CHAPTER - VI

Chapter VI

ECONOMIC EVALUATION OF ENVIRONMENTAL DAMAGE TO NATURAL ECOSYSTEMS

Introduction

The fast growing population and visitors number has increased tremendous pressure on the forests. Over the last three decades, there has been growing debate on the effects of tourism in developing countries. Mountaineering and trekking have recently inflicted adverse impacts on environment of high altitude areas (Jeffries 1982; Pawson *et al.* 1984; Karan & Mather 1985; Banskota & Upadhyay 1991; Zurick 1992; and Rai & Sundriyal 1997). The over used of forest resources has led to environmental threats to the Hindu-Kush Himalayan region (Thapa & Weber 1990; Willis & Garrod 1991 and Singh & Singh 1992). Dependence of fuel wood for energy is causing serious deforestation problem in national parks and protected areas of the Himalaya. National parks, wilderness and other protected natural areas represent efforts to preserve our natural heritage from further exploitation. Such areas also provide greater recreational opportunities. Protected areas of biodiversity interest provide a variety of benefits and services, which are essential for the economic development of a region.

Monetary valuation of any natural ecosystem is very difficult (Bergstron *et al.* 1990 and Dixon *et al.* 1994). In past, these areas were

valued only for products such as Timber, fuel, fodder and non-timber forest produce. Intangible benefits of these areas have not been properly accounted by the policy-makers while implementing development programs in developing countries. However, in developed countries, economic valuations of natural resources have been used in conservation and management of protected areas (Pearce *et al.* 1994 and Wilson & Carpenter 1999). Contingent valuation methods are widely applied in estimating the economic value of both marketed and non-marketed goods (Brookshire *et al.* 1983; Majid *et al.* 1983; Walsh *et al.* 1986 and Dixon & Sherman 1990).

The present chapter particularly deals with the quantitative assessment of current forest and other land-use, fuel, fodder and timber consumption pattern, impact of resource extraction on trail and Lake health. Economic valuation of the biologically rich forests of trekking corridor and lake site and valuing recreational/sacredness benefits of lake applying economic model of travel cost and contingent valuation methods. The estimation can prove useful for the added costs of fuel wood, fodder, and timber management prescriptions needed to protect critical habitats of Sikkim Himalaya. An attempt has also been made to demonstrate the practicality of developing WTP functions for managers in estimating the benefits of other environmental values of forests, such as soil erosion and recreation.

6.1 Methods

6.1.1 Analysis of forest and other land-use/covers

Satellite imagery (1: 50000), IRS-IA/IB, LISS-II and IRS-IC, FCC of bands 2, 3 and 4 were interpreted for forest cover and other land-use/cover map of the Yuksam-Dzongri-Goechha La Corridor and Sacred Khecheopalri lake employing a photo interpretation techniques for the year 1988 and 1997, in conjunction with the Survey of India topographical maps (1: 50000). Intensive field investigations were carried out to check the land-use/ cover for ground truth verification. Areas of different forest types and other land-use categories were quantified using digital planimeter.

6.1.2 Extraction of forest products

The study is based on a detailed primary survey conducted in 1997 and 1998. The firewood used and extraction of species by different stakeholders was based on a detailed survey. The samples were selected from different stakeholders using stratified random sampling method. A total of 129 stakeholders in Yuksam-Dzongri-Goechha La trekking corridor consisting of 39 households from the local communities, followed by 5 hotel/lodges, 2 groups (127 trainees and 37 staff members) of HMI trainees, 8 travel agents, 45 FIT's, 6 pack animal operators and 24 number of porters. A total of 15 stakeholders from sacred Khecheopalri lake involving 10 households from local community,

followed by 1 trekker hut and 4 tea /grocery shops. To provide proportionate representation to every socio-economic segment, the community households were stratified on the basis of the size of land holding, income status, ethnicity and caste reflecting social status. Stakeholder wise fuel wood consumption per day in each season (summer, monsoon and winter), supply of fuel wood from different sources, time taken and distance covered in fuel wood collection were collected through questionnaire survey.

The questionnaire is the most widely adopted method for gathering data on collection and consumption quantities of fuel wood. The wide use of questionnaires is probably due to the limitation of time, resources and logistic facilities (Uma Shanker *et al.* 1998). Although extensively used, the questionnaire method generates highly biased data, because most of the respondents do not give accurate information due to lack of interest, inadequate knowledge of the subject, and intentional distortion of information. Inadequate knowledge of quantities might also lead to incorrect reporting (Malhotra *et al.* 1991). However, the questionnaire method is useful for a rapid assessment and to collect qualitative information such as the names of species used for fuel wood. To avoid the biases, estimation of the actual quantity of fuel wood requirement/consumption by each stakeholder was worked out on the basis of personal observation over a period of 24 hours by adopting a

weight survey method. Simultaneously observations were also made in each sample to quantify fuel wood use for various tasks such as cooking, water heating and other purposes. During the survey the interviewer visited each sample stakeholder and requested the head person of the family to monitor the amount of fuel wood that would be burnt during that particular day. The wood was weighed by spring balance and then left in the kitchen (30 kg wood bundle) of each stakeholder with instruction to burn wood only from the given bundle. On the next day, interviewer returned to each sample household, the remaining wood was weighed and deducted from the original bundle to calculate the actual consumption per day. Time spent for fuel wood collection was noted when the members of the households went to the forests. People's response to the resource pressure faced by them, considered to be the most accurate indicators of fuel shortage, were used to examine the severity of the fuel wood problem.

The quantification of biomass utilization was focused on the stall-fed fodder consumption. The magnitude of this is important because this is closely linked and represents the primary direct removal of biomass from forest. Fodder demand was estimated through out the year. This was done by means of a survey of head-loads (weight and composition) collected on a daily basis by each household on both the sites.

Participatory Rural Appraisal (PRA) techniques were also used to collect the information of preferred species for fuel, fodder and timber, through group and key informant discussion. The estimates of the average amount of each forest product collected give some indication of the total volume of non-timber forest product (NTFP). People's response to the resource pressure faced by them, considered to be the most accurate indicators of resource shortage and were used to examine the severity of the problem.

6.1.3 Trail and lake site erosion

Trail erosion, refers specifically to assessments of processes and consequences of soil erosion on the trail tread and lake. Soil loss is particularly important because it is not self-limiting, unlike many other forms of trail impact. Entire trail and Lake site has been visited to select the observation sites. First, assessment was made for trail surface conditions at a sampling point including trail width, evaluate forest cover changes and composition. Stratified point sampling is the most common trail erosion survey due to its simplicity of implementation was followed (Hall & Kuss 1989). The trail side erosion along Yuksam-Dzongri-Goechha La corridor were measured from 5 experimental plots along altitudinal gradients considering slope, aspects, forest density and 12 experimental plots under different land-use/cover combinations in the lake watershed during 1997 and 1998 on three monsoon (pre-monsoon,

mid-monsoon and post-monsoon) season. These were estimated using natural shallow surface runoff channels and artificially delineated plots (Singh *et al.* 1983 and Rai & Sharma 1998). The delineated plot size was 10×3m for estimation of overland flow and soil loss. These plots were bounded with aluminum sheets (6 cm. inserted in the soil and remaining 15 cm. exposed in air) on all side to prevent water from entering from adjacent areas. The plots were located on slopes ranging from 15^0 to 45^0. The overland flow and soil losses along the slope were estimated from the collecting tank after each rainfall event. The eroded soils were sampled in the form of sediment settled at the bottom of the collecting tank and as suspended clay material.

6.1.4 Economic valuation

Several methods are available to evaluate the recreational/sacredness value of natural ecosystems. In this study, two independent methods for valuation of environmental goods, the Travel Cost Method (TCM) and the Contingent Valuation Method (CVM) were used. Both methods have been recommended as providing acceptable economic measures of the social benefits of recreational activities for both use and non-use values (Walsh 1986; Navrud 1992 and Cordell & Bergstrom 1993). The other method used in this type of assessment is cost-benefit analysis (Ableson 1979; Kneese 1984 and Haneley & Spash

1993), but it has a long controversial history (Hufschmidt *et al.* 1983). Several models from each of the methods were constructed.

6.1.4.1 Sampling design and data source

The study was based on a random survey of 545 respondents, consisting of 125 domestic visitors, 325 foreign visitors and 95 local community members from Yuksam-Dzongri-Goechha La trekking corridor, and 360 respondents from Khecheopalri lake site, consisting of 50 members of the local community, 140 pilgrims (from within Sikkim), 95 domestic and 75 foreign visitors in 1997-98. Categories of respondents were the international tourists termed as foreign, the Indian tourists as domestic and the people living in the area as local community. Out of the total only respondents 243 (31 local people, 50 domestic visitors and162 foreign visitors) in trekking corridor and 180 respondents (20 community members, followed by 34 domestic visitors, 51 foreign visitors and 75 pilgrims) showed their willingness-to-pay (WTP) for conservation and protection of the trekking corridor and lake, while others refused. Travel costs incurred by individuals in visiting the lake were estimated using a sample of 140 pilgrims, who completed travel expense information. The interviews were conducted through a structured questionnaire (Bishop & Heborlein 1992 and Arrow *et al.* 1993) over a period of six months (March to May and October to December), corresponding with two peak tourist seasons. The sampling was random and took place at different

times of a day and during all days of the week to ensure a representative sample. At the outset, the interviewer introduced herself to the respondent. Respondents were told about the nature of the work and assured that responses were to be used for research purposes, that their co-operation to this effort was sought, and confidentiality would be maintained. A brochure containing general information about the KNP and lake and about some of the environmentally sensitive issues of both the sites were facing was presented at a specific point in the course of the interview. Hence, all respondents were brought to a minimum level of information about the benefits of preserving and maintaining the sites. This would perhaps act to counter social and peer desirability bias. Face-to-face interviews (Arrow *et al.* 1993) were conducted at both the sites and lasted 30 minutes on an average. Adult visitors, who had a defined source of income, were only interviewed because they were considered to be more realistic in making personal valuations of their recreational/sacredness experiences at trekking corridor and lake sites vis-à-vis their budget constraints (Brown & Henry 1989). The visitor statistics provided information on socio-economic variables like age, sex, educational level, occupation and income.

