2 PEOPLE AND RESOURCE DYNAMICS IN MOUNTAIN WATERSHEDS OF THE HINDU KUSH-HIMALAYAS PROJECT – A Research for Development Network

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Abstract

This paper describes the aims and activities of the People and Resource Dynamics in Mountain Watersheds of the Hindu Kush-Himalayas Project (PARDYP), a regional research-for-development network operating in five mountain watersheds in four countries. It describes the lessons learned and the strengths and weaknesses of regional research projects. The use of a common framework greatly enhances the value of the information obtained. By agreeing and sharing common approaches to both monitoring and analysis and sharing the data generated, research costs can be reduced. Some findings are grouped together and the first steps towards a regional comparison or synthesis of the research watersheds are outlined.

Introduction

The People and Resource Dynamics in Mountain Watersheds of the Hindu Kush-Himalayas Project (PARDYP) is a regional research-for-development project looking at people and natural resource interactions in a meso (50-100 sq.km) watershed context. The work is funded by the Swiss Agency for Development and Cooperation (SDC) and the Canadian International Development Research Centre (IDRC). All PARDYP project components are carried out in each of five watersheds in the middle mountains of the Hindu Kush-Himalayas in China, India, Nepal (2), and Pakistan (Figure 2.1).

The national partner institutes (NPIs) conducting the research at the field level are for Pakistan, the Pakistan Forestry Institute, Peshawar; for China, the Kunming Institute of Botany; for India, the GB Pant Institute for Himalayan Environment and Development; and for Nepal, the International Centre for Integrated Mountain Development (ICIMOD) together with the Department of Forest and the Department for Soil Conservation and Watershed Management. These national focal research institutions implement, manage, and supervise the activities with the assistance of national and international partners and collaborators. The two main international partners are the Institute for Resources and Environment, University of British Columbia, Canada, and the Hydrology Group, Department of Geography, University of Berne, Switzerland. Overall coordination, guidance, and administration is provided by ICIMOD. From 2003, the Department of Geography, University of Zurich, joined the international partnership and will collaborate on research into access to common property resources.

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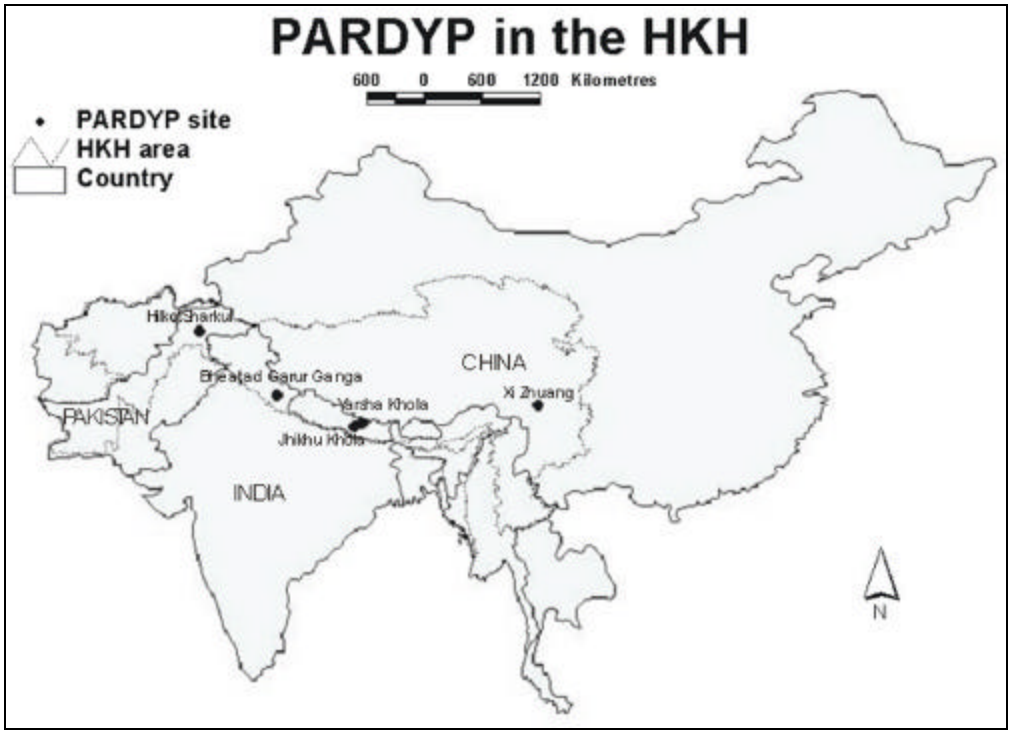

