Chapter 3. Losing the benefits of forests to degradation? A case study from Tehri Garhwal, Uttarakhand

3.1 Introduction

Forest degradation is widespread in India with severe consequences for millions of forest-dependent communities. Vegetal degradation has been pegged as the second leading cause of land degradation in India accounting for 8.91% of the total geographical area (TGA) in 2011-13 according to one source (SAC, 2016) or as much as 10.4 % of the TGA if open forests and scrub forests are considered (FSI, 2015, see Chapter 4, Volume I of this report). Forest loss and degradation deprive people of innumerable goods and services such as hydrological services, carbon sequestration and storage, pollination services for agriculture, recreation and tourism values or basic provisioning services. Consequently, their degradation places a huge burden on the exchequer although failure to capture their full market value, underestimates this loss. In the country study, we estimate that forest degradation accounts for 55% of the total costs of land degradation in India amounting to Rs 1441 billion to 1758.6 billion or 1.41% of the GDP and 8.81 % of the gross value added from forestry and agriculture.[1] Here we attempt to determine the value of forests in the Dhanulti and Devalsari area of Tehri Garhwal, Uttarakahand to local communities and to tourists and what their degradation implies in terms of lost revenues from recreation or foregone provisioning services from fuelwood, fodder and Non-Timber Forest Products (NTFPs). In addition, using a mix of primary and secondary data and remote sensing assessments, we determine the costs of forest degradation in Dhanulti and Devalsari from 2001-2015 and project this further to 2030. We then determine the costs of reclaiming these forests in 2030.

Uttarakhand is a treasure trove of forest wealth and biodiversity, apart from a rich heritage of cultural diversity, traditions and community management practices that are closely linked to the State's considerable forest reserves. These forests provide important provisioning services like firewood, fodder, timber, medicinal plants and other non-timber forest products (NTFPs). But the forest ecosystems of Uttarakhand also provide several intangible services which help to sustain life including several regulating services like climate moderation, hydrological regulation, seed dispersal, and pollination, supporting services such as nutrient cycling as well as cultural, recreational and aesthetic services (LEAD India, 2007). Consequently, a large proportion of the population of the state relies on forests and biodiversity, either directly for subsistence or livelihood needs or indirectly through various industries including tourism.

Forests account for 46.73% of the state's geographical area (FSI, 2015). Although, forest cover had stabilized from 2001 to 2013, the latest figures indicate a dip in forest cover by 268 km^2 (FSI 2015) (Fig.3.1). Forest degradation also continues to be a problem for the State given the enormous dependence on the forests for fuelwood, fodder and other NTFPs. This is evident from the decrease in dense forests in 10 districts, i.e. almost 77% of the districts. Moreover, the overall decrease in dense forests for the State is a matter of concern (Figure 3.2).

[1] At 2014/ 2015 prices. See Chapter 4 in Volume I where the costs have been estimated.

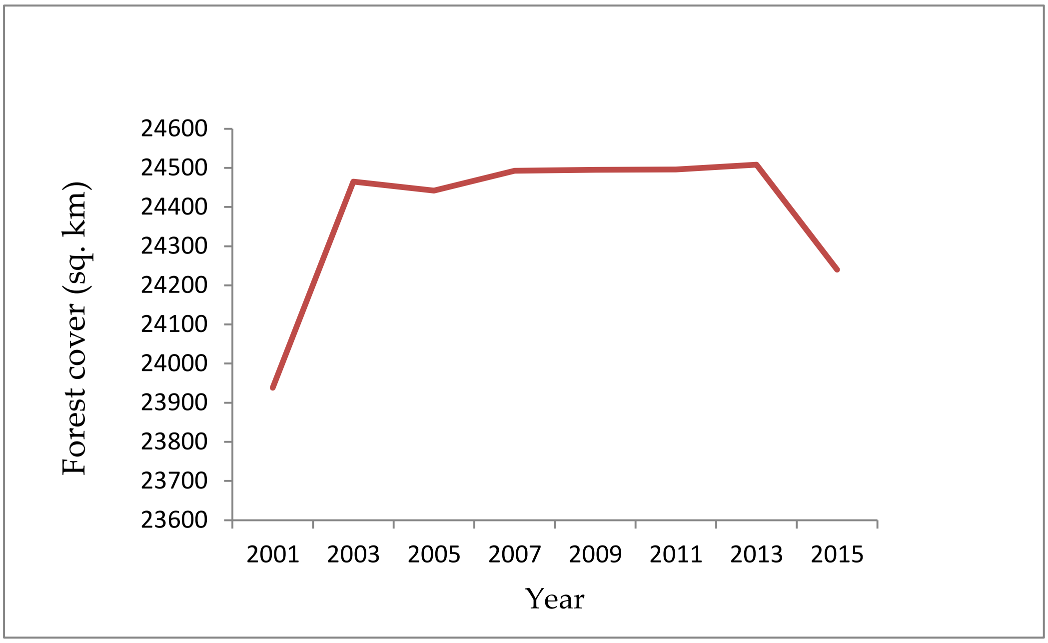

Figure 3.1 Forest cover in Uttarakhand from 2001-2015

Source: State of Forest Reports, FSI (2001-2015)

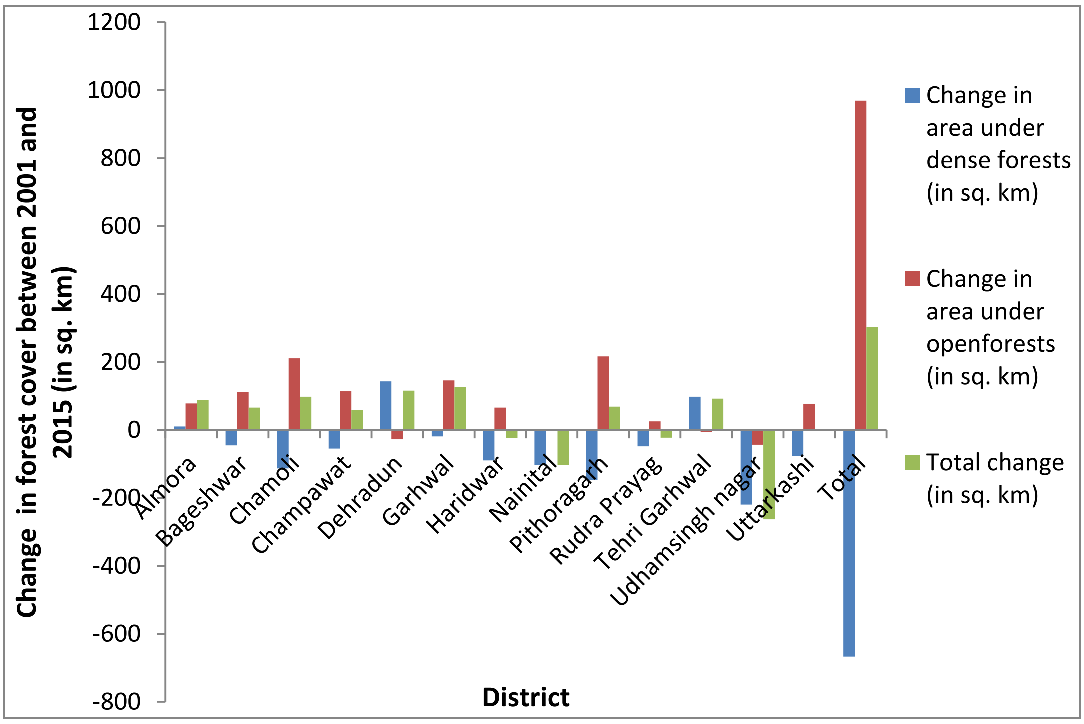

Figure 3.2 District-wise change in forest cover (dense and open forests) between 2001 and 2015

Source: State of Forest Reports, FSI (2001-2015)

Overexploitation of forest resources contributes to forest degradation in the State, despite their enormous economic value. Physical accounts for the forests of Uttarakhand from 2000-01 to 2010-11 indicate that the demand for fuel wood accounts for the largest share of change followed by diversion of forest land for non-forest use. In 2010-11, fuelwood production was estimated to be 26610 cubic meter stacks while the estimated household consumption was 3013660 cubic meter stacks (TERI, 2014)[2] pointing to grossly unsustainable fuelwood harvests. However, timber extraction is a negligible contributor to the changes in forest stock in the state (TERI, 2014). This huge burden of fuelwood harvests leads to forest degradation, rather than deforestation. Ecological studies to assess Uttarakhand's forest status conducted by Baland et al. (2006) using measures of forest quality such as canopy cover, tree lopping and forest regeneration also point to severe degradation in the State. As many as 40% of all forest patches studied fell below the sustainability threshold for canopy cover and the mean percent of trees severely lopped was 50%. Tree stock density, however, appeared quite healthy-only 15% of forest patches fell below the sustainability threshold of 35 square metres per hectare. Interestingly, Baland et al. (2006) conclude, that since, "the nature of degradation does not involve a substantial reduction in forest biomass, this would not be picked up by aerial satellite images." Therefore, official estimates of forest cover changes in Uttarakhand are unlikely to pick up finer-scale forest degradation. These studies point to severe forest degradation due to fuelwood extraction in Uttarakhand. In this study, we carry out a finer scale valuation of forest degradation in the Dhanaulti and Devalsari areas of Tehri Garhwal.

The forests of Dhanaulti, close to Mussoorie in Tehri Garhwal are an important tourism destination for people who come here to trek, to visit religious places, to enjoy the scenic beauty or to bird or butterfly watch. The forests are therefore, of value to tourists. In order to capture this value, travel costs incurred by tourists can be used as a proxy for the value of a site. The Travel Cost Method (TCM) involves the estimation of recreational demand for particular sites based on visitors' 'revealed' - as opposed to 'stated' – preferences, and assumes that a surrogate market for the good (in this case forests) exists (Chopra, 2004). This is certainly likely to be true for the sites surveyed in Uttarakhand which are thickly forested and offer scenic vistas to tourists as well as a rich diversity of birds, butterflies and flora for nature lovers.

In this case study, the value (estimated via the Travel Cost Method) that tourists place on the forests of Dhanaulti and Devalsari are assumed to be the foregone recreational benefits if the forests are degraded. In other words, these will be one of the costs of forest degradation-because it is these biodiverse forests that add value to ecotourism and once degraded or lost, ecotourism may dwindle or cease. However, tourists' valuation of the forests (and forest biodiversity) is insufficient to capture their full value. Local communities for example, derive benefits other than tourism revenue[3], based on their direct dependence on forests for fuelwood, fodder, minor timber and Non-Timber Forest Products (NTFPs). A meta-analysis of 54 studies from developing countries indicated on average income from the forest accounted for 22% of the total household income (Vedeld et al., 2004). Forest products fulfil both subsistence and livelihood needs of forest-based communities. Products derived from forests form a safety net in times of food or resource scarcity. Consequently, this case study, also determines the direct dependence of local communities on the forests for their subsistence and other needs. In addition, their perception of the forests' value is captured using an Analytic Hierachy Process. The perspectives of other stakeholders such as scientists

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[2] The study estimated fuel wood consumption based on the NSSO (2009/ 10) data on monthly per household consumption of fuel wood (193.15 kg for rural and 124.71 kg for urban) for Uttarakhand (TEDDY 2011-12, page 295); Conversion factor of 1 cubic meter=725 kg (FAO, 2012) was used and number of households using fuel wood for cooking (Census 2011)

[3] as guides, or pony owners or owners or employees of hotels, tea stalls or souvenir stalls

and conservation biologists who value these forests for their existence value or pharmaceuticals for whom they have bioprospecting potential, however, have not been directly considered in this study[4]. The focus in this study is on determining the tourism and recreational benefits provided by the forests, local community dependence on forests and their perceptions and ranking of forest value. These services are then used to derive the change in the Total Economic Value (TEV) of these forests resulting from their loss and degradation. The change in forest cover was estimated via a remote sensing assessment of land use and land cover change from 2001-2015. In summary, the case study objectives include:

- Change in forest cover in Dhanaulti and Devalsari using a remote sensing assessment;
- Estimation of the dependence of the local communities of Devalsari and Dhanaulti on their forest resources;
- Estimation of travel costs for Dhanaulti to determine the recreational benefits of the area;
- The estimations of forest dependence, recreational benefits and change of forest cover were then combined with the remote sensing assessment of forest change to arrive at a valuation of forest degradation in Dhanaulti and Devalsari.
- Projections of the costs of degradation to 2030 (scenario development) and the costs of reclaiming the forests, and
- Perceptions and ranking of the value of forest resources by local communities.

Photo 3.1 A head-load of fodder

[4] However, some of these values have been considered while establishing the costs of forest loss/ degradation in this area.

3.2 Methodology

3.2.1 Selection of state and district

According to the latest desertification and land degradation atlas of India (SAC, 2016), vegetal degradation is the second leading cause of land degradation and desertification in India (8.91% in 2011-13 and 8.60% in 2003-05). At the time of study initiation only the SAC, (2007) atlas was available according to which the states most impacted by vegetal degradation lay in the North-East of India, outside the drylands. Uttarakhand was also important in terms of vegetal degradation. Therefore, we selected Uttarakhand for our case study of vegetal degradation and because of its mountainous areas (to ensure that our study encompassed a range of topographies, ecosystems and causal mechanisms across the country). Vegetal degradation is the primary cause of degradation in Uttarakhand and has increased from 545610 ha in in 2003-05 to 606616 ha in 2011-13 (SAC, 2016), i.e. from 10.2% to 11.34% (Fig 3.3).

The share of Uttarakhand in the country-wide area affected by class of degradation was determined from the harmonised atlas (ICAR and NAAS, 2010), since this atlas was used as the basis of our selection of study sites across the country. The results are provided in Table 3.1. None of the results indicate that Uttarakhand figures high in terms of degradation status (ICAR and NAAS, 2010), probably because vegetal degradation is not included as a causal mechanism in the harmonised atlas. We then looked at the share of the districts in the state-wise degradation by class (%). According to this, Tehri Garhwal district was the most degraded district of Uttarakhand (ICAR and NAAS, 2010), (Fig 3.3, Table 3.2) and accounted for 41.27% of the state's area for acid soils under open forest. In addition, SAC (2007) indicated that Tehri Garhwal showed high levels of forest degradation (Fig 3.4/ 3.5). Consequently, Tehri Garhwal was selected for an intensive survey of vegetal degradation. Forest Survey of India (2015) data for Tehri Garhwal also indicated decreases in open forest cover from 2001-2015. Moreover, a study conducted by TERI (TERI, 2014) indicated that percentage of area under forest fragmentation in Tehri Garhwal, had increased in the very high, high and medium categories during 2001-2011 from 8.16% to 9.37%, 6.33% to 8.05% and 7.27% to 7.37%, however, fragmentation in the low and very low classes decreased during this period[5]. These figures indicate high levels of forest fragmentation for Tehri Garhwal.

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[5] The mathematical representation of the fragmentation is:

$$Frag = f(n_{\_F}, n_{\_NF})$$

Where, Frag = fragmentation; n = number of patches; F = forest patches; NF = non-forest patches. Pixels having fragmentation index values ranging 0-20 were categorized as very low fragmentation; following low (20-40), medium (40-60), high (60-80) and very high (80-100) fragmentation.

