Land Resource Management a Nectar of Human-Life to infinite of "Suyal" Catchment in Lesser Himalaya

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Abstract: **The land is the most fundamental component of the natural environment of the mother earth. It is a basic resource which facilitates the generation and development of other biophysical resources, such as water, soils, plants and animals. The altitude of the Suyalcatchment ranges between 1260 m and 2340 m from the mean sea level, that part of Lesser Himalaya. Despite several geo-environmental constraints the basin has not escaped anthropogenic impacts which continue to multiply with the increasing pressure of population and the resultant process of land use changes operative in the Suyal catchment. The practices of cultivation and grazing are now extended over large areas leading to the degradation of the fragile ecosystem and depletion of natural resources. A considerable proportion of the region is ecologically vulnerable and thus prone to the processes of environmental degradation. The region, therefore, deserves specific attention for protecting the fragile environment and sustainable development of natural resources.This paper suggests a suitable Land Use Pattern and Sustainability of Ecosystem with swains in Lesser Himalaya.**

Keyword**: Lesser Himalaya, Land Resource Management, Land Use Pattern, Suyal Catchment.**

I. INTRODUCTION

The Suyal catchment encompassing a geographical area of 245.36 km^2 from its source at Daram in the southeast to Ghurari in the southwest was taken up as the area of study for this investigation. The watershed stretches between 79°37' and 79°51' East Longitudes and 29°32' and 29°42' North Latitudes in the Lesser Himalayan Ranges of district Almora of the newly carved Lesser Himalaya state of Uttarakhand.

Land is one of the important reservoirs of a variety of bio-chemical elements that support the entire life systems on the planet. Besides, land is an indispensable factor for the production of crops, livestock, timber, fuel, fodder industrial and commercial goods etc. Land is constituted by a variety of landscapes and landforms which are necessary for the sustenance and survival of human being and wildlife as well as for the flourishing and growth of bio-diversity.

There are several types of uses and utilization of land, depending upon the natural characteristics of the land, such as altitude, slope, rainfall, soil texture, water retention capacity, etc. Besides, a set of socio-economic factors, such as, population pressure, capital, labour, technological innovations, infrastructural facilities, market forces, social traditions, indigenous knowledge, land tenure etc. also determine the development and utilization of land resources in a geographical region (Tiwari, 1995).

The development of a geographical region mainly depends on the development and management of its land and other natural resources. The land is an important geographical factor in the development and management of all other natural resources. The pattern of human activities on the earth's surface is largely controlled by the characteristics of land which include surface configuration, soil properties, water availability, vegetation characteristics, climate etc. During the recent years, the traditional resource utilization pattern in many parts of the world, including Himalaya has changed in response to increasing population pressure, and the resultant increased need of natural resources.

As a result, the natural resources of a large part of the Globe have eroded and depleted steadily and significantly, leading to long term environmental and land use changes and ecological disruptions. Hence, one of the most important challenges before us is to evolve a comprehensive strategy for the sustainable development of natural resources. Though the land is a finite resource, yet it can be put to alternative uses, and its productivity can be increased through better planning and management. During the last few decades the land use changes in the Himalaya have aggravated the problem of ecological imbalances resulting not only in decreased productivity of land, but also in its rapid degradation of land resources by accelerating erosion, landslides, desertification etc. (Shah, 1986).

