3. STATE OF MODEL AREAS

3. STATE OF MODEL AREAS

3-1 Natural Conditions

3-1-1 Climate

(1) General

Climatic data from 13 stations located in the Study Area and in its surroundings were collected from 4 volumes of the Climatological Records of Nepal (1981-1990) published by Department of Hydrology and Meteorology and the details are presented in III-1, Progress Report.

In short, the climate of the Study Area is subtropical to warm temperate. The dry season, with occasional precipitation, is mainly from October to March. During April and May, the area experiences heavy thunderstorms of a few hours duration. The wet season or monsoon lasts from June to September. Mean daily air temperature varies between 13.2 ℃ in January and 25.9℃ in August at Pokhara Airport (elev. 827m), between 9.0℃ in January and 20.4 ℃ in August at Lumle (elev. 1740m) and between 16.0 ℃ in January and 27.3 ℃ in June at Kusma (elev. 891m), indicating a generally high temperature during the rainy season in the Study Area. The Pokhara and Lumle Stations, for which wind data are available, recorded an annual high wind speed of 3.5 ~ 4.5 km/hr in the area from February to June. Wind direction data for the Study Area are unavailable. The relative humidity, which shows the amount of moisture or water vapor in the air, is low in March and April at Pokhara Airport, Lumle and Kusma stations for which records are available. Data on evaporation in the Study Area are available for the Pokhara Airport and Lumle Stations only but many observations are missing. However, according to a report on the Phewa Tal Watershed "the potential evaporation at Pokhara exceeds the precipitation from November to March and, under normal conditions, very little moisture is available for plant growth."

(2) Rainfall

The annual precipitation, some 85% of which falls during the monsoon months from June to September, varies from 2,518mm at Karki Neta in Parbat North Model Area to 5,337mm at Lumli in Northern part of Kaski District, which is said to be the highest rainfall in the country. Overall, the amount of rainfall in

Parbat District is lower than in Kaski District. There is generally a major rainfall peak on the southern aspect of the mountain range in the western part of the Kaski District which covers the Kaski North and Kaski West Model Areas and Lumle. The flow of the wet monsoon air mass from the Southern Terai Region into the Pokhara Valley is said to be responsible for this orographic type of rainfall. Moreover, the annual rainfall in the Pokhara Valley is influenced by the elevation and varies from 3,755mm at Pokhara Airport (elev. 827m) to 5,337mm at the Lumle Station (elev. 1740m). The highest maximum 24 hours precipitation in a 10 year period in the Study Area is 277mm recorded at the Lumle Station on July 12, 1981.

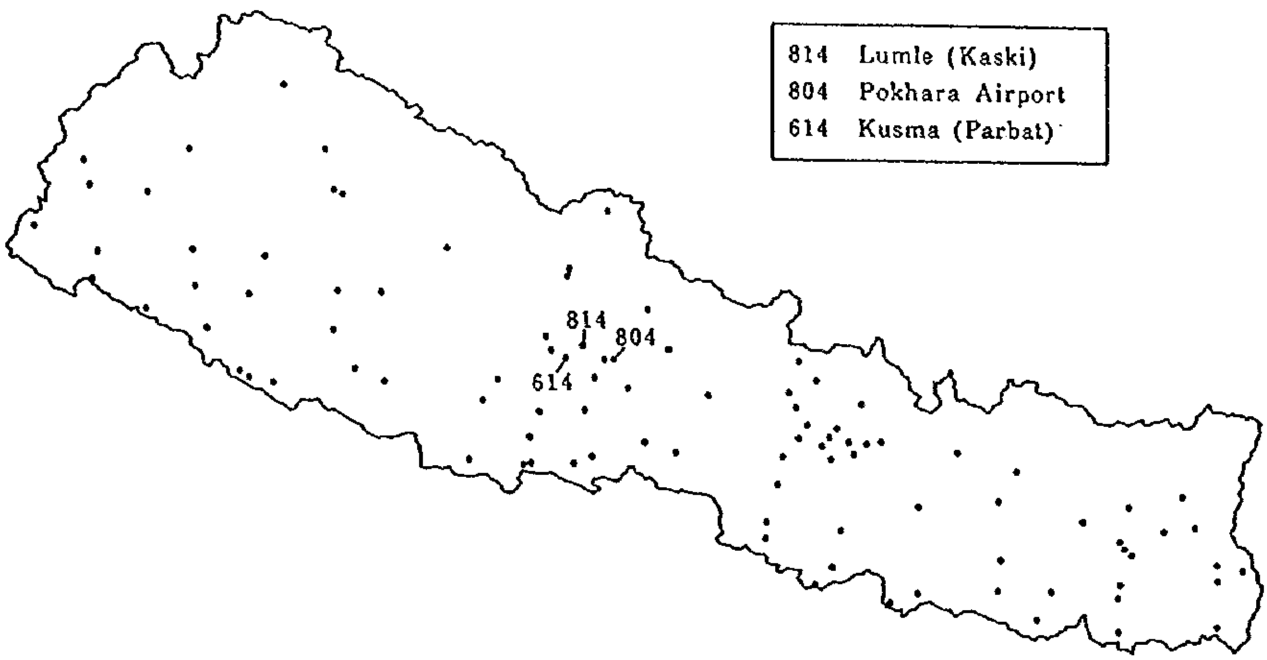


Fig. 3-1 Climate Station Network in Nepal

3-1-2 Hydrology

(1) River Flow Regime

① River System

Rivers (gandaki: large snow-fed river) in the Model Areas are Seti River and Madi River. Seti River forms the western and part of the south-eastern boundaries of the Kaski North Model Area. Madi River forms the eastern boundary of the Kaski East Model Area as well as the boundary between the Kaski and Tanahun Districts. Both rivers originate from the Annapurna Range in the Himalayas and flow north-south until Damauli where Madi River joins Seti River which flows into Narayani River. All the kholas (non snow-fed stream, river) in the Kaski Model Areas are tributaries of these 2 rivers. Kholas in the Parbat Model Areas are tributaries of the Kaligandaki which is in turn one of the largest tributaries of Narayani River (Fig. 3-2).

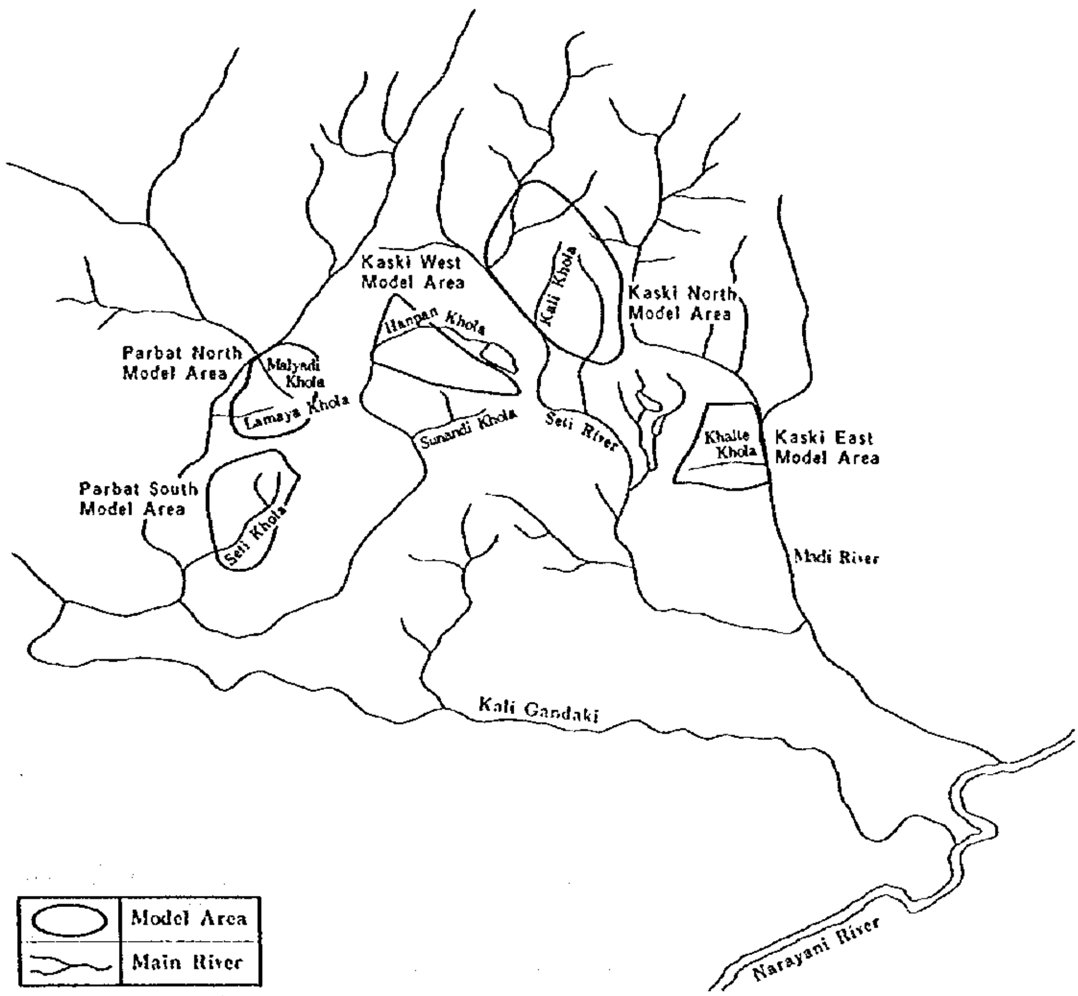


Fig. 3-2 Drainage Map of Study Area

The main streams in the Model Areas are parallel or sub-parallel and the drainage pattern generally exhibits a tree-like or dendritic pattern (see Appendixes, Volume III for drainage maps of Model Areas).

Seti and Madi Rivers, as well as such kholas as Bijaipur, Seti, Harpan and Malyahdi, have flowing water throughout the year. Other kholas also have water throughout the year at least in the form of baseflow (ground water outflow). Consequently all rivers/kholas in the Model Areas can be classified in the category of perennial stream.

② Observation and Characteristics of Flow Regime

The river discharge in the Study Area is measured (using current meters) by the Narayani Basin Office of Department of Hydrology and Meteorology at several locations. According to the office, from among the streams flowing in the Model Areas, discharge data are available for 2 kholas and one river in the Kaski Model Areas and for 3 kholas in the Parbat Model Areas (Table 3-1). Discharge measurement is occassionally carried out during the dry and monsoon seasons and regularly measured full discharge data for the Model Areas are unavailable. The data presented in Table 3-1 show only the lowest measured flow in the dry season and the highest measured flow in the monsoon season for a particular stream for the period measurement was conducted.

The discharge data in Table 3-1 indicate a large and significant decrease in the amount of streamflow for all rivers/kholas in the Model Areas during the dry season. Moreover, according to local inhabitants interviewed during the field inspection, the decrease in the streamflow and the resulting water shortage become particularly severe at the end of the dry season in the months of March and April. The streamflow of most of the kholas in these months, for example, decreases to some 25% of the already low flow in January and February according to those interviewed.

While mainly stormflow comprises the streamflow of a khola in the monsoon season, baseflow forms the main portion of the streamflow in the dry season as observed during the river survey. At some of the kholas, the streamflow percolates into the porous stream bed to form sub-surface flow and frequently springs out some distance (several hundred meters or a few kilometers) downstream, creating a dry bed along the section where the water flows underground. Along kholas where this phenomenon occurs, therefore, water may be available at one section while in another section the river bed may be totally dry. This phenomenon was observed along Kali Khola and Bhoti Khola in the Kaski North Model Area, along Virdi Khola and Khalte Khola in the Kaski East Model Area and along Magsoli Khola (a tributary of Suraudi Khola) in the Kaski West Model Area.

Table 3-1 Stream Discharge in the Model Areas

River/Khola (Model Area)	Discharge (m^3/sec.) Lowest measured flow in dry season (Recorded date)	Highest measured flow in monsoon season (Recorded date)	Measurement period	Remarks
Seti River (Kaski North)	2.1 (Feb. 18, 1990)	383.8 (Aug 18, 1973)	Jan. 1, 1964 ~ Aug. 27, 1992	Measurement discontinued after 1992
Bijaipur Khola (Kaski North)	0.3 (Apr. 7, 1980)	15.2 (June 25, 1986)	June 2, 1975 ~ Mar. 28, 1988	Measurement discontinued after 1988
Harpan Khola (Kaski West)	0.6 (Apr. 21, 1975)	11.9 (Oct. 15, 1979)	Jan. 20, 1964 ~ Jan. 21, 1983	Measurement discontinued after 1983
Madi River (Kaski East)	2.8 (—)	523.0 (Aug. 3, 1977)	Feb. 8, 1973 ~ up to 1996	Measurement continues
Modi Khola (Parbat North)	0.5 (Apr. 26, 1995)	253.2 (Aug. 25, 1989)	May 25, 1975 ~ up to 1996	- Measurement continues - Modi Khola is a tributary of Kaligandaki & forms some 3500m northwestern boundary of Parbat North Model Area
Lamaya Khola (Parbat North)	0.02 (May 17, 1988)	4.3 (Sept. 10, 1984)	—	
Seti Khola (Parbat South)	0.6 (Apr. 11, 1992)	80.7 (Aug. 9, 1984)	Feb. 22, 1976 ~ up to 1966	Measurement continues

Note: Prepared from data provided by the Narayani Basin Office (Pokhara) of the Department of Hydrology and Meteorology.

(2) Water Resources and Water Use

① Surface Flow

a. River Water

Water from the rivers/kholas in the Model Areas is mainly used for irrigation and domestic use. The Department of Irrigation has constructed intake weirs in the Kaski North Model Area (Bholi Khola), in the Kaski East Model Area (Virdi Khola, Khalte Khola) and in the Parbat North Model Area (Malyahdi Khola and Lamaya Khola) to supply irrigation water for nearby farmlands. Stream water is also diverted to small irrigation canals constructed under JICA Project programmes, by District Irrigation Office and NGOs, irrigating several hundred hectares of farmland in the area.

b. Rain Water

In the Model Areas, rain water is the main source of irrigation water for rain-fed paddy land and for Bari land. Where stable gullies or streams that dry up during the dry season exist nearby, farmers divert the rain water that enters these streams during the monsoon season to irrigate paddy fields.

c. Catchment Ponds

Catchment ponds are observed along the ridges of public land in all the Model Areas. The run-off water from the surrounding slopes is stored in the ponds and is mainly used as drinking water for livestock. The ponds also function to trap sediment. The shape of the ponds constructed by the District Soil Conservation Offices is either rectangular or circular. The standard size is a length of 15m, a width of 10m and a depth of 1m for rectangular shaped ponds, and a radius of 5m and a depth of 1m for circular shaped ponds.

② Groundwater

a. Springs

Temporary and permanent springs are found in the Model Areas. The water from temporary springs appears only during the monsoon season and is used for irrigating paddy land. On the other hand, water from permanent springs seldom dries up during the dry season, provides a source of stream baseflow and is used for domestic water, drinking water for livestock and irrigation water. In this sense, permanent spring water is one of the most important water sources in the Model Areas. Drinking water supply organizations, JICA project and NGOs supply spring water to villages via pipes using mainly the gravity method.

3-1-3 Topography / Geology

(1) Topography and Drainage

The objectives, methodology used, etc. on geological survey are presented in III-2 of Progress Report and Main Report of MREU, Tribhuvan University of June, 1996. In short, the Study Area lies in the "Midland" of Nepal, between the latitudes 28° 1' N and 28° 18' N, and the longitudes 83° 38' E and 84° 15' E. "High Himalaya" rises in north of the Study Area, and "Terai Plain" spreads in south of the Study Area. The area forms steep mountains except alluvial plains and colluvial gentle slopes that develop along main river courses. The maximum altitude reaches up to 3,000 m in the north of the Kaski North Model Area and minimum altitude is about 400 m in the south of the Parbat South Model Area.

(2) Geomorphology

The following geomorphologic features are identified in field and aerial photographs as shown on landform classification maps.

a. Recent river plain	b. Alluvial fan	c. Talus (Colluvial gentle slope)
d. Terrace	e. Erosion front	f. Karst
g. Dip slope	h. Bare rock	i. Gully
j. Rock slide	k. Soil slide	

(3) Geology

① Regional Geology

The Himalayan Range is divided from south to north into the following five zones as shown in Fig. 3-3.

② Local Geology

Several kinds of metamorphic rocks, that belong to the Lesser Himalaya or Precambrian to early Paleozoic in geological age, are widely distributed on the Study Area. High-grade metamorphic rocks, that belong to the Higher Himalaya of Precambrian in geological age, occupy remaining area. The rocks are thrust over the Lesser Himalayan rocks at the northern edge of the Kaski North Model Area. Both rocks are underlain by the following unconsolidated to semi-consolidated Quaternary deposits.

a. Recent river deposit.	b. Alluvial fan deposit.
c. Talus deposit (Colluvial deposit).	d. Terrace deposit.

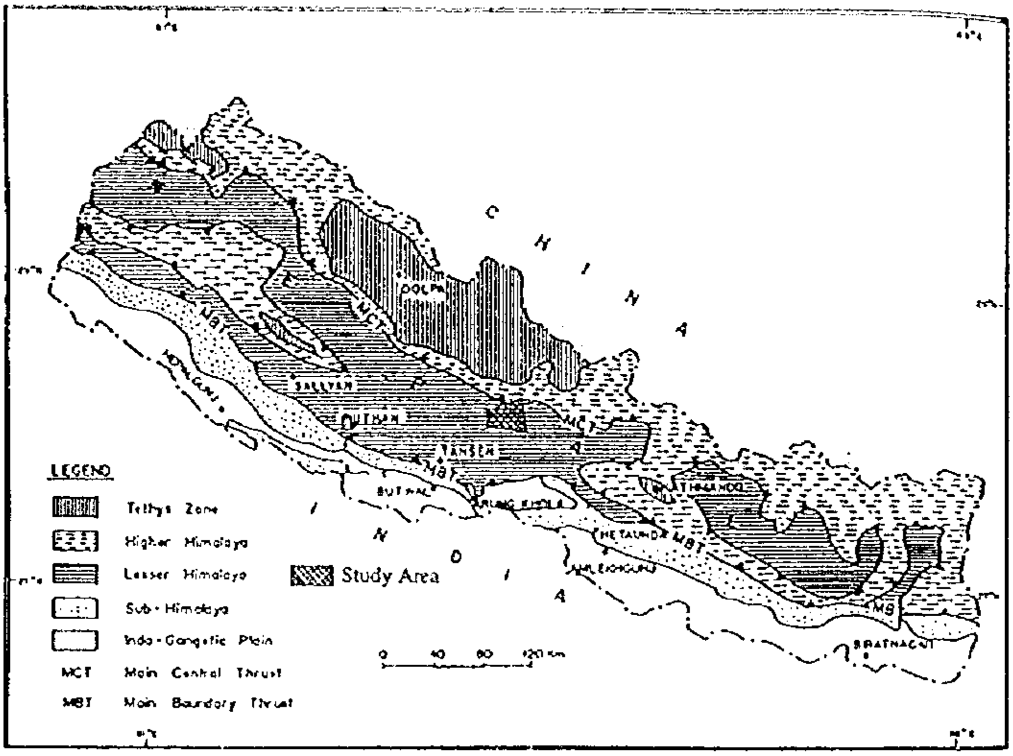


Fig. 3-3 Major Rock Units of the Nepal Himalaya
(The location of the Study Area is shown in the inset.)

