1.2.2 Historical and Cultural Heritages

There are many historical and cultural heritages distributed in the Study Area according to the information collected from the Department of Archaeology as shown in Figure 1.2.2. The figure shows the locations of temples, forts, palaces, historical places, Buddhist temples, shelters or houses and caves which have been identified so far. Since archaeological research work is still limited, it can be expected that there would be more monuments to be protected from ruin in the Study Area.

Access by visitors to these historical and cultural assets is limited due to the under-developed transportation system, improper protection of the sites and so on. Tripura Sundari in Jhulaghat (Baitadi District) attracts a particularly high number of devotees and holy men including those from India. This Tripura Sundari can be protected from being submerged even if the Pancheshwar Project is implemented, but the Pancheshwar Mahader Temple lying just upstream of the confluence between the Mahakali River and the Sarju River must be moved. This temple is located in the Indian territory, but its religious importance is shared between both Nepalese and Indian.

1.3 Important Fauna and National Parks

1.3.1 National Parks and Wildlife Conservation

The Department of National Parks and Wildlife Conservation (DNPWC) of the Ministry of Forests and Environment (MFE) is responsible for the implementation of the National Parks and Wildlife Conservation (NPWC) Act (1973) and regulations. However, the Royal Nepal Army (RNA), in practice, takes the responsibility for the protection and security of the National Parks and other nature conservation areas.

According to the Master Plan for the Forestry Sector in Nepal (Ref. III-5), National Parks and Wildlife Conservation have the following objectives:

(a) Serving as a reservoir of genetic resources,
(b) Protecting watersheds,
(c) Providing a baseline for scientific studies, and
(d) Contributing to the Nepalese tourism industry.

There are four categories of protected areas in the NPWC Act, i.e. national parks, strict nature reserves, wildlife reserves and hunting reserves, although no strict nature reserve has

yet been created. In addition to these, two conservation projects are being implemented by the King Mahendra Trust for Nature Conservation (KMTNC) in order to balance the needs of local people, tourism and nature conservation. The protected areas are listed in Table 1.3.1, and their locations in Figure 1.3.1, totalling 15,933 km^2 and accounting for 10.8% of the whole of Nepal territory (147,181 km^2). The area within the Study Area is 5,366 km^2 which is equivalent to one-third of the protected area in the nation.

The definition of the protected areas classified into five categories is as follows (Master Plan for the Forestry Sector, Plan for the Conservation of Ecosystems and Genetic Resources):

(a) National Park :
An area set aside for conservation, management and utilization of animals, birds, vegetation or landscape together with the natural environment.

(b) Wildlife Reserve :
An area set aside for the conservation of animals and birds and their habitats.

(c) Strict Nature Reserve :
An area with ecological or other significance, which is set aside for the purpose of scientific study.

(d) Hunting Reserve:
An area set aside to reserve animals and birds as hunting resources.

(e) Conservation Area:
An area set aside to balance the needs of local people, tourism and nature conservation. The inhabitants in the area are allowed to conduct socio-economic activities within a managed framework. Research activity and tourism are also permitted.

National Parks and Wildlife Conservation have an important role in protecting wildlife as mentioned above. In addition, their contribution to the Nepalese tourism industry, in particular, is considered a positive impact through increased employment opportunity and foreign exchange earnings. Simultaneously, however, NPWC has two major negative impacts.

The first one is the conflict with the interest of local people concerning resource use. The typical case is the involuntary resettlement of the local people, when an area is delineated as a national park. In case of Rara National Park, a few hundred people, evacuated from the

area, were resettled in the Terai area in 1978. Further details are discussed in the subsequent Section 2.1, Involuntary Resettlement.

The second conflict is that prosperous tourism industry is quite likely to cause high fuelwood demand, price inflation, spreading of litter and undermining of traditional life style.

1.3.2 Protected Fauna under Nepali Law

In Nepal, some fauna are protected country-wide, but there are no flora protected. The protected species of Mammalia, Aves and Reptilia as of December 1, 1989 are counted to be 27 for Mammalia, 9 for Aves and 3 for Reptilia as listed in Table 1.3.2.

The major reasons why these species of fauna are endangered are (a) destruction of their habitat, (b) hunting and poaching, (c) disease, (d) loss of food supply and (e) above physical obstruction to migration. The last reason is specific to Gangetic dolphin.

The Gangetic dolphin of Karnali river, which is protected under Nepali law, is reported to be declining in the last ten years. The main reason of this decline is probably (e), namely physical obstruction to migration. The physical obstruction in case of the Karnali River is the newly constructed barrage in the Indian territory.

1.3.3 Fauna Listed in Red Data Book

The Nepali Government protects the scientifically important and endangered animal species by law as explained in 1.3.2. In addition in Nepal there are 19 species of animal, 10 species of bird, and 5 species of reptile listed in the 1988 IUCN Red List of Threatened Animals. Once listed in this list, the so called Red Data Book, the species are internationally recognized as animals in danger and become objectives for conservation. Table 1.3.3 shows Nepali animals and their habitats listed in the 1988 Red Data Book (Ref. III-6).

Among the species listed, category "Ex" and "E" species are the most threatened, namely, Hispid Hare, Baluchistan Bear, Tiger, Snow Leopard, Asian Elephant, Great Indian Rhinoceros, Pygmy Hog, Swamp Dear, Wild Asian Water Buffalo, Pink Headed Duck, Cheer Pheasant and Gharial. These animals are, therefore, carefully monitored by nature conservation organizations, NGOs, etc.

Since there are many animal species in the Study Area listed in the Red Data Book, proposed projects are likely to affect their habitat or ecosystem, and thus friction between the interests of economic development and nature conservation might arise. A development

project, therefore, should be carefully studied and formulated so as not to seriously deteriorate habitats or ecosystems containing such endangered species.

1.3.4 Fishes

Fishes are a good source of protein in the hill area, and the fishes observed in the Karnali River are eighteen species according to the ecological report prepared by Norconsult and Electrowatt, December 1976. The features of the twelve main fishes observed in the Study Area are as follows (Ref. III-3):

(a) Tor putitora:
Its English name is Indian salmon. This fish, widely distributed through Nepal, India and adjacent areas, is in abundance in the Karnali River, especially mountain streams. The size of this fish is 1,800 mm in length, whilst its weight normally falls in the range of 1 to 3 kg despite a maximum weight of 32 kg observed in the Karnali River. The feeding habit of Indian salmon, which is edible, is partly carnivorous and partly herbivorous.

(b) Tor:
Its local name is sahar. This fish was found only in the Karnali River during the survey by Norconsult and Electrowat, 1976. The largest size recorded is 1.5 m. The body colour is dark gray with greenish tinge along the upper half of body. Lower fins are reddish yellow and dorsal fins slightly dark. This species is important as a food and game fish.

(c) Schzothorax spp.:
Its local name is asala. This fish has a migratory nature and is mainly found in the Karnali water way. This fish is commonly known as snow trout. Its length is approximately 30 cm. The body appearance is trout-like but more cylindrical. Body colour is golden yellowish with fins tinged with red.

(d) Culpisoma garna:
Its local name is Jalkapur, which is common in the Bheri River and is widely distributed in India and Nepal. Weight is approximately 500 g and length exceeds 60 cm. Jalkapur is edible, however, its feeding habit is unknown.

(e) Labeo dochyeilus:
Its local name is Gardi, which is common in the Karnali River and is most abundant in shallow backwaters. Gardi, which is only distributed in the

Himalayas and adjacent areas, is a medium-sized fish and is commonly eaten by local people.

(f) Labeo pangusia:
Its local name is Kalaut, which is a common and small fish. Its ecology is similar to that of Labeo dochyeilus.

(g) Crossocheilus latius:
Its local name is Budua, which is a common, small fish up to 25 cm in length, and is distributed in Northern India and adjacent Himalayan areas.

(h) Barilius bendelisis:
Its local name is Fokata, which is also a common, small fish up to 20 cm in length. Its distribution is in India and adjacent countries.

(i) Barilius vagra:
Its local name is Galar, which is a common, small fish up to 15 cm in length. Its distribution is the same as that of Barilius bendelisis.

(j) Botia almorhae:
Its local name is Bagi or Tiger fish, which is characterized by body colour with gray on a yellow background. Bagi grows up to 20 cm in length and lives in Cashmere and other higher altitude parts of the Himalayan range.

(k) Arguilla bengalensis:
This is a large eel like fish with the local name of Rajabam, being abundant in the Karnali River and being eaten by local people. Rajabam, which is carnivorous and catadromous, eats dead and decayed animals on the river bottom. Being 2 kg in weight and up to 2 m in length, Rajabam is extensively distributed throughout India, Burma and Indian Ocean islands, especially in lower altitude areas.

(l) Wallago attu:
Its local name of this catfish is Padani, the typical features of which are length greater than 2 meters, long mouth whiskers and small teeth in several rows. Its distribution is in India, Sri Lanka and Burma. This fish mainly resides in the Bheri River and is of non-migratory nature.

Research work on fishes of the Karnali River is at the moment limited, and thus, besides external features, information on feeding habit, breeding habit, living area and so forth of the fish species is not yet known. Furthermore, there exist few professional fishermen in the Study Area.

1.4 Water Quality

1.4.1 Water Quality in the Dry Season

Water quality tests were conducted to grasp a general idea for the water quality of the Karnali and Mahakali rivers by the Study Team in December 1991 when the first air reconnaissance to the Study Area was carried out. Sampling points of water for the tests are shown in Figure 1.4.1. It is noted that water was sampled at riverside and lakeside with a water depth of 20 to 50 cm paying attention not to include silt and sand in the samples.

The survey results of water quality are summarized in Table 1.4.1 and interpreted as follows:

EC: The electric conductivity of sampled water is high for drinking water, but is within the acceptable level for irrigation.

pH: The pH of sampled water shows alkalinity ranging from 8.4 to 9.1. These values almost exceed the maximum allowable alkalinity level of pH 8.5 stipulated in the code of Japanese First Class Tap Water.

Dissolvable Oxygen (DO) : The DO levels fall in the range of 5 to 7. The water quality is classified into b - mesosaprobic, i.e. DO>5. Judging from the correlation between DO and BOD (Biochemical Oxygen Demand), BOD of the sampled water is inferred to be less than 3 mg/l.

Chemical Oxygen Demand (COD) : The COD levels are as low as 1 to 2, classified into aligsaprobic.

Turbidity : Turbidity is low due to low flow. Long term observation for turbidity is required including observation in the monsoon season, in which higher turbidity is expected.

General Fungi : The test performed in a simple manner for grasping the pollution level of the river shows that river water contains more fungi downstream, regardless of the fact that contamination level varies by season. Activities of human beings and livestocks can be considered as a primal source of pollution, although the population density is not high in the Study Area, i.e. 56.7 people/km^2 in the Mid Western Development Region and 86.1 people/km^2 in the Far Western Development Region according to the census of 1991.

Since the propagation of general fungi is slow at low temperature, water pollution may be higher in the summer season. To assess water quality in the Study Area, the treatment guideline of the water supply schemes undertaken by DWSS (Department of Water Supply and Sewerage) (Ref. III-7) is given as follows:

Water Source	Treatment Required
Protected Spring:	No treatment
Protected Stream with low turbidity:	No treatment
Stream with turbidity more than 10 ppm:	Water is passed through a filter pipe or sand filter and no chlorination is required if the source is protected.
River with variable turbidity:	Water is passed through a filter pipe, desilting basin or sand filter with chlorination.
River with highly variable turbidity:	Ordinary treatment system.

1.4.2 Water Quality in the Rainy Season

One useful water quality analysis for the rainy season, which is not time-series but includes detailed chemical analysis, is discussed in the Karnali Multipurpose Project Environmental and Socio-Economic Situation Report prepared by New ERA (Ref. III-3). The results of this detailed analysis which was conducted in June 1987, namely the beginning of rainy season, are shown in Table 1.4.2. Water was sampled at three sites; The first one is at the proposed Chisapani dam site, the second one is along the Bheri River upstream of the confluence of the Karnali and Bheri Rivers and the third one is along the Karnali River upstream of the confluence (refer to Figure 1.4.1).

The distinctive difference between the water qualities in rainy and dry seasons is that TDS, SS and TS are very high in the rainy season. On the other hand the turbidity in the dry

season is low. This difference is clearly caused by different rainfall amounts in rainy and dry seasons, respectively.

Other factors can be interpreted as follows:

pH: Relatively high at 7.8 to 8.1 in the rainy season and higher at 8.4 to 9.1 in the dry season. The normal range of irrigation water is 6.5 to 8.4 according to FAO.

EC: The EC values are 150 to 330 micro mho/cm in the dry season and 183 to 210 micro mho/cm in the rainy season which are classified into the salinization free class of EC 0 to 4,000 micro mho/cm according to the Department of Agriculture, United States, USDA.

Calcium: Ca^{++} contents are 26.0 to 27.2 mg/l in the rainy season. On the other hand, Ca^{++} contents in the dry season are 22.9 to 48.2 according to the Himalayan Power Consultants' survey conducted in April 1992. These Ca^{++} content values are intermediate. In case of the Seti Small Hydro-power Project in Pokhara, the DOI reports that the water cannot be used for irrigation due to excessive calcium content which coagulates the surface soil, making farming difficult. However, Ca^{++} contents of the Seti are similar to that of the Study Area. For this point further study is required.

Other indicators and elements: DO, BOD and COD show a good correlation between two surveys conducted in rainy and dry seasons, and these values do not indicate any serious pollution or eutrophication. Other kations and anions analyzed fall within the normal range of unpolluted and free flowing water.

1.4.3 Water Quality in 1992 Pre-Monsoon and Post-Monsoon

The Himalayan Power Consultants surveyed the water quality of the Karnali River in 1992 pre-monsoon and post-monsoon. The sampling locations are shown in Figure 1.4.1 and the results in Table 1.4.3. The major findings of this survey are as follows:

(a) TDS, SS and TS are lower in the pre-monsoon and post-monsoon than the monsoon period.

(b) pH ranges from 7.4 to 9.0 and is relatively stable throughout the year.

(c) EC ranges from 153 to 366 micro mho/cm. The highest value was recorded at Rajapur in the Kauriyala River lying near the Indian border and is thus likely to

be polluted by human activities. This highest value is however, still within the salinization free class.

(d) Ca^{++} is 24.4 to 48.2 mg/l and the highest value was recorded at Rajapur mentioned above. $CaCO_3$ ranges from 73.5 to 178.0 mg/l, which is high.

Therefore, it is possible to conclude that the water in the Study Area can be used for irrigation. However, it is good to investigate water quality in more detail through the comparison of water quality between the Karnali and Seti Gandaki rivers in order to secure the safety for irrigation. As a drinking water source, on the other hand, appropriate treatment is required on the basis of the survey result for general fungi and the situation of the current water-born diseases identified through interview.

1.5 Water-Borne Diseases

There are three types of water-borne diseases in the Study Area. The first type is the diseases, of which the infectious agent is directly transmitted to the susceptible host, i.e. human being, via water. The examples of this type are many digestive tract diseases and hepatitis A.

The second type includes the diseases caused by pathogenic agents which need wet condition to survive and make contact with the host. A common example of this type is entozoon.

The third type is the diseases caused by pathogenetic agents which are transmitted by a vector, for which water or wet condition is essential for survival and propagation. This type includes Japanese encephalitis and malaria transmitted by mosquitoes. All of the foregoing three types of disease exist in the Study Area.

According to the study under the Karnali Multipurpose Project, the common water-borne diseases, which would occur with the implementation of dam schemes, are grouped as follows:

1st Type: Cholera, hepatitis and infant diarrhea
Places of transmission are irrigation ditches, small water supply schemes and wells.

