DAM BREACH ANALYSIS: A COMPARISON BETWEEN PHYSICAL, EMPIRICAL AND DATA MINING MODELS

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In this paper, we explore the available methodologies for dam breach modelling. A comparison between the commercially available BREACH and a simplified Dam Breach Model developed by the authors is presented. We analyse the breach outflow time series produced by both numerical models and argue their applicability in a particular case. Peak outflows are compared with available empirical relations as well as with estimated values obtained by using data mining techniques.

Different methods are available for predicting breach characteristics: empirical, semi-physical and physical methods. Many empirical relations have been developed based on the historical dam failure events. However in dam break flood hazard analysis, they are used more as a guideline rather than as a basis for flood forecasting purposes. Peak outflow and breach characteristics are estimated based on the available information of dam height, reservoir storage, depth and volume of water above the breach triggering the failure.

Semi physical and physical methods are based on many assumptions owing to the incomplete understanding of the breach formation processes. Numerous tools are available for analyzing dam failures and the resulting hydrograph; still only ± 50% accuracy is observed in predicting the breach outflow.

Zagonjolli (2005) proposed an alternative methodology for estimating breach characteristics and peak outflow, using data mining techniques. The performance of various data mining methods applied to the available database of historical dam failure events was explored and a good generalization performance was observed.

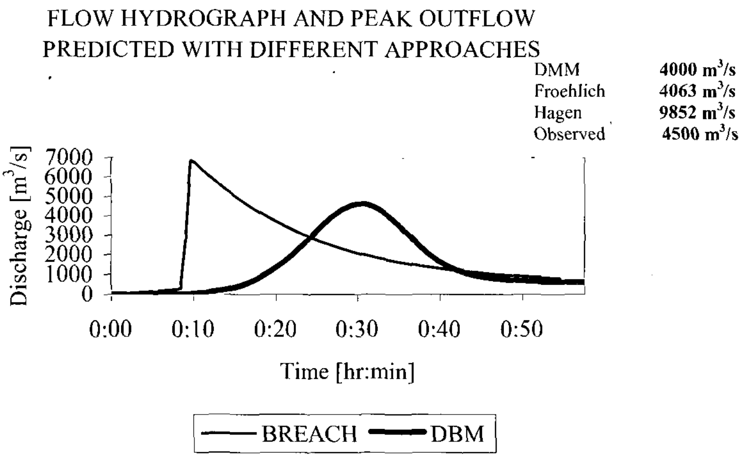
In this paper we model the breaching of Schaeffer dam, which failed from overtopping in 1921, using different methodologies and compare their capabilities. The commonly used BREACH model (Fread, 1988), a simplified Dam Breach Model (Zagonjolli *et al.*, 2005), some empirical formulations developed during the last decades as well as a number of data driven models introduced by (Zagonjolli, 2005) are used for predicting the peak outflow of Schaeffer dam. The National Weather Service BREACH model (Fread, 1988) simulates overtopping and piping failure modes for cohesive and non-cohesive dams. Breach evolution is described by erosion and slope stability theory. For overtopping failure mode, flow into the breach channel is calculated by the broad-crested weir relationship, while for piping failure mode is applied the orifice flow relationship. Simplified Dam Breach Model (DBM) calculates breach outflow for overtopping failure mode. It is based on reservoir routing scheme in which the change in reservoir volume in time equals the breach outflow. The breach develops initially vertically in a triangular shape till the time the bottom is reached, when lateral, trapezoidal development of the breach is initiated.

Data mining techniques have received considerable attention in solving water-engineering problems. In the present context, two approaches are used to predict the peak outflow based on data mining techniques: (i) Artificial Neural Networks (Multi Layer Perceptron) and (ii) Instance Based Learning (IBL).

The results showed the wide range of predicted peak outflow from different approaches. In case of estimation using the empirical relations peak outflow discharge varies from 2230 m^3/s to 9048 m^3/s excluding the upper limits from the envelope equations. For this particular case it appears that for predicting peak outflow based on dam height and storage, Singh and Snorrason and Costa's regression equation perform the same with predicted peak outflow about 50% lower than the measured one. Froehlich's equation performs better than the other equations that predict peak outflow based on the depth and volume of water above the breach at initial time. The overall conclusion is that Froehlich's equation is most appropriate for this particular case with predicted peak outflow 15% lower than the recorded one.

Using the data driven techniques the peak outflow estimated by Instance Based Learning IBk is 4000m^3/s viz. about 10% smaller than the observed value, while MLP model predicts a peak outflow 34% lower than the observed one.

When the physically based dam breach models, BREACH and DBM were applied; predicted peak outflow varies in a narrower range depending on the assumptions and parameters used.



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