II. LAND USE CLASSIFICATION

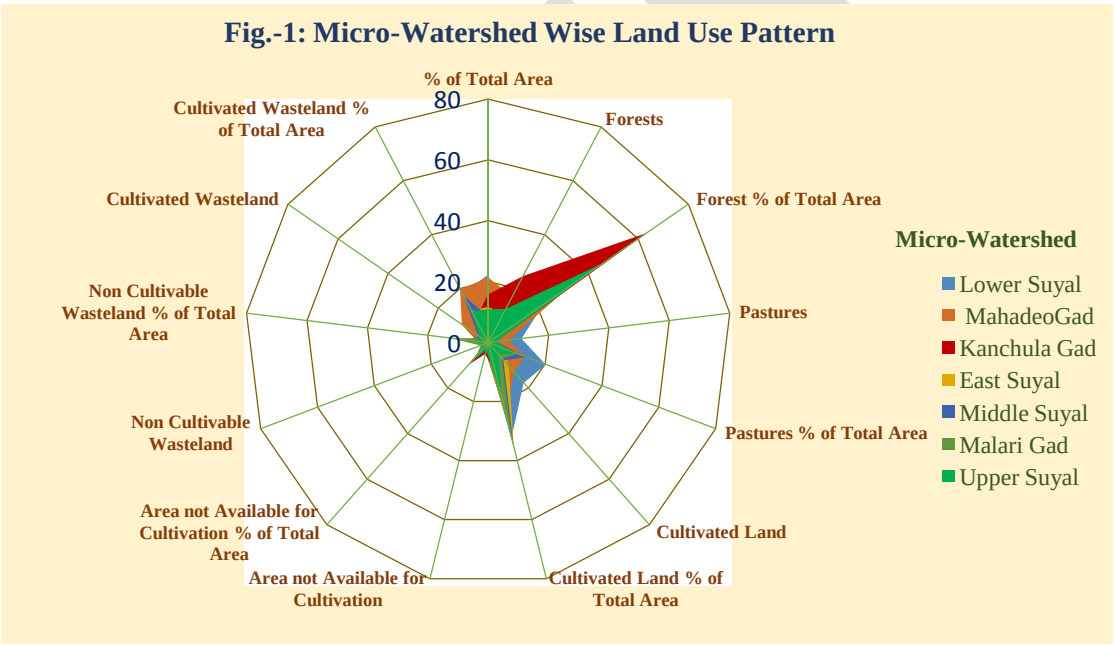
The land use interpretation and classification in the present work is based on the information collected from the Land Record Department of the State Government. Before arriving at a final land use classification of the Catchment field checks were carried out to test the validity of the data used, and accordingly, in many cases, necessary modifications were made after having discussions with the concerned authorities. The results of this exercise have been shown in Table-1& Fig.-1.

Table 1: Micro-watershed Wise Land Use Pattern in Suyal Catchment (in km^2).

Micro-watersheds	Total Geographical Area (km^2)	% of Total Area	Forests	Forest % of Total Area	Pastures	Pastures % of Total Area	Cultivated Land	Cultivated Land % of Total Area	Area not Available for Cultivation	Area not Available for Cultivation % of Total Area	Non Cultivable Wasteland	Non Cultivable Wasteland % of Total Area	Cultivated Wasteland	Cultivated Wasteland % of Total Area
1. Lower Suyal	54.72	22.30	12.04	22.00	11.12	20.32	17.66	32.27	2.62	4.79	1.35	2.47	9.93	18.15
2. Mahadeo Gad	52.73	21.49	17.32	32.85	6.90	13.09	12.92	24.50	3.29	6.24	1.90	3.60	10.40	19.72
3. Kanchula Gad	38.88	15.85	24.72	63.58	2.30	5.92	3.68	9.47	3.81	9.80	0.97	2.48	3.40	8.75
4. East Suyal	28.99	11.82	10.90	37.60	1.61	5.55	10.30	35.53	1.84	6.35	0.94	3.24	3.40	11.73
5. Middle Suyal	21.64	8.82	4.70	21.72	2.90	13.40	7.67	35.44	1.17	5.41	1.40	6.47	3.80	17.56
6. Malari Gad	21.31	8.68	5.71	26.80	2.20	10.32	6.90	32.38	1.20	5.63	2.60	12.20	2.70	12.67
7. Upper Suyal	27.09	11.04	12.54	46.29	2.70	9.97	5.12	18.90	2.46	9.08	1.20	4.43	3.07	11.33
Total	**245.36**	**100.00**	**87.93**	**35.84**	**29.73**	**12.12**	**64.25**	**26.18**	**16.39**	**6.68**	**10.36**	**4.22**	**36.70**	**14.96**

Source: Land Record Office, Almora

Fig.-1: Micro-Watershed Wise Land Use Pattern



Detailed land use survey and mapping were also carried out using field mapping techniques on cadastral maps in a Mahadeo Gad Headwater of the catchment (694.47 ha). The micro-watershed is constituted by five villages situated in Northwest of the Suyal Catchment. Besides, land use changes have also been monitored at village level in the headwater region.

III. LAND USE PATTERN

The land use pattern emerged in the catchment on the basis of the analysis and interpretation of data collected from Land Record Department is as follows:

3.1. Forests

Different types of forests cover 87.93 km^2 land surface of Suyal Catchment which accounts for 35.84 percent of the total geographical area of the watershed (Table -1). Out of the total forest area, reserve, civil and *Panchayat* forests respectively constitute 55.15, 10.96 and 33.89 percent. The forests of the region are mainly used for fuelwood, fodder, and timber and for various other minor products. A detailed account of the forests resources of the catchment has been presented in the Chapter – 4 of the volume.