2nd Type: Entozoa, i.e. roundworm and hookworm
It is more likely that this type is prevalent under irrigated conditions in the Terai rather than under dry conditions in the hill areas.

3rd Type: Malaria and Japanese B encephalitis
Malaria is transmitted by mosquitoes, i.e. Anopheles spp. and Japanese B encephalitis by mosquitoes, i.e. Culex, Mansonia, Armigeres, and Aropheles spp. Due to the density of the mosquito population, these diseases are more common in hot and wet climate of summers than cool and dry climate of winters.

For the purpose of mitigating negative impacts caused by the diseases mentioned above, hygienic education and prophylactic measures are essential in addition to the improvement of health care facilities.

1.6 Watershed

1.6.1 Present Condition

Rivers in Nepal, all draining south to the Ganges plain, are characterized by their transportation of tremendous quantities of sediment material. The fundamental background underlying this phenomenon is the regional tectonic movement uplifting and distorting the land, caused by subduction of the Indian plate under the Himalayan mountains. Constant uplifting of the land, although very slow in the ordinary sense of time, and the resulting incision of deep valleys have incessantly been forming unstable steep slopes in the mountain zone. This major geo-tectonic movement is the prime mover of the intensive erosion which provides much of the sediment material, as an unchangeable phenomenon over the long run.

The upper reaches of the Karnali and Mahakali rivers are geologically composed of gneisses, schists, shales, sandstones, conglomerates, quartzites and carbonaceous rocks of Pre-Cambrian to Mesozoic, which are folded, sheared and faulted. These meta-sedimentary bedrocks are often intensely slacked in the zone to even more than 30 meters of depth from the ground surface due to stress relief on the steep slopes. The bedrocks are intersected by frequent faults of varied sizes, of which most are minor but still may contribute to increasing the potential of slope failure or landslide.

According to the analysis of LRMP, the slope classified as "moderate to steep" occupies almost 90% of the area in the districts of the Study Area, except for five districts in

the Terai zone. This topographic situation suggests that the Study Area is highly prone to soil erosion and land slide.

Slopes are, accordingly, at marginal stability at places. Sometimes, slopes bear the scars of old landslides, which were triggered by scouring at their feet in the course of the deepening of valleys but have been stabilized by recovering balance after some extent of slumping. Such parts of slopes may easily be induced to undergo new movement by such phenomena as earthquake, change in the ground water condition or change in the slope inclination.

According to LRMP, Carson (1985), in his study of erosion and sedimentation in Nepal Himalayas, has attributed a larger part than usual of the cause for sediment material supply to a mass wasting or an accidental and massive production of sediment material, e.g. by slope failures or mud/debris flows, but not to the ordinary surface erosion by water. Carson (1985) and C.K. Sharma (1988) have referred to natural forces and man-made impacts which induce the mass wasting. According to Carson, the mass wasting is largely the result of natural forces. Sharma mentions deforestation, cultivation and construction work as three main human activities which quicken the natural activity of erosion. In the Upper Karnali zone and the river basins further upstream, where people are not densely populated yet in spite of the current trend of increasing population, the mass wasting can be more due to natural forces than due to human activities.

Among the forces inducing mass wasting, earthquakes work mainly as agents to start the movement. Earthquakes trigger slope failure in the short duration of their action by disturbing the mechanical balance of slopes or old landslides once stabilized. An earthquake, by itself, can be more the cause of localized quick landslips or rock failures than slow-moving landslides. Nepal is in a well-known active seismic zone with two major active thrust faults running in the east-northeasterly direction, i.e. the Main Central Thrust separating the high Himalayas from the midland and the Main Boundary Thrust through the foothills. Minor earthquakes of 3 to 5 in Magnitude (in Richter Scale) are frequent but destructive events occur only a few times in a century (Sharma 1988). Even in varied magnitude, earthquakes are an important natural factor in generating the slope instability.

Change in the ground water condition results from heavy rainfall or development of new water passages by slacking of bedrocks. Infiltration of surface water or rise of pore pressure may decrease the shear resistance on potential sliding surfaces, preparing the slopes for movement on any slight impact. Influence of human activities upon groundwater, especially as a result of irrigation, is a controversial issue.

Change in the slope inclination occurs as a result of scouring at the foot of a slope, and of addition or reduction of overburden through the surface erosion and transportation of soil and debris. Often a landslide, a quick landslip or a rock failure forms a new steep slope behind it and induces another failure. Although the scouring at the foot of a slope is ordinarily made by the force of flowing water on river banks, it can also be affected by human activities of large excavation for road construction or other purposes.

The surface erosion is the important natural activity to provide sediment material, not only to prepare the mass wasting by changing the stability balance of slopes. The surface erosion is obviously accelerated by deforestation or removal of vegetation which results from collection of wood to be used for timber or fuel and from reclamation to develop farm land. The cultivated land, which is regularly managed under farming activity, seems to be more stable, whether because of human care-taking or because of the natural stability for which it has been selected for cultivation.

While the effect of deforestation upon ordinary surface erosion is clear, its relation with mass wasting, an important factor for the huge amount of sedimentation, is not well defined. Some observations conclude that destructive slope failures occur regardless of vegetation.

Nevertheless, deforestation is the only extensive man-made damage to the natural environment in a visible scale in the Study Area, and this damage should be repaired so far as the reparation will not result in any substantial rejection of human development.

With the above mentioned features in consideration, the following is an outline of the environmental control applicable to the Upper Karnali/Mahakali zone:

(a) The present condition of intensive erosion or almost constant mass wasting in the mountain zones and the huge sedimentation downstream is largely due to the work of nature including tectonic movement. The human factor is rather small in isolated areas, and is practically limited to deforestation. The human activity here is not substantially at odds with natural environment..

(b) The major trend of natural activity cannot permanently be changed by man, although some tentative modification may be possible. It will be difficult to stop the continuous destabilization of the slopes, although it may be technically feasible to mitigate the sediment supply by improvement of the river course or construction of check dams.

(c) Environmental damage by human activity should be repaired. The deforestation should be compensated for by afforestation. While existing roads are only foot-paths, the future road construction with machinery will require due consideration for the protection of slopes.

Accordingly, practical countermeasures against erosion and sedimentation are afforestation to recover the vegetation cover of the mountain zone and planning of check dams in the river channel. A proposal is to be made for a comprehensive system for long-term recording of sediment transportation for the latter purpose.

1.6.2 Improvement and Preventive Activities

(1) Government strategy

Watershed management on one hand often implies for development planners in respect of the protection and safety of constructed facilities for development.

On the other hand for ordinary farmers, who are approximately 86% of the total population, soil conservation is the most serious and urgent matter for securing their food, fuelwood, timber and fodder, since remaining land resources are no longer as plentiful as earlier. It is, therefore, quite essential to determine the appropriate use of land resources for sustained agro-ecosystems environmental stability and prevention of downstream detrimental effects.

The Department of Soil Conservation and Watershed Management (DSCWM) has recognized the importance of soil conservation and watershed management and has set the following targets:

(a) Arresting watershed degradation and ecological deterioration,

(b) Reducing human pressure on land through better and integrated land management, and

(c) Helping to attain a better quality of life for the people through higher land productivity and environmental balance.

There are three countermeasures in order to achieve the above-mentioned targets; (i) preventive measures, (ii) rehabilitative measures and (iii) disseminative and educational measures (Master Plan for Forestry Sector) (Ref. III-8). There is, however, no sole

ministry which can handle all this work. In practice, the responsibility for implementing these three measures is shared by different ministries under the leadership of the DSCWM as follows:

(a) Ministry of Forest and Environment: management and protection of upstream watersheds and grazing land,

(b) Ministry of Agriculture: extension of management expertise in agricultural areas, and

(c) Ministry of Water Resources: construction and protection of water conveyance systems and control of water flows in downstream valleys.

In order to achieve their targets DSCWM is implementing the following programmes at 27 districts and 3 central offices:

(a) Land use planning:
Watershed and sub-watershed management plans are being prepared for future land use development and improvement based upon scientifically assessed land capability.

(b) Land productivity conservation:
This consists of development and improvement of land productivity through appropriate land use management on the basis of land capability.

On-farm conservation, fruit tree planting, fodder/grass plantation, conservation ponds and nurseries are main components.

(c) Development infrastructure protection:
Development infrastructure protection programmes are those which protect and stabilize the basic development infrastructures such as reservoirs, irrigation, roads and others with the aim of improving the economic life of the development infrastructure.

Road slope stabilization, water source conservation, irrigation channel improvement, trail improvement, shelter belt and buffer strips come under the development infrastructure protection programme.

(d) Natural hazard prevention:

Natural hazard prevention programmes aim to protect life, property and natural resources from natural hazards.

Gully treatment, landside treatment, torrent control, stream bank protection and degraded land rehabilitation come under the natural hazard prevention programme.

(e) Community soil conservation:
These programmes are intended to develop knowledge and skills to raise the level of community awareness and participation in soil conservation activities. Micro-catchment demonstration, farmers conservation training/study tours, women's conservation training/study tours, user group training/study tours, conservation education in schools and conservation awards come under the community soil conservation programme.

Despite the hard efforts being put forth with regards to the above, the technical staff and government budget are not enough, and thus the effects of these programmes are limited.

(2) Evaluation of watershed

Shrestha, B.D. et al of DSCWM (Ref. III-9) ranked watershed condition by district, using a relative rating method classified into five categories based on the idea of Nelson, D. et al (1980)as follows:

Class 1 Excellent : The watershed is in or near 'pristine' condition; natural or geological erosion may be present. Area in this class is 71,400 sq km (51 %).

Class 2 Good: Minor amounts of disturbance from land use exist; productivity of land is not impaired. Area in this class is 50,432 sq km (36 %).

Class 3 Marginal: Significant disturbance exists; productivity is impaired. Area in this class is 15,360 sq km (11 %).

Class 4 Poor: Impact of accelerated erosion is serious; land productivity is reduced. Area in this class is 1,410 sq km (1 %).

Class 5 Very poor: Erosion is advanced; agricultural and forage production is absent or greatly reduced. High sediment yield due to flash flow after rainfall has destroyed the natural characteristics of the stream. Area in this class is 1,410 sq km (1%).

The evaluation of watershed system by district is a two step procedure. At first, the watershed of a certain region, for example the case of Kathmandu Valley, is evaluated as follows:

The Kathmandu Valley is classified according to the above classes, namely,

Class 1	85 %
Class 3	7 %
Class 4	8 %.

Class 1 and Class 2 are given 0 point. Class 3 is 1 point, Class 4 is 2 points, and Class 5 is worst at 3 points. The Kathmandu Valley, is accordingly given 23 points as follows:

$$85(\%) \times 0(\text{point}) + 7(\%) \times 1(\text{point}) + 8(\%) \times 2(\text{point}) = 23 \text{ (points)}.$$

Secondly, a district which consists of several regions is evaluated as follows:

The Kathmandu District consists of three regions covering the Kathmandu Valley of 23 points, Indrawati Ridge and Valley Land evaluated at 115 points, and Helambu Ridge Lands of 50 points. These account for 80.74 %, 12.42 % and 6.83 % of the District, respectively. The total points assigned to the District are calculated as follows:

$$80.74(\%) \times 23(\text{points}) + 12.42(\%) \times 115(\text{points}) + 6.83(\%) \times 50(\text{point}) = 3{,}627 \text{ (points)}.$$

A rating of all the districts is shown in Figure 1.6.1 and grouped in Table 1.6.1. A further detailed rating of the Study Area is shown in Table 1.6.2. According to this, Surkhet District is classified into Class 5 and requires urgent countermeasures to protect the watershed. Three districts, Dolpa, Rukum and Dailekh, are in a marginal condition, and thus the proper corresponding measures should be taken.

(3) Watershed management

As a recent trend for soil conservation and watershed management, emphasis is placed on integrated rural development projects and community forest projects. This shift of trend is caused by understanding the importance of socio-economic factors in the degradation and banishment of forest land. Since local people do not have any alternative for energy source other than cutting forest trees, the emphasis of the Integrated Rural Development Project (IRDP) for watershed is to establish a sustainable ecosystem, which balances the requirements of people's lives and land productivity by increasing the productivity of cultivated land as well as forest.

(4) Community and private forestry programme

The Master Plan of the Ministry of Forestry and Environments prioritized the six major programmes administered by the Department of Forest (Ref. III-10). Among them, the Programme of Community and Private Forestry is the most important one, occupying half of the sector investment.

The central policy of this programme is to develop and manage forest resources through the active participation of individuals and communities to meet their basic needs. The strategy to achieve this is described in the following statement:

> "phased handing over of all accessible hill forests to the communities to the extent that they are able and willing to manage them".

In other words, while old legislation aimed to keep people out of the government forests, new legislation intends to delegate to the community the authority and responsibility to protect, manage and utilize the government forests.

The main components of the community and private forestry programme are:

- to encourage planting of degraded forests and management of natural forests as community forests,
- to distribute free or subsidized seedlings to encourage the establishment of private forestry, and
- to establish and manage community forestry in open and degraded areas.

Among the various activities of the programme, the accumulated area of afforestation over the period of year 1980 to 1988 is approximately 31,000 ha in 29 districts of the country. The districts involved in the programme in the Study Area are Darchula, Baitadi, Dadeldhura, Bujhang, Doti, Bajura and Achham in the Far Western Development Region and Jajarkot in the Mid Western Development Region as of year 1988.

The achievement of the community and private forestry programme for the fiscal year 1990/91 in the country and in the two development regions concerned is shown in Table 1.6.3. The area covered in each region is only 1,000 hectares, which is still negligible compared with the total area of the two.

1.7 Concern for the Natural Environment under Dam and Irrigation Schemes

Economic growth which proceeds without the proper management and replenishment of environmental resource can hardly be sustained. Recognizing this, the National Conservation Strategy and the Seventh Five Year Plan state that Nepal's development is largely project-led and thus that environmental impact assessment (EIA) is the most direct and effective means of combining the aims of conservation and development, requiring an EIA for each development project prior to its approval by the relevant government departments.

The National Council for the Conservation of Natural and Cultural Resources (NCCNCR) is the institution responsible for policy making and coordination of environmental matters, since environmental matters are multi-sectoral and thus cannot be covered by one ministry or department. The core ministry for environmental issues is, however, the Ministry of Forest and Environments as renamed in year 1991.

In year 1992, the National Planning Commission in collaboration with the International Union for Conservation of Nature and Natural Resources (IUCN) prepared the National Environmental Impact Assessment Guidelines under the National Conservation Strategy Implementation Programme (Ref. III-12). These guidelines, therefore, should be the base for the environmental impact assessment of all proposed development projects before the approval of concerned project executing agencies.

The guidelines explain the screening criteria which are used to determine whether a project requires an IEE/EIA or not. They are (1) threshold criteria, (2) environmentally sensitive criteria, (3) project type criteria. At the screening process, responsible agencies are

the National Planning Commission Secretariat, line-ministries and departments, and project proponents.

In the Master Plan Study for Water Resources Development of the Upper Karnali River and Mahakali River Basins, the Initial Environmental Examination is conducted in respect of the environment impacts caused by the proposed plan, following these guidelines in principle and in conjunction with the guidelines of concerned international organizations such as IBRD, ADB and JICA.

2. CASE STUDIES FOR INVOLUNTARY RESETTLEMENT, NATURAL ENVIRONMENTS AND WATERSHED MANAGEMENT

2.1 Involuntary Resettlement

Dam schemes inevitably cause socio-economic impacts, principal one of which is resettlement of local people from the reservoir inundation area to other areas.

