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# Flood Simulation Using HEC-HMS 4.8 for Ungauged Catchment During Extreme Events in Lui River, Hulu Langat

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**Abstract**

Flooding is a sort of natural disaster that can occur anywhere in the world. It is also happening more often now because of global warming and climate change. The Department of Irrigation and Drainage (DID) has designated certain sites along the Lui River in Hulu Langat as flood-prone. Therefore, this study presents a hydrological simulation of the Lui River utilising the flood management software on the Hydrologic Modelling System, HEC-HMS 4.8, which has been widely used in several studies of water management. The program replicates a river basin system's rainfall-runoff response to a precipitation input by modelling the whole river basin as an integrated system of hydrologic and hydraulic components, displaying the trends in the river's flow for 50 ARI and 100 ARI. The hydrograph of the Lui River may be determined by examining the rainfall-runoff relationship and comparing it to the peak discharge of observed data and the hydrograph for an unmeasured watershed from Hydrological Procedure No. 11. The hydrograph result must undergo model calibration to establish parameters that are validated for the model final value of peak discharge and the shape of the hydrograph. The finding shows that the optimal design hydrograph for the design stage is the model's hydrograph with the greatest peak as in HEC-HMS. Hence, the design storm with the largest output will serve as a guideline for any design matter, be valuable for future river flow research, and function as a future precaution.

**Keywords:** Flooding, HEC-HMS 4.8, ungauged catchment, Lui River, Hulu Langat

## 1. Introduction

According to the Department of Irrigation and Drainage (DID) (2017), a flood is described as a body of water that is rising, expanding, and overflowing land that is not normally covered by water. Floods are also classified according to their location, features, cause, occurrence time, and duration. Although tropical cyclones are uncommon in Malaysian regions owing to their proximity to the equator, cyclonic vortices are widespread, particularly during the transition or early portion of the winter monsoon season. Previously conducted research on the Lui River includes Sakke et al.'s (2016) discovery that the area's drought severity was under control, while Yusoff et al., (2021) study found that the Sungai Lui's streamflow trend is largely non-significant, meaning that there is little data to suggest a major shift in the hydrological series. However, flood occurrences continue to occur in the Lui River, despite its upstream location.

Department of Irrigation and Drainage (DID) has identified flood-prone areas along the study river, including Kg. Haji Hassan Batu 20 and Batu 23, Sg. Lui that were swamped on 17th June 2017 without the need for flood evacuation. On 4th November 2020, floods recurred and struck the vicinity of Kampung Batu 20 Sg. Lui again, despite the fact that the region is not prone to flooding (Bahaudin, 2020). Then, in December 2021, another large-scale flood occurred, severely damaging not just the area surrounding the Lui River, but also portions of the Klang Valley and numerous states throughout the country. According to Aiman (2021), the level of water in Lui River reached up to the roof and the affected villagers were left with unrepairable pieces as the flood swept out

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most of their belongings.

Numerous modelling studies have been conducted to determine the probability of flood events. However, there are few studies that employ HEC-HMS modelling in depth in the Lui River. Hence, this study was undertaken in the Lui sub-basin which are located in Hulu Langat, Selangor, Malaysia. Lui River basin are at a latitude of 3° 07' - 3° 12' N and a longitude of 101° 52' - 101° 58' E. It covers an area of around 68.25 $km^2$ and has a length of approximately 11.5 km. In this study we used HEC-HMS version 4.8 and Hydrological Procedure 11 (HP11) to determine the flood discharge for Lui River. The objectives that are to be accomplished in this study are to analyse the rainfall pattern in Lui River for 10 years period of data from 2010 to 2020, to produce design hydrograph on hydrological events for 50 ARI and 100ARI in Lui River by using HEC-HMS modelling software; and to create a calibrated and validated rainfall-runoff model using HP11 for ungauged catchment with insufficient observation data during extreme flood in Lui River. It is important to have a more complete scientific knowledge of the ecosystem's effects on the environment, particularly on hydrological regimes as this unexpected tragedy can cause losses in lives and goods and this circumstance will leave an effect on the local economy too. Thus, the program's hydrographs may be used for future drainage studies and flow predictions as a precaution measure.