6.1.4.2 Travel cost method

The Travel Cost Method (TCM) has been widely used in valuing freshwater ecosystems (Caulkins *et al.* 1986 and Dixon *et al.* 1994). It is

an indirect valuation method where visitors' travel costs to a recreational area are used as a proxy for the price of the recreational activity, together with participation rates and visitor attributes to estimate the recreational value of the site. Variations in travel costs and visitation rate can then be used to estimate a demand curve, which is used to compute the consumer surplus of the activity, i.e., the recreational value. The demand curve establishes a function between the price of a good (travel cost) and the quantity of the good consumed (number of visits). It is usually downward sloping because at higher prices, fewer people will visit, while at lower prices, the number of visitors is greater. The consumer surplus or area under the demand curve but above the price, is a measure of the sacredness value of Khecheopalri Lake. Pilgrims and domestic and foreign visitors were distinguished in order to distinguish the pilgrims, who were on single destination trip to the lake. Outside visitors to Sikkim usually undertake multiple destination trips, which include Khecheopalri Lake. Therefore, this part of the analysis focused only on the recreational/sacredness value of local pilgrims. This model provides an estimate of the benefits individuals receive from visiting a site by observing their travel related expenses (Clawson & Knetsch 1966; Krutilla & Fisher 1975; Dixon & Sherman 1991 and Freeman 1993).

Based on the theoretical models, questionnaires were prepared and administered to visitors to the lake. The respondents were asked about the

cost of the current trip to the lake site, the process for deciding about trip destinations, and a series of socio-demographic and economic questions. In addition, a trip diary was developed which elicited detailed itinerary, cost, time and quality information for the current trip to the lake. The travel cost to the lake, distance, household income and other socio-economic variables (age, sex, education and density) were included as independent variables in regression models, which were developed at the zone level based on individual visitor's responses. The travel cost method measures the demand function for visit to a site. A demand function is an empirical relationship between the price of a good and quantity purchased:

$$Vi = f(Pi, X) \qquad (1)$$

Where Vi = visitation rate of the ith population from each zone that is estimated by dividing the number of visits from the respective zone by the zone population; Pi = cost of visiting the site from the zone; X = set of socio-economic variables which might shift the demand function, such as income or age.

On the basis of the above demand function (Equation 1), we developed two equations to estimate the demand curve considering travel cost (T) and distance (D), as other variables such as age, literacy, income and density were not significant factors in visitation rate. Distance between the place of origin and destination was derived from the state

motor vehicle department, government of Sikkim. Distance was converted into currency by taking the fare rates. The average value in currency for kilometer distance was estimated for calculating the travel cost:

$$V = f(T, D) \quad (2)$$

$$V = f(T) \quad (3)$$

The linear specification of the above function is:

$$V = \propto_0 + \propto_1 T + \propto_2 D + e \quad (4)$$

where $\propto$ = parameters; e = error term which is independent and normally distributed.

Regression analysis was used to estimate the parameters for deriving the equation. The consumer surplus value is the willingness-to-pay over and above the price of the trip by the consumer. This is illustrated in Figure 6.1. Tm Vm is the travel cost demand curve. Tm is the maximum travel cost where the visitation rate drops to zero. Vm is the maximum visitation rate where the travel cost is equal to zero. If Ti is the travel cost for the visitors from the ith population zone, Vi will be the corresponding visitation rate. The net benefit is the consumer surplus, which is the additional utility over and above the consumer expenditure (cost) on travel to reach the site. This is, the area below the demand curve and above the price of the trip. In the figure, CS (i) (the shaded portion) is

the consumer surplus for the visitors from ith population zone. Mathematically, the consumer surplus value [CS (i)] can be estimated as:

$$CS(i) = \int_{Ti}^{Tm} Vi \, dT \qquad (5)$$

Where, Vi = visitation rate from the ith population zone, Ti = actual travel cost from the ith population zone, and T_m = maximum travel cost the visitors willing to pay.

The recreational value of the entire site was achieved by summing up the consumer surplus estimates from all observed users. The total annual consumer surplus (ACS) of the recreation at a site across all the zones was:

$$ACS = \sum_{i=1}^{N} CS \qquad (6)$$

where N = the number of surrounding population zones selected for the study.

The annual consumer surplus (ACS) for the pilgrims was estimated using the real rate of interest for corresponding period; the rate was calculated as the difference between the lending rate of interest of the Reserve Bank of India and the rate of inflation for the year 1997-98. Therefore, the present value of the ACS can be calculated by:

$$PV = ACS/r \qquad (7)$$

If the effect of inflation is considered, the real rate of interest (r*) has to be taken instead of the social rate of discount (r).

Therefore,

$$PV = ACS/r^* \quad (8)$$

6.1.4.3 The contingent valuation method

The contingent valuation method (CVM) attempts to value non-market goods by asking people directly for their willingness-to-pay to obtain specified improvements or to avoid decrements in them, using social scientific survey techniques (Heberlein 1988; Bishop & Heberlein 1992 and Arrow *et al.* 1993). The CVM uses a questionnaire or survey to create a hypothetical market or referendum, and then allows the respondent to use it to state or reveal his or her WTP for recreation, option, existence and bequest values (Mitchell & Carson 1989 and Mullarkey & Bishop 1995). The CVM survey tended to address a greater diversity of lake and terrestrial ecosystem issues. The main concern in using the WTP technique was with the validity of responses; specifically, would the respondents actually pay the money they agreed to pay in survey?

The contingent valuation method (CVM) remains the subject of heated debate within the non-market valuation literature due to hypothetical nature of markets (Hanemann 1994), and its susceptibility to biases (Cummings *et al.* 1986; Mitchell & Carson 1989 and Freeman

1993). Attempts have been made to minimize the biases in order to get a reliable estimate of economic value of recreation. One of the most important potential biases of CVM is scenario misspecification, especially on the amenity to be valued. This is a serious bias in estimating non-use values. In the present study, the bias should have been minimal for use values. Response was taken only when visitors were familiar with the non-use goods after visiting the trekking corridor and the lake. In-person interviews were initiated by informing respondents about the work and background of the Sikkim Biodiversity and Ecotourism project. Respondents were told about the nature of the project. The nature of the interview was explained, and the issue of the trekking corridor and Khecheopalri Lake were introduced. The respondents were also assured that responses were to be used for research purposes, that their co-operation to this effort was sought, and confidentiality would be maintained. The latter would perhaps act to counter social and peer-desirability bias. Face-to-face interviews secure a high response rate as to other survey techniques. People did their best to give an honest answer to the CV questions. In CV exercise, we adopted a double bounded dichotomous choice (DBDC) formulation, as it is more information intensive (Hanemann *et al.* 1991). First, the respondents were asked whether they were willing to pay for the non-market commodity benefits after being given proper information about the commodity. If the answer

was 'no', the process ended there with that particular respondent. If the answer was 'yes', then the second step was to determine the maximum amount he/she was willing to pay. The maximum willingness to pay was determined by the bidding process. The interviewer started the bidding by a particular amount. If it was above his willingness-to-pay, the interviewer reduced the bid gradually until the answer was 'yes' and the value was recorded. If the respondent agreed to the interviewer's initial bidding amount, the interviewer gradually raised the bid until the respondent said 'no'. Respondents who showed inability to pay in cash were considered for willingness to actually do service in the trekking corridor and lake. These respondents were asked if they were willing to contribute their time towards the maintenance of the sites. This provided an opportunity for those who could not pay but had the willingness to actually do service. Respondents were also asked how many days per year they would be willing to voluntary work in the park and Lake site.

Socio-economic details were also collected for regression purposes. Apart from name and addresses, information on age, education, occupation and annual income from all sources were also collected. An attempt was also made to establish the importance of environmental issues perceived by the respondents, and to measure whether or not the respondent demonstrated implicit value for the environment and non-use values. Contained questions about the environmental attitudes of the

respondents e.g., how they will give rank for the justification of biodiversity loss, its avoidance and reasons for visiting to Yuksam-Dzongri-Goechha La trekking corridor and Khecheopalri lake site. These preferences were measured on a five-point scale ranging from "strongly agreed", "agreed", "neutral", "disagreed" to "strongly disagreed'.

Community based household information was collected by primary survey using stratified random sampling. Statistical analysis was done using Systat Version 6.0 (1996) considering all the responses including those who protested the bid.

6.2 Forest Cover and Density

The five class I land-uses, were identified occurring in both the sites (Table 6.1). A total of 84% and 77% of the lake and trekking corridor area had forests. The forest cover was divided in to conifer-rhododendron, mixed-broad leaf, and rhododendron, alpine scrub and forest blanks. These forests were most predominant in the trail corridor (Table 6.1 & Plate 2c & 2d). Majority (34%) of the forestland was under degraded category (crown Cover, 20%), 19% open forest (crown cover (21-40%) and 19% dense (crown cover > 40%), whereas in Khecheopalri lake site it is dominated by open mixed forest (41%), followed by dense mixed (23%) and degraded forest (21%) (Table 6.1).

Agriculture was the predominant non-forest land-use, occupying about 14% of the total area in trekking corridor and 13% in lake site.

About 3% and 1% area fall under wasteland category (rock outcrop and landslide). In case of the lake area, major changes were recorded in the form of bog area expansion (Table 6.1). In 1963 the bog was 3.4 ha that increased to 7 ha in 1997 (Jain *et al.* 2000).

The Conversion of dense mixed forest to open mixed forest and than to degraded forests has been mainly attributed to fuel wood and timber extraction, fodder collection and grazing. Agriculture land expansion in the lake watershed had a major impact on the health of the lake through increased sediment deposition.

6.3 Resource Utilization Pattern

Forest human interaction is an age-old phenomenon for the livelihood of people. The high demand of firewood, fodder and timber provides threats to the forest in surrounding area. Chopping and lopping of highly preserved tree species for firewood, fodder and timber has made tremendous pressure on some selective species. For this, attention was focused on the fuel wood, fodder and timber flows. The magnitudes of these flows are particularly important because they are closely linked and represent the direct removal of biomass from the forests.

6.3.1 Fuel wood consumption

Consumption rate of 24 kg/day was estimated for each household in the area during 1997-98. Consumption of the commercial alternative source of energy, i.e., kerosene and LPG (14% and 3%, respectively) was

insignificant. There was no evidence of non-conventional sources of energy being used by any of the stakeholders. Fuel wood consumption by the different stakeholders is presented in Table 6.2. Domestic cooking is the major consumer of fuel wood. Consumption ranges from a maximum 2264 Mg yr^{-1} by community and lowest 1.02 Mg yr^{-1} by pack animal operators. On an average the hotel/lodges consumed about 40 to 50 kg of fuel wood per day. A large quantity (240 kg/day/group) of fuel wood was used by HMI during training period for cooking and other purposes. The porters burn about 2 kg fuel wood per day during trek for cooking and water heating.