Compensation is usually made in the form of either land or cash in case of national dam projects. The form of compensation in many countries has recently shifted from "cash for land" to "land for land", especially in the case that the displaced people are largely dependent on land for their food and income. On the other hand, the compensation under dam projects in Nepal is recently being made in cash.

The Ministry of Housing and Urban Development, which is at present responsible for the implementation of involuntary resettlement programmes, comments that the compensation under future resettlement programmes will be paid in cash due to scarcity of available land.

In the process of planning involuntary resettlement caused by national development projects, it is important to look into the following:

- Whether or not appropriate compensation either by cash or land is made to the displaced people,

- Whether or not proper attention is drawn to kinship systems, ethnic groups and other socio-economic factors which play important roles for the displaced people, and

- Whether or not proper arrangement and support service are taken for the problems after resettlement, mainly the friction between the host people and the newly settled people in case of land-for-land compensation and various orientation and educational services in case of cash-for-land compensation.

Since the involuntary resettlement programmes experienced in the past provide lessons and input for future programmes, three representative programmes, Rara National Park, Kulekhani project and Marsyangdi project (refer to Table 2.1.1), have been selected for discussion here as follows:

2.1.1 Rara National Park Resettlement

This is the displacement caused by the establishment of Rara National Park which took place in year 1978. The compensation has been made in the form of land, and various support services have been provided for the displaced people. According to the report of New ERA, the displaced people were better off at the new location than at Rara.

The major points of this resettlement programme are as follows:

(a) Location and number of displaced families

The original place where the displaced people lived was around Lake Rara located at High Mountain, and the resettlement area was in Bardiya District of Terai. Since the soil of the provided land was poor in fertility and there was no irrigation facility, land provided at first was abandoned by the majority of people two years later after settlement, and the concerned population moved to the Chisapani area. At this new area, support services have also been provided. The number of the originally displaced families was 331 in year 1983.

(b) Compensation

- Rs. 3/person/day was paid as food subsidy until the end of year 1978. In addition, food supply followed for 18 months after cash payment.
- Wood to build a house was provided. Rs. 240 per family was paid to buy roof materials.
- It was evaluated that land of 1 ha in Terai is equivalent to 1.3 ha in the hill area for compensation. When a farmer owned more than 1.3 ha of hill land, the portion in excess of 1.3 ha was compensated at a rate of 0.7 ha of Terai land to 1.00 ha of the hill area. The land distributed to the settlers is approximately 360 ha in total and can be freely and legally sold and bought.

(c) Support services

The following support services were provided:

- Transport by airplane for the movement of displaced people,
- Drinking water by well and hand pump, and
- Education and health services.

2.1.2 Kulekhani

The Kulekhani Hydro-electric Project inundated an area of 175 ha and affected 450 households and 3,000 people. The affected people were given two alternatives as compensation, i.e. cash or land. Most people preferred cash. Compensation for land, houses and water mills was made but not for fruit trees, bamboo or fodder trees.

The following points are to be noted from the compensation scheme of the Kulekhani project:

(a) Large farmers received large cash compensation. With that money, they could establish new businesses, becoming richer than they had been. On the other hand, small and poor farmers received less cash compensation.

(b) Land compensation was not regarded as a serious alternative both by the project office and the affected people.

(c) Better conditions for the small farmers were not ensured by cash compensation.

2.1.3 Marsyangdi

Under the Marsyangdi Hydro-electric Project an area of 60.5 ha was acquired, affecting 222 households and 1,800 people. Further details show that seven households lost all their land and that an area of less than 0.25 ha was left for 22 households. The rest of the households were partially affected. The land acquisition was made under a policy of cash for land.

The rates offered for land acquisition were close to the market price. However, the rates offered at the early stage of the land acquisition were low and raised later, resulting in dissatisfaction to the earlier compensation recipients. Further, no support services were provided for the affected people by the project office.

Compensation in cash is disadvantageous compared with that by land in view of minimizing the sacrifice of displaced people as mentioned above. Thus, it is desirable that compensation for people to be displaced be carried out in the form of "land for land", although there exists a problem of scarcity of available land.

2.2 Natural Environment

Three case studies have been conducted in order to grasp the actual environmental impacts of water resources development projects and their solutions in Nepal. The first two cases are mainly concerned with the impacts to wildlife and the last one is concerned with overall impacts to the environment.

2.2.1 Mahakali Irrigation Project II (MIP II)

The main canal of MIP II, which is planned to irrigate 6,800 ha in Terai plain, is located in the middle of the Suklaphana Wildlife Reserve, dividing the Reserve into eastern and western portions. The construction of this main canal is currently in progress. The main canal is 17 km in length and approximately 60 m in width including the canal itself and road for operation and maintenance.

When this irrigation project was formulated in the late 1970s, wildlife reserve comprised only the west part of 155 km^2 and thus the main canal was planned outside of the reserve. However, extension of the wildlife reserve was proposed eastward to include an additional area of 150 km^2 after the project design. As a consequence the main canal now under construction is located in the middle of the present reserve. On the other hand, the extension of the wildlife reserve has not been gazetted.

Negative impacts, which are physical reduction of habitat and food of animals such as swamp deer, elephant and tiger, are clearly assumed to arise as a result of this structure and its construction. The HMG/N and the World Bank are, however, trying to minimize these negative impacts by constructing canal crossings and waterholes/lakes and by supervising the construction work appropriately by limitation of working hour, minimum land occupation by construction activity, etc. Furthermore, the irrigation project office supports the wildlife reserve office through provision of dart guns, animal tranquilizer drugs, and scholarships in order to strengthen the capability for the game reserve management. In addition the IUCN is also making use of this opportunity for research activities on endangered species for which ecological information is very limited or almost none. The most important species in this reserve is swamp deer.

According to the game warden, the existing problems are (i) poaching from the Indian side and (ii) migration of the local people from the planned extension area. According to the game warden these two problems are more serious than the main canal construction.

From this case it is possible to learn the following:

(a) In the 1970s environmental issues were not regarded as important and thus an old project might not be well designed with respect to environmental issues.

(b) Negative environmental impacts should be carefully considered and predicted, considering future plans as well as the present situation.

(c) Although structures occupy the previous habitat of the existing fauna and thus reduce the habitat and food thereof, increase of water flow is a positive impact, and canal crossing and artificial lakes can offset other negative impacts to some extent.

(d) Construction activities themselves cause large negative impacts and thus these activities should be carefully managed.

(e) Finally the game warden's opinion is that the wildlife reserve and development activities can coexist, when the proper coordination among concerned agencies is made.

2.2.2 Babai Irrigation Project (BIP)

The intake weir of BIP which is to irrigate 40,000 ha of Terai plain is located in the Royal Bardiya National Park. Therefore, the structure of the weir and part of the main canals will generate negative impacts to the Park's fauna including reduction of habitat and food sources. However, the water level rise by the weir is regarded as a positive impact for especially gharial and fish.

The only structure which has been constructed to mitigate the conceivable negative environmental impacts to fish is a fish ladder. The important point to make is that all the activities concerned with the construction work require permission from the administration office of the Royal Bardiya National Park. This implies that the construction work takes a long time, for instance the contractor had to maintain a base 20 km away from the weir site for a few years until the camp construction in the Park was permitted by the reserve administration.

This case implies that since the construction activities are implemented only after the activities have been confirmed by the Park's office not to have serious negative environmental impacts from the outset, or after the necessary countermeasure have been taken, the construction activities do not harm the fauna of the park under the initiative of the park's administration. On the other hand, this time consuming process to get permission for every

construction activity in the park means a prolonged construction period and this long construction period itself is quite likely to cause negative environmental impacts.

The lesson which can be learned from this case is that before the start of construction, all arrangement for the permission of the planned activities should be made in order to minimize the construction period.

2.2.3 Arun III

This run-of-river type hydroelectric power project, which consists of 192 km long access road, dam, 11.5 km long headrace tunnel, powerhouse with 402 MW installed capacity, high voltage transmission line and other components, is located in Eastern Nepal. Around this project there are several hundred thousand inhabitants and the Makalu-Barun National Park.

The environmental impact study in respect of physical, social, economic and cultural impacts was conducted by the King Mahendra Trust for Nature Conservation with finance from the World Bank, UNDP and the Nepali Government (Ref. III-12). The study results show the predicted impacts, their causes, the magnitude, extent, duration, proposed mitigation measures and responsible agencies for the same. Here, the impacts, which are graded "M" (moderate) or "H" (higher), are shown in Table 2.2.1.

It is clear that most of the predicted impacts, which are graded more than "M", are caused by construction activities, although their impacts do not last long. Another point to note is that since the impacts to human population in the form of loss of cultivated and arable land and loss of houses last for a long time, these impacts must be carefully eliminated or mitigated.

2.2.4 Summary

It is possible to summarize the lessons from the three case studies above as follows :

(a) For water resources development activities, environmental impact study in respect of physical, biological, social, economic and cultural fields is essential.

(b) Environmental impacts should be carefully studied and predicted, considering the present situation as well as future plans in collaboration with the agencies concerned, such as Department of National Parks and Wildlife Conservation for the impact to fauna and flora including aquatic organisms, and Department of Housing and Town Planning under the Ministry of Housing and Physical Planning for involuntary resettlement.

(c) Countermeasures to mitigate or eliminate negative environmental impacts must be proposed on the basis of the analyses and discussions with the concerned agencies mentioned above.

(d) Necessary arrangement in respect of institutional and administrative matters is essential in order to avoid the delay of construction activities.

2.3 Watershed Management

Although it is well recognized that watershed management is extremely important for water resource development, the difficulty of effective implementation of the same is also recognized. The management should not be patchy or segregated, but integrated to be effective over the whole watershed of a river.

The methods of watershed management stated in the Master Plan for the Forestry Sector, Soil Conservation and Watershed Management Plan, Nepal 1988 can be classified into three types as follows (refer to Table 2.3.1 in detail) :

- Preventive methods which are often vegetative,
- Rehabilitative methods which are mainly engineering, and
- Institutional methods which are in a sense preventive by indirectly promoting preventive methods.

Obviously the ideal approach to watershed management is that the methods above are impelled in an integrated manner.

Below, firstly the problems of current Nepali watershed management are discussed. Secondly two case studies are explained.

2.3.1 Watershed Management Problems

(1) Whole Nepal

Safe and stable watershed is an essential element for water resources development projects in order to secure the facilities constructed and to lengthen the project life as well as to increase low flow and decrease flood flow. The current watershed condition

in Nepal is clearly proceeding in an unfavourable direction, i.e. deterioration, due to the complex combination of natural phenomena and human activities.

There are four important elements in the current landuse problems of Nepal, and these problems are closely related with watershed management problems. The Land Resource Mapping Project, LRMP, which was conducted over a period of six years, concluded the study on watershed management problems as follows:

(a) Heavy dependence of agriculture to adjacent public areas

The concept is that the maintenance of fertility of cultivated land is dependent on forest compost and livestock manure obtained from adjacent public lands as nutrient sources. These public lands are in practice not under the control of any agency or entity, and degradation continues in terms of maintenance of fertility. Insufficient nutrient supply from forests necessary to sustain the fertility of cultivated land and support livestock results in abandoning the cultivated lands due to poor land productivity. Finally, both degraded forest and abandoned cultivated land induce and accelerate the degradation of the watershed.

(b) Food shortage as a major deforestation agent

The basic deforestation problem is caused by a shortage of food supply to the poorest segment of the farming society, which leads to excessive fodder collection and to severe overgrazing, rather than fuelwood collection, timber cutting and expansion of cultivated areas. The logic of this concept relies on the fact that poor people have only small farm land from which they cannot produce enough food and that they use peripheral public lands and marginal crop lands to produce more food and manure by livestock grazing. Once these areas are overgrazed or severely lopped for fodder, deforestation rapidly proceeds. In other words, poverty causes this type of deforestation.

(c) Management problem of public land

A total of 8.9 million hectares, or 61% of Nepal's land area of 14.75 million hectares, is covered with grass land, shrub land or forest land. These areas are not well managed as underscored by the fact that the forest areas are losing crown cover at a rate of some 50,000 hectares a year. On the other hand, the managing capability of HMG to protect forests can be increased at a rate of 30,000 hectares per year at most. The difference of

20,000 hectares between two foregoing figures will inevitably lead to the deterioration of forest lands.

A conceivable way to tackle this massive management problem is to transfer the control of these forest areas from the HMG to the local farming community. Even if local people are ineffective and unorganized for the management of forest lands, the situation will not be any worse than present where there is no effective control or management for the forests.

(d) Natural and man-made erosion

Erosion processes comprise a complex combination of geological and man-made activities. Nevertheless mass wasting, which is caused by such geological activities as rock failures, landslides, slumps, riverbank cutting and gulling, plays a dominant role in Nepal. The control of this mass wasting is beyond human capability. On the other hand, although man-made erosion accounts for only a small part of the total erosion or total sediment load, it selectively erodes top-soil which is fertile and which many people depend on. Therefore, soil conservation to prevent man-made erosion by proper management is important and beneficial.

Furthermore, the LRMP discusses the factors for rational landuse or protection of farm lands from man-made erosion as follows:

<u>Policies</u>

i. Elimination of over utilizing public land,
ii. Increase of agriculture productivity
    - Appropriate land tenure system for better management
    - Rehabilitating local private irrigation schemes, and constructing and managing large irrigation schemes effectively,
    - Sufficient farm inputs
    - On-farm forestry
iii. Population control to lower population pressure on land,
iv. Mobilizing the private sector efficiently,
v. Improving the public sector's efficiency

<u>Potential projects and programmes</u>

i. Proper landuse planning and control
ii. Increasing the sustained production of public areas
    - Afforestation

- Fuelwood plantation
- Research for better watershed management
- Opening up silviculture to free foreign investment

iii. Decreasing people's demand on public areas
- Entrepreneurial training for alternative job opportunity,
- More access to credit,
- Food aid through "food for work programme" under infrastructure development,
- Agricultural research and extension for better farming, and
- Population control.

The LRMP concludes that:

> "Many policy decisions regarding landuse should have been taken some time ago. Decisions regarding productivity and development in the central bureaucracy, land tenure, administrative control of public land and so on can be postponed indefinitely. The decision to postpone such decisions, however, carries grave risks in encouraging further degradation of the land base which can cause displacement, starvation and political disintegration."

Seven years have passed since this discussion was made, and fifteen years have lapsed since the aerial photographs, which are the basic source of information for the LRMP study, were shot in year 1978 and 1979. Nevertheless, the Nepal watershed has continued to deteriorate with even more severity than before.

(2) Districts Concerned with the Priority Schemes

Although land productivity, forest type, human activities and natural environment vary from place by place in a wide range, current and future watershed conditions may be evaluated through population pressure as shown in Table 2.3.2.

The population in the Surkhet district increases with a high growth rate of 3.1% per year due to migration from the upstream areas of the Karnali River. Since the population density in agricultural land is already high in Surkhet, the watershed already evaluated to be in a poor condition will quickly worsen with the diminution of forests.

The watershed in Salyan district, a part of which is in the Bheri River basin, is evaluated at "good". However, population densities in agricultural and forest areas are already high with the population further growing at a rate of 1.8% per year. The

forests in Salyan are, therefore, likely to continue to shrink and degrade. The population pressure is high in the Baitadi and Dailekh districts as well. The LR-1, which is the reservoir type hydropower scheme, lies in the Dailekh district, where the watershed is in a marginal condition. This watershed will thus require conservation measures to protect the reservoir from in-coming sediment loads when the scheme is implemented.

The watershed in the Jajarkot, Darchula and Bajhang districts is in relatively good condition. Furthermore, population pressures are not high. Since preventive and institutional measures implemented at this stage are effective for soil conservation and watershed management, their earliest implementation is recommended.

