ANALYSIS OF FLOOD FREQUENCY AT LOWER REACH OF KELANI RIVER IN SRI LANKA

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INTRODUCTION

Submerging lands that are usually dry is called flooding. In simple terms, it can be defined as a large quantity of water flowing from a water body to a dry area due to environmental or human effects. Nowadays, flooding is one of the major disasters all over the world. According to the different magnitudes of the flood, people and animals have to face various problems. There is a massive possibility of losing life and it may cause hardships to people, and property damage. The leading cause for flooding is extreme weather conditions; rain is the most prominent reason for flooding (Dilhani and Jayaweera, 2016; Gunasekara, 2008). Hydrologists have come up with different flood risk management programs to overcome or reduce this issue and flood risk management organizations have to predict the magnitude of the flood to reduce the impact. Sri Lanka is frequently facing floods, and the Kelani River is one of the leading flood sources in Western Province, Sri Lanka. Many people have lost their lives and properties; due to that reason, various flood frequency analyses were done, and multiple predictions have been made. Many statistical methods are used by hydrologists to predict the flood magnitudes. If we consider Sri Lanka's recent past, flooding is a big issue for citizens' regular daily routines. Several researchers have made flood predictions to manage flood risk and overcome this issue (Gunasekara, 2008; Karmakar and Simonovic, 2008; Shabri and jemain, 2013). This study shows a brief analysis of flood prediction of the lower reach of Kelani River, Sri Lanka. It was carried out to estimate the flood magnitude and return period through past gauged data collected in recent years from a statistical calculation.

METHODOLOGY

The lower reach of the Kelani River was selected as the study area. It pours down by covering the Capital of Sri Lanka, Colombo and another highly populated city, Gampaha. Due to the high rainfall and because of geomorphological features, frequent floods occur in these areas (Gunasekara, 2008). Gauge data (Daily discharge in cumecs) was collected over the past 31 years (1987-2017) at the Hanwella gauge station and analyzed using statistical methods.

According to the literature, the annual peak method was utilized to analyze flood frequency in this study. Descriptive analyses such as finding mean, maximum, minimum, etc., were done as the primary analysis of flow data. Five different distribution methods (Gambel, Frechet, Weibull, Lognormal and Log Pearson) were applied for parameter estimation. The goodness of fit test was used to identify the most appropriate distribution that follows the annual peak discharge data. After analysis, the best-chosen distribution was used to estimate the flood magnitude and the return period. The flood frequency curve is also used to find the relationship between discharge values and the return periods to estimate the probability of the importance of the flood.

RESULTS AND DISCUSSION

Data from the year 1987 to 2017 were considered to obtain the descriptive statistics of each year. Figure 1 shows the annual peak discharges in cumecs each year.

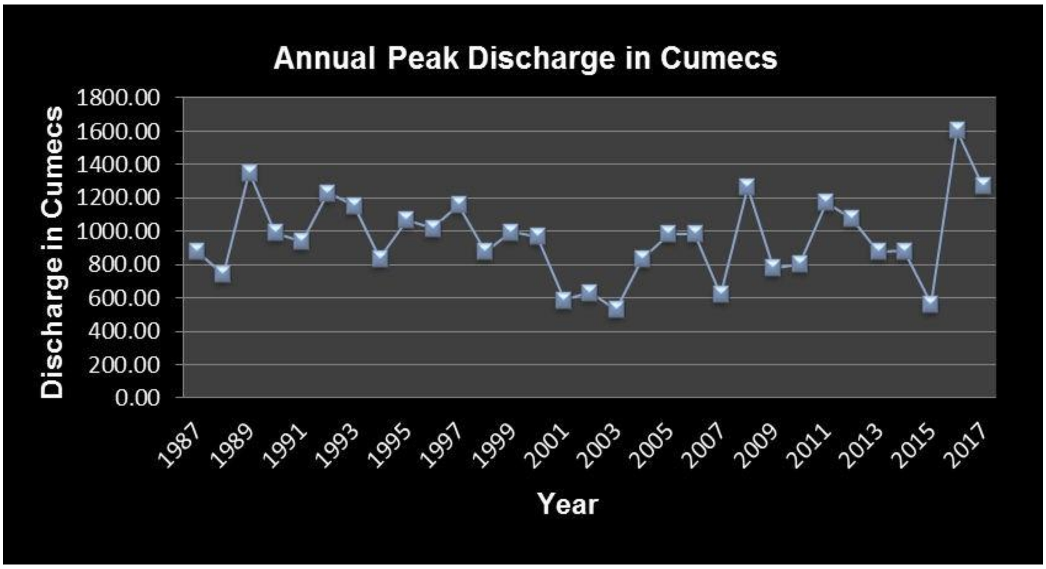

Figure 1: Annual Peak Discharge

According to Figure 1, the maximum discharge value was obtained in the year 2016 (1604.20 cumecs), and the second maximum discharge value was obtained in 1989 (1350 cumecs).