3.2. Pastures

Portions of culturable and uncultivable wastelands, degraded forests and agricultural land which have been left fallow for several years are used as pastures in the region. Only 12.12 percent (29.73 km^2) of total area of the catchment is under pastures. Table -1 shows that the highest area (11.12 km^2) under pastures is in Lower Suyal Micro-watershed and the lowest (1.61 km^2) is in East Suyal Micro-Watershed. The availability of pastures in other micro-watersheds of the catchment ranges between 2.20 km^2 and 6.90 km^2 (Table -1)

3.3. Cultivated Land

Out of total geographical area of Suyal Catchment, (64.25 km^2) which accounts for 26.18 percent of total area is under cultivation. The availability of cultivated land in the catchment ranges between 9.47 percent and 32.38 percent in different micro-watersheds of the catchment (Table-1). Cultivation is the main source of livelihood and occupation of about 76 percent population of the study area. A set of physical, socio-economic and technological factors determine the use of land for cultivation in the region. Out of total cultivated land only 6.38 percent is irrigated and the remaining 93.62 percent is completely rain-fed (Table -2).

Table 2:Distribution of Irrigated and Rainfed Cultivated Land in Suyal Catchment.

Micro-watersheds	Cultivated land (in km^2)	% of Total Micro-watershed Area	Unirrigated	Irrigated
			% of Total Cultivated Land	% of Total Cultivated Land
1. Lower Suyal	17.66	32.27	98.24	1.76
2. Mahadeo Gad	12.92	24.50	94.43	5.57
3. Kanchula Gad	3.68	9.47	84.24	15.76
4. East Suyal	10.30	35.52	83.50	16.50
5. Middle Suyal	7.67	35.44	95.17	4.83
6. Malari Gad	6.90	32.38	100.00	-
7. Upper Suyal	5.12	18.89	91.79	8.21
Total	**64.25**	**26.19**	**93.62**	**6.38**

Source: Land Record Office, Almora.

The highest proportion of irrigated land is in East Suyal where 16.50 percent of total cultivated land is irrigated, whereas, in Malari Gad Micro-watershed the entire cultivated land is rain-fed.

There are two types of cultivated land in the region – *Upraun* and *Talaun*. The term *Upraun* denotes higher elevations with low temperature, poor soils and high gradient and low agricultural productivity. The principal crops produced in the *Upraun* land are coarse grains, such as *Mandua* and *Jhungra*, pulses, upland rice, barely, wheat and soyabeans. The *Talaun* signifies fine and deep soil cover, moderate temperature; gentle and low surface slope and regular supply of water for irrigation. Main crops grown in *Talaun*are paddy, wheat, barely, mustard, potato etc. Out of the total cultivated land 93.62 percent and 6.38 percent respectively come under *Upraun* and *Talaun.*

3.4. Area under Non-agricultural Uses

The area not available for cultivation includes mainly the land under settlements, roads, footpaths and water bodies. Out of the total geographical area of the Suyal Catchment 16.39 km^2 or 6.68 percent has been categorized as area not available for cultivation. The largest proportion of non-agricultural land (3.81 km^2) is in Kanchala Gad Micro -watershed and the lowest (1.17 km^2) in Middle Suyal Micro- watershed of the catchment (Table -1). Out of the total land area identified under this category of use, 36.25 percent is under settlements, 25.19 percent is under roads and 38.56 percent is under water bodies (Table-3).

Table -3:Distribution of Area Not Available For Cultivation in Suyal Catchment.

Micro-watersheds	Area not available for cultivation (in km^2)	% of Micro-watershed area	% of Area not Available for Cultivation		
			Settlements	Roads	Water-bodies
1. Lower Suyal	2.62	4.79	30.15	19.85	50.00
2. Mahadeo Gad	3.29	6.24	48.63	17.94	33.43
3. Kanchula Gad	3.81	9.80	39.37	23.88	36.75
4. East Suyal	1.84	6.35	32.07	32.07	35.86

5. Middle Suyal	1.17	5.41	20.51	26.50	52.99
6. Malari Gad	1.20	5.63	27.50	26.67	45.83
7. Upper Suyal	2.46	9.08	36.18	36.18	27.64
Total	**16.39**	**6.68**	**36.25**	**25.19**	**38.56**

Source: Land Record Office Almora.

