extraction of NTFP products. In the case of honey, bees are poisoned: this is highly condemned.

The non-commercialised NTFPs can be extracted even by communities living in and around forest areas. Not having appropriate policy on sustainable management of NTFPs can lead to indiscriminate use

Table 28: Imputed value of NTFPs collected and key features of the collecting households

NTFPs	Qty. collected (in kg)	No. of hh. Collecting NTFP	Imputed price (₹ /Kg)	Avg. qty collected per hh.	Avg. value of collection/ hh.	Avg. value of sale/ hh.	% of surveyed hh reporting collection	Avg. Annual income	Avg. hh size
Garcinia Indica	43	7	70	6.14	350	-	3.38	39286	5
Kouli kai	5	3	40	1.67	29	-	1.45	39286	5
Mulle hannu	18	9	50	2.00	129	-	4.35	63889	6
Challe kai	9	3	35	3.00	45	-	1.45	41667	6
Carrissa	29.5	12	40	2.46	169	-	5.80	37500	4
Bamboo shoot	177	30	12	5.90	202	101	14.49	45000	5
Uppage	1310	19	100	68.95	All sold	6894	9.18	46053	5
Jackfruit	1190	24	15	49.58	1104	921	11.59	56250	5
Blueberry	39	16	100	2.44	557	-	7.73	46875	4
Mushroom	67	19	150	3.53	1264	400	9.18	40789	5
Kouli hannu	16.5	9	50	1.83	118	-	4.35	63889	6
Sampigai hanun	14	3	50	4.67	100	-	1.45	58333	16
Mango	554	53	200	10.45	6714	3988	25.60	46698	5
Fodder	568035	118	5	4814	9941	-	57	52815	5

Source: *Author's compilation based on survey results*

Table 29: Tobit model parameter estimates for NTFP

Total observations - 458 Left Uncensored observations = 145 pseudolikelihood = -253.00183		
Quantity of NTFP collected (dependent variable)	Estimate	Marginal effects
Household size	0.498(1.54)	.498 (1.54)
Price of NTFP	-1.484(-14.11)	-1.485(-14.11)
Wealth of the household	0.120(1.72)	.120(1.72)
Opportunity cost of NTFP collection	-0.127(-0.75)	-.127(-0.75)
Educational years	0.0018(0.06)	.0018(0.06)
Constant	7.150(6.70)	

of the resources. During our survey, it was pointed out that Uppage (Garcinia Cambogia) trees have been felled indiscriminately. Garcinia is a species of utmost importance to locals in maintaining sustainable flow of benefits to the society and economy. Uttara Kannada region has an abundance of this species. The seeds of this species are used by households to make butter. This species has acquired high commercial importance and hence has been exploited. The survey of communities indicated that the sustainability of the species has to be ensured and be planted in agricultural lands and other communal lands. The harvesting behaviors need to be regulated and the harvesting rights and regimes should be set in such a way that the conflicts between the local harvesters and the migrant harvesters (from different forest ranges) are minimal. Collectors are mostly driven by necessity to harvest the species as it is an important source of livelihood for them. Therefore, they tend to extract early, thus lowering the quality of Uppage and Kokum. There should be limits to extraction per harvester depending on the mean annual increment, which should be assigned by the Forest

Departments. From our survey we found that 100% of the collectors climb and pluck fruits and also collect fallen fruits. They also at times remove fruits by sticks and by shaking the trees, which is an unsustainable practice. From our analysis we found that price and per unit profit of Uppage is more, and thus of more commercial importance, which is posing a threat in the form of over-extraction of the species, so the availability is declining by 25–30%. Unpredicted variations in temperature and rainfall (climate change) are affecting the outturn of the species. There is a need for training and awareness camps for sustainable extraction. The role of middlemen should be minimized and the local community should be given direct access to the market.

The conservation and regeneration of NTFP species is not a priority for many of the species, so efforts should be made to ensure that NTFP yielding species are sustained. There is no restriction on collecting the products and no guidelines for how the NTFPs are to be collected. Further, the locals were of the opinion that only few of the timber species are prioritized but not the NTFP yielding species which should be highly prioritized on a war footing basis.

In the study region, there are few cooperative societies who procure NTFPs from forests involving rural forest dwellers and create lot of value addition to these NTFPs. Some of the NTFPs commercialized by these societies or groups include wild honey, tamarind, Kokum, Amla, soapnut, etc. They involve women and generate lot of employment (for example Kadumani, Kadamba, LAMPs society). The Forest Department leases certain forest areas to such cooperative societies. For example, in Karnataka, 23 large-sized Adivasi Multi-Purpose Co-operative Societies are working in the State with the objective of improving the social and financial conditions of the Adivasis. Their prime aim is to collect and market forest produce by the tribal people and improve the financial position by providing employment. In 2013-14, around 94,452 members are enrolled in these societies and the societies make meagre profit. According to a study by Ambina Kudige (2011), tribals could make as much as ₹200 per day by collecting and selling NTFPs to these societies, which is more profitable than working in the coffee plantations. Such employment creation through primary cooperative institutions involved in NTFP procurement, processing and sale should be encouraged. Even the locals directly sell the product to the traders at very low prices. The traders often have very high margins. The Government could think of a minimum support price so that the harvesters or the locals can get an assured price and the conservation of NTFP species is encouraged. However, the households and middle men felt that VFCs and the societies have control over resources, and so they are given a very low collection price. The community also felt that they require technological support (e.g. driers). Government involvement is also required to stop unsustainable harvest of fuelwood from the forests.

To make the sector lucrative, profitable, and sustainable, and encourage locals to take up the job of primary collectors of NTFPs along with being leaders in conservation, it would benefit NTFP management to be linked to the NREGA scheme. More coordinated efforts are required to demonstrate the potential value of NTFPs from the forests in India and their role in poverty alleviation, creation of employment, foods security, and income generating opportunities. The market potential of the NTFPs is also not known and the development of markets is required for many species. Recognizing the demonstration and capture of NTFP values in the decision-making framework helps conserve the Western Ghats forest ecosystems. The government should play an active role in tapping the untapped potential of the NTFPs in the Western Ghats and put a break on monoculture plantations. An exclusive policy on NTFPs should be implemented, recognizing their importance to local livelihoods.

3.4. Value of Carbon Regulatory Service

The benefits of carbon sequestration are estimated from the biophysical measures given in the earlier section. Carbon sequestration clearly depends on the vegetation type, species mix, the organic matter content of the species, the age distribution, soil, climate and the belowground biomass. Using the estimates that we derived earlier, we valued carbon sequestration in

More coordinated efforts are required to demonstrate the potential value of NTFPs from the forests in India and their role in poverty alleviation, creation of employment, food security, and income generation

Box 5: Value Addition by Garcinia indica, Garcinia cambogia or Garcinia gumi-gutta

Garcinia species are evergreen trees and shrubs unique to the Western Ghats area, as 17 of the 35 species found in India are endemic to this region. Two species commonly used by households include *Garcinia indica* and *Garcinia Cambogia*, or *Garcinia gummi-gutta. Garcinia indica*, known as kokum butter tree, requires 7 to 8 years to bear fruit. The rind of the fruit is dried, stored and used for cooking. The species is very popular, as it can be grown in homesteads and orchards as well, and does not require any fertilizers or pesticides. *Garcinia Cambogia* or *Garcinia gummi-gutta*, popularly known as Malabar Tamarind and Uppage Huli, is also used as spice by the local people.

Uppage and Kokum are harvested from reserved forests, sopina betta, homesteads and orchards (usually privately owned) during the monsoon season. Among the 43 collectors that we surveyed in different villages of Uttar Kannada district, 23 of them collect Uppage and 20 collect Kokum. In all, 87% of uppage collectors and 70% of kokum collectors collect from forests. The rest of the collectors get from homestead or orchard.

After collection the fruits are deseeded by households and the rind is dried for use. The processing has to be completed in a day due to fungal infection. As the collection is done during monsoon when sun drying is not a feasible option, fuelwood is used to dry the rind. Approximately 22 kg of firewood is required to get 1 kg dry Garcinia fruit rind with the traditional open fire system. The temporary processing units are situated within the forest, which is a huge hidden cost to the ecosystem (Small Grants Programme, MOEF). The firewood used for this is usually collected from forests itself. This is a major concern for the Forest Department as the revenue earned from auctioning trade rights does not commensurate with the loss of biomass (Rai and Uhl, 2004).

The processed fruit and dry rind is sold by the collectors/harvesters to the agents appointed by the contractor at a pre-determined price. We have estimated from the survey that the collectors get on an average 28% of their income from sale of Garcinia. 100% of the collectors climb and pluck fruits and some collect fallen fruits. Sometimes fruits are removed by sticks and by shaking the trees. The collectors are of the view that selling Garcinia directly to final consumers instead of middlemen yields them better prices, up to an extent of 5-15%. The value addition at the contractor level is ₹30/kg (US$ 0.48/kg).

The agent charges commission for each kilogram bought. Our survey indicated that 52% of the Uppage collectors sell to the retailer, while 48% sell to wholesaler. Among Kokum collectors, 65% of those surveyed sold Kokum to the retailer, while 35% sold to wholesaler. According to our survey, in total 1552 kg of Kokum was collected and sold at an average price of ₹66.25/kg (US$ 1.07/kg) and 9900 kg of Uppage was sold at an average price of ₹134.56/kg (US$ 2.17/kg). We have computed the average per unit profit of Uppage is ₹83.21 (US$ 1.34) and that of Kokum is ₹47.12 (US$ 0.76). The average cost of processing into dry rind is 46.75/kg (US$ .75/kg) and ₹17/kg US$ (0.27/kg) for Uppage and Kokum respectively.

The 6 wholesalers from Siddapura Taluka of Uttar Kannada district that we surveyed dealt only with raw Garcinia or Garcinia processed in the form of dry rind, and are engaged in commercial trading in the local markets as well as inter-state markets such as Bombay, Kerala, Bangalore, Delhi, Andhra Pradesh, Uttar Pradesh, Madhya Pradesh and Maharashtra. Forest was the main source of Garcinia for four of them while the remaining two got from homestead and orchards. The average per unit profit was computed by us at ₹11.66 per kg (US$ 0.19) for Garcinia indica and ₹30–70 (US$ 0.48–1.13) per kg for Garcinia Gummigutta.