## 2. Methods

### 2.1 Methodology Framework

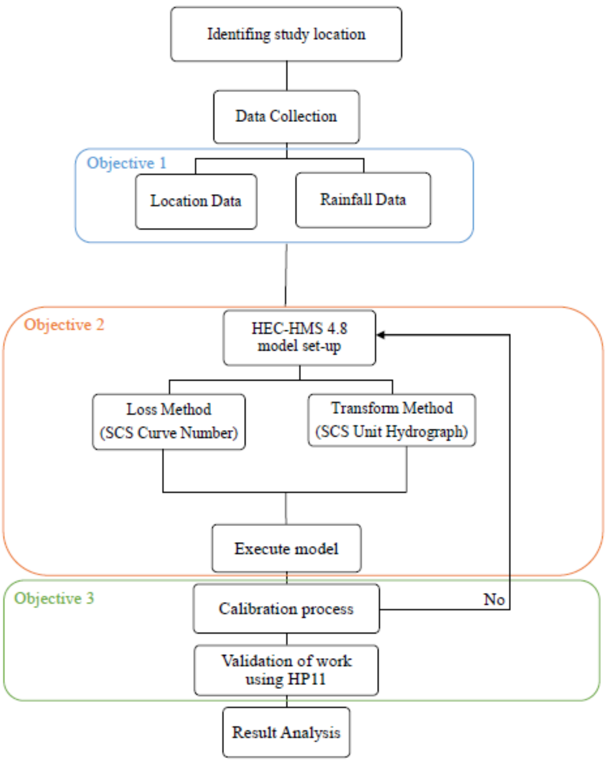
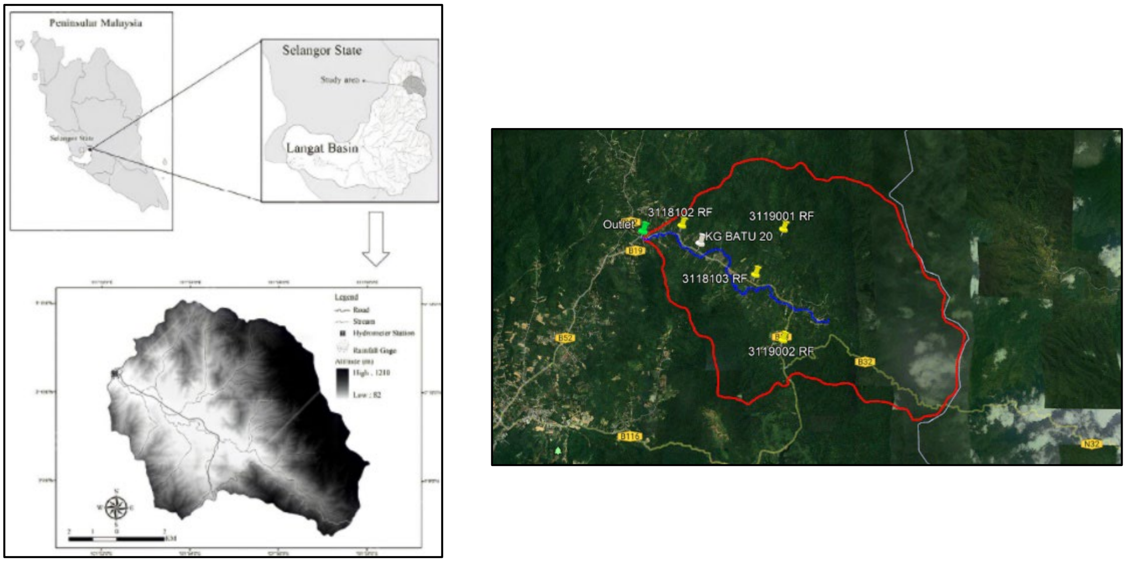



**Figure 1.** Methodology Framework

### 2.2 Study Area

The Lui River basin is located in the southern portion of the Klang Valley, Malaysia's most densely populated river basin. It is considered that the Langat basin is now facing "overspill" impacts as a result of the Klang Valley's excessive expansion. Meteorologically, the Langat basin is influenced by two monsoon types, namely the northeast that usually happened in November until March and southwest which happened in May until September monsoons (Memarian et al. 2012). Memarian et al., (2012) also determine that the annual precipitation is around 2400 mm on average; April and November are the wettest months, with average monthly precipitation above 250 mm, while June is the driest, with average monthly precipitation less than 100 mm.