3.5. Wasteland

Identification and management of wasteland has assumed great significance in view of increasing pressure of population on land and resultant process of environmental degradation. But owing to lack of detailed and precise statistical information it is almost difficult to identify and characterize wasteland. Besides, there are no standard criteria for the identification of wasteland because the concept and meaning of wasteland vary from place to place and from a particular point of time to another, mainly due to variation in people's perceptions of their problems, needs and priorities and appraisal of environment and natural resources.

Prof.Shafi (1968) included only those categories of land under wasteland, which could be brought under cultivation for raising the agricultural output to meet the food-demand of rapidly increasing population of the country. Planning Commission of India has also prepared a detailed and Comprehensive list of different categories of land which should be treated as wasteland. However, the practical problem that involves in the exercise pertaining to the identification and classification of wasteland is that detailed information is not available in land use records of the State Government on the different classes of land designated as wasteland by the Planning Commission and other government agencies. However, a National Wasteland Classification System has been evolved by the National Wasteland Development Board (NWDB) dividing the wasteland of the country into 13 categories. Based on this classification system, a wasteland atlas of India was prepared covering 241 district of the country at scale 1: 50000, using remote sensing techniques. This atlas was released in 1995.

In the present investigation the identification of wasteland in the Suyal Catchment was done mainly through the analysis and interpretation of whatever broad land use data was available with the District Land Record Department, Almora. On the basis of the data and information available two broad categories of wasteland were identified in the region which include cultivable and un-cultivable wastelands. These two categories of wasteland put together accounts for 19.17 percent (47.06 km^2) of total catchment's area:

3.6.1 Cultivable Wasteland

Out of the total geographical area of the region 36.70 km^2 or 14.96 percent is under cultivable wasteland. The cultivable wasteland includes those categories of land which were earlier under cultivation but are now lying barren, owing to various physio-cultural factors. This category of land can effectively be brought under plough, horticulture as well as under farm and social forestry and thus can play a most crucial role in the management of environment and natural resources in the region. The highest proportion (10.40 km^2) of cultivable wasteland was recorded in Mahadeo Gad followed by Lower Suyal (9.93 km^2) micro-watershed. Whereas, the lowest area (2.70 km^2) under this category of land use was registered in Malari Gad micro-watershed (Table-1 &2).

3.6.2. Un-cultivable Wasteland

This category of land includes mainly the rocky wasteland and the steep sloping area, and all these types of land put together brings 10.36 km^2 or 4.22 percent of the total geographical area of the catchment under this category of land use. Malari Gad micro-watershed has the highest (2.60 km^2) proportion of non-cultivable wasteland in the region (Table-1 &2).

IV. LAND USE CHANGES

With the increasing pressure of population on the land, the human transformation process of the bio-physical components has brought about remarkable changes in the land use pattern of the region. Consequently, the cultivation is now being pushed to forested areas, marginal lands and up slopes without taking into account the suitability of these lands for agriculture, and the vegetal cover is being lopped and cleared for meeting the increasing demand of fuel-wood and fodder. This land transformation process has brought about critical environmental changes through the erosion of topsoil and reduction in ground water recharge in this ecologically sensitive and geo-morphologically high-energy region.

In order to monitor the process of land use changes and assess their environmental impact, experimental study was carried out in Mahadeo Gad Headwater consisting of five villages of the catchment. The land use changes were monitored between 1972 and 2002. Field mapping techniques were used for the monitoring of land use changes. This exercise revealed the area under cultivation in the headwater region has increased from 164.20 ha in 1972 to 190.87 ha in 2002 registering an overall increase of 3.84 percent during the last 30 years. This increase in cultivated land is because of the extension of cultivation in wasteland and pastures, and as a result the area under these categories has respectively reduced 16.48 percent and 20.69 percent between 1972 and 2002 (Tables – 4, 5,6& fig.-2).

Table 4: Broad Land Use Pattern of the Mahadeo Gad Headwater in 1972.