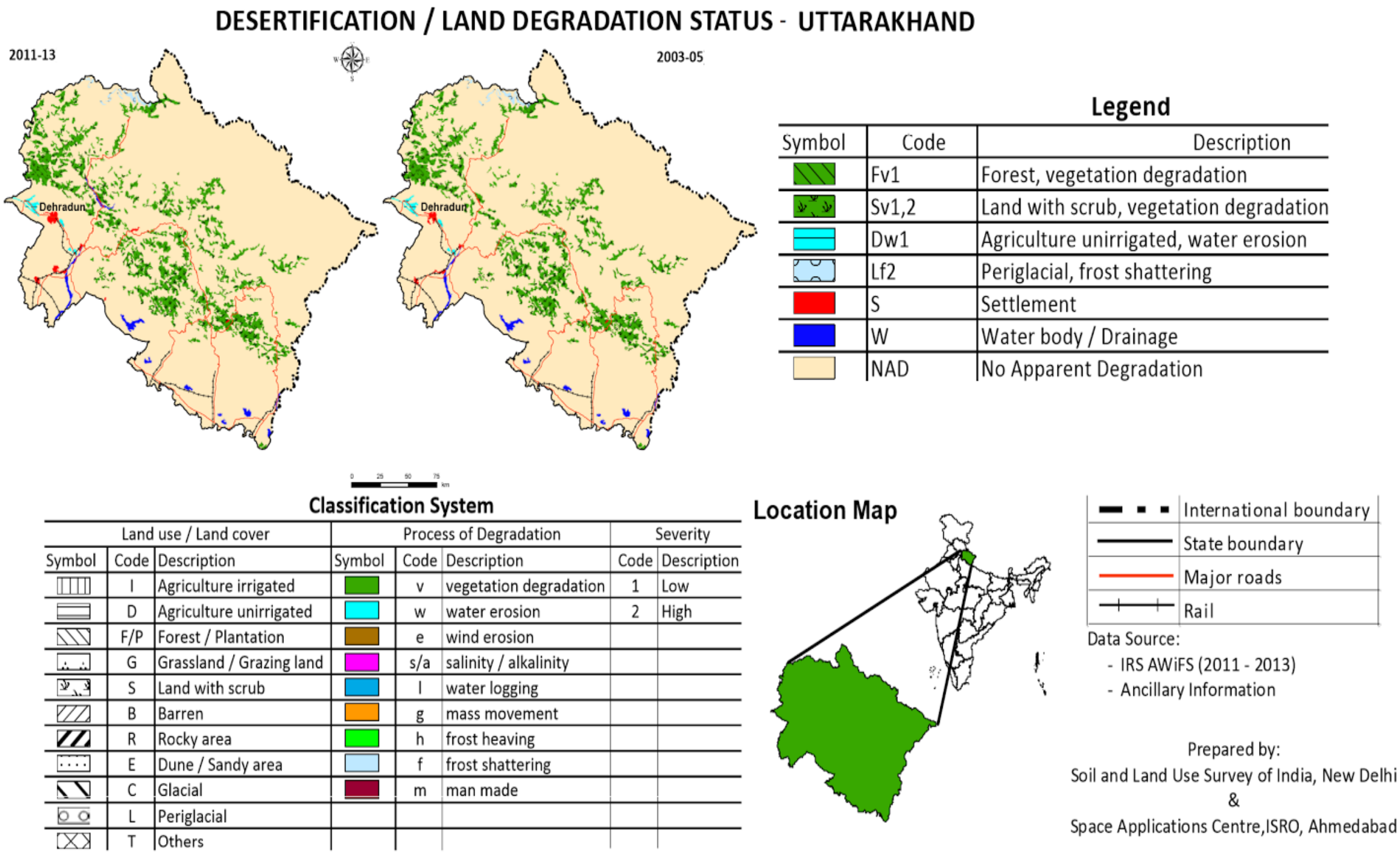

Figure 3.3 Desertification/Land degradation status of Uttarakhand in 2003-05 and 2011-13

Source: SAC (2016)

Table 3.1 Share of Uttarakhand in the country-wide area affected by degradation and share of class in degraded area of Uttarakhand

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Share of UK in the country-wide area affected by each class of degradation (%)																		
1.1	1.9	0.3	**3.3**	**2.8**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.4**	**2.9**
Share of class in total degraded area of UK (%)																		
57.8	12.5	0.9	13.2	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.7

1 **Exclusively water erosion (>10 tonnes/ha/yr);**	11 Saline soils under open forest;
2 Water erosion under open forest;	12 Waterlogged saline soils;
3 Exclusively acid soils (pH <5.5);	13 Exclusively sodic soils;
4 Acid soils under water erosion;	14 Eroded sodic soils;
5 Acid soils under open forest;	15 Sodic soils under wind erosion;
6 Exclusively wind erosion;	16 Sodic soils under open forest;
7 Exclusively saline soils;	17 Eroded sodic soils under open forest;
8 Eroded saline soils;	18 Mining/ Industrial waste;
9 Acid saline soils;	19 Waterlogged area (Permanent)
10 Saline soils under wind erosion;	

Source: ICAR-NAAS, 2010

Table 3.2 Share of district in state-wide degradation by class (%)

	1	2	3	4	5	18	19	Total of classes
Almora	3.62	0.00	0.00	0.00	0.00	100.00	8.00	2.30
Bageshwar	1.93	2.22	0.00	0.00	2.02	0.00	12.00	1.88
Chamoli	7.84	6.67	23.08	14.81	10.61	0.00	24.00	9.41
Champawat	0.36	5.00	0.00	0.53	10.10	0.00	4.00	2.37
DehraDun	16.16	5.00	0.00	10.58	7.58	0.00	0.00	12.40
Haridwar	18.21	20.00	0.00	0.00	0.00	0.00	0.00	13.03
Naini Tal	7.12	7.78	0.00	0.53	0.00	0.00	16.00	5.44
Pauri Garhwal	12.42	16.67	46.15	7.94	17.68	0.00	0.00	13.17
Pithoragarh	0.36	0.00	0.00	3.17	0.00	0.00	4.00	0.70
Rudraprayag	0.12	8.89	0.00	0.00	6.06	0.00	0.00	2.02
Tehri Garhwal	6.27	24.44	7.69	41.27	41.41	0.00	0.00	17.91
Udham Singh	21.35	0.56	0.00	0.00	0.00	0.00	32.00	12.96
Uttarkashi	4.22	2.78	23.08	21.16	4.55	0.00	0.00	6.41

1 Exclusively water erosion (>10 tonnes/ha/yr);

2 Water erosion under open forest;

3 **Exclusively acid soils (pH <5.5);**

4 Acid soils under water erosion;

5 Acid soils under open forest;

18. Mining/Industrial waste

19. Waterlogged areas

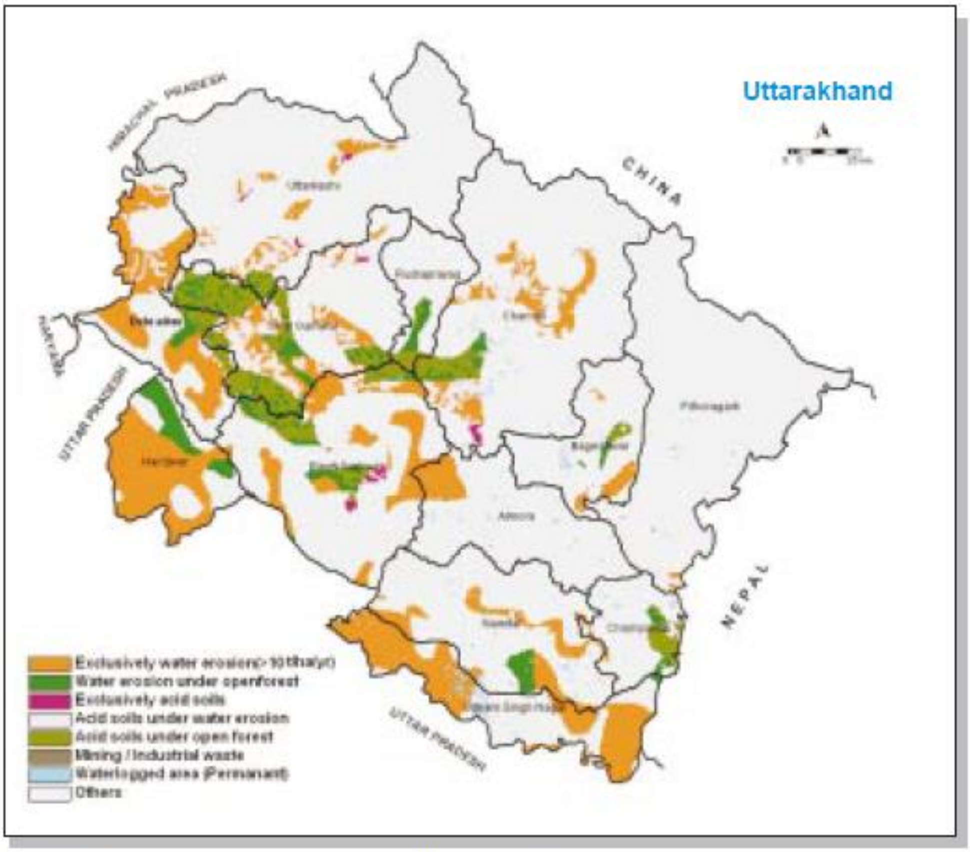

Figure 3.4 Degraded areas of Uttarakhand

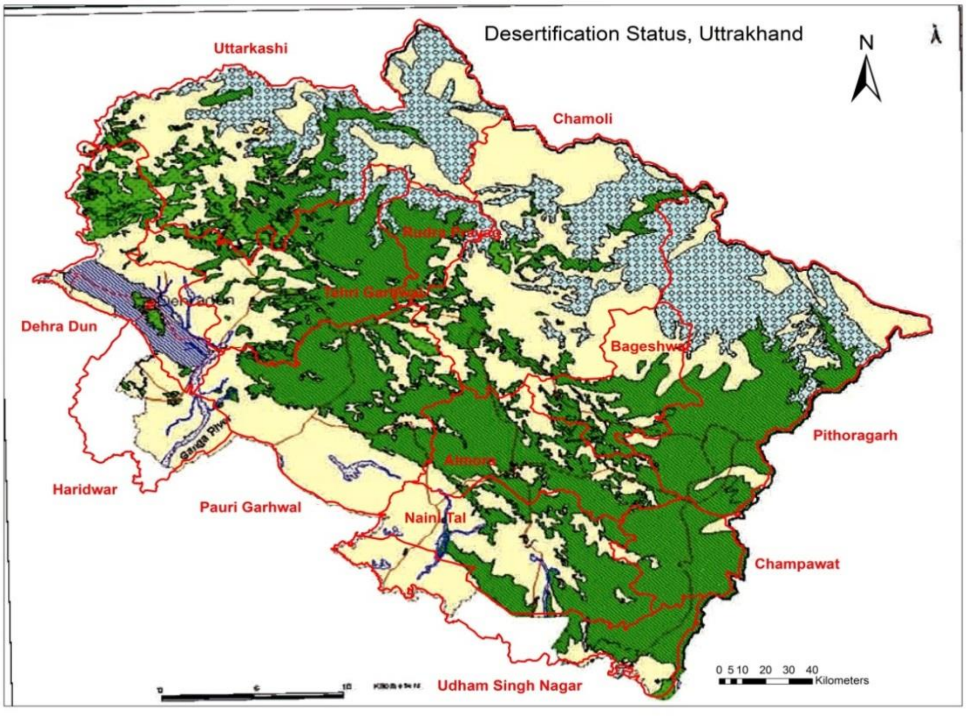

Figure 3.5 Forest degradation status of Uttarakhand including Tehri Garhwal

Source. SAC, 2007

3.2.2 Description of case study sites

Two areas were selected in Tehri Garhwal for household level surveys, travel cost surveys and GIS mapping. These included Devalsari and Dhanaulti micro watersheds. A total of nine villages were surveyed from these areas located in Thatyur block. Details of the villages surveyed and the number of households surveyed in each village are provided in Table 3.3.

Table 3.3 Details of villages sampled for the household survey

Village	Block	Panchayat	Total # of households in village	Total Population	# of households sampled
Chhanan Gaon	Thatyur	Dhanaulti	99	649	23
Dawali Mhdhe Alu Chak	Thatyur	Dhanaulti	38	263	28
Dhanaulti	Thatyur	Dhanaulti	12409	74083	17
Goth	Thatyur	Dhanaulti	23	126	7
Khaneri Madhe Batwaldhar	Thatyur	Dhanaulti	68	460	31
Lam Kande	Thatyur	Dhanaulti	59	364	21
Nakurchi	Thatyur	Dhanaulti	35	245	4
Bangsil	Thatyur	Devalsari	76	386	11
Odars	Thatyur	Devalsari	12	73	9
			410	2566	151

Dhanaulti[6] is a scenic mountainous area located close to Mussoorie (at a distance of about 24 km), a popular hill resort. Its proximity to Mussoorie, and presence of deodar, rhododendron and oak forests, mountains and pilgrimage spots has made it a popular tourist destination[7]. A recently created community managed eco-park has provided a boost to ecotourism and enhanced revenues for local communities. The 13 ha ecopark is at an altitude of 2280 m a.m.s.l. and lies between 30° 42' N, 78° 24' E (Kala, 2013). The ecopark in a single year (2011-2012 attracted 2.6 million tourists and earned revenues of Rs 3.3 million (Kala, 2013). While an eighteen member elected committee manages the eco-park as many as 25 men and women belonging to local communities are employed in the eco-park. The general body of the committee includes a number of the local business owners-hotels, tea stall, shops, restaurants and dhabas as well as about 70 mule owners. It thus ensures representation of large numbers of the local community. The committee helps in the conservation of adjoining forest areas including prevention of tree cutting, poaching of wildlife and fire prevention and have helped halve plastic waste generation. Dhanulti is also close to the Surkanda Devi temple (a distance of about 8 km), which is dedicated to the goddess Parvati.

[6] Also referred to as Dhanolti

[7] Maps of the study site are available in the section on land use and land cover change (LULC)

The forests include species of Deodar *(Cedrus deodara*), Banj Oak (*Quercus leucotricophora*), Rhododendron (*Rhododendron arboretum)* and *Pinus roxburghii* (Pine). Some of the Van Panchayats[8] upon which the villages of Dhanaulti partially depend are the Lambidhar Van Panchayat dominated by oak and deodar forests and the Kedarkhola Jangal dominated by deodar and pine.

Devalsari lies in the Aglar valley of Tehri Garhwal and is the base camp for a 10 km trek to Nag Tibba, the highest peak in the area (3048 m). It is located at a distance of about 55 km from Mussoorie and is also rich in birds and butterflies, with about 70 butterfly species recorded from the area. Tourists are now venturing to this area to bird and butterfly watch while on a very small scale, the village community are developing ecotourism facilities. We surveyed the Bangsil and Odar villages in Devalsari. The village of Odars in Devalsari depends on the Odarsu Van Panchayat which is dominated by Banj Oak (*Quercus leucotricophora*), the only oak-dominated forest within a radius of 10 km that is strictly managed by the local communities.

Photo 3.2 A Shiv temple set amongst a grove of deodars in Devalsari

[8] Uttarakhand forests are administratively managed as Van Panchayats, Reserve Forests and Civil-Soyam forests.

Photo 3.3 A view of the forest from Bangsil, Devalsari

3.2.3 Field surveys

The field survey was carried out in April, 2016. Three discrete surveys were conducted at the study sites. The first survey was a household-level analysis to understand the dependency of local communities on their forest resources. A total of 151 household heads were surveyed using a detailed, structured questionnaire provided in Appendix 3.1. At the household level, household heads or any adult member were interviewed in order to gather information. The household questionnaire consisted of questions seeking information on various aspects relating to forest-based livelihoods. These included: (i) social and demographic profile of the household, (ii) livelihood sources and assets of the household, (iii) access to and dependence on forests and (iv) people's perceptions of forest status and degradation.

Additionally, 150 local households were asked to provide their perceptions on the value of the forests which were captured using an Analytic Hierarchy Process. Details of this questionnaire are in Appendix 3.2. A travel cost assessment of 157 tourists to Dhanaulti was carried out to determine the recreation value provided by the forests of this area. This included questions relating to travel costs incurred, expenditure on various activities, preferred recreational activities, socio-economic questions and attributes of the area that they valued the most. The questionnaire is appended in 3.1

To support the quantitative data collected, informal discussions and focus group discussions were carried out with the local communities, as well as with other stakeholders such as the forest department, collectors of Non-Timber Forest Produce (NTFPs) and community elders.

Photo 3.4 A group discussion in progress

3.2.4 Data analysis

The different data analysis methods are listed below. The relationship between each component of the valuation exercise is explained in Fig. 3.6.

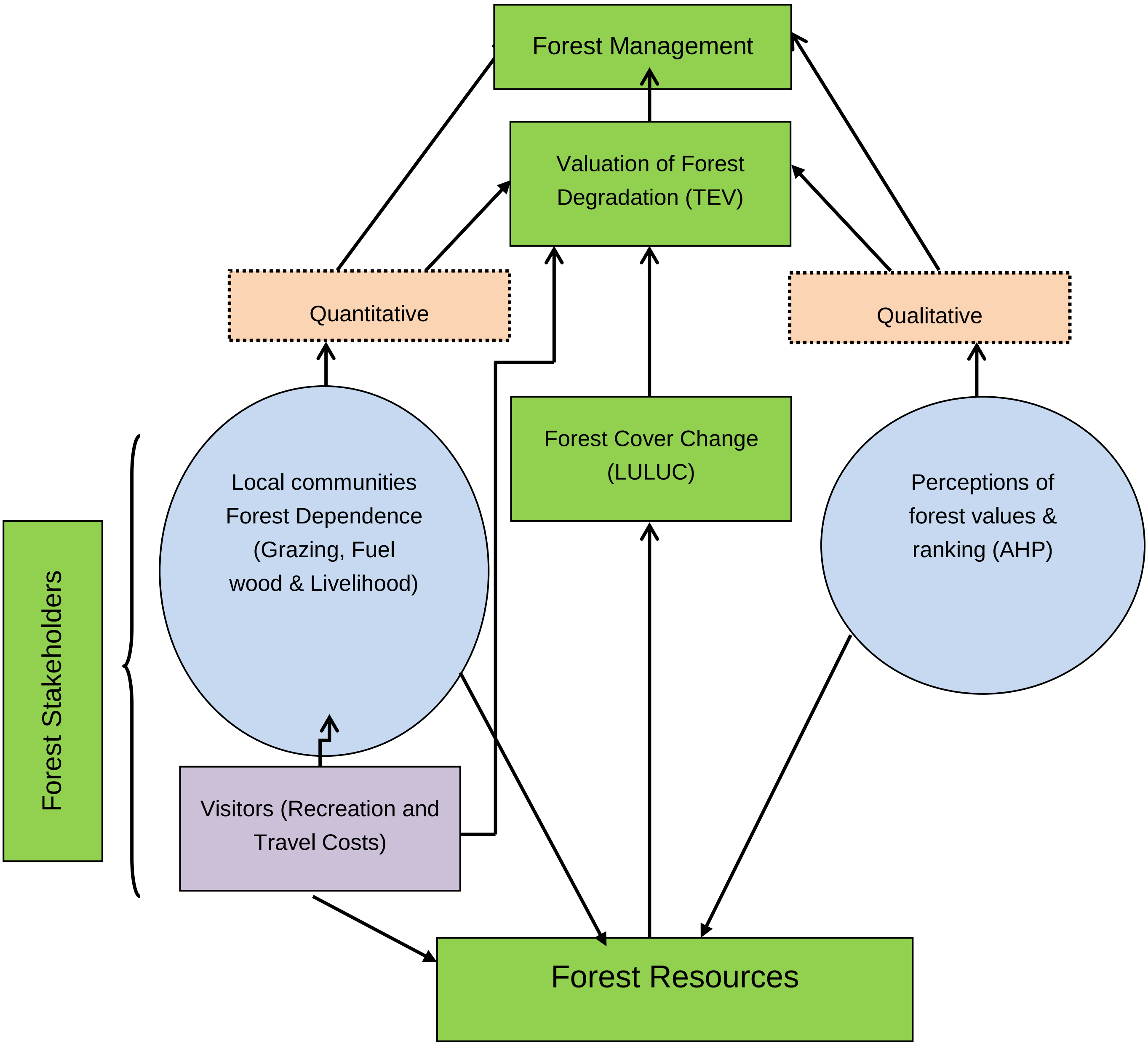

Fig 3.6. Framework of data analysis methods

Analytic Hierarchy Process to assess stakeholder perceptions' on forests

Perceptions of stakeholders on the values of the forests that can help plan appropriate management approaches for the area were captured using an Analytic Hierarchy Process (AHP), which was developed by Saaty (1977, 1980).

