2. The Measurement Network

Chapter 2 describes the hydromet measurement network in terms of the design philosophy and as it exists on the ground in Nepal. There are two main topics - the different levels (or scales) of measurement in the nested approach (small test plot to watershed scale) and the hydrological, meteorological, and test sites that make up the measurement network. in the Yarsha *Khola* watershed in Nepal. The Yarsha *Khola* watershed is one of the five PARDYP watersheds.

2.1 The Nested Approach

In each PARDYP watershed, the project activities are carried out on three scales of study: the watershed as a whole, the subcatchments, and the test plots (Fig. 5). This hierarchical structure can be termed 'a nested approach': each level forms a part of the next higher level, e.g., an erosion plot is part of a subcatchment, a subcatchment is part of the whole watershed. On each scale, the topics and the parameters of interest in the meteorology and hydrology components are slightly different (Table 1).

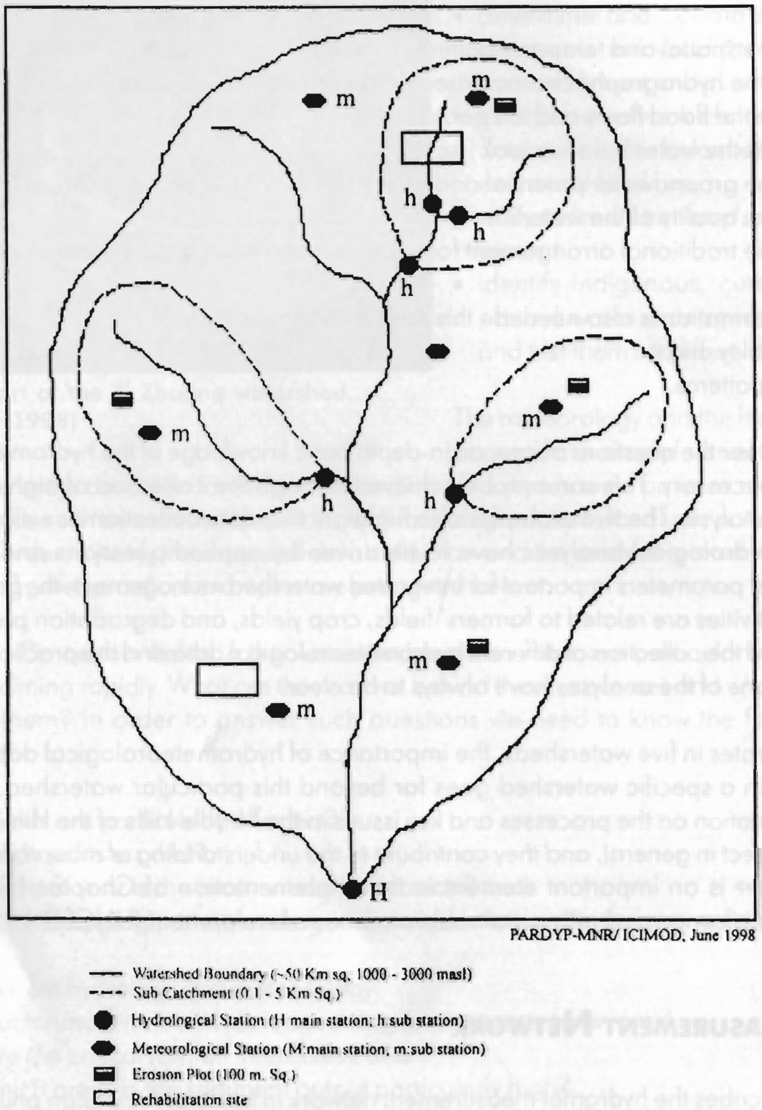

Figure 5: The nested approach of the project activities in the PARDYP watersheds

- The watershed as a whole should be representative of a larger region. Hydrologically the watershed is looked at as a closed system. The data collected at this scale provide insights into the integral response of the system. At the watershed level, the long-term processes and balances (monthly, seasonal, annual) are the centre of interest.

