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Sustainable Development and Management of Forest Resources: A Case Study of Site Specific Microplan Preparation and Joint Forest Management (JFM) Implementation in District Rudraprayag, Central Indian Himalaya

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Abstract

In the present study, efforts have been made to sketch out the required parameters by encompassing various forests based household activities like seasonal consumption of fuel wood, fodder requirement and bio-resource use pattern. Fuel wood consumption was recorded highest during winter months (15 kg day^{-1} household^{-1}) as compared to autumn and summer. Fourteen tree species were mainly being used by the villagers for fuel wood, fodder, fibre, fruits, vegetables, timber and other proposes. The most preferred fuel wood species by villagers were *Quercus leucotrichophora, Pinus roxburghii, Toona ciliata, Alnus nepalensis, Rhododenron arboretum, Pyrus pashia,* and *Lyonia ovalifolia*, respectively. *Grewia optiva, Ficus rugulosa, Celtis australis* and *Quercus leucotrichophora* provided green fodder during lean period. Fodder consumption was maximum for buffalo (35 kg buffalo^{-1}day^{-1}) than for other animals. Keeping in view, the various types of pressures on forest, a forest management flow chart has been drawn up along with problem matrix for the village. This study has illustrates the integrated forest resources management.

Key words: Eco-development, Forest products, Bio-resources, Conservation, Joint Forest Management

Introduction

The wide range of topography of Indian Himalayas harbour luxuriant growth and rich diversity of multiple plant species, and therefore, identified as one of the mega hot spot of biodiversity (Myers, 1988). These resources has provided various forest products such as fuel wood, fodder, timber, medicine, wild edibles, fibres, fruits to human beings along with fulfilling their religious and various other needs. Across the Himalayan region has a healthy tradition of harmonious relationship between people and forests (Champion and Seth, 1968). However, currently the forests of this region are under continuous exploitation for various usufructs and thereby posing a serious threat to ecological balance. Therefore, management and sustainable development of forest resources is necessarily required by applying participatory approach such as Joint Forest Management (JFM), because, forests play a pivotal role in economic and social development of the people in this region.

The Joint Forest Management is a new concept, which is fairly recognizes the community rights and responsibilities by collaborating forest personnel, non-governmental organization (NGOs) and seeker groups. The entire components from one platform for conservation, management and sustainable development of forest resources are priotized in the Joint Forest Management. The Indian National Forest Policy (1988) has envisaged the need for wide collaboration of forest department, village communities and NGOs to regenerate, manage and conserve the degraded forests on sustainable manner (Anonymous, 1996). Therefore, the present study was focuses on the microplan preparation for implementation of Joint Forest Management at village Karokhi in district Rudraprayag of central Himalaya, so that sustainable development and management of forest resources can be ensured.

The study area and climate

The study area lies in Agustmuni forest range of district Rudraprayag of Garhwal Himalaya, between 30^0 to 31^0 N and 79^0 to 80^0 E longitudes. This study was carried out at village Karokhi, which is ~8 km away from Ukhimath town and is situated on south facing slope between 1300 m to 1550 m altitudes. The total human population was 798, of which 28.57% were adult males, 29.57% adult females, 19.92% male children and 21.93% female children. Out of the total population, 60.78% were literate and rest 39.22% illiterate. The people more than 50 years of age were mostly illiterate. A total of 227 students were studying regularly in the school, out of which 63.43% were male and 36.56% female. The climate of the village is montane temperate type. The snowfall is frequent during the months of January-February. The average minimum temperature ranged from 5 ^oC (January) to 20 ^oC (June) and average maximum temperature from 15 ^oC (December) to 25 ^oC (July). In general, during winter (December-January) the minimum temperature goes down to 1 ^oC and maximum temperature during summer (June-July) rises above 30 ^oC. The mean annual rainfall was recorded as 1250 mm, out of which, 70-80% precipitation was received during monsoon season (July-September). Soil erosion and landslides are common phenomenon, which were aggravating due to man induced disturbances.