According to Hadipur *et al.* (2015), Multi Criteria Decision Making (MCDM) is a procedure that consists in finding the best alternative among a set of feasible alternatives. The AHP method which was first proposed by Saaty (2008) is mostly for solving MCDM problems. It is one of the most widely used MCDM (Lee et al., 2008).

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. This process is particularly useful in group decision making (Saaty and Peniwati 2008). More recently, the AHP has been applied in multi-objective forest management and land-use planning due to its flexibility and effectiveness in analyzing complex decision-making problems (Schmoldt et al 2001; Vacik and Lexer, 2001; Dhar et al., 2008). This interactive method allows stakeholders to express their preferences and thus contribute to decision making and planning (Proctor, 2000; Wolfslehner et al., 2005).

Fundamentally, the AHP works by developing priorities for alternatives and the criteria used to judge the alternatives. These priorities are derived based on pairwise assessments using stakeholder judgment. The software DEFINITE has been used for this exercise. Jansen (1994) provides details of the technique used for this exercise.

Data relating to household-level questionnaires were analysed using SPSS (SPSS Inc.).

Travel Cost Methodology

Two approaches can be used in a travel cost study, one is a zonal travel cost and the second is the individual travel cost. In the context of our case study of Uttrakhand we prefer the Individual Travel Cost Method (ITCM) which is appropriate for sites with high individual visitation rates. Other than that, ITCM has distinct advantages over ZTCM since it accounts for the inherent variation in the data, and can be estimated using a smaller number of observations. Furthermore, ITCM is more flexible and can be applied to a wide range of sites (Khan, 2004) while eliciting relevant information on visitors' characteristics, preferences and behaviour. However, the application of the correct TCM depends on the identification of the dependent variable. Generally, Ordinary Least Squared (OLS) estimation is used to estimate the parameters of the recreational demand equation though truncated count data models in single-site recreational demand models are increasingly being used (Creel and Loomis, 1990; Hellerstein, 1991; Englin and Shonkwiler, 1995; Shrestha et al. 2002; Martinez-Espineira and Amoako-Tuffour, 2005). For this study, we used OLS.

To formulate the travel cost function, we follow Mariwala et al. (2010) and assume that the individual's utility depends on the total number of visits to the site, the quality of the site, and a bundle of other goods.

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We represent the utility maximizing problem of the consumer as:

$$\text{Max } U(X, r, q) \qquad (1)$$

where,

U: utility function of the consumer/ household,

X: bundle of other commodities,

r: number of visits to the site yearly,

subject to two budget constraints (money and time):

$$M + P_w t_w = X + cr \qquad (2)$$

$$t^* = t_w + (t_1 + t_2) r \qquad (3)$$

where

q: an index of quality of the site

M: exogenous income or non-wage income,

p_w: wage rate,

tw: hours of work,

c: monetary cost of a trip,

t*: total discretionary time,

t_1: round-trip travel time, and

t_2: time spent at the site.

Here, equation (2) is the income constraint and equation (3) is the time constraint.

The number of visits will be an increasing function of the site's environmental quality. The time constraint reflects the fact that both travel to the site and time spent on the site take time away from other activities. Thus there is an opportunity cost to the time spent in the recreation activity which is the wage rate.

The full price of the visit is p_r includes the monetary cost of travel to the site, the time cost of travel and the cost of time spent at the site, i.e.,

$p_r = c + p_w (t_1+t_2)$…..(4)

Substituting (3) and (4) in the income constraint (equation 2) we obtain

$M + P_w .t^* = X+ p_r.r$………(5)

Maximizing equation (1) subject to the constraint of equation (5) will yield the individual's demand functions for visits:

$r = r (p_r, M, q)$ . . . . (6)

The data on rates of visitation, travel costs, can be used to estimate the coefficient on p_r in a travel cost-visitation function.

The economic valuation of a recreational site involves the estimation of the demand for recreation and calculation of the associated consumer surplus, i.e., the area under the demand curve.

Factors that Determine Recreational Demand

In the ITCM, the number of trips also depends on demographic variables; the most important variables include travel cost, travel time, substitute sites, and site quality

Demographic variables such as age, sex, education, income, employment status also affect recreational demand. Age might be an important determinant of visitation rate-for example younger people might prefer trekking and adventure sports or older people might prefer its scenic value or its biodiversity potential. Sex may be another determinant-with more men or more women visiting for various reasons. With regard to education, people with higher education are likely to appreciate the recreational benefits more (for example in terms of biodiversity value or forest quality). Household income has also been found to correlate positively with participation in outdoor recreation activities. Similarly, better-quality recreational facilities available in the area may attract more tourists to that particular site. In our study, we have included these explanatory variables in the regression analysis. Details are provided in the results.

Value of Consumer Surplus

From the linear functional form of the travel cost model, the consumer surplus is estimated as

$CS = r^2 / -2\beta_1$ where

CS: Consumer surplus

B_1: Curve of the demand function (cost coefficient).

Estimating the present value

The present value benefitsis estimated following Mariwala *et al*. (2010) as;

PVB= $CS/(1+V) + CS/(1+V)^2 + ... + CS/(1+V^n)$

Which is the yearly recreational benefit from Uttarakhand. Assuming a constant annual benefit, this simplifies to:

Present Value Benefits (PVB) = CS / v,

Where v is the discount rate[9].

3.2.5 Land Use and Land Use Change in Dhanaulti and Devalsari

Changes in land use and land cover in the study areas were mapped for three time periods. For this study, Landsat 5 Thematic Mapper (TM) imagery has been used for the year 1989; Landsat 7 Enhanced Thematic Mapper Plus (ETM+) imagery has been used for 2001 and Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) imagery has been used for 2015 (Table 3.4). This imagery was used for the preparation of Landuse and landcover (LULC) maps for the Dhanaulti and Devalsari micro watersheds (MWS) of Uttarakhand. The LULC classification has been carried out using a supervised classification technique wherein a maximum likelihood classification algorithm is used for differentiating between various classes based on the spectral signature of various pixels in the image. As a result, five major classes have been identified for this study viz. forest, agriculture, wasteland and water/ sedimentation. In addition, for forests, two density classes have been identified; open and dense forests

Table 3.4 Data used for a LULC classification of two micro watersheds

Satellite	Acquisition date	Path/row
Landsat 5 Thematic Mapper (TM)	05-12-1989	146/ 39
Landsat 7 Enhanced Thematic Mapper Plus (ETM+)	30-12-2001	146/ 39
Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)	11-11-2015	146/ 39

[9] The series is added to infinity

3.2.6 Calculation of the costs of forest degradation in the area

In order to estimate the costs of forest degradation (shift from a higher forest density class to a lower value), we adapt the Millennium Ecosystem Assessment (MEA, 2005) definition of land degradation to the forestry context in India, and then apply the Total Economic Value (TEV) approach to determine the value of forest degradation (see Nkonya et al. 2016). The following steps were followed:

$$CF_{CD} = \sum_{i,j} a_{i,j}\{F_{jT} - F_{jO}\}$$

Where

- CF_{CD} is the cost of forest degradation due to change in forest density class during periods T (2015) and O (2001)
- a_{ij}= NPV of the attribute/ ecological service i in forest density class j, where i,=1,…10 and j = 1,2 (open, dense)
- F_{jT} is the area under forests of type j in the two time periods considered, T (2015) and O (2001)

For an estimation CF from 2001-2015, we used the figures generated by the primary survey for fodder and fuelwood dependence as well for recreation. Other benefits (timber, NTFP, bamboo, carbon sequestration, soil conservation, water recharge, pollination and seed dispersal) were estimated from Verma et al. (2014) for two categories of forests found in the study areas namely, Montane & Moist Temperate Forest and Subtropical Pine/ Broadleaved Hill Forests and for two categories of forest (dense and open). The estimated values were adjusted for double counting and simultaneous delivery of ecosystem services as suggested by Verma et al. (2013) and the values were averaged for very dense and moderately dense forests to arrive at a value for dense forests. As mentioned in the previous section, the change in forest cover under various density classes (dense and open) was estimated through a remote sensing exercise. Prices were adjusted to 2013-2014 to ensure consistency with the macro-economic study.

3.3 Results

3.3.1 Demographic and socio-economic profile

Respondents' demographics

Most of the respondents were male (83%) and young (i.e. 51% fell in the age group of 21-40 years). As many as 39% of the respondents were in the age group 41 to 60 years while slightly more than 9% were in the oldest age group of 61-80 years and only 1 respondent was under 20 years. Scheduled Castes (18%) and other backward castes (OBC) (40%) formed the majority while the general caste accounted for 42% of the respondents.

Sampled households

The demographic and socio-economic profile of the study villages is discussed in this section. Females constitute 46% of the total population. The literacy rate for the entire population is 75%. A higher percentage of all males are literate (85%) while 63% of all females are literate. The age-wise distribution of gender and literacy is presented in Table 3.5. The most literate population, not surprisingly is amongst those in the age group of 11 to 18 years, the school going population. The sex ratio is highly skewed which starts from birth; for example in the age group under 5 years, girl children comprise only 42% of the population while male children outnumber them at 58%. This skewed situation continues till the age of 61 years, when the percentage of men and women equalises, probably because women tend to have longer life expectancy. Literacy is high amongst women till the age of 31 after which it dips. This is probably attributable to enhanced efforts to promote literacy for women in Uttarakhand in recent years. The older generation of women, however, did not reap its benefits.

Table 3.5 Demographic profile of sample households

Age group (in years)	Percentage of population	Gender		Literacy	
		Percentage of males	Percentage of females	Percentage literate males	Percentage of literate females
< 5	7%	58%	42%	NA	NA
6 - 10	12%	53%	47%	100%	95%
11-18	23%	53%	47%	97%	100%
19- 30	21%	55%	45%	95%	77%
31- 45	25%	54%	46%	90%	51%
46 -60	8%	58%	42%	76%	29%
>61	3%	50%	50%	46%	15%
Total	100%	54%	46%	85%	68%

The entire population of the sampled villages were Hindu although Scheduled Castes (SC) and Other Backward Classes (OBC) comprise the majority of the population (58%) (Fig 3.7).

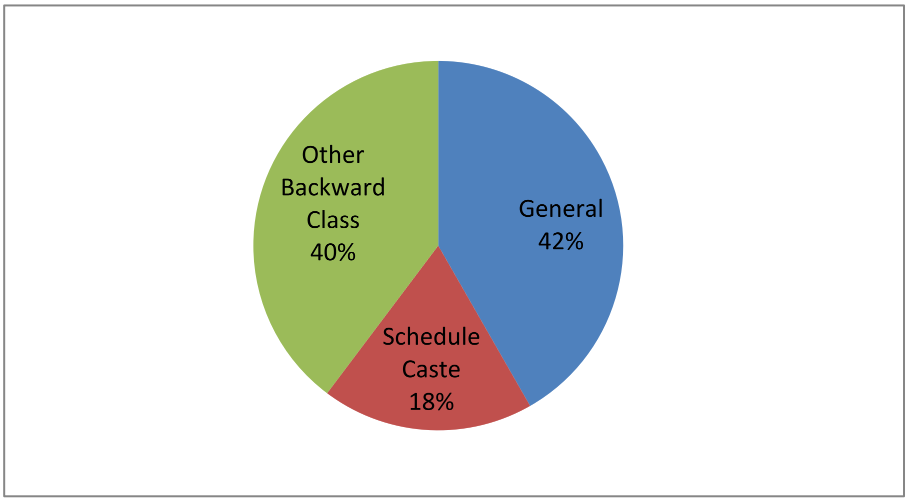


Figure 3.7 Caste composition of the sampled households (in % of households)

The primary occupation profile of the respondents is provided in Fig 3.8. While domestic work carried out by women is the primary occupation listed, this is followed by farming.

Eight percent of the population is involved in the sale and collections of NTFPs, indicating that forests are not only a source of subsistence but also provide livelihood benefits.

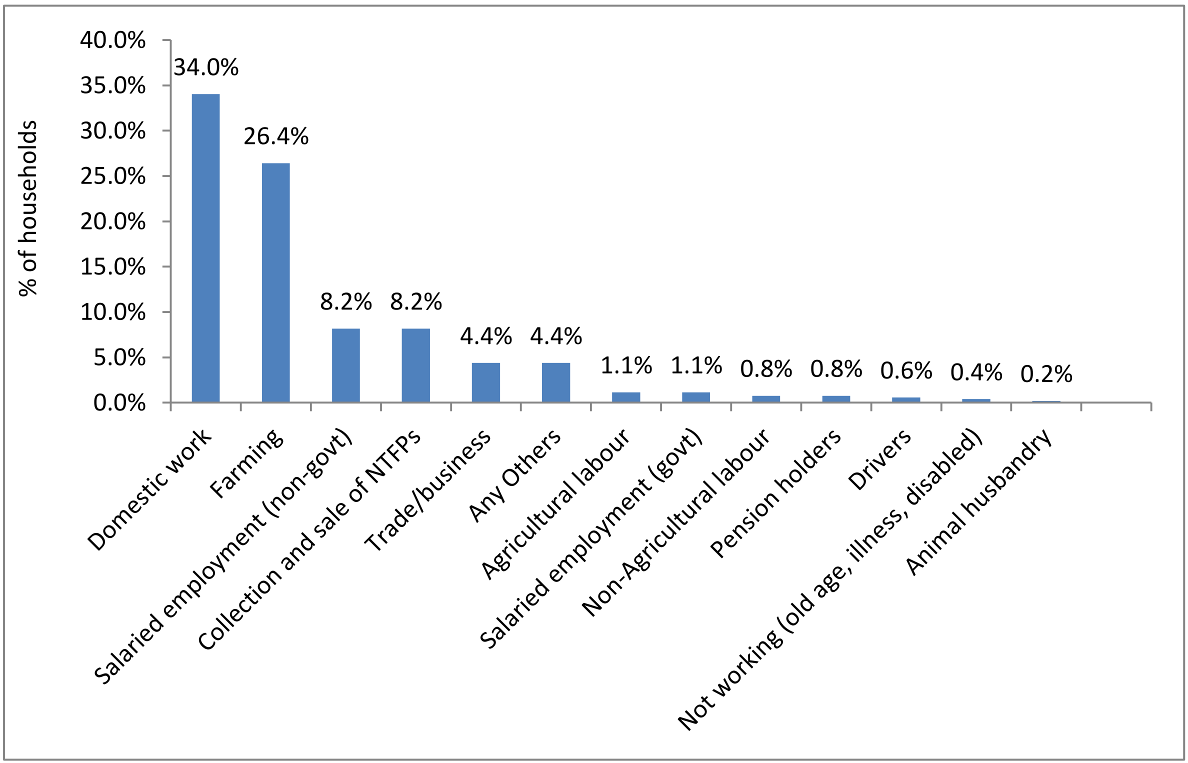


Figure 3.8 Occupation profile of the sampled households

Land is an important economic and social asset in rural societies and ownership patterns reflect the socio-economic profile of the community. Land is not only the source of food for rural households but also plays an important role in enabling access to credit, enhances social status and so on. The average land holding in Uttarakhand is low at 0. 9 ha, putting most people in the category of marginal farmers. In our sample too, 95% of households comprised landless (22%) or marginal farmers (less than 1 ha of land owned) (73.5%). A small percentage (5%) own more than 1 ha (Fig 3.9). Given the landless or marginal nature of farms owned by most of the people of our sample villages, their dependence on biomass and forests for fuel sources and for other sources of livelihood is likely to be high. While 78% of households sampled owned land, farming was the primary occupation for only 26% of the total population.

