HYDROLOGY OF NAKHU WATERSHED - BEFORE AND AFTER THE 1981 DISASTER

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INTRODUCTION

The Nakhu *Khola* watershed in the central mountain region of Nepal was severely affected by debris flows on 30 September 1981. The watershed is surrounded by hills more than 2,000m in altitude. Six per cent of the area is below 1,500m; 3 per cent is between 1,500m to 1,750m (8%- 40% hill slope); the area between 1,750m to 2,000m (6% to 40% hill slope) is 44 per cent; and the area above 2,000m (more than 50% hill slope) is 19 per cent. The longitudinal profile of Nakhu *Khola* with its main tributaries is given in Fig. 1.

The rock types are limestone, sandstone, slate, phyllite, quartzite, etc. The downstream area from Tika Bhairab/Champi consists of alluvium deposit. The land utilisation map (1984) study shows 37.5 % as forest area; 23.8% as sloping terraces; 23.9% covered by shrubs, and 14.8% as agricultural land and alluvium (including the river course and terraces).

The average maximum and minimum temperature records of Godawari (elevation 1,400m) is presented in Table 1. The area is connected by motorable roads. The natural resources are forest, water, sand, and stone.

The total population in the major seven villages (1) of the watershed has changed in the last 30 years from 1,97,343 (in 1971) to 29,707 (in 1981) and 31,738 (in 1991). The low rate of population growth (1981 - 1991) is due to migration from one local community to other and partly due to people's awareness of the advantages of a small family.

FLOOD/DEBRIS FLOW - 1981 :

Okamoto et al. (1) made a preliminary assessment of the 1981 flood/debris flow. The flood peak estimated by a rational approach and from Manning's formula, based on the information of the local people, is 600m^3/s and 1,150 m^3/s respectively.

After the experiences of the flood disaster of 1993 in Central Nepal, the author has revised the flood peak by readjusting the rainfall intensity. The maximum rainfall intensity observed during 1993 storm at Tistung is 53 mm/hr and 45mm/hr at Nibuwatar. With the help of this information, the flood peak of the 1981 disaster is estimated to be about 500m^3/s

PRECIPITATION AND STREAM FLOW

There were no rainfall stations within the watershed before 1993. So the rainfall data (1971 - 1990) of the two neighbouring rainfall stations (Godawari and Panauti) are used to compute the basin rainfall (Table 2). The average stream flows from 1963 to 1980 of Nakhu *Khola* at Tika Bhairab were used to compute the runoff in the basin. The monthly runoff values are listed in Table 2.

THE RUNOFF-RAINFALL RELATIONSHIP

One of the objectives of the study is to generate the missing record of stream flows. Linear regression analysis (Fig. 2) is carried out on rainfall and runoff data (1971 - 1980). The regression showed very low correlation (r = 51% only). The observed and estimated stream flows are shown in Fig. 3. One of the causes of poor correlation could be the errors in stream flow computation because the river is the main source of irrigation water.

CONCLUSION

The extreme rainfall on steep and weak hill slopes of Lele *Khola* and Nallu *Khola* watersheds had produced debris torrents which resulted in the loss of human lives and property. The extreme rainfall of 1981 is found to be a random meteorological event (cloudburst) which occasionally happens in one part of the country or the other. Due to poor correlation between rainfall and runoff data, the consequences of the 1981 disaster in the water balance of the watershed could not be judged.

Human interference (development activities) as well as ground coverage (vegetative cover and agricultural practices), soil and rock type (geology), terrain slope (topography), etc were other factors which, directly or indirectly, had accelerated the damages. The urbanisation thrust in Kathmandu Valley has now been slowly spreading to the villages of this watershed.

REFERENCES

Okamoto, A.; Bhusal, J. K.; and Dhakal A.. S. 'Review of the 1981 Flood/Debris Flow in the Nakhu Khola Basin in Central Nepal, October, 1993'. In *MOWR Committee, Reports on floods in Bagmati River Basin, July 19 - 21, 1993, Ministry of Water Resources, September 10, 1993.*

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Table 1. Monthly Maximum and Minimum Temperature at Godawari (Elevation 1400m)

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max.(°C)	17.6	20.5	24.7	28.2	29.5	28.7	27.5	26.6	26.7	25.1	21.3	18.7
Min.(°C)	0.4	1.9	4.5	7.3	11.1	14.1	16.8	15.8	14.9	9.4	5.1	2.4

Source : DHM

Table - 2 : Mean Monthly Total Rainfall and Runoff (1971 - 1990)

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall(mm)	16	22	32	58	123	281	458	347	261	79	6	18
Runoff(mm)	14	11	13	10	10	88	196	210	151	60	26	18

Source : DHM

Figure - 1: Stream profile

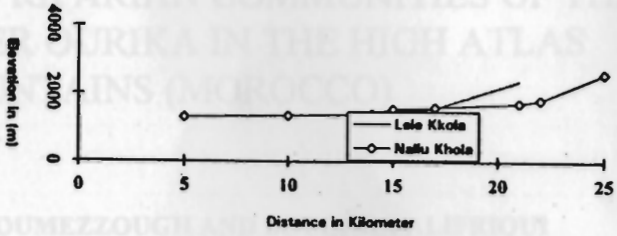

Figure - 2: Rainfall - Runoff
[Q = 0.486*P - 24.93]

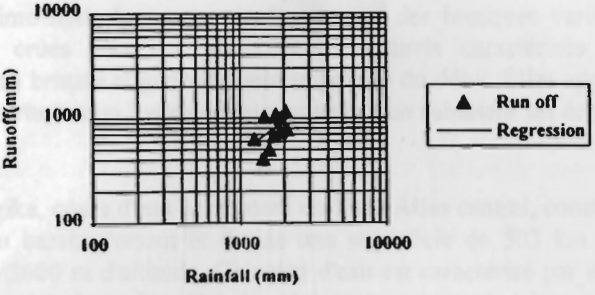

Figure - 3 : Annual Rainfall and Runoff