Chapter 3
LAND USE

This chapter commences with a description of the climate and vegetation in the study area. These environmental factors are followed by an assessment of land-use change over nearly four decades.

1. Climate and Vegetation

Climate: The climatic data are based on records of two observation stations within the study area. One was located at Nunkhani (1,030m), once a flourishing salt-brine on the left bank of the Marsyangdi (Rayamajhi et al. 1946). Another one is located at Khudi (859m), about 12 kilometres downstream from Nunkhani (Figure 2). The records of the former refer from 1943-46 in Nepalese months and the latter from 1965-98 in Gregorian months. These data have been used for local comparison despite their temporal disparity.

Although Nunkhani is 171 metres higher in elevation than Khudi it has a slightly higher annual average temperature (Table 3). This discrepancy is due to the locational factor. Khudi lies in an open valley while Nunkhani is in a deep gorge. Both places have high temperatures in July and low ones in January (Table 3 & Figure 16). The discrepancy between maximum and minimum temperature is 11.3 C° for Nunkhani and 12.1 C° for Khudi. Nunkhani has comparatively higher temperatures during the months from March to May. Temperature difference between the two places is most pronounced in December. Temperature variation is also highest at both stations during December.

The average annual rainfall varies from 2,534.9 mm at Nunkhani to 3,317.7 mm at Khudi (Table 4). Both places record their lowest rainfall during December (Table 4 & Figure 17). The maxima period occurs in July at Khudi and September at Nunkhani. The wettest period at Khudi occurs during June-August while it is from July-September at Nunkhani. The latter place recorded more rainfall during January, April, and September through November than at Khudi.

The study area has high temperatures during the summer. Winter is mild as snowfall occurs only on high ridges above 2,000 metres. Monsoon rain is also plentiful with a brief westerly shower in winter. Thus, the climate is suited to year-round crop cultivation. The only limitation is the occasional hailstorm during the Spring and Autumn.

Figure 16: Temperature at two locations

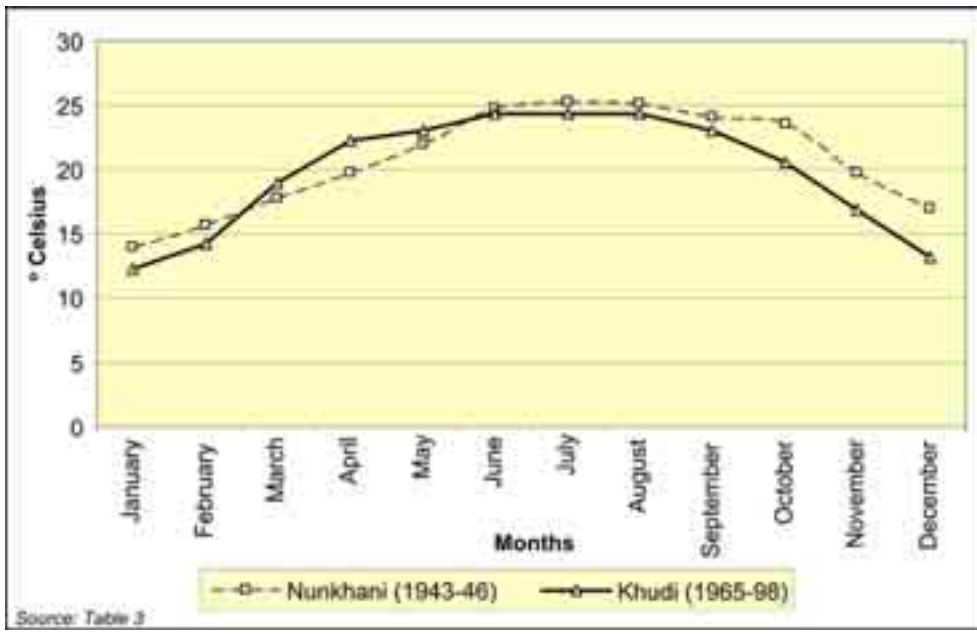


Table 3: Temperature at t wo locations

Nunkhani 1943 -46a		Khudi 1965 -98b	
Months	Celsius	Months	Celsius
1. Pus (mid-December/mid-January)	14.0	January	12.3
2. Magh (mid-January/mid-February)	15.6	February	14.2
3. Falgun (mid-February/mid-March)	17.7	March	18.9
4. Chaitra (mid-March/mid-April)	19.8	April	22.2
5. Baisakh (mid-April/mid-May)	22.0	May	23.0
6. Jetha (mid-May/mid-June)	24.7	June	24.3
7. Ashar (mid-June/mid-July)	25.3	July	24.3
8. Sharwan (mid-July/mid-August)	25.1	August	24.4
9. Bhado (mid-August/mid-September)	24.1	September	23.0
10. Asoj (mid-September/mid-October)	23.6	October	20.5
11. Kartik (mid-October/mid-November)	19.8	November	16.9
12. Mangsir (mid-November/mid-December)	17.0	December	13.1
Annual Average	20.7	Annual Average	19.8