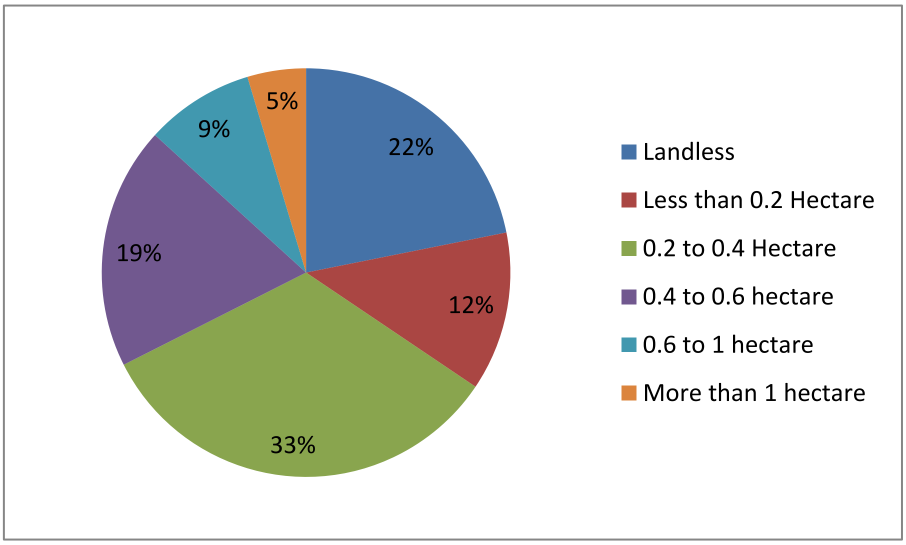


Figure 3.9 Ownership of agricultural land by sample households (in % of households)

Migration to cities for work was relatively high in the sampled population which is also typical of the State as a whole. As many as 34 % of sampled households had one or more migrant member in each household. Of these 46 households, more than 41.3% had members who were employed in the unskilled sector (Fig 3.10) while 32% were employed in the service sector and 4% owned their own businesses. Most of the migrant population included adults over the age of 30 (76 %). While most migrated to other districts in Uttarakhand (46% of the migrant population), 39% migrated outside the State and only 15% migrated within the same district).

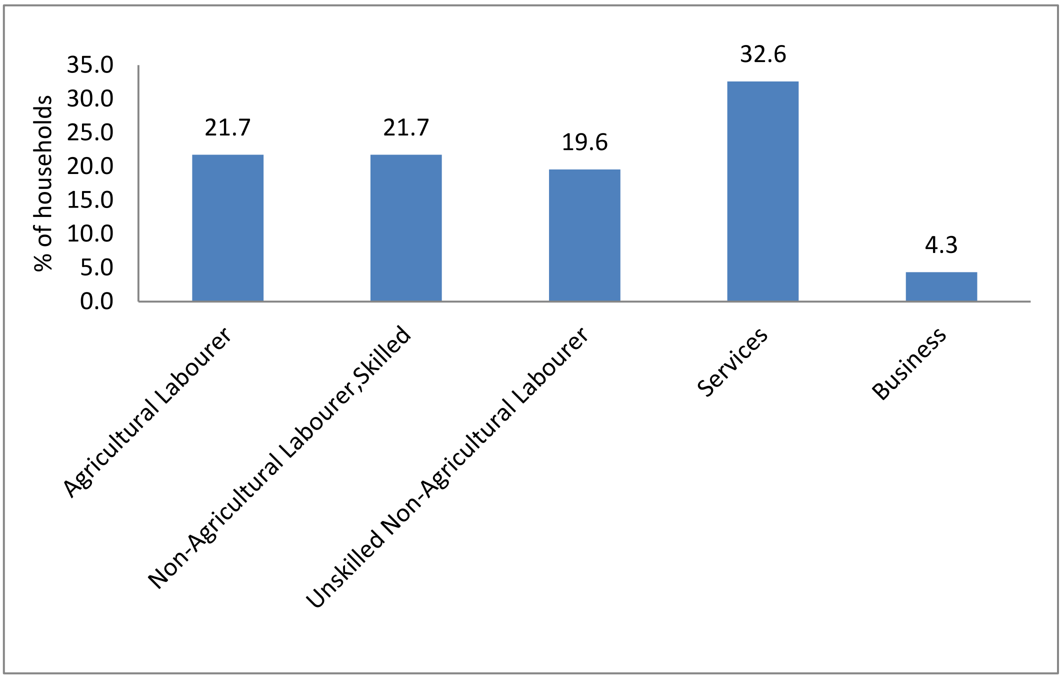


Figure 3.6 Distribution of occupations amongst migrant members of each household (in % of household)

Fragmentation of land holdings and resultant reduced farm sizes was the most frequent reason for outmigration (32.5%) with decreased land productivity and the need for additional incomes tying as the next most important categories (24.7% each). Decreasing wage opportunities accounted for 15.6% of the out-migration (Fig 3.11).

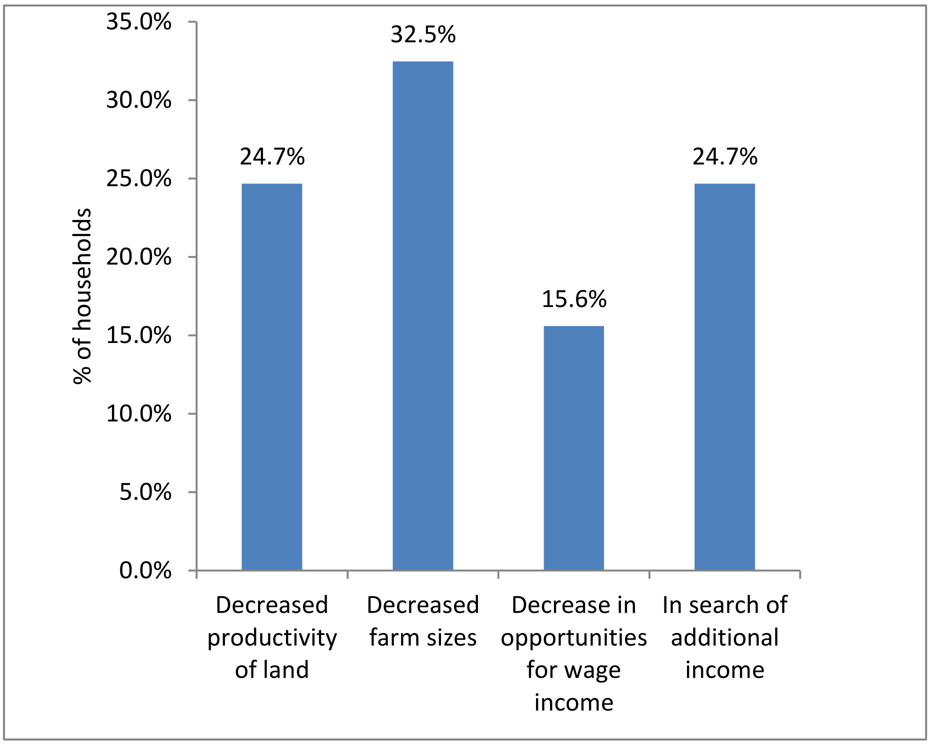


Figure 3.7 Reasons for out-migration (in % of households)

At least 37% of households own livestock. Amongst those that do, only 20% of households rear sheep and 5% own goats while as many as 32% own mules. The ownership pattern of bovines is in Table 3.6. The ownership pattern of mules which are used to ferry tourists, is a possible indication that some of the households are involved in tourism. Of the households owning livestock, stall feeding is predominant (96% of households) (that is fodder is cut from the forests) for bovines but all the goats are left to graze while a larger percentage of sheep also graze in the forest. Figures for open grazing are lower at 50% of households who own livestock. Forty one percent of households both graze their cattle in the forest and collect fodder from the forest.

Table 3.6 Patterns of livestock ownership and their forage patterns

Type of livestock	% of HH that own livestock	% of total households	% carrying out stall feeding	% carrying out open grazing and stall feeding
Cows	34%	13%	79%	21%
Bullocks	20%	7%	45%	45%
Buffaloes	36%	13%	65%	35%
Calves	27%	10%	87%	13%
Sheep	20%	7%	27%	73%
Goats	5%	2%	0%	100%
Mules	32%	12%	28%	72%

Each household (amongst those who own and graze their livestock) on average graze their livestock for an average of 5.44 days±0.35 (SE), while fodder collection for each household is an average of 47kg ±11.5 (SE) per day. In terms of fodder availability, grass and tree fodder (from the forest) is collected by 44.3% of the households who own livestock, while agricultural residues are used by 30% of the households and commercial fodder by 25.6% of households. The total fodder utilisation in these villages from open grazing and stall feeding is 533, 96,617.88 kg. Therefore, the total green fodder in kg/ ha is 4512 which converts to 1128 kg/ ha of dry fodder. Assuming a price of Rs 5 per kg of dry fodder this provides a value of Rs 5640 per ha. We have utilised this figure to arrive at a value for fodder for the valuation of forest loss from 2001-2015.

Most of the houses are electrified (87.4%), self-owned (99%) and permanent (pucca) (39.1%) or partially pucca (52%), and 94% of all households own a ration card while the majority (78%) have a MNREGA card entitling them to one hundred days of employment a year.

3.3.3 Dependence on forests

In terms of jurisdiction, the forests of Uttarakhand are classified as Reserve Forest (RF), Civil-soyam forest and Van Panchayats (VPs). The state forest department has exclusive control over Reserve Forests, the Civil-soyam forests fall under the jurisdiction of the revenue authorities of the state while Van panchayat forests are under operational control of local communities. In general the vegetation status of Van Panchayats and Reserve Forests are better than Civil-soyam forests. In our study sample, all the households had access to the Reserve Forest, 81.5% had access to Van Panchayats while only 51% of the households had access to Civil-soyam lands (Fig 3.12). Correspondingly similar trends are visible in terms of ranks in which these forests are accessed and this may be partially attributed to distance of these villages from these forests which range from an average of 2.3 km for RFs, 3.02 for VPs and 4.11 for civil-soyam forests (Fig 3.13). Another reason for reduced access to the Van Panchyats could be because of management restrictions imposed by the local communities themselves on their locally managed VPs.

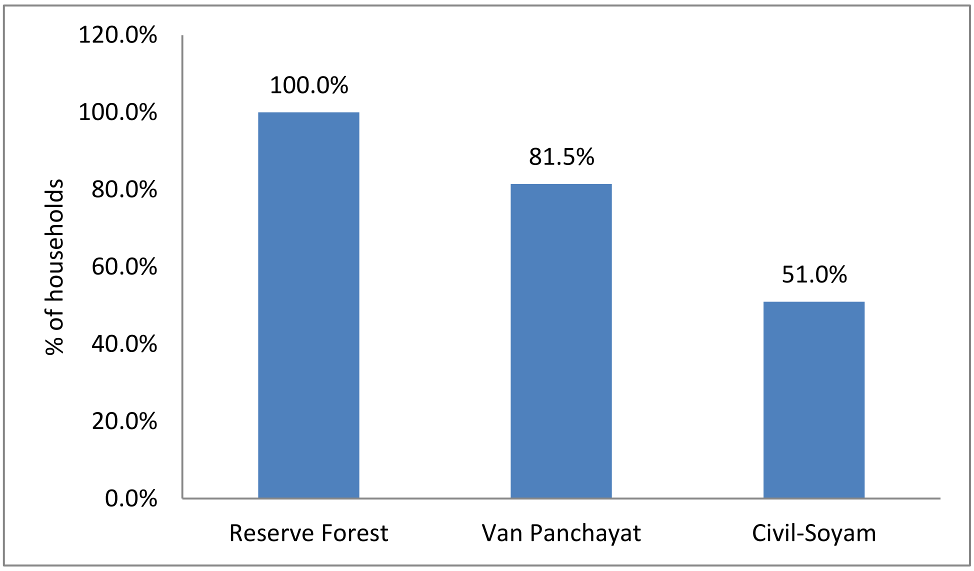


Figure 3.8 Percentage of households with access to different types of forests

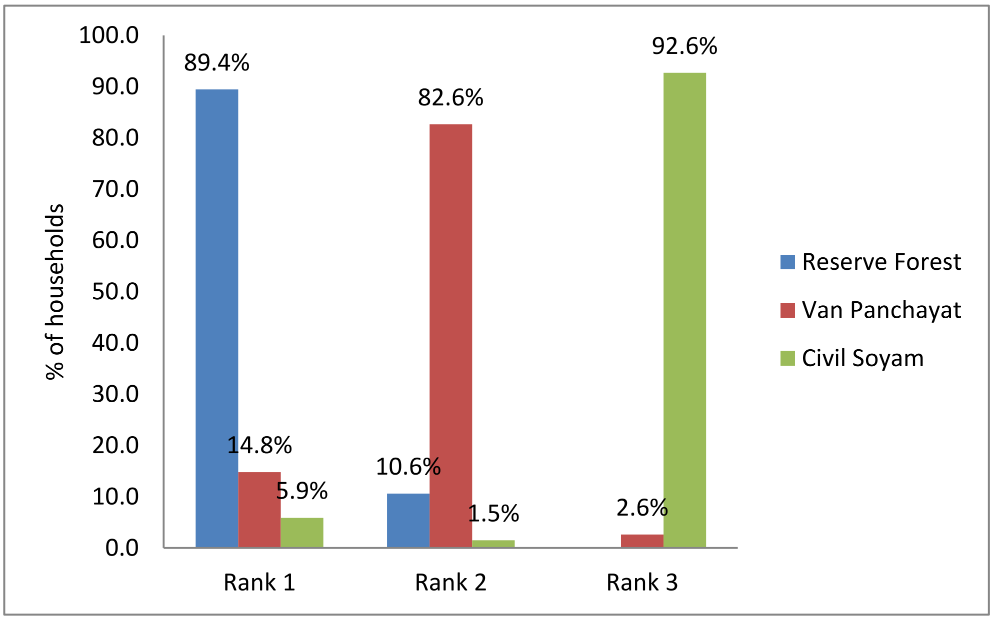


Figure 3.9 Percentage frequency at which the different categories of forest are accessed

The most commonly cited reason for accessing the forests was collection of fuelwood (100% of respondents), while 95% and 75% mentioned collection of small timber and NTFPs from the forest (Fig 3.14). Collection of fodder cited by 42% of households or grazing of animals (28%) is another important activity. The figures strongly indicate that local communities are entirely dependent on the forests for their subsistence and possibly their livelihood needs. Their perception of the forests is very utilitarian in nature; tourism and recreation which are largely leisure activities were the least cited reasons for accessing the forests.

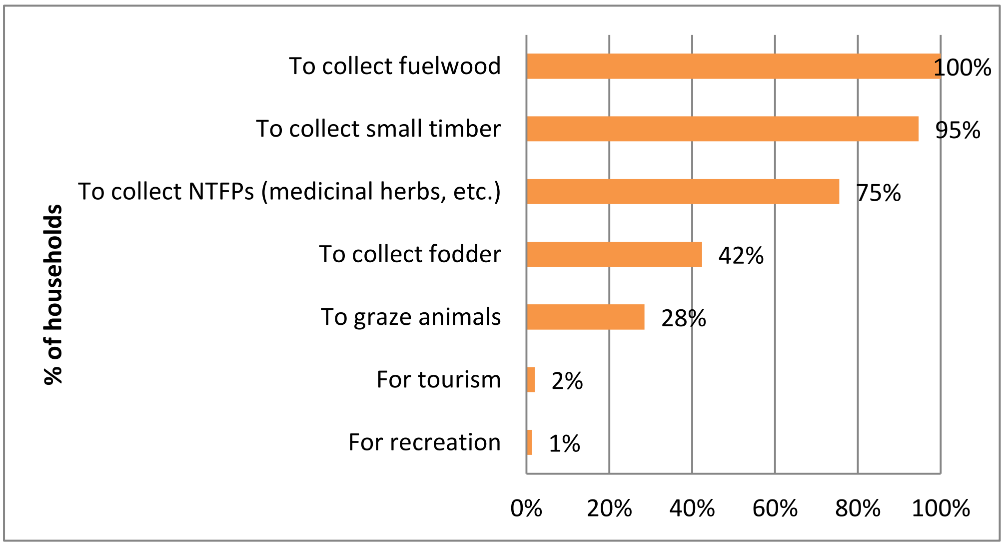
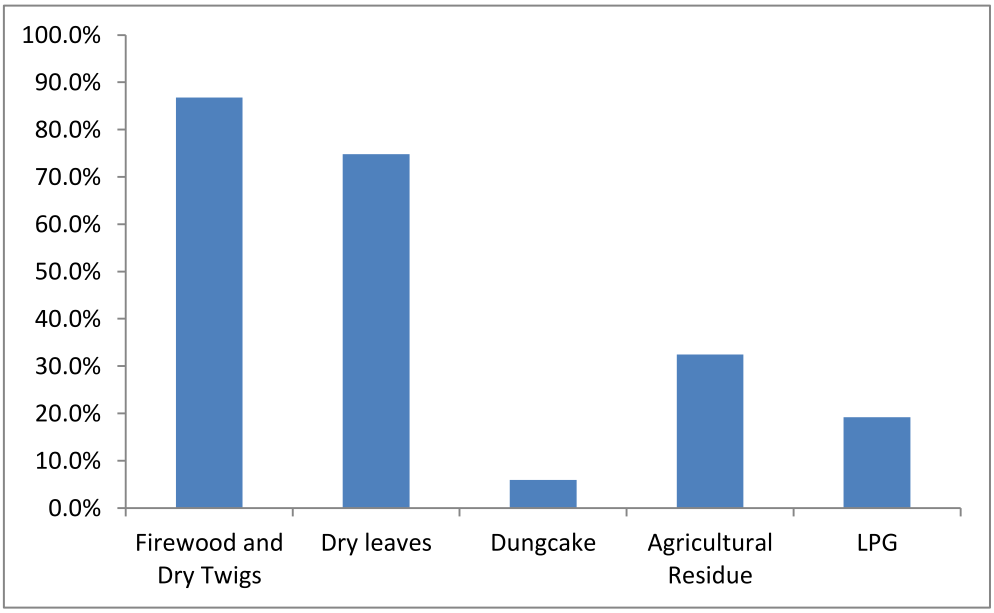


Figure 3.10 Percentage-wise distribution of causal reasons for forest access[10]

Most of the households (87%) are dependent on fuelwood as their primary fuel source while only 32.5% use LPG. A large percentage of households are also dependent on low-grade biomass sources such as dry leaves (74.8%), agricultural residue (32.5%) or dung cakes (6%) (Fig 3.15) signifying a predominantly biomass-based fuel economy.



