Chapter 2

Database Development and Management for Micro-Level Development Planning

2.1 Introduction

Watershed management requires a three-tier management strategy focussing on: (i) a micro-regional planning approach, (ii) the analysis and appraisal of the biophysical and socio-economic environs, and (iii) agro-ecological zoning. The necessity for a micro-regional approach to planning arises primarily because the actual conditions of watersheds vary, depending on the local, biophysical conditions, population pressure, and natural resource conditions (Thapa et al. 1992). Due to the interdependence of biophysical environs and socioeconomic conditions both aspects need to be assessed for sound micro-regional planning.

The database can be updated in every respect. For village-level (i.e., *Nyaya Panchayat* level) planning, census data can be added every ten years in order to visualise demographic trends. The data in Arc/Info can be viewed in ArcView giving a better illustration for decision-makers. By using a specific growth rate, projections for the future are also possible.

2.2 Methodology

1) Available information from various sources, such as the Survey of India, Forest Department, Revenue Department, Public Works' Depatment, and District Administration, was used to compile the maps presented here. The Geographic Information Systems' software Arc/Info (from ESRI, U.S.) was used to prepare the database. The software was run on a PC-based platform for digitisation, analysis, and map preparation. Final outputs were processed on a IBM RISC based workstation.

(2) The Survey of India topographic sheets for 1963 on a scale of 1:50,000 were used as the basis for registration and digitisation. The maps were based on an International Modified Polyconic Projection.

(3) Climatic data collected from four recording sites in the watershed were used to extrapolate the temperature and moisture regimes.

(4) Elevation data were extracted from a topographical map on a scale of 1:50,000. Elevation and other parameters derived from contours (viz., slope and aspect) were segregated by isopleths for classification. Initially, contours were digitised at 20m intervals, later, for land classification, 200m intervals were selected. Aspects were manually segmented from the topo sheet.

(5) Mapping of natural resources, such as forest area, agricultural area, pastures, and wastelands, was based on revenue records, maps available with the Forest Department, and visual interpretation of satellite data with sufficient ground truth.

(6) Population data from 1981 and 1991 were obtained from the Census of India Abstract and the District Statistical Handbook. Demographic maps were prepared for each census year and comparisons made between 1981 and 1991.

7) Village boundaries were based on revenue maps of the Census of India (1981) and were fitted as closely as possible to the base map derived from topographical sheets.

8) Livestock data were collected by members of the team. To facilitate comparison, cattle, horses, sheep, goats, and poultry were converted into livestock units (or cow equivalents) which are based on food requirements (Lalwani 1988; Swarup 1991, 1993). This system presents animal population in cow units.

2.3 Results

(1) The database derived showed that the revenue map boundaries for villages in some places did not coincide with the topographical features on the topo sheet. Intensive ground work was carried out to match the boundaries.

(2) The watershed is a fifth-order river basin, with 240 first-order streams, 54 second-order streams, 14 third-order streams, and four fourth-order streams. The average bifurcation ratio (Rb) is 3.95 (Strahler 1952). Thus, the drainage network can be classified as mature. The total length of the drainage system is 262km, of which the first-order streams constitute 164.4km. The average drainage density is 2.79km/km^2 and the average drainage texture (i.e., number of stream segments per unit area) is 3.33 segments/km^2. Both perennial and seasonal streams are present in this watershed (Map 1). Seasonal streams generally have steep gradients, rapids and waterfalls, and a high proportion of bedload with which the channel is filled during dry season. Perennial streams, though fewer, are longer and provide water for powering, watermills and, to some extent, for irrigation and other needs.

(3) Altitudinal zonation of the watershed reflects a gradual rise in elevation throughout from a minimum of 1,120 to a maximum of 4,070masl at its northern limit at Jatropani (northernmost point of the watershed in Map 3). The longitudinal section of the trunk stream (Pranmati) shows a normal concave profile with a gradual descent and no major break-of-slope. It is only upstream of 2,400masl where the gradient is higher due to hard rock and a high rate of downcutting (Fig.1).

(4) The main part of the watershed has an average slope of 20° - 30° (Map 4). Areas with very high slopes (> 45°) or very gentle slopes (< 10°) are limited. Table 1 gives some indication of watershed area distribution in relation to slope classes, and Table 2 gives some indication of area distribution according to slope aspects.

5) As the trunk stream runs roughly from north to south, the topographic aspects of the landscape are predominantly south-east or west facing (Map 5).

