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Quantification of Flood Hazards Due to Assumed Breaching of Attabad Landslide Dam, Pakistan

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ABSTRACT

A massive landslide of 210 m height, occurred in Hunza river near Attabad village which is located about 100 km upstream of the confluence of Hunza with Gilgit River. At crest level, this landslide has a capacity of 305 Mm^3 of water, width 350 m and length 2 km along the river. Subsequent to this landslide, the uncontrolled blockage formed a reservoir with a very steep downstream slope; 1.0(H):0.7(V). Arial view of Attabad Landslide Dam along the Hunza River is shown in Fig. 1. The snow melt in summer causes overflow of this landslide mass. A progressive erosion of the landslide is anticipated due to overtopping/piping phenomenon. Keeping in view the high storage capacity of this landslide, the flow may washout this landslide mass within a few hours, once collapse start, with disastrous impacts downstream. In order to quantify the parameters of the flood wave that will be generated due to possible dam break event and resultant inundation, Dam Break Analysis has been carried out using Mike 11; an application by Danish Hydraulic Institute, Denmark.

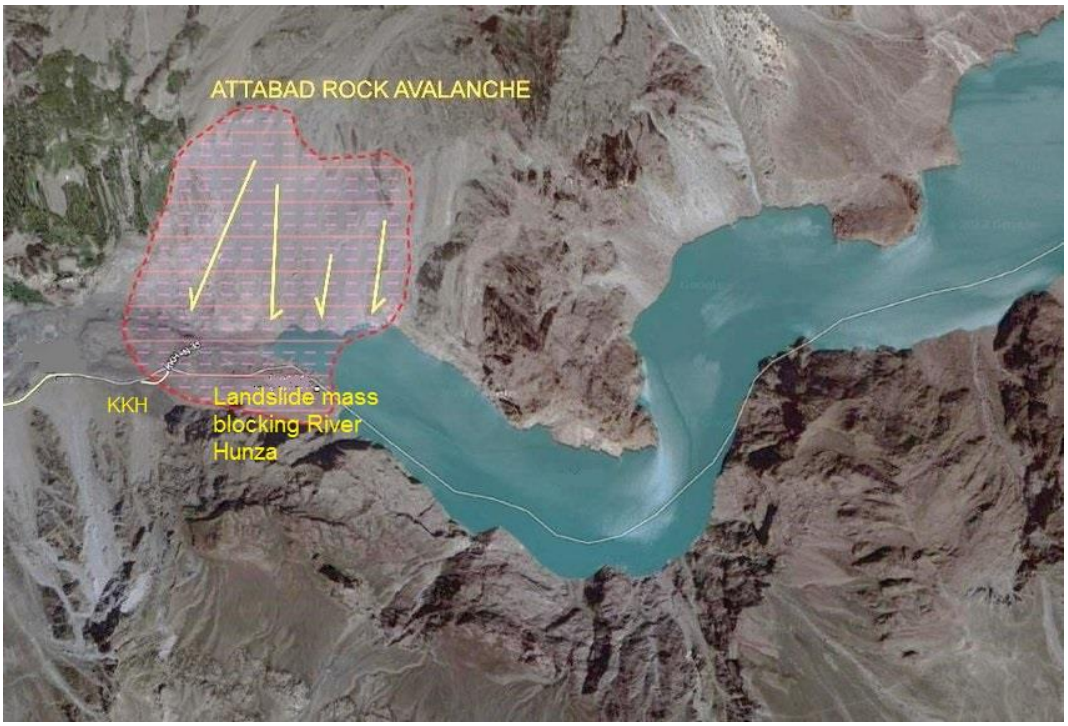

Fig. 1. Arial view of Attabad Landslide Dam along Hunza River

The main objectives of this dam break study are to predict flood wave arrival time, peak discharge and wave height at Daniyor Bridge upstream of the confluence of River Hunza and River Gilgit. Fully dynamic Saint Venant equation has been used in MIKE 11 to route the outflow hydrograph to predict flood characteristics downstream of the landslide mass. The gauging station upstream of the landslide mass, Daniyor Bridge and Alam Bridge on River Gilgit are considered as upstream boundary, calibration point, and downstream boundary respectively, for calibration and validation of the routing model. The model calibration and validation is done by using the flow data measured in the years 2011 and 2012, respectively. The results of calibration are found to be very satisfactory. A sensitivity analysis is also performed on the model's main input parameters and their effect on the peak outflow, flood wave arrival time and wave height are studied.

This study incorporates computations under six different breach triggering and breach shape scenarios which include trapezoidal and triangular breach shapes with failure due to either piping phenomenon or overtopping of the dam crest or user-defined breach of the dam.

The results show that shape of breach and mode of triggering has major effects on discharge and time of peak. At Daniyor Bridge a maximum water depth of 13.16 m with a peak discharge of 11,545 m^3/s was observed due to Erosion based dam breach with the breach shape to be trapezoidal. This discharge is 2.3 times the historic maximum flood magnitude i.e. 5,000 m^3/s which Daniyor Bridge has faced in 1967.

Comparison of the results of trapezoidal and triangular shapes of dam-breach shows that peak out flow through the dam in case of trapezoidal shape is about three times greater than the peak out flow through the dam for triangular shape. All the parameters of the two cases were same except the shape of the breach.

Results of this study may be used for the preparation of an Emergency Preparedness and Action Plan (EPAP) for the area potentially prone to threat. It is recommended that researchers should try to incorporate the randomness of breaching initiation in future numerical models and investigate characteristics on the initial breach in order to determine the worst case scenario of a dam breach. Also, the model setup should be extended, in the next step to confluence of Indus River and then up to Tarbela Dam to find the effect of dam break of Attabad Landslide Dam on other part of the country.

The paper presents the details of the project, the model set up and details of the studies carried out.