Villages Name	Total Area (ha)	Cultivated Land (ha)	Forest (ha)	Pastures (ha)	Wasteland (ha)
1. Tyarikhan	2.20	2.00	-	-	0.20
2. Kalimat	29.07	0.30	3.23	-	25.54
3. Sariapani	64.10	5.00	29.30	10.00	19.80
4. Mat	206.60	63.70	63.00	44.40	35.50
5. Matena	392.50	93.20	100.00	92.20	107.10
Total	**694.47**	**164.20**	**195.53**	**146.60**	**188.14**

Source: Land Record Office Almora.

Table 5 Land Use Pattern of the Mahadeo Gad Headwater in 2012.

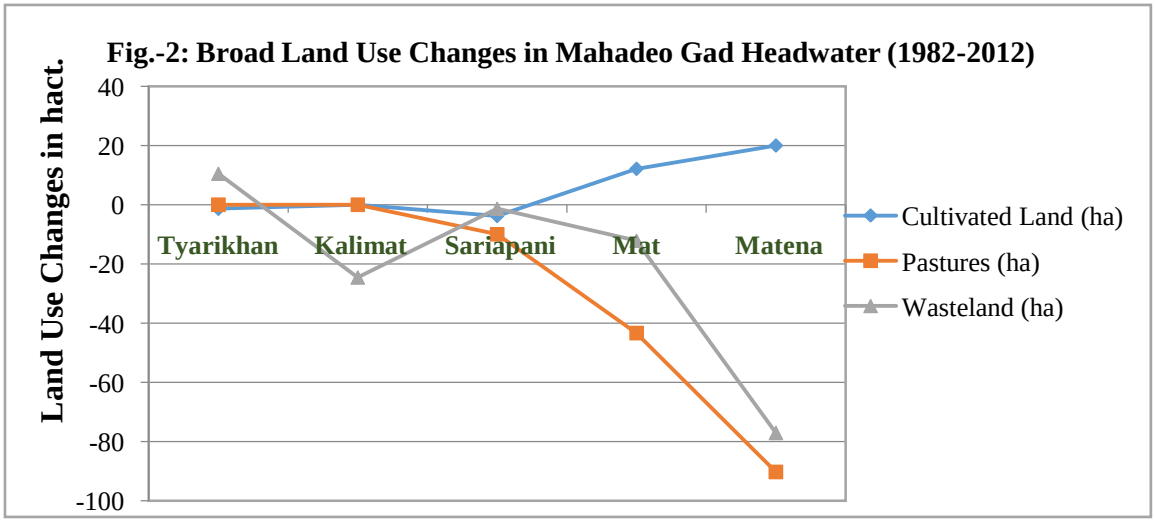
Villages Name	Total Area (ha)	Cultivated Land (ha)	Forest (ha)	Pastures (ha)	Wasteland (ha)
1. Tyarikhan	2.20	0.65↓	0.60↑	-	0.95↑
2. Kalimat	29.07	-	28.06↑	-	1.01↓
3. Sariapani	64.10	1.20↓	44.50↑	-	18.40↓
4. Mat	206.60	75.82↑	106.40↑	1.00↓	23.38↓
5. Matena	392.50	113.20↑	247.50↑	1.90↓	29.90↓
Total	**694.47**	**190.87**	**427.06**	**2.90**	**73.64**

Source: Land Record Office Almora.

Table 6:Broad Land Use Changes in Mahadeo Gad Headwater (1982-2012).

Villages Name	Cultivated Land (ha)	Forest (ha)	Pastures (ha)	Wasteland (ha)
1. Tyarikhan	-1.35	+0.60	-	+10.55
2. Kalimat	-	+24.83	-	-24.53
3. Sariapani	-3.80	+15.20	-10.00	-1.30
4. Mat	+12.12	+43.40	-43.40	-12.12
5. Matena	+20.00	+147.50	-90.30	-77.10
Total	**+26.67**	**+231.50**	**-143.70**	**-114.50**

Source: Land Record Office Almora.



Interestingly, the area under forests in the Mahadeo Gad Headwater has increased by as much as 33.33 percent. This unusual increase in the forest area is explained by the fact that a considerable proportion of wasteland in the Mahadeo Gad Headwater has been brought under forest through afforestation and reforestation programme, during the last few decades.

V. DEGRADATION OF LAND RESOURCES

It has been estimated the average rate of soil erosion in Kumaon Himalaya ranges between 0.8 and 1.7 mm per annum (Bartarya&Valdiya, 1988). Each tonne of sediment generated through erosion removes 12.50 to 19.90 kg of organic carbon, 0.82-1.44 kg of nitrogen, 0.41 to 0.49 kg of phosphorus and 0.64 to 0.71 kg of potassium (Bhatnagar&Kundu 1992).