(a) (b)

**Figure 2.** a) Location of Study Area (Atan et al., 2017); b) Catchment area of Lui River

2.3 Hydrologic Data

In order to study the flood problem in detail, some catchments have difficulty with missing hydrological data or data unavailability. Ungauged catchment refers to areas with no data for rainfall and streamflow data or when there are very few rainfall gauges in large catchment areas. The parameters to be utilized in the hydrograph model for this catchment cannot be produced simply by adjusting the rainfall and runoff data. In Malaysia, there are many studies reported on rainfall data insufficiency, especially in rural catchments, by several authors. For complementary and comparison purposes, the use of mathematical formulas as in HP1 and HP11 were also studied to perform calibration and validation for both observed and simulated rainfall models. According to the Zanial et.al, (2018) and Badyalina et. al (2021) their research depicts several available methods to predict the design rainfall for ungauged catchments in Malaysia, for example, by using multivariate statistical techniques.

To generate rainfall data to accommodate unavailable datasets, the rainfall intensity has been calculated using Hydrological Procedure No. 1 (HP1). HP1 is a procedure to estimate the design rainfall intensity based on the rainfall intensity-during-frequency relationship (IDF relationship). It has been used as standard practice for the design of water resource systems. The IDF relationship gave an idea about the frequency or return period of a mean rainfall intensity or rainfall volume that can be expected within a certain period of storm duration. Rainfall intensities and design rainfall for various storm durations are the outputs generated from HP1 that are calculated from the IDF parameters. To generate simulated discharge data for the Lui River, Hydrological Procedure 1 (HP1) was used to calculate the rainfall intensity values as complimentary data to missing rainfall records in the selected rainfall stations. The design rainfall values from HP1will then will be used in the simulation to generate streamflow data.

Hydrologic data were obtained from the inventory station of the Department of Irrigation and Drainage (DID) and through application from the website of Infobanjir for a ten-year period (2010-2020) of data. Additionally, the 10 years data set was chosen to focus mainly on recent extreme rainfall events and flood. Table 1 shows that there are four (4) rainfall stations while Table 2 shows that there are one (1) streamflow gauging station along the Lui River basin. Following the formation of the hydrological model, input hyetographs for the hydrological model are needed. Then, the rainfall analysis will be done in order to determine the annual rainfall data as well as maximum, minimum and mean value of annual rainfall from the required data.

**Table 1.** Rainfall Station along Lui River

| No | Name | Station Number | Latitude | Longitude |
|---|---|---|---|---|
| 1 | Sek. Keb. Kg. Sg. Lui | 3118102 | 03° 10' 25" | 101° 52' 20" |
| 2 | Sg. Gabai di Kg. Lui | 3118103 | 03° 09' 26.6" | 101° 53' 47.4" |
| 3 | Sawah Sg. Lui | 3119001 | 03° 10' 20" | 101° 54' 20" |
| 4 | Lalang Sg. Lui | 3119002 | 03° 08' 10" | 101° 54' 20" |

Table 2. Streamflow Station along Lui River

| No | Name | Station Number | Latitude | Longitude | Elevation (m) | Catchment Area ($km^2$) |
|---|---|---|---|---|---|---|
| 1 | Sg. Lui di Kg. Lui | 3118445 | 03° 10' 25" | 101° 52' 20" | 98 | 68.25 |

2.4 Hydrologic Modelling using HEC-HMS 4.8

The Hydrologic Engineering Center of the United States Army Corps of Engineers created the HEC-HMS hydrological surface water model, which was used in this study. HEC-HMS is a hydrological model that has been extensively utilised in several research of water resources. The software simulates a river basin system's rainfall-runoff response to a precipitation input by modelling the whole river basin as an integrated system of hydrologic and hydraulic components, which include river basins, streams, and reservoirs (Fung et al., 2021). The programme employs a different model for each component of the runoff process, including runoff volume, direct runoff, baseflow, and routing. The specified hydrological methods and parameters used are specified accordingly as shown in Table 3 which involve loss and transform method.