Sources: a. Rayamajhi et al, 1946
b. Dept. of Hydrology & Meteorology of HMG Nepal

Figure 17: Rainfall at two locations

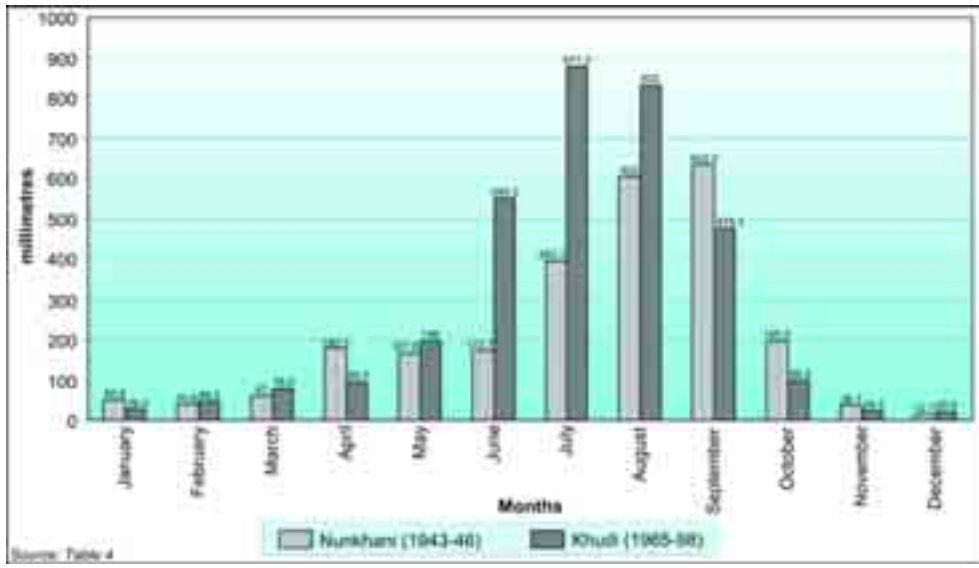


Table 4: Rainfall at t wo locations

Nunkhani 1943 -46a		Khudi 1965 -98b	
Months	mm	Months	mm
1. Pus (mid-December/mid-January)	50.8	January	26.4
2. Magh (mid-January/mid-February)	40.6	February	48.2
3. Falgun (mid-February/mid-March)	61.0	March	78.5
4. Chaitra (mid-March/mid-April)	180.3	April	95.5
5. Baisakh (mid-April/mid-May)	167.6	May	198.0
6. Jetha (mid-May/mid-June)	172.7	June	548.3
7. Ashar (mid-June/mid-July)	393.7	July	877.2
8. Sharwan (mid-July/mid-August)	602.0	August	832.0
9. Bhado (mid-August/mid-September)	632.5	September	475.4
10. Asoj (mid-September/mid-October)	195.6	October	99.3
11. Kartik (mid-October/mid-November)	38.1	November	24.9
12. Mangsir (mid-November/mid-December)	12.7	December	20.9
Annual Average	2,534.9	Annual Average	3,331.7

Sources: a. Rayamajhi et al, 1946
b. Dept. of Hydrology & Meteorology of HMG Nepal

Vegetation: The study area lies just above the tropical *Shorea robusta* (sal) forest zone. Thus, most of it is in the sub-tropical wet forest zone with *Schima wallichii* (chilaune) and *Castanopsis indica* (katus) as the indicator plants (Figure 18). This zone is superseded at about 1,900 metres in elevation by lower temperate forest of *Rhododendron arboreum* (gurans) and *Quercus lamellosa* (phalat). Since Zones 5 and 6 of the ecological map (Dobremez & Jest 1970) are virtually the same, the study area represents only two forest zones: tropical (7) and lower temperate (6). Forest zone boundaries in the ecological map shown are too much aligned to the contour line. In reality, floral composition differs much according to the aspect. Thus, south-facing slopes (pahara) have drier plant species while north-facing slopes (sinyala) have a richer variety of shade-loving plants.

Schima wallichii and *Castanopsis indica* are both East Himalayan species and extend into the humid parts of the central hills (Stainton 1972). Thus, *Schima-Castanopsis* forest is most conspicuous at 1,000-1,900 metres elevation in the study area. It is not, however, very extensive since the level corresponds with the zone of maximum cultivation. The lower section of this forest has *Bauhinia variegata* ('koiralo'), *Berberis* spp. *leontice* ('kaphal'), *Rhus acuminata* ('bhalayo'), *Acer oblungum* (pirpire), *Cretaegus crenulata* (ghangaru) and *Berberis nepalensis* ('chutra'). Higher up, the common associates are *Fraxinus floribunda* ('lankuri'), *Juglans regia* ('okhar'), *Michelia champaca* ('chanp'), and *Alnus nepalensis* ('utis'). *Pandanus furcatus* and other species of wet mixed forest are common in shaded gulleys.