[10] Multiple responses were possible for this question

Figure 3.11 Percentage of households dependent on various fuel sources[11]

While fuelwood is an important fuel source for all the households surveyed, in terms of sources of collection, all the households collected firewood from the Reserve Forest, while 35% collected firewood from Van Panchayats and only 4% collected fuelwood from Civil-soyam forests. Village trees and private sources also provided firewood to 18% and 3% of households surveyed respectively, accounting for a much lower percentage of total fuelwood collection. Forests were indisputably the main source of firewood (Fig 3.16) with the most pressure imposed on Reserve Forests. The households collect an average of 1500±130.63 (SE) kg of fuelwood per household per year. This figure appears to be fairly conservative. According to the 68th round of NSSO (National Sample Survey Organization consumer expenditure), in 2011/ 12, the average monthly per household consumption of firewood for Uttarakhand was estimated at 260.71 kg in rural areas and 204.1 kg in urban areas (NSSO, 68th round, 2012), This translates into roughly 3132 kg per household per year for Uttarakhand. However, of this NSSO figure it is not clear how much is collected from forests and how much from other sources. Our figures translate to 14480 tonnes of annual fuelwood collection in all the villages sampled[12]. This translates into fuelwood usage of 1223.46 kg per ha or 1.69 cum/ ha. Using a price of fuelwood of Rs 849 per cum the value of fuelwood per ha is estimated at Rs 1433.

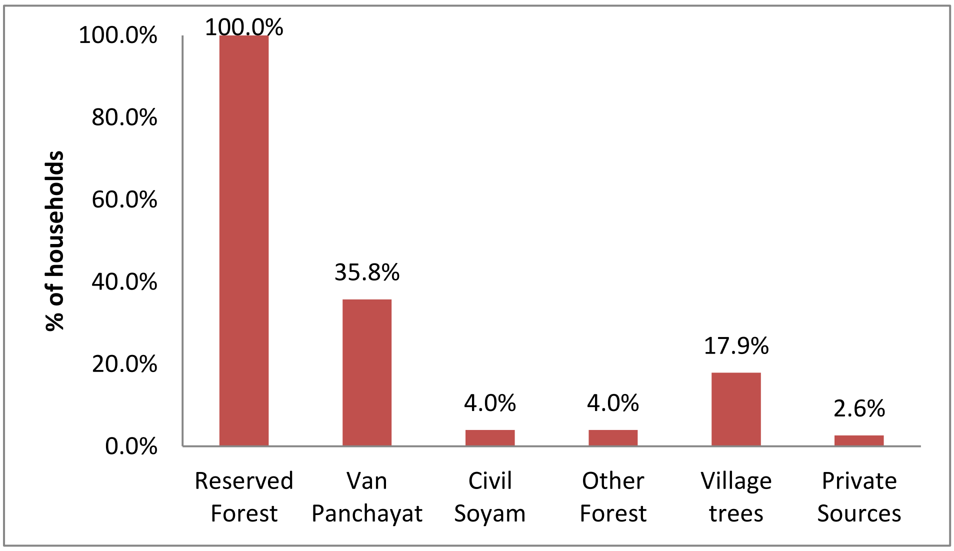


Figure 3.12 Percentage of households collecting firewood from various sources

On average, each household collects firewood 2.6 ±2.3 (SD) times a week with an average quantity of 35.2 kg ± 30 (SD) collected every week. On average it takes 3.4 ±1.4 (SD) hours

[11] Multiple responses were possible in this question

[12] This is calculated based on population figures of the villages sampled from the 2011 census.

per visit. Each household sends 1-2 members for fuelwood collection. Greenwood accounts for an average of 14.31% of the total fuelwood collection (14.31 ±6.6 (SD)).Amongst NTFPs collected from the forest, wild vegetables and fruits accounted for the majority of forest products (Fig 3.17).

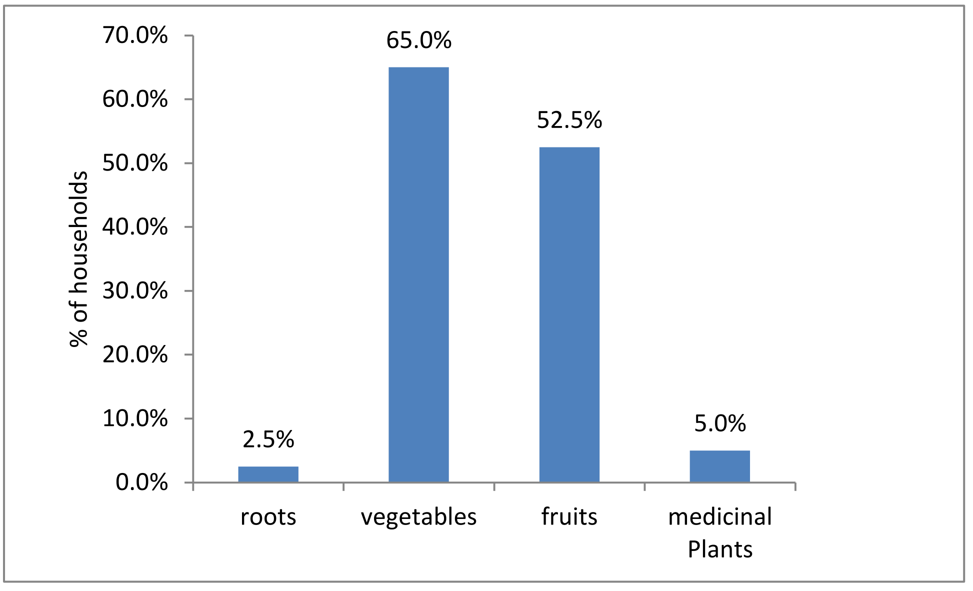


Figure 3.13 Products collected from the forest (in percentage of households)

3.3.4 Perceptions of forest status and its impacts

Sixty two percent of the households surveyed found that forest quality had decreased in the last decade. In terms of availability of fuelwood, 33% felt it had decreased while 46% felt it had remained the same and 21% felt it had increased. Reasons for the decrease in availability were attributed to increased degradation (the majority at 72%), the need to walk increasing distances (20%), and the increase in hours taken to collect fuelwood (8%). Interestingly, the minority who reported an increase in fuelwood attributed this to prohibition of use by the forest department (84%) in reserve forests and community-imposed bans (16%) in Van Panchayats, indicating that efforts to protect the forest appeared to have an impact on forest status. However, remote sensing maps of land use change point to decreasing forest cover. Only 20% felt that timber had decreased in the last decade while the majority 61% felt it had remained the same. This is consistent with studies of the forests of Uttarakhand cited earlier (e.g. Baland et al. (2006) which indicate decreases in forest quality rather than in tree stock density. Similar reasons as for fuelwood were given for increases and decreases in availability of timber. In terms of forest products collected, of the 41% who responded, 13% found their availability had decreased while the majority felt it had remained the same (25%). For fodder, of the 50% of people who responded, 14% felt it had decreased while 33% felt it had remained the same. Decreases in availability of fodder were squarely blamed on the prohibition bans of the forest department (100% of respondents who felt it had decreased).These indicators suggest a decline in forest status and increased hardship in forest product collection for some, but not all the sampled houses, perhaps related to the accessibility of different types of forest (RF, VP or civil-soyam).

About 50% felt the decrease in vegetation had negatively impacted agricultural productivity while 24% felt that soil erosion had also increased due to forest degradation and 33% felt that deteriorating forest status had impacted the quantum and 26% the distribution of rainfall in the area. As many as 38% of the households felt that vegetation decline had impacted the number of rainy days in the area. About 30% of respondents indicated that increases in summer temperatures were attributable to forest degradation. The respondents also reported an effect on water-as many as 33% of respondents felt that the availability of drinking water had decreased while 19% of respondents perceived a reduction in quality of water.

Interestingly as many as 56% of the respondents, felt that decreasing vegetation status had enhanced the migration rate while 47% felt that decreasing vegetation status had necessitated their looking for non-farm work. The response of the local community to these changes in livelihood systems relates to their coping and adaptation capacity. Short-term actions are termed as coping strategies whereas longer term actions are called adaptation (Osbahr et al, 2008). Both the coping and adaptation responses vary among the individuals within a community and are influenced by a host of factors affecting their livelihood system. What is evident in our study villages is that local communities are adjusting to vegetation degradation. In an area where land fragmentation is high and most people are marginal farmers or landless, people are highly dependent on forests. Decreasing forest status impacts agricultural productivity as well as their access to forest products for subsistence or sale. This in turn forces shifts to non-farm sources of income or out-migration.

3.3.5 Impact of tourism

A significant proportion of the sampled households (44%) benefitted from ecotourism while as many as 48% of households wanted tourism to be developed as the primary activity in the area. Eighty percent of households that felt the need to boost ecotourism cited low incomes derived from agriculture and migration as the primary rationale for this. Interestingly, many respondents viewed ecotourism as a means to protect the forest (51%) and reduce dependence on them (49%) (Fig. 3.18). They evidently view ecotourism as being less detrimental to forest management.

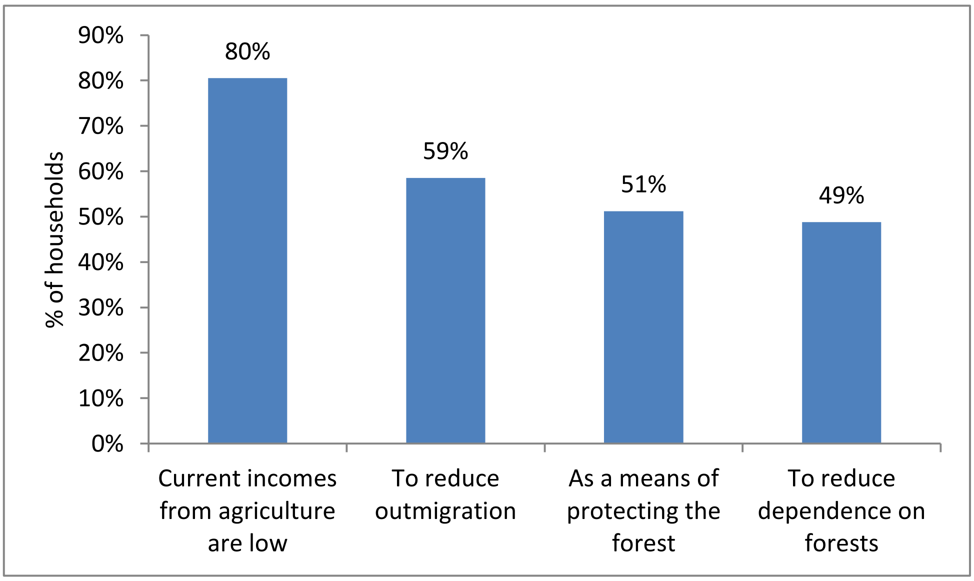


Figure 3.14 Reasons cited for strengthening ecotourism in the area

Photo 3.5 Community-based ecotourism hut in Devalsari

Photo 3.6 A quaint forest resthouse in Devalsari

3.3.6 Perceptions and ranking of forest value by community stakeholders

Perceptions of ecosystem services derived from forests

The village community was asked for their relative ranking of five different services provided by the forests and their perceptions of relative importance. We used AHP to arrive at the rankings. Interestingly, the people ranked biodiversity the highest, perhaps realising its importance for tourism as also in providing ecosystem services and ensuring forest resilience. Ecotourism ranked the second highest given that Dhanaulti is a popular tourist destination and Devalsari is slowly developing its tourism potential. Given the enormous dependence on forests for their livelihood needs, this was ranked next followed by forest products (e.g. NTFPs) and then grazing.

Table 3.7 Perceptions of ecosystem services provided by the forests[13]

Criteria	Final weights	Rank		
Biodiversity	0.246	1		
Grazing	0.144	5	Consistency Index (CI)	-0.179
Ecotourism	0.262	2	Random consistency Index (RI)	1.12
Livelihood	0.191	3	Consistency Ratio (CR)*	-0.161
Forest Products	0.158	4		

*Only abbreviations are used in subsequent tables

Importance of forest products

The local communities are dependent on a wide range of forest products. When asked to rank the value of forest products derived from the forests, fuelwood was ranked the highest (Table 3.8). This is not surprising given the almost complete dependence on forests for fuelwood and since it is the dominant forest product collected by households. Timber was ranked second, followed by fodder, medicinal plants, and then wild food. Timber is a high value product in terms of its market value and the high revenues it fetches. In general the ranking of forest products indicates the extent to which local communities are dependent on, and hence value these forest resources.

Table 3.8 Ranking of forest products

Scenario	Final weights	Rank		
Fuel-wood	0.281	1	CI	-.01
Fodder	0.206	3	RI	1.12
Timber	0.208	2	CR	.00

[13] Detailed tables are provided in Appendix

Scenario	Final weights	Rank
Medicinal Plant	0.161	4
Wild food	0.144	5

Benefits accrued from forest conservation

For the benefits accruing from forest conservation, the people rated additional sources of income and employment, increased availability of forest produce, increased availability of clean air, increased availability of water and wildlife, in that order. Again the utilitarian view for protecting forests- as sources of important subsistence and livelihood needs dominated the perception rankings. Increase in wildlife is valued the least, possibly because of human-animal conflicts resulting from population increases in species like wildboar or nilgai that damage agricultural crops.

Table 3.9 Benefits accrued from forest conservation

Criteria	Final weights	Rank		
Additional source of income and employment	0.253	1		
Increased availability of clean air	0.191	3	CI	-0.15
Increased availability of forest produce	0.243	2	RI	1.12
Increased availability of water	0.168	4	CR	-0.13
Increased availability of wildlife	0.145	5		

Ranking of various types of forests in terms of forest management and conservation

The highest score was given to Reserve Forests, possibly because they are the well-conserved in the area, while Van Panchayats are ranked second. Civil-soyam forests, that in general are highly degraded and poorly managed, ranked last.

Table 3.10 Ranking of forest management regimes with regard to their existing strategies

Criteria	Final weights	Rank		
Van Panchayat	0.35	2	CI	0.002
Reserve Forest	0.43	1	RI	0.58
Civil Soyam	0.22	3	CR	0.003

Impact of forest management regime on availability of forest products

The perceptions of people in terms of which forest management regime resulted in the highest collection of forest products were determined. Reserve forests ranked the highest followed by Van Panchayats and then Civil-Soyam forests. This could be due to two reasons

a) Parts of Van Panchayats are often closed to community-usage and hence forest product collection is restricted while RFs are easier to access and/ or Reserve Forests are better managed by the forest department, are less degraded and hence provide more forest products.

Table 3.11 Ranking forest management authorities in regard to access to forest products collection

Criteria	Final weights	Rank		
Van Panchayat	0.34	2	CI	0.0012
Reserve forest	0.43	1	RI	0.58
Civil Soyam	0.23	3	CR	0.002

The current study is the first application of AHP to forest management in Uttarakhand. Many of the perceptions are intuitive since the local communities lives are closely linked to the status of their forests. The results also suggest that apart from forest products, their importance also lies in their biodiversity and ecotourism value. These perceptions underline the need to support ecotourism as an important activity and expand its reach-for example to Devalsari, which currently witnesses limited tourism. This AHP perception ranking can play an important role in forest management, and can be used to involve local communities in the decision-making process.