The four retailers that we surveyed in Sirsi town of Uttara Kannada district engaged in selling processed (value added) Garcinia products such as kokum, kadi, squash, butter, seed, dry rind, white kokum jam, and

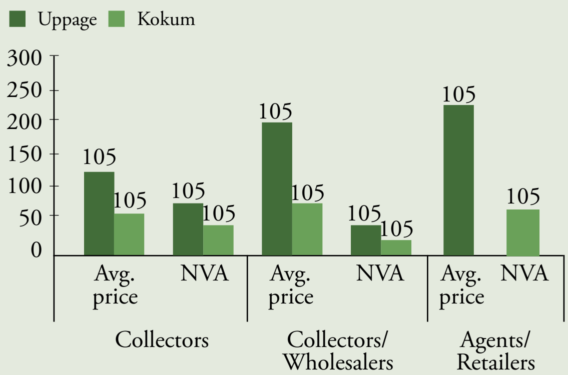
terms of the social cost of carbon. Varying estimates are available based on the emission scenarios, damage and abatement functions considered, and the choice of discount rate, since the Nordhaus (1991) and Cline (1992) studies. The most conservative estimate of social cost of carbon used in literature has been $20 per tC as the estimate (see the discussion summary in Atkinson and Gundimeda, 2006). However, there has been some discussion on the appropriate estimated social cost of carbon, and the latest estimate of $37/tC seems an appropriate estimate (see Gundimeda and Atkinson, 2014, referred as UNU-IHDP and UNEP, 2014).

The field level analysis showed that in the district of Uttara Kannada, the total stock of carbon is 183.15 MtC, which is equivalent to 672 MtCO2. The annual carbon sequestered in forests of Uttara Kannada is 1.12

sell these processed products directly to consumers. The profit depends on the product sold ranging from ₹5/kg (US$ 0.08/kg) in case of seeds to ₹100–133/kg (US$ 1.61–2.14/kg) in case of kokum butter. The average value addition at the contractor level is approximately ₹48 (US$ 0.77) per kg. Average proportion of income from sale of Garcinia products to total annual income is 7.5%. Figure 24 gives the graphical representation of value addition by stakeholders in the Garcinia value chain

Village traders also engage in selling uppage and kokum rind to other small buyers from other regions that operate in the black market. The presence of black market ensures that the market price is kept high. The prices vary from region to region, as the villagers from different regions also benefit from high prices. This difference in prices is due to lack of regulation after the auctioning of the contract, as a result of which there are conflicts between the contractors, agents and traders during the harvest season.

Figure 24: Graphical representation of value addition (₹/Kg) by stakeholder of Garcinia value chain



Source: *Author's representation of survey results.*
Note: *The average price (₹/kg) indicates the average selling price of each stakeholder and the NVA*

tC/ha/year, based on the ecological sampling of the study site. The value of this stock of carbon is based on the distribution of different forest types in Uttara Kannada district alone and has been estimated using avoided social costs. Social cost of carbon is the extra climate change impact that would be caused by the emission of one more tonne of carbon dioxide in the atmosphere. Thus the benefit of carbon sequestered in the forests is the avoided social costs, which is estimated at ₹756 crores (US$ 124million) annually, equivalent to ₹9673/ha/year (US$ 11.0563/ha/year) which would accrue to the global community.

The values accrue to the global community as well, which can be appropriated and traded on voluntary carbon markets. In India, the corporate sector can offset their emissions by investing in Western Ghat ecosystems.

3.5. The Economic Opportunity from Tourism

In several countries across the world ecotourism is gaining popularity and contributes a lot to the economic growth of the countries. For example, in countries like USA and Canada, the economic impact of tourism has been between US $236–US $370 billion in the year 1996 (Eagles, P.F, 2010). In Brazil, tourism is responsible for 5.3% of GDP through contributions from food services (22.6%), air transportation (17.9%), ground transportation (16.8%), hotels and other lodging (12.9%), secondary residence (8.9%), and cultural services, recreation and leisure (8.5%) among others (Flecha, 2010). However, the exact role of protected areas in attracting tourists has often been undervalued and not documented properly. The prime reason for the lack of value is because the data is not collected systematically, leading to placing a low value on the parks. The lack of value or undervaluation often leads to degradation of the natural areas. In India, despite a lot of investment in the parks, lack of funds leads to mismanagement of the resources. Due to the ecological importance of Western Ghats, Uttara Kannada can have high potential tourism values. Panchmukhi et al. (2008) study shows that the total recreational value of forests in Karnataka constituted 0.02% of GSDP at current prices for 2002-03. Using Dandeli-Anshi National Park and Sanctuary as a case study (Figure 26), the study tries to demonstrate the true economic value of the Park.

Protected areas benefit the local, regional and national economies in several ways. They have several direct, indirect use and non-use values. The direct benefits from protected areas stem from the money injected into the economy directly as a result of visitors spending. Some of the parks also get funds from different international agencies, which could benefit the local economy significantly. The money is injected in the form of spending on entry fee, transportation, accommodation, food, attractions and local shopping. Part of the expenditure goes in the form of tax revenues and some are absorbed by the local, regional or national

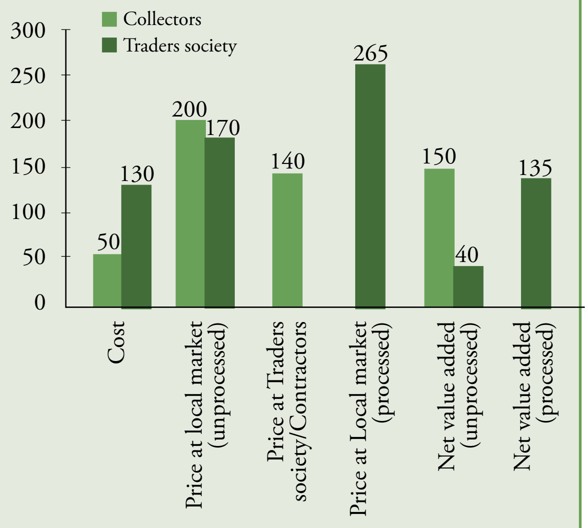
Box 6: Honey Value Addition in Uttara Kannada District

Honey bees provide two crucial ecosystem services in form of honey (Provisioning services) and pollination services (Regulating services) which are both in direct and indirect form. Pollination services are essential for development of fruits, vegetables and seeds. According to FAO, food security, food diversity and human nutrition depend strongly on animal pollinators, however, pollination services have been very little understood, as they are provided by biodiversity at essentially no cost at all. FAO identifies cardamom in Western Ghats as a key crop for good pollination practice managed by bloom sequences to keep pollinators in fields.

Beekeeping is a forest and agro-based industry that enables humans to derive direct benefits. According to Environment Information System (ENVIS) Technical Report, 2012, Apis, of the family Apiade, is the main genus of honey bee that accounts for the bulk of honey production. The genus Trigona from the same family is the minor producer of honey. The district of Uttar Kannada has three species of Apis and one species of Trigona. ENVIS made an attempt to survey across 83 villages in the district and surveyed about 105 bee-keepers. According to the survey results, the total honey production from the district, based on household surveys, was about 10,424 kg in 2011, at a district average of 6.68 kg/ per bee box.

The study made an estimate of the value of beekeeping for the Uttara Kannada district. A survey was conducted in Coorg district (also known as Kodagu) and Uttara Kannada. In total we surveyed 7 respondents (2 from Coorg and 5 from Uttara Kannada), out of whom 5 were honey collectors and two were traders. The results here are based purely on the responses of the interviewed stakeholders. The collectors are engaged in collecting honey directly from forests while the traders purchased honey from the collectors; the marketing society purchases honey from the harvester's association. Figure 25 is a graphical representation of value addition by stakeholders in the honey value chain. The total revenue earned by all the stakeholders engaged in honey collection and trading is ₹17,99,440 (US$ 28,985.87) for 16,476 kg of honey. This value was attained after adjusting for the costs of honey collection and processing. Processing costs ₹41,100 (US$ 662.05) for that amount of honey. Employment aspects have been ignored. The rate approximates to ₹2,57,062 per household per year (US$ 4,140.82/household per year) or ₹110 per kg (US$ 1.77/kg) of honey produced.

Figure 25: Graphical representation of value addition (₹/kg) by stakeholders of honey value chain



economies. The increased expenditure may generate more activity in other related sectors in addition to providing income generating activities and employment for the local people. Thus the local, regional and national economy would benefit depending on the extent of tourism and the type of tourists visiting the park. Some of the indicators can be the expenditure incurred by tourists, the number of businesses depending on tourism and their turn over, contribution of tourism to household incomes, the number of jobs supported, and the extent of tax revenue generated by tourism.

Some economic sectors in particular benefit more from tourism, and these benefits could accrue directly to the stakeholders, businesses and society. For example, the sector which would have greater impact could be "Hotels and Restaurants". More overnight visitors means larger benefits to lodges and resorts. The sector would create temporary and permanent jobs resulting in flow of money in the economy through wages and salaries. These hotels and restaurants procure materials

Figure 24: Dandeli-Anshi Tiger Reserve in Uttara Kannada

Source: *villagemap*

from other businesses locally or in adjacent areas resulting in further increase in economic activity. In addition the tourists hire transportation services, local guides, etc., resulting in further income generating opportunities for the local economy. Thus the tourism sector also has some spillover effects through backward and forward linkages in the economy, which have to be taken into consideration while estimating the value. The larger the linkage, the greater would be the impact of tourist spending on the economy.

In addition to the direct benefits, protected areas have ecological, intrinsic and spiritual values. While the direct and indirect use benefits could be captured through the market transactions, these non-use values fall outside of the market pricing system. For example, some of the parks do not have entry fees and this is by no means a reflection of the fact that tourists do not value the park. Ninan (2007) in his study estimates that the net forest resource benefits from Dandeli Wildlife Sanctuary is 18.1 US$/ha/year at 1999-2000 prices, at 1% discount rate. Moreover, where the entry fee is levied, figures do not reflect the real consumer surplus that the tourists derive by visiting the park. These non-use values thus cannot be measured directly. Hence, one can use techniques like the contingent valuation methods or travel cost models to get the non-use values. In the contingent valuation method, a hypothetical market is created for the service generated by the protected area and a hypothetical demand curve is estimated for the good under consideration. The key criticism of this approach is the level of understanding required by the respondent to be able to properly value the good in question and also the relevance in a Developing Country setup.

The travel cost method approximates the value of the park using the expenditure incurred in visiting the park. Here the expenditures incurred are used as a surrogate for the price paid by that visitor for the site's use. The total cost incurred in visiting the park in turn depends on the distance, family size, interest in environmental conservation, income, etc., which impact the visitation rate. From the demand curve, one can estimate consumer surplus as a proxy for the value placed by tourists on the park. However, this method gives only the use value and not the existence or intrinsic values.