Quercus lamellosa is an East Himalayan oak species and occurs abundantly in the lower temperate zone of the study area (Op cit. pp.89-91). It predominates at 1,900-2,500 metres. Since this elevation zone lies above the cultivation zone, such oak forest forms a continuous belt above the sub-tropical forest and below upper temperate forest. *Quercus lamellosa* forest has dense undergrowth of shrubs such as Hydrangea, Viburnum, ferns and of *Arundinaria* (nigalo) in shady places. The trees are festooned with epiphytes, orchids, and mosses.

2. Land-use Change (1958-1996)

The Land Resource Mapping Project (LRMP) defined land capability as the inherent capacity of land to be productive under, and sustain, specific management methods (Carson 1986). Its mapping exercise combines three criteria: class, sub-class, sub-division. The classes are based on the degree of slope, sub-classes on temperature regime, and sub-divisions as moisture regime. Accordingly, valley bottoms of the study area are classified as Class II Au or land with 1-5° slope, sub-tropical and sub-humid (Figure 19).[3] The lower hill slopes are placed in Class III, with 5-30° slope and sub-tropical (A) to warm temperate(B) sub-class. The higher slopes are in Class IV with over 30° slope and sub-tropical (A) to warm temperate (B) sub-class. The moisture regime is humid for warm temperate and sub-humid for sub-tropical sub-classes.

[3] Map sheet 71 D/7, scale 1:125:000, see Figure 19

Figure 18: Ecological map (after Dobremez 1970)