③ Geologic Unit

The rocks in the five Model Areas are divided into 9 geologic units (formations) based on their lithology and metamorphic grade. Table 3-2 shows the name of main rock type, geologic feature, and engineering geological features of the units. Among the engineering features, hardness of rock has a great effect on slope stability, and it seems to be an important factor for preparation of a hazard map.

Table 3-2 Geological Unit in the Model Area

Zone	Group	Unit	Main rock type	Geologic feature	Engineering geological feature
The Higher Himalaya		Kyanite Schist and Gneiss Unit	Gneiss (Mylonitic augen gneiss and banded gneiss)	Massive and course-grained high-grade metamorphic rock characterized by gneissose structure (banded structure of white and black stripes).	Hard (stiff rock pieces and massive with wide joint intervals). Sometimes deeply weathered along joints to be sandy.
			Kyanite schist	Light- to dark-grey and medium- to coarse-grained medium- to high-grade metamorphic rock with kyanite, possessing a schistosity and an obscure banded structure.	Moderately hard (relatively stiff rock pieces but a little flaky along schistosity). Weathered to be sandy to silty.
The Lesser Himalaya		Graphitic Schist and Marble Unit	Graphitic schist	Intensely deformed, dark-grey to black, and medium-grained medium-grade metamorphic rock possessing a good schistosity and originated from peritic rock.	Weak (relatively soft rock pieces intensely deformed and very flaky along schistosity). Weathered to be silty.
			Calcareous schist	Intensely deformed, green- to light-grey, and medium-grained medium-grade metamorphic rock possessing a good schistosity and originated from carbonaceous peritic rock.	Weak (relatively soft rock pieces intensely deformed and very flaky along schistosity). Weathered to be silty.
			Calcareous quartzite and dolomitic marble	Massive, light- to yellow-grey to white, and fine- to medium-grained calcareous metamorphic rock intercalated in the schists above.	Very hard (very stiff rock pieces massive with relatively wide joint intervals). Hardly weathered.
		Garnetiferous Schist Unit	Garnetiferous schist	Intensely deformed, grey to green- or dark-grey, and medium- to fine-grained medium-grade metamorphic rock with garnet, possessing a good schistosity.	Weak to very weak (soft rock pieces intensely deformed and very flaky along schistosity). Weathered to be silty to muddy.
			Gneiss (Augen gneiss)	Strongly foliated and course-grained high-grade metamorphic rock composed of thick (3 to 5 mm) light colored bands and thin (about 1 mm) dark colored bands.	Hard (stiff rock pieces and massive with wide joint intervals). Sometimes deeply weathered along joints to be sandy.
	Lower Nawakot Group	Kuncha Formation	Phyllite, gritty phyllite and quartzose phyllite	Green-grey to dark-grey and medium to fine-grained metamorphic rock originated from poor-sorted sedimentary rock, accompanied by phyllitic meta-sandstone and quartzite.	Moderately weak (slightly soft rock pieces and flaky along foliation). Weathered to be silty to sandy.
		Fagfog Quartzite	Quartzite	Medium- to thick-banded (0.5 to 2 m), white to light green, and medium- to course-grained siliceous metamorphic rock accompanied by phyllite lenses, and thick and massive amphibolite.	Very hard (very stiff rock pieces massive with relatively wide joint intervals). Hardly weathered.
		Dandagaon Phyllite	Quartzose phyllite and gritty phyllite	Green-grey and medium- to fine-grained medium-grade metamorphic rock accompanied by olive-green quartzite, meta-conglomerate lenses and dark-green amphibolite lenses.	Moderately weak (slightly soft rock pieces and flaky along foliation). Weathered to be silty to sandy.
		Nourpul Formation	Slate and phyllite	Purple-, green- to dark-grey, fine- to medium-grained low-grade metamorphic rock accompanied by grey-green fine- to medium-grained meta-sandstone.	Moderately weak (relatively soft rock pieces and relatively flaky along cleavage or foliation). Weathered to be silty.
			Quartzite	Light-grey, coarse-grained, and cross-laminated low-grade siliceous metamorphic rock accompanied by green-grey and thin-banded phyllite lenses.	Very hard (very stiff rock pieces massive with relatively wide joint intervals). Hardly weathered.
		Dhading Dolomite	Dolomite	Blue- to light-grey, very thick-banded non to slightly metamorphic carbonate rock accompanied by purple siliceous dolomite and thin bedded black slate.	Very hard (relatively stiff rock pieces massive with wide joint intervals). chemically weathered to be silty to muddy.
	Upper Nawakot Group	Benighat Slate	Slate	Dark-grey to black, fine-grained, highly cleaveged, and often laminated non to slightly metamorphic rock intercalating carbonaceous films.	Moderately weak (relatively soft rock pieces and relatively flaky along clavage). Weathered to be silty to muddy.

3-1-4 Land Use and Vegetation

To establish the present conditions of the land use and vegetation in the Model Areas maps showing land use and vegetation were prepared for each Model Area. (For survey process and methodology used, etc. see III-4 Land Use and Vegetation Survey of the Progress Report.)

(1) Outline of Land Use

Land use in each of the Model Areas is shown in Table 3-3. Forest is 46%, Bari land 28%, khet land 11%, grassland 6% and others 9%, respectively of the total area. In each of the Model Areas in Kaski District, forest is about 53~55% but in Parbat District Model Areas, forest is 17~29% and accordingly farmland occupies a larger proportion in reverse to the case of Kaski District.

Table 3-3 Land Use Categories and Their Respective Size by Model Area

(Unit: ha)

Model Area		Cultivation Ratio	Kaski North	Kaski West	Kaski East	Parbat North	Parbat South	Total
Land Use	Level Terrace 4,365 ha (11%)	3	(6) 840	(7) 670	(4) 204	(14) 1,071	(1) 17	(7) 2,802
		2	(4) 498	(7) 663	(2) 126	(3) 223	(0) 0	(4) 1,510
		1	(0) 14	(0) 39	(0) 0	(0) 0	(0) 0	(0) 53
	Sloping Terrace 11,663 ha (28%)	3	(0) 0	(0) 24	(0) 2	(1) 96	(4) 156	(1) 278
		2	(14) 1,941	(22) 2,198	(26) 1,401	(42) 3,305	(50) 1,929	(26) 10,774
		1	(1) 122	(1) 92	(1) 50	(3) 275	(2) 72	(1) 611
	Abandoned Farmland		(0) 33	(0) 0	(0) 0	(0) 0	(0) 0	(0) 33
	Valley Bottom Flat Land		(1) 113	(2) 191	(6) 306	(0) 0	(0) 0	(1) 610
	Alluvial Fan		(13) 1,794	(2) 190	(6) 312	(3) 241	(8) 326	(7) 2,863
	Grassland		(5) 768	(4) 405	(0) 28	(5) 368	(18) 690	(6) 2,259
	Bar		(1) 210	(1) 89	(2) 138	(0) 0	(0) 0	(1) 437
	Landslide Site, etc.		(0) 13	(0) 0	(0) 0	(0) 0	(0) 0	(0) 13
	River and Water Body		(0) 48	(0) 0	(0) 0	(0) 0	(0) 0	(0) 48
	Forest		(55) 7,674	(54) 5,325	(53) 2,904	(29) 2,298	(17) 651	(46) 18,852
	Total		(100) 14,068	(100) 9,886	(100) 5,471	(100) 7,877	(100) 3,841	(100) 41,143

Note: Shrub is included in forest.
Figures in ( ) are Percentages

① Forest

As to the distribution of forests in the Model Areas, it is a general tendency that they are seen mostly from the hillside on the northern slopes toward the mountain tops. Forest trees are used by the inhabitants as fuelwood, fodder, wood material, etc. In the area formed by land collapses and landslides, Alnus nepalensis has grown and plays a great part in controlling soil erosion.

② Shrubland

Small in area as a whole (some 500 ha and included in the category of forest) the shrubland is distributed mostly on steep slopes, which were used as bari land or not suitable for access of cattle. From the view point of land conservation, if these zones are left as they are, there may be a possibility of soil erosion. For this and other reasons such as exhaustion of forest resources, it is advisable to reforest these areas. Where the soil conditions are good, cash crops, etc. may be introduced. The shrubland is shown as a category in land use and vegetation maps.

③ Grassland

The grassland is closely related to the inhabitant's life as the place of fodder supply for those farmers who raise cattle. Grassland is used mainly in the monsoon season, and the fodder from the forest is obtained in the dry season. Grassland use is divided roughly between grass collection and grazing: the grass collection land is seen on the steep slopes on the hillside and the grazing land in less steep areas than the grass collection land. As will be described in the section on erosion control, a severe erosion is occurring in grasslands located on steep slopes, and in the future, it will be necessary to improve the method of stockraising and to increase the productivity of grassland. In respect of management, the grassland is owned by the community in some cases and by the government in the others, and in order to realize appropriate management, it is necessary to have discussions with the inhabitants.

④ Bari land

Bari land is widely distributed between the hillside of south and southwest slopes and the mountain tops, and soil erosion occurs where the terrace management is inadequate. Although differing from area to area, maize, crops and beans are mainly planted. Only limited, grass is planted on the ridges and fodder trees and soil improving trees also are seen where the terrace management is good, as an attempt to make soil conservation and resource utilization effective. Most of cultivated bari land is located on the steep slopes, and various measures to maintain the land fertility will be necessary.

⑤ Khet land

Khet land is seen especially in the areas from the mountain foot to the hillside of the south and southwest slopes, and irrigated khet land is rare. Khet land is filled with water in the monsoon season to temporarily alleviate downstreams run-off, which is a favourable form of water recharge of the water source. In the Model Areas, maintenance and management are generally good, although being neglected in some areas resulting in water leakage from the terrace.

⑥ Others

In the surroundings of some communities, the various trees are planted and used as fodder, fruit tree, etc. However, around the communities where the poor live, such devices of land use are hardly seen and therefore, it is necessary to promote the introduction, etc. of the agro-forestry for these farmers as a model. For collapsed lands and landslides, prevention and rehabilitation should be done quickly.

(2) Land Area by Vegetation Categories

Table 3-4 shows the distribution of different vegetation categories. Of the forested land in the entire Model Areas, 15,333 ha (81%) is covered by tropical mixed hardwood forest, 1,588 ha (8%) is mixed deciduous broad-leaved forest, 1,283 ha (7%) is Shorea forest. There are small distributions of the forest as Alunus spp and Pines spp in the remaining land. In terms of crown density, a density between 40-70% covers 7,100 ha, and a density of 70% or more covers 8,819 ha, Thus, 84% of all the forested area has a crown density of 40% or more. In terms of maturity, 86% (16,248 ha) of the forest is immature. Mature forest accounts for only 11% (21,144 ha) of the total.Many parts of the mature forest is distributed in the Kaski North Model Area and the Kaski West Model Area.

Table 3-4 Vegetation Categories and Their Respective Size by Model Area

	Category	Crown Density	Maturity Class	Kaski North	Kaski West	Kaski East	Parbat North	Parbat South	Total	
Vegetation	Pine spp.	3	Ix	0	0	0	3	0	(0)	3
	13 ha (0%)	4	Ix	0	0	0	10	0	(0)	10
	Shorea spp.	3	Mx	0	0	0	0	0	(0)	0
	1,283 ha (7%)	3	Ix	44	5	8	153	0	(1)	210
		4	Mx	0	0	0	0	0	(0)	0
		4	Ix	0	10	845	212	6	(6)	1,073
	Tropical Mixed	2	Mx	0	0	0	0	0	(0)	0
	Hardwood species	2	Ix	1,777	532	5	46	36	(13)	2,396
	15,333 ha (81%)	3	Mx	775	0	0	0	0	(4)	775
		3	Ix	2,830	1,952	224	487	79	(29)	5,572
		4	Mx	0	336	0	0	0	(2)	336
		4	Ix	832	1,909	1,819	1,294	400	(33)	6,254
	Deciduous Mixed Broad-	2	Mx	0	0	0	0	0	(0)	0
	Leaved species	2	Ix	0	0	0	0	0	(0)	0
	1,588ha (8%)	3	Mx	0	248	0	0	0	(1)	248
		3	Ix	205	0	0	0	33	(1)	238
		4	Mx	493	262	0	0	0	(4)	755
		4	Ix	347	0	0	0	0	(2)	347
	Alnus spp.	2	Mx	0	0	0	0	0	(0)	0
	145 ha (1%)	2	Ix	37	0	0	0	0	(0)	37
		3	Mx	0	0	0	0	0	(0)	0
		3	Ix	46	0	0	8	0	(0.5)	54
		4	Mx	0	0	0	0	0	(0)	0
		4	Ix	19	23	0	12	0	(0.5)	54
	Shrub			269	48	3	73	97	(3)	490
	Total			7,674	5,325	2,904	2,298	651	(100)	18,852

Note: ① Figures in ( ) are percentages.
② Crown density 2; 10-40%, 3; 40-70%, 4; >70%
③ IX; Immature or small diameter trees for timber use, MX; Mature trees of usable size for timber.

3-1-5 Soil

Methodology used in soil survey, distribution of soils and their properties in the Model Areas, preparation method of soil maps, etc. are given in III-3 Soil Survey of the Progress Report.

(1) Soil Classification

A soil survey based on the FAO-UNESCO's Guidelines for Soil Profile Description was conducted in 5 Model Areas. The mapping units used on the soil maps are given in Table 3-5. Seven main FAO-UNESCO soil units were found in the 5 Model Areas and these 7 units were further classified into 12 soil units.

Table 3-5 Soil Classification of Model Areas

Mapping Symbol	Main Soil Units	Soil Units
Flc/c/d	Fluvisols	Eutric/Calcaric/Dystric Fluvisols
Flc		Calcaric Fluvisols (Cement Pan)
Rgc	Regosols	Calcaric Regosols
Rgd		Dystric Regosols
Lpd	Leptosols	Dystric Leptosols
Lpk		Rendzic Leptosols
Cme	Cambisols	Eutric Cambisols
Cmd		Dystric Cambisols
Cmu		Humic Cambisols
Lvh	Luvisols	Haplic Luvisols
Lvh/Alh	Luvisols/Alisols	Haplic Luvisols/Haplic Alisols
Ach	Acrisols	Haplic Acrisols

Others: S - Sand Outcrop (River), C - Cliff Outcrop (Lithic Leptosols)

(2) Soil Distribution

The distribution of soil units in Model Areas is mentioned in Table 3-6. Dystric Cambisol, Dystric Regosols and Eutric/Calcaric/Dystric Fluvisols occupy some 48% (19,653 ha), 21% (8,687 ha) and 7% (2,966 ha) of the Model Areas respectively.

Table 3-6 Land Area by Soil Class in each Model Area

Unit: ha

Soil unit	Kaski North	Kaski East	Kaski West	Parbat North	Parbat South	Total
Eutric/Calcaric/Dystric Fluvisols	1,470	543	547	193	213	2,966
Calcaric Fluvisols	0	33	138	0	0	171
Dystric Regosols	2,548	830	2,745	2,050	514	8,687
Calcaric Regosols	118	0	0	0	647	765
Dystric Leptosols	846	73	508	582	31	2,040
Rendzic Leptosols	0	0	0	0	200	200
Eutric Cambisols	799	0	0	0	738	1,537
Dystric Cambisols	6,275	3,332	5,082	4,055	909	19,653
Humic Cambisols	1,494	136	648	383	292	2,953
Haplic Luvisols	117	0	0	0	230	346
Haplic Alisols	0	146	0	0	0	147
Haplic Acrisols	216	281	93	386	67	1,043
Others	185	97	125	228	0	635
Total	14,068	5,471	9,886	7,877	3,841	41,143

Note: Figures have been totaled by means of GIS.

In connection to land use/vegetation as shown in Table 3-7, Dystric Cambisols is mainly distributed in forest, Bari land and Khet land, while Dystric Regosols is mainly found in shrub land and grassland.

Table 3-7 Main Soils by Land Use Category

Unit: ha

	Forest	Shrub land	Grassland	Bari land	Paddy	Total
Dystric Cambisols	8,806	127	542	6,945	3,233	19,653
Dystric Regosols	5,245	186	665	2,065	526	8,687
E/C/ Dystric Fluvisols	412	11	218	213	2,112	2,966
Dystric Leptosols	1,478	61	277	189	35	2,040
Eutric Cambisols	121	5	113	539	759	1,537
Haplic Acrisols	162	6	4	573	298	1,043
Others	2,138	94	440	1,139	1,406	5,217
Total	18,362	490	2,259	11,663	8,369	41,143

Note: ① figures have been totaled by means of GIS.
② figures for rivers, alluvial fan, etc. are included in paddy.

(3) Soil Suitability

Suitability of soil seen in terms of soil properties and land use are as mentioned in Table 3-8.