Figure 2.1: **Location of the PARDYP watersheds**

PARDYP has its origin in the Land Resource Mapping Project (LRMP) funded by the Canadian International Development Association (CIDA) in the 1970s and 1980s. LRMP mapped Nepal's land resources. Similar mapping and natural resource inventories were conducted in other countries, pilot provinces, and districts. During this period, lack of understanding of the natural resource base was seen as a major limiting factor to development. In the 1980s many large integrated rural development projects and agricultural development projects either expanded this type of mapping and inventory work or tried to use it, but with limited success. Initially, the IDRC funded two projects, the 7-year 'Mountain Resource Management Project', which undertook resource dynamic studies in the Jhikhu Khola watershed of Nepal (1989-1996) and the 'Rehabilitation of Degraded Lands in Mountain Ecosystems Project' (1992-1996) in China, India, Nepal, and Pakistan. The latter project involved research on the rehabilitation and re-greening of small patches of degraded land in middle mountain landscapes. PARDYP combines the regional and the integrated approaches of its two predecessors. PARDYP phase 1 ran from 1996 to 1999 and phase 2 from 2000 to 2002. Phase 3 started on the 1 January 2003 and will run to the end of 2005.

The phase 3 project objective, as it appears in the project log frame, is "Sustainable options applicable at household, community and policy level with proven impact potential for improving food and water security and income of rural households are developed through applied interdisciplinary research."

The Research Watersheds

The PARDYP network looks at watersheds of similar size (50-100 sq.km) and similar elevations (800-3,000m) and in each watershed carries out similar activities, surveys, and questionnaires, uses similar instrumentation, and furthermore uses the same software, so that results are directly comparable. The main cropping systems in the studied watersheds are broadly the same: rice and wheat in the irrigated valley bottoms and maize in the rain-fed upland areas (see Table 2.1).

Research in the Jhikhu Khola watershed, Nepal, started in 1989 and has continued to date without a break. Now 13 years of data on soil and water dynamics are providing new insights into both intensification and degradation processes. The lessons learned in the Jhikhu Khola continue to be adopted and guide the current phase of PARDYP in watershed management research across the Himalayas. For the other four watersheds data collection started in 1996.

Table 2.1: **Characteristics of the PARDYP watersheds**

	Xi Zhuang (China)	**Bheta Gad Garur Ganga (India)**	**Jhikhu Khola (Nepal)**	**Yarsha Khola (Nepal)**	**Hilkot-Sharkul (Pakistan)**
Physiography (maps at different scales)					
Total area (ha)	3,456	8,481	11,141	5,338	5,230
Elevation range (masl)	1700-3075	1090-2520	800-2200	1000-3030	1448-2911
Climate	wet and dry seasonal variation	sharp wet and dry seasonal variation	humid sub-tropical to warm temperate	humid sub-tropical to warm temperate	humid sub-tropical to cool temperate
Dominant geology	limestone and sandstone	schists and gneiss	mica schist and limestone	gneiss, slate, and graphitic schist	micaceous schist, and slates
Total population	4,016 (1997)	14,524 (1998)	48,728 (1996)	20,620 (1996)	11,322 (1998)
Population density (people/km^2)	116	171	437	386	62
Av. family size	4	7	6	5	8
Dominant ethnicity	Han Chinese	Brahmin, Rajput, Scheduled Castes	Brahmin, Chettri, Tamang, Danuwar	Brahmin, Chettri, Tamang	Gujar, Swati, Syed
Major cash crops	tea, tobacco, fruits	winter vegetables, fruits, tea, fodder	potatoes, tomatoes, rice, fruits, vegetables	seed potato, some fruits	fruits, fodder
Main staple crops	maize, wheat, beans, potatoes, rice	mixed cereal, grains, rice, wheat	rice, maize, wheat, potatoes, millet	maize, rice, millet, potatoes, wheat	wheat, maize, rice

Project activities range from agronomic and horticultural initiatives, socioeconomic and market studies, rehabilitation of degraded lands and forestry, soil fertility studies, and participatory conservation activities, to water and erosion studies. PARDYP encourages regional data exchange, and generation and dissemination of knowledge.