The population density of the whole Nepal is as high as that of Salyan, Baitadi and Dailekh. On the other hand, the population density in agricultural land and forest land is much higher for the whole of Nepal than the Study Area, although the degradation and deterioration levels for watershed seem to be about the same. This probably implies that population pressure can be one of the major factors but not a sole factor in watershed degradation. In other words, the watershed could well be maintained or sustained by various management efforts despite the population pressure. Therefore, it is concluded that the watershed in the Study Area can be improved or at least sustained by better management.

2.3.2 Case Study

(1) Upper Pokhara Valley

This case is the research work to clarify the system of environmental degradation and economic deprivation in mountain watersheds, and to discover solutions with respect to human activities. The main human activities are modes of farm land use, utilization of forest, shrub and grass lands, and extraction of materials therefrom. The area of this research is located in the Upper Pokhara Valley, 210 km^2, of High and Middle Mountains in the Western Development Region.

In this area the valleys and ridges are used for cereal cultivation, and slopes are used for forestry and agroforestry. Under this situation Nepalese in earlier times developed a subsistence agricultural economy which was the best-fit life style to cope with the physical and economic isolation. The important point to make in the case of this ecosystem of subsistence agriculture (refer to Figure 2.3.1) is that forest is always

exploited as population increases, livestock population increases and the demand for farm land increases.

When forest resources are abundant enough to supply food, timber, firewood and forest land to support human activities and when population is relatively small, the reproduction speed of forest resources is larger than the speed of consumption of the same. As population increases and forest area decreases by the transformation of forest land to farming land, consumption speed of forest resources exceeds the speed of forest resource reproduction, in other words, beyond the balanced speed for the reproduction and consumption. Beyond this balanced speed or critical point the speed of forest land shrinkage is accelerated more and more, and thus subsistence agriculture cannot be maintained. In other words the sustainability of this ecosystem is broken.

Simultaneously there are several constraints to maintaining this sustainability such as no other employment opportunity besides farming, poor accessibility to other markets to sell farm products and to buy farm inputs for better productivity, no appropriate irrigation system and less availability of productive land. Furthermore, people are more likely to have a larger family to complement limited farming income with other small non-farming activities. Under this kind of vicious cycle, depletion of forest progresses, and the watershed is subsequently degraded.

In order to improve soil quality and crop productivity, farmers have made various efforts such as crop rotation, mixed cropping, inter cropping, terracing, following, manuring and mulching within their ecosystem of subsistence agriculture. Land productivity, however, has still degraded due to people's poverty and steady emphasis on cereal crop cultivation.

Towns and market centres can often play important roles in developing hinterlands in terms of agricultural intensification and commercialization, employment opportunities and income generation, and extension of new technology. In other words, towns and market centres power the engine for economic development of hinterland. In case of the Upper Pokhara Valley, however, Pokhara played a very limited role as a development centre. Rather, it had a backwash effect or an adverse effect on the hinterlands; i.e., the rapid increase in demand for fuelwood and timber in Pokhara promoted watershed degradation, and the demand for labour in Pokhara which had previously been employed for managing and improving natural resources induced worse management of the natural resources in the watershed.

The conclusion of this research on mountain watershed management is that the twin objectives of sustainable ecological balance and economic development cannot be achieved under the subsistence farming system. Rather the key issue is how this system of watershed economy can be transformed from a subsistence to a market oriented economy. In other words, within the closed subsistence agricultural system there are too many people and livestock to be sustainable. People in this ecosystem need something to attract money inflow. In reality, however, there is an outflow of people and earned money is invested outside the subject area. In order to improve this situation this subsistence system should produce something to attract money inflow. This is the meaning of the transformation from a subsistence to a market oriented economy. The conceivable alternatives to subsistence farming in this watershed are:

Farming:

- temperate climate fruits
- field cropping enterprises
- dairy farming

Industry:

- cottage and agroprocessing industry based on locally produced raw materials

Others:

- improved access to external markets
- mass education and human resources development
- resettlement from marginal lands.

(2) Marsyangdi Watershed Management Project

A primary objective of this project is to minimize soil degradation in the project area, which is also the catchment area for the Marsyangdi Hydropower Project. It is anticipated that the execution of the proposed measures would reduce the soil erosion by approximately 25% and furthermore promote better agricultural productivity and diversify watershed uses. The total project area is 3,905 km^2 and the headwaters of the catchment include permanent snow and ice-capped peaks, glaciers and natural lakes.

Since the project cannot cover the whole 3,905 km^2 at once, the area has been classified into three grades according to the level of the necessity of the countermeasures for soil erosion mainly on the basis of LRMP data and the soil erosion types, namely natural/uncontrollable or man-made/controllable.

Firstly, 20,200 ha (5% of the project area) has been classified as highly degraded category. This area, which is mostly covered with shrub, forest, and farming land on slopes steeper than 30°, is regarded as a controllable area to some extent, requiring watershed management.

Secondly, 820 ha (0.21% of the project area) out of the 20,200 ha above has been classified as a dangerous area which requires immediate countermeasures.

Thirdly, 820 ha of the above has been divided into two with countermeasures proposed as follows :

(a) The Five Year Plan, 100 ha (0.03% of the project area)

- Afforestation and engineering works;
- Recuperation through natural regeneration and establishment of demonstration areas;
- Preparation of a management plan for government forest;
- Livestock breed improvement, pasture and fodder development, extension and training programme, credit facilities, development of markets, etc.;
- Establishment of infrastructure for agricultural development, improved agricultural practises, cropping intensities, variant trials, etc.;
- Improvement and development of infrastructure such as roads, marketing centres, health centres, water supply, alternative sources of energy, etc.; and
- Preparation of operational manuals, specifications construction standards, publicity centres, detail surveys, etc.;

(b) 20-Year Perspective Plan, 720 ha (0.18% of the Project area)

- Management of the balanced part of the highly degraded area through structural measures;
- Afforestation and forest rehabilitation through natural regeneration and management plan for remaining area; and
- Continuation of livestock and agricultural programmes through monitoring and research.

The important points to note from this case study are (a) not only structural measures but also vegetative and educational measures are incorporated, (b) the project is phased in two stages since both manpower and finance are limited, and (c) most importantly it

is anticipated that soil erosion reduction will be as high as 25% with a project area covering just 0.21% of the whole catchment area.

3. WATERSHED MANAGEMENT IN THE STRATEGIC AREAS

3.1 General

In order to consider watershed condition and forecast watershed changes, it is important to study three major factors, namely soil and rock materials , geological structure and impact of human activity.

The rocks where the strategic areas are located are geologically classified into Nuwakot Group (refer to Appendix I, Topography and Geology for details). This Nuwakot Group is metasedimentary rock and thus shows generally high erodibility. Secondly, the geological structure varies area by area over a wide range. The general geological structure, however, is not flat and thus the erodibility also seems to be high. Lastly, human activity has both negative and positive impacts to the watershed. The effects, however, seem to be mostly negative, if the development of Strategic Areas is promoted without appropriate countermeasures for watershed management. This is because the population increase resulting from development will result in demand for more forest resources.

In conclusion, since all three factors imply negative impacts for watershed conservation, it is necessary for the purpose of watershed conservation to improve the present situation, minimize negative impacts, and propose and take countermeasures against watershed deterioration within the Master Plan Study.

The erosion-prone area maps were prepared by the Department of Soil Conservation and Watershed Management, DSCWM, for the four Strategic Areas as shown in Figures 3.2.1 to 3.5.1 based on the land utilization maps prepared by LRMP and Table 3.2.1. On the basis of these maps, discussions are needed to identify the areas requiring action in the form of intensive countermeasures for soil conservation and watershed management by strategic area. It is noted that the land utilization maps by LRMP and the erosion-prone area maps by DSCWM are in principle based on the aerial photographs shot in year 1978 and 1979, and thus some changes in land use are presumed to have occurred during the last 15 years. Indeed, the Study Team observed such changes especially in forest areas.

3.2 Jumla Strategic Area

The Jumla Strategic Area lying in an altitude higher than 2,500 m is developed in a narrow valley, consisting of valley floor, alluvial fan and sloping terrace. These areas are evaluated to be erosion-prone in a medium level, but high erosion-prone areas spread in the

sloping grazing land with the altitude of 2,600 to 3,000 m (refer to Figure 3.2.1 and Table 3.2.1).

There were many coniferous forests of pines and abies species around the Strategic Area, when LRMP was carried out. However, these forests developed on the slope have seriously been degraded after LRMP study, and the lower parts of these slopes now show bare land.

According to the results of hearings and questionnaire to the District Forest Office (DFO), the major tree species are Blue pine (Pinus wallichiana), Himalayan Cedar (Ceder deodara), Himalayan pencil cedar (Juniperus communes) and Walnut (Juglans regia), and all these species are used for fire wood.

As reforestation activity of DFO, an area of 18 ha was reforested with Himalayan ceder, Blue pine, etc., and 75,000 seedlings for reforestation activities were produced in year 1991. The effects, however, seem to be minimal so far. Much more budget and manpower should be invested.

3.3 Surkhet Strategic Area

The southern half of the Surkhet Strategic Area is evaluated as a low erosion-prone area due to the flat wetland paddy area. Within this area, there is a sal forest with crown density of 40 to 70%, and this forest is relatively well reserved and evaluated as a medium erosion-prone area (refer to Figure 3.3.1).

On the other hand a matured sal forest located north of the strategic area decreased its crown density from more than 70% to 10 to 40%. Forest surrounding the strategic area seems to have been degraded after the LRMP study due to the limited forest areas in the strategic area.

The Surkhet district watershed was evaluated at "very poor", and the population pressure on the agricultural land is high as discussed in Section 2.3.1, Watershed Management Problems. Under these conditions, the demand for fuelwood is high, and thus the degradation of forests in the surrounding areas seems to continue at a high speed.

One well reserved sal forest with low erodibility extends on the hill behind the army barracks. In the early stage of forest deterioration, the army recognized such deterioration and strictly reserved the area. The forest is not large, but the army enjoys abundant high quality water with the help of the recharging function of forest. This may suggest there is a risk that

the sources of drinking water in the strategic area would dry up, if the forests in the surrounding areas continue to deteriorate.

In conclusion, watershed management is important and necessary in the strategic area. Soil conservation, and thus watershed management are likewise essential in the surrounding areas in order to provide ample supply of drinking water and fuelwood to the strategic area.

The results of the questionnaire which was distributed to DFO are shown in Table 3.3.1.

The important points are as follows :

(a) The average cereal farming size is 1.2 ha per household,

(b) The average distance to market is as far as one and half days walk,

(c) The number of cow, ox and buffalo per household is 6.4, which causes quite high pressure on the watershed. Population density is 92 persons/ km^2,

(d) Firewood consumption is estimated at 10 kg/day/household,

(e) People are spending more than twice as much time now as they were in 1980 in order to collect firewood,

(f) Although the watershed condition is graded as very low, there are no landslides. This is probably because the land slopes of this district area are gentle. Soil erosion is, however, presumed to be high, and

(g) Reforested area was 55 ha in 1991 and the target reforestation is about 100 to 150 ha for the next four years.

3.4 Dipayal-Silgadhi-Rajpur Strategic Area

The levelled and sloping terraces occupy most of the strategic area. The levelled terraces are intensively cultivated and well maintained. There existed two protected forest areas on the map of LRMP extending south of the strategic area (refer to Figure 3.4.1) but these areas are in fact treeless. Shrub land, which occupied more than 50% of the surrounding area

in the past, is being transformed to bare land probably due to severe grazing. Lack of forest in the Strategic Area is causing a serious problem to local people in obtaining fuelwood.

The degraded shrub and forest area can be concluded to be highly erodible, and therefore engineering and rehabilitative countermeasures might be required. In addition, afforestation is also urgently required for securing a stable supply of fuelwood.

The results of the questionnaire completed by the District Forest Office for Doti District in which the Strategic Area is located (Table 3.4.1) are as follows :

(a) The average cereal farming size is 0.8 ha per household,

(b) The average distance to market is one day walk,

(c) The number of cattle per household is 7.8 and the number of goat and sheep per household is 3.1. This represents quite high pressure on not so highly productive land,

(d) Horticultural tree crops are widely planted, 2.5 trees per household,

(e) Firewood consumption is estimated at 10 kg/day/household,

(f) Landslide was not recorded in year 1991,

(g) Reforested area was 43.5 ha in year 1991 and the plan for year 1992 is 40 ha for timber, 20 ha for fuelwood and 10 ha for fodder, and

(h) Fruit tree seedlings are also produced.

3.5 Baitadi Strategic Area

The Baitadi Strategic Area is composed of two development zones, Baitadi and Patan.

(1) Baitadi Zone

The levelled terraces in the Baitadi zone are well maintained and evaluated as a low erosion-prone area (refer to Figure 3.5.1). There are many shrub areas on the land

utilization map prepared by LRMP. Most of these shrub lands, however, have transformed to bare land at present.

The forests of hardwood and mixed species have been severely degraded, and only small patches of trees are at present left. Therefore, shrub and forest areas, which were evaluated to be of medium erosion susceptibility by LRMP, are now evaluated to be highly erodible.

Since forest area is far from towns, it is concluded that people have extremely difficult time getting fuelwood. Community afforestation projects, therefore, should urgently be implemented.

(2) Patan Zone

The levelled and sloping terraces in the Patan zone are well maintained and evaluated as low erodible area. Although forest and shrub areas are relatively well maintained, they are showing net deterioration. It is recommended at an early stage of forest deterioration like this area to implement reforestation programmes since effectivity is high. The grazing land west of Patan town is highly erosion-prone, and thus an afforestation project is urgently required.

The road construction which links the district headquarters of Darchula and Dadeldhura districts is in progress. This construction on steep slopes in the northern part of the District is already facing severe landslide.

The results of the questionnaire completed by the District Forest Officer (Table 3.5.1) are as follows :

(a) The average cereal farming size is one ha per household,

(b) The average distance to the market centre of Baitadi is as far as three days walk,

(c) The number of cattle per household is five heads which is lower than other districts. The population density, however, is as high as 198 persons per km^2,

(d) Horticultural trees are widely planted at 3.3 trees per household,

(e) Firewood consumption is estimated at 12 kg per day per household,

(f) It is estimated that forest land has recently shrunk by 25% and that people are spending longer time for firewood collection,

(g) Landslide damage is recorded for 60 ha in total, including 15 ha of cultivated land and 25 houses,

(h) Reforested area in year 1991 was 42 ha covering five VDCs, and the reforestation plan for year 1992 is 120 ha for remaining VDCs, and

(i) Activities of the Soil Conservation and Watershed Office in year 1991 were five ha of reforestation and one small scale gully control. For year 1992 a variety of activities are planned such as terrace improvement, waterway protection, horticulture/fodder plantation, green belt, landslide control, etc.

4. INITIAL ENVIRONMENTAL EXAMINATION FOR THE PRIORITY SCHEMES

4.1 Hydropower Priority Schemes

4.1.1 Introduction

Initial Environmental Examination, IEE, for the selected four hydropower priority schemes was conducted in consultation with the following Nepali governmental agencies and non-governmental organizations:

Ministry of Water Resources,
IUCN - The World Conservation Union Nepal,
Department of National Parks and Wildlife Conservation,
Department of Soil Conservation and Watershed Management,
Department of Forest,
Department of Survey,
Department of Epidemiology,
Department of Archaeology,
Department of Housing and Town Planning,
Department of Agriculture Development,
United Nations Development Programme,
World Wide Fund for Nature (WWF), and
Rural Housing Co. Ltd.

Besides the consultation and information collection from the above agencies and organizations, field investigation was conducted twice at the project sites of the four priority schemes during the field investigation stage of Phase III.