Table 3-8 Suitability of Soil Seen in Terms of Soil Character and Land Use by Soil Unit (1)

Soil Unit	Soil Characteristics							Land use and Vegetation	Soil suitability
	Key Horizon	pH (H2o) value	CECA Layer	B-S (%)	Texture	Landform	Parent material		
Eutric/ Calcaric/ Dystric Fluvisols	Alluvial soils Shallow A layer	>5.5	<5	>50 Flc/c <50 Fld	SL SiL L	Riverside lowland River terraces	Various. Sedimentary rock is broken by Ca.	Cultivated land	The riverside lowland containing fluvisols is extremely important for agriculture in the mountain areas. Owing to a low CEC value, the soil is basically lacking in water-retaining capacity and fertility, so productivity is not high. However, the soil responds well to fertilizer use (mainly nitrogen and phosphorous) and provision of irrigation is essential for obtaining very high crop yields. The most suitable land for cultivation is that containing no stony deposits to a depth of 1 m, but such land only occupies a meager portion of the overall Model Area.
Calcaric/ Fluvisols (Cement Pan)	Surface cement C horizon at and below 30 cm	7.0	<5	>100	SiL	Riverside lowland	Limestone	Cultivated land (irrigated areas) and grassland (not irrigated)	There is a thick, cement-like, depositional limestone horizon at around 30 cm below the surface, and the soil is alkaline. For this reason, the cement horizon blocks root growth, and the A horizon with a pH value of more than 7.0 slows the inorganic conversion of nitrogen and makes other elements insoluble, thus making the soil devoid of nutrients for growing crops. Unless agriculture is practiced intensively, there is little likelihood that this soil will generate high yields.
Calcaric/ Regosols	A-C horizon, Calcic layer	>6.8	<10	>100	SiL L	Steep slope with surface erosion and slope collapse	Dolomite Limestone	Grazing land, shrub forest, agricultural land (where irrigation is possible)	This soil type is widespread in the Parbat South Model Area. As the Regosols layer is stony and shallow, the soil has limited suitability for cultivation purposes. Because the dolomite and other basic rock which forms the parent material of this soil contains much magnesium, the soil quickly dries out if it is shallow, and this creates problems for cultivation. If this soil is to be used, it is probably most appropriate to use it for grazing. In the case of reforesting, a careful choice of species would be necessary (species that can adapt to the base rock and dry conditions).
Dystric Regosols	A-C horizon	<5.5	5-13	<50	L SL	Residual ridges Surface erosion Collapsed slopes Mountains	Schist Quartzite Slate	Grassland for grazing Forest Shrub forest Abandoned cultivated land	The residual soil of ridges and collapsed slopes are very stony, making cultivation difficult. The soil texture is also coarse and surface erosion and slope collapse is apt to occur in exposed areas. It is best to maintain forest on the land, and the abandoned cultivated land and collapsed slopes should also be planted with trees. Because the abandoned cultivated land on ridges has poor permeability, it is necessary to take preservation measures (erection of rock fences, etc.) to ensure that surface water does not affect other cultivated land, etc.
Dystric Leptosols	A-R horizon Bed rock within 30 cm	<5.5	<10	<50	L	Steep slopes Rocky land	Schist Quartzite Slate Not yet eroded	Abandoned cultivated land Shrub forest and forest Grazing land	Because there is only a 30 cm layer of soil, this land is basically moorland unable to support cultivation. However, there are cases of burning the base vegetation and cultivating the land in the few areas where the soil is fertile. As the land is not suited to cultivation, the preservation of forest is desirable.
Rendzic Leptosols	A-R horizon Bed rock within 30 cm	>7.0		>100	SL L SiL	Very steep Slopes Cliff	Dolomite	Abandoned cultivated land Shrub forest and forest Grazing land	This soil is similar to Carcaric Regosols. Dolomite bed rock is exposed in places, and the land is barren and unsuited to cultivation. The land is used as coarse grazing land.
Eutric Cambisols	Cambic B horizon Umbric A horizon	5.5>	> 10 Forest < 10 Agriculture land	>50 B Horizon	L SiL Sic Cl	River terraces Hill slopes	Slate Dolomite Parent material with much basic rock	Terrace cultivated land (collapsed slopes) Forest (steep slopes)	Terraces are formed for cultivation in areas except for steep slope forest. The irrigated terraces do not lose their fertile surface soil during the rainy season, and high yields can be expected if only nitrogen and phosphorous are supplemented. The gentle slopes are almost totally under cultivation. Because soil erosion is apt to occur in areas of exposed soil on steep slope forest land, it is best to maintain the forest.

Table 3-8 Suitability of Soil Seen in Terms of Soil Character and Land Use by Soil Unit (2)

Soil Unit	Soil Characteristics							Land use and Vegetation	Soil suitability
	Key Horizon	pH (H2o) value	CEC Ahorizon	B-S (%)	Texture	Landform	Parent material		
Dystric Cambisols	Cambic B horizon Ochric A horizon	4.8-5.5	5-15	<50 B horizon	L SiL Sic CL	Mountain slopes Collapsed alluvial fan River terraces	Schist Mica-Schist Qurzait Slate		This is the representative soil over the whole Model Area. Weathering on the southern side slopes up to an altitude of 1,200 m is advanced, and the soil color is orange red (hematite color). Surface erosion would not occur on the gentle slopes if terraces were formed properly, but the high permeability means that there is a risk of slow slope collapse. The soil is suited to cultivation or grazing, but due to a lack of nitrogen and limited suitability, supplying organic fertilizer and limestone would be effective. The fertilizing effect of limestone and organic fertilizers is soon realized.
Humic Cambisols	Cambic B horizon Umbric A horizon	4.8-5.5	>10	<50 B horizon	L SL	Mountain slopes of altitude 2,000 m or more Collapsed gentle slopes	Schist Mica-Schist Qurzait Slate	Terrace cultivated land (collapsed gentle slopes) Forest (mountain slopes of 2,000 m or more)	This soil is sandy and has good permeability. As the surface soil is fertile if irrigated, the gentle slope areas form good cultivated land. If soil in the currently forested areas was exposed, even if the soil layer were thick, surface erosion and slope collapse would soon occur due to the steep topography and sandy soil. Thus, it is desirable to preserve the forest as it is.
Haplic Luvisols	Argillic B horizon	>6.0	+-10	>50	CL SiL L	Old river terraces Gentle ridges and slopes on hills	Various (river-carried deposits) Dolomite (hills)	Cultivated land (with irrigation) Grazing land (not yet irrigated)	In the sub-tropical climate, this soil originating from basic rock parent material can be fertile if irrigation is carried out. The B horizon is Clayey, and weathering from the Cambisols is advanced. The thick soil covering and abundant basic rock make the land suited to cultivation, but there is a lack of organic substances in the soil, and the surface soil is prone to being washed away. Thus, although there is no need to carry out acidic improvement, it is necessary to carry out fertilization to maintain the soil goodness, and form terraces and carry out irrigation to prevent surface erosion. If the surface soil is lost, the clay-like nature of the soil means that cultivation is difficult without irrigation.
Haplic Alisols	Argillic B horizon	5.5	5	>50	CL SiL	Old river terraces	Various (river-carried deposits)	Cultivated land (with irrigation) Grazing land (not yet irrigated)	The soil is dark red to red in color and mixes with the above-mentioned Luvisol. The basic rock saturation level is more than 50%, but the CEC value is lower than in Luvisol, meaning that the soil cannot retain its fertility. The suitable land use is the same as in the case of Luvisol, but the degree of fertility is lower.
Haplic Acrisols	Ochric A horizon Argillic B horizon	<5.0	5	<50	CL SiL C	Gentle hills	Schist Mica-Schist	Cultivated land (terrace) Grassland (abandoned cultivated land)	This red-colored soil containing a thick layer of clay appears on old topographical surfaces and is well eroded. The pH level is less than 5.0, and this soil is generally rare in steep areas such as the Model Area. The low pH level and lack of basic rock makes the soil poor in quality, but, within the overall Model Area, it is not very stony and can be cultivated, so terraces are formed for cultivation. The land is covered by forest and crops that are suited to a low pH level. It is desirable to cultivate rice, etc. which is resistant to low pH levels. It is difficult to achieve a fertilization effect. The thick layer of red clayey soil which appears in places on eroded slopes and ridges could possibly be relic soil formed in a warmer era (interglacial), and it has become more complex as a result of more recent formation.

Note:
L: Loam; SL: Sandy Loam; LS: Loamy Sand
SiL: Silt Loam; C: Clay; SiCL: Silty Clay Loam
Sic: Silt Clay; S: Sand; SC: Sandy Clay
CL: Clay Loam; Si: Silt; S: Silt

(4) Land Suitability Classification

The main items of land use in the Model Areas are forest, grassland, farmland, etc., and as the soil-man relation is concerned, soil has the major connections with the inhabitant' life. 3 classes of land suitability as seen from the view point of soil condition (land suitability classification in relation to agriculture) are shown in Table 3-9.

Table 3-9 Land Suitability Classification

Class	Evaluation of land productivity and land suitability
1 (Unsuitable)	Not suitable for agricultural land use. (land unsuitable for agriculture.) Can be used for stockraising and forestry.
2 (Semi-suitable)	Agricultural land use can be done, and a definite yield can be realized if intensive land improvement (irrigation, terrace construction, etc.) is conducted.
3 (Suitable)	Agricultural land use can be done, and a definite yield can be obtained.

The areas used for forestry and grassland are necessarily other than those suitable for farmland, and regarding the forestry at present, it may be said difficult to change any forests other than privately owned to any other kind of land use because of the land ownership. Based on this classification, from the combination of soil type and slope, land suitability for agriculture is shown.

However, the criteria for evaluation do not take into account differences in annual yields brought about by infrastructure factors such as irrigation, implementation of intensive soil improvement by means of planned fertilization, etc. and mechanization, meteorological factors such as rainfall, sunshine, wind and slope direction, and also methods of cultivation.

Table 3-10 Land Suitability Classification based on Soil and Slope Classes

Soil unit	Slope class (%)		
	Gentle (0 ~ 15)	Medium (15 ~ 30)	Steep (30 ~)
Eutric/Calcaric/Dystric Fluvisols	3	2	1
Calcaric Fluvisols	2	2	1
Dystric Regosols	3	2	1
Calcaric Regosols	2	1	1
Dystric Leptosols	2	1	1
Rendzic Leptosols	3	1	1
Eutric Cambisols	3	3	2
Dystric Cambisols	3	2	2
Humic Cambisols	3	3	2
Haplic Luvisols	3	3	2
Haplic Alisols	3	2	1
Haplic Acrisols	2	2	1
Others	1	1	1

3-2 State of Erosion

3-2-1 Mass Movement (Mass Wasting)

(1) Landslide

① Landslide condition

Landslides can be classified according to the type of movement, dimension, material composition, history of movement etc. In this study, material composition (debris type landslides, rock type landslides and complex type, combination of debris type and rock type landslides) and other aspects of the surveyed landslides are clarified, but for planning the amount of work required and for determining the size of countermeasures the landslides are classified according to their dimensions. Those with a depth of 1.0m to 3.0m and an affected area size of 100m^2 to 3,000m^2 are classified as shallow small scale landslides, and those having a depth of more than 3.0m and affected area size of more than 3,000m^2 are classified as deep-seated large scale landslides.

The number of large and small landslides that were recorded in 5 Model Areas through photo interpretation and field inspection is as shown in Table 3-11. Maps showing distribution of landslides in each Model Area are shown in Appendixes, Volume III. However, not all of these landslides are currently active or have the type of conservation objects nearby in need of urgent protection. Moreover, in Study Area each year during the heavy rains of the monsoon season, some of the old landslides are reactivated and new ones occur. For example, it was found out during field survey that 12 new small scale landslides had occurred on the slopes along Mardi Khola in the south-east part of Parbat South Model Area at the end of the monsoon season (July-August) of 1996.

Table 3-11 Number of landslides by size in the Model Areas

Model Area		Landslide Distribution			Density/100ha
Name	Area (ha)	Small ($100m^2$-$3,000m^2$)	Large ($>3,000m^2$)	Total	
Kaski North	14,068	235	58	293	2.08
Kaski East	5,471	35	14	49	0.89
Kaski West	9,886	87	25	112	1.13
Parbat North	7,877	79	38	117	1.48
Parbat South	3,841	101	23	124	3.20
Total	41,143	537	158	695	1.68

a. Small landslides

Conditions of 9 active small landslides in the Model Areas are given in Table 3-12. Most are of the debris type slides occurred on the steep slopes (26°-41°) in geological material having a low degree of hardness such as Phyllite and Garnetiferous Schist. Little vegetation is established on the scars. This indicates that the slides are relatively new and their scars are active and unstable.

Table 3-12 Characteristics of Some Active Small Landslides in the Model Areas (1)

Surveyed in February and March, 1996

Location: Ward No., VDC, Model Area	Type and geology	Scar specification: Length (m)	Width Max. (m)	Width Mean (m)	Depth Max. (m)	Depth Mean (m)	Slope (°)	Area (m²)	Volume (m³)	Date occurred	Conservation object	Existing countermeasure	Immediate cause	Surrounding area land use	Remarks
1, Lahachok, Kaski North	Debris slide, Schist	150 E	17	15	2.2	1.8	36	2,250	4,050	July, 1995	A trail & 2 irrigation canals	None	Weak geology, steep slope & water seepage from canals	- Upper slope degraded grassland - Lower slope paddy land & Alnus nepalensis trees	- 2 destroyed canals supplied irrigation water to some 100ha of paddies - Tension cracks in upper slope (10-20cm wide)
6, Armala, Kaski North	Debris Slide, Schist	80 E	37	30	2.5	2.5	34	2,400	6,000	Aug., 1995	Rain-fed Paddy fields	None	Weak geology, steep slope & concentrated rain water from upper slope farms	Rain-fed paddy fields	
1, Mauja, Kaski North	Debris slide, Schist	20	11	8	2.1	2.0	31	160	320	Significant enlargement in Aug., 1995	Buildings in the upper part	None	Same as above	Degraded grassland	
3, Puranchaur, Kaski North	Rockslide, Schist	40	27	26	3.0	2.5	41	1,040	2,600	1988 or 1989 E	Trail & terraces	None	Stone excavation, weak geology, steep slope	Alnus nepalensis (H.=8-10m), level terraces	Tension cracks (15cm-40cm wide) at the left side slope
5, Arba, Kaski North	Debris Slide, Phyllite	35	12	8	3.0	2.5	34	280	700	Tension cracks appeared some 8 yrs ago & sliding in 1993	District constructed road & a trail	None	Weak geology, steep slope, concentrated rain water from upper trail	Degraded grassland & sparse natural broad leaved forest	Debris from the slide deposited on road surface creating a hummock

Note: E means estimated

Table 3-12 Characteristics of Some Active Small Landslides in the Model Areas (2)

Surveyed in February and March, 1996

Location: Ward No., VDC, Model Area	Type and geology	Scar specification: Length (m)	Width Max. (m)	Width Mean (m)	Depth Max. (m)	Depth Mean (m)	Slope (°)	Area (m^2)	Volume (m^3)	Date occurred	Conservation object	Existing countermeasure	Immediate cause	Surrounding area land use	Remarks
1, Pumdibhumdi, Kaski West	Debris slide, Phyllite	35	18	16	3.0	2.3	26	560	1290	July, 1995	Trail & farmland	None	Weak geology & concentrated rain water from upper farm lands	Grassland & farmland	
5 and 6, Chapakot, Kaski West	Debris slide, Phyllite	28	16	13	1.0	1.0	35	364	364	Significant enlargement in July, 1995	Trail, irrigation canals, paddies	None	Same as above pius seepage from canal	Grassland & paddies	
1, Thapa Thana, Parbat North	Debris slide, Phyllite	60	35	30	4.0	3.0	29	1,800	5,400	1989 or 1990 E	Trail, houses, farm lands	one loose stone check dam by Parbat DSCO	Weak geology & concentrated rain water from upper farm lands	Settlement, sloping terraces	- A few Alnus nepalensis (H.=0.4-3.0m) & grasses on the scar. Some plants destroyed by gazing animals. - Tension cracks in upper slope (villagers).
5, Karkineta, Parbat North	Debri slide, Phyllite	75	45	33	3.5	2.8	26	2,475	6930	Between 1984 & 1988	Trail & farm lands	None	Weak geology & ground water (seepage)	Natural forest of Alnus nepalensis, farm lands	- Seepage from underground water emerges in the middle part of scar - Tension cracks 12cm-15cm wide in the upper slope - A few Alnus nepalensis (H.=1.5-5m) & shrubs (H.0.5-1.0m) on the scar

b. Large landslides

(a) Kaski North Model Area

The largest landslide in Kaski North Model Area is located in the upstream of Sond Khola, a tributary of Bijaipur Khola in Ward No. 8 of Mauja VDC. According to the local inhabitants, it first occurred some 20 years ago but was reactivated and enlarged significantly in 1995. Farm lands were destroyed by the slide and some 30 households moved to Pokhara or other places permanently.

It's a complex type of landslide (combination of rockslide and debris slide) and is some 350m long, 200m wide and 10-15m deep. The geological material of the site is Phyllite. Tension cracks 10cm-15cm wide were observed on the left hand side of the slide's crown. Water overflowing from a catchment pond located at the left hand side of the crown and run-off water from rain-fed farm lands at the head of the crown flows into the surface of the slide. This created 2 deep gullies on the scar.

Another deep landslide in the Model Area is located in Jumleti in Ward No. 1 of Armala VDC. According to the local residence it occurred in the August of 1995 and 7 families living near the slide moved to Pokhara soon after the slide occurred, but returned to their homes after 2 months. It's a debris type slide and its active scar is about 100m long, 40m wide and 4-6m deep. The slope of the scar, as was measured in the field was 35 degrees. However, the total area affected, including the upper slope with wide tension cracks, is far larger than the active scar size. The slide is on Garnetiferous Schist. Tension cracks measuring up to one meter in width were observed on the slope between the crown and the ridge. Tension cracks were also observed on the walls of some houses located near the slide.

(b) Kaski West Model Area

The large landslide in Bamdi in Ward No. 6 of Chapakot VDC is some 30 year old. Farm lands and 3 or 4 houses were destroyed by the slide and a number of households from the area moved to Pokhara, according to local inhabitants.

The active scar of the slide, as measured in the field, is 70m long, 50m wide, 5m deep and has a slope of 36 degrees. But the whole slide is much larger and is estimated as being 800m long, 200-300m wide and 15-20m deep. It's a complex failure and is on phyllite. Tension cracks 20-25cm wide were observed near the slide crown.

3 gabion check dams some 2m heigh and retention walls were constructed under the Phewa Tal Watershed Management Project at the toe of the slide some 7 years ago to control the resulting debris flows and sedimentation. The area around the crown is fenced by the same project for protection purposes.

(c) Parbat North Model Area

Kamere landslide in Thuli Pokhari VDC has an estimated length of 200m, a width of 150m and a depth of 10-15m. It's a complex type of landslide and is on phyllite. Many tension cracks, 15-20cm wide, were observed near the crown. It's an old landslide, it damaged some farm lands and is still active. 8 stone filled gabion check dams are being constructed and tree planting is being carried out by JICA Project and local community users group to stabilize the landslide.

Khalte landslide in Ward No. 7 of Thana Maula VDC is about 10-12m deep and occurred some 40 years ago but was reactivated two years ago. The slide is on alternate rock. Tension cracks measuring up to 80cm in width were observed in the middle section of the slide and near the crown. Tension cracks were also observed on the walls of some houses located near the slide. Seepage from several small springs were seen flowing in the lower and middle sections of the slide. The slide destroyed farm lands and forced some 40 households to move to Kusma and Pokhara. Construction of a wetstone masonry check dam at the toe and forest and fruit tree planting on the scar are the countermeasures taken by JICA Project and the local community users group to stabilize the slide.