3.5.1. Survey Methods and Description of Sample Area

Dandeli Wildlife Sanctuary situated in the city of Dandeli is spread over 834.16 sq. km and is the second largest wildlife Sanctuary in Karnataka. Along with Anshi National Park, it has been named Dandeli-Anshi Tiger Reserve (Figure 27). The Dandeli Sanctuary and Anshi Tiger Reserve is mainly comprised of moist deciduous and semi-evergreen forests and is a natural habitat for wildlife: the Sanctuary is home to tigers, leopards, black panthers, elephants, Gaur, deer, Antelopes and many kinds of Crocodiles and snakes. Some of the birds found in Dandeli wildlife sanctuary include the golden-backed woodpecker, crested serpent eagle, white breasted kingfisher, grey hornbill, great pied hornbill, and the Malabar pied hornbill. Recently, it has also been notified as a Hornbill Reserve. The area has a population of more than 20,000 people living within and on the periphery of the boundaries. In the Anshi Tiger reserve, there are pockets of revenue land where agriculture is practiced.

The Sanctuary attracts many local and foreign tourists. Adventure sports like kayaking, canoeing, and mountain biking, white water rafting, and wildlife safaris, are the main attractions for the tourists in Dandeli. According to the Panchmukhi et al. (2008)

study, the recreational value of the Sanctuary was about ₹1.8 crores in 2004-05, which was more than the revenue earned by the state. Apart from the Sanctuary, Supa Dam, Syntheri Rocks, Kavala Caves, Ullevi temple are some of the other spots that tourists visit often.

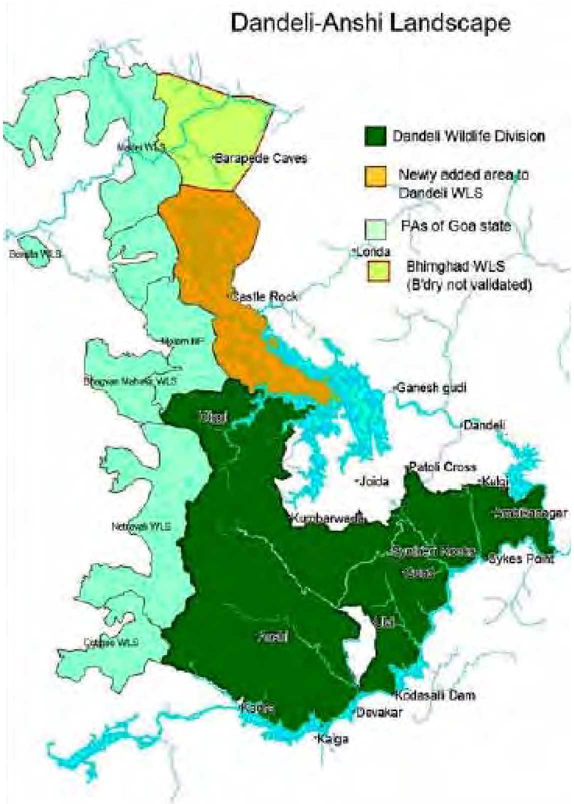
3.5.2. Tools and Methods Used in Estimating the Value of the Dandeli-Anshi Tiger Reserve

We engaged in face-to-face interviews in Dandeli Wildlife Sanctuary and Anshi National Park by interviewing the park visitors present at the location at the time of our survey during June 2014. The tourists were interviewed outside the Sanctuary (as soon as they came out of the wildlife safari), in the resorts, homestays, and when they were resting. Most of the tourists surveyed came in groups, and hence we could survey around 75 groups (450 individuals in all).

The prime purpose of this survey is to understand visitors' reason for visiting, their spending patterns, their socio-economic backgrounds, their attitudes towards the environment in general and the Western Ghats in particular, and their perceptions. Dandeli-Anshi Tiger Reserve region is entirely scenic and has multiple sites and attractions. Visitors may visit any one of these or a combination of them, so our survey is not for a single site, but for the entire area spanning Dandeli-Anshi Tiger Reserve. Hence, we have not made any attempt to value the site-specific characteristics of different sites.

From the sample surveyed we obtained a trip generating function, for which obtaining visitation rates is crucial. We used a variant of the travel cost method, wherein the number of hours spent on site per trip was used as a dependent variable and the travel costs (on-site costs, off-site costs), time costs, socio-economic characteristics of study participants, distance from the place of origin, trip type dummy and awareness dummy were used as explanatory variables. We included time costs based on the individuals' income or wage rate, however most said that they visit their site during their leisure time. We asked the tourists about the expenditure incurred on different activities, which were aggregated to get the on-site and off-site costs. If tourists came in a group and in their personal vehicles, we computed per individual cost based on the mileage of the vehicle, the distance travelled and the fuel consumed. Group costs were a function of group size, number of adults and children and distance travelled. We looked at the average costs and then normalized the figures by distance travelled. Group size was not incorporated as a variable into the econometric model. We did ask the respondents about substitute sites, but some of them did not have any idea about the possible expenditures that could be incurred for the substitute site. Nonetheless, they mentioned that they would visit a similar natural park in another area.

Figure 25: Dandeli-Anshi Landscape after declaration of Tiger Reserve



Source: *DATR (http://dandeli-anshi.blogspot.in/)*

Based on this trip generating function, we obtained a demand curve for the site from which consumer surplus from recreation for the study period has been estimated. In the process of ensuring demand curve, we ensured that there is no loss in statistical integrity. That is, we selected suitable variables for the model using standard procedures of regression and correlation analysis. As we found that the distance travelled and the expenditures are correlated, we used the number of hours spent on site per every kilometer travelled by the tourist as the dependent variable and the expenditure incurred per kilometre of travel as one of the independent variable. In addition, we included distance as one of the explanatory variables.

To be able to transfer the results from the sample to the population we divided the visitors into three categories depending on their average expenditures and then into percentages: percent of visitors from the local areas, percent of visitors staying overnight in the area and percent of visitors staying in different categories of accommodation. We also classified the information based on the length of the stay and size of the group. (For details on methodology refer to Appendix 3.)

3.5.3. Value to the Local Economy

The study involved face-to-face interviews with the locals dependent on tourism. In June 2014 we surveyed taxi drivers, tour operators, homestays, hotels, restaurants, and forest department officials, to understand the impact of tourism on them. The prime purpose of this survey was to understand their income opportunities from tourism, along with their attitude towards tourists, and to gauge their perceptions on environmental damages to the site. The traditional sources of income in Dandeli-Anshi area are agriculture, areca nut and spices. The local people are also hired by the forest department for different forest related activities. Tourism has played an important role in providing additional income sources to the local communities. Running small-scale homestays, naturalists, guides, drivers, hotel workers and cooks are some of the employment options that locals take up. Over the past few years, due to the increased tourist activity, many resorts and homestays have sprung up around the DATR. Several eco-homestays have sprung up under the name "Kali Parisara Pravasam Samasthana" (Kali Eco-tourism Organization).

Based on the survey we found that of all the businesses that flourished in the region, it is mainly the accommodation sector – resorts, hotels, lodges, homestays – which benefitted a lot from tourism. Most of the tourists came in their own/hired vehicles, due to the inaccessibility within the region, so the tour and travel operators, car hire companies and other tourism-based businesses as such are not major beneficiaries. However, the rafting, adventure sports, and safaris are the key revenue contributors in the region. We could not find any evidence of local businesses flourishing in the region directly as the supplies are procured either from the market or directly from farmers and outside the region. Most of the accommodation facilities include food as part of their package costs, so it was difficult to separate out the stay from the food expenses. Anshi region did not have any accommodation facilities except the Anshi Nature Camp, maintained by the forest department.

3.5.4. Total value from Tourism in Dandeli-Anshi Tiger Reserve

The total value from tourism is obtained by adding the consumer surplus and producer surplus (whoever is supplying the services). An important thing is to assemble the information obtained through primary survey and secondary sources of information in a consistent manner so as to obtain the economic value estimates. As mentioned earlier, tourism does have some spill over or multiplier effects in terms of new money flows into the economy. Hence, we separated local residents from non-residents to understand the circulation of money from different regions to the local economy. Based on the surveyed population we extrapolated this for the total visitors visiting the area in a given year.

3.5.4.1. Ecotourism value of Dandeli-Anshi Tiger Reserve

In 2011, about 41,175 tourists visited Dandeli Sanctuary, of which only 65 were international visitors. However, during the period we surveyed we could not find any foreigner, and hence our survey is limited to Indian visitors. Figure 28 shows the region-wise sample of people interviewed in our study. We also asked the respondents about their experience and whether they would like to visit the park again: 91.3% said that they would come back.

There is a mix of participants in the sample. Some are regular visitors, and some are outside the region and visited the area for the first time. The average expenditure on recreation amounted to ₹3,442.15/day/person (US$ 55.11/day/person), from which the average total off-site expenditures amounted to ₹4,200.563 (US$ 67.25) and the average total on-site expenditures amounted to ₹2,4037.5 (US$ 384.82). The average annual income of the respondent group was ₹9,64,586.2 (US$

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Over the past few years, due to increased tourist activity, many resorts and homestays have sprung up around the DATR. Several eco-homestays have sprung up under the name "Kali Parisara Pravasam Samasthana" (Kali Eco-tourism Organization)

15,442.03), ranging from ₹1,44,000 (US$ 2,305.29) to ₹24,00,000 (US$ 38,421.53) per annum across groups. Figure 29 shows the group size of the visitors and Figure 30 shows the income distribution of the surveyed groups and the number of groups belonging to particular income classes. On an average the education level of the respondents was 16 years. Amongst the 58 groups of tourists surveyed at different locations of Dandeli-Anshi Tiger Reserve, about 96.4% of the respondents had an education level of more than 12 years, while 65.51% of them had an education level of more than 15 years. For many of the respondents (68.96%), the trip was their first visit. Around 32.5% of the tourists travelled from less than 100 kms away.

The survey found that the travel costs incurred by individuals were inversely related to park visitation rates, which implies that higher travel costs translate to less frequent visits. In addition to travel cost, household income had a positive impact on recreational demand, and the visitation rate fell as the expenditure per hour spent on site increased, which is as expected. The positive coefficient on the income variable suggests that a higher income translates to a greater preference for natural areas, and thus that nature tourism is a luxury. The opportunity cost of time is positive, showing that high income earners would have a substantial opportunity cost of travel time. In contrast, lower income groups face greater opportunity cost of travel time

The variable values of interest to the econometric recreational demand analysis are presented in Table 29 and Figure 31. Most of the visitors came solely for the purpose of visiting Dandeli-Anshi area. Though the visitors spent some money as entry fees to enjoy wildlife safaris or various activities in the area, they do not necessarily represent the value visitors attach to the recreational services. Where there are no entry fees, this does not suggest a zero value. Hence, it is important to estimate the consumer surplus that the tourist derives from the park from the estimated demand curve (Figure 31). From this, the total surplus that the economy derives per hectare of Dandeli-Anshi Protected Area is around ₹83,337/ha/yr (US$ 1,369/ha/year), based on the estimate that on an average, there are 41,175 visits to the Sanctuary in a year. The surplus to the economy from all visitors visiting the Dandeli and Anshi Protected Area is ₹11,375 million (US$ 187 million) per annum for the year 2014.

