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GLACIAL LAKE OUTBURST FLOODS AND RISK ENGINEERING IN THE HIMALAYA

Jack D. Ives

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Cover photograph: Low level aerial oblique photograph showing loss of cultivable land, trail destruction and endangered houses. Dudh Koshi at Chat. Photograph by Dr. Victor Galay.

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Foreword

The physical geographer's technical term, "*jokulhlaup*", used for the often catastrophic surge of water and debris caused by the sudden outburst of glacier lakes in the high mountains, would certainly be unfamiliar to the vast majority of the peoples of the Hindu Kush-Himalaya but, sadly, the phenomenon itself is not. These glacier lake outburst floods have caused disasters to life and property in a number of places along the whole of the mountain range, resulting in serious death tolls and the destruction of fields, farms and costly mountain infrastructure. In Nepal alone in this decade, glacier outbursts with heavy debris flows destroyed (in 1981) a large stretch of the road linking Kathmandu and Lhasa, including the Friendship Bridge on the frontier, and (in 1985) similarly destroyed a Small Hydel Project in the Everest region with lives lost and much damage to land and forest and farmhouses.

Clearly these sudden and spectacular debris torrents are major hazards to human habitation and assoiated infrastructure development in the high mountains. It is increasingly obvious that catastrophic glacier lake outbursts have to be fully recognised as a significant factor in the design and construction of major infrastructure - in roads andbridges and large scale hydroelectric projects - in fragile mountain environments. In locating new infrastructure projects the degree of risk has to be assessed much more specifically, and indeed more skilfully, than appears to have been the case in the past. The Arun River Basin in Nepal, for example, with a number of sites currently being studied for major hydroelectric projects costing many hundred million dollars, may be at a considerable risk from glacier lakes to the north in the high mountains of the Upper Arun across the border in Tibet.

If essential but highly costly investments in mountain infrastructure are to be made with confidence, much more research is needed into the active physical processes at work in the high mountains. This 'risk engineering research' in mountain areas is increasingly urgent as, with increasing population pressure, the resources of the mountains are being exploited for hydroelectric power, mining, forestry, agriculture and tourism. A skilled examination of the physical processes - with the academic geomorphologist in close, practical alliance with the design engineer - may well lead to the development of the protective measures, in design and location criteria, that will reduce the risks of major disaster - given the inevitable and accelerating processes of mountain resource utilisation and infrastructure investment.

In the summer of 1986, with generous financial help from the International Development Research Centre (IDRC) of Canada, ICIMOD invited Professor Jack Ives of the University of Colorado, President of the International Mountain Society, and one of the world's leading scientists in the field of mountain geo-ecology, to prepare a special 'risk engineering' analysis of the glacier lake outburst flood that occurred in the Namche area of Nepal on 4 August 1985, wiping out the Hydel Project and causing heavy damage for some 40 kms downstream.

We are pleased to publish this particularly useful study, drawing on a wide range of international knowledge of the 'jokulhlaup' phenomenon, in the ICIMOD Occasional Paper Series. We must express our thanks to Professor Ives for this contribution to the international exchange of knowledge and experience with regard to one of the major hazards to habitation and infrastructure in the high mountains. As Professor Ives fully indicates, much practical field research is now required if these spectacular natural events - and the associated degree of risk in specific locations - are to be adequately understood in the Hindu Kush-Himalaya.

Colin Rosser
Director
ICIMOD

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Work on the first draft of this report was completed at ICIMOD, Kathmandu, during July and early August, 1986, at the invitation of the Director, Dr. Colin Rosser. The International Development Research Centre, Canada, bore a significant proportion of the expense incurred.

On a personal level I wish to express my thanks for the kindness and encouragement showed by the entire ICIMOD staff. I am also indebted to Dr. C. K. Sharma, Executive Director, Water and Energy Commission, HMG/N, and to Mr. K.B. Malla, Chief, Remote Sensing Centre, HMG/N, for their encouragement and willingness to provide all manner of assistance. Drs. Victor Galay and Ramiro Mayor-Mora were unstinting in their provision of internal reports and first-hand Khumbu field experience. Drs. Suresh Chalise, Victor Galay, Ramiro Mayor-Mora, Gordon J. Young and Alton C. Byers all read and made helpful comments on an early draft of this report. Especially valuable has been the outstanding photography by Dr. Galay and his willingness to make it freely available.

This paper is an outcome of the United Nations University/Nepal MAB Programme, Mountain Hazards Mapping Project (Ives and Messerli 1981). The second phase of this project involved systematic hazard mapping of a section of Khumbu Himal and the production of a prototype hazard map, scale 1:50,000 (Zimmermann *et al* 1986).

It should be apparent that I have relied for much of the content on the field observations and office reports of individuals other than myself. In addition to those mentioned above, special thanks are due to Messrs. Daniel Vuichard and Markus Zimmermann, University of Berne, and members of the UNU/Nepal MAB Mountain Hazards Mapping Project.

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