6) One large landslide (0.20km^2) at the lower end of the major settlement is causing severe communication hardships to the local populace (Map 6). Minor landslides and landslips

Figure 1: Longitudinal Profile of Pranmati *Gad* (Stream)

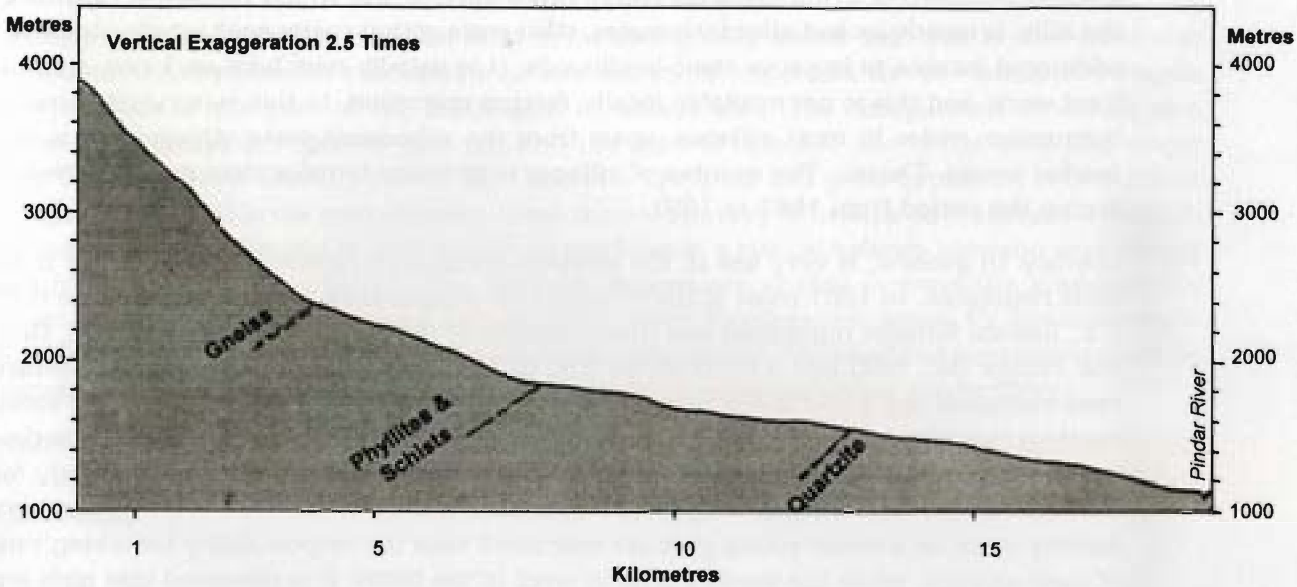

Table 1: Distribution of Watershed Area in Different Average Slope Classes

Average Slope (in degrees)	Geographical Area (ha)	% of Total Area
< 10	32.9	3.5
10-20	136.6	14.5
20-25	206.9	22.1
25-30	251.7	26.8
30-35	215.6	22.9
35-40	77.1	8.2
40-45	18.8	1.9
> 45	00.9	0.1
Total	940.5	100.0

Table 2. Distribution of Watershed Area in Different Slope Aspects

Aspect	Geographical Area (ha)	% of Total Area
N	14.1	1.5
NE	33.4	3.5
NW	68.5	7.3
E	207.1	22.1
W	231.8	24.6
SW	191.0	20.3
SE	103.5	11.0
S	91.2	9.7
Total	940.5	100.0

are found in various places, e.g., near the villages of Dungri and Ratgaon. Rockfalls are common in the high altitude region.

7) The transportation network in the watershed area is based on pack tracks and footpaths (Map 1). The road construction, once completed, will have a prominent impact on the ecosystem of the watershed (Map 6). The road has been designed to traverse the major landslide and will cut across agricultural lands and forests and, more importantly, through slopes which are more prone to slope failure, leading to an added loss of productive land.

8) Population density is far below the national average. However, in the context of the Himalayas (Swarup 1993), above 40 persons per km^2 is considered a relatively high density (Map 2), and it is to be noted that the entire village area is not habitable due to steep slopes, forests, rocky terrain, and land stability hazards. The villages having large areas of relatively gentle slope lands are more densely populated.