3.5.4.2. Value to the Local Economy

With a view to assess the flow of eco-tourism benefits to the local economy, we surveyed the local accommodation

Figure 26: Region wise (percentage) of tourist arrivals at Dandeli-Anshi National Park during survey

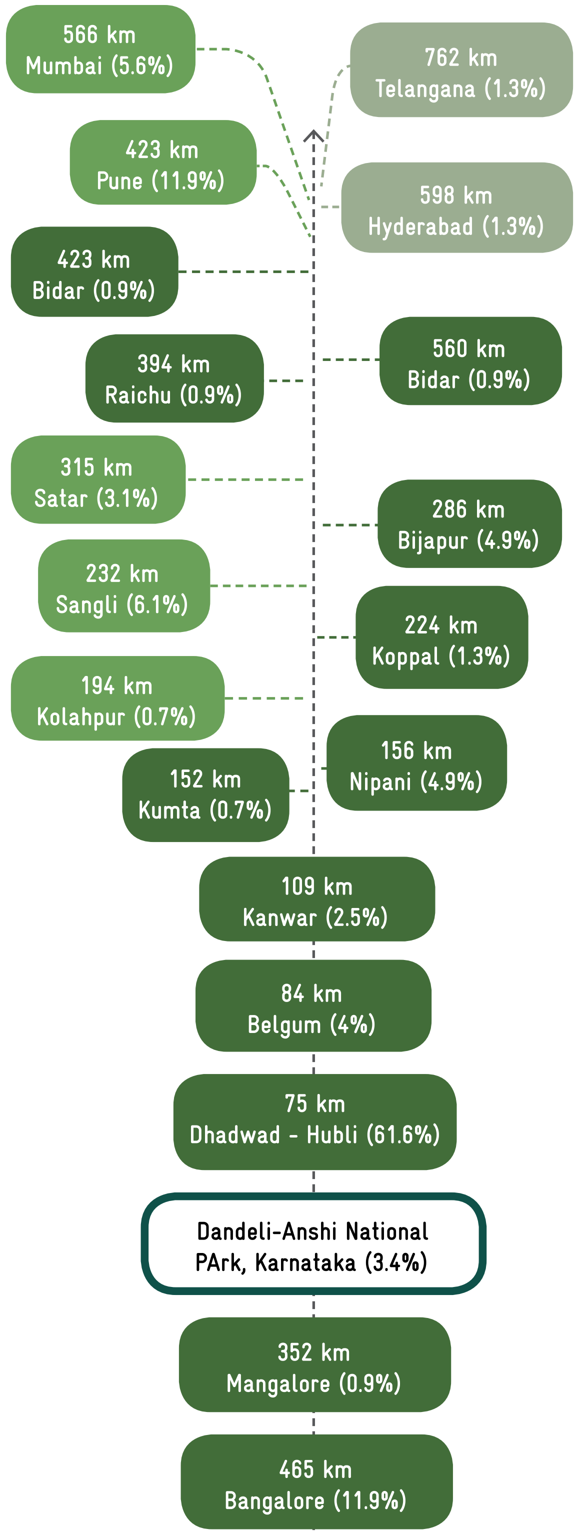


Figure 27: Group size of tourists surveyed

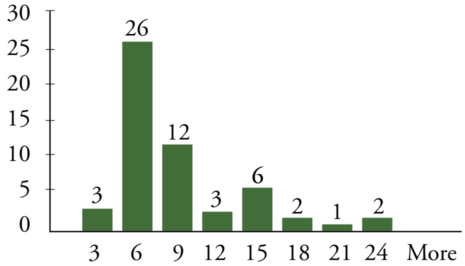
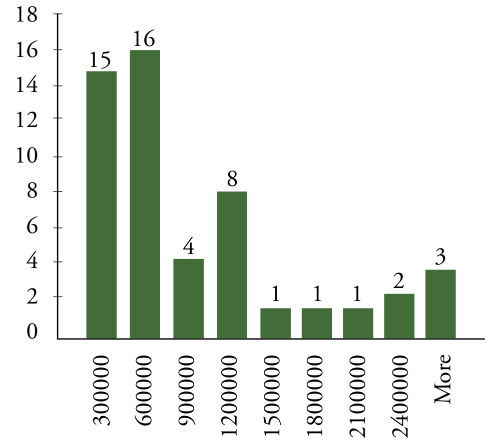


Figure 28: Income distribution of surveyed tourist groups



service providers. Accommodation service providers like resorts and homestays are flourishing rapidly in areas surrounding the DATR, as they are providing nature-based activities like rafting, rapelling, kayaking, etc., as the main source of tourist attraction. Amongst all the existing resorts in the Dandeli area, Kali Adventure Camp, Old Magazine House, and Dandeli-Anshi Nature Camp are managed under the Jungle Lodges and Resorts (JLR) banner and owned by the Karnataka Tourism Department and Karnataka Forest Department. The rest are all private undertakings, and almost all homestays are private undertakings. There are different assessments of the total number of homestays, as none of them are registered and many are illegal. There are no specific guidelines for the homestays and there are lot of discrepancies regarding registration, taxes and tariffs.

Our survey covered 14 resorts and homestays, out of which two are resorts managed by the government, four are privately-managed resorts, and the remaining eight are homestays. The surveyed resorts and homestays vary in scale of operation depending upon the number of rooms and occupancy rates (Table 30).

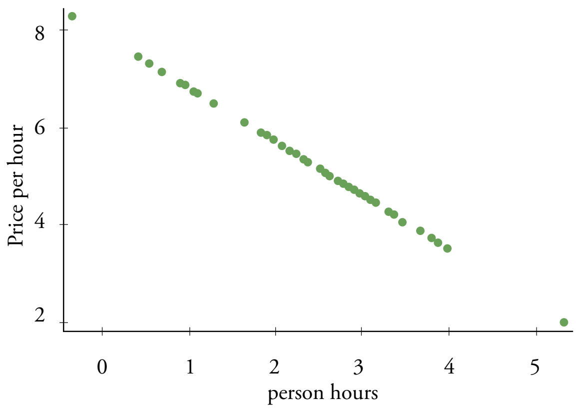
Occupancy rate has been computed based on the specified rate by the respondents. The occupancy rate varies across different resorts and homestays, ranging from 65–100%. These rates are dependent on the size of the business and the location of the resorts and homestays. The occupancy rate in peak and lean season is different. Usually peak season is four months (December, January, March and May) and the rest are lean season. The lean season revenue has been considered to be 10% of the peak season for small operations and 15% for large and medium sized operations. Resorts located on the banks of the Kali river experience high occupancy rates as they provide adventure sports facilities. Homestays located near the Jungle safari point experience 100% occupancy during peak season. The location of homestays is quite dispersed.

3.6. Economic Disincentives for PA conservation

Would protected areas always generate a win-win scenario? Who are the losers and winners when PAs are conserved? Declaring a particular area as Tiger reserve or Sanctuary would pose an economic cost to the local population as they lose access to the park and its resources. The costs that the local communities suffer may be disproportionately larger than the benefits incurred. If the net costs for the local communities are larger, the designation of natural areas as protected areas may meet considerable opposition.

From interactions with villagers in Anshi, we found that the villagers traditionally depend on the land in and around the forest for forest products and animal grazing. After declaring Anshi a Tiger Reserve, several restrictions were imposed on them. The villagers are also persuaded to shift out of the region to some

Figure 29: Demand Curve for visiting Dandeli-Anshi Protected Area



other place, which would entail many displacement costs.

Anshi Gram Panchayat covers 4,945 acres and consists of Anshi, Barpoli, Nigundi and Nujji, of which Anshi is the main village. As per the 2011 Census, 1,982 residents and 488 families reside in Anshi panchayat. There is no electricity supply in the villages and only solar lamps are used at night. Agriculture, mainly for subsistence and rain-fed, is the main source of livelihood. After October, in case of no rain, land dries fast due to percolation, Paddy and Banana are the main crops grown in the region. Around 1,051 acres of land is classified under cultivated land. Most of the families own small or very small land holdings. Vegetables are grown in homes and no fertilizers are used in farming. The agriculture is also not mechanized. Fuelwood collected from forests is the main source of fuel for cooking and heating along with kerosene. The households do not use LPG or biogas. 90% of the population in the area is dependent on forest raw materials. The households collect fuelwood, tendu leaves, twigs, cinnamon, wild pepper, ram patram, honey, etc., mostly in the season after monsoon. Approximately one male member from each household collects honey. In total, around 75% of the households are engaged in honey collection and collect on an average 10-15 kg/household. Households receive approximately 50,000 ₹/yr from selling NTFPs collected from forests. The villagers do not engage in poaching and illegal logging due to strict rules and the vigilance of the forest department.

After announcing Anshi as a tiger reserve, locals were restricted from entering the forests, and as a result the collection and selling of NTFPs has declined. If the local villagers are found collecting NTFP from forests, they are caught by the forest officials and FIRs are filed against them.

Human animal conflicts are quite common in this area. During the time of our survey, it was reported that 2 acres of paddy land was destroyed by two elephants, resulting in the loss of around 40 quintals of paddy. One quintal of paddy usually sells in the market for ₹1,550. But the villagers were paid a compensation of only ₹3,960 per acre. If elephants destroy coconut trees they are granted a compensation of only ₹300-400 per acre, as against the loss of ₹5000 per tree. The villagers cannot protect their agricultural land through fencing as it is not allowed. Only bamboo is permitted to be used, which has to be procured from the forest department by paying a royalty. Prior to declaring Anshi a tiger reserve, the local people were given licensed guns to protect their crop land from animals, but since the declaration of the tiger reserve, only sound can be made to scare the animals.

A few villagers were killed in the recent elephant rampage. The villagers were given a compensation of ₹2 lakhs as against the villagers' ₹5 lakh demand. Compensation given to the affected people is minimal. Compensation paid by the forest officials for killed cattle is approximately ₹3000-3500 per animal. However, one cow costs ₹25,000-30,000. The villagers have also mentioned some rent-seeking behavior by the officials to report a complaint about loss to cattle crops and humans by wildlife. The forest department is seen as not paying adequate attention to the villagers' complaints. The villagers were not informed beforehand that the area was being declared a reserve.