The research teams work closely with farmers and are able to observe what works and what does not. The approach is that farmers who are employed as erosion plot or hydrometeorology readers are also the project's point of contact with farmers for research and demonstration trials and dissemination of findings. This is a cost effective approach. PARDYP is a little different from many other donor-funded research initiatives in that the researchers are full-time employees of the project and are generally recent graduates with often limited experience. Guidance and staff development are provided by the Country Coordinator, a full-time employee of the NPI.

Research Approaches

During PARDYP phase 1 the emphasis was on improving the understanding of environmental and socioeconomic processes associated with degradation and rehabilitation of mountain ecosystems and on generating wider adoption and adaptation of proposed solutions by stakeholders in the Hindu Kush-Himalayas (ICIMOD 1996).

The first phase focused on six components:

- water balance and sedimentation;
- soil fertility improvement and soil erosion control;
- socioeconomic factors in terms of resource management;
- natural resource management strategies;
- capacity building of project partners;
- dissemination of knowledge.

Achievements in this phase were primarily to set up the research network, to set up the gauging stations and the meteorology stations, and to recruit staff and train them in research methodologies.

The results from phase 1 (1996-1999) clearly showed the need to adopt a much broader and more inclusive approach to natural resource management research. Community institutions, common property resource management, issues of gender and equity, as well as livelihood potentials were considered to be important next steps for research and were, therefore, more prominent in phase 2.

In PARDYP phase 2 (1999-2002) the emphasis shifted more to research issues targeted at achieving balanced, sustainable, and equitable development for mountain communities and families in the Hindu Kush-Himalayan region (ICIMOD 1999). To achieve these aims, project activities were organised around six major components:

- understanding community institutions and their dynamics;
- social and gender inequity, marginalisation;

- water resources for irrigation and domestic use;
- on-farm resources
- common property resource management;
- livelihood potentials for mountain communities.

What worked in PARDYP Phases 1 and 2?

Project staff began to think in terms of watersheds. There was an improved understanding of the interactions between agriculture, forestry, and water, in particular the extent to which forests provide organic matter inputs into farming systems, the importance of these nutrient transfers, and how improved composting can help maintain soil fertility levels. Databases and data collection methodologies on water have been developed to an extent that they are regionally and probably globally significant. An initial synthesis of the water and erosion studies is adding value to the data from the four participating countries. The operational approaches developed in phases 1 and 2 have been assessed; so phase 3 will run based on the best practices developed in each of the watersheds. At an operational level, the regional annual meetings, where exchange of ideas, peer critique, and triggering of competitive behaviour among partners took place, were considered by all to be very useful. Similar conclusions, drawn from several sites across the watersheds, increased confidence in the results and conclusions. There is increased research capacity in the PARDYP teams through regionwide training and mutual exchange of skills and competences. All teams are now very much aware of the importance of sociopolitical issues, an important development for natural resource scientists to grasp.

What did not work in PARDYP Phases 1 and 2?

Data were not fully shared and the quality of the shared data was sometimes questionable. There was a lack of project ownership at the regional level, often teams felt they were collecting data for ICIMOD and generally there was not a feeling of being part of a regional project but of four country projects in competition. This was seen where country teams were reluctant to pay for regional activities out of their country budget and in a lack of peer feedback on publications and management suggestions. There was poor communication between and among countries, universities, and donors and some of the management meetings were not very effective. There was limited regional thinking, perhaps because project design assumed regional thinking would come about by merely linking four country programmes.

A New Approach

In PARDYP phase 3 (2003-2005) the intention is to build on the lessons learned and to develop a more effective regional synthesis of results. It is anticipated that this can be achieved through a new approach whereby team members based in each of the watersheds carry out 21 research sub-projects.

The 21 sub-projects of phase 3 (ICIMOD 2002) are grouped into four ‘expected results’. Each sub-project has its own log frame.