Table 1: Hydrometeorological Programme on the Different Scales of the Watershed

	Watershed	*Subcatchment*	*Test plot*	*Rehabilitation site*
Main topics	• Water balance and sediment output	• Water balance and sediment output • Nutrient balance • Soil fertility	• Processes of runoff generation and erosion • Soil fertility	• Rehabilitation of degraded lands
Main parameters	• Meteorological parameters (main station) • Water level • Discharge • Sediment transport	• Rainfall intensity • Temperature • Water level • Discharge • Sediment transport • Water chemistry • Nutrients (water and sediments)	• Rainfall intensity • Components of runoff • Erosion • Nutrients (water and sediment)	• Meteorological parameters • Surface runoff • Erosion • Nutrients
Representative for	• Watershed and larger region	• Land units (dominant land use, dominant aspect, degree of degradation)	• Small land units with specific, homogeneous land-cover/land-use conditions	• Reaction of the system to interventions

- In the subcatchments, the focus is on the analysis of specific 'local factors': distinct land use, most degraded area, more or less natural conditions, dominant aspect, specific treatment, etc. Each selected subcatchment is as homogeneous as possible in terms of specific physical characteristics. The different time scales (event, month, season, year) are of equal interest.
- An erosion plot represents the conditions and processes under a specific homogeneous land-use or land-cover type (Fig. 6). On the plot level, the processes originating on the smallest scale on farmers' fields are investigated: erosion, runoff, or decline of soil fertility under different conditions. The farmers' fields provide the scale of agronomic interventions and trials as well as of the assessment of appropriate technologies. On the plot level, the main interest lies in single events. Monthly, seasonal, and annual balances are less important.

Figure 6: The erosion plot on red soil in Namdu, Yarsha Khola Watershed, Nepal (photo: May 1997)

Rehabilitation sites are selected in areas of the watershed that are intensely degraded and where measures for rehabilitation should be carried out and tested. The size of the rehabilitation sites is determined by the extent of the degradation. Rehabilitation sites are preferably, but not necessarily, located within selected subcatchments. In the ideal case, a rehabilitation site is situated in one part of a twin catchment (subcatchment with two branches): if one part is rehabilitated and the other is left in the original condition, then the success of the rehabilitation measures can, after several years, be measured quantitatively by discharge and sediment measurements at properly sited hydrological stations.

Figure 7: The site of the main hydrological station in Yarsha Khola Watershed, Nepal (photo: May 1997)

The hydrological network has to fulfill the requirements of the nested approach described above: there has to be a main station at the outlet of the watershed (Fig. 7) and sub-stations at the bottom of each subcatchment (Fig. 8).

The selection of meteorological stations has to cover several criteria:

- spatial coverage of information over the watershed,
- potential to study altitudinal gradients of meteorological parameters, and
- location near to erosion plots (for rainfall intensities) and hydrological stations.

The main meteorological station should be representative of the conditions in the watershed and should be located at the mean elevation of the watershed (Fig. 9).

In the different PARDYP watersheds, the theoretical structure of the 'nested approach' had to be adapted to local conditions. It was, for example, not always possible to find subcatchments with homogeneous or dominant land-use/land-cover conditions. Furthermore, an ideal measuring network may exist in theory, but not in reality: in each PARDYP watershed, a compromise had to be found between an optimum net-

Figure 8: Hydrological sub-station in the Bheta Gad Watershed, India (Photo: May 1997)

Figure 9: The main meteorological station in the Xi Zhuang Watershed, China (photo: February 1998)

work and a manageable network.

The World Meteorological Organization describes hydrological network design in the guide to hydrological practices (WMO 1974) as an evolutionary process in which a minimum coverage (minimum network) is established early in the development of an area, and the network is then upgraded periodically until an optimum network is attained. This approach fits the philosophy in the PARDYP watersheds. In each watershed, an initial station network is established. Based on the experiences with this first set-up, the network is upgraded after the first year of measurements (for more information regarding hydrological network design see Moss 1982).

2.2 The Measurement Network of Yarsha Khola Watershed, Nepal

The Yarsha *Khola* Watershed is situated approximately 190km east of Kathmandu in Dolakha District. The watershed drains into the Tamakoshi River. The size of the watershed is roughly 54sq.km. and the elevation ranges from 1,000 to 3,000masl. The watershed is mainly drained by the Yarsha *Khola* in the north and the Gopi *Khola* in the south. The two rivers merge just upstream of the main hydrological station.

The measurement network of the Yarsha *Khola* Watershed is shown in Figure 10. There are six hydrological stations, 11 meteorological stations, and four erosion plots. The different sites are described in Tables 2, 3, and 4. There is a concentration of monitoring activities on the south facing slope and a strong focus on the Khahare *Khola* catchment.