**Table 3.** Hydrologic Method and its Parameters Chosen for Sub-basins

| Name | Options | Parameters (unit) |
|---|---|---|
| Loss Method | SCS Curve Number | Initial abstraction, Ia (mm)<br>Curve number, CN<br>Impervious (%) |
| Transform Method | SCS Unit Hydrograph | Lag Time (K) |

2.4.1 Loss Method – SCS Curve Number

The loss method is used to calculate the quantity of water infiltrated into the earth. To calculate losses and excess rainfall from total rainfall, the SCS Curve Number approach is employed. The parameters for the loss method are the initial abstraction (IN), curve number (CN) and impervious area. The CN values for individual sub-basin can be determined using the following formula:

$$CN = \frac{\sum A_i \, CN_i}{\sum A_i} \tag{1}$$

Where,

$A_i$ is the area of sub-basin
$CN_i$ is the sub-basin curve number

Additionally, the initial abstraction (Ia) may be calculated by,

$$I_\alpha = 0.2S \tag{2}$$

with,

$$S = \frac{25400 - 254\,CN}{CN} \tag{3}$$

Where,

S is the highest possible abstraction (mm)

2.4.2 Transform Method – SCS Unit Hydrograph

The transform method functions to replicate the excess rainfall excluding its losses in the watershed and convert it into direct runoff. In this study, SCS Unit Hydrograph technique is selected for the analysis. The parameters needed for this step are graph type and lag time in minute. The sub-basin lag time can be calculated by:

$$t_{Lag}\,(hrs) = \frac{l^{0.8} \times (S+1)^{0.7}}{1900y^{0.5}} \tag{4}$$

Where,

$t_{Lag}$ is the basin lag time
$l$ is distance between exit of sub-basin and the longest flow path (ft)
Y is the slope of sub-basin (%)

2.5 Validation of Work Using HP11

To ensure that the simulated value from design hydrograph on HEC-HMS is reliable, the observed value obtained from manual calculation using Hydrological Procedure 11 (HP11) is necessary to compare or differentiate between the simulated and data calculated since the observed data from JPS are insufficient. Therefore, the validation of results from HEC-HMS requires the following design technique and steps based on HP11 - revised and updated version (2018):

Step 1: Based on the topographical map, the catchment area, length of stream and weighted stream slope needs to be determined.

Step 2: By using data of rainfall stations located at the catchment area obtain from DID, a frequency analysis needs to be performed.

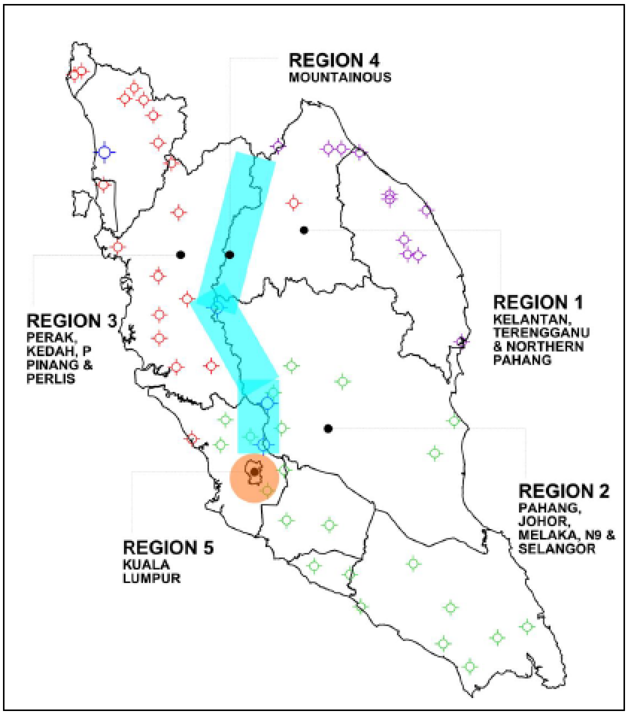
Step 3: Area Reduction Factor (ARF) is obtained by interpolating the value from Table 4.

