Prediction of Potential Outburst Floods from Tsho Rolpa Glacial Lake of Nepal

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1. Introduction

Glacial Lake Outburst Floods (GLOFs) can cause catastrophic flood disasters along the river valley. Therefore, the study on hydrodynamic characteristics of potential outburst flood from glacial lake is very urgent in order to reduce the hazards and disasters. Tsho Rolpa Glacial Lake (27°51'N, 86°29'E) is located in the Rolwaling valley at an altitude 4555m. The lake lies in Gaurishanker Village Development Committee, Dolakha District, Nepal. The lake has been developed only in the last 50 years, as the glacier feeding it has begun to melt rapidly. The lake is 3.23km long and 0.5km wide, and 1.76km^2 surface areas and contained 85.94 million m^3 water. The lake is considered one of the most dangerous glacial lakes in Nepal. In this study, the hydrodynamic characteristic of potential outburst flood from the Tsho Rolpa Glacial Lake has been computed by using numerical model.

2. Potential Outburst Flood from Tsho Rolpa Glacial Lake

A numerical model was developed to predict the hydrodynamic characteristics of glacial lake. A numerical model was developed by coupling a flow and erosion model, a seepage model and a slope stability model. By using developed numerical model, the hydrodynamic charactiristics of potential outburst flood from Tsho Rolpa Glacial Lake have been analyzed along the Rolwaling and Tamakoshi River valleys. The main drainage in the Rolwaling valley is Rolwaling River originating from Tsho Rolpa Glacial Lake. Rolwaling River joins with Bhote-Tamakoshi River near Chetchet at about 26km downstream from the lake. The average slope of the Rolwaling River is about 12% and the average slope of the Tamakoshi River downstream from the confluence point is about 1.59%. Figures 1(a) and 1(b) show the location of the Tsho Rolpa Glacial Lake and longitudinal river profile downstream from the lake, respectively. The river cross-sectional data and river bed profile were extracted from digital contour data prepared by the Survey Department of Nepal. The cross-sectional data, longitudinal bed profile and water depth of the lake were derived from the topographical and bathymetrical map prepared by the International Center for Integrated Mountain Development (ICIMOD, 2010).

The seepage and slope stability analyses of the dam were carried out in the worst cases. In seepage analysis, water infiltration inside the dam was considered from upstream water depth of the dam. Figure 1(c) shows the shape of moraine dam used in the calculations, failure surface due to seepage and dam shape after collapse. The mean diameters of sediment particles of the moraine dam and river reach were as 5.7mm and 98mm, respectively, which were obtained from grain-size analysis of the sediment particles. The erosion depth of sediment on the river was estimated to be about 5.9m throughout the reach based on interpolation of river cross-sectional data. More than 60 cases were simulated and Figure 2 shows the typical results of potential outburst floods from the Tsho Rolpa Glacial Lake in the cases of 20m and 30m breaching depth with 70m breaching width. The discharge in the figures is sediment-water mixture flow. The peak discharges in the cases of 20m and 30m breaching depth are 21,551m^3/sec and 34,234m^3/sec, respectively. The volume of lake water released in the cases of 20m and 30m breaching are about 26.5 million m^3 and 39.4 million m^3,

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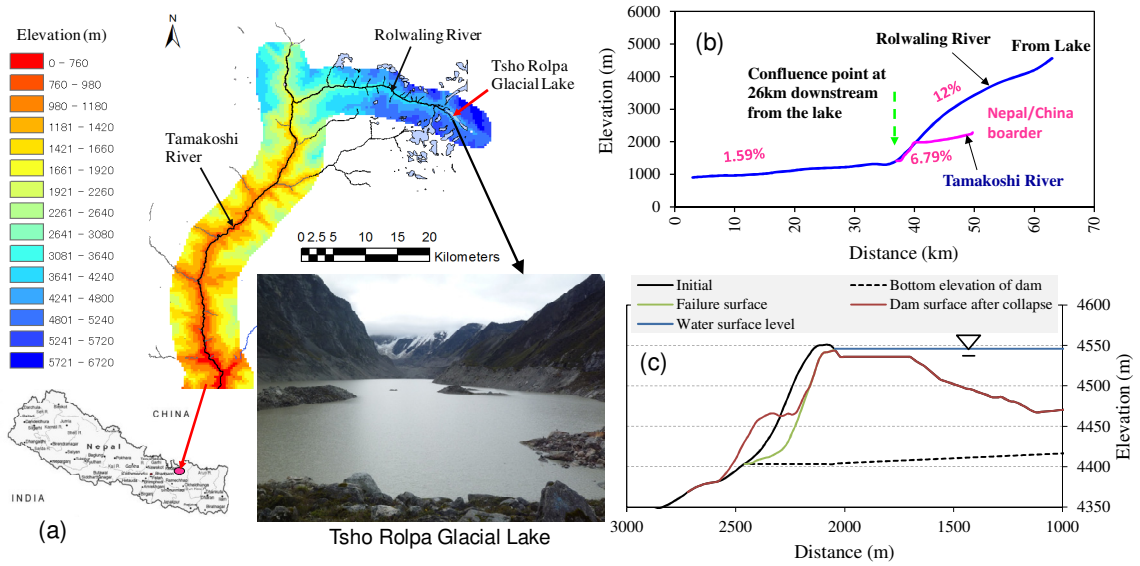