The literacy rate in Anshi reserve is less than

Table 30: Description of independent variables

Explanatory variables	Mean	Std. Dev.
Annual income	964586.2	1684775
Years of education	16.16	2.71
Distance travelled	316.29	210.81
Offsite expenditure	4200.56	3203.79
No. of persons in the trip/group	7.86	4.76
On site expenditure	24037.5	63978.69
Time spent onsite	23.95	23.51
No. of visits to the site	2.53	4.40
Opportunity cost per hour	353.03	618.25
Visitation rate	0.12	0.14

Table 31: Size of surveyed resorts and homestays

Room details	No. of operating units	No. of rooms	No. of beds
Small (≤ 10 rooms)	4	4-5	8-10
Medium (10≤rooms≤20)	3	10-18	20-36
Large (≥ 20 rooms)	6	22-40	42-74

The study suggests that potential recreational benefit can be generated by the protected areas if ecotourism policy clearly details the guidelines to facilitate, regulate and monitor ecotourism in the state

35%, with few employment opportunities, hence the villagers are in a poor position from which to negotiate appropriate compensation. The villages are very far from markets. The local people are not aware of the forest rules and regulations, as there is no flow of information to the villagers. As the government officials posted in the village do not belong to the village, the villagers feel that there is emotional disconnect between the villagers and the officials, who do not understand the ground realities faced by the villagers.

The government has given the villagers the option to relocate to some other place of their choice and has proposed to give ₹10 lakh to each family without any other guaranteed income earning opportunity. Around 40 families have applied and indicated their willingness to relocate from Niggundi village. The relocated people would lose permanent rights to their lands along with the cancellation of their voters' cards and ration cards. The villagers who chose to relocate were of the view that their hardships have increased after declaring Anshi a tiger reserve. Overly strict forest policies are affecting their livelihoods, as they cannot collect forest products to sell. Their land and cattle are under wildlife threat. No arrangement of water supply is made by the forest officials. There is no electricity in the village and forest officials are not at all cooperative. The Panchayat has provided 200 solar lamps to the households (Diya solar lamps, costing ₹4000, with 8 hours battery backup, product cycle 2 years max, however they cannot be charged in rainy season). There is no organization that is fighting for the rights of the villagers.

3.7. Conclusions and Policy Implications

The results of the study suggest that there can be potential recreational benefit that can be generated by the protected areas, which can be tapped into without disturbing the ecology of the area. This would yield high revenues for the Sanctuary and the Park. Right now the region is characterized by low volumes of tourists, but their willingness to pay is quite high, which is why this region can be a very important ecotourism destination. The ecotourism can offer livelihood opportunities without damaging the environment. Instead of making ecotourism a part of tourism strategy, a clear statement on ecotourism should be in place. However, the carrying capacity of the park needs to be calculated and implemented, and permission has to be given only within the carrying capacity of the park and the sanctuary. There has been evidence of considerable destruction of the ecosystem due to resorts in the area. The ecotourism policy should be chalked out, clearly detailing the guidelines to facilitate, regulate and monitor the ecotourism in the state. Our survey indicated that there is no clear policy on sewage, plastic, and the waste generated from tourism. Some areas, like Kali resort, were extremely polluted because of the waste generated from tourists. Though Karnataka has a wildness tourism policy, it is part of the overall tourism policy. Our recommendation is that the ecotourism policy should be separate, and the prime sector generating tourism – in this case the forests – should be given the complete benefit. The forest department should promote ecotourism and the benefits should be shared with the local community. As stated in the wildlife policy, private resorts should not be permitted within the National Park or Sanctuary, or their enclosures. The Karnataka tourism policy vision document envisages expansion of tourism through formation of special tourism areas, development authorities, and through involving private players. Though the policy talks about public-private partnerships, our recommendation is for local public partnerships wherein the local people directly provide services to the tourists. Thus, if developed, it can be a type of Payment-for-Ecosystem-Services scheme, in which the ecosystem services that is traded is scenic beauty, the beneficiaries being the tourists, with services supplied by the forest department through the local communities. The public-private partnership models alienate the local community and their involvement is necessary for sustainable development. This has come up very clearly when we interacted with the locals. The aim should not be to increase the volume of tourists but to tap highly willing environment-conscious tourists, with the forest department as facilitator and regulator.

It is also important to design a compensation mechanism to offset local resource use foregone. In the Dandeli-Anshi region, there are conflicts between local communities and wildlife. Though there is some compensation mechanism, there are several problems with implementation. It is important to estimate the opportunity costs associated with loss of traditional activities in the region through another study of these villagers, which could not be attempted here. Rather than alienating the local community through unrelated tourism, a clear vision on strategies for tourism and conservation methods focused on community participation, with people and ecosystems given central importance, need to be evolved.

3.8. How much is Forest Ecosystem Worth in Uttara Kannada?

Our discussions in the earlier sections showed that there are important trade-offs faced in this region, where 80% of the geographical area is under forests and, more importantly, the ecosystem is the biodiverse Western Ghats. The need to conserve forests in Western Ghats can be easily justified if we value the ecosystem benefits. For this, of course, we require reliable information on the actual conditions of trends and the status of ecosystems and their services, along with the key drivers of change. Ecosystems provide a specific flow of services, and any shift will alter the flow of benefits. Economic valuation provides a useful way to aggregate the impacts across different stakeholders of the society. As clarified by Costanza et al. (2012), by valuation we do not mean privatization, nor commodifying services in markets, but instead intend to explicity show hidden values for better decision-making.

We have discussed the concept of the total economic value of the output, but here we would like to clarify at the outset that we should use these to compare two alternate scenarios. In the present case, the comparison should be between the present scenario of flow of benefits in a tightly regulated regime, vis-à-vis the alternate scenario, in which forest conversion is not regulated and hence the benefits are absent.

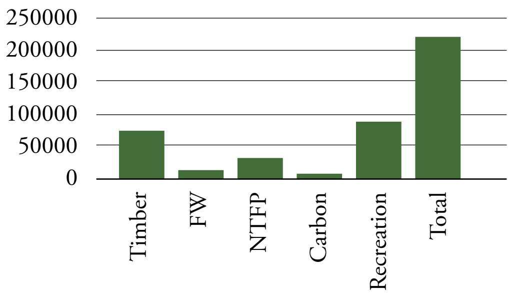
Figure 32 provides the flows from the ecosystem services considered in the study of the extreme conservation regime. The low contribution of the forestry sector should not be viewed as the sector being unproductive, but as the result of the nexus formed by the allocation of forests for logging and other uses versus the conservation of forests for protecting biodiversity and ecosystem services. In Karnataka, as a matter of policy, there is a complete ban on any green felling; only the removal of dead and fallen timber is permitted, though mature green trees are available in some of the forests. Thus, in the Western Ghats, the trade-offs are clearly illustrated. Further, while deriving the estimates, an extremely conservative approach has been used.

As ther is a highly regulated regime where clear felling in prohibited, locals incur some use restrictions on the collection of forest products. We have not considered the biodiversity value and the option value of the forests.

Our results show that the non-timber forest products have a significant value in the business-as-usual scenario. However, in the sustainable scenario, where the forests can be harvested until the point of maximum sustainable yield, timber can be a significant part of the benefit. The growing stock in Uttara Kannada is approximately 64 million cubic meters (estimated based on the growing stock figure in Karnataka across all forest types). This figure can be higher as well, due to the quality of forest in the region. Assuming a rotation age of 50 years for the species, the annual timber available under the sustainable management regime is 1.28 million cubic meters, which gives an annual revenue of ₹1,64,448 per hectare (US$ 2,648.97 per hectare). Similarly, if marketing channels are improved and the NTFPs get efficient prices, the value of NTFPs per hectare would be five times more than what is imputed by the locals. Thus, this result is very comparable to the average returns per hectare of agricultural land in Uttara Kannada, despite the fact that all the ecosystems services are not included. This is in comparison with the next-preferred alternative, i..e areca plantation, which generates returns of around 6–9 lakhs/hectare.

In case of protected areas, the recreational values are quite significant. Further, the carbon sequestration function of forests provides large global benefits. While these give the flow per year, the stock of carbon is pretty high. The flow value is higher than the typical flows from a hectare of agricultural land (approx. 6–9 lakhs per hectare). This is despite the fact that our study did not consider sedimentation, watershed regulation, biodiversity value, soil conservation potential, climate

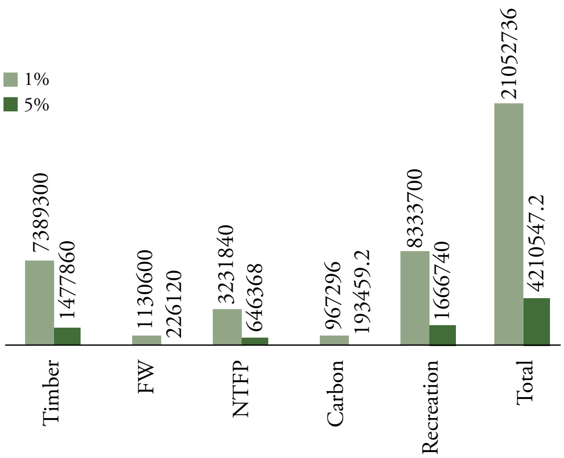
Figure 30: Flow of ecosystem services (highly conservative scenario)



regulation, existence values, etc. As the area is very rich in biodiversity, the international community may place a huge existence value of the ecosystems. There is lot of potential to explore these win-win opportunities to benefit the locals, businesses, global community and the policymakers. Failure to recognize the positive externalities provided by ecosystems would have detrimental environmental and human consequences. Thus, it is important to identify the values to different stakeholders and capture these values accruing to the different stakeholders in the decision-making framework. These values create a strong case for the conservation of the Western Ghats ecosystem.

The net present value of the five ecosystem services in the current high protection regime (discounted at 1% and 5%) is expressed in Figure 33. The net present values show how much the asset would earn during its life span. High discount rate implies that the present is more valuable than the future, and hence would be exploited more, and vice versa, as there are restrictions on the use of forests. These values do not include extraction from non-forest areas. The recreational value is high. There would be trade-offs between recreational values and other provisioning services. The study did not include many of the other services provided by forests,

Figure 31: Net Present Value of ecosystem services



particularly those related to water, due to limitation of time. Table 32 gives a comparison between the values generated in this report and that of the NPV committee set up by the Government of India. The values are not comparable, as NPV values are for Western Ghats as a whole, while the values generated in this report are for Uttara Kannada district alone. The values in this report are based on primary survey and field data, while those of the NPV report were based on secondary sources of information and relied on benefit transfer estimates. For these reasons, the values are not comparable.