(d) Parbat South Model Area

Argaundi (Hosarandhi) large landslide was investigated by JICA Project Watershed Management Short Term Expert and by the Geological Survey Team under this study. The results of their findings are in the short term expert's report of April, 1996 and in the Geological Team's report of March , 1996.

According to the reports, the landslide is some 200m wide, 300m long and 7m deep. It's a complex type of failure and is on the phyllite. The local inhabitants first noticed the landslide activity in 1978. According to them, the activity significantly accelerated around 1985. The slide is active and many tension cracks are seen at its crown and in the whole village of Argaundi. Some houses were damaged as the result of tension cracks developing in their walls and floors, paddies have been abandoned and some households living nearby migrated to other areas.

② Possible Causes

Generally, the possible causes of landslides in the Study Area could be summarized as a. geological factors inherent to the mountains of the area such as fractured and deeply weathered rock which allows water penetration, undercutting by fluvial action, unconsolidated deep regolith, etc. b. human action factor such as forest and grassland degradation by over exploitation, improper farm land management, construction of trails and roads without proper drainage facilities, poorly maintained irrigation canals built on the slope, etc., all of which increase run off and therefore gullying and incision. Excavation of stones for trail and house construction is another factor leading to landsliding in the area, c. external factors acting as triggers such as concentrated and heavey monsoon rains and seismic activities.

Specifically, however, as was observed in the field, small landslides mainly occur where concentrated surface run-off from upper fields, trails, roads, etc. flow on steep slopes with weak geology, which indicates a strong humen influence in the occurrence of these landslides. On the other hand, large landslides are mainly controlled by geological structure, groundwater, etc. and exacerbated by humen actions as mentioned above.

Concerning the influence of the forest cover on landslides, mechanical reinforcement of the soil by tree roots is often cited as one of the positive influences of forest cover on slope stability and landslides. It's said that forests are effective in controlling shallow landslides because these types of slides are mostly within the rooting depth of trees and shrubs. A fact to notice in the model areas is the absence of forest in the sites where shallow slides occurred. However, it's unlikely that the forest tree and shrub roots will have a significant reinforcement effects on soils at the depth deep-seated and large landslides occur.

(2) Gully Erosion

In Model Areas, gully erosion occurs mainly by an increase in surface run-off because of overgrazing, improper farm land management, construction of trails without provision of proper drainage facilities and the like. The gully erosion that occurred in this way was observed in several locations in Model Areas. However, the sites with a significant gully erosion, threatening paddy fields, farm lands, trails, etc. which were in need of urgent treatment, were investigated in the field and measured on the topographic maps of the Scale 1/25,000 and are as mentioned in Table 3-13.

(3) Bank Erosion and Flooding

① Characteristics of local streams

The boundaries of the five Model Areas follow the administrative boundary lines of the VDCs or districts which do not necessarily correspond to the natural watershed boundaries. Each Model Area, therefore, is not a unit watershed discharging surface stream-flow through one outlet or mouth. Instead, each Model Area is drained by several streams, having relatively small sub-watersheds, through 2 or more outlets.

Longitudinal profiles and length of some of the kholas flowing in the Model Areas are given in Appendixes, Volume III. Among the kholas originating inside the Model Areas, Bijaipur Khola of the Kaski North Model Area is the longest with a length of 17,200m while Mardi Khola in the Parbat South Model Area is the shortest with a length of 3,200m. The profiles show the steepness of the channels, especially in the upstream areas, and consequently the erosive nature of the channels in the steep sections. The kholas have characteristics typical of mountain streams with limited width of 17m - 67m, except a downstream section of Bijaypur Khola having a width of some 190m. Streambed width and water condition are as shown in Table 3-14. The streamflow was mainly transparent during the period when river survey was conducted but according to local inhabitants, the streamflow during the monsoon season is mainly muddy, presumably the result of soil erosion due to strong rain.

Table 3-13 Current Condition of Some Active Gullies in the Model Areas

Surreyed in February and March. 1996

Location	State of Progress	Length (m)		Main channel (m)				Bed gradient (°)	Existing Control measure	Conservation Object	Land use in Vicinity	Remark
				Depth		Width						
		Main channel	Branch	Max.	Mean	Max.	Mean					
Gaire Sawara, Ward No. 1, Purunchaur VDC, Kaski North Model Area	Active & continous. The gully head is eroding actively towards the trial & farm land	36	-	6.0	4.5	10.0	6.5	26	None	Traial & farm lands at the gully head	Irrigated paddies & grazing land	The gully has a U shape & consists of only one main channel.
Kaure, Ward No. 3, Purunchaur VDC, Kaski North Model Area	Active & continous	200 E	10 E	3.4	2.3	10.0	6.5	22	None	Farm land, trial & drinking water tank	Rainfed paddies, grazing land, etc.	The gully has a U shape & consists of main channel & one branch.
Ward No. 2, Arba VDC, Kaski North Model Area	Active & continous. The gully already destroyed a portion of paddies in its head & sides	105	-	6.5	3.7	21	13.5	7	None	Rain-fed paddy fields	Rain-fed paddy fields	The gully has a V shape & started some 3 years ago.
Same as above	Same as above	102	76	4.5	4.0	17	14	7	None	Same as above	Same as above	Same as above
Ward No. 9, Tribini VDC, Parbat South Model Area	Active. Unstable sediment on gully bed	150 E	-	2.2	2.0	13.5	12.0	15	None	2 trails & irrigation canals	Bush land & overgrazed grassland	The gully forms a part of the south-east boundary of the Model Area

Notes: 1) U Shape: is formed when the erosion resistance of the subsoil equals that of the top soil.
V Shape: is formed when the erosion resistance of the subsoil is stronger than that of the top soil.
2) E: Estimated

Table 3-14 Conditions of Some Streams in the Model Areas (1)

Surveyed in Feb. and March. 1996

Stream (Model Area)	Stream width (m)	Water condition: Surface width (m)	Water condition: Depth (m)	Water condition: Colour	Bed slope (°)	Bank erosion condition: Height (m)	Bank erosion condition: Depth (m)	Bank erosion condition: Slope (°)	Bank erosion condition: Existing control measure	Land use in vicinity	Remarks
Bijayapur Khola (Kaski North)	190.0	4.5	0.12-0.18	Transparent & colourless	2.5	2.4	1.2	80	None	R. Arba Bijaya School yard. L. Terraced land & shrub land.	- Flood mark height at R. 1.1m. - River flow is reduced to 1/4 in March & April (villagers).
Kali Khola (Kaski North)	67.0	3.6	0.09-0.12	Transparent & colourless	2.5	3.0~4.0	1.0-1.5	50-70	Gabions (poor condition)	Paddies along both banks	- Some paddies on the R. were destroyed during Aug. 1995 flooding. - In March-April river flow is reduced to roughly 1/2 of current amount (villagers)
Bhoti Khola (Kaski North)	22.5	2.2	0.05-0.10	Transparent & colourless	1.5	0.8	1.0	80	None	Paddies along both banks	- Paddies on both sides of the river are flooded up to some 50-80m from the banks during the monsoon (villagers). - Baseflow appears some 100m upstream from surveyed point.
Virdi Khola (Kaski East)	56.5	3.5	0.05-0.15	Transparent & colourless	5.0	0.6-1.4	1.0	80	None in survey points. Near river mouth traditional round shaped bamboo structures & conventional gabions.	Paddies along both banks	- Paddies on both sides of the river are flooded up to some 60-70m during monsoon (villagers) - Intake of Polyangtar Irrigation Canal in the midstream R.

Note: ① R. and L. denote the right bank and left bank of a stream respectively.
② When one figure is given for bank erosion condition it means that erosion was significant only at one bank.
③ For location of surveyed sites of Kholas in Model Areas refer to River System (maps) in Appendixes, Volume III.

Table 3-14 Conditions of Some Streams in the Model Areas (2)

Surveyed in Feb. and March, 1996

Stream (Model Area)	Stream width (m)	Water condition			Bed slope (°)	Bank erosion condition				Land use in vicinity	Remarks
		Surface width (m)	Depth (m)	Colour		Height (m)	Depth (m)	Slope (°)	Existing control measure		
Khalte Khola (Kaski East)	61.0	Dry bed at survey point	-	-	3.5	0.7-2.8	0.6-1.8	65-70	None at survey point. Near river mouth traditional round bamboo structures & conventional gabions.	Paddies along both banks	- R. up to 100-150m flooding during monsoon (villagers). Stony surface paddies. - Some 1.5km upstream of survey point baseflow percolates in riverbed & some distance downstream of the point reappears. - The stream drys up from the end of Aug. (villagers). - Dhontar Irrigation Canal intake on right bank (dry).
Magsoli Khola (Kaski West)	17.0	1.2	0.02-0.06	Transparent & Colourless	5	1.0-1.4	1.0	40-50	None at survey point. Upstream of the point gabions in several locations	Paddies along both banks	- Flooding of R. & L. paddies up to some 50-80m in monsoon (villagers). Stony surface paddies. - Baseflow appears some 100m upstream of survey point. Upstream from baseflow emerging point dry river bed.
Phusre Khola (Kaski West)	44.0	7.0	0.1-2.0	Transparent & Colourless	3	1.2-1.6	0.5	50-70	Some 12m gabions of poor condition at R. (survey point)	Paddies along both banks	- Flooding of R. & L. paddies up to some 50 in monsoon (villagers).

Table 3-14 Conditions of Some Streams in the Model Areas (3)

Surveyed in Feb. and March, 1996

Stream (Model Area)	Stream width (m)	Water condition			Bed slope (°)	Bank erosion condition				Land use in vicinity	Remarks
		Surface width (m)	Depth (m)	Colour		Height (m)	Depth (m)	Slope (°)	Existing control measure		
Malyahdi Khola (Parbat North)	26.5	5.0	0.02-0.20	Transparent & colourless	4	1.2	1.0	65	None at survey point but at upper & lower streams of the point gabions of good condition in several locations.	R. Degraded grazing land & irrigation canal running parallel to the stream. L. Paddies	- L. flooded up to some 100m in monsoon (villagers). - Piple Tari Irrigation cannal intake weir on R. some 500m upstream of survey point.
Lamaya Khola (Parbat North)	48.0	7.4	0.10-0.30	Transparent & colourless	5	6.0	1.0	70	None	R. Paddies L. Sparse natural forest of Alnus nepalensis	- No signs of flooding or flood mark were observed.
Seti Khola (Parbat South)	50.0	15.3	0.10-0.30	Transparent & colourless	2	12	2.0	60	None at survey point. But downstream of the point until end of Model Area gabions in several locations.	R. Small community (houses, Bari land, Khet land) L. Paddy fields	- R. erosion first occurred some 3 years ago & destroyed 3 houses (villagers). - L. flooding for some 50m in monsoon.

② Bank erosion

During high flows in the monsoon season, generally there are 2 types of problems related with river flood that occur in the streams flowing in Model Areas. These are the bank erosion and overflowing. The upper layer of most banks consists of agriculture soils of various depth overlaying a loose sediment layer composed of sand and gravel which is relatively easily eroded (specially in areas lacking riparian vegetation) and washed away during high flows leaving the upper layer hanging. When the overhang part becomes sufficiently large the bank collapses into the stream and washed away by the flood and a new cycle of bank erosion begin.

Though the sites affected by bank erosion in Model Areas are relatively small in terms of land area, its significance is in affecting the valuable and highly productive land of the valley floors. The distribution of bank erosion along some streams in Model Areas was confirmed through field inspection or aerial photo interpretation. The lengths of the streams affected by bank erosion were measured on topographic maps of the Scale 1/25,000 and are given in Table 3-15.

③ Flooding

Where a stream can't accommodate the flood water due to its size and the banks are low and lacking vegetation, flood water spills over the bank damaging the crops, which is mostly rice, and other objects.

As is mentioned in Table 3-14, flooding occurs along some of the kholas in the Model Areas during the monsoon season. Interview with the farmers and post flood signs such as debris deposited by flood water on the surface of paddies, indicate that depending on the size of a stream and height of river terrace, from 50m-200m on both sides of streams are affected by flooding. The extent of damage also varies. In some areas, farm lands on both sides of a stream remain under the flood water for a few hours or a day, one or more times a year, and severe damage is not caused. In other instances, sand, stones and other debris are deposited on the affected farm lands, making rice planting and farming very difficult. In more severe cases, revetments along streams, bridges and houses are damaged or washed out by flood water.

Table 3-15 Current Condition of Bank Erosion

(Feb. and March 1996 Survey)

Location		Estimated stream lengths affected by bank erosion	Estimated existing revetments along streams	Remarks
Model Area	Stream	(km)	(km)	
Kaski North	Bijaipur Khola	11.0 (2.5)	1.0	Including Khau Khola and Thado Khola
	Kali Khola	7.0 (2.0)	0.5	Including Dhao Khola and Gharmi Khola
	Bhoti Khola	3.0	--	
	Bhatte Khola	2.5	--	
	Sub-Total	23.5 (4.5)	1.5	
Kaski East	Khalte Khola	6.0 (1.0)	0.8	
	Virdi Khola	5.0 (1.0)	0.8	
	Anpu-Phushre Khola	7.0 (2.0)	1.0	Including Phidi Khola.
	Sub-Total	18.0 (4.0)	2.6	
Kaski West	Magsoli Khola	4.0 (1.5)	0.4	
	Phurse Khola	7.0 (2.0)	1.5	Including Khade Khola, Bhunge Khola and Kalimaki Khola
	Harpan Khola	4.0	0.2	Including Handi Khola
	Sub-Total	15.0 (3.5)	2.1	
Parbat North	Malyahdi Khola	5.5	0.8	
	Lamaya Khola	6.0	0.4	Including Chirdie Kholq
	Sub-Total	11.5	1.2	
Parbat South	Seti Khola	9.0	1.4	Including Boke Khola and Makre Khola
	Mardi Khola	2.5	1.0	
	Sub-Total	11.5	2.4	
Total		79.5 (12.0)	9.8	

Note: ① The estimated lengths of bank erosion and existing revetments include both left and right banks of a river
② Figures in parenthesis ( ) are stream tributary lengths affected by bank erosion where riprapping will be carried out.

3-2-2 Surface Erosion

(1) State of Surface Erosion in Study Area

① Erosion of grassland

In Study Area, a severe surface erosion occurs in grasslands, mostly located on steep slopes, mainly due to increased surface run-off caused by the loss of vegetation cover and compaction of soil as the result of overgrazing. Surface run-off as high as 53% of the total annual precipitation is reported (Impat, 1981) in overgrazed grasslands in Phewa Tal Watershed located inside Study Area.

As was observed during field inspection, most of the grasslands are already bare due to grazing and grass cutting and surface soil appears at the beginning of the monsoon season in the months of May and June, the period during which thunderstorms of short duration but high intensity occur frequently. A significant surface erosion in grasslands therefore could occur during this period. In the later part of the monsoon season, grasses grow again and the vegetation cover is established to a certain extent.

② Erosion of Bari land and Khet land

In Bari land, terraces are without bunds and the terrace surfaces are sloping, either outward or in one side, having a gradient of 5 degrees or more, as was observed in the field. Only scattered fodder trees exist on the terrace risers or along terrace edges. Under the crop rotation currently practiced in Bari lands in Model Areas, maize is planted in the middle of March or beginning of April, harvested at the beginning of July and followed by the planting of millet, which is harvested in mid November. In some areas a crop of pulse such as beans, peas, lentils, etc. is intercropped with maize. From December to February the land is fallow.

As surface mulching and planting of grasses and shrubs to control erosion are mostly not practiced and the newly planted maize crop does not provide sufficient cover for the just plowed terrace surfaces, a severe erosion of the surfaces and risers of the Bari land terraces is expected to occur, especially, during the pre-monsoon (May-June) when thunderstorms bring high intensity rains.

In paddies, both in irrigated ones located on flat lands in valley floors and in rain-fed ones located on the lower slopes, terraces are bunded and terrace surfaces are level. In order to obtain a maximum crop of rice, farmers control run-off within a terrace and in between terraces, repair terraces regularly and maintain them in relatively good conditions. This keeps soil erosion in level terraces at minimum, and generally the terraces perform their soil and water conservation functions satisfactorily. Moreover, because of their location on lower slopes, level terraces act as a deposition zone for eroded soil coming from sloping terraces of Bari land located on the upper slopes.

From the above mentioned observations it can be concluded that surface erosion in Study Area is an accelerated or men-induced type of erosion and the level of its occurrence is closely related to the way land is managed.

The on-site significance of surface erosion is in its effect to reduce the productivity of affected land through physical removal of nutrients, degradation of soil texture and reduction of the soil depth. While its off-site significance is in causing siltation, water pollution, etc. in the downstream areas.

③ Actual soil loss by land use type

The actual rate of soil loss from surface erosion by land use type was investigated through reviewing the existing references and by installing erosion pins in 5 Model Areas under this study. The results are as summarized in Table 3-16.

Measuring erosion using erosion pins is a simple and inexpensive reconnaissance method which measures both cycles of erosion and deposition in a site. (see Appendixes, Volume III for further information on installation of erosion pins in Model Area.) By applying this method, it was intended to obtain estimates of the amount of erosion for sloping terraces and overgrazed grassland for which data from inside Model Areas is unavailable. The results obtained are only from one monsoon season and thus can't be said to be the final figures for erosion estimation in Study Area. The figures obtained, however, indicate a similar trend in erosion by land use type as that of the existing data as can be observed from Table 3-16, which shows the highest rate of surface erosion in overgrazed grassland and sloping terraces and the lowest in dense forest, protected grassland and level terraces.

Table 3-16 Actual Rate of Soil Loss from Surface Erosion by Land Use Type in Study Area and Other Parts of Nepal

Land use	Soil loss (Ton/ha/year)		Remarks
	(a)	(b)	
Farmland			
Sloping terrace	17.0-100.0	60.0-70.0	All (a) data is from outside Study Area
Abandoned terrace	20.0	-	
Level terrace	2.0-10.0	-	
Home garden	-	30.0	
Grassland			(a) include data from Phewa Tal Watershed located inside Study Area
Overgrazed	7.7-200.0	110.0	
Protected	1.0-9.4	-	
Forest			
Dense	0.4-10.0	-	
Degraded	15.0	-	

Sources: (a)
1. B. Carson, ICIMOD Occasional Paper No.1, 1985: Erosion and Sedimentation Process in Nepalese Himalaya, Pp. 6, 7, 28.
2. DOSC, UNDP, FAO, 1991: Summary on run-off and soil loss data from surface run-off plots. Phewa Tal soil loss data from 1978 (full year).
3. Soil fertility and erosion issues in the middle mountains of Nepal. Workshop proceedings Thikhu Khola Watershed April, 1991, Pp. 25, 85, 208-211.
4. T. Partap and H. R. Watson, ICIMOD Occasional Paper No.23, 1994: Sloping agriculture land technology (SALT), Pp. 4-5
5. W. J. Ramsay, The University of British Columbia, 1985: Erosion in the middle Himalaya, Nepal with a case study of the Phewa Valley (MSc. Thesis) Pp. 21-27.