- **Improve farming systems productivity**
  Activities include: analysing the effect of land-use policies on systems to develop conducive policy options, participatory action research (PAR) for incorporating non-timber forest product species into farming systems; testing options for high-value cash crop-cum-irrigation using PAR; developing with women strategies for reducing their workload in common natural resource use and studying the impact; using a case study approach, further research on 'farmers' decision-making processes' in livelihood strategies of their farming systems through adoption studies; PAR with farmers in marginal lands to improve land management practices and linking to extension services; and organising farmer exchange programmes and training.
- **Increase productivity of agricultural land**
  Activities include designing an intervention and testing programme on sustainable soil management for possible replication in all PARDYP watersheds; conducting PAR in collaboration with appropriate partners on soil fertility covering a few topics (for example, biofertiliser, compost, vermiculture); analysing soil erosion data and identifying critical land practices; monitoring soil fertility dynamics in upland/lowland sites; looking at land use changes from high-resolution satellite imagery; and conducting repeat surveys and questionnaires from earlier research for reporting change.
- **Identify, test, and disseminate water management options for equitable access**
  Activities include continued monitoring and analysis of water data to detect dynamics and testing management options for water supply, quality, and demand at household level.
- **Optimise access to ensure sustainable, secure, and equitable use of resources**
  Activities include assessing access and use rights from gender and equity perspectives; carrying out livelihood analysis based on previous surveys; conducting institutional analysis for equity and access at macro, meso, and micro level; reviewing and recommending equitable options for water, land, and forest resources through policy briefs; and continuing dialogue with policy makers at multiple levels.

Studies of Dynamics

One of the main project outputs is the increased understanding of natural resource dynamics and changes in socioeconomic conditions. Hydro-meteorological monitoring provides the indicators at the watershed level as to how land-use dynamics and changes in farming practices are impacting on some of the natural processes in the watershed.

Water, erosion, and related matters

This group of activities specifically aims at the generation and exchange of information on water as a resource and its role in land degradation, and at identifying and testing options to enhance water management decisions. The main activities in this context are monitoring and collection of baseline information, water quality monitoring, soil conservation, and water management. The resource monitoring is mainly looking at the water resources from a biophysical point of view. The water management activities have people at the centre of the research. For understanding water quality issues and soil

conservation approaches, the activities have to be addressed equally from biophysical and socioeconomic points of view.

The set-up of the station network in all watersheds followed the same principle of the nested approach. The nested approach is presented in Figure 2.2.

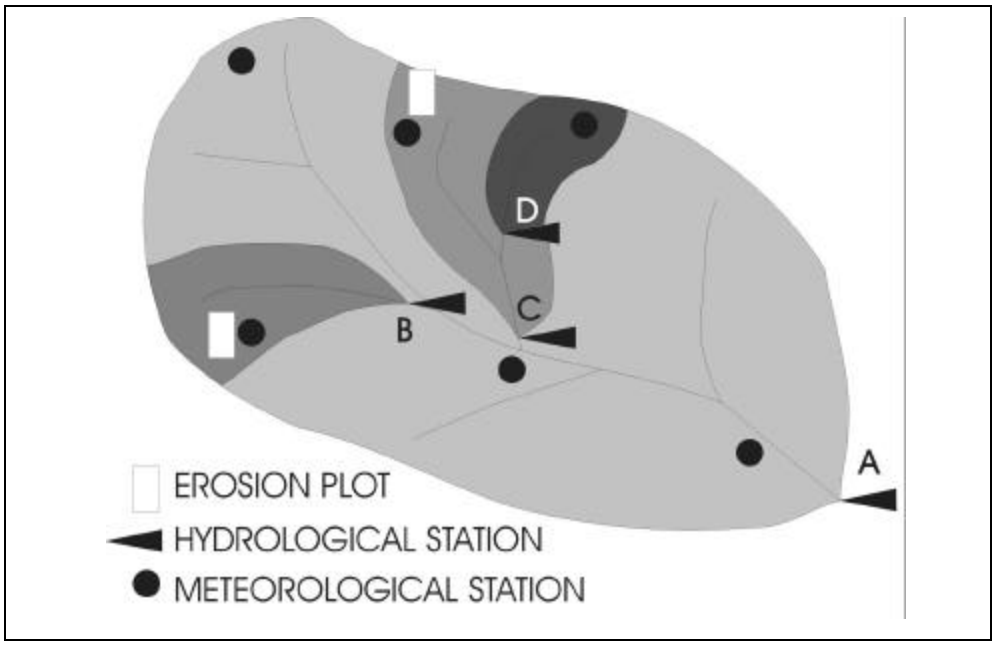

Figure 2.2: **Principle of the nested approach (schematic). Letters indicate sub-catchment gauging stations**

This nested approach allows us to investigate the processes from a micro- to a meso-level, that is from the plot to the watershed level, and subsequently to determine the scale dependency of these processes. Erosion plots and, more recently, surface flow collectors are used for the plot level investigations at 100m^2 and 2-5m^2 respectively. Sub-catchments and catchments ranging from a few hectares to several square kilometres are monitored with hydrological stations equipped with different instruments. The watersheds range from 34 to 110 sq.km in size.

