FLOOD FREQUENCY ANALYSIS FOR SARAWAK USING WEIBULL, GRINGORTEN AND L-MOMENTS FORMULA

Onni S. Selaman[1], Salim Said[1] and F.J. Putuhena[1]
[1]*Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak*
E-mail: onni70@yahoo.com, E-mail: ssalim@feng.unimas.my

ABSTRACT

The objective of this study is to determine the magnitude and frequency of floods for Sarawak using Gumbel distribution. Nineteen stations were selected for the study based on the criteria stated in Hydrological Procedure No. 4 (HP4). The probability plot and flood-frequency curves by Gumbel distribution of each individual station are prepared using three different plotting position formulas (i.e. Weibull, Gringorten and L-Moments). From the results and analysis of each individual station, Gumbel distribution based on L-Moments always give the least ratio of peak discharge of T year's recurrence interval over mean annual flood (QT/MAF) but at some stations, it gives unreasonable return period (T) and reduced variate (y) range. The appropriateness of L-moments with Gumbel distribution had some limitation. It is only good for small samples data. If compared between Gumbel distribution by Weibull formula and Gumbel distribution by Gringorten formula, the latter is better because it gives the least ratio (which is in agreement with the literature). Therefore, it could be concluded that for some stations, L-Moments method is the best, but since L-Moments method had some limitations, Gringorten formula is still the best plotting position method to be applied with Gumbel distribution.

Keywords: *Gringorten, Gumbel Distribution, L-Moments, Weibull*

1. INTRODUCTION

In the planning and design of water resources projects, engineers and planners are often interested to determine the magnitude and frequency of floods that will occur at the project areas. Besides the rational method, unit hydrograph method and rainfall-runoff models method, frequency analysis is one of the main techniques used to define the relationship between the magnitude of an event and the frequency with which that event is exceeded.

As a guidelines to determine the magnitude and frequency of Floods in Peninsular Malaysia, the Department of Drainage and Irrigation (DID) of Malaysia has published a hydrological procedure called Hydrological Procedure No 4 (HP4) [1]. The procedure is based on the regional frequency analysis method used by the Natural Environmental Research Council (NERC) [2]. In NERC method, the flood frequency analysis of individual station flood data is determined using Gumbel distribution and the theoretical fits are determined by the method of moments. The plotting position of each sample is calculated using the Weibull formula.

Cunnane [3] had studied various plotting position methods using the criteria of unbiasedness and maximum variance. He found that the Weibull plotting position formula was biased, and it plotted the largest values of a sample at too small a return period. He said, for data distributed according to the Extreme Value Type I distribution (or Gumbel distribution), the Gringorten formula (b = 0.44) was the best.

No such procedure has been developed for Sabah and Sarawak but there was a prior research on regional flood estimation for ungauged basins in Sarawak by Lim and Lye [4]. They had examined the flood records in Sarawak using an index-flood estimation procedure based on L-moments technique. They adopted four-parameter Kappa distribution to simulate the flood data. From the simulation, they obtained two homogeneous flood frequency regions. The two regions were described by the Generalised Extreme Value and the Generalised Logistic distributions.

This paper focuses on the application of Gumbel distribution with Weibull Formula, Gringorten Formula and L-Moments Method. It is hoped that the findings from this study could contribute to the knowledge of the application of Gumbel distribution in flood-frequency analysis study in Sarawak.

2. LITERATURE REVIEW

2.1. Probability Distributions for Hydrologic Variables

According to Arnell [5], in principle, it is possible to estimate the frequency of a given magnitude event by using an empirical distribution function (because in the empirical distribution function the magnitude of event are plotted against the proportion of events greater than or equal to that event), but in practice where too few data are available, the empirical distribution produced could not be used to estimate the frequency of occurrence of events larger than the maximum records. He suggested, as an alternative, the samples of data are fitted using a theoretical frequency distribution.

There are several types of theoretical probability distributions (or frequency distribution functions) that have been successfully applied to hydrologic data [6]. Some of the probability distributions commonly used for hydrologic variables were Normal Distribution, Lognormal Distribution, Exponential Distribution, Gamma Distribution, Pearson Type III Distribution, Log-Pearson Type III Distribution and Extreme Value Distribution. Extreme Value Distribution which is further subdivided into three form – EVI (Gumbel Distribution), EVII (Frechet Distribution) and EVIII (Weibull Distribution) [7].

The most popular theoretical probability distributions (or frequency distribution functions) have been the lognormal, log-Pearson Type III and Gumbel distributions [6, 8]. In the United