Table 32: Comparison with values from earlier studies for the Western Ghats region

Economic values	NPV report (2013) (in ₹/ha/yr) (values for Western Ghats region)	Present study (in ₹/ha/yr) (Values for Uttar Kannada district of Karnataka under Western Ghats)
Timber	7,02,146	73893
Bamboo	6,261	X
Fodder	24,898	X
NTFP	50,586	32319
Fuelwood	30,268	11306
Carbon sequestration	29,801	9673
Bioprospecting	1622144	X
Pollination and seed dispersal	95844	X
Soil conservation	72707	X
Water Recharge	15,703	X
Recreation	X	83337

Despite the high protection costs and the income foregone from moratorium on timber exploitation and other access regulations, the forest ecosystems still provide net benefits to the society. The discussion has focused on aggregate benefits and costs, and conservation seems worthwhile. However, the benefits and costs are unevenly distributed. While the local communities bear the costs of conservation, others benefit from the ecosystems, like the resorts, hoteliers, and downstream water users. There is no payment to the local community for bearing the costs of conservation, which points to the need for appropriate compensation for the local communities. Estimates are on the lower side, but the income forests provide is substantial for the local communities. Further, the sector generates huge value addition in the society and also provides employment to the local community, which is very important given excess labour supply.

The study has considered only a limited set of a whole range of ecosystem services, and thus could be extended. However, the extrapolated values from small case study or sample areas to regional or national scales should be viewed with caution.

4. Key Conclusions and Recommendations

This report is part of TII initiative on forest ecosystems, for which the region of Western Ghats has been observed, as it is the most biodiverse hotspot in India. Despite having the most progressive forest conservation and development legislations, policies, and programs, the forest ecosystems are under severe stress. The reasons for the degradation of valuable ecosystems can be complex and varied, including incomplete information and the non-recognition of values of the Western Ghats ecosystems. Not recognising the policy and institutional triggers of stress can impact human well-being. This clearly justifies the need to recognise, demonstrate, and capture the ecological and economic values, and internalise them in decision-making. A comprehensive evaluation of the ecosystem services enables clear visualisation of the trade-offs that different groups of people face. Such an evaluation would also aid in guiding efficient resource allocations, foreseeing uncertainties in resource availability, designing biodiversity conservation programs, and disclosing distortions from non-recognition of values of ecosystem services.

The objective of this report is to assess the ecological and economic values provided by the ecosystem services in Western Ghats for the study region of Uttara Kannada district of Karnataka. Uttara Kannada district is selected as it is representative of the diversity of the Western Ghats. To illustrate values, the report considers three types of ecosystem services: provisioning services (food, fuel, raw materials, manure, medicine and other non-timber forest products), regulating services (reflecting the ecosystem's ecological processes, such as carbon sequestration), and cultural services (e.g. recreation). The rest of the services could not be considered, due to lack of complete information. The need to conserve forests in Western Ghats can be easily justified if we value the benefits provided by these ecosystems, as long as the information is available.

A key contribution of this report is the biophysical quantification of biodiversity and some of the key ecosystems services. Data was generated using standard field ecological methods during 2014, based on the permanent plots established in the region, and the monetization of values based on primary survey of various stakeholders in the region. The study was conducted in 9 villages covering three forest types: namely, evergreen, moist deciduous, and dry deciduous forests. In addition, the study undertook a detailed case study of Garcinia and Honey.

The study indicated that forest ecosystems underpin the well-being of populations directly and indirectly dependent on them. The study also revealed important synergies and trade-offs faced in the selected study area of Western Ghats. Table 33 lists the main synergies and trade-offs found in the Western Ghats.

To be able to quantify the synergies and trade-offs better, we require reliable information and actual conditions of the trends and statuses of ecosystems and their services, along with the key drivers of change. The study also highlights the need to strengthen the existing data on statuses, trends, and the benefits that people derive from ecosystems. As already highlighted by two high-level working groups on Western Ghats, it is important to consider the damage that the developmental projects cause on eco-sensitive areas in Western Ghats. The impacts need to be mainstreamed into key sectoral policies. Appropriate action is required at different levels of governance.

India has initiated several policies for the Western Ghats region and two high-level committees were set up to monitor issues of conservation of valuable landscapes. Calculating from an ecosystem services perspective is still an emerging concept; no official framework has yet been developed for ecosystem service

Table 33: Synergies and trade-offs in Western Ghats region

Action	Synergy	Trade-off
Ban on green felling	More supporting services, regulatory services and cultural services	Slower net primary productivity as the climax is reached faster, lesser revenues from timber and fuelwood
Protected areas	More supporting, regulatory and cultural services	Lower provisional services, loss of livelihoods and relocation of the population
Sustainable forest management for timber	Recreation, provisioning services	Lower biodiversity and ecological services
NTFP management	Biodiversity, recreation, ecological values	Lower values of timber and fuelwood

Strenghten the information base through regular assessment of the resources of the Western Ghats, systematic measurement of benefits and costs of ecosystems, identification of values to stakeholders, and estimatation of sustainable extraction forest products

indicators. However, India has developed a framework for Green National Accounting and is currently looking at the feasibility of its implementation. India does have National Biodiversity Strategies and Action Plans as a signatory to the Aichi Protocol.

Our key recommendations are categorized as follows: strengthening the information and knowledge base, policies, incentives, and capacity building.

Strengthening of the Information Base

- **Biophysical assessment of resources needs to be undertaken at regular periodic intervals**

There is ambiguity on the area under Western Ghats – as highlighted by the two high-level working groups set up by the Government of India – pointing to the need for defining and delineating the boundaries of the Western Ghats. The definition and the area need to be clarified so that the status and trends of the forest ecosystem of the Western Ghats can be monitored accurately. Forests in the Western Ghats are subjected to conversion, degradation, and over-exploitation in many locations. In addition to boundaries, a more accurate assessment of biophysical statuses and trends, species richness, abundance, vulnerability, species carrying capacity, and sustainable yields, needs to be assessed and should be prioritized.

There is an opportunity to involve locals in inventorying the information, similar to the People's Biodiversity Registers. Currently, only FSI is monitoring the area under forests and the crown cover at a district level. There is no monitoring of the status of the forests at the village level, especially in locations subjected to extraction of fuelwood and commercial NTFPs. The case studies of NTFPs such as Garcinia and cinnamon have indicated degradation and loss of tree species, due to over-exploitation.

Ideally, BMCs and JFMCs should monitor the status of forest and biodiversity of forests in and around the villages, especially the commercially valuable tree species. Participatory monitoring techniques and methods are available and have been tested in many regions. Participatory monitoring arrangements should be institutionalized at least in JFMCs and BMCs, where commercial extraction of NTFPs, bamboo, and fuelwood is occurring. This monitoring could be a part of the Peoples Biodiversity Registers, to be prepared and maintained by the BMCs. Future research needs to focus more closely on measuring the monetary value of the benefits and costs associated with protection.

- **Focus on systematic and standardized measurement of the value of the full range of benefits and costs provided by ecosystems**

Due to the complexity in non-market valuation of ecosystem goods and services, there are varying approaches to valuation. As a result, the values are not comparable across locations or studies. This poses a challenge in making scientific studies useful for policy. Standardized guidelines and techniques need to be developed and capacity developed across various stakeholders and local communities. Estimation of economic values based on standardized methods and location-specific field studies is crucial for critical forest ecosystems such as the Western Ghats.

- **Estimate the sustainable extraction rates of timber, fuelwood and NTFPs**

There is limited information and knowledge on the sustainable rates or modes of extraction of different forest products, such as timber, fuelwood, grass, and other non-timber forest products. As a result, local communities and commercial contractors may be over-harvesting many forest products, or even over-grazing in the forests, leading to degradation and loss of the services. This was observed in the cases of Garcinia and cinnamon species and honey collection in the Western Ghats. Hence, research has to be done on sustainable methods of extraction of forest products to determine sustainable rates of harvest. These rates may vary from location to location, thus a potential range of rates of extraction may have to be developed for the Western Ghats region.

The traditional knowledge of local communities could also be utilized in determining sustainable rates of extraction. The ranges of sustainable rates of extraction should be communicated to the BMCs and JFMCs.

- **Identify the values to different stakeholder and capture these values accruing to the different stakeholders in the decision-making framework**

Currently there is lack of information and data on the value of forest biodiversity and ecosystem services. The value of forest ecosystems is not recognized in the decision-making framework. Even where values exist, there is severe undervaluation. Failure to recognize the positive externalities provided by ecosystems leads to distorted policies, with detrimental environmental and human consequences.

Implications of distorted policy making can be:

- Conversion of forests to low-return non-forestry activities, where the economic returns could be lower than the opportunity cost of retaining the forest ecosystems;
- Lower compensation paid for forest land conversion due to undervaluation;
- Enhanced forest conversion and irreversible loss of forest biodiversity and ecosystem services in the Western Ghats due to undervaluation; and
- Undervaluation leads to the belief that forest conservation is a low-return non-profitable option.

Identifying the ecological and economic values makes a strong case for the conservation, maintenance, restoration, and sustainable management, of the Western Ghats ecosystem.

Policy Recommendation Aimed at Individual Ecosystem Services:

- **Target sustainable timber management**

In Western Ghats, due to the diversity in species, policies should be in place for a very strict conservation regime. Sustainable management of timber should be strictly observed. Here is a list of suggested implementations:

- Curb illegal activities through appropriate monitoring and effective enforcement
- Efficiently price timber so as to ensure profitable returns to traders, taking into account all externalities
- Encourage farm forestry and allow individual farmers to grow commercial species of high value
- Prioritize replanting the species in natural forests
- Plant multi-diverse species instead of mono-culture species.
- Meet conservation targets through close substitutes like aluminium and cement.
- Special impetus should be given to forest industries to make the sector more competitive.

The village forest committees can provide good alternatives in this respect but better incentives need to be in place to grow and save forests.

- **Target reduction of fuel dependence and provide sustainable alternate fuel**
  - Provide alternate fuels like biogas to reduce the fuel dependence.
  - Manage the forest sustainably, taking into account the fuel requirements of the local communities.
  - Fast growing species to specially meet the fuel needs of the communities can be planted.

- **Recognize, demonstrate and capture the value of NTFPs**

The study has shown that in the Western Ghats region a large number of NTFPs are extracted and used locally. In addition, many NTFPs are in commercial demand. Extraction of some of the NTFPs is regulated by the forest department, leading to over-exploitation by the contractors.