Materials and methods

Data on various aspects were collected through semi-structured questionnaires. The *Pradhan* (head of village legislative council) and surpanch (head of forest committee known as van panchayat) were consulted for getting the useful overview of each household. Afterwards, each household was visited personally to gather information regarding their profession, literacy rate, income and level of dependency on forests. Major emphasis was given on collection of data by direct interaction with those individuals, who were actually engaged in utilization of forest resources. The villagers were also asked to identify the real problems and requirements of the village in order to most crucial being the foremost to generate the fuel wood, fodder, timber and problem matrices.

Total numbers of cattle per household were counted under each category to know the status of livestock in the village. Measurement of fodder consumption was estimated in replicate of five for each category of animals, five times in a month. Average value was considered to be the fodder consumption per animal for that category as per Maikhuri and Ramakrishnan (1990, 1991) and Vishvakarma *et al.,* (1998). Following formula was used for the estimation of fodder consumption.

Net Fodder Consumption for 24 hours = Known amount of fodder given to an animal - Left over

After initial survey, 100% families were selected for fuel wood consumption. The estimation on the basis of personal observation for a period of 24 hours using weighed survey method following Maikhuri (1991), Maikhuri and Gangwar (1991) and Vishvakarma *et al.,* (1998). Known amount of fuel wood (25 kg) was given to each selected household to use for 24 hours. After 24 hours leftover was collected and weighed, and deducted from 25 kg. Thus, actual fuel wood consumption was calculated per household in a particular season. Mean fuel wood consumption per household was calculated on the basis of average value of four months during summer (April-July), three months during autumn (August-October) and five months during winter (November-March) as per climatic conditions of the region.

The selective choice of villagers for best fuel wood, fodder, timber and species suitable for agroforestry systems was also simultaneously noted. The fuel wood matrix was thus generated by direct interaction with the real collectors of fuel wood on the basis of their relative preference for a particular tree species. On merit out of 10 fixed marks for each variable, out of different parameters/quantities. Thus, a cumulative value was computed by compounding all marks accorded by each household to obtain the overall preference. Thus, highest sum of all marks scored by a species was the most preferred species. Similarly, fodder matrix was also generated by direct interviews with the persons actually involved in fodder collection. Similarly, by aggregation of preference exhibited by the villagers in respect of each criterion for respective species, different matrices were executed. Workshops were also organised for finalizing the study by exchanging thoughts for improvement in future.

Results and discussion

The protection, management and sustainable development of forests are necessary for checking the continued degradation of forest resources. Forest resources are also important to battle the global warming and climate change problems as carbon sink (IIPCC, 2001). It has also been realized that this will not be possible without active co-operation of the inhabitants living adjacent to forest areas. This situation demands a more coherent system for sustainable development of forest resources in Joint Forest Management, which should be based on regulating management for capacity building of community. The success of Joint Forest Management Programme depends on the appropriate micro-plan preparation, for which the control factor is collection of data by direct interaction. Therefore, data on the following key issues were collected from the village Karokhi.

Fuel wood consumption

The fuel wood consumption was recorded to be maximum during winter (15.00 kg/day/household) followed by autumn (12.00 kg/day/household) and lowest during summer (8.00 kg/day/household) (Table 1). These values are similar to the reported values for fuel wood consumption in Himalayan region (Maikhuri and Gangwar 1991, Vishvakarma *et al.,* 1998, Bhatt and Sachan 2004). Maikhuri (1991) found that from large to small family size of various tribes such as Nishi (6.6-15.1 kg/capita/day), Karbi (3.6-7.6 kg/capita/day), Kacharis (2.6-4.6 kg/capita/day) and Chakma (3.0-6.6 kg/capita/day) in Arunachal Pradesh used relatively higher quantity of fuel wood. This may be due to greater availability of the resources and also due to non availability of other sources of energy such as Liquid Petroleum Gas (LPG). However, in the Karokhi village the supply of LPG have reduced the pressure on forest for fuel wood up to some extent. Traditionally, the people of the Himalayan region have been fulfilling the major share of their fuel wood needs from forests. Bhatt *et al.,* (1994) and Bhatt and Sachan (2004) reported that high altitude population above 2000 m consume 20% more biomass fuel than low-altitude (500-1000 m) population, irrespective of socio-economic conditions in central Himalaya.