Descriptive statistical results obtained from Annual peak discharge data showed the mean annual peak discharge is 961.07 cumecs, and it falls within the 95% confidence limit of (868.39 cumecs, 1053.75 cumecs). Maximum and minimum were 1604.19 cumecs and 531.40 cumecs respectively. Further, the Shapiro-Wilk test result was confirmed that the data are normally distributed at 5% significance level (alpha level).

The data analysis often requires the estimation of parameters for a few probability distributions. In this study, we focused on applying Gambel, Frechet, Weibull, Lognormal and Log Pearson III distributions for parameter estimation.

Table 1: Summary Statistics of all five distributions

Distribution	**Gambel**	**Frechet**	**Weibull**	**Log normal**	**Log person III**
Mean	**961.07**	967.53	938.82	962.0	962.14
Variance	63839.0	-6.4517E+6	58581.0	67851.0	64676.0

According to Table 1, Gamble distribution provides the mean as 961.07; it is the same as the mean value of actual data distribution. The other five models also offer a similar approximate mean value to the actual data distribution.

Goodness-of-fit tests for five statistical distribution techniques applied in this study were evaluated using Kolmogorov–Smirnov, Anderson–Darling, Chi-squared tests at a critical value of 0.05. Results of the goodness-of-fit test showed that the Log-Pearson III distribution gives the best results for annual peak discharge data.

Further, log-Pearson III distribution was used for flood frequency calculations and to draw the flood frequency curve.

Table 2: Flood frequency Calculation using log- Pearson type III distribution

Period of Record (1987 - 2017)		
Return Period	**Skew Coefficient**	**Discharge**
(Years)	**K(-0.3027)**	**Q (cumecs)**
2	0.050432	941.3067084
5	0.853054	1169.388925
10	1.244622	1299.957218
25	1.642001	1447.375958
50	1.888488	1547.101931
100	2.101975	1639.012637
200	2.291489	1725.167411

Figure 2: Flood Frequency curve for Kelani River at Hanwella using Log-Pearson Type III for Average Peak Discharge values (WY 1987 - 2017)

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According to Table 2 and Figure 2, it says that after 100 years, it will exceed the maximum value of annual peak discharge of 1604.20 cumecs showed in the year 2016. Further, it is revealed that after 25 years, it will exceed the second maximum value of annual peak discharge of 1350 cumecs showed in the year 1989.

CONCLUSIONS/RECOMMENDATIONS

It is noted that annual peak discharge data obtained at the lower reach of Kelani River were normally distributed, and the maximum value of annual peak discharge was observed in the year 2016. Furthermore, annual peak discharge data followed all five distributions (Gumbel, Frechet, Weibull, Lognormal and Log-Pearson 3) at 0.2, 0.1, 0.05, 0.02, and 0.01 significance levels. According to the goodness of fit test and ranking of five distributions, Log-Pearson III distribution (a distribution with the lowest rank) was selected for further predictions. The frequency curve was fitted for Average Peak Discharge values (1987 - 2017) using the Log-Pearson Type III model. As in the hydrological report on the Kelani River flood, the recent flood in the year 2016 was the most severe hydrological hazard faced by the people of the Kelani River basin after the main flood event in 1989. It is noted that the return period of the flood is 100. The approximate flood magnitude is 1600 cumecs, and it is approximately similar to the annual peak discharge in the year 2016. The frequency curve graphically shows that 100 years as the return period and approximate flood magnitude is 1600 cumecs. When considering the annual peak discharge in the past year 1989, flood frequency analysis reveals that it reaches the same amount of peak discharge in 1989 after 25 years.

The rainfalls may cause floods, but maybe other reasons, such as most of the agricultural lands and marshy areas in the past have been converted to residential areas, and sand mining and gem mining are being carried out in the lower reach of the Kelani River. Therefore the protection levels of original schemes may be insufficient for the present conditions. Consequently, it can be concluded that the levels of protection should be increased at least up to 50 year return period (which is comparable to the 1989 flood).

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