- Recognize the contribution of NTFPs to local livelihoods and explore the market potential of the NTFPS, as it is not fully understood. The overnment should play an active role in tapping the untapped potential of the NTFPs in Western Ghats
- Prioritize the development of organized markets for all NTFPs so that local communities get better prices for forest products. The short shelf-life of many of these products leads to distress selling at very low prices. Better storage facilities or immediate processing is required to avoid distress sales at low prices
- Develop efficient prices for NTFPs, as there is no information on the demand and supply of these products. There is an opportunity to involve locals in inventorying the information, similar to the People's Biodiversity Registers
- Prioritize conservation and regeneration of NTFP species and ensure that NTFP yielding species are sustained.
- Generate employment through agencies involved in NTFP procurement, processing and sale of NTFPs, or encourage locals to take up the job of being primary collectors of NTFPs as well as leaders in conservation. This makes the sector lucrative, profitable, and sustainable.
- Give full access to NTFPs for local communities or institutions, such as BMCs and JFMCs. The policy of auctioning and the involvement of contractors should be avoided. The state forest departments could charge a fee for the NTFPs gathered.
- Link NTFP management to NREGA scheme
- Demonstrate the potential value of NTFPs in poverty alleviation, creation of employment, foods security,

The district of Kodagu in Karnataka, also known as Coorg, lies in the Western Ghats range, and is one of the largest coffee growing regions of India. The district contributes about 53% of coffee production in Karnataka and about 35% of India's total production. Coffee is mainly raised as a plantation crop, with Arabica and Robusta being the main varieties. About 2,54,628 persons were employed in coffee plantations as of 2009-10 (Coffee Board of India, 2012). These coffee plantations cover about 30% of the landscape in the region and provide essential ecosystem services to the community, apart from economic returns. However, despite such high importance of coffee plantations, eco-labeling of coffee was absent until 2008. In 2009, under the EU-funded Coffee Agroforestry Network (CAFNET) project, group certification was initiated to ensure better prices to farmers. Eight farmer groups and 89 farmers have been certified under the project. However, many small and medium farmers are not satisfied with the process; according to them, the majority of the profits goes into the hands of certification agencies, importers, exporters, distributors, and agencies. For this reason, landscape labeling is being promoted in the district. Landscape labeling is an idea of next-generation Payment of Ecosystem Services (PES), which also includes the idea of product certification. The Kodagu landscape provides a bundle of ecosystem services: firewood, Coorg Honey, Coorg Orange, Coorg Cardamom, water, carbon, pollination, soil enrichment, air and water quality, and tourism, to list a few. Therefore, valuation of the ecosystem services provided by the Kodagu landscape would ensure payments to such services and also assure that the benefits from the payments are realized at the community level. Since landscape labeling is applicable at landscape level the recognition of landscape labeling is not product specific and will be applicable to any commodity produced by the farmers within the landscape. Services like eco-tourism can also benefit from the increased recognition.

Landscape labeling in Kodagu is being implemented under the Kodagu Model Forest Trust (KMFT) which is a partnership of diverse organizations interested in environmental management of the landscape. The members of the trust represent landholders, NGOs, the Karnataka Forest Department, community groups and research institutions.

Another effort in this term is being considered in the Nilgiri Biosphere Reserve of the Western Ghats, where the Keystone Foundation is developing a framework for PES mechanisms for three services –hydrological regulation, pollination and NTFP provision. Successful development and identification of key stake holders can enable formulation of wider policy on PES in the Western Ghats (ATREE, 2013).

and income-generating opportunities, through more coordinated efforts

- Exclusive policies on NTFPs should be in place, recognizing their importance to local livelihoods

Incentives for ecosystem management and conservation

- **Make conservation attractive through ecotourism by providing financial Incentives**

The protected areas offer a large potential for ecotourism and generate economic benefits to the local communities. At the moment, the potential is unutilized and local communities benefit very little. No clear guidelines exist on involving local communities or for sharing benefits from eco-tourism. The local communities are unaware of the existing ecotourism guidelines.

- Give the primary sector generating tourism the complete benefit through separate ecotourism policy, emphasizing minimal impact of tourism on the ecology; this should not be part of the department of tourism policy
- Have in place a mechanism to share the revenues from tourism with the local communities through involving local communities in providing direct services to the tourists. Community participation is essential.
- Develop a scheme for payment-for-ecosystem-services, wherein the ecosystem service that is traded is scenic beauty, the beneficiaries are tourists, and the supplier of services is the forest department through the local communities.
- Design a compensation mechanism to offset local resource use foregone and make suitable provisions to ensure that the local communities are adequately compensated for any loss of access to goods and services from the PAs. Conflicts between local humans and the wildlife need to also be avoided.

- **Provide incentives for industries and corporations for the conservation of biodiversity and ecosystem services**

In the Western Ghats region, many industries depend on the forest for raw materials, such as pickle manufacturing units, Garcinia processing units, and pharmaceutical units. These industries rely on species such as *Terminalia chebula, Terminalia bellerica* and *Emblica officinalis.* There are no clear guidelines enforcing sustainable harvest practices or ensuring that benefits are shared with local communities. This is not in the interest of either the industry or forest biodiversity in the long-term.

- **Develop mechanisms to ensure payments to ecosystem services, such as the Payments-for-Ecosystem-Services (PES) schemes**

Payment-for-Ecosystem-Services has received lot of attention. PES is a voluntary transaction with well-defined, secured provision of ecosystem services bought by at least one ecosystem buyer from at least one provider (Wunder, 2005). In the real world, different kinds of PES-like approaches exist, and they are not necessarily voluntary. The basic advantage of PES is that it incentivizes provision of ecosystem services, thereby leading to ecosystem conservation. Great potential exists in the western ghats region to tap PES-like schemes, where the ecosystem provided is scenic beauty. Especially in the Dandeli-Anshi area, PES schemes are strongly encouraged, and further research is required to design the mechanism to ensure a win-win scenario for the environment and the locals. Some examples of PES-like schemes exist in the region.

Capacity Building:

There is a need for capacity building in forest departments, State Biodiversity Authorities, BMCs, and JFMCs, to adopt and internalize the values of forest ecosystem services in decision-making

State forest departments, SBAs, BMCs, and JFMCs, are not aware of the many values that the forest ecosystem provides, and hence do not internalize them in decision-making. Policymakers should be made aware of the provisions under NBA on valuing ecosystems, sustainable rates of extraction, approaches and methods for valuation of forest biodiversity and ecosystem services, and the need for enforcing these provisions.

Simple guidelines and tools need to be developed and disseminated, along with periodic training programmes. The BMCs and JFMCs may also have to be trained to adopt the values of ecosystem services estimated for the Western Ghats region when charging royalty or user fees.

ANNEX 1

Species wise variation in prices (₹ per m^3) depending on classification

Teak (Tectona Grandis)									
	B	C				D			
	b	A	B	c	d	a	b	c	d
I	150862.1		139266.6	120622.1	87444.93	116225.9	96210.35	68446.62	72683.32
II	-	331632.7	148879.6	112338	517781.5	100138.4	111818.6	78591.48	58331.65
III	-	134511.6	113245.4	85730.96	-	121848.7	101351.4	438039.4	53068.74
IV	-	-	-	123838.8	-	75278.19	72104.4	70851.7	78846.15
V	-	-	-	-	-	68068.36	76087.75	49483.2	57506.04

Rosewood (Sissum) Dalbergia latifolia									
	B	C				D			
	b	a	B	c	d	a	b	c	d
I	-	-	183131.4	106624	61278.42	111111.1	103115.4	53126.46	52548.44
II	-	241935.5	155841.5	114254.4	61613.69	79781.11	165479.1	84049.31	46706.97
III	173992.7	-	114936.1	90384.64	66050.92	-	113648.6	60259.83	43032.38
IV	-	177133.7	139922.5	87993.42	52654.57	-	86632.51	48461	66536.55
V	-	-	-	102739.7	-	70769.23	-	62500	39373.93

Kindal (Terminalia paniculata)									
	B	C				D			
	b	a	b	c	d	a	b	c	d
I	-	-	28497.41	-	-	-	85621.12	13116.89	12165.24
II	-	-	-	21774.63	-	18257.06	16730.8	15049.16	13541.59
III	-	-	-	-	-	19615.1	14015.53	14475.49	11649.45
IV	-	-	-	17676.77	-	-	-	-	9132.995
V	-	-	-	-	-	-	-	-	6666.667

Matti (Terminalia tomentosa)									
	B	C				D			
	b	a	b	c	d	a	b	c	d
I	-	-	43898.16	29799.91	-	19707.92	24028.56	18245.47	16083.92
II	-	-	29508.2	25897.79	-	-	22803.01	24090.6	14429.95
III						30614.96		17152.18	12815.82
IV						10483.4	14056.22	16698.85	17183.95
V							13392.86		18518.52

Honni (Pterocarpus marsupium)									
	B	C				D			
	a	a	b	c	d	a	b	c	d
I	74312.46	53785.93	50408.95	37429.36	-	35421.06	31645.57	33523.29	34000
II	-	61085.97	58652.45	-	-	-	31770.87	31228.27	283857.7
III	-	-	69230.77	-	-	35433.07	30836.09	26969	20044.12
IV	-	-	34807.15	43252.6	-	23266.64	21099.35	27994.61	13483.15
V	-	-	-	-	-	-	-	-	18181.82

Quality Class: *(based on outturn) less than 25% – reject, 25% outturn – D quality, 35-50% outturn – C quality, 51-80% outturn – B quality, 81% and above – A quality; Length class: I – 5.05 m to 6m, II – 4.05m to 5m, III – 3.05m to 4m, IV – 2.05m to 3m, V – 60 cm to 2m; Girth class: 60-100 cm – 'D' girth, 101-150 cm – 'C' girth, 151-200 cm – 'B' girth, 201 cm and above – 'A' girth.*

ANNEX 2

Methodology for Valuing the Contribution of NTFPs and Fuelwood to the Households

The study has employed the household production model to assess the value of fuelwood, fodder and NTFP for the forest dependent population in the Western Ghats region. The household production function approach renders an understanding of household behavior and the allocation of time to different activities. The objective of the study is to determine the demand curve of fuelwood for the households based on individual household behavior. The approach combines marketed goods and non-marketed goods to produce goods and services that accrue direct benefit to the household, and also entails an understanding of household time allocation. The household production function is based on the theory that an individual household tries to produce utility maximizing bundles of goods through combining the time endowments of its members with other variable and fixed inputs, including available forest resources (Sill et al., 2003).

