

Flash floods and Debris Flows as a Result of Glacier Lake Outburst Floods **Karma Chhophel, Hydro-met Services Division, Department of Energy, Thimphu**

Abstract

Bhutan is a landlocked country located in the eastern fringes of the Himalayas. It has an area of 38,394 km² and lies between 88.7°-92.2°E and 26.7°-28.4°N. It is bordered by the Indian states of West Bengal, Assam and Arunachal Pradesh in the west, south and east and the Tibetan Autonomous Region of China in the north. The terrain is rugged and wholly mountainous, thereby providing an ideal setting for development of hydropower. While this setting is considered advantageous, the disadvantages lie in being prone to numerous water related disasters. Glacial Lake Outburst Floods (GLOFs) are among the most serious natural hazards in the country. The inventory of glaciers and glacial lakes indicate that there are 2,674 glacial lakes in Bhutan. The study has identified 24 glacial lakes as 'potentially dangerous lakes' that could pose a GLOF threat in the near future. In the past, the Punakha-Wangdue valley, Thimphu and Paro valleys have been affected with damages inflicted to houses, bridges, water mills, paddy fields, river systems, lives and livestock. Future threats are likely to encompass regions that fall within the Chamkar Chu basin, the Mangdge Chu basin, Kuri Chu basin, Mo Chu basin, and Pho Chu basin. Overall, GLOFs regularly threaten the lives and livelihoods of people living in the valleys and low lying river plains. Also susceptible to damage is industrial infrastructure such as hydropower projects and communication facilities.

GLOFs cause huge debris flow in addition to loss of human lives and livestock., While inundation due to outburst is limited due to the steep terrain, the sheer force washes everything in its path.

The need, therefore is strongly felt to adequately deal with disasters caused by flash floods resulting from lake bursts events. The events of the past indicate that these are occurring at an accelerated rate, apparently due to climate change because of global warming. The need to reduce risks to lives and property has assumed dimensions that warrant urgent attention.

This paper looks at causes of GLOFs, the problems they have created, the scale of the events, how these have been handled so far and what were the lessons learnt. The importance of creating awareness in people living in risky areas and setting up of warning systems are also addressed.