Annual (394 Mg) fuel wood consumption for water heating and other purposes was low compared to cooking (Table 6.2). When consumption for cooking, water heating, and other purposes was pooled, the fuel wood required was 2264 Mg yr^{-1} for community, 101 Mg yr^{-1} by hotel/lodges, 45 Mg yr^{-1} by HMI and 26 Mg yr^{-1} by other stakeholders (Table 6.2). Seasonal differences in firewood use were attributed to colder weather in winter, followed by rainy and lowest were recorded in summer season (Table 6.3). The annual consumption was thus 1222, 814 and 400 Mg respectively in winter, rainy and summer season.

The survey indicates that fuel wood is the most important forest products collected (Table 6.2 & Plate 2e) by users. The average household collects about 2433 Mg yr^{-1} in Yuksam-Dzongri-Goechha La

corridor and 1126 Mg yr^{-1} Khecheopalri Lake site or about Rs 3046259 (US$ 74299) and Rs 1407478 (US$ 34329) worth of firewood per year. The total value of collected firewood in both the sites are Rs 4535748 (US$110628) yr^{-1} (Table 6.2).

Based on assumption that the consumption quantity corresponds to the collection quantity, the total fuel wood consumption calculated earlier could be regarded as the demand or pressure on the forests. If the demand per day (7 Mg) is divided by the total area of the trail (3709 ha) and multiplied by 365, an annual pressure is of 0.68 Mg fuel wood on each hectare forestland. The assumption underlying this calculation is that all the fuel wood required in the area is supplied from the forest alone.

Fuel wood demand by communities and tourism related activities in the mountains are believed to have considerable impact in the forests and wildlife (Bjonness 1980; Byers 1986 and Banskota & Sharma 1994). The demand for forest wood for fire in KNP trekking corridor appears to be at the first instance less (2434 Mg) than the net wood production (21769 Mg). However, the gap between demand and supply is not in fact so small for the following reason. First, the people in the surroundings of the forest area tend to collect fuel wood repeatedly from the same patches of the forestland. The forest cover in close proximity to the settlement and camping sites experience maximum pressure. As the supply decline near by the people walk further and further into the forest widening the

area of impacted zone. The second factor that has put pressure is the selective use of species of choice for fuel. In recent years quality fuel wood trees have become sparse. Now, the quality of fuel wood used is poor and the shortage of good quality has led to widespread switching over to inferior quality fuel wood. The distance covered and time devoted to fuel wood collection from surrounding forests are widely used indicators of fuel wood scarcity. High pressure was observed in Monastery forest at Dubdi (39%) followed by KNP trail (22%), Goucharan (21%) and trail outside KNP (18%) (Table 6.4). It is apparent that if the harvested quantity exceeds the production capacity, one would not lose the growing stock but also biodiversity. The wood for fuel is derived from live, dead and damaged trees and woody shrubs. The large scale felling of trees and shrubs along the trek route and campsite is accelerating the degradation process. Forest is depleted, leading to erosion of topsoil and disturbing the ecology of the area. The drudgery associated with fuel wood collection is generally recognized from many parts of India (Guller 1982; Agarwal 1989 and Sharma 1993) and other developing countries (Soussan *et al.* 1991).

The settlements that depend on firewood from the KNP corridor and other forests are given in Table 6.5. The total consumption of fuel wood is estimated to be 1223 Mg yr^{-1} in the KNP corridor and 1141 Mg

yr^{-1} on other forests. Thus the total consumption of fuel wood in and around the KNP is estimated to be 2434 Mg yr^{-1}.

The choice of fuel wood species has now changed from *Castanopsis* spp.(Katus), and *Quercus* spp. (Book and Phalant) to *Alnus nepalensis* (Utish), *Engelhardia spicata* (Mahuwa), *Symplocos theifolia* (Kharane), and many shrub species, due to indiscriminate felling of preferred species. At Dzongri, rhododendron bushes are cut for fire wood purposes. The major impacts on forests are found in the areas of traditional settlements. Forests within about 3 km of Yuksam village have been degraded as a result of fuel wood collection and tree felling. Pair-wise ranking of species used as fuel wood along Yuksam-Dzongri-Goechella corridor is presented in Table 6.6.

6.3.2. Species under pressure

An inventory of species used for fuel wood at low and high altitudes showed that the trees surrounding the village vicinity, irrespective of species, have the maximum pressure of fuel wood extraction. Nevertheless, certain species are preferred over others for fuel use because of their better amount of heat. *Quercus lamellosa, Schima wallichi, Eurya acuminata*, and *Cedrela toona* are the most preferred species at low altitude. At high altitude, Rhododendron spp., *Quercus lineata, Quercus lamellosa, Betula alnoides,* and *Magnolia* spp. are the preferred firewood species. But the availability of these preferred species

in the forest is on tremendous pressure (Table 6.6). At Tshoka where a major portion of fuel wood consumers are the Tibetan refugees, tourists and HMI trainees form a fairly large portion of fuel wood resource user groups. Still many species from natural forests especially *Rhododendron arboreum, R. barbatum, Magnolia* spp. are fell for fuel use.

6.3.3 Fodder utilization

Animal husbandries in both the sites are mainly dependent on the surrounding forests (Plate 2f). This dependence and structured biomass utilization are outlined in Table 6.7. These forests are heavily lopped along the trail route and margins of the settlements. The grazing pressure of cattle and Yaks/Dzos are seasonal and more prominent in the study sites (Plate 3a & 3b). During the past five years an emphasis was given in Yak/Dzo rearing. The livestock populations of Yuksam-Dzongri-Goechha La corridor have increased from 1530 in 1996 to 1708 in 1998. The Yak/Dzo and cattle need about 33 kg. of green fodder per day, and a sheep needs about 15 kg per day. Average fodder collection per household is 22 Mg yr^{-1} at both the sites. The annual consumption was thus 13092 Mg yr^{-1} and 2193 Mg yr^{-1} respectively in Yuksam and Khecheoaplri Lake site.

The livestocks that depend on fodder from the KNP and Lake site are given in Table 6.7. The total consumption of fodder is estimated to be 20728 kg/day in the corridor forests. Pairwise ranking of fodder species

along the Yuksam-Dzongri-Goechha La corridor and Khecheopalri Lake are presented in Table 6.8. Nebara, Kanyu, Gagoon, Dudhilo were the most preferred species because these species are highly nutritious. The other species such as Amliso, Asaray, Pipli are less preferred in both the sites. Major portion (60%) of the fodder demand is fulfilled mainly by forests and 40% from agricultural fields.

6.3.4 Timber utilization

A detailed survey in the surrounding villages of both the sites revealed that a large number of woody species are utilized for different purposes, in house construction and in making agricultural implements (Table 6.9). Nearly 21 different woody species were listed as highly preferred by the villagers in both the sites (Table 6.10). Most of these species are collected from the surrounding forests. Okhar is highly preferred timber species but now is not available because of high extraction. The other preferred species are Chanp, Bajrant and Katus. The least preferred species for timber purposes are Dhuppi, and Uttis.

Family fragmentation in every 20-25 years leads mostly to construction of many new houses and almost all houses are made of wood. A survey of households in the villages of Yuksam and Khecheopalri lake showed that a double-storied building/lodges needs about 600 to 700 ft^3 wood. The Government of Sikkim has restricted felling of trees for construction of lodges and the houses, however, huge

amounts of timber are still being used. Generally large timber poles are harvested for making ceilings, doors, windows and beams. Medium size poles are used for furniture and their repair. Small size poles (mainly bamboos) are cut for making cattle sheds or temporary huts (Table 6.9).

Despite the large area of relatively unutilized forests available in both the sites, there is ample evidence of long term degradation. In general, the condition of the forest varies with altitude (distance from the village) and aspects. The forest surrounding the settlements is most degraded. Similar concentric circles of degraded forests surround the villages in other portion of the Indian Himalaya (Pandey and Singh 1984).

6.3.5 Overland flow and soil loss

Water runoff (% of rainfall) was highest in trekking corridor (6.57%) and lowest in the alpine pasture (2.44%). Soil loss was also recorded greatest in the trekking corridor (Table 6.11 & Plate 3c) in Yuksam-Dzongri-Goechha La corridor. The runoff was recorded greatest in wasteland (4.8%) and smallest in cardamom based agroforestry (1.8%). Soil loss was highest in the cropped area while it was lowest in the cardamom based agroforestry system in the Khecheopalri lake area. The overland flow and the soil loss in the large cardamom based agroforestry system were less because of good tree canopy and understory thick large cardamom bush coverage. The total soil loss from the lake watershed was

502 Mg km^{-2} yr^{-1}. Soil deposition in the lake was 141 Mg yr^{-1}. The increase in heavily laden pack animals in the trail caused soil erosion.

6.3.6 Solid waste

Garbage has been an ongoing concern for many years in the Yuksam-Dzongri-Goechha La corridor and Lake site. Since 1980, KNP regulations have required mountaineering training and trekking groups to pack out their wastes, but very few groups have complied with. The result has been a continuing accumulation of trash on the route up to Goechha La and HMI base camp and surrounding the scared lake area. The increasing proliferation of plastic, metals and glasses has bee exacerbated not only by careless disposal of trash but also by the increased non-biodegradable, garbage being generated by Khanchendzonga Conservation Committee a village based NGO. The garbage dumps at base camp have become dangerous (Plate 3d). Tourism waste has continued to be an eyesore along the trekking corridor. Garbage dumps induced by tourism have high visibility and raise immediate concern both from the tourists as well as from the host community. In 1996, Khanchendzonga Conservation Committee organized a clean up campaign of the trekking corridor and they collected huge amount of litters i.e., 50 kg of plastic bags, 100 kg. of empty cans and 100 kg. of bottles during fall season.