**Table 4.** Table to Determine ARF's Value

| Catchment Area (km²) | Storm Duration (hrs) | | | | |
|---|---|---|---|---|---|
| | 0.5 | 1 | 3 | 6 | 24 |
| 0 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 50 | 0.82 | 0.88 | 0.94 | 0.96 | 0.97 |
| 100 | 0.73 | 0.82 | 0.91 | 0.94 | 0.96 |
| 150 | 0.67 | 0.78 | 0.89 | 0.92 | 0.95 |
| 200 | 0.63 | 0.75 | 0.87 | 0.90 | 0.93 |
| 250 | 0.61 | 0.73 | 0.85 | 0.89 | 0.93 |
| 300 | 0.59 | 0.71 | 0.84 | 0.88 | 0.93 |
| 400 | 0.58 | 0.68 | 0.81 | 0.86 | 0.92 |
| 500 | | 0.67 | 0.80 | 0.85 | 0.92 |
| 600 | | 0.66 | 0.79 | 0.84 | 0.91 |
| 800 | | 0.65 | 0.78 | 0.83 | 0.91 |
| 1000 | | | 0.78 | 0.83 | 0.91 |

*Source: USWB (1957-58)*

Step 4: The rainfall temporal pattern region for the location of the study area is determined from Figure 4.




*Source: HP 1 (2015)*

**Figure 4.** Peninsular Malaysia's Rainfall Temporal Pattern Regions

Step 5: Calculate the Lag time, Lg.

$$Lg = 0.639\, A^{0.4143}\, L^{0.1403} S^{-0.4321} \quad (5)$$

Where,

Lg is the lag time (hr)
A is the catchment area ($km^2$)
L is the length of the main stream from the catchment, division to the catchment outflow (km)
S is the weighted slope of main stream (%)

Step 6: From the value of lag time, rainfall duration of standard UH, tr can be calculated.

$$Lg = 5.5\ tr \quad (6)$$

Step 7: Based on rainfall temporal pattern and catchment response time, determine the rainfall duration necessary to generate the calculated UH, $t_R$.

$$\text{Usually, } t_R \leq \frac{Lg}{5}. \quad (7)$$

Step 8: Calculate the required catchment lag time, $t_{pR}$

$$t_{pR} = L_g - \frac{t_r - t_R}{4} \quad (8)$$

Where,

$t_R$ is the rainfall duration of required UH (hr)
$t_{pR}$ is the lag time of required UH (hr)

Step 9: Calculate the peak discharge of the standard UH, $q_p$

$$q_p = \frac{C\, C_p}{L_g} \quad (9)$$

Where,

$q_p$ is peak discharge of standard UH ($m^3/s/km^2/mm$)
$C_p$ is UH peaking coefficient
C is conversion factor which is 0.275 for 1 mm standard UH

Step 10: Calculate the peak discharge of the required UH, $q_{pR}$

$$q_{pR} = \frac{C\, C_p}{t_{pR}} \quad (10)$$

Where,

$q_{pR}$ is peak discharge of required UH ($m^3/s/km^2/mm$)

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Step 11: Calculate the peak discharge of UH for the catchment, Qp.

$$Q_p = q_{pR} \, x \, A \tag{11}$$

Where,

Qp is the peak discharge

Step 12: Calculate the time base of UH, tb.

$$t_b = \frac{0.556}{q_{pR}} \tag{12}$$

Where,

$t_b$ is time base (hr)

Step 13: Calculate the time to peak of UH, Tp.

$$T_P = t_{pR} + \frac{t_R}{2} \tag{13}$$

Where,

$T_p$ is time to peak (hr)