The results of the IEE are shown in Table 4.1.1. The generally important points are discussed below and specifically important points for each project are discussed in the next section.

Air Quality

Since the construction activity takes place in the river gorge where air movement is limited, some impacts on air quality are foreseen due to operation of crushing plants and cement silos, dust from the road and emission from vehicles. Devices such as (1) installation of filter (2) mounting of air pollution control equipment (3) dust control on roads and crushing plants and

(4) planning for minimization of vehicle travel time and distance are considered as a countermeasure to mitigate such impacts. It is noted that these impacts are temporary and largely disappear with the completion of scheme construction.

Water Quality

Leakage of oil and hazardous materials from the construction site could contaminate the tributaries on which rural water supply relies. Protection of drinking water will require the implementation of control measures to prevent introduction of contaminated materials to the natural river course in the project area.

Land Occupation and Soil Loss

Whether the scheme is large or small in size and whether the scheme is a run-of-river or storage type, significant and specific impacts of the scheme are likely to occur in the form of land occupation and soil loss as follows:

- loss of productive land,
- loss of vegetation cover,
- interruption of local drainage,
- creation of spoil dumps,
- increased erosion and river sedimentation, and
- creation of long-term instability of area because of slope cutting.

The above mentioned possible impacts will require mitigation measures, and in particular the following sites will need a detailed examination in the coming feasibility study stage:

- Structure sites such as diversion weir, intake and powerhouse,
- Quarry, borrow area and spoil bank,
- Reservoir/Pondage,
- Construction plant, and
- Quarters including the permanent staff houses and the temporary construction camp.

If compensation is necessary, the proper amount should be assessed and paid.

Maintenance Flow

Many sorts of flora and fauna as well as human beings depend on river water. Once the river water is diverted elsewhere, the local fauna and flora, which are deprived of life giving water, will certainly suffer. Maintenance flow is, therefore, vital for maintaining wildlife in the

downstream reaches of the proposed structure. The amount of maintenance flow must be carefully studied and determined considering the specific conditions at the site in order to minimize negative environmental impacts as well as to maximize project benefit.

Social and Cultural Impacts

In remote areas where human population is not large, the influx of work force for project construction might affect the present inhabitants in the following ways :

- Influx of a large number of work seekers, small traders and others from outside may result in exploitation of the already almost vanished forest resources primarily for fuel wood and timber for work camp construction.

- The project workforce, job seekers, small entrepreneurs and others are likely to exceed the allowable limit of population at the site. Even if the contractor provides housing, fuel and food for employees, the immigrant population will continue to seek resources beyond the capacity available at the site.

- Socially disruptive impacts to fairly isolated communities may be caused by temporary immigrants to the area.

Specific remedial measures have to be studied and proposed for the above impacts. The specifically important points of IEE for each priority scheme are discussed hereinafter.

4.1.2 BR-1 Scheme

Main features of the BR-1 scheme are summarized below:

River	:	Bheri and Babai
Installed capacity	:	82.9 MW
Type	:	Run-of-river
Intake dam height	:	35 m
Catchment area	:	11,815 km^2
Waterway length	:	9.35 km

Judging from the results of the environmental field survey carried out in the field investigation stage of Phase III as given in Table 4.1.1, negative environmental impacts such as water-borne diseases, inundation and involuntary resettlement are unlikely to occur. However, the following factors must carefully be considered in further studies:

(1) Royal Bardiya National Park (RBNP)

This scheme lies in the Surkhet and Bardiya districts. There exists a national park called the Royal Bardiya National Park (hereafter refer to as RBNP), occupying the northern part of the Bardiya district, and no activities are allowed in RBNP except for permitted tourists, scientific studies and specially permitted development activities. In case of carrying out development activities within RBNP, potential risks of damage to the protected fauna and flora are expected to be large. The implementing agency of the proposed development project must thus study how to eliminate or minimize the negative potential environmental impacts with the Department of National Park and Wildlife Conservation and other concerned agencies under the coordination of the National Planning Commission. Development activities can be implemented, only if the proposed countermeasures are approved by the National Planning Commission through the process above.

Currently on-going development activities within RBNP are the East-West Highway including the construction of Karnali Bridge and Babai Irrigation Project. The Karnali (Chisapani) Multipurpose Project is under the study.

The original development plan of the BR-1 scheme proposed to site an open-air type powerhouse in RBNP, naturally requiring much human activity in the park and probably damaging the fauna and flora in it. A new plan to avoid this situation was proposed by shifting the powerhouse to the Bheri River side and by changing it to an underground type. This plan makes it possible to avoid not only the siting of the powerhouse in the national park but also construction activities within the park boundaries including the access to the plant for operation and maintenance after completion.

Even so, the siting of the tailrace outlet in the national park will require construction of at least one access road inside the park to haul rocks drilled from the tailrace tunnel, even if no high level of disturbance is expected to the park. An optimum design of waterway route and an appropriate construction plan for it should be formulated in consultation and collaboration with the Department of National Parks and Wildlife Conservation and other agencies concerned in order to minimize negative potential impacts.

It is noted that the access road to be constructed can be utilized for other purposes such as patrolling against poaching and for tourism after construction as well as operation and maintenance for the project.

On the basis of the discussion with the Game Warden of the Park, the following three alternative routes were proposed for access to the tailrace outlet (refer to Figure 4.1.1):

Route 1

RBNP has proposed the same route for patrolling against poaching, although the construction works are delayed due to budgetary constraints. This route 1, therefore, has dual functions as the patrolling road in the park and the access road to the tailrace outlet. It is noted that the first several kilometers from Chepang might have to pass through either steep slopes or hilly area above the slopes in the route. The game warden most prefers this route among the three alternatives including the other two mentioned below.

Route 2

This route lies between the tailrace outlet and the intake weir of Babai irrigation project. The hilly terrain with several gullies will make it rather hard to construct this route.

Route 3

RBNP has a plan to build this route for patrol and tourists as well. This route will hardly provide width enough for the passage of heavy construction machines according to the game warden.

(2) Maintenance Flow

Since BR-1 is the trans-basin scheme from the Bheri River to the Babai River, the maintenance flow to be released to the downstream reaches of the Bheri River must carefully be determined to protect the environment.

Field survey was conducted at Hariharpur, which is located approximately 23 km downstream of the proposed weir site, to identify the degree of dependence of local people on the Bheri River. The survey results are given in Table 4.1.2 and summarized below:

- Tributaries originated in the Siwalik Hills have never dried up even during drought,
- Local people rely on the Bheri River and the tributaries as drinking water sources,
- Water sources for irrigation are sought from tributaries, and
- No water mill exists on the Bheri River.

The findings of this survey indicate that a large amount of water is not required to maintain the present lifestyle of local people, since they mainly rely on tributaries as water sources. However, some amount of flow is necessary for fisheries and tourist boating. The appropriate amount of maintenance flow must be determined during the coming feasibility study.

(3) Access Road along the Bheri River

An access road with several kilometer length will be built by branching off from the Nepalganj to Surkhet road along the Bheri River to approach the diversion weir and the powerhouse. One land slide is observed on the left bank of the river, 4 km upstream of the proposed diversion weir. This route will be the sole approach to the site, requiring a detailed study to align the route in the coming feasibility study.

(4) Aquatic Fauna

There are a variety of fish species including Shizothorax sps (Asala) and Tor sps (Sahar) in the Bheri River. Although people catch fish mainly in the monsoon season by fishing rod, fishing by a few families was observed in February 1993 when the field survey was carried out. In fact, they had come from 10 km away to fish.

Local people say they sometimes catch fish longer than 1 m around the proposed diversion weir site. Some of them seem to be Gangetic Dolphin, which is caught with frequency of a few times in a year. Necessary measures to allow fish to migrate, i.e. fish ladder, and to protect Gangetic Dolphin should be studied in the coming feasibility study.

(5) Watershed

Although the watershed of the Surkhet district is evaluated at "very poor", the watershed of the BR-1 scheme is relatively well covered with forests. In addition, this scheme is a run-of-river type, and thus the sedimentation is unlikely to become a serious problem. However, the fact that one land slide recently occurred 4 km upstream of the proposed diversion weir site and that the Siwaliks is erodible will require the formulation of an appropriate watershed management plan in the coming feasibility study.

4.1.3 LR-1 Scheme

Main features of the LR-1 scheme are given below:

River	:	Lohore
Installed capacity	:	81.0 MW
Type	:	Reservoir
Dam height	:	120 m
Inundation area	:	1,040 hectares
Catchment area	:	733 km^2

A reservoir type scheme is likely to cause relatively large negative environmental impacts such as involuntary resettlement, inundation of the road network in the reservoir area, increase of water-borne diseases and change of the aquatic ecosystem.

(1) Inundation Area

The proposed LR-1 scheme will inundate an area of approximately 1,040 hectares, in which there exists the cultivated land of 250 hectares, two bridges, 160 houses in three villages of Rajogoan Chubra, Belpat and Khaitara, three schools and approximately 25 shops. The scheme, therefore, requires a full scale of Environmental Impact Assessment (EIA) in the feasibility study stage in order to design an appropriate resettlement programme including compensation and rehabilitation for displaced people and reconstruction or replacement of bridges and road network. The plan for land acquisition and the compensation for lost properties should follow the World Bank Resettlement Policy Guidelines (1987) and Land Acquisition Law of HMG, Nepal 1977.

Some people say that people currently living in the mountain area would tend to migrate to the Terai plain but that they can hardly do so due to low capital stock. If people in the inundation area are appropriately compensated for their property, they may be willing to migrate to other areas. These issues must be carefully studied in detail in the coming feasibility study. Since new development on reclamation of the existing forest lands is forbidden by the HMG, this kind of compensation, namely cash for land might only increase the number of squatters.

(2) Water-borne Diseases

By the creation of the proposed reservoir, riverine environment will be transformed into a relatively stable lentic environment. This might cause significant changes in the existing lotic ecosystem. The stagnant water body formed by the created reservoir might promote water-borne diseases to the extent of epidemic, such as malaria, gastroentirisis, cholera and so on. Local people normally use the river as a toilet and a water source for everyday life, and thus the potential risk of water-borne diseases is not small when the existing lotic ecosystem is transformed into a lentic environment. This should carefully be studied in the coming feasibility study.

(3) Aquatic Fauna

Formation of a high dam like LR-1 is a physical barrier to seasonal migration of some fish species. As a result, some fish species become dominant, whilst others might disappear. If the fish species which are important as a nutrition source and/or a cash income source are likely to disappear with the implementation of scheme, large negative socio-economic impact might occur.

Fish species such as Sahar (Tor sp), Asla (Schizothorax sp), Katle (Acrosscheilus sps) and so on are reported to be found in the Lohore Khola in abundance. These species of fishes are migratory in habit. Since the proposed dam will hinder their up and down stream migration, a fish ladder installed in the dam might help their migration. Experience from other projects, however, indicates that the fish ladder may not be effective for a 100 m class high dam. Fish culture is thus recommended to secure the nutrition source for local people and to increase their cash income. This should be studied in detail in the feasibility study.

(4) Watershed

Tackling of sedimentation is one of the most important and critical factors in Nepal to make water resources development schemes successful. The situation is in particular severe when a reservoir type scheme is built in a watershed judged to be in poor condition.

According to watershed evaluation by the Department of Soil Conservation and Watershed Management, the Dailekh watershed is in a marginal condition. Apart from this, activities such as construction of access road, quarrying, erection of concrete batching and mixing plant, slope cutting and so on also contribute to the sediment

increase. It is, therefore, necessary that both preventive and rehabilitative measures for watershed management be studied and that the appropriate measures be formulated in the detailed design stage.

4.1.4 CR-2 Scheme

Main features of the CR-2 scheme are summarized below:

River	:	Chamliya
Installed capacity	:	24.1 MW
Type	:	Run-of-river
Intake dam	:	65 m
Catchment area	:	785 km^2
Waterway length	:	4.9 km

The proposed diversion weir site is located in a small valley, and the upstream area also forms a steep valley. Thus, the inundation area is small, and human activity seems to be very light. Therefore, the environmental impact in the upstream reaches would be negligible. On the other hand, local people much rely on the river as a water source for everyday living, small scale irrigation, water-mills and fishing activities in the reaches between the diversion weir and the tailrace outlet. Although negative environmental impacts are not expected to be large, the following factors must carefully be studied in the coming feasibility study:

(1) Maintenance Flow

It is evident from the condition above that an adequate quantity of maintenance flow should carefully be studied and determined in order to facilitate the existing water utilization in the river reaches between the diversion weir and the tailrace outlet.

(2) Fisheries

The Chamliya River is rich in fish species and provides a good source of protein and cash income through fishery to the local people. According to the information collected from local people, fish species such as Shizothorax sps (Asla), Tor sps (Sahar) and Arossocheilus sps (Katle) are available in abundance at present in the Chamliya River. Sahar is a long distance migratory fish. It is, therefore, important to formulate the scheme in order not to damage aquatic fauna by providing a proper amount of maintenance flow as well as a fish ladder to facilitate the seasonal migration. Some

investigation is required to ascertain the magnitude of such problem and to formulate necessary countermeasures in the coming feasibility study.

(3) Access Road

An access road with a length of some 10 kilometer must be extended for the scheme construction works from the Darchula - Baitadi road which is now under construction. The route of the access road should be studied and determined in the later stage.

(4) Watershed

The Chamliya River lies in the Darchula and Baitadi districts, the watershed of which is classified as "good". However, according to the study of the Department of Soil Conservation and Watershed Management, the watershed is moderately or highly erosion-prone. Furthermore most parts of the watershed were observed to be bare land without any vegetation through the field investigation of Phase III. A proper watershed management plan, therefore, should be proposed for lengthening the project life.

4.1.5 SR-3 Scheme

Main features of the SR-3 scheme are given below:

River	:	Seti
Installed capacity	:	56.4 MW
Type	:	Run-of-river
Intake dam height	:	35 m
Catchment area	:	2,421 km^2
Waterway length	:	9.2 km

The project site is located just below Chainpur town, and the terrace along the Seti River is well developed for agriculture. Negative environmental impacts are not expected to be high, but the following factors will require careful study in the feasibility study:

(1) Inundation Area

Since the area is well developed for agricultural activities and since the scheme is close to Chainpur, the proposed diversion weir might cause submergence of some arable land and a part of the road network. If this takes place, environmental impact assessment

(EIA) for socio-economic aspects should be conducted for compensation and replacement of public facilities.

(2) Maintenance Flow

The length of the Seti River is some 11 km between the diversion weir and the tailrace outlet, along which there are a number of irrigation schemes implemented by SHIP. In addition to these, there exist 3 to 4 water mills, and fishing and washing are practiced there.

Considering these points, an appropriate amount of maintenance flow must be determined for the above 11 km long river stretches in the future study stage.

(3) Fauna

Since the Khaptad National Park is nearby, wild animals come to the river to drink water. Thus, the change of the water flow regime might affect their habitat. Nevertheless this impact caused by the change of flow regime does not seem to be large but rather moderate in scale.

Local people practice fishing mainly for home-consumption rather than on a commercial basis. In order to minimize negative impacts to aquatic fauna, in-depth study is required in the feasibility study stage.

(4) Watershed

Although the watershed condition is "good" according to the evaluation of the Department of Soil Conservation and Watershed Management, some parts of the watershed are observed to be without cover. Another finding in this field investigation is that the steep slope above the proposed diversion weir site has been afforested by the Department of Forest.

Although the watershed condition is not bad and afforestation efforts are going on, a proper watershed management plan seems to be essential due to the fact that the human activities which are now concentrated on the flat area near the riverbed are likely to shift to the watershed area of high elevation due to inundation, and thus the watershed condition may deteriorate in the future.