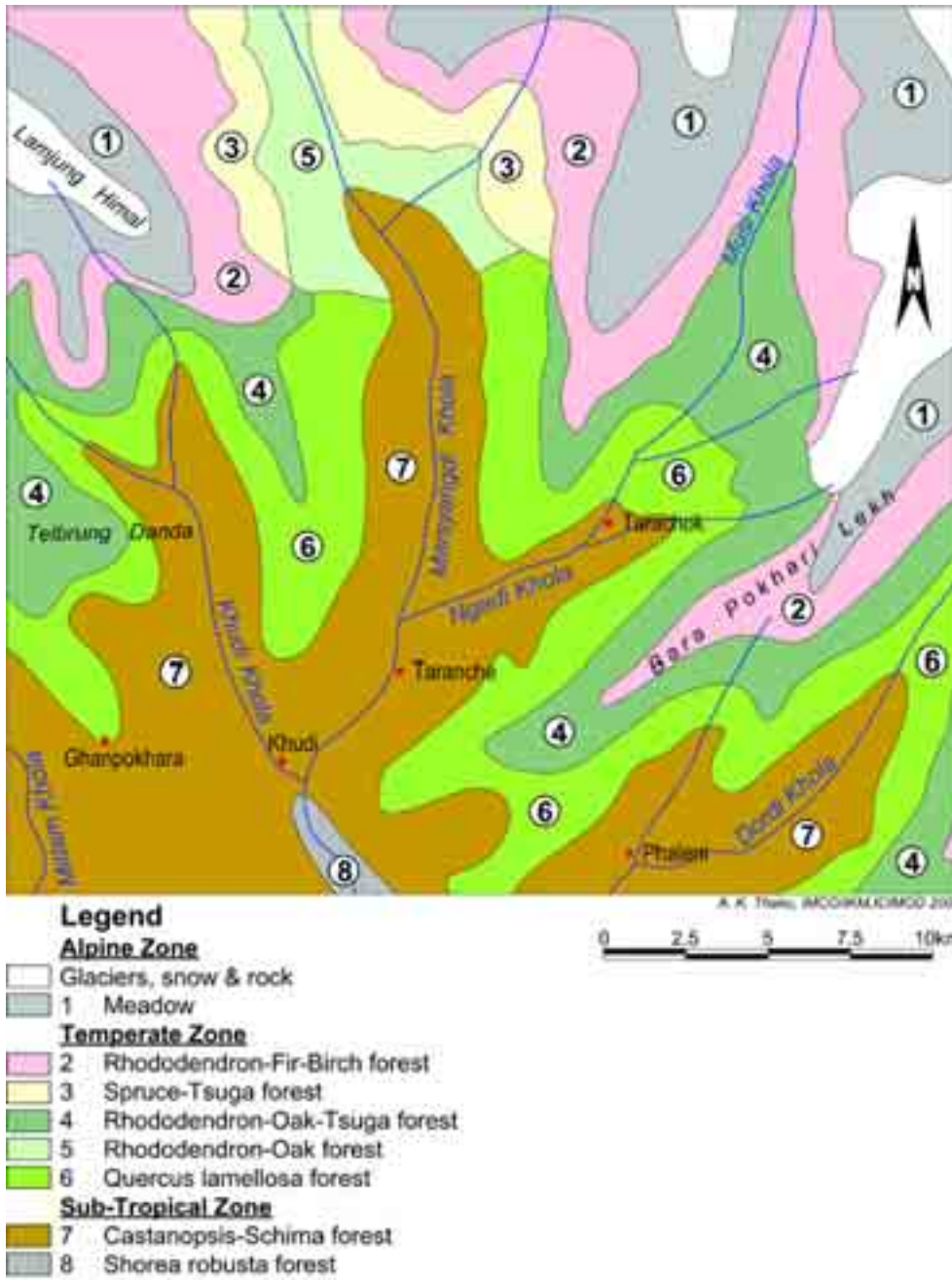
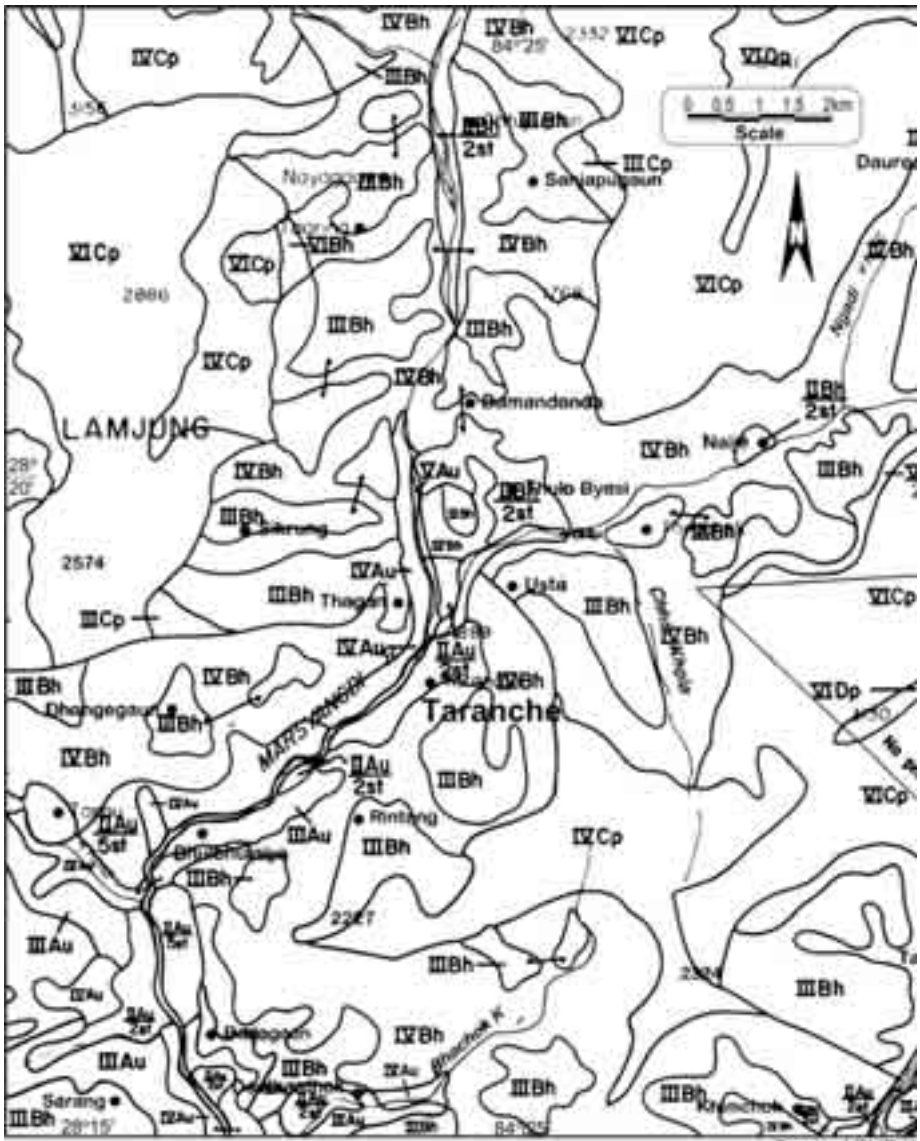


Figure 19: Land capability (after LRMP 1989B)



Legend

Class	Sub-class	Moisture regir
VI (Slopes 40° - 50°)	D Alpine (3000 - 4500m)	p (perhumid)
VI (Slopes 40° - 50°)	C Cool temperate (2000 - 3000m)	p (perhumid)
V (River Terrace)	A Sub-tropical (<1000m)	u (subhumid)
IV (Slopes >30°)	B Warm temperate (1000 - 2000m)	h (humid)
IV (Slopes >30°)	A Sub-tropical (<1000m)	u (subhumid)
III (Slopes 5 - 30°)	B Warm temperate (1000 - 2000m)	h (humid)

The Land Resource Mapping Project also prepared land-use maps with such major categories as (1) cultivation land, (2) grazing land, (3) forest land and (4) non-agricultural land. For the hills, cultivated lands were differentiated as level terraces, sloping land, and abandoned. Forest lands were differentiated by cover type (coniferous, hardwood, shrub, and other combinations). Grazing lands were differentiated into six ecological zones (sub-tropical, warm temperate, temperate, cool temperate, sub-alpine and alpine). The LRMP category of 'grazing lands' is problematic as such use of land transcends other categories: upland forest in summer and fallow cultivated land in winter. In fact, land categorised as 'grazing land' by LRMP includes grass and scrub land adjacent to the forest land. Therefore, it would have been more appropriate to designate this category as 'grass shrub' and not as 'grazing' land.