3.3.7 Land Use and Land Use Change

The LULC data for Dhanaulti, an important tourism spot of Tehri Garhwal indicates that the largest declines in dense forest cover occurred between 1989 to 2015 (Fig 3.19, Table 3.12). Following creation of Uttarakhand in 2000, large decreases in dense forest continued to occur-a decrease of 1414.53 ha. Correspondingly open forests increased following Uttarakhand formation, due to conversion from dense to open forests. Wastelands have also increased by 236.25 ha from 1989-2015 and 16.56 ha between 2001 and 2015. Habitation increased marginally between 2001-2015 by 12.96 ha. However, agriculture has increased substantially suggesting that some forest cover has been diverted to agriculture in the same time period (448.83 ha).

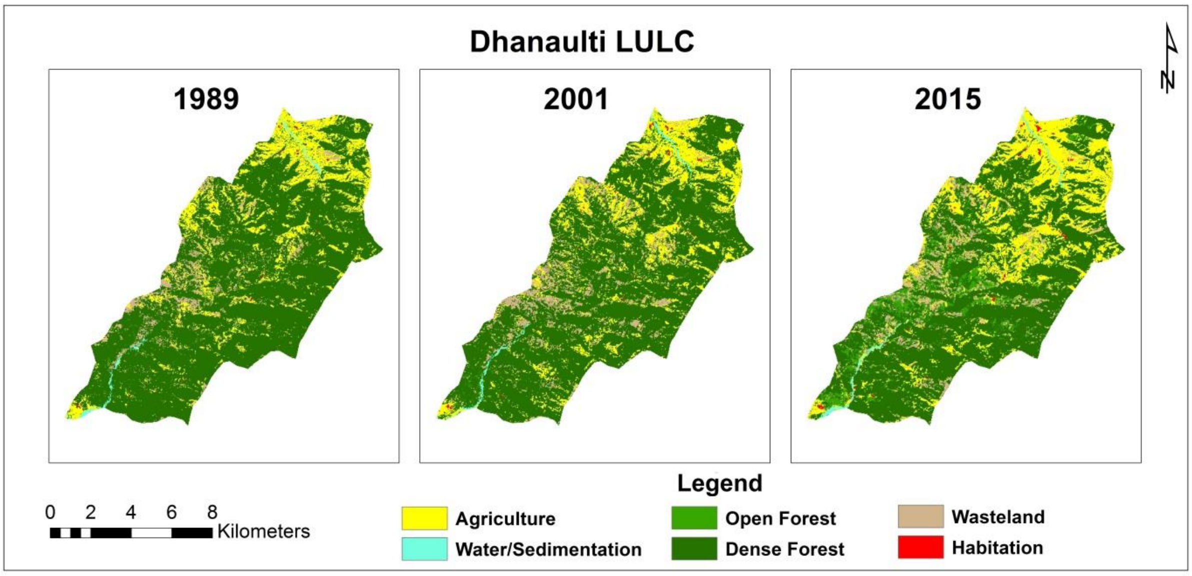


Figure 3.19 Maps indicating land use and land cover (LULC) in 1989, 2001 and 2015 in Dhanaulti MWS, Tehri Garhwal

Table 3.12 Land use and land cover (LULC) for 3 time periods-1989, 2001 and 2015 in Dhanaulti MWS, Tehri Garhwal

Land use (in ha)	1989	2001	2015	Change 2001 to 1989	Change 2001 to 2015	Change 1989 to 2001
	(in ha)	(in ha)	(In ha)			
Agriculture	1801.71	2088.36	2537.19	286.65	448.83	735.48
Dense Forest	8794.17	8262.99	6848.46	-531.18	-1414.53	-1945.71
Open Forest	187.47	196.38	1130.58	8.91	934.2	943.11
Water/ Sedimentation	80.37	85.32	87.3	4.95	1.98	6.93
Wasteland	809.73	1029.42	1045.98	219.69	16.56	236.25
Habitation	15.03	26.01	38.97	10.98	12.96	23.94
Total	11688.48	11688.48	11688.48			

The LULC data for Devalsari indicates a steep decline in dense forest cover from 1989 to 2001 but a slight increase between 2001-2015 (Fig 3.20, Table 3.13). Open forests have, however, decreased significantly from 2001-2015, of which some must have upgraded to dense forests accounting for a dense forest increase from 2001-2015 of 18 ha. The remaining open forests were probably converted to other land uses such as wastelands or scrub or for development or agriculture, given increases in these land use categories. This signifies a net decrease in open forests of 100 ha.

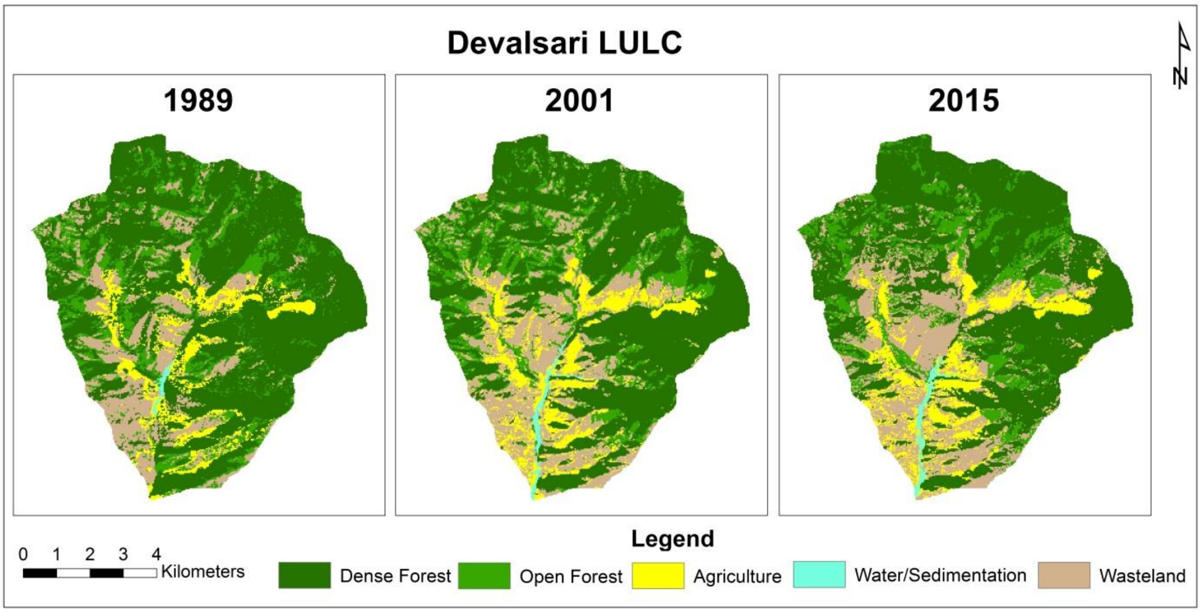


Figure 3.15 Maps indicating land use and land cover (LULC) in 1989, 2001 and 2015 in Devalsari MWS, Tehri Garhwal

Table 3.13 Land use and land cover (LULC) for 3 time periods-1989, 2001 and 2015 in Devalsari MWS, Tehri Garhwal

Area (in ha)	1989	2001	2015	Change 2001 to 1989	Change 2001 to 2015	Change 1989 to 2001
Dense Forest	3507	3009	3027	-498	18	-480
Open Forest	892	947	829	55	-118	-63
Agriculture	480	600	626	120	26	146
Water/ Sedimentation	17	48	51	31	3	34
Wasteland	942	1234	1305	292	71	363
Total	5838	5838	5838			

3.3.8 Tourism in Dhanaulti

We carried out a TCM for tourists visiting Dhanaulti as well as Devalsari. However, tourism has not picked up sufficiently in Devalsari and only 2 tourists responded from this area. Consequently, the results of this TCM relate to Dhanaulti.

Demographic profile of respondents and tourists

The majority of tourists had a higher secondary education (59%), while the number of graduates was lower at 26% (Fig 3.21). In terms of the gender profile of respondents 91% were male- males provided the most responses, even when couples or families were interviewed. The average family size was 4.6±0.13. Almost 93% were Hindus[14] with a small proportion of Muslims (4%) and Sikhs (3%)

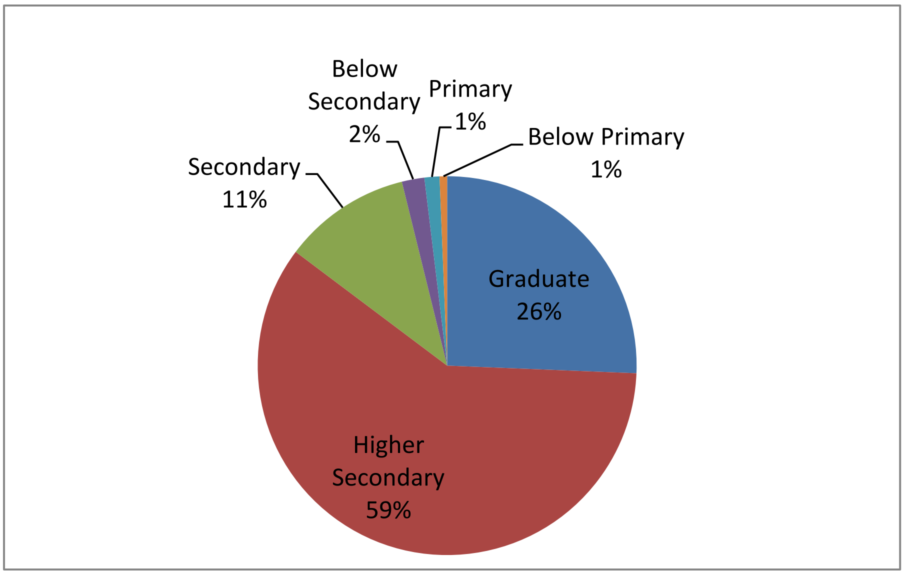


Figure 3.16 Education profile of the tourists

Permanent salaried employees (33%) and the self-employed (20%) comprise the bulk of the tourist population (Fig 3.22). Students are also a significant proportion (29%) and are particularly likely to value the area for adventure or nature tourism including treks, bird, butterfly, wildlife and nature watching.

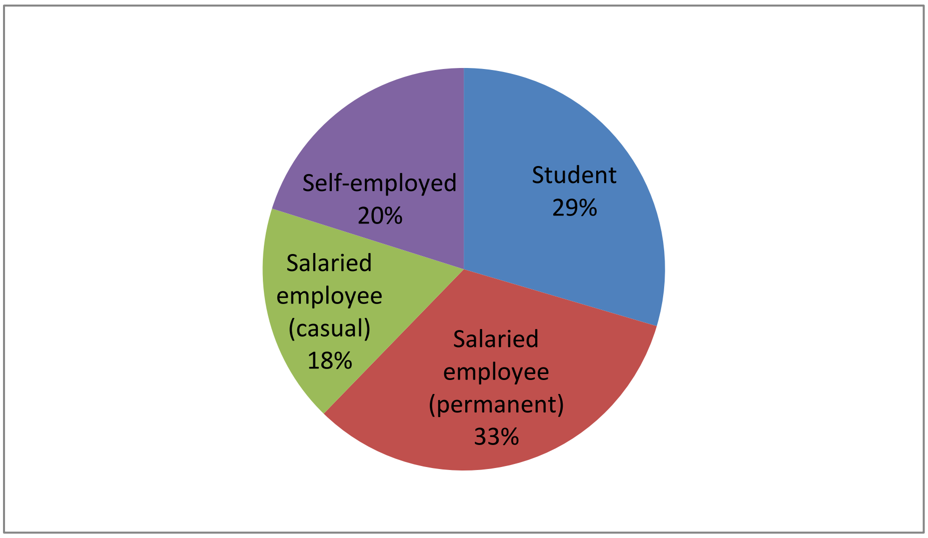


Figure 3.17 Occupation profile of the tourists

[14] Dhanaulti is also an important pilgrimage spot because of a number of Hindu shrines especially Surkanda Devi temple

Most of the people owned a house (68%) or utilised free accommodation[15] while 5% lived in rented accommodation. The average monthly rentals for those owning their own house was Rs 5378±544 (SE). The average incomes suggest that our sample on average consisted of a middle-class population (Rs 34,385±2620.84 (SE). The high standard error, however, indicates much variation in the data ranging from Rs 12000 to Rs 2,50,000.

Travel details of the tourists

The average number of days spent by the tourists was 2.5 days (2.48 ±0.11 (SE)), with a median of 2 days. Only 6.2% of the tourists spent more than 5 days at the site. Most of the tourists came on a family holiday (`60 %) while 32% came in groups of friends or colleagues. The average number of people in each group was 3.92 ±2.9 (SD), while the mean number of males, females and children (<16 years) were 1.92 ±1.7 (SD), 1.61±1.3 (SD), 1.52 ±0.8 (SD), respectively. Thus adult males outnumbered adult females marginally (median of 2 versus 1). As many as 73% of visitors came in small groups (group sizes of ≤ 4) while the largest group consisted of 30 individuals.

The majority of tourists were from neighbouring states or local tourists from Uttarakhand. (Fig 3.23). The average of the total number of annual visits to Dhanaulti was 1.05.

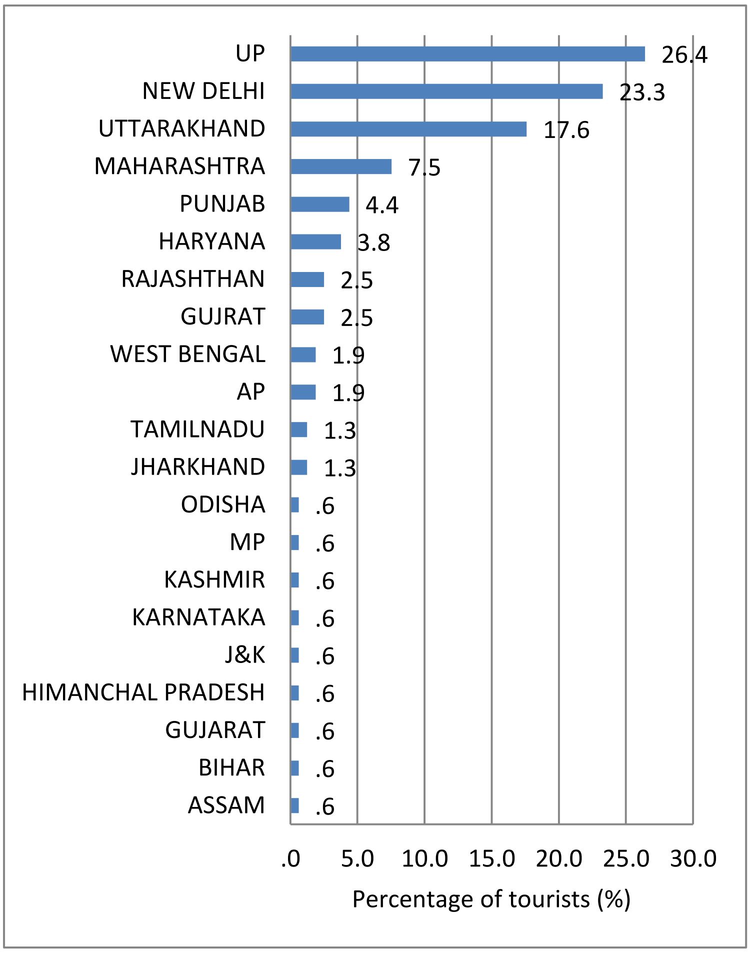


Figure 3.18 Place of origin of the tourists (in %)

[15] Government employees are normally provided with accommodation

Consequently, the majority of tourists (54.7%) travelled a maximum distance of 101-400 km to reach their destination, while 21.4% travelled more than 1000 km to reach their destination. Only 13.2 percent of visitors travelled less than 100 km (Fig 3.24).

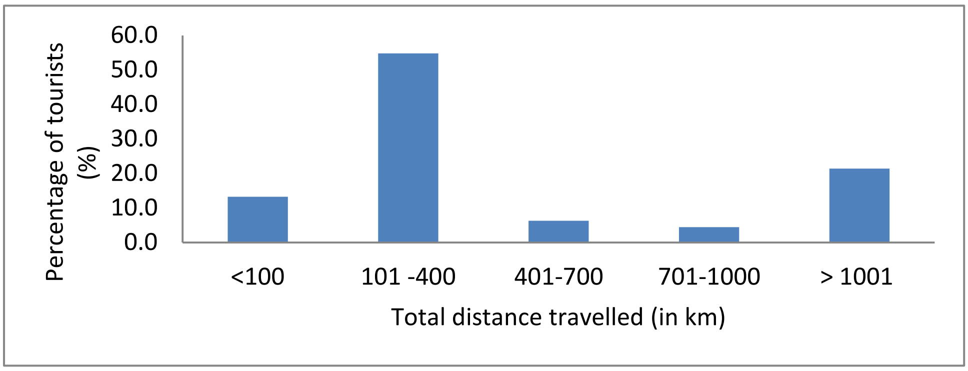


Figure 3.19 Distance travelled to their destination (% of tourists)

Since most of the tourists were from nearby areas, the primary mode of transport was by bus (76% while only 6.3% of visitors reached Dehradun (the nearest airport) by air (Fig 3.25). Naturally, 89 % of visitors had spent on local travel of which the preferred mode of transport was a taxi (79.7%) followed by an auto (10.5%). Mules were used by 9.2% of visitors. The mean expenditure on local travel was Rs 2501 although there was much variation in this figure from a minimum of Rs 200 to a maximum of Rs 18050.