6.4 Economic valuation

6.4.1 Socio-economic analysis

(i) Yuksam-Dzongri-Goechha La trekking corridor

The preliminary findings and summary statistics of the samples of 545 respondents are presented in Table 6.12. In the case of local community members the sample had a mean age of 36 years, with respondents ranging from 20 to 55 years of age. More than 90% of the samples consisted of male respondents. The mean household size was 5 members and ranged from 2 to 9 members. As far as domestic visitors were concerned, mean age was 33, with respondents ranging from 19 to 65 years of age. The foreign visitors mean age was 39, ranging from 20 to 67 years of age. With respect to educational qualification of the local communities, 15% of the respondents were illiterates and 23% had less than 10 years of schooling. About 34% of the respondents had obtained high school, 9% higher secondary and 19% had a bachelor's degree. The educational qualification of domestic visitors showed that 9% were master degree holders, 81% bachelor degree holders and 10% had higher secondary education. In the case of foreign visitors, 25% respondents had master degree, 60% bachelor degree and 15% had a higher secondary education.

Occupation of local community members showed 31% respondents are from service sector, 32% are from farming and off-farm activities, 21% are from tourism and 16 % are from business people. Occupation of domestic and foreign tourists showed 45% and 40% in government service, 34% and 51% professionals, 10% and 6% business, 10% and 1% students, respectively. Small fractions (1 to 2%) of domestic and foreign visitors were retired persons. Thirty four per cent of the foreign tourists were French and Swedish, 16% Britishers, 11% were Germans, 5% were American and 33% were from other countries.

The attractions for visitors were diverse. A majority came for recreation/trekking, followed by viewing mountain peaks, wilderness and bird watching, and specialized interest groups on flora and culture. Trekking duration ranged from 5 to 15 days with an average of 9 days. Normal daily expenditure by tourists ranged from Rs 190 to 1710, with average value of Rs 988 depending on nature of trek (independent or organized tourism). In response to their interest on protecting the forest/wildlife of the park, about 23% foreign and 26% domestic tourists were "not interested", 26% foreign and 42% domestic tourists were "fairly interested", 33% foreign and 12% domestic tourists were "interested", and 18% foreign and 20% domestic tourists were "very much interested".

Analysis of visitors' attitude on environment perception towards protection of the KNP revealed that 42% and 59% domestic and foreign visitors considered it "very important", 38% and 32% "important", 12% and 5% "not very important" and 8% and 4% "unimportant", respectively. Perception on biodiversity loss justification in the context of India showed that majority of both domestic and foreign tourists agreed to this point (Table 6.13). A question on the direct relevance of KNP for avoidance of biodiversity loss at any cost was not acceptable to the local community, the reasons being their dependency on natural resources. In contrary, about 50% of both domestic and foreign tourists agreed to the avoidance of biodiversity loss at any cost (Table 6.13).

In response to environmental problems and steps to be taken for conservation, about 10% said that there was no need to conserve the biodiversity of KNP because it is already in good condition, while 90% expressed conservation needs. On the question that who should conserve and maintain the KNP, about 55% was not sure. Of proposed implementing authorities, the majority of international tourists felt that the conservation in the KNP should be a collective effort, with the next ranked being government and community jointly (Table 6.14). The domestic tourists responded similarly, desiring government and community to play the main role, followed by collective effort and then government (Table 6.14). When asked whether they feel responsible for

nthe maintenance of the Yuksam-Dzongri- Goechha La trek route, 855 of the respondents gave a positive response, whereas 15% responded negatively.

(ii) Khecheopalri Lake

The basic statistics of lake site are presented in Table 6.15. The average household size was 6 people and the mean age of the respondents was 43, ranging from 25 to 75 years. About 40% of the community respondents were illiterate, while 45% were educated up to secondary level. Of the respondents 85% were involved in farming-related activities, 13% business/tourism sector and 2% in government sector (Table 6.15).

The mean age of the pilgrims was 43 yrs ranging from 22 to 68 years and the average group size was 8 (Table 6.15). About 20% of the pilgrims were illiterates, 33% passed secondary education, 31% passed higher secondary and 15% bachelor degree holders. The mean monthly income was Rs 6232 and from 2993 to 13981. Majority (48%) of the pilgrims was government service holders, 31% are farmer, 12% are business people and 9% are students.

In case of domestic visitors, the mean age was 33 yrs raging from 19 to 65 years. The average family size was 4. About 21% of the domestic visitors received higher secondary education, 67% had bachelor degree and remaining 12% had master degree. The average monthly income of domestic visitors was Rs 6724. Majority (78%) of the

respondents was from government sector followed by 18% business people and 4% students.

An average age of foreign visitors was 34 yrs ranging from 20 to 60 years. Majority of the foreign visitors was free and independent trekkers (FITs). The mean monthly income was Rs 65969. About 72% of the foreign visitors were bachelor degree holders, 16% was master degree holders and 12% passed higher secondary. About 53% were engaged in professional occupation, 29% were in government sector, 11% were students and 3% were retired personnel. Total expenditure by the pilgrims at the lake site (including travel, food, and accommodation) varied from Rs 164 to 1474 per visit per group (Fig.6.2). The maximum expenditure was by north zone visitors, and the least by those from the west zone.

About 78% of the pilgrims visited the lake for religious purposes, while the majority (85%) of the domestic visitors came for recreation. Most (65%) of the foreign visitors came to the Lake for recreation, but 19% came for religious purposes and 16% cited the rich biodiversity of the area as their purpose in visiting.

Approximately 56% of foreign visitors, 43% domestic visitors, 35% of local community members and 28% of pilgrims showed some interest in conservation and maintenance of the Lake and its surrounding watersheds. Approximately 53% of domestic visitors, 50% of pilgrims, 45% of community members and 37% of foreign visitors felt that the

state government should take initiation for conserving the Lake watershed, whereas 26% of the local community, 22% of local pilgrims, 20% of domestic and 6% of foreign visitors felt that the village level institutions, in this case the panchayat (village council), should have this responsibility.

6.4.2 Recreational/sacredness value

Across all zones, travel cost for local pilgrims was positively related to visitation rate. Assuming that each zone represents a single average travel cost and opportunity cost of time, a TC model was used to calculate the consumer surplus (Table 6.16). A demand curve was prepared by evaluating the travel expenditures that visitors were willing to make to visit the Lake. Multiple regression analysis was carried out to estimate the parameters of the linear travel cost demand equation.

The coefficients of the first and second equations were statistically significant (Table 6.17). In the second equation, the *t* values of both variables were statistically significant ($P<0.01$, $P<0.05$) although the adjusted R^2 value was low because only one independent variable was considered (Table 6.17). The adjusted R^2 value of the first equation was higher than that of the first, but the *t* value of distance was not significant. We tried to develop other equations including all the variables, namely travel cost (T), distance (D), income (INC), age (AGE), density (DEN), and literacy (LIT), but these equations were not considered because the

coefficients were not statistically significant. In fact Khecheopalri Lake is a place of religious importance, therefore literacy, age, distance and income did not play an important role for visiting the site. The lending rate of interest of Reserve Bank of India was 10% during 1997-98. The inflation rate showed fluctuations during the year, however the average annual rate of inflation was estimated to be 4.83%. Therefore, the real rate of interest was 5.17%. The present sacredness values presented in Table 6.18. The estimated consumer surplus for visits to Khecheopalri Lake was US$661 and 1562 from the first and second consumer surplus, respectively (Table 6.16). Recreational/ Sacredness value per visitor was US$3.87 as calculated from the consumer surplus. The total number of local pilgrims to Khecheopalri Lake was 7800 in 1998, the aggregate annual recreational/sacredness value amounted to US$30186 for pilgrims. The higher cost of travel and distance of the Lake from various zones restricted visitation rate by pilgrims. The west zone was the closest and exhibited a minimum travel cost, as the Lake is located in this zone, whence the highest visitation rate was recorded (Fig. 6.3).

Time spent by visitors on worship, viewing and photography of the lake was 27% of the total. Assuming a constant sacredness value of time for all activities, the sacredness value of Khecheopalri lake viewing was estimated to be US$2378 per annum.

The demand curve function for recreational value showed that the probability of visitation increased with decreasing travel cost and distance for local pilgrims (within Sikkim visitors). The consumer surplus of Khecheopalri lake was very low compared to ecotourism demand in Madagascar (Mallie & Mendalsohn 1993) and economic value of elephant viewing in Kenya (Brown & Henry 1989) because of low visitation rate. However, the sacredness value of the lake was fairly intact, and consequently, the biodiversity and recreation values also remained high. An expected growth in tourism may increase the consumer surplus but this may be at the cost of the aesthetic, biodiversity and religious value of the lake. Therefore, a balance between consumer surplus and other values for conservation and preservation has ultimately to be established. The results of the present study are very similar to those from some other sites in tropical India, especially on protected area at a tiger reserve in Kerala and a national park in Bharatpur that showed low values (Chopra *et al.* 1997 and Manoharan *et al.* 1998). However, the present value for the lake were higher, inspite of its low visitation rate and lack of protection compared to the above two destinations.

6.4.3 Analyzing willingness-to-pay

Generally those respondents who are getting direct benefits from the park were considered for the analysis of WTP, but in the present study the WTP was assumed to be a function of the respondents' personal

characteristics and income level. Another variables, education level, was used as an explanatory variable. Greater number of years of schooling would arguably increase the knowledge of a person. Perhaps education would help a person comprehend news about the environmental effects of economic development. Age and gender were also used as explanatory variables. Results of both the sites of the willingness-to-pay (WTP) exercise, for community members, pilgrims, resident visitors and non-resident visitors are presented in Table 6.19 & 6.20. The result shows that the average response rate for Yuksam-Dzongri-Goechha La corridor was 45%, on the question regarding the motivation behind respondents WTP for conservation. Only 31 local community members indicated a willingness to pay for better management of the KNP. About 25 community members said that they were willing to pay, but due to their financial constraints and other responsibilities they were unable to pay. Thirty community members indicated willingness to perform voluntary work by providing manual labour for trail maintenance and cleanup. Respondents who were willing to volunteer agreed to set aside about a day per month. Some of them said they could provide seedlings for plantations in the surrounding areas. Nine community members refused completely to pay in kind or in cash for conservation. In case of foreign tourists, only 49% indicated a positive reaction to WTP for conservation, while 27% agreed on condition that the amount would be utilized in

constructive manner, and 24% refused to pay. In case of domestic tourists, about 60% respondents showed an indifferent attitude towards paying for conservation because they felt that it was the responsibility of the state government and local communities.