4.2 Bheri-Babai Irrigation Scheme

4.2.1 IEE

IEE of the Bheri-Babai irrigation scheme was conducted in collaboration with the district offices of the Banke and Bardiya for land revenue, land reform and agriculture in addition to the agencies mentioned in the Section 4.1, Initial Environmental Examination for the Hydropower Priority Schemes. The main features of the scheme are outlined as follows:

Location :	Bardiya and Banke districts
Net command area :	74,270 ha in Monsoon
	33,270 ha in Winter.

Table 4.2.1 summarizes the results of IEE based on the questionnaire result of Table 4.2.2 and the field survey. The potential problems in physical environmental aspects which might arise in this Bheri-Babai irrigation scheme are water-borne diseases, maintenance flow to the downstream reaches of the intake weir and deforestation along the canal as follows:

(1) Water-borne Diseases

Irrigation water might create a favourable condition for water-borne diseases where it has been dry and unfavourable to those diseases. The current water-borne diseases are malaria, Japanese encephalitis, cholera, gastroenterisis and so on. The epidemic of these diseases might occur when the scheme is implemented. The necessary countermeasures to avoid water-borne disease epidemic are to facilitate more health outposts and to educate people in proper hygiene.

(2) Maintenance Flow

There is a community irrigation scheme with a gross command area of 12,600 ha downstream of the Babai Irrigation Intake Weir. The most important potential impact might be the competition for water between both schemes. Other impacts will be effects on fish habitation and the depression of tubewell ground water level. Local people rely on this tubewell as a water source for drinking and washing.

(3) Deforestation along the Canal

The forest where the canal passes must be cleared. Thus, the determination of canal alignment by the Department of Irrigation shall be made with the consultation of the Department of Forest.

The current policy of HMG on forestry is not to deforest any more and to maintain current forest under community management and with government protection. On the other hand, the Ministry of Water Resources tends to extend irrigation command area as much as possible, even where accompanied by deforestation, since Nepal experienced a shortage of cereal food supply of more than nine thousand tons in 1989/90. Discussions for mutual agreement on the formulation of the scheme will be required between the departments.

The scheme does not seem to generate serious negative environmental impact in respect of socio-economy. Even so, agricultural services, forest encroachment, land holding system and other socio-economic issues warrant discussion, and appropriate measures should be taken in order to materialize the project benefits. Following are brief descriptions of the above three issues:

(1) Agricultural Extension Services

Farmers enjoy few benefits of agricultural extension services due to (i) lack of transportation system and access road, (ii) lack of the government budget, and (iii) low availability of farm inputs. The plan to strengthen agricultural support services, therefore, must be formulated and implemented simultaneously with the irrigation facilities.

(2) Forest Encroachment

Forest encroachment is currently a serious problem caused by squatters, who have migrated from the densely populated hill area.

Squatters comprising approximately thirty households who encroached into the government forest were expelled from it and now stay along the Nepalganj-Gulariya road without land to cultivate. HMG/N has promoted the resettlement and reclamation in the Terai in the past in order to increase food supply and to resolve the high population density problem in the hill area. HMG/N at present, however, forbids the reclamation of public forests in the Terai. Although it is true that the forest area is

already limited and that there are many potential squatters from the hill area, mitigative countermeasures are desirable to alleviate the living conditions of the poor squatters which have migrated from the hill area.

(3) Land Tenure Situation

According to data collected on land revenue and land reform in the Bardiya and Banke districts, farm land tenure is as follows:

	Unit	Bardiya	Banke
Total cultivated land	ha	53,800	45,900
No. of land owners		47,569	55,949
Average land holding size	ha	1.13	0.82
No. of small farmers		-	15,235
Farm land tenanted	ha	25,150	14,300
No. of tenants		9,019	15,889
Average tenant size	ha	2.8	0.9

The ratios of tenants to land owners are as low as 20% in the Bardiya district and 30% in the Banke district. Even so, the tenants should be protected by law when irrigation is facilitated. In addition, when tenanted land is acquired for right of way and compensation is necessary under the laws of Nepal, fair arrangement is required to protect tenants. It is noted under the current Nepal law that 75% of compensation goes to the land owner, whilst 25% goes to his tenant.

4.2.2 Land Use Plan

On the basis of the Karnali Multipurpose Project Study and the study by the irrigation engineer of the JICA study team, the land use of the Bheri-Babai Irrigation Scheme can be planned as shown in Figure 4.2.1 and summarized as follows:

	Land Use Plan	%
Present Rainfed Arable Land (Suitable for Irrigation)	49,100 ha	52.7%
Present Irrigation Land (Suitable for Irrigation)	25,200 ha	27.1%
Total Net	74,300 ha	79.8%
Present Forest and Grass Land (Suitable for Irrigation)	11,900 ha	12.8%
Others (Unsuitable for Irrigation)	6,900 ha	7.4%
Total	93,100 ha	100%

The boundaries of the scheme are RBNP to the north, Dundawa Khola to the east, the Indian border to the south and Arahi Nala to the west.

Since the HMG/N does not reclaim national forest, in principle, the present forest area is excluded from the irrigation plan despite its irrigation suitability. The net irrigable area is, therefore, 74,300 ha (approximately 80% of the whole area).

4.3 Conclusions and Recommendations

Implementation of any of the proposed priority schemes causes environmental impacts over a wide range of aspects, as discussed above and shown in Table 4.1.1. Some of the impacts last long, and some last short but might be very severe in magnitude. Most of the negative environmental impacts can be eliminated or mitigated by appropriate countermeasures in collaboration with concerned agencies/organizations. It is important to start this kind of collaboration and cooperation from the time of feasibility study, namely the time of project formulation considering the economic, financial and engineering viability of project implementation and operation.

The study aspects at the next study stage, namely feasibility study, should cover the points discussed in sections 4.1 and 4.2, especially the aspects evaluated as "significant impact" or "moderate impact" in Table 4.1.1.

5. EXPERIMENTAL WATERSHED MANAGEMENT STUDIES IN THE LR-1 BASIN

As discussed in the preceding Section 4.1.3, the watershed condition of LR-1 scheme located in the Dailekh district is not preferable for the storage type dam project. Unpreferable factors are rephrased as follows:

(a) The watershed of the district is evaluated at "marginal" by DSCWM.
(b) The surrounding areas are erosion-prone in a medium level.
(c) Both the populations per unit agricultural land and per unit forest land are relatively high. This implies the high population pressure and forest deterioration.

Since the proposed scheme of LR-1 is a storage type in addition to the factors above, the appropriate watershed management is essential in order to secure the project facilities and to reduce sedimentation.

The Study Team conducted surveys during the field work of Phase III to propose countermeasures for the river basin of LR-1 scheme evaluated to be marginal in terms of sediment yield. Figure 5.1.1 gives such geological hazard information as rock expose, trace of land slides, thrusts and so on in the river basin of LR-1 scheme.

Rock expose in the basin is concentrated in the area surrounded by the 6,000 ft contour line and the basin water divide, where the mountain slope is steep. The Main Central Thrust (MCT) zone runs in the direction of north-west to south-east in the basin with a narrow band of a few kilometers in its north-west corner and with a wide band more than 15 km in its south-east end.

The basin upstream of the upper MCT boundary is composed of gneiss, which is rather resistive against weathering, forming steep mountain slopes. The geotectonic movement caused by subduction of the Indian plate under the Himalayan mountains makes the slope fragile for failure and contributes to mass wasting, which is beyond the capability of control by human being.

The area in the MCT zone is composed of phyllite and augen gneiss, and the basin downstream of the lower MCT boundary is composed of phyllite, which is prone to weathering, developing gentle hill slopes with rather thick top soils suitable for cultivation. It can be said that top soil erosion mainly results from the area extended downstream of the upper MCT boundary due to the deterioration of watershed, i.e. deforestation.

Figure 5.1.2 depicts the forest areas in the basin delineated on the basis of the Landsat images shot in January and April 1984, indicating the development of forests in the area higher than El. 6,000 ft (refer to Figure 5.1.1). This implies that the area with sparse population density (refer to Table 5.1.1 and Figure 5.1.3), where human activities are low, is only left as forests.

The forest areas developed in the lower basin were not well observed by helicopter reconnaissance carried out in the field investigation of Phase III. This is probably due to the diminution of crown cover by the activities of human being, which are translated as the sum of collection of forest compost to maintain the fertility of cultivated lands, excessive fodder collection and fuelwood collection. Overpopulation in the area extended downstream of the upper MCT boundary (refer to Figure 5.1.3), in fact, spurs the activities of human being mentioned above, resulting in the deterioration of watershed by accelerating the erosion of top soils.

As a conclusion, the main causes of the basin evaluated as marginal in terms of sediment yield are classified into two: One is the mass wasting in the area upstream of the upper MCT boundary, and the other is top soil erosion in its downstream area. The countermeasures to protect the LR-1 reservoir from sediment yield will be the construction of check dams at proper places for the former cause. But, the problem is not so simple as the countermeasures for the latter are reforestation and levelled terrace cultivation, since primal demands of local people staying at a subsistence level are largely dependent on forests and their products.

Dam construction requires the construction of access road to the site, which will be used by local people after its completion and will function as an arterial road to transport the products produced in the area to the markets in the Terai for earning cash. Daily requirements and fodder to feed livestocks will be sought from Terai by the cash earned. The construction of access road will reduce the dependence of local people to forests, resulting in the protection of forests. Thus, guidance to yield marketable agricultural products will be most important to local people.

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TABLES

Table 1.1.1 RELATIONSHIP OF SOIL GREAT GROUPS FOUND IN NEPAL AND THEIR RESPECTIVE SOIL FORMING FACTORS

Soil Order		Soil Great Group	Dominant Parent Material on which Soil Occurs	Associated Climate	Dominant Slopes	Dominant Vegetation	Theoretical Period of Time Required to Develop Profile (Years)	Major Factor Controlling Pedogenetic Development
A. Entisols	1	Orthents	Colluvium	All	15-45° +	Bare or Pioneer species	0	Colluvial removal
	2	Fluvents	Recent alluvium	All	0-5° (1/2°)	Riverine Species	0-10	Fluvial deposition
B. Inceptisols	3	Aquepts	Stable low lying alluvium	Mostly subtropical	1	Coarse Grasses	10-100	High ground water level
	4	Ochrepts Dystric	Acid bedrock*	Warm & cold temperate	15-45	Mixed conifer forest	100-1000	Colluvial removal & deposition; leaching & enriching in equilibrium
	5	Ochrepts Eutric	Non acid and calcareous bedrock*	Warm & cool temperate	15-45	Mixed Oak foret	100-1000	Colluvial removal & deposition; leaching & enriching in equilibrium
	6	Ochrepts Ustic	Non acid Bedrock and Alluvium*	Subtropical warm temperate	15-45 1° on alluvium	Mixed Sal forest	100-1000	Colluvial removal & deposition; leaching & enriching in equilibrium
	7	Umbrepts Cryic	Acid bedrock*	Alpine & Arctic	15-45	Alpine meadow	1000-10,000	Colluvial removal & deposition; leaching & enriching in equilibrium (and temperature)
	8	Umbrepts Spodic	Acid bedrock*	Cool temperate	15-45		1000-10,000	Colluvial removal & deposition; leaching & enriching in equilibrium (and temperature)
C. Mollisols	9	Ustolls	Stable alluvium	Subtropical	2	Sal forest	1000-10,000	Surface Erosion
D. Altisols	10	Ustalfs	Ancient alluvial terraces	Subtropical	2	Sal forest	10,000-100,000	Surface and gully erosion destroying surfaces

* All colluvial to some degree

Source : LRMP, 1986

Table 1.1.2 LAND SYSTEM AND CRITERION LEGEND (1/2)

MAPPING APPROACH

CATEGORY	DIFFERENTIATING CRITERIA
Region	Physiography, Geology and Geomorphology
Land System	Recurrent Patterns of Landforms, Geological Materials, Slopes and Arable Agriculture Limits
Land Unit	Landscape Features : Position, Slope, Degree of Dissection, Flooding Frequency Soil Characteristics : Drainage, Depth, Texture, Profile Development, pH

TERAI REGION

Quaternary alluvium, Subtropical

Land System	Land Form	Land Unit
1	Active Alluvial Plain (depositional)	1a present river channel 1b sand and gravel bars 1c low terrace 1d higher terrace
2	Recent Alluvial Plain Lower Piedmont (depositional and erosional)	2a depressional 2b intermediate position, level 2c intermediate position undulation 2d high position
3	Alluvial Fan Apron Complex Upper Piedmont (erosional)	3a very gentle slopes 3b gentle slopes 3c undulating 3d highly dissected

SIWALIK REGION

Tertiary interbedded incompetent sandstone, shale, conglomerate and Quanternary alluvium; Subtropical

Land System	Land Form	Land Unit
4	Active and Recent Alluvial Plains	4a sand and gravel bars 4b low terrace 4c higher terrace undulating
5	Fans, Aprons and Ancient River Terraces (Tars)	5a very gentle slopes 5b gentle slopes 5c undulating 5d rolling
6	Depositional Basin (Duns)	6a depressional 6b non-dissected high position 6c gently rolling 6d highly dissected
7	Moderately to Steeply Sloping Hilly and Mountainous Terrain	
8	Steeply to very Steeply Sloping Mountainous Terrain	

Source : LRMP, 1986

Table 1.1.2 LAND SYSTEM AND CRITERION LEGEND (2/2)

MAPPING APPROACH

CATEGORY	DIFFERENTIATING CRITERIA
Region	**Physiography, Geology and Geomorphology**
Land System	**Recurrent Patterns of Landforms, Geological Materials, Slopes and Arable Agriculture Limits**
Land Unit	**Landscape Features : Position, Slope, Degree of Dissection, Flooding Frequency**
	Soil Characteristics : Drainage, Depth, Texture, Profile Development, pH

MIDDLE MOUNTAIN REGION

Precambrian to Eocene phyllites quartzites, schists, limestones and gneisses, generally deeply weathered; Subtropical to Warm Temperate

Land System	Land Form	Land Unit
9	Alluvial Plains and Fans (depositional)	9a river channel 9b alluvial plains 9c alluvial fans
10	Ancient Lake and River Terraces (Tars) (erosional)	10a non-dissected 10b dissected
11	Moderately to Steeply Sloping Mountainous Terrain	
12	Steeply to very Steeply Sloping Mountainous Terrain	

HIGH MOUNTAIN REGION

Precambrian to Eocene gneisses, quartzites, schists, phyllites, and limestones, generally not deeply weathered; Glaciated; Warm Temperate to Alpine

Land System	Land Form	Land Unit
13	Alluvial Plains Fans	13a active alluvial plain 13b recent alluvial plain 13c fans 13d ancient alluvial terraces
14	Past Glaciated Mountainous Terrain below Upper Altitudinal Limit of Arable Agriculture	14a moderate to steep slopes 14b steep to very steep slopes
15	Past Glaciated Mountainous Terrain above Upper Altitudinal slopes Limit of Arable Agriculture	15a moderate to steep slopes 15b very steep slopes

HIGH HIMALAYAN REGION

Land System	Land Form	Land Unit
16	Alluvial, Colluvial and Morainal Depositional Surfaces	16a glacioalluvial plains 16b morainal deposits 16c alluvial colluvial fans 16d colluvial slopes (talus)
17	Steeply to very Steeply Sloping Mountainous Terrain	17a shallow till or colluvium 17b rock headwalls