Table 1. Seasonal fuel wood consumption pattern in the village

Season	Household/day (kg)	Village level (kg)
Summer	8.00	1072
Autumn	12.00	1608
Winter	15.00	2010

Number of households= 134

Animal husbandry and fodder consumption

Animal husbandry is a requisite traditional system in rural areas of the developing countries for economic development with dynamic growth of population and reduction in employment opportunities. The animal husbandry has become a substitute source of income for rural people worldwide. In village Karokhi, the total population of cattle was 909, of which buffaloes (10.45%), cows (28.82%), bullocks

(21.78%), sheep and goat (38.06%) and horses and mules (0.88%) were being used for various domestic purposes (Table 2).

Table 2. Livestock population and its fodder consumption pattern in the village

Name	No. of individuals	% of animals	Consumption/day/animal (kg)	Consumption of fodder/day (kg)
Buffalo	95	10.45	35	3325
Cow	262	28.82	22	5764
Bullock	198	21.78	26	5148
Sheep & Goat	346	38.06	7	2422
Horse & mule	8	0.88	22	176
Total	909	100	112	16835
Annually				6144775

In general, most of the villagers fed their animals through stall feeding. During winter dry fodder (hey and husk) of various crops was major fodder, however, *Grewia optiva, Ficus rugulosa, Celtis australis* and *Quercus leucotrichophora* provided green fodder during lean period. In addition, lesser quantity of agriculture weeds was also the source of green fodder. Sometimes, a mixture of straw of wheat, paddy, millet and pulses were mixed with green fodder and also fed to cattle as supplement the scarcity of fodder. Shortage of fodder is orderly met out from the forest trees. The villagers also store dry hey and husk of grasses in heaps for lean period. Grains were also given to cattle in insignificant quantities.

Fodder matrices

Straw and grass

The farming system in the Himalaya is crop-livestock-forest (including grassland) as interconnected production crop sub-system in which fodder is supplied to livestock in the form of crop by-products (Maharjan, 2005). The grasses from margins of terraced agriculture fields were kept as a stored fodder on the basis of production cycle, likeness of animals (preferred fodder by animals), nutrients and palatability. On the basis of preference, great variation was observed in the selection of villagers (Table 3). The preferential importance by the villagers for fodder from top to down was (i) grass from terraced agriculture fields, (ii) wheat straw, (iii) millet straw, (iv) finger millet straw, (v) millet (*Setaria italica; Cheena)* straw, (vi) paddy straw (Table 3).

Trees for fodder

The highly preferred fodder tree species by the villagers were (i) *Grewia optiva,* (ii) *Quercus leucotrichophora* (iii) *Celtis australis,* (iv) *Boehmeria rugulosa,* and (v) *Ficus auriculata* (Table 4). These were lopped for fodder during scarcity of fodder, particularly in winter months.

Table 3. Fodder matrix of straw of various agriculture crops and grasses (On the basis of preferential importance by villagers, out of 10 marks for each respective of variables)

Species	Production	Likeness of animals	Nutrients	Useful/Palatable	Preference	
					Score Marks	Series
Grass from terraced agriculture fields	9	8	8	8	33	I
Wheat straw (*Triticum aestivum* L.)	8	8	5	5	26	II
Millet straw (*Echinocloa frumetacea* Link.)	7	5	5	6	23	III
Finger Millet (*Eleusine coracana* Gaertn)	3	7	6	5	21	IV
Cheena straw (*Setaria italica* Beauv.)	5	3	5	6	19	V
Paddy straw (*Oryza sativa* L.)	5	4	5	4	18	VI