9) Sex ratio (i.e., number of females per 1,000 males) in the hills generally indicates that there are more females than males in rural areas. This is because the poor economic conditions in rural areas, *inter alia,* and the glamour of city life encourage younger men to

migrate from rural to urban centres for employment, which may not necessarily result in a better standard of living (Swarup 1993). Since agriculture, which yields low returns in the hills, is mostly looked after by females, their male counterparts seek jobs/business for additional income to improve their livelihoods. It is usually men who seek non-agricultural work, and this is not available locally, forcing migration. In this watershed, females outnumber males in most villages, apart from the scheduled caste villages and in the market centre, Tharali. The number of villages with fewer females than males increased during the period from 1981 to 1991.

10) Literacy, in general, is very low in the western Himalayan region. Female literacy is almost negligible. In 1981 most of the villages had female/male literacy ratios below 0.25 (i.e., literate females numbered less than a quarter of the number of literate males). Only one village (No. 668) had a ratio above 0.5. In 1991, the positive female/male literacy ratio increased to 0.5 and above in most villages. This low literacy ratio is a result of social customs that restrict the girl child from receiving education and a result of difficult access to school. Schools in every village would help to improve literacy rates, particularly for women. Another factor restricting female education is the low standard of living and high fertility rates, as a result young girls are entrusted with the responsibility for taking care of their siblings, while the mother goes to work in the fields. It is observed that girls are very eager to receive a proper education for a variety of reasons (Swarup 1993).

11) The scheduled caste population is distinctly high in certain villages (e.g., Harinagar, Darmola Chak Dungri) and significantly low (less than 30% mostly) in others, indicating social segregation in the area. In 1981, five villages had no scheduled caste population and in 1991 this number increased to seven. Harinagar (No. 661) had the highest (> 90%) percentage of scheduled caste population in 1981, and in 1991 it was accompanied by Darmola Chak Dungri. A comparison between 1981 and 1991 figures leads to the inference that out-migration of the scheduled caste population to sparsely populated or uninhabited villages has taken place due to shortage of agricultural land and fodder supplies.

12) Although greater numbers of villages show a rise (positive growth) in population in accordance with the average trend, some reveal a decrease (negative growth) (Map 7). This has been mainly due to out-migration of a section of the villagers to a neighbouring (previously uninhabited or sparsely-populated) village. Such incidences are known to have taken place in Darmola Chak Dungri (from Dungri), Pai (from Bunga), Sosia (from Kolpuri), and Koppar (from Ratgaon). The out-migration was induced by the need for agricultural land to meet the demands of the growing population and declining production from the existing agricultural land. The out-migration mainly involved the scheduled castes, though not exclusively.

13) The occupational structure of the inhabitants of this area is predominantly in the primary sector (according to the District Primary Census Abstract 1991); and most people are cultivators.

14) The livestock population includes cows, buffaloes, mules, horses, goats, sheep, pigs (only in the scheduled caste villages), and poultry. The density of livestock is particularly high (above 8 units per hectare) in large and populous villages such as Dungri and Ratgaon. Other villages have four to five units of livestock per hectare. Thus, improvement in fodder production would be a priority in Dungri and Ratgaon but not in other villages. The bovine population is reared for milk and milk products, organic manure, and draught power. Buffaloes are stall-fed, whereas cows are grazed on nearby open lands. Goats are fed upon agricultural wastes and oak fodder for six months and taken to alpine pastures for the warmer half of the year. Horses are fed on barley, grams, and grass. Sheep and goats are sheared twice a year, and some of the wool is spun locally.

2.4 Conclusions

Development programmes must be built upon ecologically sound land use in this particular ecosystem. Environmental considerations become more important for an ecologically fragile ecosystem as in the case of the Himalayan mountain area. The occupational structure also reflects the ecosystem-specific land use and the natural resource use in the area. The major land use is of forest lands, whereas land used for cropping and grazing/pasture is of a minor category (discussed in the next chapter). Since the productivity of farm lands is sustained through the inputs derived directly or indirectly from the forests, a critical balance between agricultural and forest land use is required. The available forests are unable to meet the sustainability criteria (Singh et al. 1984; Rao and Saxena 1994). Here, development action for agriculture will have to go together with forestry and tree-based occupations. Value-added production must be introduced and encouraged, in addition to efforts to improve biological productivity.

With the database created it will be easier than it was previously to identify resource-deficient or resource-surplus villages. Demographic conditions can also be assessed and decisions taken accordingly.