An analysis of the WTP provides an opportunity to study the content and context validity of the interview schedule. An Ordinary Least Squares (OLS) regression was used to analyses WTP. The regression revealed that the variables attained the expected signs, as presented in Table 6.21. The R^2 value is encouraging in the present context. Age showed a positive correlation with WTP in the case of all domestic, foreign visitors, and local communities. It was found that the middle age group and older age group of people could spare the money to accept CV bids while the young age group could spare less. This suggests that age is a major factor for all types of respondents to accept the WTP.

Educational qualification did not show a significant correlation with WTP when zero bid was included, however, on exclusion of "refuse the bids" it showed positive correlation with WTP ($P< 0.003$). This was mainly attributed to less educated respondents opting for most of the "refused the bids" for WTP. Fifty five per cent of the total responses were "refuse to pay". Occupation was not a major factor to accept the CV bids. Those people who were directly involved with tourism related activities and getting more economic returns were interested to pay for WTP as

compared to those who were not getting the economic benefits from tourism. The results also indicate that businessmen were willing to pay more than professionals. This finding has important policy implications as businessmen have the most potential for financing environmental improvements. Sex also did not influence the visitation rate and WTP for conservation. The income of visitors significantly influenced their WTP for conservation of the area (Table 6.21).

For the entire samples, using means of variables, the estimated willingness to pay for the management of the KNP was US$8.84 by foreign visitors per trip, US$1.91 by domestic visitors per trip, and US$6.20 by the local community on an annual basis. This shows that the foreign visitors had higher recreational/conservation values than did the domestic visitors and local community members.

The question regarding the confidentiality concerning the right amount for their conservation contribution, about 26% local community members, 22% domestic, and 20% foreign visitors stated that they were "very confident", while 55%, 52% and 40% were "confident", respectively. About 13% local community members, 16% domestic, and 28% foreign visitors were "undecided"; the remaining were "not very confident". These responses suggest that the amount stated by the respondents were valid.

The response rates for Khecheopalri lake against WTP were highest for the foreign visitors (68%), followed by pilgrims (54%), community members (40%) and domestic visitors (36%) (Table 6.20). The regression revealed that the variables attained the expected signs as presented in Table 6.22. Age of the interviewer showed a positive correlation with WTP for all visitors and also in local community members. It was found that the middle age group and older age group people could spare the money to accept CV bids while the young age group spared less. Thus age of the people is a major factor for all types of respondents in WTP. Sex did not influence the visitation rate and WTP for conservation. Occupation, education and income of the visitors significantly influenced their WTP for conservation of the area (Table 6.22). Multiple *R* was very encouraging and so were the *F*-statistics. For the entire samples, using means of variables, the estimated annual WTP for the management of Khecheopalri Lake was US$ 0.88 for local community members per year, and US$2.16 for local pilgrims, US$2,51 for domestic visitors, and US$7.19 for foreign visitors per visit (Table 6.22).

Compared to other parts of India, the frequency of visitors was less at both the sites because most of the visitors seldom return to trek for a second time in the same area. Therefore, the WTP stated by all the visitors was for that particular trek, while a small number of foreign

tourists stated that they would like to help voluntary organizations for community and environmental development in the host region. This study revealed that the visitors' WTP did not depend upon the benefits they would get in preserving the sites, but most of them stated that their WTP was just to keep the beautiful, unexploited landscape and rich biodiversity of these areas intact. The demands for nature/ecotourism in Sikkim by foreign and domestic visitors have also been increasing enormously. Walsh (1986) gave an overview of the price elasticity of demand for various recreational activities. The price elasticity of demand for a recreational activity is generally low when the proportion of income spent on it is low (Walsh 1986). This may be an indication of the income effect at the national income level. As respondents income level grow the income elasticity may improve for environmental goods. The probability of participation increased with age and increasing income. The magnitude of economic problems restricted domestic visitors from visiting the trekking corridor because the entry fees for the park are relatively high as compared to other protected areas. Therefore, visits to the KNP are given low priority by most of the domestic tourists, except for a few rich individuals and people from India's West Bengal, Maharastra, Delhi and Gujarat State. WTP for all categories of visitors and local community showed significant co-variance. The WTP was significantly related to age, edu on and income levels. The findings of this study are similar to

those of Walsh (1986), where age and income appeared to be the most important socio-economic variables determining the probability of participation in recreation activity. This was expected, as an increase in income level would show respondents' greater willingness to spend on recreation. Sex did not significantly influence the WTP. The WTP per trip was much higher for foreign tourist than domestic one, which was mainly attributed to higher income levels and environmental awareness. Local residents' WTP for the entire year is no less significant for this group has a long term stake in the area. Aspects of time, services, or traded goods (tree seedlings in the present study), contributed by the local community, are of no less value than WTP. Therefore, contributions by those who are willing to give time and materials for environmental conservation should be a part of WTP. A quantification methodology of this needs to be developed in future studies. Extrapolating to Yuksam-Dzongri-Goechha La corridor and sacred Khecheopalri Lake, using total visitors and community households, annual WTP of US$ 8777 and US$ 46940 for the maintenance and preservation looks significant. Application of the TCM and WTP strongly support the enterprise-based community involved biodiversity/nature conservation, and suggest that the concept of ecotourism has percolated to all levels of direct and indirect beneficiaries/stakeholders.

6.5 Conclusion

Dependence on fuel wood for energy is causing serious deforestation problems in trekking corridor and Lake Site. The pressure is far greater in Monastery forest than in the trail forest out side Khangchendzonga National Park. The consumption of fuel wood varied amongst stakeholders with respect to different physical and economic factors causing serious deforestation problems in the trail and Lake Site. The widespread switching over to inferior quality of fuel wood species is the indicator of pressure in the forests of both the sites. The fuel wood continues to be the prime source for cooking in trekking corridor, while commercial alternative energy sources contributed very little. Enhancing the supply of fuel wood through plantations and reducing the fuel wood demand through providing alternate source of energy can facilitate these.

A contingent valuation method was used to estimate the Willingness-to-pay (WTP) for conservation and protection of natural resources in the sites. The results showed that the response is an emphatic positive. The survey received good response from local communities, pilgrims, resident and non-resident visitors for their willingness to conserve the area. The analysis reports a mean WTP per visitor per visit was higher for non-resident visitors than resident visitors. Local community members were willing-to-pay for environmental management. The multiple regression on WTP reveals that the attitudes

of respondents, their visitation rate, and number of aspects of the area they considered valuable, were important determinations of WTP for trekking corridor and lake site. Variables attain the expected sign and they are statistically significant and encouraging for a small study such as the present one.

The CVM may also be useful in providing more relevant information for decision-makers for investment and policy purposes. The study results are very encouraging for trail and lake management. It proves that the local people as well as visitors are aware of the environmental damages caused by increasing visitation rate and over exploitation of natural resources of the area and its importance. It was also clear that a willingness-to-pay in terms of cash or kind exists for contributing towards the upkeep and improvement of trail and lake.

The lake has recreational and biodiversity values for domestic and foreign visitors, and more sacredness values for the Sikkimese. The demand curve function for recreation increased with decrease in travel cost and distance for Sikkimese. The lake showed high recreational/sacredness values that were attributed to conservation of the site for biodiversity and pilgrims.

The study shows that the Travel Cost (TC) and the Contingent Valuation (CV) methods can be successfully applied to evaluate natural resources of the Hindu-Kush Himalayan region. The results of the study

suggest that the both the sites have an economic potential far greater than its realized economic earnings. Therefore, TCM and CVM could be a useful tool in providing more relevant information for decision-makers for investment and policy purposes in biodiversity hot spot and protected area management.

Table 6.1. Area under different land-use/cover categories in Yuksam-Dzongri-GoechhaLa trekking corridor and Sacred Khecheopalri lake site in 1997.

Land-use / Cover	Yuksam-Dzongri-Goechha La Corridor		Khecheopalri Lake	
	ha	%	ha	%
Forest				
Dense mixed forest	689	18	272.20	22.53
Open mixed forest	720	19	492.01	40.69
Degraded forest	1289	35	254.00	21.00
Rhododendron	30	1	-	-
Alpine Scrub	40	1	-	-
Forest blank	100	3	-	-
Settlement and cultivated area	598	16	162.50	13.44
Rock out crop	45	1	17.50	1.45
Land slide area	58	2	-	-
Water surface (river & lakes)	140	4	3.79	0.31
Bog area	-	-	7.01	0.58
Total	3709	100	1209.00	100

Table 6.2. Fuel wood consumption for different purposes by stakeholders and its economic costs

Stakeholders	Purpose				Cost (Rs)
	Cooking (Mg yr^{-1})	Water-heating (Mg yr^{-1})	Other (Mg yr^{-1})	Total (Mg yr^{-1})	
Yuksam-Dzongri-Goechha La corridor					
Community	1896	260	109	2264	2829984
Hotel/Lodges	86	12	3	101	126239
HMI	37	6	2	45	56252
Travel Agents	6	1	0.2	7.2	8979
FIT's	1.4	0.3	0.2	1.9	2378
Pack-animal operator	0.8	0.08	0.1	0.98	1230
Porter	13	0.6	2	15.6	19516
Total	2040	280	116	2437	3046259
Khecheopalri lake					
Community	563	737	335	670	837507
Trekker's hut/ Teashops	392	502	137	456	569982
Total	955	1239	472	1126	1407489

Table 6.3. Stakeholder wise seasonal fuel wood consumption pattern

Stakeholders	Consumption (Mg)				
	Summer (61days)	Rainy (122 days)	Winter (182 days)	Average (Mg d^{-1})	Annual (Mg y^{-1})
Yuksam-Dzongri-Goechha La corridor					
Community	378.32	756.64	1128.76	6.20 [1]	2263.72
Hotel/lodges	16.72	33.45	49.90	0.27 [2]	100.07
HMI	2.30	13.07	28.51	0.24 [3]	43.88
Travel agent	0.16	3.40	3.56	0.010 [4]	7.12
FIT's	0.65	0.0	1.30	0. 001 [5]	1.95
Pack-animal operator	0.086	0.41	0.53	0.002 [6]	1.026
Porter	0.28	6.25	8.85	0.002 [7]	15.38
Khecheoaplri lake					
Community	111.99	223.99	334.15	0.67	670.14
Trekker's hut/ Tea shops	7.625	15.25	22.75	0.046	45.62