During the first three years, between 1997 and 1999, major emphasis was given to data collection. Long-term data collection was initiated with the set-up of a measurement network in five watersheds in the Hindu Kush-Himalayas. A total of 89 measurement sites were operational in June 2001 and were monitored by local residents who received annual training and new instructions if needed (Table 2.2).

The collected data are being thoroughly checked and then stored in a watershed database running on the hydrological software HYMOS 4. The use of the same software in all watersheds ensures the exchangeability of data between the different country teams. The final data are published annually in the form of a yearbook; the yearbooks for the Nepal watersheds have been compiled up to 2001 and are available on CD-ROM.

Table 2.2: **Measurement sites in the five PARDYP watersheds, June 2001**

Watershed	Hydrological stations	Meteorological stations	Erosion plots
Xi Zhuang, China	4	10	6
Bhetagad, India	6	5	4
Jhikhu Khola, Nepal	5	10	7
Yarsha Khola, Nepal	4	11	4
Hilkot, Pakistan	4	6	3

Changes in land use

PARDYP produced land-use maps for 1972 and 1990 for the two research watersheds in Nepal from 1:20,000 scale aerial photographs. In brief, the major changes in the last 15 years in the Yarsha Khola occurred in the forest cover (increase) and the rain-fed agricultural areas (decrease). In the Jhikhu Khola both the forest cover and the rain-fed agricultural areas increased and shrub and grassland decreased. Shrestha and Brown (1995) and Shrestha (2000) discuss the results in detail. In Pakistan there has been little change in land use. In China there has been a big increase in tree cover as a result of government reafforestation programmes including aerial seeding of *Pinus yunnanensis.* The current upland conversion policy will also impact significantly on the study area as cultivation on steep slopes is to be replaced by perennial tree crops. In India, significant changes can be seen clearly, with decreased annual cropping and increased tree cover as perennial crops increase. There are significant increases in the area of tea plantations. High-resolution satellite imagery (IKONOS) will be used to update the land use in all the watersheds in 2003.

Soils and land systems

Maps have been produced for each watershed. Significant changes in soil nutrient levels, particularly in the heavily used valley bottom of the Jhikhu Khola watershed in Nepal, are apparent from the periodic surveys of soil fertility carried out. Of great significance is the way farmers have adopted new practices to overcome nutrient deficiencies. In the early 1990s nitrogen was limiting. This was compensated for by increasing the amount of farmyard manure applied as well as some use of nitrogen rice mineral fertilisers. In the mid 1990s phosphate deficiencies were observed and farmers compensated by increasing the use of phosphate fertilisers. Now potassium is becoming a limiting nutrient. Monitoring of soil fertility, particularly in the intensively cropped valley bottoms, will continue for the next three years.

Water demand

In 1999 a water demand and supply survey was conducted in the Nepal watersheds. This same survey collected information on agricultural production and agrochemical inputs as baseline information for water quality surveys. The results are presented in Merz and Nakarmi (2001) and Merz et al. (2002). For the allocation of water resources, a detailed public water resources survey was carried out in both Nepalese watersheds. A total of 319 springs in the Jhikhu Khola watershed (Shrestha et al. 2000) and 215 springs in the Yarsha Khola watershed (Shrestha et al. 2000) were mapped and basic physical parameters measured. Similar studies have been completed in the other watersheds.

Socioeconomics

Initial household surveys were conducted in 1998 and 1999 in all watersheds. It is intended to carry out repeat surveys in 2003. In Jhikhu Khola, Nepal, the initial surveys were carried out in 1993 and a repeat survey in 1998. Unfortunately the current instability in Nepal has prevented a repeat survey, but it is hoped that this can be carried out in 2004. One common thread, appearing to be increasingly significant, is the remittance economy. Overall, farm incomes have increased at a greater rate where there is access to (irrigated) valley bottomland than for farmers with only upland rain-fed land.

On-farm trials of promising technologies and new approaches

A network consisting of natural resource institutions from across the region can be an effective way of carrying out research, particularly by concentrating on the research strengths of the different institutes. For example the PARDYP team in China has particular expertise in fruit trees, in India bio-fertilisers and microbiology are strengths, and in Pakistan agroforestry research has been particularly successful. In addition, there are different pressing problems faced by the inhabitants of the different watersheds: water in the dry season in Nepal, poor planting material in Pakistan. This concentrates the efforts of different teams on different issues and the findings can then be shared with the other partners. However, it is very important to establish very clear research hypotheses at the start of any research and make sure that the results are related to these.