Table 4. Fodder matrix for tree in the village (On the basis of preferential importance by villagers, out of 10 marks for each respective of variables)

Species	Availability	Nutrients	Likeness of animals	Distance	Availability in months	Preference	
						Score marks	Series
Grewia optiva J.R. Drumm. ex Burret.	7	8	8	8	November-December	31	I
Quercus leucotrichophora	8	6	5	3	Over the year	22	II
Celtis australis L.	5	6	4	6	April-October	21	III
Boehmeria rugulosa Wedd.	2	6	5	7	Over the year	20	IV
Ficus auriculata Lour.	3	2	3	6	April-October	14	V

Fuel wood matrix

The villagers were dependent on forest for fuel wood, fodder, leaf litter for cattleôs bed and manures, and a variety of other tangible and intangible benefits, which are needed for sustained livelihood. Like other rural regions, the main dependence was for fuel wood. Keeping in view, the various parameters of good fuel

wood, namely less smoke, high calorific value, in flammability and long duration of burning, readiness to catch the fire. The most preferred species by villagers were (i) *Quercus leucotrichophora,* (ii) *Pinus roxburghii* (iii) *Toona ciliata,* (iv) *Alnus nepalensis,* (v) *Rhododenron arboretum* and *Pyrus pashia,* and (vi) *Lyonia ovalifolia*, respectively. The *Quercus leucotrichophora* was the most preferred fuel wood species because it has all the specified quantities (Table 5).

Table 5. Fuelwood matrix of tree species in the village (On the basis of preferential importance by villagers, out of 10 marks for each respective of variables)

Species	Less smoke	Maximum flame	Durability of flame	Maximum ash	Availability	Preference	
						Score marks	Series
Quercus leucotrichophora	9	8	8	9	8	42	I
Pinus roxburghii A.B. Jackson	3	8	4	6	5	26	II
Toona ciliata M. Roem.	5	6	4	5	3	23	III
Alnus nepalensis D. Don	4	5	3	5	3	20	IV
Rhododendron arboretum L.	3	4	5	4	3	19	V
Pyrus pashia Buch.-Hum. ex D. Don	3	5	3	4	4	19	V
Lyonia ovalifolia Hort.	4	3	2	3	2	14	VI

Timber matrix

Timber was needed by the villagers for construction and repairing of houses and every household had the demand of sleepers and small timbers (for agricultural implements). The order of preference for timber species was (i) *Toona ciliata*, (ii) *Quercus leucotrichophora,* (iii) *Pinus roxburghii,* (iv) *Alnus nepalensis* and (v) *Grevillea robusta*, respectively (Table 6).

Table 6. Timber matrix of tree species in the village (On the basis of preferential importance by villagers, out of 10 marks for each respective of variables)

Species	Availability	Strengthen	Durability	Weight	Free from disease	Preference	
						Score marks	Series
Toona ciliata M. Roem.	4	9	9	7	8	37	I
Quercus leucotrichophora	6	8	9	6	7	36	II
Pinus roxburghii A.B. Jackson	3	7	5	6	5	26	III
Alnus nepalensis D. Don	5	6	6	4	4	25	IV
Grevillea robusta A.Cunn. ex R.Br.	4	5	6	5	3	23	V

Bio-resources use pattern

A total of fourteen tree species, four shrub species and four climber species were being used by the villagers for fuel wood, fodder, timber, fibre, fruit, vegetable and other purposes (Table 7). Amongst these, *Quercus leucotrichophora* was considered to be best quality fuel wood, *Grewia optiva* as best quality fodder species and *Toona ciliata* as the best quality timber species. Seven tree species were encountered in agroforestry system. *Grevillea robusta* was found exclusively in road side plantation. Four shrubs and four climber species were being used commonly for fuel, fodder and fencing purposes.