1, 2: Community and hotel consumption per day; 3, 4: Per group; 5, 6, 7: per person

Table 6.4. Dependency pattern of local community on trekking corridor and lake surrounding forests

Forest	Household number	User's population	Consumption Pattern		
			Kg d^{-1}	Kg hh^{-1} d^{-1}	Mg yr^{-1}
Yuksam-Dzongri-Goechha La Corridor					
KNP trail	58	331	1432	24.68	522
Trail outside KNP	52	306	1188	22.86	434
Monastry forest at Dubdi	107	610	2517	23.52	919
Goucharan	57	325	1341	23.52	489
Khecheopalri area					
Lake surrounding forest	47	282	1213	25.80	443
Other forest	25	160	630	25.20	230

Table 6.5. Settlement wise fuel wood consumption pattern in the study sites

Settlements	Consumption		
	Kg d^{-1}	Kg $capita^{-1}$ d^{-1}	Mg yr^{-1}
Yuksam-Dzongri-Goechha La corridor			
Dependent on corridor forest			
Tshoka (inside KNP)	250	4.39	91
Geychen	422	3.52	154
Norbugang	494	4.05	180
Khongtay	893	3.69	326
Yuksam	1292	4.41	472
Total	3351	3.87	1223
Dependent on other forest			
Kopchey	282	4.21	103
Mantabong	518	3.75	189
Tshong	988	5.77	360
Topsing	494	3.66	180
Gufa Danra	141	4.03	52
Dostang	282	3.62	103
Mangsabong	424	3.71	154
Total	3129	4.10	1141
All Settlements (corridor)	6480	4.73	2364
Khecheopalri lake			
Khecheopalri	403	4.2	147
Chojo & Golai	1557	4.5	568
All Settlements (Khecheopalri lake)	1960	4.3	715

Table 6.6. Pair-wise ranking of species used as firewood in both the sites

Species (local name)	Yuksam-Dzongri-Goechha La Corridor		Khecheopalri Lake	
	Preferred	Available	Preferred	Available
Abies densa (Gobre salla)	4	9	-	-
Acer oblongum (Phirphire)	4	4	-	-
Acer papilio (Kapase)	3	4	-	-
Albizzia procera (Seris)	-	-	7	0
Alnus nepalensis (Uttis)	2	11	0	1
Arundenaria sp. (Parang)	6	1	-	-
Beilschmiedia sikkimensis (Tarsing)	7	5	-	-
Betula alnoides (Saur)	8	3	-	-
Castonopsis hystrix (Jat katus)	4	10	9	10
Cedrela toona (Tooni)	6	2	-	-
Cryptomeria japonica (Dhuppi)	2	2	-	-
Dendrocalamus sp. (Bans)	1	3	9	4
Edgeworthia gardeneri (Argeli)	-	-	4	12
Engelhardtia spicata (Mahuwa)	-	-	7	6
Eurya acuminata (Jhinguni)	8	8	13	7
Litsaea elongata (Pahenli)	2	4	-	-
Magnolia campbellii (Ghonge chanp)	6	5	-	-
Magnolia sp. (Phurse chanp)	6	7	-	-
Machilus sp. (Chanp)	-	-	7	2
Michilus edulis (Phumse)	-	-	6	10
Prunus cerasoides (Panyun)	5	1	-	-
Prunus nepaalensis (Arupate)	2	4	-	-
Quercus lamellosa (Bajrant)	10	8	-	-
Qurcus linesata (Phalant)	11	3	-	-
Rhododendron arboreum (Lali guras)	6	10	-	-
R . barbatum (Curling)	6	4	-	-
R . falconeri (Curling)	4	14	-	-
Rhus insignis *(Bhalayo)*	-	-	3	12
R . semialata *(Bhakimlo)*	-	-	3	7
Schima wallichii *(Chilauney)*	9	2	-	-
Sorbus sp. (Pansi)	2	2	-	-
Symplocos ramosissima (Kharane)	1	1	10	10
Viburnum codyfolium (Asare)	5	7	11	6

* Availability for species were assigned as per their abundance at the designated plots. Higher the scores, more abundance are the species.

Table 6.7. Fodder consumption rate of different livestock in the study sites

Livestock	Number		Consumption			
			(kg d^{-1})		(Mg yr^{-1})	
	Yuksam	Khecheopalri	Sites			
			Yuksam	Khecheopalri	Yuksam	Khecheopalri
Cattle	454	110	13620	3300	4971	1204
Goat	311	106	4665	1590	1703	580
Sheep	461	22	6915	330	2524	120
Pig	260	66	3120	792	1139	289
Dzo	122	-	4270	-	1558	-
Yak	78	-	2730	-	996	-
Horse	22	-	550	-	201	-

Table 6.8. Pair-wise ranking of preferred and available species of fodder in study sites

Species (local name)	Yuksam-Dzongri-Goechha La Corridor		Khecheopalri lake	
	Preferred	Available	Preferred	Available
Acer oblongum (Phirphire)	1	2	-	2
Acer papilio (Kapase)	1	6	-	8
Aconogonum molle (Thotne)	-	-	6	14
Albizzia procera (Siris)	-	-	8	4
Artemesia vulgaris (Teteypaty)	9	13	1	12
Arundinaria sp. (Parang)	9	3	14	8
Beilschmiedia sikkimensis (Tarsing)	17	15	-	-
Betula alnoides (Saur)	3	6	-	-
Bassaiopsis mitis (Phutta)	-	-	21	10
Cedrela toona (Tooni)	6	1	20	6
Cyperus sp. (Bukki)	7	3	-	-
Dendrocalamus sp. (Bans)	8	4	14	12
Elastosima sessile (Gagleto)	14	17	7	20
Engelhardtia spicata (Mahuwa)	-	-	4	10
Eragrostis tenella (Banso)	16	12	-	-
Ficus nemoralis (Dudhilo)	19	11	19	8
Ficus roxburghii (Nebera)	22	20	25	17
Ficus foereslata (Dudhe lahara)	-	-	23	11
Koelaria cristata (Seeru)	10	13	-	-
Litsaea citrata (Siltimur)	-	-	14	6
Litsaea elongata (Pahenli)	10	4	-	-
Macaranga pustulata (Malata)	-	-	13	10
Machilus edulis (Phunse)	-	-	7	20
Magnolia sp. (Phusre chanp)	1	8	-	-
Pauzolzia viminea (Chiple)	15	14	13	23
Paveta indica (Kanyu)	21	2	-	-
Prunus cerosoides (Panyun)	3	20	14	-
Prunus rufa (Lekh panyun)	4	2	-	-
Pentapanax leschenaultii (Chinde)	-	-	2	-
Quercus lamellosa (Bajrant)	4	6	-	-

Rhaphidophora sp. (Kanchirna)	-	-	22	8
Saurauia nepaulensis (Gagoon)	20	9	23	14
Symingtonia populnea (Pipli)	2	9	4	-
Symplocos ramosissima (Kharane)	1	1	-	23
Thysanlaena maxima (Amliso)	17	18	17	18
Viburnum cordifolium (Asare)	1	18	3	20

* Availability for species were assigned as per their abundance at the designated plots. Higher the scores, more abundance are the species.

Table 6.9. Other uses of forest products (house construction and maintenance) for an average household

Large size poles	
Time interval (years)	15 – 25
Tree number	2 - 5
Average (DBH) size	20 – 40 cm
Wood volume required	2.35 – 4.77 m^3
Medium size poles)	
Time interval (years)	5 – 7
Tree number	10 – 15
Average size (DBH) size	10 – 20 cm
Wood volume required	2.16 – 7.1 m^3
Small size poles (mainly bamboo)	
Time intervals (years)	3 – 5 years
Number of poles required	80 – 120
Average(DBH) size	< 10 cm

Table 6.10. Pair-wise ranking of preferred and available species of timber in study sites

Species (local name)	Yuksam-Dzongri-Goechha La corridor		Khecheopalri Lake	
	Preferred	Available	Preferred	Available
Abies densa (Gobre salla)	11	12	-	-
Acer laevigatum (Putli)	4	1	-	-
Acer oblongum (Phirphire)	8	3	-	-
Albizzia procera (Siris)	-	-	5	10
Alnus nepalensis (Uttis)	1	11	10	3
Beilschmiedia sikkimensis (Tarsing)	2	5	12	2
Betula alnoides (Saur)	8	11	10	8
Castonopsis hystrix (Jat katus)	7	8	11	12
Cedrela toona (Tooni)	7	4	6	6
Dendrocalamus spp (Bans)	1	9	-	-
Elaeocarpus lanceaefolius (Bhadrase)	-	-	7	7
Engelhardtia spicata (Mahuwa)	-	-	7	0
Juglans regia (Okhar)	11	2	9	12
Machilus *sp. (Bhaise kawlo)*	-	-	13	5
Machilus edulis *(Phunse)*	5	8	11	9
Machilus odoratissima (Lali kaula)	5	2	-	-
Magnolia campbellii (Ghoge chanp)	4	13	-	-
Michelia exelsa (Rani chanp)	10	2	2	14
Michelia sp. (Bhalay chanp)	-	-	1	12
Prunus nepaulensis (Arupate)	3	5	-	-
Quercus lamellosa (Bajrant)	16	14	3	13
Quercus lineata (Phalant)	8	4	-	-
Rhaphidophora sp (Kanchirna)	6	5	-	-
Schima wallichii (Chilaune)	6	2	7	7
Spondias axillaris (Lapsi)			-	-
Symingtonia populnea (Pipli)	8	9	15	13
Weigtia gigantia (Bauni kat)	2	3	-	-

- Availability for species was assigned as per their abundance at the designated plots. Higher the scores, more abundance are the species.