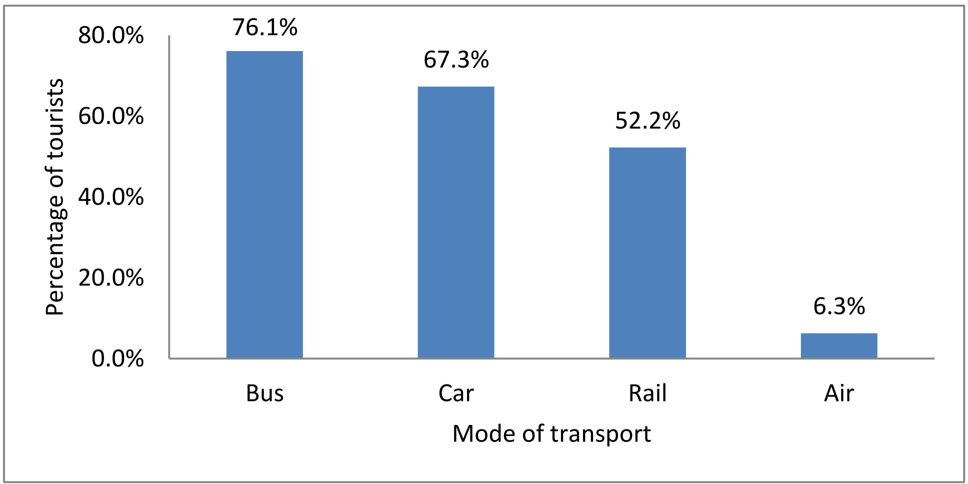


Figure 3.20 Primary mode of transport (in percentage of tourists who used these modes)

As many as 91% of the visitors had visited Uttarakhand 3 times or less while only 8.6% had visited more than 3 times. Overall, 65.4% of visitors were on a repeat visit to Uttarakhand.

Only 32.1% of visitors were aware of another recreational/ biodiversity site within Uttarakhand that they would prefer to visit. Amongst those that were 89% suggested Mussoorie while 7% suggested Rishikesh and 2% suggested Nainital

The primary expenditure of the tourists is provided in Fig 3.26. The highest expenditure was on local cuisine followed by temples and religious activities. A significant percentage of people (30%) visiting these areas were interested in nature tourism and spent on bird and butterfly guides and tours. Expenditure on the Uttarakhand Bird Festival, however, was limited to only 1% of the visitors. The estimated mean per head expenditure was Rs 12470.

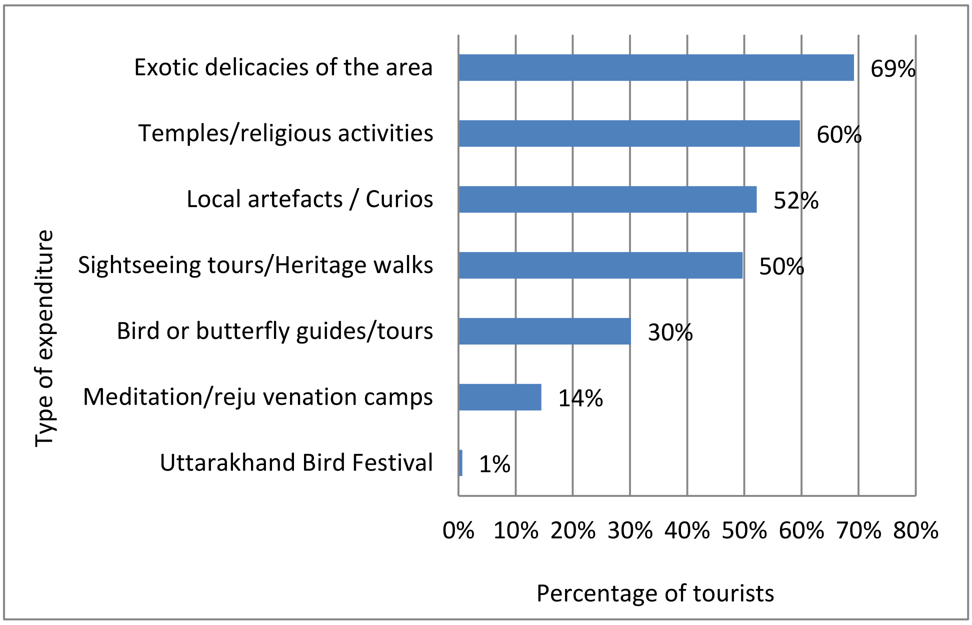


Figure 3.21 Type of expenditure (in % of tourists)

The tourist experience

For the tourists the most important attributes of Dhanaulti was its biodiversity value (98.7% of tourists). These figures suggest that loss of forest cover, degradation and biodiversity loss will endanger this area as a major tourist spot. Nevertheless, its importance as a religious spot has led to 72% valuing these attributes (Fig 3.27). Other important attributes is the experience it provides in terms of trekking. As many as 83% of the tourists were satisfied by the recreational benefits provided by the forests with 64% of tourists rating them as good or very good and the remaining rating the quality of recreational benefits as fair.

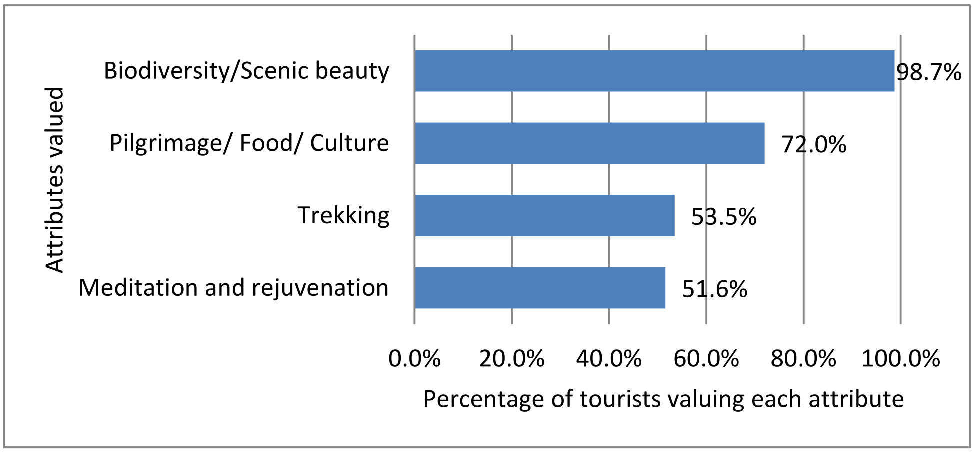


Figure 3.22 Attributes valued by tourists (in percentage of tourists rating each attribute)[16]

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[16] Multiple responses were possible.

Photo 3.7 Himalayan bluetail or Himalayan red-flanked bush-robin (*Tarsiger rufilatus*)

Photo 3.8 Green-backed Tit (*Parus monticolus*)

Photo 3.9 Deodar forests touching the sky

When tourists were asked about the improvements they would like to see in the area, they provided the following assessment (Fig 3.28). 73% of the people wanted to have enhanced sightseeing facilities and improved road conditions. The lack of trained guides was also a big drawback (65%). Several of the indicators suggested that people would like to see improvements in walking trails (53%), bird and butterfly watching facilites as well as local field guides or brochures highlighting biodiversity hotspots (30%), and appropriate signate (34%). Presence of toilets and the need for improved waste disposal were also considered important.

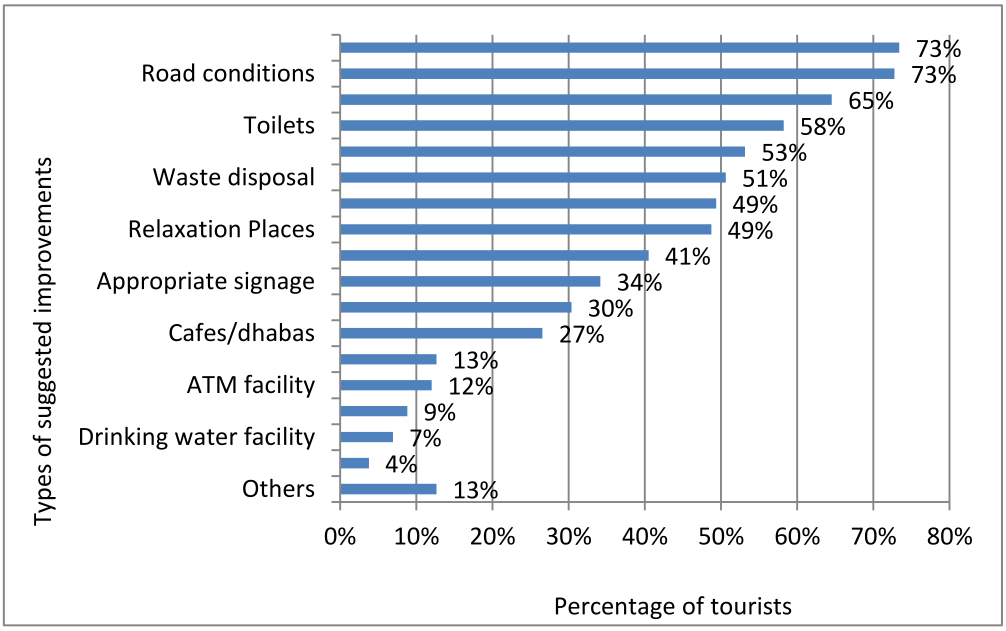

Figure 3.23 Suggested ways to enhance the recreational experience (Percentage of tourists)

Results of the TCM to estimate recreational demand

In the basic model, the number of visits to Uttarakhand is a function of factors such as the travel cost, total household income, age and gender. Having tried various functional forms, the linear functional form provided the best fit of our data.

Thus, the model may be specified as follows:

r_i = ß0 + ß1 travel cost + ß2 household income + ß3 age of visitor + β4 gender[17] +β5 biodiversity+β6 Meditation+ ei .

Where r_i the dependent variable, is the number of visits by the ith individual to Uttarakhand per unit of time. The explanatory variables are travel costs, household income, age of the visitor and attributes of the site including biodiversity-related activities and meditation.

Table 3.14 Parameter estimates of the linear regression model

Parameters	**Coeff (S.E)**
Constant	1.136 *** (.262)
Total household income	--3.39e-06(9.66e-06)
Travel cost	-.0006**(0.0003)
Age	.0038(0.008)
Gender	.0996(0.276)
Biodiversity of the site	.0056***(0.318)
Meditation	-.282*(0.216)
R^2	0.1
Number of observations	157

*****1% significance level, **5% significance level, *10% significance level with two- tailed tests**

Parameter estimates of the linear regression model are in Table 3.16. As expected, high travel costs incurred by individuals are inversely related to visitation rates (see Ortacesme., 2002, Khan, 2006). Thus the higher the travel cost paid by the tourists to reach Uttarakhand, the less frequently they visit. The household income has a negative relationship with demand for recreational activities although it is not significant. Age and gender are not significant factors in determining visitation rates to the site. This is in line the results of Ali et al., 2011. Visitors value the site for its biodiversity value (this is highly significant) although most people do not think that activities like meditation add to the value of the area.

Estimation of consumer surplus

The individual consumer surplus was estimated as Rs $-((1.05)^2) / (2(0.0006))$= Rs 918.75 using equation

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[17] A dummy variable was used where males=0 and females=1

$CS = r^2 / -2\beta_{SL}$ where

CS: Consumer surplus

β_{SL}: Curve of the demand function (cost coefficient) (ie. ß1 of the travel cost in the regression equation cited earlier).

Or $CS = r^2 / -2\beta_1$

The number of Indian tourists that visited Mussoorie in 2005 was 1050245 (ACNielsen ORG-MARG 2008). We use this figure to determine the total recreational demand for Dhanaulti, conservatively assuming that about 20% of the people who visit Mussoorie also visit Dhanaulti, that is 210049 people. The proximity of Mussoorie to Dhanaulti suggests that this is plausible in the absence of any more accurate information and this figure is probably conservative. Using this figure, the total consumer surplus amounts to Rs 0.1 billion. With a forest area for Dhanaulti of 7979.04 ha, this works out to a consumer surplus Rs 24,186 per ha of forest area.

We estimate the present value of the benefits from recreation in Dhanaulti (Table 3.15). This is Rs 2.5 billion at a discount rate of 4%. We measure benefits in perpetuity assuming that the forest ecosystems in Uttarakhand will be preserved in their natural state indefinitely. This recreational benefit is only one of the several benefit accrued from the forest ecosystem of Dhanaulti. If the others benefits are also included the present value will increase further.

Table 3.15 Present value of benefits from recreation in Dhanaulti

Head	**Amount (in billion Rs)**	**Per ha value (Rs)**
Total Consumer surplus	0.1	24,186
PVB (at 4%)	2.5	3,13,320.9

3.3.9 Valuation of forest degradation in Dhanaulti and Devalsari

The costs of forest degradation for Dhanaulti and Devalsari from 2001-2015 using values obtained from the primary survey for fodder, fuelwood and ecotourism (recreation) and secondary values from Verma (2014) for the remaining ecosystem services are Rs 97.8 million. We calculated an NPV over 25 years using a 4% discount rate as per Verma (2014). The loss in in NPV of forests from 2001-2015 is Rs 0.049 million per ha.

3.3.10 Scenario development

Cost of forest degradation in 2030

The forest cover in 2030 was projected for Dhanaulti and Devalsari. These are provided below (Figure 3.29 to Figure 3.38 and Table 3.16 and Table 3.17). These figures were used to determine the costs of forest degradation from 2001-2030 for these areas. This was assumed to be the Business As Usual (BAU) scenario if the current pace of forest degradation continues.