(b) Erosion pin plots
- Plot size 2m × 5m (sloping terrace 3 plots, grassland 1 plot, home garden 1 plot)
- Pin distance 1m × 1m (18 pins in one plot)
- Plot establishment date: Feb. 16-March 8, 1996
- Final reading date: Nov. 4-Nov. 15, 1996

④ Tolerable soil loss

Basically, a sustainable use of land without progressive deterioration can be achieved when the rate of soil loss is no greater than the rate of formation of soil. The rate of formation of soil can't be precisely measured but the best estimate of soil scientists is that when the disturbances and aeration and leaching actions are speeded up by tilling the land, it will take something like 100 years to form 25mm of soil (N. Hudson: Soil Conservation, 1995). Other estimates put the rate of soil formation at 25mm in some 30 years. Assuming a bulk density of 1.2 (according to NARC, values for soils in the middle mountains of Nepal vary from 1.0 to 1.4) these rates of soil formation are approximately 3-10 ton/ha/year.

The value of acceptable soil loss will also depend on the soil depth and condition of weathering. For example, the loss of 3-10 ton/ha/year soil from a deep soil with high rate of weathering will be less serious than from a shallow soil on a rocky terrain. Nevertheless, as a tool to assist the process of planning 10 ton/ha/year will be assumed as upper limit of tolerable soil loss for this study.

3-2-3 Existing Erosion Control Activities and Facilities

(1) Bio-engineering

The method of vegetative soil conservation or bio-engineering is widely used in Nepal for landslide rehabilitation, gully control, road erosion control and farmland terrace improvement, etc. Bio-engineering consists of such activities as tree and shrub planting, grass seeding and planting, cutting planting, bamboo planting, fascine construction and live fence construction, etc. Tree planting is mainly carried out for slope surface protection, landslide and gully rehabilitation. Both fruit trees and forest trees are planted. The grass types planted are mainly napier grass (*Pennisetum purpureum*) and broom grass (*Thysanolaene maxima*). Both seeds and rooted cuttings of the grasses are used as planting material. Grasses are planted on the surfaces of landslides, on cut and fill slopes of roads, along gullies and on farmland terrace risers for terrace improvement.

Napier grass is, in particular, multi-purpose in that it is effective for erosion control and the leaves and young stems are good quality fodder. People living adjacent to a project area planted with the grass are allowed to harvest it for fodder under the supervision of the project. In the Study Area, bio-engineering methods for soil conservation purposes are applied by JICA projects, the Department of Soil Conservation, the Department of Roads and NGOs active in the area.

(2) Check Dams

Drystone masonry check dams, wetstone masonry (using cement) check dams and stone-filled gabion check dams are constructed in the Study Area as measures for gully control, debris flow control and the rehabilitation of landslides. Old drystone masonry check dams and wetstone masonry check dams are observed in the upperstream of Harpan Khola and in its downstream areas in Chapakot VDC and in Salangkot VDC South facing slopes. The check dams were built under the Phewa Tal Watershed Conservation Project in the 1970s. Except for one gully near Sidane community in the upperstream area where some of the check dams were destroyed by debris flow, the dams in other locations are in good condition. All 3 types of check dams have also been constructed under the JICA Project, the Department of Soil Conservation and NGOs active in the area for the above mentioned purposes.

(3) Revetments and Groynes

Revetments and groynes made of stone-filled wire gabions of different mesh sizes are structures extensively constructed by the Department of Soil Conservation, the Department of Irrigation and NGOs active in the area for stream bank protection and flood control. As was observed during the field survey, revetments and groynes generally consist of 2 or 3 block high gabions (each gabion being one meter in height). The iron meshes of some of the gabions is broken and a number of them are in poor condition and in need of maintenance.

Traditional round-shaped structures (Bhakari) built by local inhabitants using bamboo sticks and filled with stones are observed along Virdi Khola and Khalte Khola in the Kaski East Model Area. The structures range in diameter from 2.00 m - 2.5m and have a height of 0.5m-1.0m from the ground surface. The depth of the foundation is 50cm and the bamboo sticks used have a diameter of 7cm to 10 cm. According to local inhabitants, a bhakari can last for 2 - 3 years. The structures are temporary but effective in controlling bank erosion and are generally in good condition.

(4) Traditional Terracing of Farmland

① Sloping Terraces

In sloping terraces in Bari Land (rain-fed farmland), mainly corn, millet, buckwheat etc. are grown by farmers at the beginning of the rainy season. Trees, both planted and naturally grown, the leaves and branches of which are used as fodder, are also found on the edges of the terraces. Sloping terraces are constructed on slopes and usually run all the way to the ridge top with the risers becoming increasingly high and the terrace face becoming increasingly narrow as the slope becomes steeper. When sufficient stones are available, the terraces are strengthened by stone risers. While the terraces mainly slope downwards, they occasionally slope towards the hillside or to the left or right sides as was observed during the field survey.

The field inspection at 5 locations in the Model Areas show that sloping terraces exist on slopes of upto 30 degrees. The terrace face slope ranges from 2 degrees to 5 degrees and the terrace width ranges from 1.6m on steep slopes to 5.0m on moderately steep slopes. According to the farmers interviewed, sloping terraces are constructed at sites where spring and other water sources to supply irrigation water do not exist. Therefore, the only water source for sloping terraces is rain falling during the monsoon season.

② Level Terraces

Level terraces on Khet Land (irrigated paddy land) are located on the valley floor along streams where a steady supply of irrigation water is available. Level terraces are also found on moderately steep slopes where water from temporary and permanent springs or diverted run-off water can be used for irrigation.

The main crops grown on level terraces are rice during the monsoon season and wheat during the dry season. In order to obtain a maximum crop of rice, the farmers maintain level terraces in good condition by repairing them every year before the start of the monsoon season. SAMAH (small spillway), measuring some 50cm in length, are created along the bund at a corner of a terrace through which excessive rainwater during the monsoon season is safely discharged to the terrace below. Because of their location on lower slopes, level terraces also act as a trap for eroded material coming from sloping terraces located on the upper slope.

Therefore, it can be said that level terraces in the Study Area perform their soil and water conservation functions satisfactorily, and from the viewpoint of erosion, serious soil loss is unlikely to occur at these terraces.

(5) Existing Surface Run-off Management

The current management of run-off from farmlands in Study Area during the monsoon season can be summarized as follows:

① Surface run-off from farmlands is drained into trails located nearby. To use trails as drainage ways during the monsoon season, in some areas walls made of loose stones and up to some one meter high are constructed in one or both sides of the trails to prevent overflowing and to guide the water into natural streams. Where trail surfaces are stone-paved and well maintained erosion is minimum. But, where a trail's surface is partially stone-paved, the trail is not maintained properly and is located on a steep slope, as the result of concentration of run-off, the trail is turned into a gully. The water flowing from such trails causes more erosion on the slopes on its way to down slope areas, and is one of the factors of slope failure in Study Area;

② The run-off from farmlands located in upper slopes, where trails do not exist nearby, is drained onto the terraces situated in down slope areas, causing erosion and collapse of the terrace risers, before entering into a natural stream;

③ Some run-off from surrounding slopes are collected into the ponds mostly seen near the ridges. The watersheds of these ponds are usually small in terms of area and so are the ponds themselves, having a depth range of approximately 1.0m-1.20m and a surface area of $20m^2$ -$100m^2$. Water from the ponds is mainly used as drinking water for domestic animals.

3-2-4 Past Disasters and Statutory Regulations

(1) Past Disasters

Damages due to such past natural disasters as landslides, floods and forest fires, etc. in the Model Areas were investigated by the Socioeconomic Baseline Survey conducted under this Study. The data on the subject will be presented in the reports presented on the survey.

(2) Statutory Regulations

No statutory regulations applicable to watershed conservation in the Study Area exist.

3-3 Socioeconomic Conditions

3-3-1 Outline of Socioeconomic Conditions

(1) Household and population

The total households and population in the model areas were 20,769 and 129,384 as of the end of 1995, respectively, as given below:

Table 3-17 Total Household and Population in the Model Areas

Model Area	Total HH (nos.)	Female-headed HH (%)	Population			Average family size
			Male	Female	Total	
Parbat North	6,061	22.5	19,128	19,590	38,718	6.4
Parbat South	2,823	18.2	9,075	9,544	18,619	6.6
Kaski East	2,026	26.1	6,270	6,410	12,680	6.3
Kaski North	5,958	16.1	17,134	17,553	34,687	6.8
Kaski West	3,901	14.0	12,349	12,331	24,680	6.3
Overall	20,769	19.0	63,956	65,428	129,384	6.2

Source: Administrative Survey, JICA/Multi Disciplinary Consultants (P) Ltd. (1996)

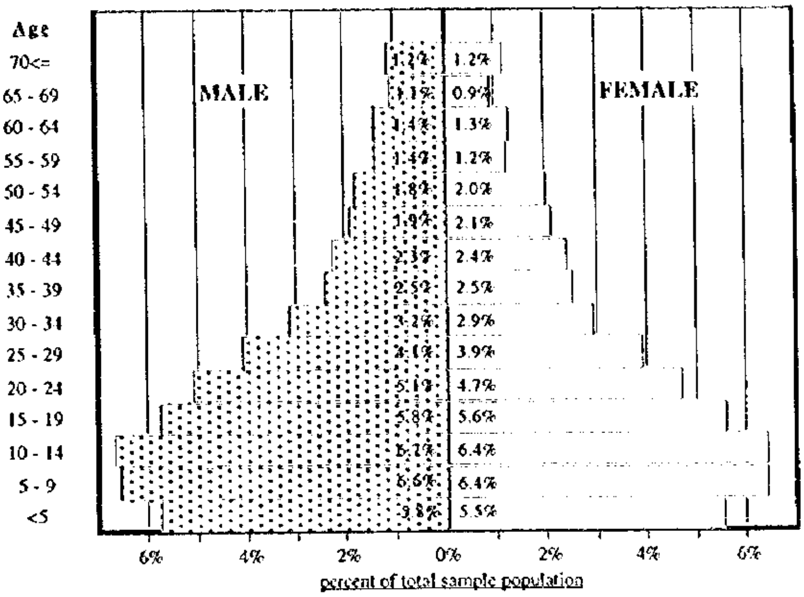
Of the total households in the model areas, about 19% were female-headed households. Higher proportion of female-headed households were found among Gurung and Magar families than other castes.

The annual population growth rates in the rural area of Parbat and Kaski districts were 1.12% and 1.24% between 1981 and 1991, respectively, which was low compared with the national average of 2.10% per year. Judging from the CWR (child woman ratio)[1] calculated for the model areas, however, the population growth rate in the area was as high as the national average. Out-migration of adults resulted in the ostensibly lower population growth rate than the actual.

The age group composition of the sample population in the model areas is shown below. Among the 5-year age groups, children between 10 and 14 years were the highest in proportion (13.1%). This suggests the population growth has been lessen over the last 15 years. Meanwhile, economically active population (age 15

[1] : CWR is an indicator of fertility. The ratio is computed by dividing the total number of children below 5 years old by the number of women at the ages between 15 and 49.

to 60 years old) in the five model areas accounted for about 56% of the total sample population.



Source: Household Survey, JICA/Multi Disciplinary Consultants (P) Ltd. (1996)

Fig. 3-4 Sample Population by Age Group and Sex

(2) Caste composition

Brahman was a major caste (43.6% of the total households) followed by Chhetri (12.2%) and Gurung (10.7%) in the model areas. One of the so-called "occupational caste," Kami, was the fourth largest in the model area and constitutes of 9.0% of the total households. Comparing Parbat district with Kaski, more Brahman was found in Parbat than Kaski, while the proportion of Gurung was larger in Kaski than Parbat. According to the Administrative Survey, a great variation was found out in the caste composition of VDCs and wards.

(3) Migration and absentees

The Administrative Survey found out that the number of households migrated out from the model areas surpassed that of in-migration. Pokhara and districts in Terai were popular destinations for the out-migrants. It is considered that the out-migration was attributed partly to comparatively easy access to farm land, higher farm productivity, and better working opportunity in the destination areas. Among the five model areas, Parbat South model area showed the highest proportion of net out-migration over total households. It is speculated that the high proportion could be attributable to the comparatively severe remoteness and economic condition of the area.

According to the Household Survey, 19.5% of the total population of the sample households were absent for more than three months a year. The absentee ratio was higher among male (27.5%) than female (11.1%). The male of Gurung/Magar/Kunwar group had the highest absentee ratio of 33.2%. Many of the absentees have gone to India, England or other places of Nepal in connection with their employment.

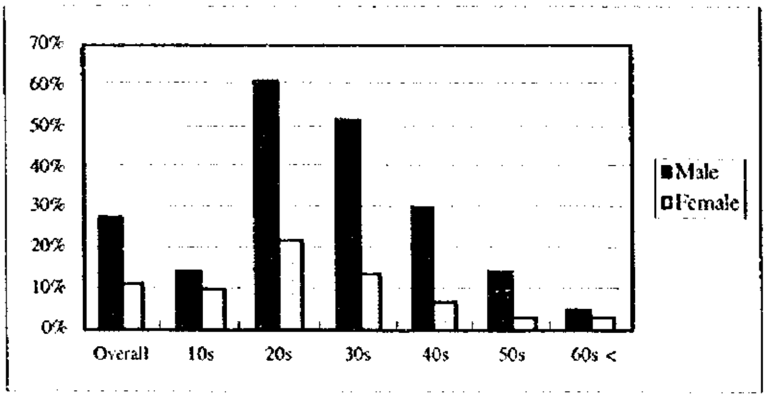


Fig. 3-5 Absentee Ratio by Sex and Age Group

(4) Education Status

The education status of economically active sample population (15 - 60 years old) is summarized in Table 3-18.

Table 3-18 Education Status of Economically Active Sample Population

Model Area	Econo. active population	Education attainment (%)					
		No formal education	Upto class 6	Class 7 to 10	SLC passed	Inter-mediate	Graduate / University
Parbat North	9,083	43.4	15.5	25.0	10.1	3.7	2.4
Parbat South	4,513	45.8	18.9	26.2	6.5	2.0	0.6
Kaski East	2,857	38.2	23.6	27.6	5.3	3.6	1.8
Kaski North	8,279	40.2	17.0	30.0	7.6	3.0	2.2
Kaski West	5,313	41.2	20.5	29.4	5.3	2.3	1.3
Overall	30,052	42.0	18.1	27.6	7.5	3.0	1.8

Source: Household Survey, JICA/Multi Disciplinary Consultants (P) Ltd. (1996)

The propoition of population without formal education was 42% and was higher in Parbat than Kaski district. Meanwhile the proportion was much higher among female (60%) than male (24%).

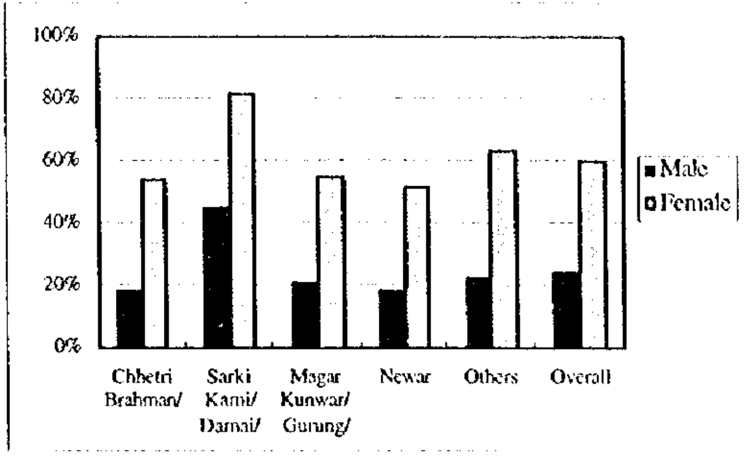


Fig. 3-6 Proportion of Non-educated Population by Caste Group

(5) Occupation

Farming is the main occupation among the economically active sample population, followed by student, salary worker, and wage labor. The survey revealed the characteristics of occupational castes: lesser salary worker, more engaged in temporary labor works, and the fewer enrollment in education.

Table 3-19 Occupation of Economically Active Sample Population

Model Area	Econo. active population	Occupation (%)						
		Salary worker	Wage labor	Private business	Farmer	Student	Pension receiver	No job
Parbat North	9,083	11.4	7.7	2.2	58.5	17.0	0.1	2.5
Parbat South	4,513	14.1	11.5	2.1	53.1	12.9	1.6	4.6
Kaski East	2,857	14.3	15.4	2.5	46.7	13.6	3.0	4.5
Kaski North	8,279	12.0	17.6	2.8	44.2	17.6	2.2	3.5
Kaski West	5,313	16.5	11.4	2.8	48.2	14.4	2.1	4.5
Overall	30,052	13.1	12.4	2.5	50.8	15.7	1.5	3.6

Source: Household Survey, JICA/Multi Disciplinary Consultants (P) Ltd. (1996)

(6) Community Organization

There were different types of community organizations in the model areas. Mothers' clubs were the most active organization among them. They have been motivating people to construct temples, toilet, foot trails, and Chautara, and to carry out income generating activities. They have also worked as pressure groups to suppress male's undesirable behaviors: gambling (playing cards) and drinking alcohol.

Table 3-20 Number of Community Organizations

Unit : nos.

Model Area	Mother's club	Farmer's club	Youth club	Users' group	Ethnic group	Others
Parbat North	76	9	16	92	0	5
Parbat South	31	9	12	37	2	0
Kaski East	26	2	5	24	2	1
Kaski North	67	27	20	77	0	13
Kaski West	35	5	8	35	1	3
Overall	235	52	61	263	5	22

Remarks: "Users' group" does not include forest users' group.
Source : Administrative Survey, JICA/Multi Disciplinary Consultant (P) Ltd. (1996)

Users' groups have worked for the operation, repair and maintenance of the irrigation and drinking water supply systems under their own rules and regulation. Farmers' clubs have been engaging in the production and marketing of improved seeds or livestock raising. But, there is a tendency that farmers' organizations became inactive after the withdrawal of the external support. The activities of Youth clubs were more or less similar to those of the mothers' clubs and directed toward the betterment of community life. But again there is a general phenomena that the youth clubs have been weakened due to lack of fund and temporal or permanent out-migration of young population.

Users' groups for forest and/or water were popular organizations among males, while mothers' club among females. On average 15.5% and 13.4% of adult males and females belonged to any types of organizations.