Table 6.11. Overland flow and soil loss of different land-use/cover from the study sites

Land-use	Yuksam – Dzongri – Goechha La Corridor		Khecheopalri Lake	
	Overland flow (% of precipitation)	Soil loss (Kg ha^{-1})	Overland Flow (% of precipitation)	Soil loss (Kg ha^{-1})
Maize field	5.15	335.56	3.79	405
Cardamom field	2.27	49.41	1.79	15
Wasteland	3.15	88.34	4.77	156
Trail corridor	6.57	661.81	-	-
Forest cover	3.46	105.82	2.06	25
Alpine Pasture land	2.44	41.90	-	-

Table 6.12. Basic statistics of important variables in Yuksam-Dzongri-Goechha La trekking corridor

Respondents	Variables					
	AGE	SEX	EDQ	OCU	INC ($)	WTP ($)
Foreign Visitors						
Mean	38.96	1.41	15.11	4.25	4011	8.84
Std. Dev	11.73	0.49	1.50	0.82	4281	11.94
Domestic Visitors						
Mean	32.71	1.18	14.90	4.01	159	1.91
Std. Dev	8.29	0.38	1.12	1.23	66	4.05
Local Community						
Mean	36.20	1.09	8.53	3.19	832	6.20
Std. Dev	8.67	0.29	4.76	1.42	375	19.08

AGE: Respondent's age in years; SEX: Male–1, Female–2; EDQ: Year of schooling; INC: Income (households annual income for local community and monthly for visitors); OCU: Occupation; Service-5, Professional-4, Business-3, retaired-2 and student-1 for visitors and Tourism involved-5, Service-4, Bussiness-3, Labourer-2, and Agriculture-1 for community members; WTP: Willingness to Pay (per trip for visitors and annually for local community).

Table 6.13. Respondents perception on the importance of environmental issues (%) in Yuksam-Dzongri-Goechha La trekking corridor

Opinion	Respondents	Questions	
		Biodiversity loss justification in the context of India	Avoidance of KNP biodiversity loss at any cost
Strongly disagreed	LC	-	28
	DT	3	2
	IT	1	2
Disagreed	LC	-	40
	DT	4	24
	IT	1	28
Neutral	LC	-	17
	DT	19	19
	IT	22	13
Agreed	LC	-	13
	DT	64	48
	IT	63	50
Strongly agreed	LC	-	2
	DT	10	7
	IT	13	7

LC = local community; DT = domestic tourist; IT = international tourist
(-) This question was not asked to the local community

Table 6.14. Respondents attitude for the protection of Yuksam-Dzongri-Goechha La trekking corridor

Implementing authority	Visitors			
	International		Domestic	
	Number	(%)	Number	(%)
Government	38	12	19	15
Non-Government Organization (NGO)	10	3	9	7
Local Community	10	3	12	10
Government and Community	123	38	49	39
Collective effort*	142	43	30	24
Can't Say	2	1	6	5

*Includes visitors, local community, travel operators, NGOs, and government

Table 6.15. Basic statistics of important variables in Khecheopalri Lake

Respondents	Variables					
	AGE	SEX	EDQ	OCU	INC ($)	WTP ($)
Local Community						
Mean	43.42	1.26	5.38	2.08	415.39	0.88
Standard deviation	13.25	0.44	4.39	1.48	392.83	1.57
Local Pilgrims						
Mean	42.67	1.32	10.39	3.80	152.43	2.16
Standard deviation	11.84	0.46	5.09	1.43	68.26	3.50
Domestic Tourist						
Mean	33.04	1.18	14.85	4.10	163.54	2.51
Standard deviation	8.61	0.39	1.13	1.16	67.32	4.48
Foreign Tourist						
Mean	33.84	1.38	14.44	4.25	1608.88	7.19
Standard deviation	9.59	0.49	1.73	1.05	563.31	8.94

AGE: Respondent's age in years; SEX: Male-1, Female-2; EDQ: Year of schooling; INC: income (household annual income for local community and monthly for visitors); OCU: Occupation; Service-5, Professional-4, Business-3 Retired-2, and Student-1 for visitors and Tourism involved-5, Service-4, Business-3, Labourer-2, and Agriculture-1 for community members; WTP: Willingness to pay (per trip for visitors and annually for local community).

Table 6.16. Zone wise sacredness value of Khecheopalri lake by the local Sikkimese pilgrimage

Zone (within Sikkim)	Visitation Rate	Travel Cost	Mean Distance	Density	Literacy	Sacredness Value Consumer Surplus (US$)*	
	(%)	(US$)*	(km)	(km^2)	(%)	CS1	CS2
North	23	9.14	225	75	42	12	173
East	29	5.85	129	388	54	109	308
South	32	3.90	72	239	44	189	417
West	45	1.82	55	235	37	351	664
Total	-	-	-	-	-	661	1562

CS = Consumer Surplus,

- Calculated at 1 US$ = Rs. 41/- (Average conversion rate calculated for the year 1998)

CS1 calculated based on travel cost and distance, and CS2 calculated based on travel cost only.

Table 6.17. Functional characteristics of travel cost demand curve for valuing sacredness of Khecheopalri Lake

Equation Number	Travel Cost Model	Estimated equation	R^2	P-value
I	V = (T, D)	V = 47.959 – 0.184T + 0.196D	0.997	0.03
II	V = (T)	V = 46.988 – 0.069 T	0.845	0.05

V = Visitation rate, T = Travel cost, D = Distance

Table 6.18. Present sacredness value of Khecheopalri Lake by local pilgrims based on the travel cost method

Travel cost model	Total value for 1998	Present value per person	
	(Rsx10^3)	(US$.)*	(Rs.)
V = f (T, D)	380	1.19	49
V = f (T)	910	2.85	117

V = Visitation rate, T= Travel cost and D= Distance

* Calculated at 1 US$ = Rs. 41/- (Average conversion rate calculated for the year 1998).

Table 6.19. Summary results from the contingent valuation (CV) question from Yuksam-Dzongri-Goechha La trekking corridor

Variables	WTP		
	Foreign visitors	Domestic visitors	Local community
Mean value per visitor (US$)	8.84	1.91	6.20
**Aggregate value for all visitors (US$.)	5852	1226	1699
*Respondents with WTP (%)	50	40	33
+Response rate (%)	49	19	35

WTP: Willingness to pay, US$ 1 = Rs.38/- (as per the conversion rate in 1997)

** The non-respondents were assumed to have a WTP equal to those that answered

* Based on total respondents who responded positively for WTP

+ Based on total visitors/House holds

Table 6.20. Summary result from the contingent valuation in Khecheopalri Lake

Variables	WTP			
	LC	LP	DT	IT
Mean value per respondents (US$)*	0.88	2.16	2.51	7.19
Aggregate value for all respondents (US$)**	63	16848	25943	4149
Respondents with WTP (%) +	40	54	36	68
Response rate (%) #	69	76	59	80

LC = Local Community, LP = Local Pilgrims, DT = Domestic Tourist, IT = International Tourist, WTP = Willingness-to-pay

* Calculated at 1 US$ = Rs. 41/- (Average conversion rate calculated for the year 1998).

** The non-respondents were assumed to have a WTP equal to those that answered

+ Based on total respondents who responded positively for WTP

Based on sampled visitors/ Households

Table 6.21. Result of multiple regression estimation in Yuksam-Dzongri-Goechha La trekking corridor

Components	
Dependent Variables	WTP
No. of observation	243
Multiple R	0.348
Squared multiple R	0.121
Adjusted squared multiple R	0.103
Standard error	489.155

Variables	Coefficient	Std. Error	t value	P<
AGE	9.534	2.860	3.334	0.001
SEX	-41.927	68.196	-0.615	0.539
EDQ	34.167	11.195	3.052	0.003
OCU	-6.886	31.567	-0.218	0.828
INC	0.005	0.002	3.148	0.002

Analysis of variance

	Sum-of-squares	DF	Mean-Squares	F-Ratio	P<
Regression	7828703.690	5	1565740.738	6.544	0.000
Residual	5.67075E+07	237	239272.254		

AGE= Age, SEX= Sex, EDQ= Educational qualification, OCU=Occupation, INC=Income

Table 6.22. Result of multiple regression estimation in Khecheopalri Lake

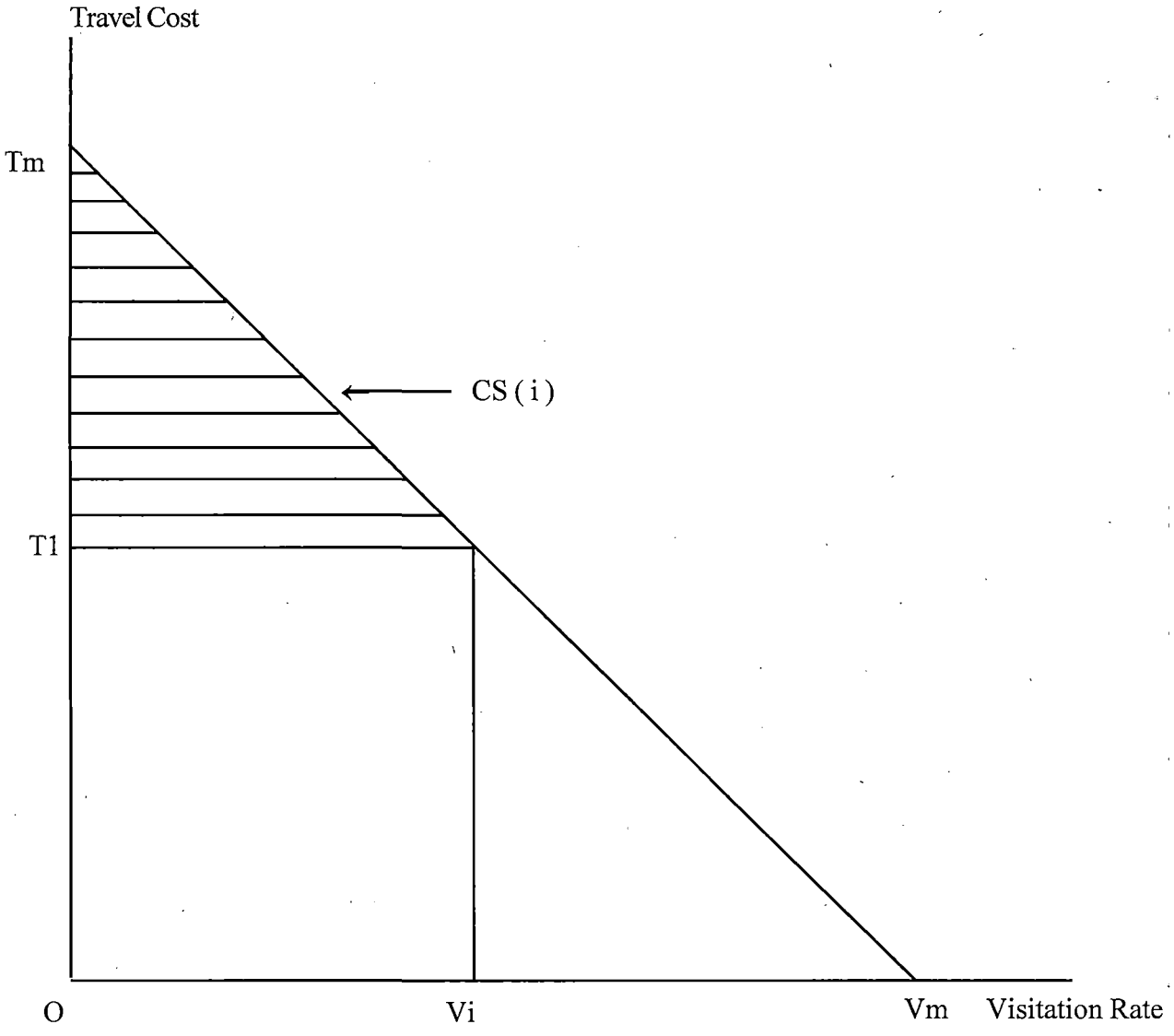
Components	
Dependent Variable	WTP
Number of observation	360
Multiple R	0.492
Squared multiple R	0.242
Adjusted squared multiple R	0.231
Standard error of estimate	4.683