Dhanaulti 2030 LULC scenarios

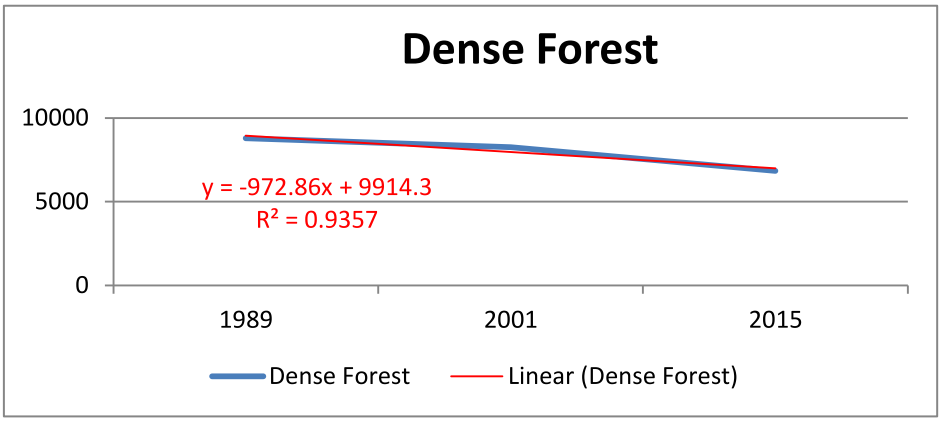

Figure 3.29 Projected dense forest cover for 2030

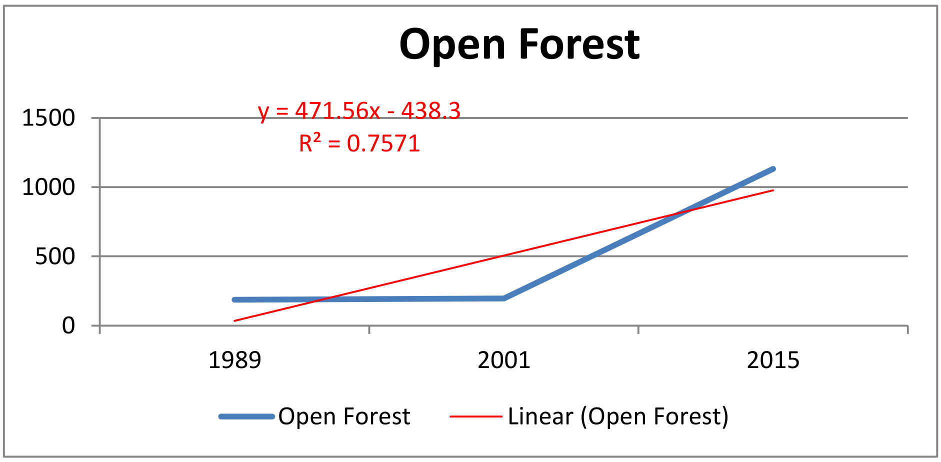

Figure 3.24 Projected open forest cover for 2030

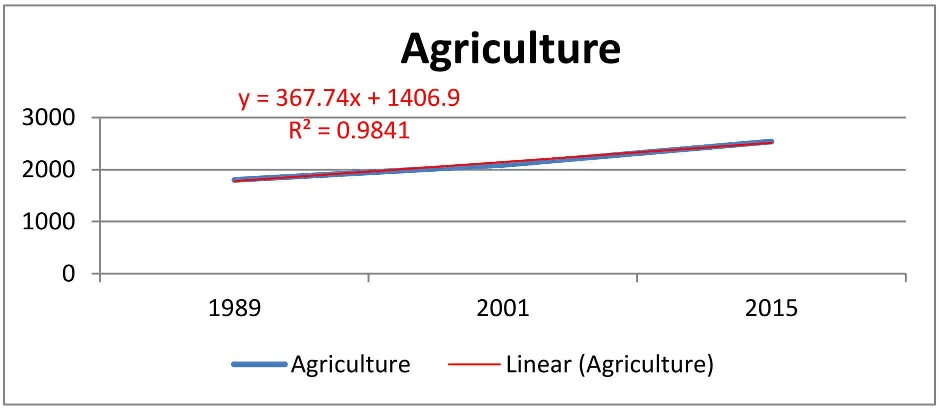

Figure 3.25 Projected agricultural cover for 2030

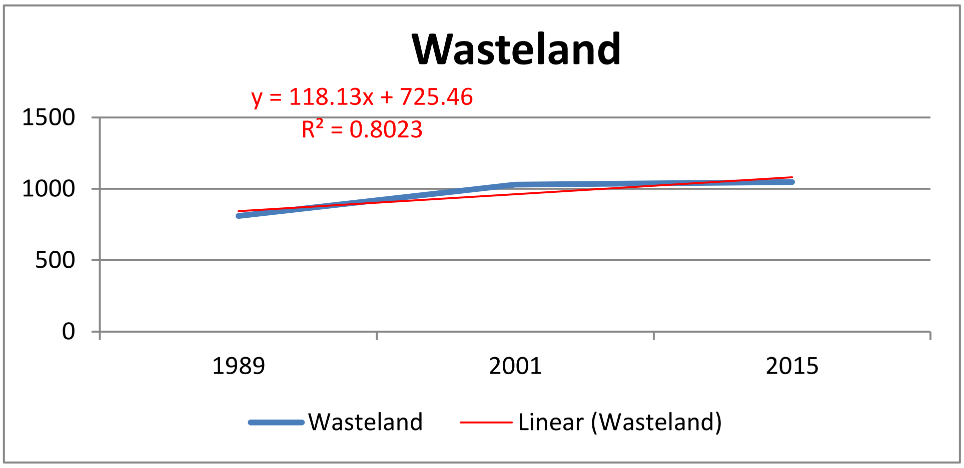

Figure 3.26 Projected wasteland cover for 2030

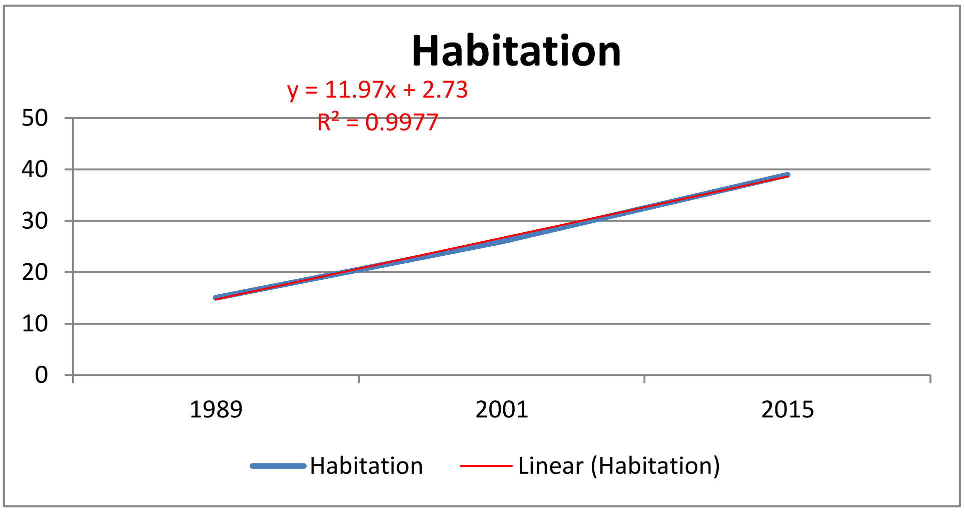

Figure 3.27 Projected habitation cover for 2030

Table 3.16 LULC for Dhanulti projected in 2030

	1989	**2001**	**2015**	**2030**
Agriculture	1801.71	2088.36	2537.19	2877.86
Dense Forest	8794.17	8262.99	6848.46	6022.86
Open Forest	187.47	196.38	1130.58	1447.94
Wasteland	809.73	1029.42	1045.98	1197.98
Habitation	15.03	26.01	38.97	50.61
Water/ Sedimentation	80.37	85.32	87.30	91.23
Total	**11688.48**	**11688.48**	**11688.48**	**11688.48**

Devalsari 2030 LULC scenarios

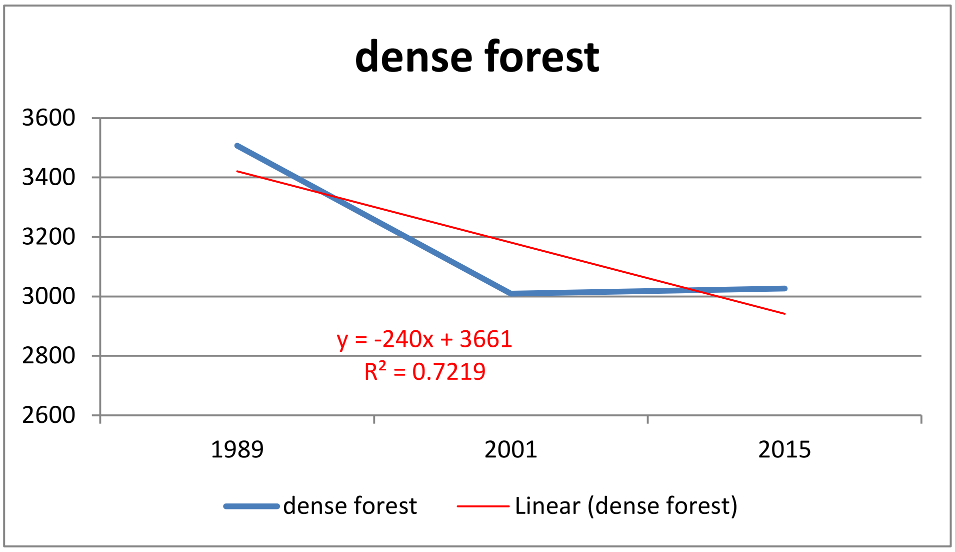

Figure 3.28 Projected dense forest cover for 2030

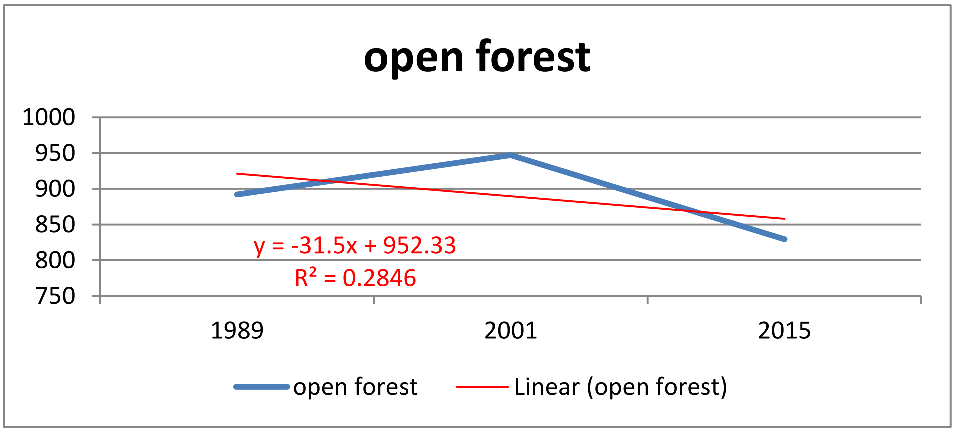

Figure 3.29 Projected open forest cover for 2030

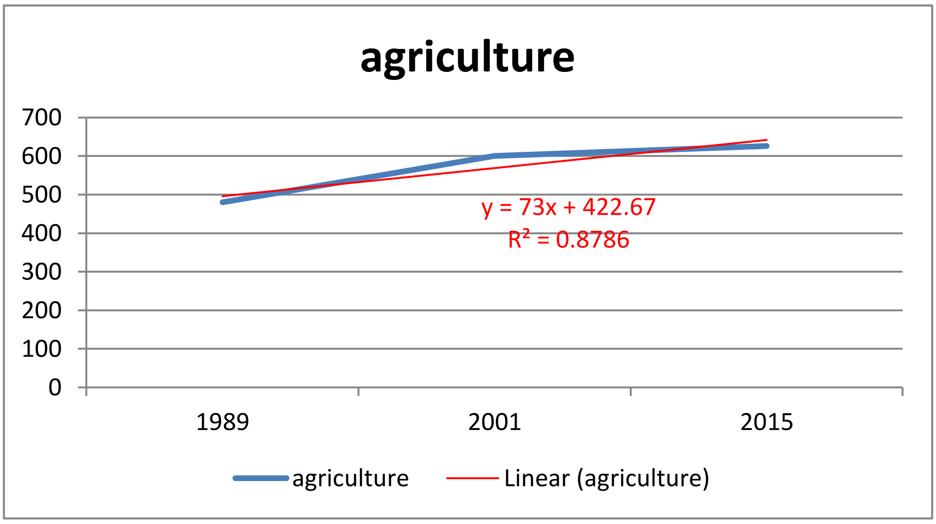

Figure 3.30 Projected agricultural cover for 2030

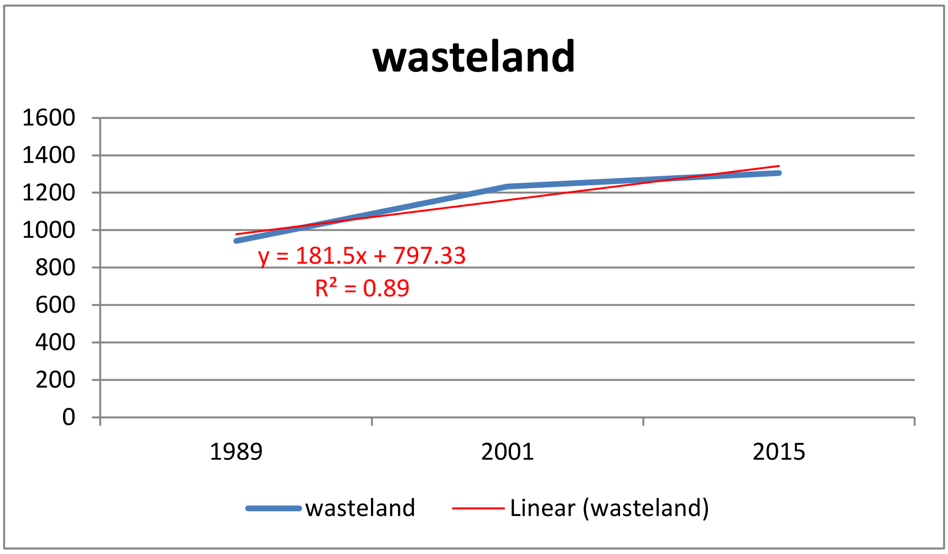

Figure 3.31 Projected wasteland cover for 2030

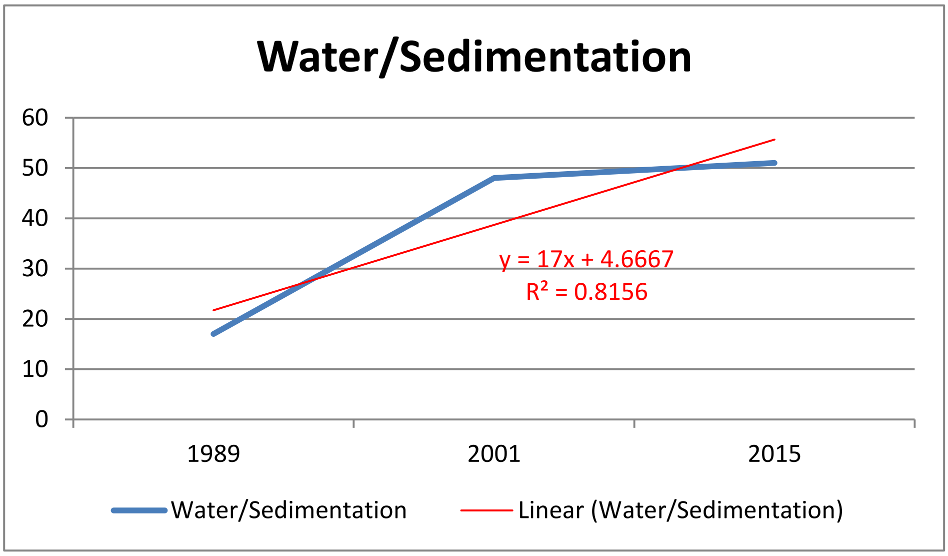

Figure 3.32 Projected water/sedimentation cover for 2030

Table 3.17 LULC for Devalsari projected in 2030

	1989	2001	2015	2030
Dense forest	3507	3009	3027	2701
Open forest	892	947	829	826
Agriculture	480	600	626	715
Wasteland	942	1234	1305	1523

	1989	2001	2015	2030
Water/ Sedimentation	17	48	51	73
total	5838	5838	5838	5838

The costs of forest degradation for Dhanaulti and Devalsari from 2001-2030 using the values for forest cover projected above and the values obtained from the primary survey for fodder, fuelwood and ecotourism (recreation) and secondary values from Verma (2014) for the remaining ecosystem services are Rs 1087.8 million (at 2013 prices). We calculated an NPV over 25 years using a 4% discount rate as per Verma (2014). The loss in in NPV of forests from 2001-2030 is Rs 0.187 million per ha (at 2013 prices).

Costs of forest reclamation till 2030

The cost of reclaiming degraded forests in 2030 was determined. The cost norms as per NAP guidelines (2009) are Rs 37085 per ha for artificial regeneration and Rs 27,163 for natural regeneration. We assume that open forests will require higher costs of regeneration as compared to moderately dense forests and hence utilise the value of Rs 37,085/ ha at 2009 prices to determine the costs of reclaiming degraded forests.We convert these to 2013 prices using the WPI which works out to Rs 49,853.85 per ha. This leads to a cost of Rs 41.2 million to reclaim open forests in 2030 in Devalsari (826 ha of open forests). For Dhanaulti, the costs of reclaiming open forests in 2030 would be Rs 72.2 million (for 1447.94 ha of open forests). Therefore, the total costs of forest regeneration in Dhanaulti and Devalsari in 2030 (at 2013 prices) would be Rs 113.4 million. The costs of forest reclamation of Dhanaulti and Devalsari (Rs 113.4 million) are only 10% of the costs of degradation projected above (Rs 1087.8 million), and hence it makes economic sense for the State to focus on a) prevention of degradation and b) forest reclamation.

3.4 Conclusion

The results from this study underline the high costs associated with forest degradation. It also strengthens the conclusion of other studies from Uttarakhand that one of the primary causes of forest degradation in the State is fuelwood collection (Baland, TERI, 2014). Most of the households (87%) were dependent on fuelwood as their primary fuel source and forests were indisputably the main source of firewood with the most pressure imposed on Reserve Forests. The local communities also rated fuelwood as the most valued product derived from the forests. The households collect an average of 1500±130.63 (SE) kg of fuelwood per household per year. This figure translates into fuelwood usage of 1223.46 kg per ha or 1.69 cum/ ha in all the villages sampled[18]. Using a price of fuelwood of Rs 849 per cum the value of fuelwood per ha is estimated at Rs 1433. The total dry fodder consumption was 1128 kg per ha. The remote sensing assessment of land use change from 2001-2015 also underlined the large-scale conversion of dense forests to open forests (degradation) but also conversion to other land uses (e.g. agriculture) or deforestation. This suggests that in our sampled forests, deforestation is also an important reason for forest loss in the fifteen years since the creation of Uttarakhand.

The local people view ecotourism as an important activity for revenue generation that they believe will also reduce the pressure on forests. This view is echoed by the tourists (to

[18] This is calculated based on population figures of the villages sampled from the 2011 census.

Dhanaulti) for whom the most important attributes of the area was its biodiversity value (98.7% of tourists sampled). A travel cost analysis of recreational benefits provided an individual consumer surplus of Rs 918.75 and a total consumer surplus of Rs 24,186 per ha of forest area. The present value of recreational benefits is Rs 3,13,320.90 per ha of forest area (discount rate of 4%). The costs of forest degradation for Dhanaulti and Devalsari from 2001-2015 using values obtained from the primary survey for fodder, fuelwood and ecotourism (recreation) and secondary values from Verma (2014) for the remaining ecosystem services are Rs 97.8 million. We calculated an NPV over 25 years using a 4% discount rate as per Verma (2014). The loss in in NPV of forests from 2001-2015 is Rs 0.049 million per ha.

This study highlights the enormous costs of forest degradation and the need to stem this loss, particularly given that it is the second most important cause of degradation in the country and the main cause of degradation in Uttarakhand. Moreover, the costs of reclaiming forests in 2030 works out to only 10% of the costs of forest degradation. It therefore, makes more economic sense to reclaim forests rather than to degrade them. Several measures will need to be taken at national and state levels to address the pervasive issue of forest degradation, arguably one of the most important reasons for land degradation in India. These issues are discussed in detail in the macrostudy in Volume I.

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