

## Comparison of the Two Watersheds

The major differences between the two watersheds are in elevation, topography, and proximity to markets. Both watersheds were thought of as dry – by 75 % of the respondents in the Jhikhu Khola and 53 % of those in the Yarsha Khola. Water quantity is a major issue in both watersheds (Figure 9). Irrigation water in particular is in short supply: 33 % of the respondents in the Jhikhu Khola and 41% in the Yarsha Khola mentioned shortage of water for irrigation. Many residents also face a shortage of water for domestic use: 27 % of those in the Jhikhu Khola and 37 % in the Yarsha Khola. The quality of drinking water is of increasing concern, particularly in more densely populated parts, with 17% of the respondents in the Jhikhu Khola and 9% in the Yarsha Khola indicating water quality problems. Other problems like flooding, erosion, and slumping are not seen as significant.

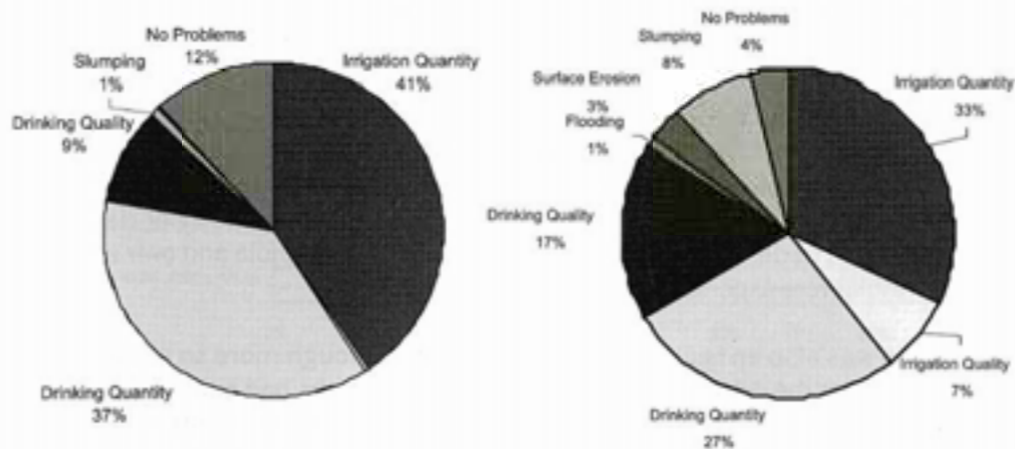


Figure 9: Water related key issues in the Yarsha Khola watershed (a) and the Jhikhu Khola watershed (b) as perceived by the local residents

## Agricultural Water Supply

The biggest water-related hardship felt by the local residents of the Yarsha and the Jhikhu Khola watersheds is the inadequate supply of water for irrigation. In the Jhikhu Khola watershed in particular, irrigation water is in short supply for the increasing number of cash crops for the Kathmandu market. Water shortage for irrigation is only an issue in the dry season months, particularly towards the end. Peak shortage was felt in the

months Falgun to Baisakh (mid-February to mid-May) in the Yarsha Khola watershed and from Falgun to Jestha (mid-February to mid-June) in the Jhikhu Khola. This reflects the long-term rainfall pattern in which there is a high likelihood of premonsoon rainfall events that can recharge sources in the more eastern Yarsha Khola, but no reliable annual pattern of such events in the Jhikhu Khola.

The problems with supply of water for agriculture are partly the result of changing practices. It is argued that water used to be adequate when farmers followed the traditional cropping systems with less than two crops per annum. With the introduction of cash crops, demand on water resources has increased significantly but supply per unit area has remained the same. In other words, the supply of water is insufficient for the new agricultural practices.

The water deficiency period coincides with the growing season of winter crops such as wheat and potato. Winter rains greatly facilitate the production of these crops, but they cannot be relied on. Farmers rarely face any problems with rice at plantation time, which generally falls in the monsoon, although there can be difficulties earlier. Transplanting can be postponed if the monsoon rains are late.

Irrigation water is a constraint throughout the watersheds. In the upper areas there is no surface water available and there are no irrigated fields. In the lower areas, most of the production is on irrigated fields, and water availability is the main constraint. Thus interventions aimed at increasing the availability of water should focus on the winter period.

### ***Domestic Water Supply***

Water supply for domestic use is also a major constraint in both watersheds. The average water use per person is already well below the design value for rural water supply schemes: 22.4 l per person per day in the Jhikhu Khola and 20.6 l per person per day in the Yarsha Khola. Just under a third of respondents in the Jhikhu Khola and over a third in the Yarsha Khola were experiencing problems with supply.

Water quality was also an issue in both watersheds, although more so in the Jhikhu Khola, in particular the presence of sediment as well bad taste, bad quality, and animal waste. The sediment problem is the result of improper construction of intakes, misused and dirty intakes, broken supply pipes, and collection from turbid sources like rivers. The major problem with sediment is the microbiological pollution that can be associated with it.

The problems in water quality noted by the respondents were confirmed by chemical and microbiological investigations. A total of 31 public water sources and 20 river sites in the Jhikhu Khola were monitored in the pre-monsoon period in 2000. Microbiological parameters like total and faecal coliform were in most cases found to be orders of magnitude above the values recommended by WHO (WHO 1993) (Figure 10).