(7) Cash Income Sources

Among various income sources, remittance from family members working outside their villages was the most important. It was followed by salary, wage and pension. The dependency on farming as a cash income source was generally higher in VDCs located near towns, Pokhara and Kusma. However, the cash income from farming and livestock raising was much less important compared to that from non-farming activities.

A significant difference was found out for the importance of cash income source by caste group. Livestock raising was an important income generating activities for Brahman and Chhetri, though they depend more on the income from salary and remittance. Occupational castes (Damai, Kami and Sarki) relied much more on wage and other income (from temporary jobs) than other castes. The importance of remittance and pension was the highest in the group of Gurung, Kunwar and Magar. Newar was most active in business fields.

3-3-2 Living Condition

(1) Drinking Water Supply

On average more than 60% of sample household used piped water as a main source of drinking water. Natural springs were of second importance and used by about 30% of the sample households. Among caste groups, the use of piped water was least in proportion among occupational castes.

Table 3-21 Sources of Drinking Water

Unit : HH %

Model Area	Dry season			Wet season		
	Piped water	Spring water	River	Piped water	Spring water	River
Parbat North	50.4	38.6	3.8	47.6	41.0	4.4
Parbat South	55.7	41.2	3.0	54.3	42.3	3.3
Kaski East	47.2	50.6	2.1	50.7	47.3	1.7
Kaski North	79.9	16.9	3.0	86.0	12.0	1.7
Kaski West	56.0	39.5	4.4	74.4	24.1	1.2
Overall	60.4	34.0	3.4	65.0	30.3	2.6

Source: Household Survey, JICA/Multi Disciplinary Consultants (P) Ltd. (1996)

As for the sufficiency of drinking water, about 40% and 24% of the sample households reported short or very short in dry and wet seasons respectively. Kaski East model area is worst suffering from drinking water shortage. Among caste groups, on the other hand, occupational castes were facing the most severe water shortage.

The average time required for fetching water was found to be about 17 minutes and 16 minutes in the dry and wet seasons respectively. It was longer in case the source was springs (38 and 32 minutes in the dry and wet season). Among the five model areas, people in Kaski East model area spent longer time to fetch water. The occupational castes generally spent more time to collect water than other castes did.

(2) Fuel Sources

Fuelwood was the most important fuel source for cooking and heating purposes, followed by crop residue. Unlike households in Terai area, use of dried cow dung as fuel source is not popular in the model areas. Kerosine is generally used for lightning purposes only in relatively wealthy households because it is hardly available in remote villages due to the high cost associated with transportation problems. Only 2% of the sample households used biogas as a fuel source, mostly in combine with fuelwood. Many villages have faced the difficulty in obtaining fuelwood as shown in Fig. 3-7.

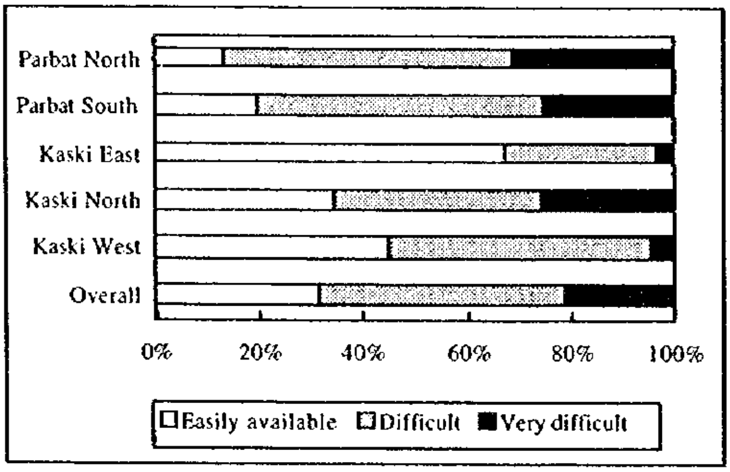


Fig. 3-7 Availability of Fuelwood by Model Area

The availability of fuelwood reported by sample households depends partly on the distance to forest. The average one way distance to forest was in the range between 30 and 118 minutes at VDC level and the distance considerably varies from place to place. Among the five model areas, Kaski East had the shortest distance to the source (33 minutes on average). The per capita annual consumption of fuelwood varied from place to place and was estimated at 542 kg on average[2]. Of the total consumption, the share of own harvest account for about 90% and the rest come from purchase.

[2] : The absentee family members were included when calculating the per capita annual consumption. If they were excluded, the amount increases to 677 kg/year.

(3) Food

Most of the households in the model areas has been engaging in farming to produce cereals and vegetables for their home consumption as well as for income. The deficit of the own-produced cereals and vegetables respectively is shown in the table below.

Table 3-22 Sufficiency of Cereal and Vegetable Produced by Sample Households

Unit: HH %

Model Area	Cereals			Vegetables		
	More than enough	Just enough	Not enough	More than enough	Just enough	Not enough
Parbat North	4.7	25.2	70.1	0.5	49.0	50.4
Parbat South	2.3	20.4	77.2	0.4	51.9	47.8
Kaski East	4.8	21.2	73.9	0.4	28.2	71.4
Kaski North	9.0	25.2	65.7	5.2	63.4	31.4
Kaski West	6.4	15.8	77.9	0.5	42.9	56.6
Overall	5.9	21.5	71.1	1.8	50.4	47.8

Source: Household Survey, JICA/Multi Disciplinary Consultants (P) Ltd. (1996)

Among the food-deficit households, the average period of deficit for cereals and vegetables were about 4.6 and 3.0 months a year respectively. Many reported June to August as the most severe food deficit period. The cereal deficit was most severe among occupational caste households: 97% reported the deficit and their average deficit period was 7.8 months a year. The biggest reason for that is their smaller holding of farm.

(4) Health and Sanitation

① Diseases

Nearly 80% of the sample households in Parbat district reported that the household members had some kind of diseases for the last one year, while it was 53% in Kaski district. Cold was a common disease in both districts. Bacillary dysentery and other diarrhea was also reported by 13% of the sample households, probably due to the use of unsafe water for drinking and unhygienic surroundings. Respiratory diseases was reported in about 9% of household, which could be attributed to laborious work being done without adequate nutrient intake. Eye diseases, which can be attributable to smoky kitchen/rooms and less intake of green vegetables, was reported in about 8% of the sample households.

② Sanitation (Toilet)

Availability of toilet can be an indicator of better sanitary condition. On average 33% of the sample households owned toilet. Nearly a half of households in Kaski owned toilet and the proportion was much higher in Kaski district than Parbat. Meanwhile, the toilet availability in occupational caste households was lowest among caste groups, showing only 19.2% of the households owned toilet.

(5) Family Planning

Of the sample households, about 57% were visited by family planning workers in the past. The percentage was higher in Kaski district (about 64%) than Parbat (about 48%), probably due to the better access to villages in Kaski than Parbat. As for the use of contraceptive methods, the survey results indicated higher popularity in Kaski than Parbat. One reason for that could be comparatively more active family planning workers. Of the methods, vasectomy was the most popular followed by tubectomy and condom.

3-3-3 Agriculture

(1) Farm Land Area

A household own about 0.46 ha of farm land on average, composed of 0.29 ha of khet land and 0.17 ha of bari land. As the Table 3-23 indicates, more than 90% of the sample households owned bari land, while only 75% khet land.

Table 3-23 Average Holding of Farm in Model Areas

Model Area	Khet Land		Bari Land		Ave. farm land area (ha/HH)
	Landless (HH %)	Ave. area (ha/HH)	Landless (HH %)	Ave. area (ha/HH)	
Parbat North	18.4	0.30	7.3	0.19	0.49
Parbat South	26.8	0.19	3.6	0.19	0.38
Kaski East	31.2	0.27	6.1	0.21	0.48
Kaski North	25.6	0.30	12.3	0.15	0.45
Kaski West	31.8	0.32	7.2	0.15	0.47
Overall	25.4	0.29	8.1	0.17	0.46

Source: Household Survey, JICA/Multi Disciplinary Consultants (P) Ltd. (1996)

Meanwhile the farmers cultivates rented land in addition to their own land. The overall average of such rented land area was calculated at 0.05 ha and 0.01 ha per household for khet and bari land respectively. As a result, the total farm land area per household was averaged to be 0.34 ha for khet land and 0.18 ha for bari land. Average farm area per household by cast is shown in Fig. 3-8.

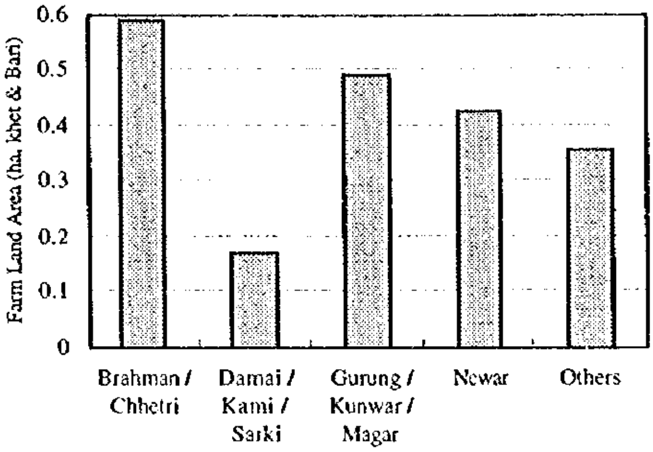


Fig. 3-8 Average Farm Area per Household by Caste Group (khet plus bari)

(2) Damage to Farm by Natural Incidences

The sample households responses on the frequency of damage to their farm by natural incidences during the last 10 years show that the flood damage has occurred more frequently in Kaski district than Parbat district. The highest frequency of flood damage was reported in Kaski East model area where a large portion of farm land is located along rivers. Meanwhile, the damage to farm land by land slide and top soil erosion was more frequent in Parbat district than Kaski. This can be attributable to comparatively steeper topography and scarce forest cover in Parbat district.

(3) Cropping Pattern

The major crops grown in khet land were paddy, maize, wheat, potato and mustard, while maize, finger millet and mustard were cultivated in bari land. Pulses were intercropped with maize, while finger millet was relayed with maize. The cropping pattern varies in the model areas depending upon the climate condition (elevation) and availability of irrigation water. The major cropping patterns in khet and bari land of the model areas are illustrated as shown in Fig. 3-9.

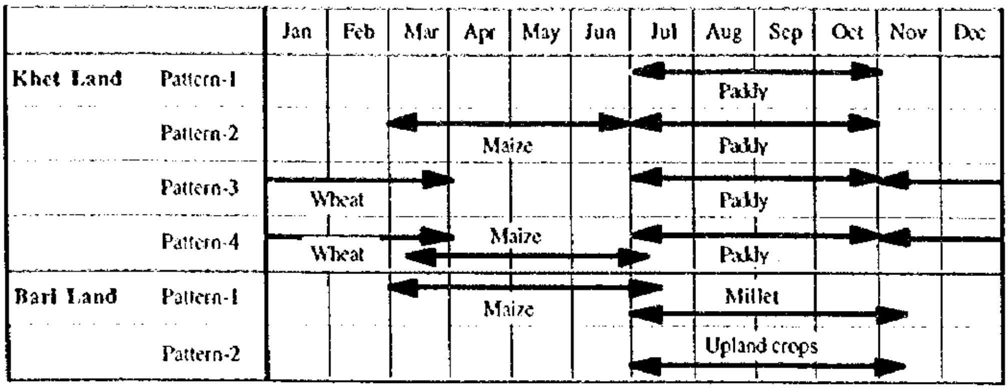


Fig. 3-9 Major Cropping Pattern in Khet and Bari

In both Parbat and Kaski districts, paddy-fallow-fallow was the dominant cropping pattern in khet land. Paddy-wheat-fallow and paddy-wheat-maize were also prevailing where irrigation is available. In bari land, about 65% of the total sample households followed millet-fallow-maize. In Kaski district, some bari land was cropped three time a year where condition allows.

The average cropping intensity in khet and bari land were 185% and 224% respectively. The cropping intensity in khet land was higher in Parbat district than Kaski. The reverse characteristics were observed for the cropping intensity of bari land. In Kaski West model area in particular, three crops a year was common in bari land. The cropping intensity in the model areas was much higher compared with the national average of 177%.[3] This suggests people in the area has made their best effort to increase the crop production by cultivating their limited farm land as intensively as possible.

(4) Cropped Area and Production

Cropped area, yield and production of major crops in 1995 are given in Table 3-24.

[3] : The averaged cropping intensity in hill areas. (Statistical Pocket Book of Nepal, 1996)

Table 3-24 Cropped Area, Yield and Production of Major Crops

Crops		Parbat North	Parbat South	Kaski East	Kaski North	Kaski West	Overall
Khet Land							
Paddy	Area (ha/HH)	0.33	0.21	0.32	0.33	0.37	0.32
	Yield (kg/ha)	1,841	1,972	2,087	2,117	1,642	1,914
	Production (kg/HH)	608	414	668	699	608	612
Wheat	Area (ha/HH)	0.08	0.10	0.02	0.08	0.04	0.07
	Yield (kg/ha)	1,303	1,192	1,075	1,029	941	1,151
	Production (kg/HH)	104	119	22	82	38	81
Maize	Area (ha/HH)	0.09	0.10	0.02	0.07	0.04	0.07
	Yield (kg/ha)	1,309	1,249	994	1,140	968	1,202
	Production (kg/HH)	118	125	20	80	39	84
Bari Land							
Maize	Area (ha/HH)	0.18	0.20	0.17	0.16	0.16	0.17
	Yield (kg/ha)	1,140	1,259	1,011	1,071	1,089	1,116
	Production (kg/HH)	205	252	172	171	174	190
Millet	Area (ha/HH)	0.18	0.19	0.18	0.15	0.16	0.17
	Yield (kg/ha)	1,342	1,300	1,174	1,160	1,241	1,249
	Production (kg/HH)	242	247	211	174	199	212

Source: Household Survey, JICA/Multi Disciplinary Consultants (P) Ltd. (1996)

The yield of the major crops except millet were low compared with the national and regional averages. It is considered that the major constraints for crop production are low soil fertility caused by intensive use of land, inadequate supply of crop nutrient, higher altitude, and prevailing crop damages.

Table 3-25 Comparison of Crop Yields

Unit : kg/ha

Items	Paddy	Wheat	Maize	Millet
National average (1994/95)	2,060	1,440	1,650	1,070
Western average (1994/95)	2,010	1,440	1,580	1,070
Model Area (Khet land)	1,914	1,151	1,202	-
Model Area (Bari land)	-	-	1,116	1,249

Source: Statistical Pocket Book of Nepal (1996), Central Bureau of Statistics
The model area averages were calculated from Household Survey results.

Overall production of the major cereals per household was computed at 1,180 kg, that corresponds to annual per capita production of only 178 kg. This clearly indicates the cereal deficiency in the areas.[4]

(5) Crop Damage

One reason of low crop productivity in the area was damages to crop. Drought was the most common causes for khet land crops. Diseases were ranked second as a cause of damage to paddy. As for maize, many households reported the damage by wind. This could be because the cropping period of maize extends over the windy monsoon season. Hail stone also affected the maize particularly in Kaski North and West model areas..

3-3-4 Livestock

(1) Livestock Population

Popular livestock raised by farmers were buffalo followed by cow, goat and chicken. Buffalo is the most popular livestock raised by the sample households probably because it can be used for multiple purposes: for production of milk (female) and meat (male) and draft animal. About 87% of households owned buffalo in the model areas and the average population per household (including non-owner) was 2.0 heads. Cow was owned by about 59% of sample households with the average population per household of 1.2 heads. Goat and chicken were kept by about 47% and 44% of the sample household respectively. No fish pond was reported in the model areas.

Table 3-26 Proportion of Sample Household Who Keep Livestock

Unit: owner HH % (ave. heads)

	Cow	Buffalo	Goat	Pig	Chicken
Parbat North	64.1 (1.2)	89.5 (1.9)	48.0 (1.2)	1.0 (0.0)	33.7 (2.2)
Parbat South	66.5 (1.5)	94.5 (2.4)	40.9 (1.3)	4.8 (0.1)	44.3 (3.4)
Kaski East	61.6 (1.7)	87.1 (2.1)	62.4 (2.3)	10.7 (0.2)	68.9 (5.0)
Kaski North	53.7 (1.0)	82.8 (1.9)	41.9 (1.5)	1.4 (0.0)	38.9 (5.8)
Kaski West	51.7 (1.1)	85.7 (2.0)	48.7 (1.5)	2.7 (0.0)	49.8 (3.4)
Overall	59.3 (1.2)	87.4 (2.0)	46.8 (1.5)	3.1 (0.1)	44.4 (4.1)

Source: Household Survey, JICA/Multi Disciplinary Consultants (P) Ltd. (1996)
The figures in parenthesis indicate the average population of each livestock per household (including those who do not own the livestock).

4 : Land Use Mapping Project (1986) estimated per capita cereal requirement to be 190kg per year.

Of the caste groups, Brahman and Chhetri are the richest in terms of the livestock ownership: cow, buffalo, and goat were raised by 68%, 94%, and 57% of the households respectively. On the other hand, the proportion of occupational castes who own livestock was much smaller. Further, the occupational castes owned smaller number of livestock per households as shown in Fig. 3-10.

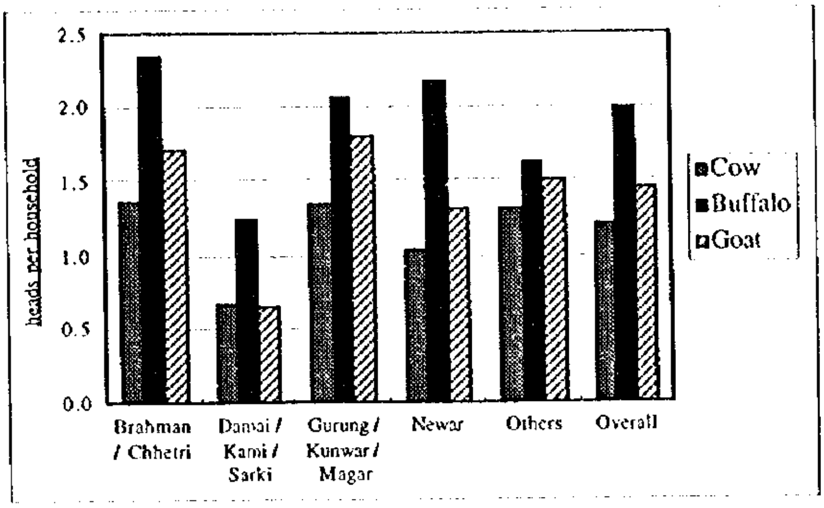


Fig. 3-10 Average Number of Livestock Owned by Caste Group

(2) Livestock Feed and Sufficiency

Grass, tree fodder, crop residue (straw of paddy and millet) and grain were major livestock feed used by the sample households. Grass is an important feed during the wet season because it is abundant from place to place. Tree fodder and crop residue were fed mainly during the dry season when grass are scarce. Grains were equally important throughout the year to supplement nutrient, particularly for milking animals.