In the Khahare *Khola*, the nested approach is distinct with two hierarchies of subcatchments (subcatchment 5 being a part of subcatchment 7). It is obvious that only a selection of subcatchments within the watershed can be monitored, and it was difficult to find subcatchments with more or less homogeneous land-use/land-cover conditions. In this respect, subcatchments 4 (see Fig. 11) and 5 are the most appropriate ones. In selecting subcatchment 2 (Fig. 12), it was not intended to monitor a homogeneous subcatchment but to obtain information about the behaviour of the Gopi *Khola*, the second major stream in the watershed.

Regarding the network of meteorological stations, the three main criteria were fulfilled: spatial coverage of information, altitudinal gradients, location near to erosion plots, and hydrological stations.

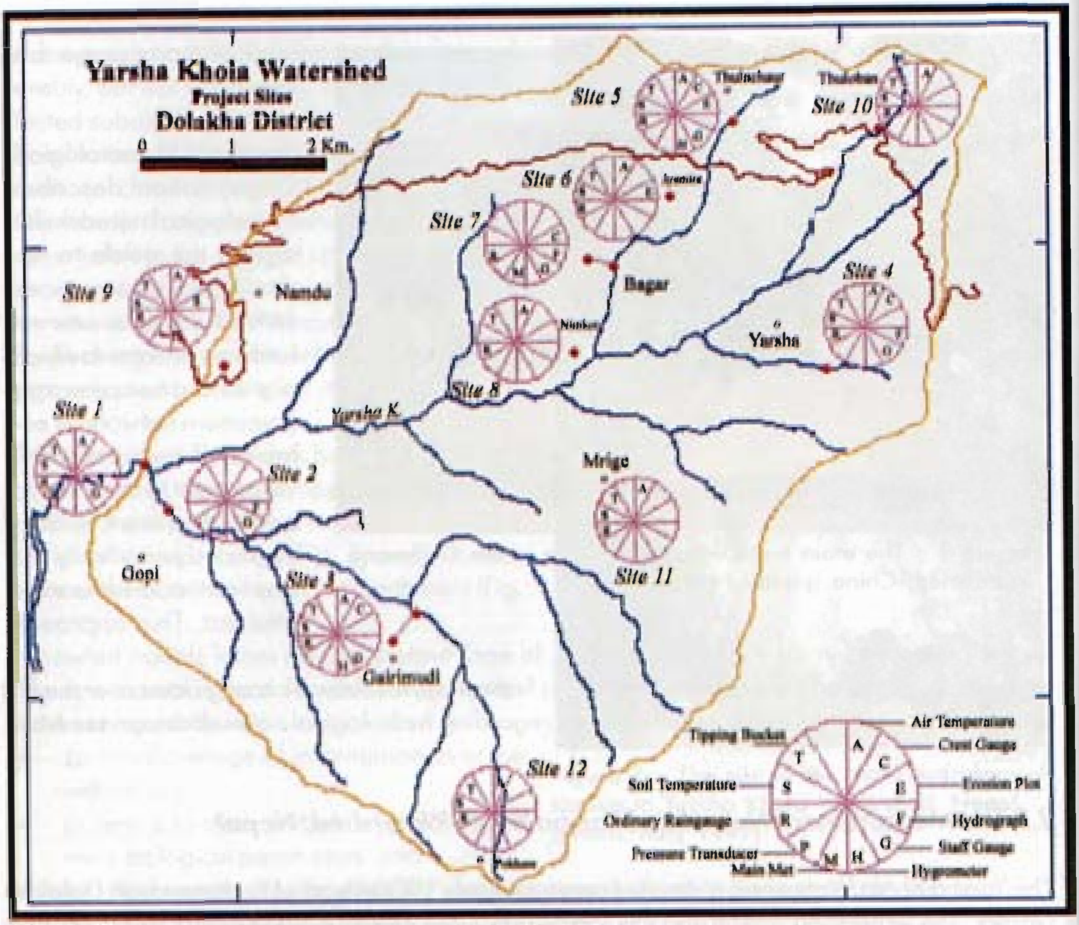

Figure 10: The monitoring sites in the Yarsha Khola Watershed, Nepal

The four erosion plots are located on two land-use types with potentially high soil loss and runoff (grazing/shrub land, *bari* [rainfed agriculture, fields]) on both red soil and non red soil.

The numbering of installations was not carried out according to stations, but according to sites (see Fig. 10). For the data collection and file structure, this approach proved to be much more transparent than the separate numbering of the hydrological and meteorological stations as well as the erosion plots. In Figure 10, the sites as well as the measured parameters are documented.