

Probabilistic Assessment of Large Dam Breach Hazard

Hiroimi D. FONTANILLA, Taro UCHIDA

University of Tsukuba

1. Introduction

Historically dams have played a vital role in sustainable water resource management by regulating water supply, both domestic and agricultural, and in mitigating floods. However, dam failures remain one of the most catastrophic infrastructure-related disasters, often resulting in severe environmental, social, and economic consequences.

In the Philippines, the Pantabangan dam is an earthfill multipurpose embankment dam with a height of more than 100 meters. This study aims to develop an understanding of possible dam breach scenarios that may occur given the type of dam, height of dam, and reservoir volume of the said watershed.

The following points may be considered as challenges, as various empirical formulas for predicting the peak discharge during dam failures have been proposed; 1.) However, there are few studies that compares the characteristics of these empirical formulas considering large dams, so it is unclear which formula is appropriate to use when evaluating dam breach risks. 2.) There are also few examples in which the uncertainty of peak discharge obtained from empirical formulas have been evaluated, and methods for making predictions from a safety perspective have not been sufficiently developed. Therefore, this study aims to assume risk management for large-scale earth dams in the Philippines and to uniformly evaluate the following two points using many proposed empirical formulas with a database of dam failure cases aiming for: a.) Prediction accuracy for large-scale earth dams and, b.) Reduction on the uncertainty of the calculated results.

2. Methodology

This study then proposed using an empirical method to understand the possible dam breach scenarios. For this, we will need to collect and analyze past dam failure records.

This study will consider dam failure characteristics of piping and overtopping, such as breach width and peak discharge, that have been recorded as observed data and we will compute for predicted values using empirical equations from these observations. However, since these empirical formulas have been developed based on the analysis of information mainly concerning the failure of relatively small-scale dams, we will aim to propose the best fitting empirical formula that will consider large dams using graphical analysis and trendlines. With further consideration required for their applicability to large-scale dams. This study have analysed dam breach data from the studies of Froehlich (2008), MacDonald and Langridge-Monopolis (1984), and Azmi and Thomson (2023). Of the three studies, with 282 recorded dam failures studied, only 3 were above 100m. Just 1% from these studies were higher than 100 meters. We will then aim to consider a different category that is already being used in the Philippines, from the National Irrigation Administration's Memorandum Circular No. 111, series of 2019. Which categorizes dams into either small, medium or large considering not only the height of the dams but also using the reservoir's storage capacity.

This study will then aim to verify the relationship and trend of the observed and predicted values used for what is categorized as large dams.

3. Results

For the first step towards resolving this issue, we verified the applicability of the existing proposed formula to large-scale dams. We collected dam failure cases used in formulating the empirical formula and organized them by dam height and storage capacity. We then examined whether the discrepancy between the predicted values derived from each empirical formula and the observed values from the historical data. We tried to find how it was related to the dam's scale, and if so, what kind of relationship and trend existed.