Variables	Coefficient	Std. Error	t-value	P (2 Tail)
AGE	0.092	0.024	3.762	0.000
SEX	-0.349	0.545	-0.641	0.522
EDQ	0.228	0.062	3.702	0.000
OCU	-0.290	0.147	-1.974	0.049
INC	0.003	0.000	8.118	0.000

Analysis of Variance

Source	Sum-of-squares	DF	Mean-square	F-ratio	P <
Regression	2474.004	5	494.801	22.56	0.000
Residual	7763.96	354	21.932		

AGE: Age of the respondent, Sex: Gender, EDQ: Educational Qualification, OCU: Occupation, INC: Income, WTP: Willingness to pay



CS(i) is the consumer surplus for the ith population zone (shaded portion)

Fig. 6.1 Travel cost demand curve

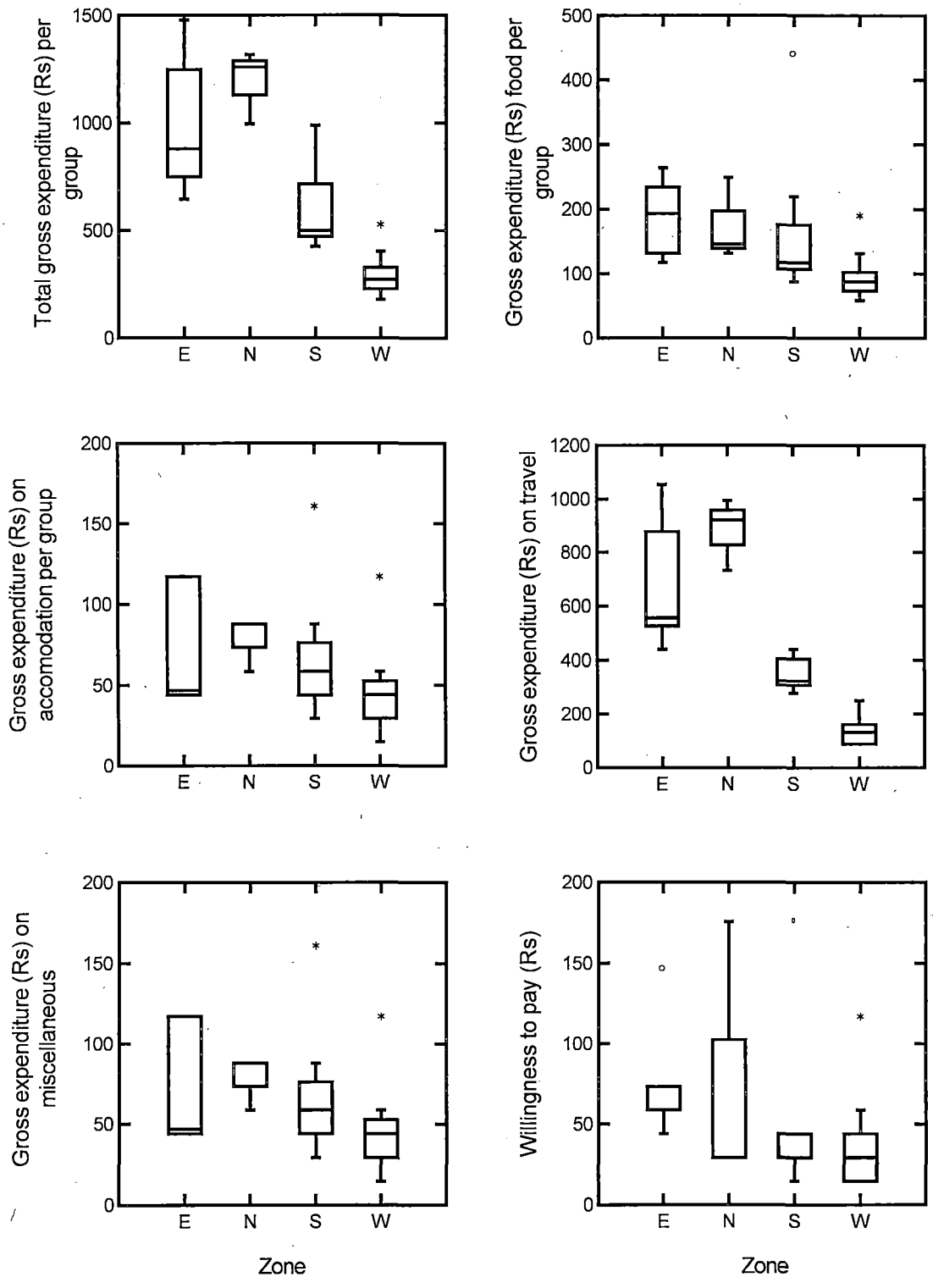


Fig. 6.2 Box-whisker plot showing expenditure and willingness to pay for conservation by visitors from four zonal (E=east, N=north, S=south, and W=west) areas of Sikkim. The central horizontal lines mark the medians of samples, the edges of the boxes mark the first and third quintiles and the whiskers show the range of the values. Values outside the inner fences are called 'outside values' and plotted with asterisks, and values outside the outer fences, called 'far outside values', are plotted with empty circles.

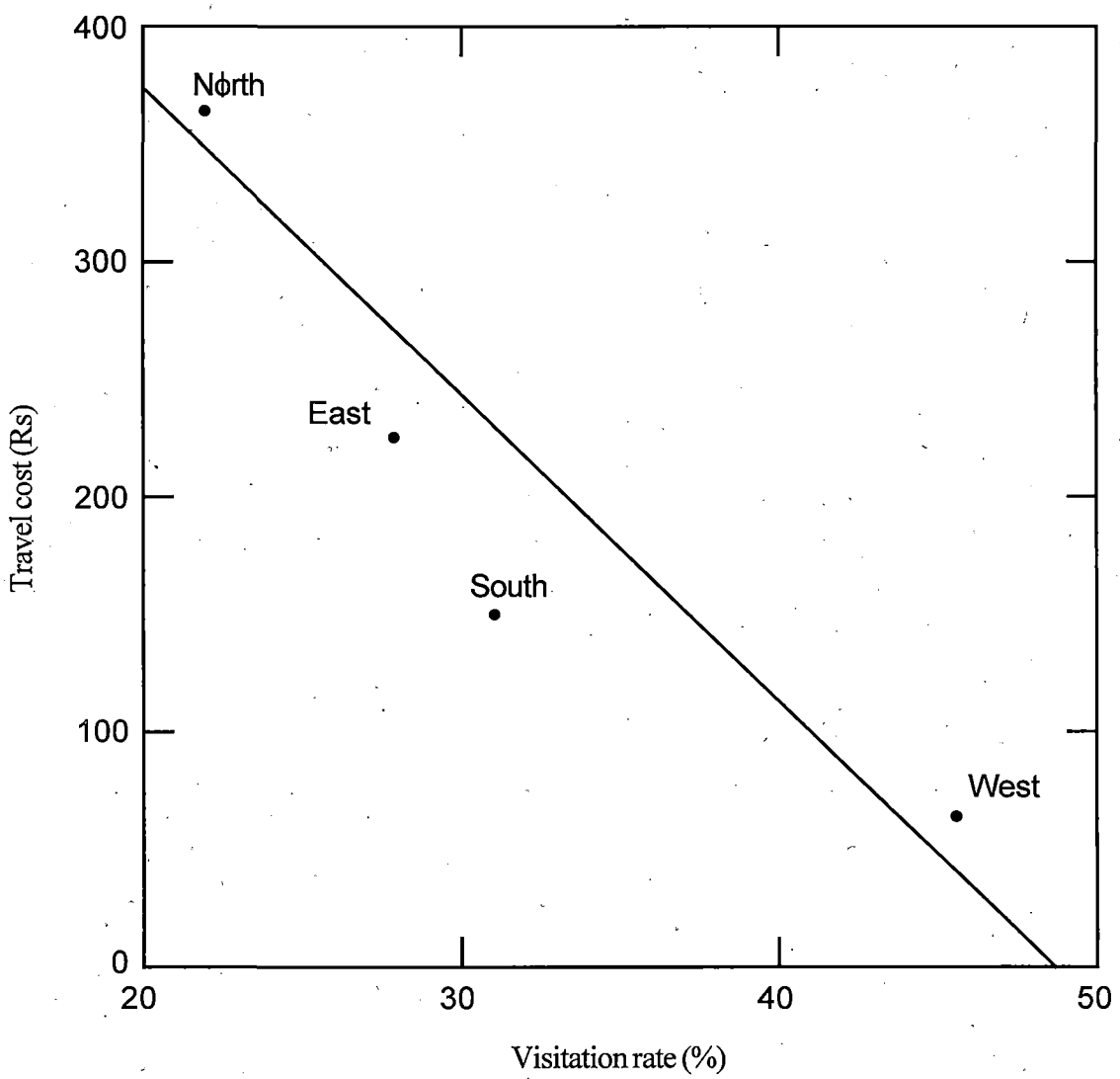


Fig. 6.3. Travel cost and visitation rate of local pilgrims to Khecheopalri Lake from the four zones (east, north, south, and west). The lake is located in the west district.