Regional Comparisons

In addition to the topical studies mentioned above, regional comparison and synthesis of the data collected is a significant activity and is becoming increasingly interesting as more data become available.

Attempts to integrate the results from each watershed using geographic information systems and other technologies in order to construct a picture of the behaviour of, for example, water and sediment in terms of time, season, land cover, and extremes are proving to be very interesting. The comparison of these results and key findings between the watersheds is being used to formulate and explain the main similarities and differences across the region and to model scenarios under given and changing conditions to predict flow regimes and sediment transport on an ‘if this, what then’ basis.

Three PARDYP watersheds were used as part of an even broader comparison between the Himalayas and Andes (see http://www.ire.ubc.ca/himal/index.htm) funded by IDRC.

In 2003 a major effort is underway to consolidate the data collected and analyse the information, and to provide position papers and next steps for further studies. In addition, the purposes for which the studies were initiated have also changed. For example, the information is now proving increasingly important as baseline data for measuring climate change. Cropping patterns and nutrient levels have shown great

change and will continue to be monitored for the next few years. These studies in the Jhikhu Khola watershed are particularly relevant to the other PARDYP watersheds (and more widely in the region). The Jhikhu Khola watershed is near the big markets of Kathmandu and land use and crop production methods are very dynamic. The lessons learned and the strategies adopted by farmers to overcome the various nutrient deficiencies may help farmers who will face similar problems elsewhere as they too intensify crop production.

Conclusions

There are many benefits from conducting research on natural resources through a regional network approach, either by all participating groups conducting the same or very similar research and comparing the results or by partners taking on separate tasks and then sharing the results. Joint problem solving can clearly lead to economies of scale and enhanced South-South exchange and capacity building. There are also benefits from improved coordination of training, facilitating mutual learning, cost-effective support, and strengthened self-confidence of the partners. A regional network also ensures scaling up of positive experience. Such collaboration can also enhance mutual understanding that may lead to collaboration beyond the scope of a project, as well as mutual respect among competing partners.

However, such approaches are very time consuming to manage and often end up with methodological outputs and 'meta' products and can be more difficult to evaluate than stand alone projects. Watershed management research requires the understanding of many natural resource processes and functions, and how they interact. These interactions are complex and very dynamic and the results inevitably raise more questions. We can learn from farmers who have overcome pressing problems in one location and share the results across the region.

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References

ICIMOD (1996) *People and Resource Dynamics in Mountain Watersheds of the Hindu Kush-Himalayas*, Project Document. Kathmandu: ICIMOD

ICIMOD (1999) *PARDYP – The Project Document*. Kathmandu: ICIMOD

ICIMOD (2002) *PARDYP Project Proposal for Phase 3*. Kathmandu: ICIMOD

Merz, J.; Nakarmi, G. (2001) 'Water Availability in Rural Watersheds of the Middle Mountains in Nepal'. In *Proceedings of the International Symposium on the Himalayan Environments, Kathmandu, November 2000*, pp 202-212. Kathmandu: Tribhuvan University and Hokkaido University

Merz, J.; Nakarmi, G.; Shrestha, S.; Shrestha, B.; Shah, P.B.; Weingartner, R. (2002) *Water and Erosion Studies of PARDYP Nepal: Water Demand and Supply Survey*, CD-ROM. Kathmandu: ICIMOD

Shrestha, B. (2000) 'Population Dynamics and Land Use in the Yarsha Khola Watershed'. In Allen, R.; Schreier, H.; Brown S.; Shah, P.B. *The People and Resource Dynamics Project – The First Three Years*, pp 75-84. Kathmandu: ICIMOD

Shrestha, B.; Brown, S. (1995) 'Land Use Dynamics and Intensification'. In Schreier, H.; Brown S.; Shah P.B. (eds) *Challenges in Mountain Resources Management in Nepal – Processes, Trends, and Dynamics in Middle Mountain Watersheds*, pp 141-154. Kathmandu: ICIMOD/IDRC/UBC

Shrestha, S.K.; Nakarmi, G.; Merz, J.; Osti, R.C. (2000) Survey of the Public Water Sources in the Jhikhu Khola, Report to Capacity Building for Community Water Quality Assessment Project. Kathmandu: ICIMOD