Land-use assessment for the present study is based on five major categories. These are: (1) cultivated land, (2) forest land, (3) shrub/grass, (4) rocky slope/landslide, and (5) river channel. Cultivated land includes farm land in active use as well as left fallow. The distinction between forest and shrub/grass land is based on the vegetation density rather than relative height of trees. Thus, areas with a combination of trees and dense undergrowth were classified as forest land. There may be some degree of error in delineation between forest and shrub land due to poor resolution of the 1958 airphotos. However, there was no such problem in distinguishing between cultivated and non-cultivated areas. Airphoto interpretation was the primary source of information for land-use interpretation and classification.

However, the difference in scale between the 1958 photos (1:40,000) and those of 1996 (1:25,000) posed a problem in comparison since the former were of smaller scale and of poor resolution (Figure 3A). The existing land use in 1958 and 1996 and their change during the 38-year time internal are presented at two spatial levels: (a) the Marsyangdi-Ngadi confluence area and (b) the Taranche focus area. The former covers an area of 9,887 hectares of land and the latter 320.5 hectares.

Marsyangdi-Nagdi Confluence: The scale and level of resolution of the two photographic sets influenced land-use interpretation and classification. The number of major categories was kept the same for the purpose of comparison. However, delineation of land-use categories is comparatively more precise for 1996 than 1958. In 1958, shrub and grass land constituated the most extensive category, covering 43% of the study area (Table 5). This type of land use was dominant on hill slopes whatever their elevation or aspect (Figure 20). Forest land came next with 30.8% coverage of the study area. Such land use was more pronounced on steeper slopes and very extensive on higher ridges above the cultivation zone. Cultivated land came third in areal extent with 22.8% coverage. This land-use type occupied the valley bottom with river terraces and hillsides with gentle to moderate slopes. Rocky slopes and landslides were in restricted areas with 2.1% coverage and river channels even less (1.3%).

The 1996 airphotos at a larger scale with superior resolution provide a better precision in land-use delineation. Thus, Figure 21 has much smaller areal units of use types compared to Figure 20. In 1996, forest land became the dominant land-use category