Step 14: Using triangular UH assumption, calculate the intervals count in tb.

$$N3B = \frac{t_b}{t_R} \tag{14}$$

Step 15: Calculate the intervals count in Tp.

$$N3A = \frac{T_P}{t_R} \tag{15}$$

Step 16: Determine and verify the volume of UH runoff in the synthetic triangular UH.

$$Revised\ Q_p\ (\text{m}^3/\text{s}) = \frac{Q_p}{Volume} \tag{16}$$

Then, the volume should be recalculated using the revised Qp, where,

$$Volume\ (mm) = \frac{\frac{1}{2} \times t_b \times Q_p}{A} \tag{17}$$

Step 17: By utilizing the synthetic triangular UH, the UH ordinates is calculated and sorted in a table form.

Step 18: Calculate the catchment rainfall, P.

Catchment rainfall, P (mm) = ARF x Design rainfall for design duration (18)

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Step 19: Calculate the direct runoff, Q.

$$Q = 0.33\,P \quad ; \quad P < 75mm$$
$$Q = \frac{P^2}{(P+150)} \quad ; \quad P > 75mm \tag{19}$$

Where,

P is the total storm rainfall (mm)
Q is the direct runoff (mm)

Step 20: Calculate the baseflow, $Q_B$.

$$Q_B = 0.11\,A^{0.8589} \tag{20}$$

Where,

$Q_B$ is the baseflow ($m^3/s$)

Step 21: Carry out the UH Convolution in tabular form.

Step 22: Calculate and create the total runoff hydrograph.

### 2.6 Calibration and Validation of Data

Calibration of a model is modifying or changing model parameters until the simulation output closely matches the observed behaviour. Model validation is essentially a procedure identical to model calibration, except that it employs a different set of hydrological data. The objective of model calibration is to determine the model parameter values that will be utilised for model validation and, subsequently, for simulating hydrographs using prescribed data input. Some parameters in the HEC-HMS model are calculated based on observations and measurements, while others require calibration. The value of particular parameters is derived from the initial assumption and adjusted by trial and error until a correlation between the simulated and observed hydrographs can be established and validated.

## 3. Results and Discussion

### 3.1 Rainfall Data Analysis

#### 3.1.1 Annual Rainfall Data

There are four (4) rainfall stations data collected at the catchments for the study of Lui River. The stations that are used in this study are chosen based on the location and data availability. There are stations 3118102 (Sek. Keb. Kg. Sg. Lui), 3118103 (Sg. Gabai di Kg. Lui), 3118103 (Sawah Sg. Lui) and 3119002 (Lalang Sg. Lui). The data of annual rainfall for the 4 stations can be seen in Figure 5. However, since there's inconsistency in the annual rainfall data, estimation and replacements must be made for missing data based on the average precipitation at nearby stations. Since the normal annual precipitation at neighbouring stations vary considerably, the normal ratio approach is utilised. The normal ratio method was used to estimate missing daily precipitation from gathered data.