As mentioned in the preceding sections of this chapter that the land use pattern in the catchment has been changing with more land coming under cultivation. The extension of cultivation in the region is taking place in wasteland and grazing areas which are not suitable for crop farming. Since, the suitable arable land is no more available in the basin, agricultural encroachment is also taking place into the village forest land. Although the area under forests has shown considerable increase in the Mahadeo Gad Headwater, yet the area shown under forests are highly degraded and devoid of healthy vegetation, except some compartments of reserved forest and wildlife protected area of the catchment. These changes in the traditional land use and resource development practices have created several kinds of environmental and ecological problems in the catchment. These problems include, deforestation, drying of natural springs and decreased water flow in streams and channels, accelerated erosion of top soils, landslides and landslips, and loss of biodiversity and genetic resources in the region. In the present study, erosion and landslides have been considered as principal degradational processes which have caused considerable depletion of land resources in the catchment.

5.1. Soil Erosion

Erosion of top soils is one of the most serious environmental problems in the entire Himalayan ranges. It would have not been possible owing to several practical reasons to scientifically analyse, and interpret the process of soil erosion in the study area. But it was observed during the field surveys carried out in the Mahadeo Gad Headwater that the process of soil erosion in region is controlled and regulated by the following factors:

- The nature and characteristics of soil.
- The type and condition of the vegetative cover.
- The amount and intensity of rainfall.
- The slope and its aspect.
- The pattern of land use practices.

The areas affected by soil erosion were delineated and mapped in the cadastral maps by the observation of above factors and categorized into low, medium and high erosion intensity classes. The result of this exercise has been presented in Table-5.

5.2. Landslides

The stability of a slope is disturbed with the sliding movement of varied nature. These movements may be due to sliding of hard rocks, unconsolidated deposits, superficial sediments and also the top soil along a definite plane of separation. Depending upon the rate of movement these can be classified into rapid and slow movements. The rapid movements are known as landslides. The landslide is gravitational or downward movement of rocks along weak plane. Bloom (1977) defined landslide as a downhill movement along discrete shear surface. Strahler (1965) defined landslide as the rapid sliding of large masses of rocks with little or no flow of materials. Landslides are caused by natural as well as anthropogenic processes. Natural landslides are triggered by toe erosion of rivers. Some landslides occur on free slopes without the influence of streams on which tectonic activity is very effective. Human induced landslides are mainly caused by deforestation, slope cutting for cultivation and construction of roads and building on sensitive slopes.

Since the catchment comes under the tectonically alive Lesser Himalayan domain, the region is highly vulnerable to slope failure and mass movement. The entire watershed is marked with a large number of active and old landslides. The process of deforestation and extension of cultivation to up-slopes, construction of house and roads, and stone quarrying have rendered the catchment sensitive to the activity of landslide. In order to study the spatial pattern and causative factors of landslides detailed study was carried out in Mahadeo Gad Headwater of the catchment using field survey and mapping techniques.

As many as six active landslides were identified and mapped in Mahadeo Gad Headwater. It was observed that all the identified landslides in the region are man-induced landslides. The nature of these landslides is almost similar. The rocks are composed of crushed material, and the vegetal cover has been removed that have rendered the slopes vulnerable to landslides. A few trees of pine are standing sparsely above these landslide areas. These landslides have occurred at an elevation of 1800 m above mean sea level along an average slope of 30°. The crown of slide is located at a height of about 15-30 m. The surface is characterized with a number of terraces which indicate the instability of the area. The head-scarp is fairly steep and free from vegetative cover in all the landslides identified.

It was investigated that the most important causative factor of these landslides is the deforestation, expansion of settlements and construction of roads. Cultivation of steep slopes without protective vegetal and other unscientific method of farming create structural disturbances, and finally rendered the area prone to landslides.