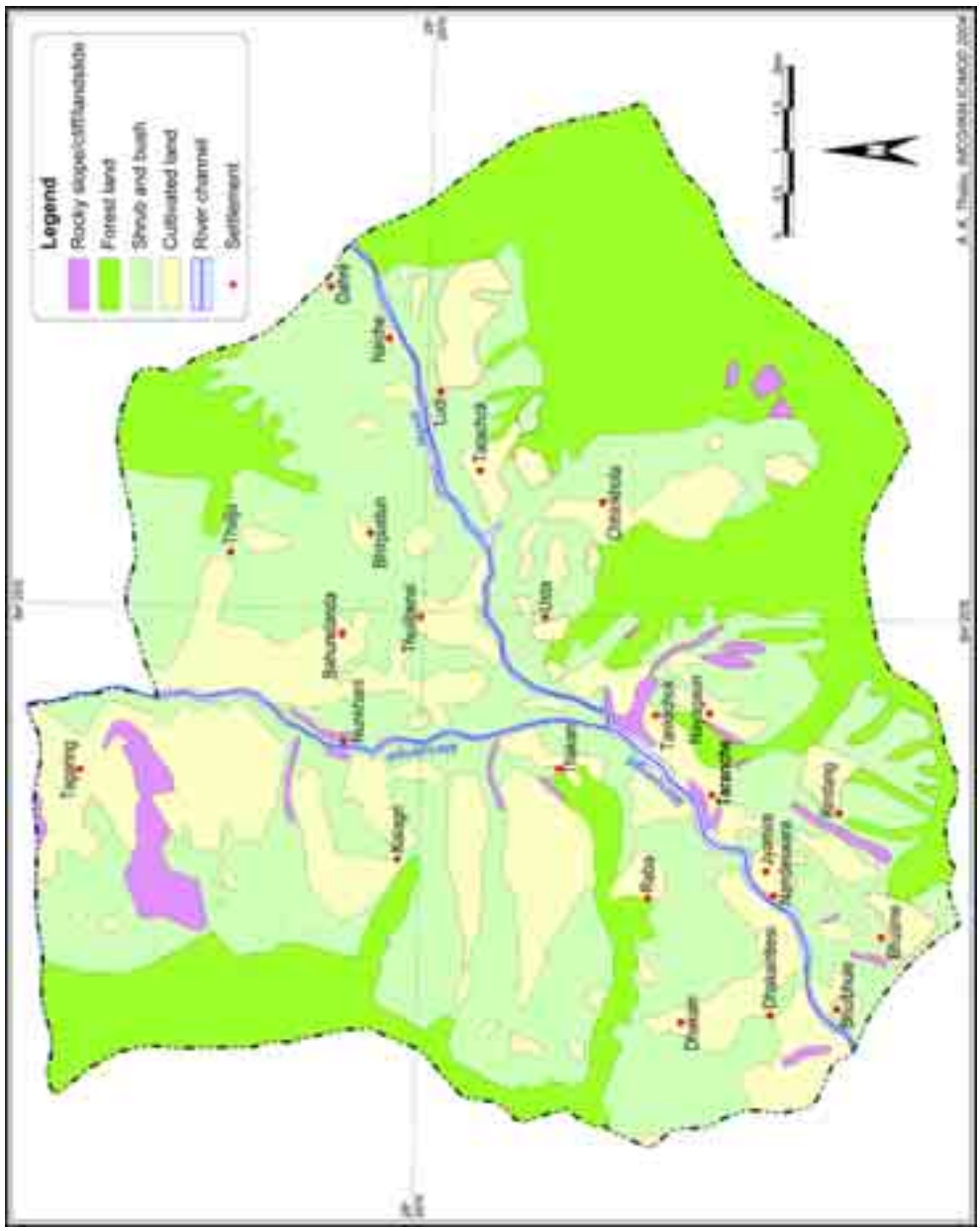


Figure 20: Land use, Marsyangdi - Ngadi, 1958

Figure 21: Land use, Marsyangdi - Ngadi, 1996

and covered half of the study area (Table 5). As in 1958, such land use occurs mostly on high ridges, particularly those facing north, and on slopes that were shrubland in 1958. Cultivated land occupies second place in areal extent, claiming about a quarter of the study area. This land-use category is prominent in valley bottoms and on gentler slopes, whatever their aspect. Shrub and grassland that predominated in 1958 declined by half and covered 21.9% of the total area in 1996. This land-use category was noted mostly in the buffer zone between the cultivated land and forest land. By 1996, rocky slope and landslide land surface had declined by 80% (Table 5). Land surface as river channel had increased by 18.7% since 1958.

Table 5: Land-use change, Marsyangdi -Nagadi confluence

	1958		1996		Change	
Land Use	Area (ha)	%	Area (ha)	%	Area (ha)	%
Shrub & Grass	4,254.4	43.0	2,164.9	21.9	+2,089.5	-49.1
Forest land	3,044.7	30.8	5,135.0	51.9	+2,090.3	+68.7
Cultivated land	2,258.3	22.8	2,399.2	24.3	+140.9	+6.2
Rocky slope & landslide	207.5	2.1	43.0	0.4	-164.5	-79.3
River channel	122.2	1.3	145.0	1.5	+22.8	+18.7
Total	**9,887.1**	**100.0**	**9,887.1**	**100.0**	-	-

Source: Airphotos 1958 & 1996

The most significant change in land use from 1958-1996 was in the increase of forest land against shrub and grass land. Thus, forest land increased by 68.7% while shrub/grass land decreased by half. Cultivated land did increase but only marginally. The decrease in shrub/grass land is due to less pressure from grazing. The increase in forest land is due to improvement of shrub/grass into forest land along with abandoning of some cultivated land Figure 22). Another important change has been in the reversal of degradational and aggradational land forms. In 1958, rocky slope/landslide surface was 1.7 times more extensive than river channels. By 1996, the latter exceeded the former type by 3.4 times (Table 5).

Taranche Locality: The Taranche locality between Sisneri Khola and Hwang Khola covers an area of 320.5 hectares east of Marsyangdi River. In 1958, the most extensive land-use type was cultivated land covering 44.4% of the locality (Table 6). These were mostly on the river terraces (Figure 23&24). Next to this type, shrub/grass accounted for 35.7% of the land use. Forest land was confined to steep slopes to the east with 10.9% of the area. Area covered by river channel was 5.4% and that by rocky slope/landslides 3.6% of the locality area. The latter type was mostly along the escarp faces of Taranche and Tanklichok river terraces.

By 1996, there was a dramatic increase in forest land that now covers 48.2% of the locality area (Table 6). This was mostly due to the drastic reduction in shrub and grass land from 114.5 to only 6.5 hectares. Moreover, cultivated land area decreased by 2.6%. There was also reduction in area of both river channels and rocky slope/ landslides. The Taranche landslide of 1955 had become stabilised as shrubland. Some

January 2002

Figure 22: Abandoned fields, Deurali: Deurali paddy fields lie an hour's walk from Tanklichok. The irrigation channel from Hwang Khola was dug across a rock face and the area yielded over 100 bushels of paddy. Its 32 ropanis of land has nine Gurung owners of which six have outmigrated. The fields have been abandoned since 1986 due to a shortage of labour. The field terraces are now overgrown with *Alnus nepalensis* and ferns.

of the fertile paddy land at Bimire has now been converted into the built-up area of Ngadi bazaar (Figures 25 & 26). Cultivated land above Hwang Khola at Deorali has been abandoned and colonised by *Alnus nepalensis* (Figure 22). Thus, coverage of non-cultivated land in the locality increased marginally from 55.6% in 1958 (Figure 23) to 56.8% in 1996 (Figure 24). Overall, natural landforms have become more stabilised and vegetation cover has improved. On the other hand, cultural landscape evinces much rapid change owing to improvement in transport access.