Source : LRMP, 1986

Table 1.1.3 LAND SYSTEMS IN THE STUDY AREA

Physiographic Region	Land System	Land Unit	Far-Western Dev. Region		Mid-Western Dev. Region		Total Study Area		Nepal	Total
			(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Terai	1	1a, 1ab, 1b, 1c, 1d	23,035	1.2	31,820	0.7	54,855	0.9	230,296	1.6
	2	2a, 2b, 2c, 2d	130,316	6.7	102,983	2.4	233,300	3.7	1,151,408	7.8
	3	3a, 3b, 3c, 3d	184,205	9.5	123,497	2.9	307,702	4.9	740,382	5.0
Siwaliks	4	4a, 4b, 4c, 4Com	3,473	0.2	40,824	1.0	44,297	0.7	163,754	1.1
	5	5a, 5b, 5c, 5d	8,513	0.4	99,564	2.3	108,077	1.7	308,742	2.1
	6	6a, 6b, 6c, 6d	0	0.0	39,594	0.9	39,594	0.6	57,230	0.4
	7		20,361	1.0	18,973	0.4	39,334	0.6	88,793	0.6
	8		165,702	8.5	370,191	8.6	535,894	8.6	1,260,482	8.5
Middle Mount.	9	9a, 9b, 9c, 9Com	6,588	0.3	13,622	0.3	20,211	0.3	136,775	0.9
	10	10a, 10b, 10Com	10,923	0.6	12,304	0.3	23,227	0.4	123,633	0.8
	11		243,094	12.5	306,971	7.2	550,064	8.8	1,853,680	12.6
	12		420,608	21.6	456,747	10.7	877,355	14.1	2,236,410	15.2
High Mount.	13	13a,13b,13c,13d,13com	5,683	0.3	14,793	0.3	20,476	0.3	32,477	0.2
	14	14a, 14b	263,765	13.6	646,179	15.1	909,945	14.6	1,471,396	10.0
	15	15a, 15b	168,530	8.7	469,883	11.0	638,413	10.3	1,395,699	9.5
High Himalayan	16	16a,16b,16c,16d,16Com	24,700	1.3	237,833	5.6	262,533	4.2	478,416	3.2
	17	17a, 17b	264,792	13.6	1,287,952	30.1	1,552,743	24.9	3,007,823	20.4
Others	18		0	0.0	6,473	0.2	6,473	0.1	11,237	0.1
Total			1,944,287	100.0	4,280,205	100.0	6,224,492	100.0	14,748,631	100.0
High Agricultural Potential Area			265,726.9	13.7	400,997	9.4	666,724	10.7	2,194,968	14.9
Terai		2, 3a	176,652	9.1	138,268	3.2	314,920	5.1	1,423,356	9.7
Siwaliks		4c, 5a, 6a, 6b, 6c	3,487	0.2	76,557	1.8	80,044	1.3	216,386	1.5
Mid. Mount.		9b, 9c	4,283	0.2	6,859	0.2	11,142	0.2	59,526	0.4
High Mount.		13b,13c,13Com,13d,14a	81,305	4.2	179,313	4.2	260,618	4.2	495,698	3.4
Low Agricultural Potential Area			377,962	19.4	530,100	12.4	908,062	14.6	2,765,343	18.7
Terai		3b, 3c	93,186	4.8	63,739	1.5	156,925	2.5	358,619	2.4
Siwaliks		4b, 5b, 5c, 5Com	6,025	0.3	48,545	1.1	54,570	0.9	184,615	1.3
Mid. Mount.		9Com, 10a, 11	248,855	12.8	315,316	7.4	564,171	9.1	1,935,678	13.1
High Mount.		15a	29,897	1.5	102,500	2.4	132,397	2.1	286,431	1.9
Non-Agricultural Potential Area			1,300,598	66.9	3,349,108	78.2	4,649,706	74.7	9,788,320	66.4
Terai		1a,1ab,1b,1c,1d,3d	67,719	3.5	56,294	1.3	124,013	2.0	340,111	2.3
Siwaliks		4a,4Com,5d,6d,7,8	188,537	9.7	444,045	10.4	632,583	10.2	1,477,998	10.0
Mid. Mount.		9a, 10b, 10Com, 12	428,075	22.0	467,469	10.9	895,544	14.4	2,353,593	16.0
High Mount.		13a, 14b, 15b	326,776	16.8	849,042	19.8	1,175,818	18.9	2,117,443	14.4
High Himal.		16, 17	289,491	14.9	1,525,785	35.6	1,815,277	29.2	3,487,939	23.6
Others		18	0	0.0	6,473	0.2	6,473	0.1	11,237	0.1

Source : LRMP, 1986

Table 1.1.4 LAND USE IN NEPAL

Unit : 1,000 ha

Landuse	Physiographic Region					Total
	Terai	Siwaliks	Middle Mountains	High Mountains	High Himal	
Total Cult. Land	1,351.7 (64.1)	314.1 (16.7)	1,888.0 (42.5)	391.6 (13.2)	9.7 (0.3)	3,955.1 (26.8)
Terai Cult	1,234.5	70.5	-	-	-	1,305.0
Hillslope Cult	0.1	29.0	1,034.8	220.5	1.0	1,285.4
Valley Cult	-	159.3	187.7	23.9	6.8	377.7
Noncultivated	117.1	55.3	665.5	147.2	1.9	987.0
Grazing	49.7 (2.4)	20.7 (1.1)	292.6 (6.6)	509.9 (17.2)	884.2 (26.4)	1,757.1 (11.9)
Total Forest	591.4 (28.0)	1,445.2 (76.6)	1,793.3 (40.4)	1,631.9 (55.1)	155.0 (4.6)	5,616.8 (38.1)
Coniferous	-	38.2	349.0	494.8	54.1	936.1
Hardwood	586.4	1,193.5	1,014.8	560.2	16.9	3,371.8
Mixed Wood	5.0	213.5	429.5	576.9	84.0	1,308.9
Shrub	1.4 (0.1)	31.3 (1.7)	409.3 (9.2)	181.3 (6.1)	66.6 (2.0)	689.9 (4.7)
Others	116.1 (5.5)	74.3 (3.9)	60.5 (1.4)	244.7 (8.3)	2,233.8 (66.7)	2,729.4 (18.5)
Total	2,110.3 (100.1)	1,885.6 (100.1)	4,443.7 (100.1)	295.4 (99.9)	3,349.4 (100.0)	14,748.4 (100.0)

Source: LRMP 1986

Table 1.1.5 PRESENT LAND USE BY DEVELOPMENT REGION

Unit : 1,000 ha

Development Region	Agricultural Land		Forest Land		Other Land	Total (Ha.)
	Cultivated	Grazing	Forest	Shrub		
FWDR (thousand ha)	404.87	215.09	989.15	60.39	274.79	1944.29**
Percentage/14748.5	2.75	1.46	6.71	0.41	1.86	13.18
Percentage/1944.29	20.82	11.06	50.87	3.11	14.13	99.99
MWDR (thousand ha)	683.87	730.92	1,646.85	77.28	1,141.29	4280.2**
Percentage/14748.5	4.64	4.96	11.17	0.52	7.74	29.02
Percentage/4280.20	15.98	17.08	38.48	1.81	26.66	100.01
The Study Area (FWDR + MWDR) in thousand ha	1,088.74	946.01	2,636.00	137.67	1,416.08	6,224.50
Percentage/14748.5	7.38	6.41	17.87	0.93	9.60	42.20
Percentage/6224.49	17.49	15.20	42.35	2.21	22.75	100.00
Nepal (thousand Ha)	4,010.56	1,701.66	5,605.62	689.85	2,729.84	14,748.50
Percentage (%)	27.19	11.54	38.01	4.68	18.51	99.99

* Other lands include rock, ice, lakes, rivers, abandoned land, urban, forestry plantations and lands recently burned over.

** These figures are slightly different from the Government statistics.

Source : Land Resource Mapping Project, Land Utilization Report, 1986, HMG of Nepal and Government of Canada

Table 1.2.1 POPULATION BY MOTHER TONGUE FOR DEVELOPMENT REGION AND DISTRICT

(Unit : person)

Mother Tongue	Nepal	%	Far West	%	Mid West	%	Dailekh District	%
Nepali	8,767,361	58.4%	1,044,474	79.1%	1,523,006	77.9%	161,250	96.8%
Maithali	1,668,309	11.1%	15,418	1.2%	17,913	0.9%	545	0.3%
Bhojpuri	1,142,805	7.6%	107	0.0%	655	0.0%	7	0.0%
Newari	448,746	3.0%	515	0.0%	1,958	0.1%	44	0.0%
Gurung	174,464	1.2%	1,221	0.1%	3,962	0.2%	34	0.0%
Tamang	522,416	3.5%	5,878	0.4%	8,547	0.4%	161	0.1%
Abadhi	234,343	1.6%	111	0.0%	61,786	3.2%	7	0.0%
Tharu	545,685	3.6%	142,985	10.8%	177,339	9.1%	41	0.0%
Magar	212,681	1.4%	1,169	0.1%	14,178	0.7%	730	0.4%
Limbu	129,234	0.9%	329	0.0%	163	0.0%	4	0.0%
Rai, Kirati	221,353	1.5%	7,362	0.6%	8,350	0.4%	753	0.5%
Bhote, Serpa	73,589	0.5%	873	0.1%	8,079	0.4%	73	0.0%
Thakali	5,289	0.0%	71	0.0%	186	0.0%	27	0.0%
Rajbanshi	59,383	0.4%	184	0.0%	1,164	0.1%	24	0.0%
Satar	22,403	0.1%	60	0.0%	107	0.0%	1	0.0%
Sunwar	10,650	0.1%	116	0.0%	104	0.0%	4	0.0%
Danuwar	13,522	0.1%	29	0.0%	96	0.0%	3	0.0%
santhal	5,804	0.0%	264	0.0%	552	0.0%	2	0.0%
Others/Unstated	764,802	5.1%	98,923	7.5%	127,466	6.5%	2,817	1.7%
Total	15,022,839	100%	1,320,089	100%	1,955,611	100%	166,527	100%

Source : Population of Nepal 1981 Census

Table 1.3.1 LIST OF PROTECTED AREAS

	Unit :km2
National Park	10,144
In the Study Area	3,886
Shey Phoksundo National Park	3,555
Rara National Park	106
Khaptad National Park	225
Out of the Study Area	6,258
Royal Bardiya National Park	968
Royal Chitwan National Park	932
Langtang National Park	1,710
Sagarmatha National Park	1,148
Makalu-Barun National Park	1,500
Wildlife Reserve	974
In the Study Area	
Royal Suklaphanta Wildlife Reserve	155
Out of the Study Area	819
Parsa Wildlife Reserve	499
Koshi Tapu Wildlife Reserve	175
Shivapuri Conservation and Wildlife Reserve	145
Hunting Reserve	1,325
In the Study Area	
Dhorpatan Hunting Reserve	1,325
Conservation Area	3,490
Out of the Study Area	
Annapurna Conservation Area	2,660
Makalu-Barun Conservation Area	830
Total Protected Area in the Study Area	5,366
Total Protected Area out of the Study Area	10,567
Total Protected Area	15,933

Source : MFE "Master Plan of the Forestry. Sector, Nepal" and IUCN Protected Areas in Relation to the Pysiographic Zones of Nepal.

Table 1.3.2 LIST OF ANIMAL SPECIES PROTECTED BY ACT IN NEPAL

Mammalia

SPECIES		LOCAL NAME	ENGLISH NAME	Listed in Red Data Book
Macaca	assamensis	Assami rato bandar	Assamese macaque	
Manis	crassicaudata	Salak	Pangolin	
Manis	pentadactyla	Salak	Indian pangolin	
Caprolagus	hispidus	Hispid Kharayo	Hispid hare	√
Platanista	gangetica	Sons	Gangetic dolphin	√
Canis	lupus	Bwanso	Wolf	√
Ursus	arctos	Himali rato bhalu	Himalayan brown bear	
Ailurus	fulgens	Habre	Red panda	√
Pridnodon	pardicolor		Linsang	
Hyaena	hyaena	Hundar	Hyena	
Felis	bengalensis	Chari bagh	Leopard cat	
Felis	lynx		Tibetan lynx	
Neofelis	nebulosa	Dhwanse chituwa	Clouded leopard	√
Panthera	tigris	Bagh	Tiger	√
Panthera	uncia	Hiun chituwa	Snow leopard	√
Elephas	maximus	Jangali hatti	Wild Elephant	√
Rhinoceros	unicornis	Gainda	Rhinoceros	√
Sus	salvanus	Pudke bandel	Pygmy hog	√
Moschus	chrysogaster	Kasturi mriga	Musk deer	√
Cervus	duvauceli	Barhasingha	Swamp deer	√
Bos	gaurus	Gauri gai	Gaur bison	
Bos	mutus (grunicns)	Yak and nak	Wild yak	
Bubalus	bubalis	Arna	Water buffalo	√
Ovis	ammon	Nayan	Tibetan argali	
Pantholops	hodgsoni	Chiru	Chiru	
Antilope	cervicapra	Krishnasar	Blackbuck	
Tetraceros	quadricornis	Chauka	Four horned antelope	

Aves

SPECIES		LOCAL NAME	ENGLISH NAME	Listed in Red Data Book
Ciconis	nigra	Kalo sarus	Black stork	
Cionia	ciconia	Seto sarus	White stork	
Brus	grus	Sarus	Common crane	
Catreus	wallichii	Cheer	Cheer pheasant	√
Lophophorus	impeyanus	Danphe	Impeyan pheasant	
Tragopan	satyra	Monal	Satyr tragopan	
Houbropsis	bengalensis	Khar mujur	Bengal florican	
Sypheotides	indica	Sano khar mujur	Lesser florican	
Buceros	bicornis	Thulo dhanesh	Great hornbill	

Reptilia

SPECIES		LOCAL NAME	ENGLISH NAME	Listed in Red Data Book
Python	spp.	Ajingar	Python	√
Gavialis	gangeticus	Gharial gohi	Gharial	√
Varanus	flavescens	Sun gohoro	Monitor lizard	

Source: Master Plan for the Forestry Sector Nepal, and 1988 IUCN Red List of Threatened Animals, IUCN

Table 1.3.3 NEPALESE ANIMALS LISTED IN THE 1988 IUCN RED LIST OF THREATENED ANIMALS (1/4)

Name of Animal				Habitat **						Protected by
Scientific Name		Common Name	Categories *	Bardiya	Suklaphanta	Rara	Khaptad	Sheyphoksundo	Others	Nepalese Law
1. Mammals										
Order LAGOMORPHA										
Family Leporidae										
	Caprolagus hispidus	Hispid Hare	E		√					Yes
Order CETACEA										
Family Platanistidae										
	Platanista gangetica	Ganges River Dolphin	V	√					Ch, Ko	Yes
Order CARNIVORA										
Family Canidae										
	Canis lupus	Grey Wolf	V			√	√	√		Yes
	Canis alpinus	Dhole	V	√	√				Ch,	No
	Vulpes bengalensis	Bengal Fox	K	√					Ch,	No
Family Ursidae										
	Melursus ursinus	Sloth Bear	I	√	√				Ch,	No
Family Procyonidae										
	Ailurus fulgens	Red panda	K					√*	La, Sg	Yes
Family Mustelidae										
	Aonyx cinerea	Oriental Small-clawed Otter	K	√	√	√		√		No
	Lutra perspicillata	Smooth-coated Otter	K	√	√	√				No
Family Felidae										
	Neofelis nebulosa	Clouded Leopard	V	√					Ch,	Yes
	Panthera pardus	Leopard	T	√	√	√	√	√	La, Sg	No
	Panthera tigris	Tiger	E	√	√				Ch, Pa	Yes
	Panthera uncia	Snow Leopard	E					√	Mt	Yes

Table 1.3.3 NEPALESE ANIMALS LISTED IN THE 1988 IUCN RED LIST OF THREATENED ANIMALS (2/4)