VI. PROPOSED LAND USE PLANNING

The proposed village wise optimal land use plan is primarily based on the land capability assessment. The land capability classification thus arrived at earlier in this Chapter enabled us to divide the total village area of Mahadeo Gad Headwater (excluding the reserved forest) into five broad land use classes. These land use categories are as follows:

Forests

The forest area of the headwater region has been proposed to be increased from the existing 331.14 ha or 57.39 percent to 334.54 ha or 57.98 percent of the total area of the headwater. It has not been possible to suggest substantial increase the area under forest in the region mainly because all the villages except Tyarikhan of the headwater have 52.46 percent to as much as 94.70 percent of their geographical area is under forest that needs to be properly managed. The slight increase in the village-forest area could be attained by bringing 0.50 ha of cultivable wasteland in village Tyarkhan, 1.00 ha pastures in Mat and 1.90 ha grazing land in Matena village under forest. Thus the area under forest in Tyarikhan, Mat and Matena villages will respectively increase from existing 27.27 percent to 50 percent, 57.36 percent to 57.84 percent and 52.46 percent to 53.12 percent ;

Cultivated Land

The total cultivated land of the headwater region has been proposed to be reduced from 33.08 percent to 21.60 percent. This sizable decrease in the cultivated land has been possible mainly because of the unsuitability of considerably large proportion of existing agricultural land for crop farming in Mat, Matena and Tyarikhan villages of the region.

Area for Non-agricultural Uses

At present 33.78 or 5.85 percent of the total area of Mahadeo Gad Headwater is under non-agricultural uses, such as, residential houses, tourist houses, guesthouses, etc. The villages of the headwater, particularly, Tyarikhan, Kalimat and Saryapani are now emerging as popular tourist sites owing to the beauty of their natural landscapes from where one can enjoy the breathtaking view of the Himalayan ranges. There is, therefore an increasing demand of land for non-agricultural purposes in these villages. Keeping this in view, the provisions have been made in the land use plan for the expansion of tourist infrastructure, in Tyarikhan and Kalimat villages which are the most popular tourist destinations but are very small in size compared to other villages of the region. The area for non-agricultural uses has been increased from existing 20.45 percent to 34.55 percentTyarikhan and from 2.62 percent to 5.30 percent in Kalimat. This increase will be possible by releasing 0.31 ha of existing misfit cultivated land in village Tyarikhan; and 0.61 ha of non-cultivable wasteland, culturable wasteland and abandoned cultivated land in Kalimat for non-agricultural purposes.

Area for Horticulture and Plantation Crops

The misfit cultivated land, proportion of abandoned cultivated land and cultivable wasteland in Saryapani, Mat and Matena villages have been suggested to be brought under horticulture or under tea plantation depending upon the viability of the size of holding in different villages. This will bring 16.86 percent, 24.67 percent and 15.12 percent such lands respectively in Saryapani, Mat and Matena villages under tea or horticulture.

Conservation and Village Safety Areas

A little more than 13 percent of the total geographical area of the headwater has been recommended to be used as protected area for the conservation of dwindling water resources of the region, checking of erosion and stabilization of landslides. This requirement emerged in Sariyapani, Mat and Matena villages of the watershed where respectively, 1.40 ha of non-cultivable wasteland, 1.30 ha of non-cultivable and cultivable wasteland, and 1.90 ha of non-cultivable and cultivable wasteland has been proposed to be treated for the conservation of land and water resources.

VII. CONCLUSION

The strategy for the management of natural resources has been evolved within the framework of land use plan and taking into consideration the conservation need, resource requirement, people's options for the development of their natural resources, and the needs of the user agencies. The land provides the basis for the development of all other natural resources. The main objective of the land resource management in the region is to facilitate the conservation and sustainable development of land and other natural resources and increasing the productivity of rural ecosystem through optimal land use planning. The land use model worked out in the preceding section of the Chapter provides the basic framework for the sustainable development of land and other natural resources in the headwater region. The Planning Commission of India has recommended minimum 60 percent forest cover for the mountain region, at the same time it has been suggested that the cultivated land in mountain ecosystem should not exceed 25 percent of the total area (Maithani, 1989).

These two important objectives of land management have been by and large attained in the land use planning. Though there is no sizeable increase in total forest area, yet substantial decrease (33.08 percent to 21.60 percent) has been suggested in existing cultivated land in the headwater. The proportions (78.87 ha or 13.63 percent) of existing cultivated land which are not suitable for traditional crop farming have been recommended to replaced by environmentally conducive and income generating resource development activities, such as, tea cultivation and horticulture. Out of the total area of the headwater 4.60 ha has been demarcated for the conservation of land and water resources (Table 7.6 and Fig. 7.2). Besides, keeping in view the prospects of tourism development in the

region, suitable land has been delineated for the expansion of tourism infrastructure in Tyarikhan and Kalimat villages of the watershed.

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