The model is found applicable to Uttara Kannada, as the majority of the rural population of the district dwells in the forest fringes and is dependent on fuelwood for their energy requirements. Residents collect NTFP mostly to fulfill their subsistence. The household production function of the region is found to be sensitive to various factors, like socio-demographic factors (household size; income and expenditure levels of household; education level of the household head; ownership of land and livestock; and occupational arrangements), resource availability and accessibility, time allocated in collection, and frequency of collecting forest produce. The decision is driven by the amount of endowments that they have, like land, access to forests, income opportunities and household size. The household production function approach uses data on the actual behavior of households collected through well-designed surveys. Household time allocation decisions are typically based on household preferences, the technology they use to produce both marketed and non-marketed goods, and the price of marketed goods. The allocation of time has played a central role in most applications of the household production function model (Pollak and Wachter, 1975).

Based literature reviews, our study has identified two important studies, i.e. Schaafsma et al. (2012) and Sills et al. (2003), which explain the fuelwood and NTFP collection and utilization behavior of households in Uttara Kannada district. Time allocation behavior usually suggests that households try to maximize their utility, by allocating their time to different utility-generating activities, such as agriculture, collecting forest products, and wage earning activities. These combined with other inputs produce commodities and leisure, from which households derive the highest utility, conditioned on household characteristics (Schaafsma et al., 2012, Sills et al., 2003). According to Sills et al. (2003), households are engaged in fuelwood and NTFP collection until the time their marginal benefits equal the marginal costs. Costs can be in form of opportunity costs.

Our study has tried to evaluate the value of fuelwood and other NTFPs separately. The study has used the Schaafsma et al. (2012) household production function given by equation (1)

$$Qjimt = f(h_{imt,}\ F_{jmt,}\ R_{jmt}) \text{-----} \ (1)$$

The function is a reduced form of the household production function, where the quantity of NTFP j extracted by household i living at location m in period t (Qjimt) is considered as the dependent variable. Sills et al. (2003) argue that if multiple markets are incomplete, as is the case with the study area, it is important to obtain reduced form models, wherein household behavior is modeled as a function of socioeconomic and environmental characteristics reflecting preferences, technology, and input endowments, rather than prices. In the reduced form equation, h is the set of socio-demographic characteristics (such as household size; education level; wealth, like land possession; annual income and expenditure; labor; time inputs; frequency of collection, etc.) of household i at location m. The term F is the physical availability of NTFP j to households at location m (in this case the nine villages considered for this study), and R indicates the resource accessibility conditions faced by households at location *m* (also determined by forest management practices).

Schaafsma et al. (2012) considers distance to forests as the opportunity cost of travel time to harvesting location, and constructs a variable reflecting the availability of a resource weighted by the distance from each of the resource patches to the household (Equation 2). More weight is given to households living farther from forest fringes.

$$DF_i = \sum_{k=1}^{k} \exp\left(-(d_{i,k} / \sigma)^2 \right) \text{ ----- } (2)$$

Here, DF reflects the total resource availability inversely weighted by distance d from each resource cell *k* (forest fringes surrounding a particular village) in the vicinity of the location *m* of household *i*. Distance d is divided by a sigma value ∑, which sets the shape of the distance decay function. Forest patches at longer distances *d* are assumed to contribute less to the total DF variable, reflecting higher costs for locations farther away. The smaller the sigma, the higher is the distance-decay effect (the steeper the curve). After taking the exponential, all weighted resource values are summed per household over all *k* cells around household location *m* where the range was based on survey information of distance to harvest location. The resulting DF variable is included in the household production function.

However, since households in the Uttara Kannada district primarily collect fuelwood and NTFP for meeting their livelihood requirements and are not engaged in any type of selling activities (except for Uppage, mushroom, jackfruit and bamboo shoot), distance from home to forest fringe is an important factor. Moreover, our study selected the villages within a particular distance, ranging from 1-5 km. Therefore, the opportunity costs of collecting forest produce in our study might appropriately relate to a given household's engagement in other occupations, such as agricultural activities or casual labour. The household allocates the time for NTFP and fuelwood collection up to the point at which the marginal costs equal the marginal benefits from collecting the forest products. In fuelwood or NTFP markets, either the labor or the product market is considered to be incomplete (Sills et al., 2003), and therefore the shadow value of time spent collecting forest products can be regarded as the marginal product of labor in fuelwood collection. The shadow wage can be estimated as the value of the marginal product of labour (Kohlin and Parks, 2001), whereas when the labor market is incomplete the shadow price of fuelwood can be estimated as the value of the time required to collect a unit of fuelwood. Our study, like Schaafsma et al. (2012), considered the quantity of fuelwood collected rather than the total value of NTFP extracted, as prices of non-marketed NTFPS are often unknown, and households choose from a set of NTFPs available based on their requirements and preferences. Moreover, the households in Uttara Kannada district are mainly involved in seasonal collection of NTFPs; majorly before the onset of monsoons. Households stock up the collected fuelwood and other NTFPs for consumption throughout year. In order to capture the behavioral responses of the households in time allocation, our questionnaire-based survey conducted as a part of our study queried households on frequency of fuelwood and NTFP collection per month, time required per trip, and number of months for collection. Based on the details provided by the households, total time for fuelwood and NTFP collection was computed. In order to convert the NTFP quantities into economic value, our survey asked the households to impute value on fuelwood and NTFP.

Sill et al. (2003) proposes the use of linear or log-linear functional forms to analyze the determinants of NTFP collection and consumption. Our study used the log-linear form to estimate the demand curve of fuelwood, considering log of quantity of fuelwood collected and log of price of fuelwood (opportunity cost of time) as the two variables (refer to Figure 16 in the main text). From the demand analysis, the shadow price of fuelwood was computed as the mean value of quantity of firewood collected, the mean hours spent collecting the firewood, multiplied by the marginal product of labour. The values obtained for the surveyed region were then scaled for the entire Uttara Kannada district, based on population statistics and forest cover of the district (values are clearly indicated in the main text). However, since the households are not engaged in any type of trading of collected fuelwood, the values totally represent the consumptive stock value under the business-as-usual scenario. Using the estimates of sustainable fuelwood extraction (from the ecological part of the study) the sustainable flow of fuelwood was computed.

For assessing the factors determining the collection of NTFPs apart from fuelwood, a Tobit analysis was carried out. Unlike Tejaswi (2008) and Quang et al. (2006), our model considers quantity of NTFP collected as the dependent variable in the Tobit model, since households generally collect NTFPs for consumptive purposes (refer table 5 in the main text). Results of the Tobit analysis are mentioned in Table 6 (for detail on model refer to Tejaswi; 2008 and Quang et al.; 2006).

ANNEX 3

Travel Cost Method (TCM)

Travel cost method was formulated by Hotelling in 1946, with the purpose of finding way to make economic valuations of benefits from national parks (Bulow and Lundgren, 2007). Travel cost method (TCM) is a technique for the non-market valuation of environmental goods that possess characteristics of public good. TCM is a revealed preference method, which infers an individual's expenditure on travel as the value of the public good. Basically, TCM is an extension of household production function and uses cost of travelling to a non-priced recreation site in order to infer recreation benefits provided by the site (Khan, 2009). TCM is a survey technique where a questionnaire is often prepared and administered to a sample of visitors at a non-priced site in order to ascertain: their place of residence; necessary demographic and attitudinal information; frequency of visits to the site under consideration and other sites; and trip information, such as purposefulness, length, associated costs, etc. (Das, 2013). The survey also queries visitors on the costs incurred in reaching the site. It is usually assumed that higher costs mean lower visitation rates, ceteris paribus; thus generating a negatively sloped demand curve.

The TCM evaluates the recreational use value for a specific recreation site by relating demand for that site (measured as site visits) to its price (measured as the costs of a visit). A simple TCM model can be defined by a 'trip-generation function' (tgf) such as;

$$V = f(C,X)$$

where, V = visits to a site
C = visit costs
X = other socioeconomic variables which significantly explain V.

The trip generating function can be used differently depending upon on what factors and what method is used (Bulow and Lundgren, 2007). Usually two approaches are used in TCM, i.e. Individual Travel Cost Method (ITCM) and Zonal Travel Cost Method (ZTCM). The Individual Travel Cost Method (ITCM) considers the dependent variable as the number of site visits made by each visitor over a specific period; say one year. On the other hand, the Zonal Travel Cost Method (ZTCM), segregates the entire area from which visitors originate into a set of visitor zones and then defines the dependent variable as the visitor rate (i.e., the number of visits made from a particular zone in a period divided by the population of that zone).

For our analysis we have used the Individual Travel Cost Model (ITCM), which accounts for estimating individual recreation demand functions, based on Das (2013). Our study tried to observe the visitation rates of individuals who make trips to the Dandeli-Anshi Tiger Reserve (DATR) as a function of the travel cost. The value of a recreation site to an individual is the area under each demand curve summed over all individuals. This model requires that there is a variation in the number of trips individuals make to the recreational site, in order to estimate the demand function.

We can specify the individual travel cost model as:

$$V_{ij} = f(C_{ij}, OC_{ij}, D_{ij}, E_{ij}, T_{ij}, Y_i, N_i, O_i, M_{ij})$$

where, V_{ij} = number of visits made per year by individual *i* to site *j*

C_{ij} = onsite expenditure of individual *i*

OC_{ij} = offsite expenditure of individual *i*

D_{ij} = distance travelled by individual *i* to site *j*

E_{ij} = years of education of individual *i*

T_{ij} = individual i's time spent on site *j*

Y_i = annual income of individual i's household

Ni = no. of persons in group

Oi = opportunity cost per hour of individual *i*

M_{ij} = number of visits made by individual *i* to site *j*

The demand curve for the site is illustrated in Figure 31. Integrating under this curve gives us our ITCM estimate of consumer surplus per individual. Consumer surplus for the site is then obtained by multiplying the individual consumer surplus with the number of individuals visiting the site annually.

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India a biodiversity hotspot

India is one of the megadiverse countries in the world. It faces unique circumstances as well as challenges in the conservation of its rich biological heritage. With only 2.4% of the world's geographical area, her 1.2 billion people coexist with over 47,000 species of plants and 91,000 species of animals. Several among them are the keystone and charismatic species. In addition, the country supports up to one-sixth of the world's livestock population. The rapid growth of her vibrant economy, as well as conserving natural capital, are both essential to maintaining ecosystem services that support human well-being and prosperity.

To demonstrate her empathy, love and reverence for all forms of life, India has set aside 4.89% of the geographical space as Protected Areas Network. India believes in "वसुधैव कुटुम्बकम" i.e. "the world is one family".

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Ministry of Environment, Forest and Climate Change, Government of India
Indira Paryavaran Bhawan, Jor Bagh Road
New Delhi 110003 India
www.envfor.nic.in

Indo-German Biodiversity Programme
GIZ India
A-2/18, Safdarjung Enclave
New Delhi 110029 India
www.indo-germanbiodiversity.com