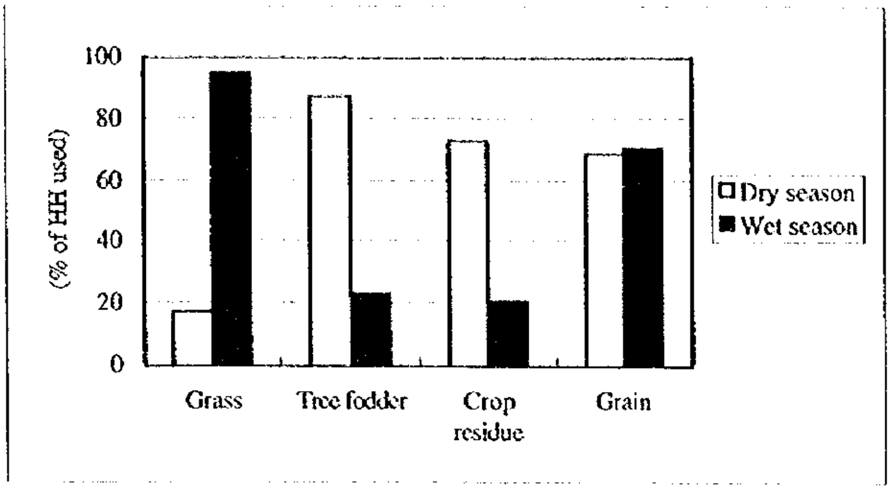


Fig. 3-11 Importance of Animal Feed in Dry and Wet Seasons

According to the Household Survey, 45% and 36% of the sample households reported "short" or "very short" in animal feed in dry and wet seasons respectively.

Meanwhile, the survey revealed that larger proportion of occupational castes, compared with other castes, have faced severer shortage of animal feed, despite the smaller number of livestock they own.

3-3-5 Forest

(1) Community and Private Forest

About 17% of the sample households possessed private forest with the average area of 0.18 ha per household. The proportion was slightly higher in Parbat district than Kaski district. Meanwhile, the proportion was the smallest in occupational castes.

Forest is an integrated part of life in the area. There is a growing popularity in protecting and managing the limited resource by organizing themselves as forest users' group (FUG). According to the Household Survey, about 47% of them reported they were members of FUG (either formal or informal). There was no difference in the participation in FUGs among caste groups. In Puranchaur, Sildujure and Sardikhola VDCs in Kaski North model area in particular, 100% of sample households were FUG members.

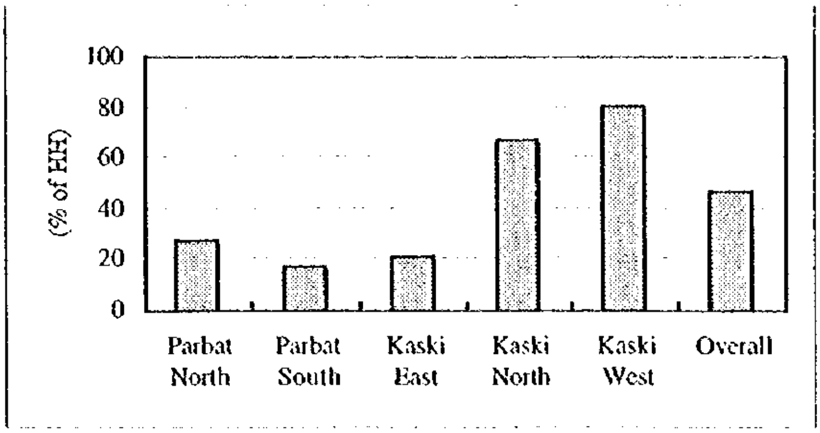


Fig. 3-12 Proportion of Households Belonging to Forest Users' Group

(2) Private Trees

People in the model area has grown a variety of horticultural trees for home consumption as well as for marketing. The average number of horticultural trees per household was 11.8 trees. They include orange, banana, guava, lime, papaya, pear, mango, litchi, and coffee. Banana, mango and litchi prefer hot climate and thus grow mainly in lower altitude. Meanwhile lime, lemon, orange, pear and guava are grown in comparatively higher altitude.

Beside horticultural trees, people privately grew and managed trees for the purpose of producing fodder, fuelwood, timber and crafting materials. On average, one household owned about 55 trees. Of these, about 60% were for the purpose of fuelwood production and the rest was for fodder and timber production. The occupational castes households possessed quite few number of trees compared to other caste groups.

3-3-6 Cottage Industries

Rice mills, poultry farming, bamboo works, and wood processing were only cottage industries operating in the model areas. Rice mills exist in almost all VDCs in the model areas. Poultry farming was observed in a number of VDC and the products were sold to nearby markets. Bamboo works and wood processing were limited in number probably due to low demands in the area.

Though there are limited number of cottage industries in the area, quite large number of the population have acquired one or more traditional skills such as carpentry, mason, bamboo crafting, and tailoring. Their skills have been utilized from time to time within or in the vicinity of the model area. Further, more than 1,500 persons have earned their livelihood by working as porter in the model areas.

3-3-7 Current Condition of Infrastructure

(1) Condition of Existing Trails

Foot trails, both stone paved and unpaved, are the main form of access between communities in the area. Fuelwood, fodder, timber, animal products and other commodities are transported by these foot trails. In Model Areas, foot trails are constructed by the Village Development Committees (VDCs), District Development Committees (DDCs), JICA Project, District Soil Conservation Offices (DSCOs) and NGOs active in the area. The standard riser size, tread size, overlap and width of the foot trails constructed by VDCs and DDCs are 15cm, 50cm, 15cm and 1.0m ~ 2.0m respectively. The standard sizes for the trails built by DSCOs and NGOs are a riser of 15cm, a tread of 40cm - 50cm, overlap of 15cm and a width of 1.20m. The maximum gradient of a trail to be constructed is set at 28 degrees.

As was observed during the field survey, most of the trails having steep gradients were paved with stones and generally met the above-mentioned standards. However, the drainage, which is necessary to control surface run-off and therefore erosion of the trails and their surroundings, especially those trails that are built on steep slopes, is rarely provided. There are examples of trails built on steep upper slopes and without the provision of proper drainage facilities in Model Areas, the concentrated run-off from which is suspected of being one of the main triggering factors of landslides in the lower sections of the same slopes. The aggregate trail length by Model Area is as shown in Table 3-27.

Table 3-27 Aggregate Trail Length in the Model Areas

Trail length unit: km

Category	Model Area					Total
	Kaski North	Kaski East	Kaski West	Parbat North	Parbat South	
Trail	293.5 (20.9)	163.0 (29.8)	225.0 (22.7)	193.3 (24.5)	123.0 (32.0)	997.8 (24.2)

Note: ① Length of the existing trails by Model Area was measured on topographic maps of the Scale 1/25,000.
② As some sections of the trails in forested area do not appear on topographic maps due to crown cover, the actual aggregate trail length may be somewhat longer than given in the table.
③ Figures in ( ) show trail density in meters per hectare.

(2) Condition of Roads

The surface condition of the asphalt-paved Sidhartha highway, running in Kaski West Model Area, is good and where necessary side drains are constructed to safely drain the surface run-off. There are a number of landslides and gullies along the highway which are dealt with by Department of Roads.

Such feeder roads as Pokhara to Lamachour VDC road, Pokhara to Armala VDC road, road in Kahun village and Jimira Yoil to Amalchour road, all located in Kaski North Model Area, are running along the valley floors and in relatively flat areas. A particularly serious erosion of roads located in such topography is not expected. However, some sections of these roads may be affected by flooding during the monsoon season. Also the road surfaces are in poor conditions, disturbing the traffic, and therefore, necessitating proper gravel paving of the surfaces, drainage ditch improvement and regular maintenance of these roads.

The newly built road in Amalchour, Kaski North Model Area and the road extended from the Sidhartha highway at Tilahar as well as the newly built road between Phurse Khola and Kristi in Kaski West Model Area are constructed by relevant VDCs under the supervision of Kaski DDC Road Office. These roads are running along the ridges and in steep sections of the hillslopes. As was observed during the field survey, cut and fill slopes along these roads are not protected and stabilized, side drains and gravel paving are mostly lacking and in some sections road surface grades are steep and curve radius insufficient. All of these resulted in erosion of the cut and fill slopes as well as surfaces of these roads. Moreover, if the situation continues unchecked the roads may even become unsuitable for use by vehicles during the monsoon season.

According to Department of Roads, the standard width (carriage way) for the asphalted highway is 6.5m. The standard width for the feeder roads is 4.5m while the standard side drains for both type of roads is 1.0m. The aggregate road length by Model Area is as shown in Table 3-28.

(3) Permanent Springs

Seasonal and permanent springs are found in Model Areas. The water from seasonal springs appears only during the monsoon season and is used for irrigating paddy lands. On the other hand, water from permanent springs seldom dries up during the dry season, provides a source of stream baseflow and is used for domestic water, drinking water for livestock and irrigation water. In this sense, permanent spring water is one of the most important water sources in Model Areas. Drinking water supply organizations, JICA project and NGOs supply spring water to villages via pipes using the gravity method. Table 3-29 (A~E) give the flow rate and pH of the water and land use of water source area of some permanent springs in Model Areas.

Except the 2 springs in Kaski North Model Area which have high discharges of over 100 ℓ/minute, other springs are having medium to low discharges. Variations in pH values of water from the springs are may be due to the influence of rock types (geological material) through which the water comes. The water from those springs having low or high pH values may have to be examined from the view point of water use based on the water quality standards in force in Nepal.

Table 3-28 Aggregate Road Length by Model Area

Road length Unit: km

Road Category		Model Area					Total
		Kaski North	Kaski East	Kaski West	Parbat North	Parbat South	
Highway	Sidhartha highway	-	-	11.5	-	-	11.5
Feeder road	Pokhara to Lamachour VDC	5.5	-	-	-	-	5.5
	Newly built road (1997) between Sunar Gaun and Kure Chour, Lamachaur VDC and Armala VDC	-	-	-	-	-	2.0
	Pokhara to Armala VDC	2.5	-	-	-	-	2.5
	Road in Kahun Village	2.3	-	-	-	-	2.3
	Jimira Yoil to Amalchour along Vijaipur Khola, Arba Vijaya VDC	3.0	-	-	-	-	3.0
	Newly built (1996) road in Amalchour, Arba Vijaya VDC	2.0	-	-	-	-	2.0
	Road extended from Sidhartha highway at Tilahar to Muresowara, Pumdibhumdi VDC	-	-	7.0	-	-	7.0
	Newly built road (1996) between Phurse Khola and Kristi, Kristi Nachnechour VDC	-	-	7.0	-	-	7.0
Total		17.3 (1.1)	-	25.5 (2.6)	-	-	42.8 (1.0)

Note: ① lengths of the existing roads by Model Area were measured on topographic maps of the Scale 1/25,000. Information on the lengths of the new roads built in 1996, 77 which are not shown on the topographic maps, was collected from the relevant VDC and/or estimated.

② Figures in ( ) show road density in meters per hectare.

Table 3-29 Location, Discharge, pH Value and Land Use of Water Source Area of Some Permanent Springs in 5 Model Areas

A. Kaski North Model Area

Spring location		Discharge	pH	Land use of water source area	Remarks
VDC, Ward No.	Community	(ℓ/minute)			
Kalika, 3	Deomadi	120	8.0	Hardwood forest, C.D. 40-70%	High discharge
Kalika, 6	Thuloswara	12	6.5	Hardwood forest, C.D. 10-40%	
Kalika, 3	Sunpadeli	13	7.0	Valley floor	
Sildujure, 9	Chilaunedanda	13	7.8	Hardwood forest, C.D. 40-70%	
Sildujure, 9 or 8	Chhachok	14	7.1	Hardwood forest, C.D. 40-70%	
Sildujure, 8	Thak	13	6.2	Hardwood forest, C.D. 10-40%	
Arba Vijaya, 6	Chisapani	12	7.4	Hardwood forest, C.D. >70%	
Arba Vijaya, 9 or 1	Pandanda	15	6.8	Hardwood forest, C.D. 40-70%	
Mauja, 9	Gaunje	17	6.5	Hardwood forest, C.D. >70%	
Mauja, 1	Mohoria	110	6.1	Hardwood forest, C.D. 10-40%	High discharge
Mauja, 1 or 4	Antighari	6	7.7	Sloping terrace	
Armala, 5	Ranjeet	13	8.1	Grassland	
Armala, 1	Gharmi	5	5.9	Paddy land	
Armala, 1 or 3	Jumleti	7	7.7	Hardwood forest, C.D. 10-40%	
Armala, 3	Harpak	12	7.3	Paddy land	
Ghachok	Ghachok	70	6.0	Old river terrace	
Sardi Khola, 3	Bhurjung Khola	13	7.2	Hardwood forest, C.D. 10-40%	

Note: ① Data on spring discharge, water pH and community names were collected from Geological Survey (Conducted under this study), Main Report, MRE Unit, Tribhuvan Univ., 1996. Information on land use-vegetation and VDC, ward No. was obtained from land use-vegetation maps and maps showing administrative boundaries in Model Areas, respectively.

② C.D. = crown density of forest trees.

B. Kaski East Model Area

Spring location		Discharge	pH	Land use of water source area	Remarks
VDC, Ward No.	Community	(ℓ/minute)			
Deurali, 4	Deurali	5.0	8.4	Hardwood forest, C.D. >70%	
Deurali, 5 or 6	Gairagaon	10.0	7.8	Hardwood forest, C.D. >70%	
Siddha, 6 or 5	Dungagare	3.0	7.7	Hardwood forest, C.D. >70%	
Deurali, 1	Malepatan	0.2	8.8	Old river terrace	
Deurali, 1	Malepatan	0.2	9.1	Hardwood forest, C.D. >70%	
Deurali, 2	Deuraliphedi	3.0	7.8	Hardwood forest, C.D. >70%	
Deurali, 2	Anpu Khola	2.0	7.7	Sal forest, C.D. >70%	
Deurali, 5	Bhorle	30.0	7.6	Hardwood forest, C.D. >70%	
Thumki, 7 or 6	Ukhubari	20.0	7.8	Sloping terrace	
Thumki, 1	Majhkot	1.5	8.5	Sloping terrace	
Thumki, 1 or 4	Ghunguwà	4.0	8.8	Sal forest, C.D. >70%	
Thumki, 1	Bategoan	2.5	9.0	Sal forest, C.D. >70%	
Thumki, 5	Siastri	1.0	8.5	Hardwood forest, C.D. >70%	
Thumki, 3	Phalyngkot	5.0	7.9	Hardwood forest, C.D. >70%	
Siddha, 5 or Deurali, 6	Northeast of Chisapani	8.0	7.7	Hardwood forest, C.D. >70%	
Thumki, 7 or 5	Charpe	1.5	8.4	Hardwood forest, C.D. >70%	
Deurali, 2 or 3	Beteni	2.0	7.9	Hardwood forest, C.D. >70%	

C. Kaski West Model Area

Spring location		Discharge (l/minute)	pH	Land use of water source area	Remarks
VDC, Ward No.	Community				
Kristi Nachnechour, 8	Kristi	3.0	8.7	Hardwood forest, C. D. 40-70%	
Kristi Nachnechour, 9	Bhaldara	15.0	8.5	Hardwood forest, C.D. 40-70%	
Pumdibhumdi, 3	West of Ramadi	2.0	8.4	Hardwood forest, C.D. 40-70%	
Pumdibhumdi, 3	Archalbot	6.0	8.1	Hardwood forest, C.D. >70%	
Pumdibhumdi, 6 or 5	Kalabang	1.5	8.7	Hardwood forest, C.D. 40-70%	
Pumdibhumdi, 6	Kavre	2.0	7.9	Sloping terrace	
Pumdibhumdi, 5 or 3	Anadu	6.0	8.8	Hardwood forest, C.D. >70%	
Chapakot, 3	Jaubari	1.5	7.9	Hardwood forest, C.D. >70%	
Pumdibhumdi, 8	Tore Khola	5.0	7.7	Hardwood forest, C.D. >70%	
Chapakot, 8	Handi Khola	30.0	7.9	Hardwood forest, C.D. >70%	
Chapakot, 6	Bamdi	2.0	8.2	Hardwood forest, C.D. >70%	
Bhadaure Tamagi, 9	Sidhane	5.0	8.0	Hardwood forest, C.D. >70%	
Bhadaure Tamagi, 8	Sidhane	3.0	7.9	Hardwood forest, C.D. 40-70%	
Bhadaure Tamagi, 8	Panchase	2.0	7.9	Hardwood forest, C.D. 40-70%	
Bhadaure Tamagi, 1	Damdame	10.0	8.3	Hardwood forest, C.D. 10-40%	

D. Parbat North Model Area

Spring location		Discharge	pH	Land use of water source area	Remarks
VDC, Ward No.	Community	(ℓ/minute)			
Kurgha, 8	Lame	15	7.8	Hardwood forest, C.D. 10-40%	
Limithana, 2	Khalte	10	7.2	Paddy land	
Bhangara, 7	Bhangara	4	8.1	Hardwood forest, C.D. 40-70%	
Bhangara, 5	Sirubari	6	6.9	Hardwood forest, C.D. >70%	
Bhangara, 4	Kaule	2	6.5	Paddy land	
Limithana 2 or 5	Thana	20	7.7	Sloping terrace	
Devisthan, 2	Phalebas	3	8.3	Shrub land	
Thapa Thana, 8	Ghaiyara	15	7.1	Paddy land	
Shankar Pokhari, 5 or 1	Nuwara	20	7.9	Sloping terrace	
Shankar Pokhari, 4 or 5	Sankarpokhari	6	7.9	Sloping terrace	
Shankar Pokhari, 4	Ratmata	8	8.0	Paddy land	
Thapa Thana, 7	Bhindabari	30	7.2	Paddy land	
Bhangara, 1	Limi Khola	14	7.1	Hardwood forest, C.D. 40-70%	
Bhangara, 1 or 2	Lasi Khola	6	7.8	Sloping terrace	
Bhangara 2	Gairiswara	35	8.1	Sloping terrace	
Khoula lankuri, 3	Sisnepani	15	8.5	Paddy land	
Thuli Pokhari, 2	—	3	9.1	Sal forest, C.D. >70%	
Thuli Pokhari, 1	Kalpata	7	7.3	Paddy land	

E. Parbat South Model Area

Spring location		Discharge	pH	Land use of water source area	Remarks
VDC, Ward No.	Community	(ℓ/minute)			
Beulibas, 5	Beulibas	40	7.7	Sloping terrace	
Beulibas, 8	Dungrung	3	7.3	Hardwood forest, C.D. 10-40%	
Huwas, 2	Khasiathok	2	6.8	Sloping terrace	
Huwas, 5	Dharadi	12	7.9	Sloping terrace	
Sarau Khola 8 or 7	Hile	2	8.0	Sloping terrace	
Beulibas, 3	Bharabari	5	9.1	Hardwood forest, C.D. >70%	
Sarau Khola, 3	Sadane	45	7.2	Hardwood forest, C.D. >70%	
Sarau Khola, 2	Sadane	5	7.5	Sloping terrace	
Sarau Khola, 3	Sadane	25	7.5	Sloping terrace	
Hosrangdi, 6	Hosrangdi	2	8.2	Paddy land	
Hosrangdi, 4	Hosrangdi	25	7.8	Hardwood forest, C.D. 40-70%	
Hosrangdi, 8 or 3	Pallogoradi	15	7.3	Hardwood forest, C.D. >70%	
Hosrangdi, 9 or 4	Medi Khola	20	7.7	Sloping terrace	
Hosrangdi, 1	Argaundi	5	7.4	Shrub land	

3-3-8 Role of Men and Women

In the survey, sampled adult members were asked about the frequency of their involvement in major activities, in order to identify the role of male and female members of households. The activities were grouped into seven categories, namely (1) home activities, (2) farming activities, (3) livestock raising, (4) forestry activities, (5) domestic business, (6) communication, (7) religious and cultural activities. It is important to note that there were quite large variation in the survey results at VDC and ward levels.