Table 7. The utilization pattern of bioresources by the villagers

Species	Vernacular name	Family	Uses	Habitat
Tree				
Alnus nepalensis D. Don	Utis	Betulaceae	Fu,Fo,	Agroforestry
Boehmeria rugulosa Wedd.	Genthi	Utricaceae	Fu,Fo, Ut	Agroforestry
Celtis autralis L.	Kharik	Ulmaceae	Fu, fo, Ed	Agroforestry
Citrus sp.	Malta	Rutaceae	Ed	Agroforestry
Ficus auriculata Wall.	Timla	Rosaceae	Fu,Fo,Ed	Agroforestry
Grevillea robusta A.Cunn. ex R.Br.	Oak	Proteaceae	Fu, Tm	Planted
Grewia optiva J.R. Drumm. ex Burret	Bhimal	Tiliaceae	Fu,Fo,Fb,Ed	Agroforestry
Juglans regia L.	Akhrot	Junglandaceae	Fu, Ed	Agroforestry
Lyonia ovalifolia Hort.	Anyar	Ericaceae	Fu,	Forest
Myrica esculenta Buch.-Hum. ex D. Don	Kaphal	Myricaceae	Fu,Fo,Ed,St	Forest
Pinus roxburghii A.B. Jackson	Chir	Pinaceae	Fu,Tm,	Forest
Pyrus pashia Buch.-Hum. ex D. Don	Mehal	Rosaceae	Fu,Fo,St,Ed	Forest, agroforestry
Quercus leucotrichophora	Banj	Fagaceae	Fu, Fo, St	Forest, agroforestry
Rhododendron arboretum L.	Burans	Ericaceae	Fu,Fo,St,Ed.	Forest
Shrub				
Berberis spp.	Kingor	Berberidaceae	Fu,Ed, Me	Forest, Agroforestry
Prinsepia utilis Royle	Bhenkuli	Rosaceae	Fu, Oi	Forest,Agroforestry
Pyracantha crenulata M. Roem.	Ghingaru	Rosaceae	Fu, Ed	Forest, Agroforestry
Rubus ellipticus Sm.	Hissar	Rosaceae	Fu, Ed	Forest,Agroforestry
Climber				
Rosa moschata Herrm.	Kunja	Rosaceae	Fe, Fo	Forest, Agroforestry
Smilax aspera L.	Kukardara	Smilacaceae	Me, Fo	Forest
Tinospora cordifolia Hook. f. & Thoms.	Giloi	Tinosoraceae	Me	Forest, Agroforestry
Trichsonthes tricuspidata Lour.	Inrayani	Cucurbiticeae	Me	Forest, Agroforestry

Note: Fu-Fuel, Fo-Fodder, St-Small timber, Ed-Edible, Tm-Timber, Fb-Fibre, Ut-Utensil, Me-Medicinal, Oi-Oil, Fe-Fencing

Problems matrix

Lacks of fundamental facilities in rural areas are due to site specific government policies. In village Karokhi, the people have a number of problems but some major problems recorded were incorporated in the problems matrix (Table 8). A list of problems (Table 8) indicates that non-availability of (i) drinking water and veterinary hospital, (ii) health and hygiene (including toilet), (iii) LPG (Liquid Petroleum Gas) distribution centre, (iv) post-office and telephone exchange for rapid communication, (v) play ground, (vi) poling centre, (vii) motor road and bridges, *etc* were the main problems enumerated by villagers (Table 8).