Table 6: Land-use change, Taranche

	1958		1996		Change	
Land Use	Area (ha)	%	Area (ha)	%	Area (ha)	%
Cultivated land	142.2	44.4	138.5	43.2	-3.7	-2.6
Shrub & Grass	114.5	35.7	6.5	2.0	-108.0	-94.3
Forest land	35.1	10.9	155.2	48.5	+120.1	+342.2
Rocky slope & landslide	11.4	3.6	4.3	1.3	-7.1	-62.3
River channel	17.3	5.4	16.0	5.0	-1.3	-7.5
Total	**320.5**	**100.0**	**320.5**	**100.0**	-	-

Source: Airphotos 1958 & 1996

Figure 23: Land use, Taranche, 1958

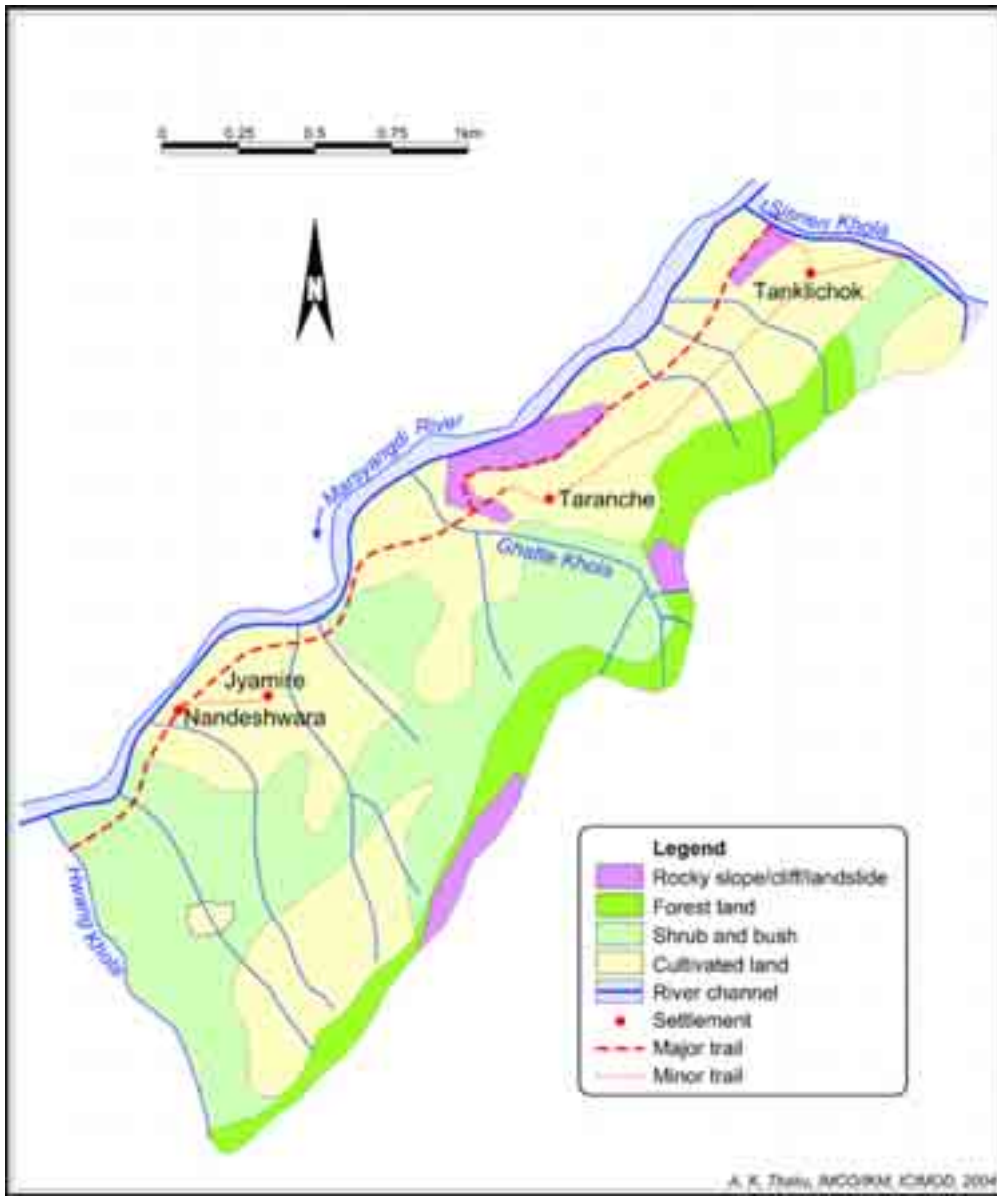
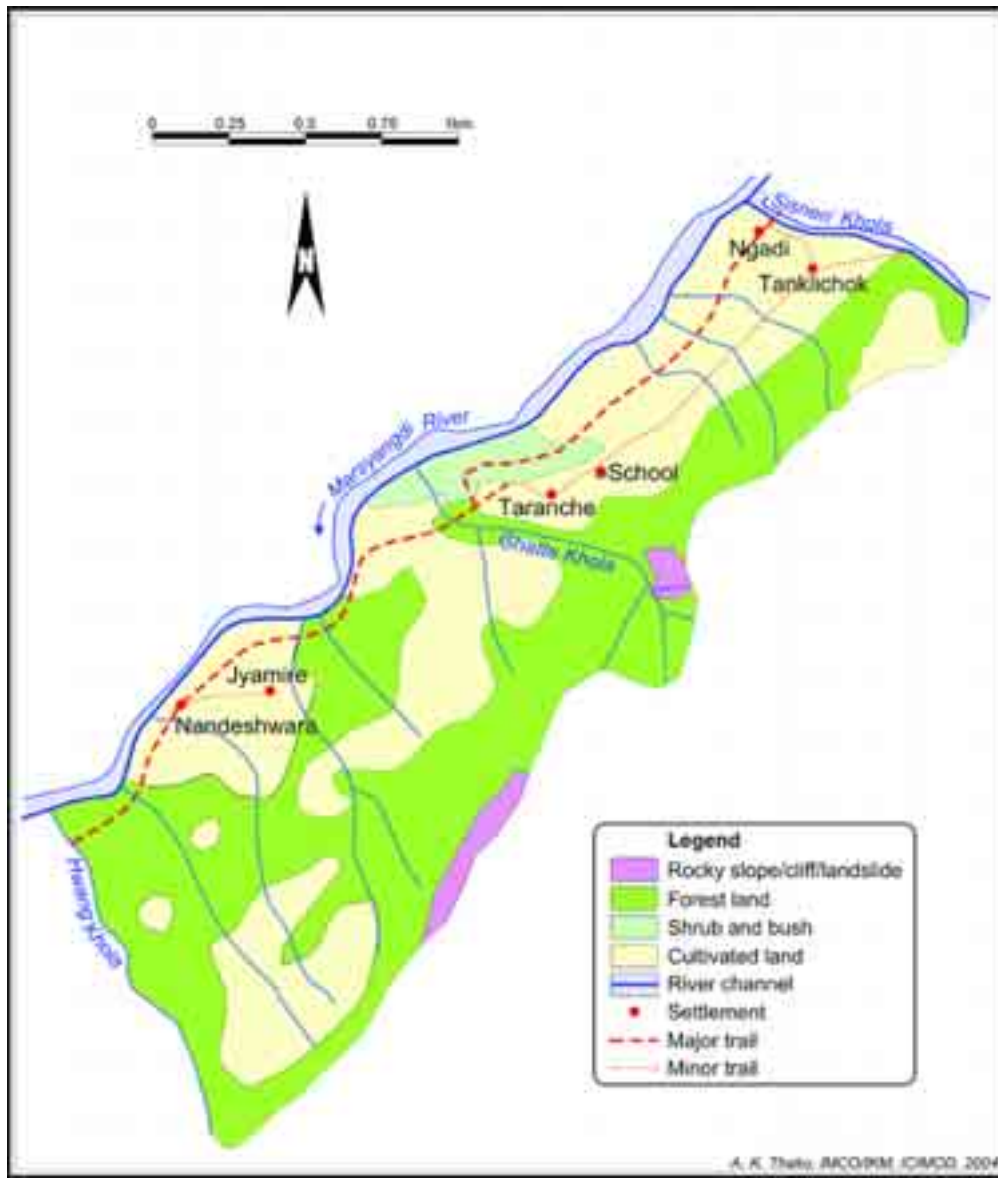


Figure 24: Land use, Taranche, 1996



A. November 1962

B. January 2002

Figure 25: Bimire from the south: Bimire fields on the fan deposit of Sisneri Khola. In 1962, the place had no houses although the Manangi used to winter in temporary sheds (Figure 25A). The first permanent settler in 1976 was a Manangi. Since the opening of Manang for trekking in 1978, the place has acquired numerous tourist lodges and shops (Figure 25B). A recent construction boom is apparent from the solid structures of Figure 25B (2002) that were thatch huts a year earlier (see page 45, this volume). It lies a quarter km. south of the Marsyangdi (M) and Ngadi Khola (N) confluence (884m).

January 2001

Figure 26: Ngadi Bazaar and Tanklichok: Ngadi Bazaar on either side of Sisneri Khola in a linear pattern along the trail to Manang. Tanklichok on the higher river terrace below Chiyabari (C), the site of the 1988 landslide. Sisneri Khola feeds two irrigation channels to the lower terrace fields. It also had a water mill, but this has been superseded by a 10-horsepower rice mill operated with electricity since August 2001.