(1) Home activities

Home activities include fetching water, cooking, washing, sweeping house, house repair, child or elderly care, kitchen gardening, sewing / knitting, and shopping in bazaar. The survey results shows that women are much more responsible for all the activities except shopping in bazaar. This findings very well reflects the traditional and general practices of villagers in Nepal.

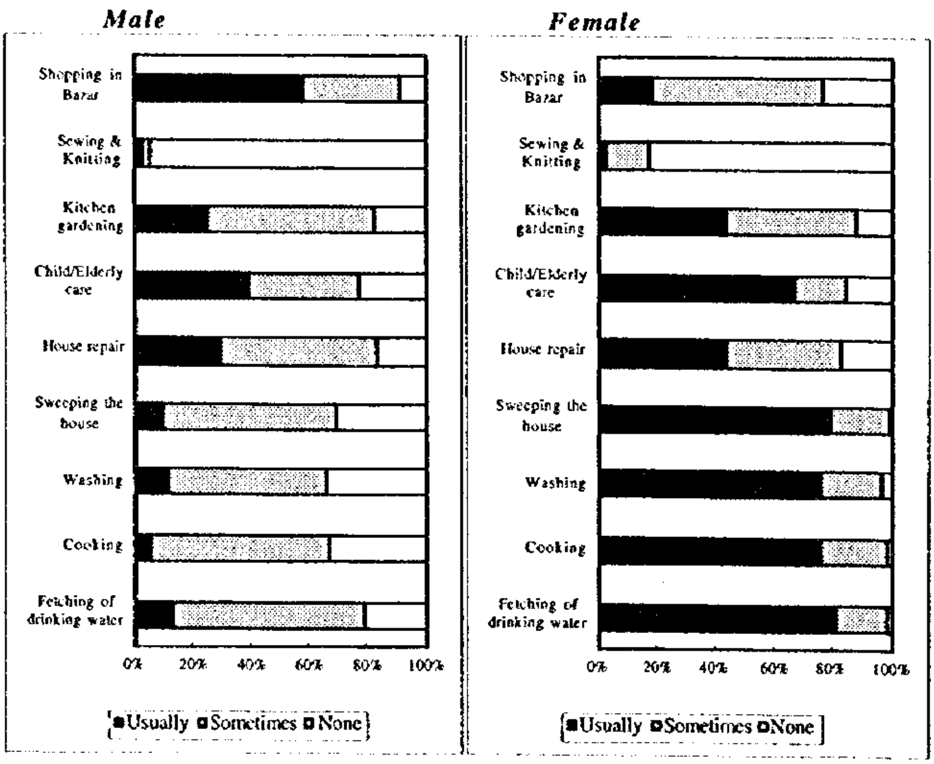


Fig. 3-13 State of Involvement in Home Activities by Sex (Overall)

(2) Farming activities

The responsibility of most of the farming activities lies in women farmers as shown in the following figure. Men were found responsible only for activities that require physical inputs or some special technique, such as plowing, applying fertilizer, and repairing terrace.

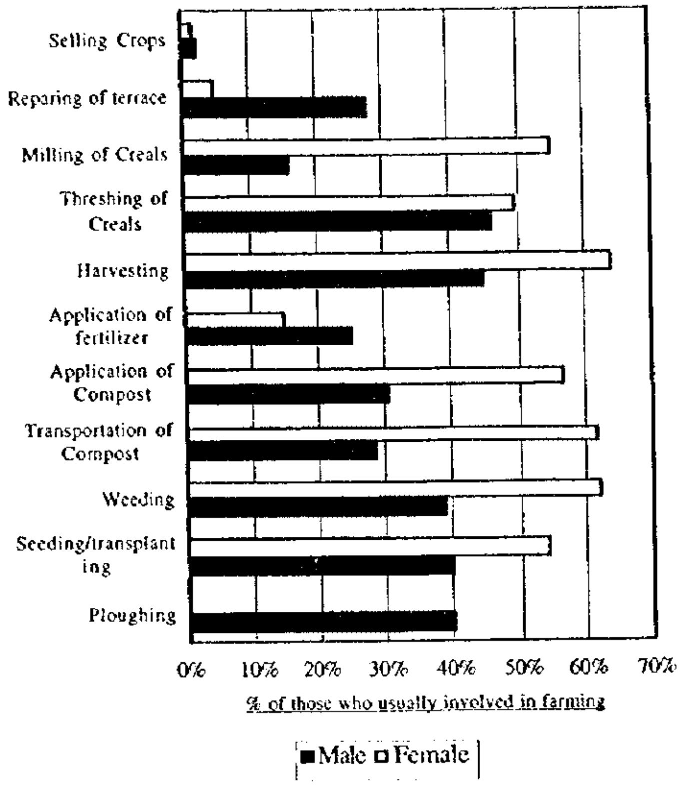


Fig. 3-14 State of Involvement in Farming by Adults

There was no remarkable difference between occupational castes and others in the state of female's participation in farming activities. However, male member of occupational caste engaged more in plowing than others, despite their small holding of farm. This indicates many of them worked for plowing their patron's farm.

As for age difference, women at the ages of 20s and 30s were most active for farming activities: about 80% of them usually involved in farming. Among male members, the group of age 40s was most active for farming. Younger male members (ages 20s and 30s) were less involved in farming probably because many of them were away from village for the certain period of a year.

(3) Livestock raising

Women usually worked for collecting fodder, feeding and watering animals, and sweeping livestock stalls. Men also involved in these activities but to a lesser extent as shown below.

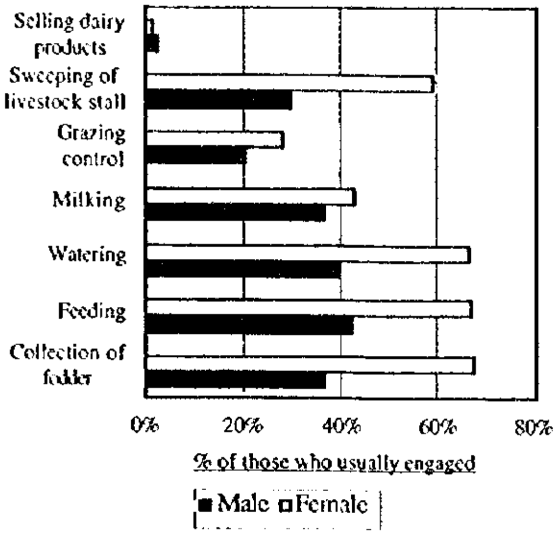


Fig. 3-15 State of Involvement in Livestock-related Activities

No remarkable difference was found out between occupational castes and others for the involvement in the activities, except for milking. As for the difference in age groups, males at the age of 50s were the most active, while females 30s.

(4) Forest activities

Gender role seems to be well defined with regard to forestry-related activities. Women were found engaged more in collection of fuelwood and leaf litter than men. They usually carried out the activities together with neighbors. On the other hand, men were generally engaged more in timber harvesting than women, although it was not carried out often in the area.

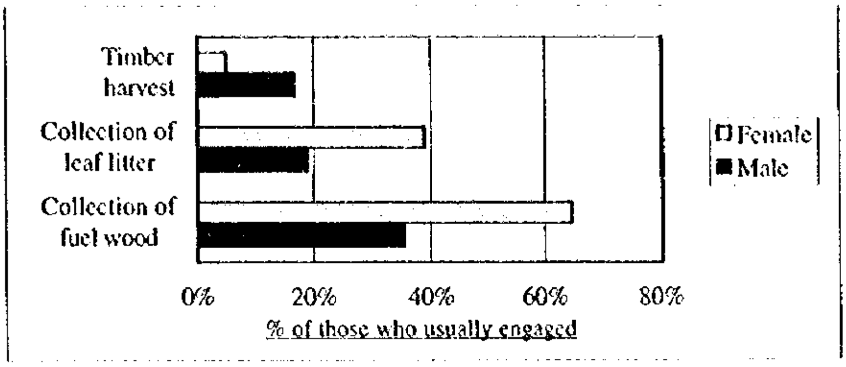


Fig. 3-16 Gender Role in Forest-related Activities

Comparing occupational castes with others, both men and women of occupational castes involved more in fuelwood collection. The survey also found out that younger women involved more in fuelwood and leaf litter collection than older ones.

(5) Domestic Business

Very small number of respondents were found engaged in domestic business like shop keeping and manufacturing goods. The proportion of male members' participation was comparatively higher than females'. Among men, many of occupational caste households worked for manufacturing goods because some of them are black-smith, carpenters, and tailors.

(6) Communication related activities

Most of the communication related activities such as message delivery, information gathering from TV, radio and papers, conflict resolution, and discussion with others were dominated by male members of households. Female members also involved in the activities, but to the lesser extent than male.

Occupational caste households were likely to have lesser means in getting information than other castes. In addition, the members of occupational castes were less involved in community meetings and the delivery of message than others. Meanwhile, there was a clear division of activities between young and old. Young people involved more in information gathering from newspaper, TV and radio than old ones. On the contrary, older people participated in community meetings and resolving village conflict more than younger ones.

The survey also found out that, unlike other activities, people become active for the communication-related activities as their educational status raises. This indicates that people with higher education attainment are more aware of external information and the development of their villages.

(7) Religious and cultural activities

For religious and cultural activities, female played leading role but the gender difference were found smaller than other activities. Among the activities, people tended to actively involve in festival preparation and worship ceremony.

Of the caste groups, the occupational castes were the least active for festival preparation and worship ceremony. Age difference was quite notable for the participation in religious and cultural activities: young people prefer dance party, picnic, film watching and games, while older ones were active in festival and worship.

3-3-9 People's Needs, Concerns and Aspirations

(1) People's Needs for Lessening the Burden of Works

The top five work items that men and women wanted to make easy are listed below:

	Men's priority	Women's priority
Collection of fuelwood	1 (40.7)	1 (52.2)
Fetching of drinking water	2 (29.2)	2 (37.7)
Ploughing	3 (28.6)	- (0.6)
Collection of fodder	4 (25.7)	3 (34.1)
Shopping in bazaar	5 (23.9)	- (15.6)
Cooking	- (12.8)	5 (20.0)
Transportation of compost	- (14.8)	4 (31.3)

(Figures in parenthesis indicate the score)

Both sex gave first and second priority to fuelwood collection and fetching of drinking water, respectively. Collection of fodder was ranked similarly; fourth and third by men and women respectively. The common feature of these works is hardship. Though women have the main responsibility for these works, men also involved in such works sometimes. This resulted in similar ranking by both sex.

Plowing of land was ranked third by men while the women's score was almost zero. This reflected a fact that the work has been done almost exclusively by men. Shopping in bazaar was another hard work for men because it requires a physical strength to carry food and living necessities from market to remote villages.

(2) People's Concern and Aspirations

The top 10 concerns or aspirations by sex are shown below:

Concerns	Men's priority	Women's priority
Cash income	1 (90.5)	1 (89.4)
Motable road	2 (89.1)	2 (87.5)
Irrigation	3 (79.7)	3 (76.7)
Crop productivity	4 (76.9)	5 (74.7)
Food availability	5 (76.7)	4 (76.5)
Communication facility	6 (76.2)	9 (67.6)
Forest resource	7 (70.4)	8 (68.1)
Electric supply	8 (68.6)	10 (67.5)
Education of children	9 (68.0)	7 (68.8)
Fuelwood availability	10 (67.7)	6 (70.1)

(Figures in parenthesis indicate the score)

Majority of respondents, both men and women, were strongly concerned about cash income and motable roads. This could be understood as a strong aspiration for economic development.

Though the result shows similarity in the degree of concern between men and women, there were some items that given different scores by both sex. Men gave higher score for terrace maintenance, political discussion and meeting on community development than women did. By contrast, women gave higher score to worship of god than men did.

When looking at the ranking by model area, it well reflected the characteristics of each model area: people in Kaski North and West model areas were less concerned about communication facilities, electricity and motable road than the people in other model areas; people in Kaski East, Parbat South and North model areas were more concerned on electricity and motable road than cash income; and people in Kaski East model area showed much smaller concern on fuelwood than the people in other model areas.

For occupational castes, food was as important as cash income. Their degree of concerns on living necessity such as fodder, fuelwood and drinking water was comparatively higher than that of other castes. By contrast, the desire for goods and conditions that are not essential for living was lower among occupational castes than others.

(3) Participation in Community Activities

① Experiences of participation

For most of the community activities, men had more experiences in participation than women did. Particularly for income generation and community meeting, men's experiences in participation was much larger in proportion than women.

The experience in participation seems to be high for activities for which external assistance were provided. Examples are activities related to drinking water supply, electric supply and motable road. According to the survey, people in Kaski district involved more in such activities because the assistance from NGOs or governmental agencies has been available in that area.

② Willingness to participation in community activities

The respondents showed quite good willingness to participate in most of the activities. This is partly because the question did not limit "yes" answer. Exceptions were for labor force availability, self education, family planning, sanitation, and political discussion.

3-3-10 Perception on Importance of Forest

(1) Importance of forest

People were asked to prioritize the important functions of forest. The overall results are in the following order:

	Score
1. Fuelwood source	(87.8)
2. Fodder source	(64.8)
3. Timber source	(52.0)
4. Leaf litter source	(34.5)
5. Soil conservation	(26.9)
6. Water conservation	(15.9)

Further analysis for the importance of forest was made for model areas, caste groups, age groups, and educational status groups. The major findings are summarized below:

① There was no remarkable difference in the perception of forest between the people of the five model areas.

② Women placed more importance on the functions of supplying fuelwood, fodder , and leaf litter than men did.

③ Men placed more importance on the soil and water conservation functions of forest than women did.

④ Occupational castes paid less attention to water and soil conservation function of forest than other castes.

⑤ Younger people placed more importance on the water and soil conservation function of forest than older people did.

⑥ People with higher education status gave higher importance to the water and soil conservation functions of forest than those with lower education status.

⑦ People with lower education status, by contrast, placed higher importance to forest products than those with higher education status.

(2) Measures to improve forest condition

The survey also inquired respondents to prioritize the measures to improve the production and conservation function of forest. Overall results of the model areas are given below:

Table 3-30 Measures Selected by Respondents for the Improvement of Forest Function

Unit : % of respondents

Measures	Functions of Forest					
	Fuelwood production	Fodder production	Leaf litter production	Timber production	Soil conservation	Water conservation
Tree planting in private land	25	52	26	21	25	4
Tree planting in community land	17	27	36	22	21	15
Protection of forest	13	17	38	53	50	78
Use of biogas as an energy source	28	1	1	3	1	1
Use of gas cylinder	0	0	0	0	0	0
Use of kerosine	1	0	0	0	0	0
Use of improved stove to reduce fuelwood consumption	16	0	0	1	0	1
Others	1	4	1	1	3	2

Source: Household Member Survey, JICA/Multi Disciplinary Consultants (P) Ltd. (1996)

The table clearly indicates that people chose different measures for different purposes. They generally preferred tree planting for the improvement of fodder and leaf litter production, while emphasized forest protection for the improvement of timber production and for the conservation of soil and water. Comparatively many people chose the use of biogas and improved stove as the measures for the improvement of forest as fuelwood source. This means people seriously consider the reduction of fuelwood consumption rather than the production increase. There was a tendency that people in Kaski district paid more attention to the use of improved stove and biogas than those in Parbat. Probably people in Kaski district have been better influenced by the active support for such matters by NGOs and donor agencies.

The difference in the responses by caste group, sex, age group, and education status group were analyzed. The major findings are:

① "Tree planting in private land" was not a popular measure among occupational castes because many of them do not own private land.

② The use of biogas and improved stove as the measures to improve fuelwood condition were not popular yet among occupational castes. This suggests their poorer access and affordability to such technologies.

③ There is a tendency that younger people emphasized more on the use of biogas as a measure to improve fuelwood condition than older people.

④ Similarly, people with higher education status gave higher importance for the use of biogas than those with lower education status.

⑤ People with lower education status emphasized more on protection of existing forest rather than new plantation of trees. People with higher education status, by contrast, showed the reverse attitude.

3-3-11 Measures to Prevent Natural Disasters

Respondents were asked about their preference to the preventive measures against landslide and terrace destruction.

(1) Preventive Measures for Landslide

In the five model area as a whole, people prioritized the preventive measures against landslide in the following order: 1) check dam construction, 2) tree planting in the upstream of landslide prone area, 3) controlled use of landslide prone area, and 4) construction of drainage ditch. There was no difference in the ranking order between caste groups. However, younger people tended to give more emphasis on tree planting than old ones. People with higher education status had the same inclination as the younger people had.

(2) Preventive Measures for Terrace Destruction

The respondents expressed their preference to preventive measures against terrace destruction in the following order: 1) regular maintenance of terrace, 2) tree planting in upstream of farm land, 3) construction of drainage ditch, and 4) others. No remarkable difference was found in the selection of measures between caste groups, sex, age groups, and groups of educational status. Since the questionnaire provided only few possible answers, many respondents specified measures other than the answers provided. The measures specified by respondents include stone wall, gabion wall, construction of stronger ridge, land consolidation, rat control, etc.