Table 8. Problem matrix of the village (On the basis of preferential importance by villagers, out of 10 marks for each respective of variables)

Problems	a*	b	c	d	e	f	G	h	Preference	
									Score marks	Series
Drinking water	9	9	9	10	8	8	10	9	72	I
Veterinary hospital	9	10	9	10	9	8	9	8	72	I
Health and hygiene (including toilet)	9	8	9	10	9	8	9	8	70	II
LPG distribution centre	8	7	8	9	8	8	7	8	63	III
Post office and Telephone	8	9	7	6	8	7	8	9	62	IV
Play ground	9	6	7	5	6	8	8	8	57	V
Poling centre	6	8	7	6	5	8	8	8	56	VI
Road	7	6	5	6	7	5	7	6	49	VII
Bridge construction on rivulets	6	5	6	4	5	6	5	6	43	VIII
Concrete cement road in village	5	4	5	6	4	5	4	5	38	IX

*The alphabets are express, knowledgeable and recognised male and female person in the village

Role of women in Joint Forest Management

The rural women interact daily with nature, because it is the land, water, air, flora and fauna regime that provide them the means of survival. Women are responsible for the entire domestic chores including cooking, cleaning, maintaining health and hygiene of the household. Hence, they are takes an extra initiatives to bridge the over widening gap between the demand and supply of resources.

Women are backbone of Indian farming system, therefore, they are the main sufferer of the ecological hazard, having their perception pertaining to ecological sustainability (Lahiri, 2006). The studies postulated so far have indicated that the women of mountainous region have maximum work inputs for agricultural activities and domestic responsibilities, particularly in rural areas (Salam *et al.,* 2005). These are the healthy managers and caterers to the families. However, gender and social issues are main obstacles for women in rural areas to express their thoughts. In JFM programme, there are provisions for expression of women and for facilitating the programme they are given equal opportunities. If a conflict arises, it will be solved on the spot through steering committee in which women are also the members and have the equal rights.

Conclusion

1. Site-specific microplaning and peopleôs participation are extremely important for the success of Joint Forest Management Programme. The enforcement of the law and policies upon the villager should be avoided that had happen in past without their consent. Efforts should be made to introduce the quick profitable crops (cash crops, agriculture, horticulture, herbal, *etc.*) and multipurpose tree species (MPTs) for fulfilling the basic requirements of the villagers, which will reduce the pressure on natural resources. Introduction of forestry practices for maximum production of fuel wood, fodder, fruits, timber, fibre, *etc.* must be encouraged.

2. By adopting JFM programme, employment for village communities is ensured, therefore, through this the socio-economic status of villagers particularly the weaker section of the society would be benefited. A participatory approach through institutional and policy support is needed for developing new strategies and approaches for land utilization, integrated forest management and enhancement of the farm productivity with selecting the elite landraces and maintaining the growing demands of villagers on one hand and ecosystem services on the other to increase the forest wealth along with rural development. Attempts must be made to meet out the subsistence requirements, which are ordinarily fulfilled from forests, they should be realized through agroforestry and horticultural models, afforestation, energy plantation and pasture development activities.

3. Need to be established agricultural and horticulture products based distribution centre and stable market. Need to be distributed seeds of high yielding varieties (HYVs) such as vegetables, agricultural crops, horticulture plants and MPTs. In addition, traditional agricultural systems are also protected on the basis of merits for gene pool conservation and food security issues. The foresters should maintain the affection and discipline, from control to involvement, implementation to facilitation, policy making to participation. Thus, a collection decision making approach has to be followed for integrated forest resource management (Fig. 1).