Figure 1: (a) Location of the Tsho Rolpa Glacial Lake in Rolwaling valley, (b) Longitudinal River Profile Downstream from the Lake and (c) Shape of Moraine Dam and Failure Surface due to Seepage

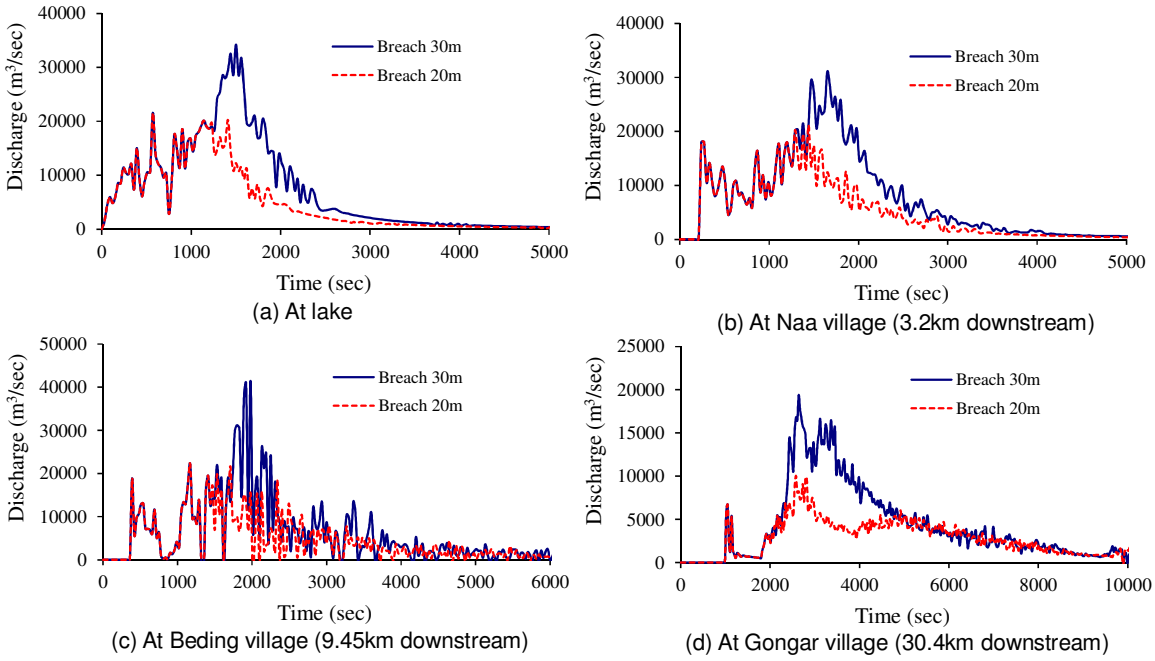

Figure 2: Potential Outburst Flood Hydrographs from Tsho Rolpa Glacial Lake

respectively. In upstream of confluence point, active erosion occurs on the riverbed. In river reach downstream from confluence point, flow discharge decreases due to milder slope and deposition of sediments in this reach. The resulting outburst discharge from the lake generates catastrophic floods and debris flows along the river. Therefore, the potential floods from this lake can cause serious damage of properties and loss of lives along the Rolwaling and Tamakoshi rivers.

3. Conclusions

By using developed model, the potential outburst floods from Tsho Rolpa Glacial Lake in the Rolwaling valley of Nepal were predicted and were analyzed. The estimated peak discharges in the cases of 20m and 30m breaching depth with 70m breaching width are found to be 21,551m^3/sec and 34,234m^3/sec, respectively. The volume of lake water released in the cases of 20m and 30m breaching are about 26.5 million m^3 and 39.4 million m^3, respectively. The resulting flood from the outburst of Tsho Rolpa Lake can cause serious damage for more than 100km downstream, threatening many people and infrastructures.