Name of Animal				Habitat **						Protectd by
Scientific Name		Common Name	Categories *	Bardiya	Suklaphanta	Rara	Khaptad	Sheyphoksundo	Others	Nepalese Law
Order PROBOSCIDEA										
Family Elephantidae										
	Elephas maximum	Asian Elephant	E	√	√				Ch, Pa	Yes
Order PERISSODACTYLA										
Family Rhinocerotidae										
	Rhinoceros unicornis	Great Indian Rhinoceros	E	√					Ch	Yes
Order ARTIODACTYLA										
Family Suidae										
	Sus salvanius	Pygmy Hog	E						Ko	Yes
Family Cervidae										
	Cervus duvauceli	Swamp Deer	E	√	√					Yes
	Moschus cyrysogaster (Subspecies)	Himalayan subspecies of Musk Deer	V			√	√	√	Mt	Yes
Family Bovidae										
	Bubalus bubalis	Wild Asiatic Water Buffalo	E						Ko	Yes
2. Birds										
Order CICONIIFORMES										
Family Ardeidae										
	Ardea imperiatis	White-bellied Heron	K*	√	√				Ch, Ko	No
Family Anatidae										
	Rhodonessa caryophyllac	Pink-headed Duck	Ex		√				Ch, ko	No
Family Phasianidae										
	Erancolinus gularis	Swamp Partridge	K*		√				Ko	No
	Catreus wallichi	Cheer Pheasant	E		√	√	√	√	Mt	Yes

Table 1.3.3 NEPALESE ANIMALS LISTED IN THE 1988 IUCN RED LIST OF THREATENED ANIMALS (3/4)

Name of Animal				Habitat **						Protected by
Scientific Name		Common Name	Categories *	Bardiya	Suklaphanta	Rara	Khaptad	Sheyphoksundo	Others	Nepalese Law
Order CHARADRIIFORMES										
Family Scolopacidae										
	Gallinago nemoricola	Wood Snipe	K*	√	√				Ch, Ko	No
Order CORACIIFORMES										
Family Alcedinidae										
	Alcedo hercules	Blyth's Kingfisher	K*	√	√	√			Ch, Pa, Ko	No
Family Bucerotidae										
	Aceros nipalensis	Rufous-necked Hornbill	K*	√	√				Ch	No
Order PASSERIFORMES										
Family Muscicapidae										
	Saxicola insignis	Hodgson's Bushchat	K*	√	√				Ch, Pa, Ko	No
	Bradypterus major	Large-billed Bush Warbler	K*	√	√	√	√		Ch, Ko	No
	Chaetornis striatus	Bristled Grass Warbler	K*	√	√	√	√		Ch, Ko	No
3. Reptiles										
Order TESTUDINES										
Family emydidae										
	Kachuga kachuga	Red-crowned Roofed Turtle	I		√					No
	Melanochelys tricarinata	Tricarinate Hill Turtle	I	√	√					No
Order CROCODYLIA										
Family Crocodylidae										
	Crocodylus palustris	Mugger	V	√	√				Ch	No
Family Gavialidae										
	Gavialis gangeticus	Gharial	E	√					Ch	Yes
Order SERPENTES										
Family Boidae										
	Python molurus	Indian Python	V	√	√				Ch, Pa	Yes

Table 1.3.3 NEPAL ANIMALS LISTED IN THE 1988 IUCN RED LIST OF THREATENED ANIMALS (4/4)

*: IUCN threatened Species Categories

Species identified as threatened by IUCN are assigned a category indicating the degree of threat.
Definitions are as follows :

Ex : Extinction, Species not definitely located in the wild during the past 50 years (criterion as used by the Convention on International Trade in Endangered Species of Wild Fauna and Flora)

E : Endangered, Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating.

V : Vulnerable, Taxa believed likely to move into the 'Endangered' category in the near future if the causal factors continue operating.

R : Rare, Taxa with small world populations that are not at present 'Endangered' or Vulnerable', but are at risk.

I : Indeterminate, Taxa that are suspected but not definitely known to belong to any of the above categories, because of lack of information.

K* : Taxa which are currently under review by ICBP and which are likely to be designated a category in the near future.

T : Threatened, Threatened is a general term to denote species which are 'Endangered', 'Vulnerable', 'Rare', 'Indeterminate', or 'Insufficiently Known' and should not be confused with the use of the same term by the U.S. Office of Endangered Species.

**:

Bardiya	:	Royal Bardiya National Park
Suklaphanta	:	Royal Suklaphanta National Park
Rara	:	Rara National Park
Khaptad	:	Khaptad National Park
Shey Phoksundo	:	Shey Phoksund National Park
Others	:	Others areas outside the Study Area
	Ch :	Royal Chitwan National Park
	Ko :	Koshi Tappu Wildlife Reserve
	La :	Langtang Naional Park
	Mt :	All mountain National Parks.
	Pa :	Parsa Wildlife Reserve
	Sg :	Sagarmatha National Park
	√ :	Habitat confirmed
	√* :	Probable habitat

Source : 1988 IUCN Red List of Threatened Animals,
International Union for Conservation of Nature and Natural Resources

Table 1.4.1 WATER QUALITY IN THE DRY SEASON

No.	1	2	3	4	5	6	7	8
River	Bheri	Bheri	Babai	Lake Rara	Lake Rara	Karnali	Seti	Mahakali
Site	Jajarkot	BR 1	Babai Barrage	Tap Water	Lakeside	KarnaliBend	West Set/SR1	Pancheshwar
Date	Dec. 08,	Dec. 08,	Dec. 08,	Dec. 09,	Dec. 09,	Dec. 9,	Dec. 10,	Dec. 10,
Time	13:50	14:30	15:35	10:12	11:00	13:00	8:55	11:03
Weather	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Water Tem (°C)	12	14	20	8	11	10	10	12
Air Temp. (°C)	23	23	20	12	12	18	11	19
EC (µS/cm)	200	200	330	220	170	150	230	220
pH	9.1	8.7	8.5	8.4	8.5	8.6	8.7	8.8
DO (mg/l)	6	5	6	5	6	5	7	5
COD (mg/l)	1	1	1	-	2	1	2	2
Turbidity	0	1	2	1	1	1	1	1
Water Color	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Smell	No	No	No	No	No	No	No	No
General Fungi	not found	a lot	a lot	-	1 spot	not found	a lot	a lot
Remarks	Wide river Many people live nearby	Deep valley Few people	Storage water	SS found	Most polluted water in the lake		Sampling site is downstream of village	

Methods of measurement

EC : DIST 3 EC meter by HANNA Instruments
PH : pHep pH Meter by HANNA Instruments
DO : CHEMets self-filling ampolues for colorimetric analysis
COD : by oxidization with Alkaline KMn 04 at room temperature
Turbidity : Turbidity and Colorimeter WA-PT-4 by Kyoritsu Chemical-Check Lab., Corp.
General Fungi : Test Pater for General Fungi by Fuji Chemical Co. Ltd.

Table 1.4.2 WATER QUALITY IN THE RAINY SEASON

Stations		Karnali at Chisapani	Bheri upstream at Ghatgaon	Karnali upstream Thuligad
SO4	mg/l	8.3	10.8	14.1
PO4	mg/l	0.5	0.5	1.5
TDS	mg/l	264.0	208.0	264.0
SS	mg/l	112.0	744.0	304.0
TS	mg/l	376.0	952.0	568.0
TH	mg/l	90.2	78.2	95.2
pH		8.0	7.8	8.1
DO	mg/l	10.5	9.3	8.6
Eletrical condutivty	micromho/cm	183.0	210.0	208.0
BOD	mg/l	1.5	1.1	1.8
Na +	mg/l	1.5	1.9	1.8
K +	mg/l	1.3	1.3	1.4
Fe +	mg/l	*	*	*
Mn +	mg/l	*	*	*
Ca ++	mg/l	27.2	26.0	26.0
Mg ++	mg/l	5.3	3.9	7.3
CO3 --	mg/l	18.0	12.0	12.0
Mco3 --	mg/l	109.8	85.4	97.6
C1-	mg/l	0.8	1.0	0.6

Abbrevations :

TDS = Total Dissolved Solids
SS = Suspended Solids
TS = Total Solids
TH = Total Hardness
DO = Dissolved Oxygen
BDD = Biological Oxygen Demand

Note : * Denotes less than 0.1

Source : The Karnali Multipurpose Project, Environmental and Socio-Economic Situation Report prepared by New ERA, 1987

Table 1.4.3 WATER QUALITY IN 1992 PRE-MONSOON AND POST-MONSOON

Stations		1. Seti R. Beni		2. Karnali R. Gauze ST. Beni		3. Seti + Karnali Badigaon		4. Bheri R. Kuinae		5. Karnali Pitmari		6. Bheri R. Surkhet		7. Kauriyala R. Tiger Top		8. Kauriyala R. Rajapur		9. Guruwa R. Kothiyaghat	
		Apr.	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	Oct.			Apr.	Oct.
SO4	mg/1	12.0	18.0	12.0	21.0	12.0	19.0	14.0	22.0	16.0	18.0	18.0	22.0	14.0	17.0	12.0	18.0	18.0	19.0
PO4	mg/1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
TDS	mg/1	134.0	87.0	107.0	108.0	130.0	93.0	162.0	121.0	137.0	102.0	161.0	125.0	149.0	96.0	255.0	147.0	141.0	85.0
SS	mg/1	0.5	4.0	0.5	9.0	0.5	5.0	0.5	6.0	0.5	4.0	0.5	8.0	0.5	3.0	1.0	7.0	0.5	7.0
TS	mg/1	0.5	3.0	0.5	4.0	0.5	12.0	1.0	4.0	1.0	9.0	1.0	2.0	1.0	4.0	5.0	9.0	1.0	6.0
TH	mg/1	6.0	5.0	6.0	7.0	7.0	6.0	9.0	9.0	8.0	7.0	6.0	8.0	8.0	7.0	13.0	11.0	8.0	7.0
pH		8.4	7.4	8.3	9.0	8.3	8.9	8.5	9.0	8.3	8.4	8.5	8.6	8.3	8.2	7.9	8.0	8.2	8.4
DO	mg/1	12.0	11.0	10.4	10.0	10.6	11.0	9.0	11.0	9.0	11.0	9.0	**	9.0	**	9.2	10.0	9.6	12.0
Eletrical condutivty	micromho/cm	194.0	153.0	155.4	194.0	188.3	179.0	234.0	240.0	197.1	199.0	232.0	240.0	215.5	210.0	366.0	310.0	204.0	199.0
BOD	mg/1	5.2	-	3.6	-	2.2	-	1.2	-	2.5	-	1.3	-	1.1	-	3.6	-	3.3	-
Na +	mg/1	2.0	3.0	2.4	22.0	2.6	3.0	2.2	2.4	2.4	2.8	2.0	2.4	2.4	2.8	2.4	3.4	2.4	3.0
K +	mg/1	2.2	1.8	1.6	2.6	1.8	2.2	1.6	0.2	1.8	0.2	1.6	0.2	1.8	2.2	1.8	4.2	1.8	2.2
Fe +	mg/1	*	0.2	*	0.3	*	0.2	*	0.2	*	0.2	*	0.2	*	0.2	*	0.3	*	*
Mn +	mg/1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Ca ++	mg/1	27.0	22.9	26.2	26.0	26.6	24.4	33.5	31.0	29.4	26.1	32.3	30.1	28.6	27.1	48.2	45.4	28.6	27.0
Mg +	mg/1	10.9	4.9	6.2	9.7	8.2	7.4	13.4	13.0	9.4	9.3	13.4	13.0	9.9	8.7	16.6	13.2	10.2	10.9
CO3 - -	mg/1	5.0	5.0	-	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	15.0	10.0	5.0	5.0
CaCO3	mg/1	99.0	73.5	84.0	104.7	94.0	89.2	124.0	120.8	99.0	99.8	114.0	120.8	99.0	105.0	178.0	168.0	99.0	99.8
Cl -	mg/1	6.7	4.0	7.7	5.0	8.6	5.0	6.7	4.0	6.7	5.0	5.8	5.0	8.6	4.1	5.0	5.0	6.7	5.0

Abbrevations :
TDS = Total Dissolved Solids
SS = Suspended Solids
TS = Total Solids
TH = Total Hardness
DO = Dissolved Oxygen
BOD = Biologcial Oxygen Demand

Note :* Denotes less than 0.1

Source : Karnali Multipurpose Project, January 1993

Table 1.6.1 WATERSHED CONDITIONS AND NUMBER OF DISTRICTS

Class	Evaluation	Numerical Value	Number of Districts graded in Each Class	Number of Districts in the Study Area
Class I	Excellent	less than 500	25	7
Class II	Good	500 - 1500	25	11
Class III	Marginal	1500 - 3000	13	4
Class IV	Poor	3000 - 4500	5	0
Class V	Very Poor	over 4500	7	2

Source : Shrestha, B.D. et al, Watershed Condition of Districts of Nepal, 1983.

Table 1.6.2 DISTRICTS IN ORDER OF WATERSHED CONDITION

	District Name	Value
1	Surket	5,118
2	Dang	4,944
3	Piuthan	2,341
4	Dolpa	1,990
5	Rukum	1,854
6	Dailekh	1,544
7	Baitadi	1,449
8	Salyan	1,294
9	Bajhang	1,159
10	Rolpa	1,144
11	Jajarkot	1,036
12	Doti	944
13	Darchula	823
14	Kalikot	812
15	Jumla	636
16	Banke	627
17	Bajura	623
18	Achham	471
19	Bardia	246
20	Dandeldhura	219
21	Kailali	170
22	Mugu	138
23	Humla	0
24	Kanchanpur	0

Source : Shrestha, B.D. et al, Watershed Condition of Districts of Nepal, 1983.

Table 1.6.3 HILL COMMUNITY FORESTRY DEVELOPMENT PROGRAMME
(Achieved)

Fiscal Year - 1990/1991

Programme (Activities)	Whole Country	Far-Western	Mid-Western
1. User's Group Initiation and Formation	680 Nos	116 Nos	29 Nos
2. Management			
2.1 Management Plan Preparation	1,485.83 ha	174.57 ha	0
3. Nursery			
3.1 Operation	542 Nos	98 Nos	24 Nos
3.2 Seedling Production	13,033,722 Nos	2,033,289 Nos	548,500 Nos
3.3 Seedling Purchase	894,773 Nos	98,075 Nos	0
4. Community Plantation			
4.1 Survey & Handover	1,533.4 ha	129.9 ha	100 ha Survey
4.1.1 Pitting	1,233.01 ha	135 ha	50 ha
4.2 Plantation	747.91 ha	105 ha	42 ha
5. Plantation Protection & Maintenance			
5.1 Weeding	2,855.73 ha	488.3 ha	228.2 ha
5.2 Replacement	498,477 Nos	49,744 Nos	54,000 Nos
6. Seedling Distribution for Private Forest Est.	2,262,559 Nos	210,000 Nos	46,456 Nos
7. Improved Stove Distribution	2,899 Nos	51 Nos	0
8. Demonstration Plot Operation	2 Nos	0	0
9. Training & Extension			
9.1 Workshop/Seminar (District/Ranger)	13 Nos	2 Nos	2 Nos
9.2 Training (Nursery Naike/Watchers)	16 Nos	3 Nos	2 Nos
9.3 Study Tour (CFA/User's Group)	7 Nos	0	0
10. Total Budget Expenditure (including Administrative Expenditure)	32,397,632 Rs.	5,026,439 Rs.	1,830,081 Rs.
11. Total Progress Achievement	76.38%	75.30%	54.49%

Source : HMG/DNDP/FAO Community Forestry Development Project, Annual Progress Report for 1990/1991