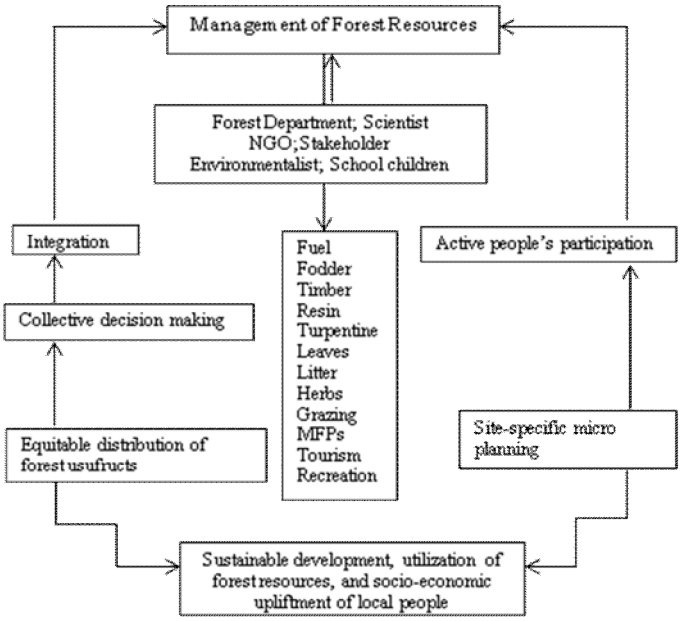

Figure 1. Integrated Forest Resource Management

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References

Anonymous, 1996. Training needs assessment of frontline forest personnel- A JFM Perspective. Joint Forest Management series. Assessment of training needs of frontline forestry staff-A JFM Perspective. Haryana Forest Department and Tata energy research Institute 20, 1-38.

Bhatt, B.P., Negi, A.K., Todaria, N.P. 1994. Fuel wood consumption at different altitudes in Garhwal Himalaya, *Energy* 19(4), 465-468.

Bhatt, B.P., Sachan, M.S., 2004 Firewood consumption along an altitudinal gradient in mountain villages of India, *Biomass & Bioenergy* 27, 69-75.

Champion, H.G., Seth, S.K., 1968. *A revised survey of the forest type of India*. Manager of publication, Govt. of India. Delhi 330p.

Gupta, S.K., 2000. Joint Forest Management: aspects and prospects. In*:* K.G. Mukerji B.P. Chamola and A.K. Sharma, eds., Glimpses in Botany: Prof. G.S. Paliwal Festschrifts Volume, APH Publishing Corporation, New Delhi pp. 173-180.

Gupta, S.K., 2002. Aspects of Joint Forest Management. *Aspects and sustainability of Joint Forest Management.* Bishen Singh Mahendra Pal Singh Dehradun, India pp. 11-22.

IPPCC, 2001. Climate Change 2001. Impacts, Adaptation and Vulnerability, contribution of Working Group II to the Third Assessment of the Intergovernmental Panel on Climate Change.

Lahiri, P., 2006. Women and forests a prefect partnership, *Women and environment* 3, 1-2.

Maharjan, K.L., 2005. Community participation in forest resource management in Nepal, *Journal of Mountain Science,* 2, 32-41.

Maikhuri, R.K., Ramakrishnan, P.S., 1990. Ecological analysis of a cluster of villages emphasising of land use of different tribes in Meghalaya in north-east India, *Agriculture, Ecosystems & Environment* 3, 17-37.

Maikhuri, R.K., Ramakrishnan, P.S., 1991. Comparative analysis of the village ecosystem function of different tribe living in the same area in Arunachal Pradesh in North-eastern India, *Agriculture Systems* 35, 377-399.

Maikhuri, R.K., 1991. Fuel wood consumption pattern of different tribal communities living in Arunachal Pradesh in North-East India, *Bio-resource technology* 35, 291-296.

Maikhuri, R.K., Gangwar, A.K., 1991. Fuel wood use by different tribal and non-tribal communities in North East India, *Natural resources forum* 162-165.

Myers, N., 1988. Threatened biotas: ôhotspotsô in tropical forests, *Environmentalist* 8, 187-208.

Salam, M.A., Noguchi, T., Koike, M., 2005. Factors influencing the sustained participation of farmers in participatory forestry: a case study in central Sal forests in Bangladesh, *J. of Environment and Management* 74, 43-51.

Vishvakarma, S.C.R., Kuniyal, J.C., Singh, G.S., 1998. Indigenous agroforestry system of North Western Himalaya. *Research for mountain development*: Some initiative and accomplishment. Publish by Gyanodaya prakashan, Nainital.