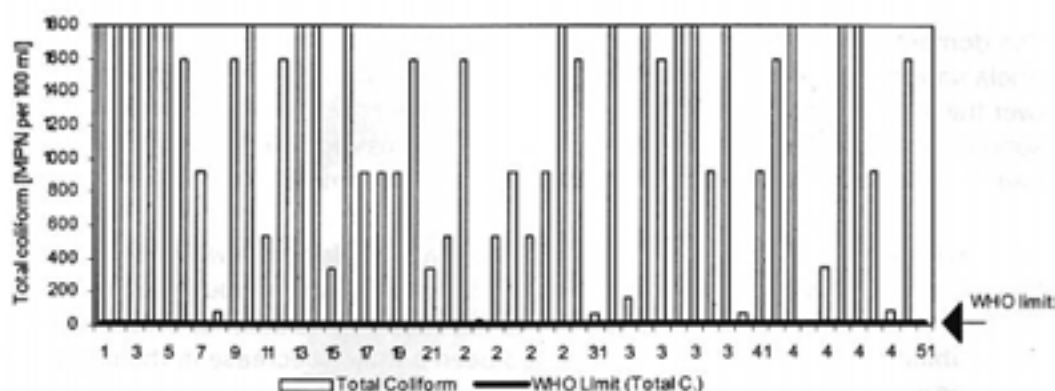


Figure 10: Microbiological contamination of selected water sources in the Jhikhu Khola watershed

Thus it seems that access to safe drinking water has become a major problem, although for local people it is apparently considered to be a secondary issue after quantity. The relevant authorities should take this issue seriously.

### Water Resource Dynamics

The overall water resources dynamics were assessed by asking respondents whether they thought the supply of irrigation water (men) and domestic water (women) had changed over the last 5 and 25 years. The results are shown in Figure 11.

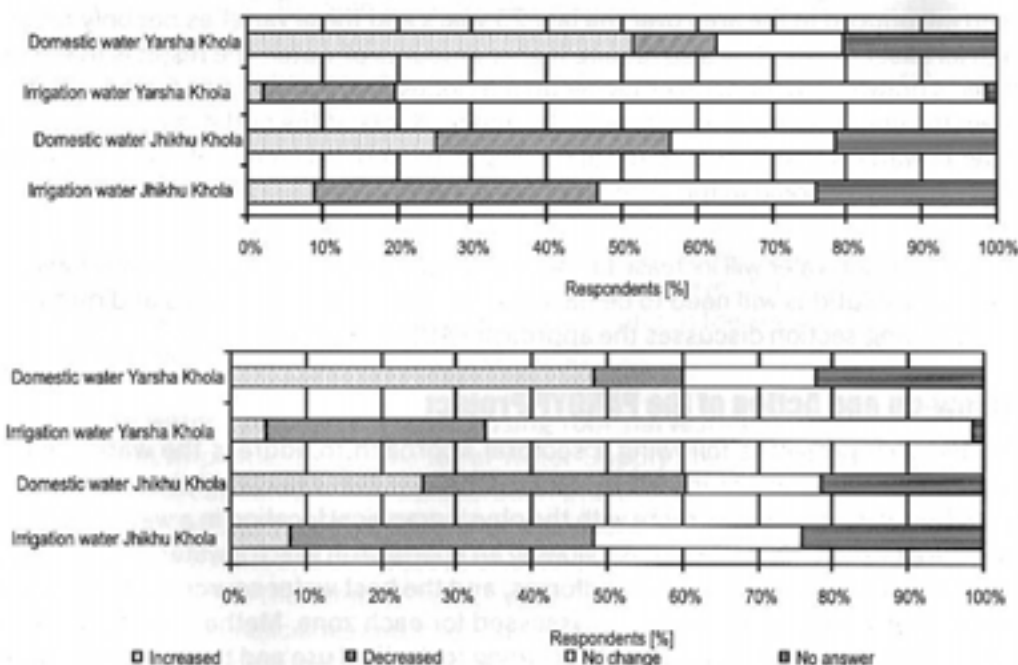


Figure 11: Perceived changes in water availability in the last (a) 5 years and (b) 25 years in the Yarsha Khola and Jhikhu Khola watersheds

The domestic water supply seems not to have changed dramatically. In the Yarsha Khola watershed a majority of the respondents said that the water supply had increased over the last 5 and 25 years, mainly as a result of the construction of drinking water supply systems. In the Jhikhu Khola the situation was less positive, although the supply had increased for many respondents it had decreased for more.

Similarly, the majority of respondents in the Yarsha Khola felt that availability of water for irrigation had barely changed over the last 5 and 25 years, although a substantial minority did think that it had worsened. In contrast slightly more than half of respondents in the Jhikhu Khola thought that there had been a major decrease in the supply of irrigation water.

The observation by respondents that the amount of water available for irrigation had gone down cannot be explained by decreasing rainfall; the long-term data of the meteorological stations in the Jhikhu Khola watershed show no significant change in rainfall over the years 1980 to 1996 with slopes for Dolaghat of  $-0.00002$ , for Panchkhal of  $-0.00002$  and for Dhulikhel of  $+0.0002$ .

The reason for the decrease in available water is believed to be the intensification of agricultural practices. Shrestha and Brown (1995) reported a slight increase in the area of irrigated agricultural land between 1972 and 1990, and a big change in cropping intensity from 1.3 crops per annum in 1980 to 2.3-2.6 crops per annum in 1994. One survey mentioned by Shrestha and Brown (1995) indicates that 13% of the households in the Bela area grow four crops per annum. Furthermore, high yielding varieties have been introduced in the area over the last 25 years and these varieties not only require high fertiliser doses, they also require higher amounts of water. The result is that more water is drawn from the sources higher up the slopes, and less remains for those further down the line. The dry season flow of the Jhikhu Khola at the outlet is observed to be lower nowadays than 10 years ago according to personal accounts of PARDYP project staff who have worked in the watershed since 1989.

The demand for water will increase further if development proceeds as currently forecast. Proposed solutions will need to be based on well studied technologies and methods. The following section discusses the approach PARDYP has taken.