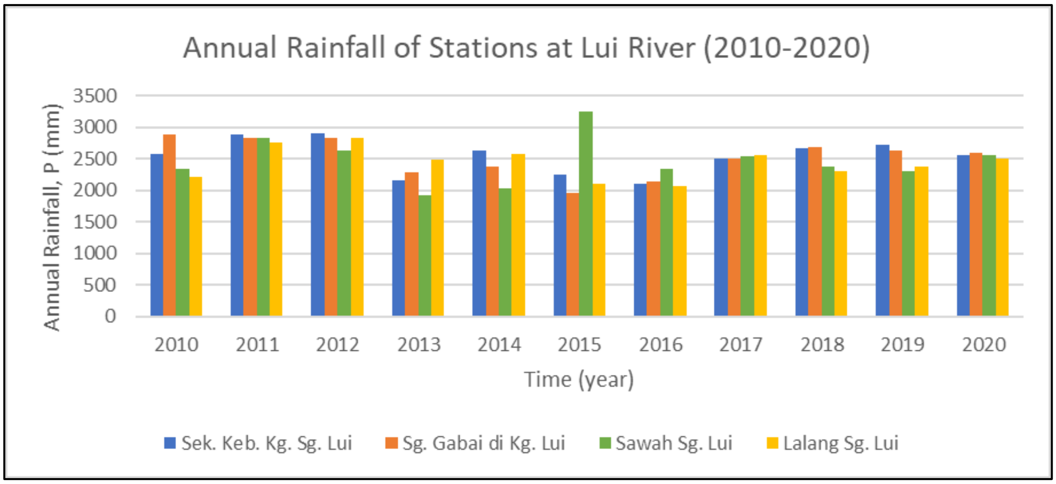


**Figure 5.** Annual Rainfall of Stations at Lui River from the Year of 2010 to 2020

Figure 5 shows the yearly precipitation results from all rainfall stations along the Lui River from 2010 to 2020. All of the data shows great consistency except in 2015, Sawah Sg. Lui station had the greatest yearly precipitation compared to other stations. This condition may be a result of its location upstream near Sg. Gabai Waterfall that are higher in altitude and rich with forestry. Next, 2011 and 2012 had the greatest annual precipitation averages for all stations. However, based on historical reports of flooding conditions, the worst and most recent flooding incidents on the Lui River happened in 2017 and 2021, respectively. Since the JPS data on flooding cases are only available from 2015 to 2020, there are few possibilities for comparison to be done for the year 2011 and 2012 conditions.

### 3.1.2 Min, Max and Mean Annual Rainfall Data

The maximum, minimum and mean annual rainfall data for all stations in Lui River was computed and shown in Figure 6. The mean value for all stations is constant as it does not fluctuate to far from each other values. Sawah Sg. Lui have both the greatest (3244.50mm) and minimum value (1915.70mm) for yearly rainfall. This suggests that this place may experience unexpected huge rainfall or practically to no rainfall on daily basis. It is crucial to establish which station have the greatest and least annual rainfall at the location. This is to guarantee greater precaution may be taken in the future.

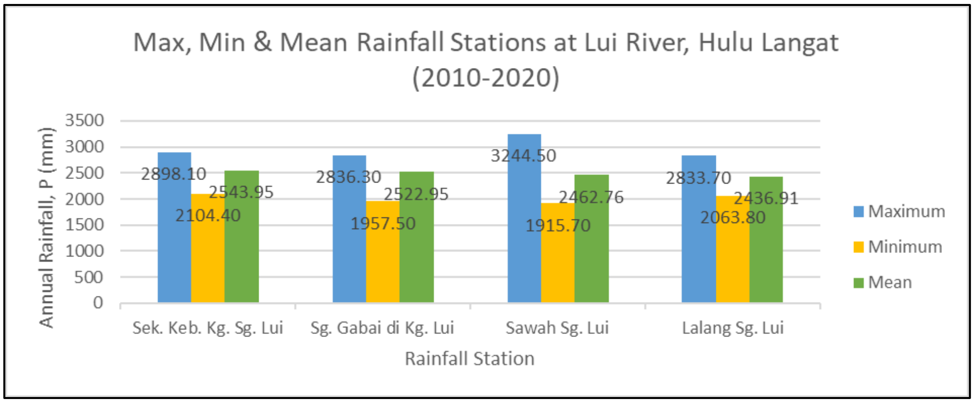


**Figure 6.** Maximum, Minimum and Mean Annual Rainfall Data from the Year of 2010 to 2020

### 3.1.3 Double Mass Curve

To ensure the consistency of the data between stations, hydrological analysis have been conducted. The consistency of the rainfall station record has been examined using the double mass curve approach. This approach is founded on the assumption that all recorded data are consistent when they come from the same area of population. The study compares the cumulative precipitation for a single station to the concurrent accumulated values of the mean precipitation for a group of neighbouring stations. For this study, the double mass curve approach is applied from 2010 to 2020, as shown in Figure 7. The results indicate that rainfall data from the selected case study sites, Lui River area are consistent.

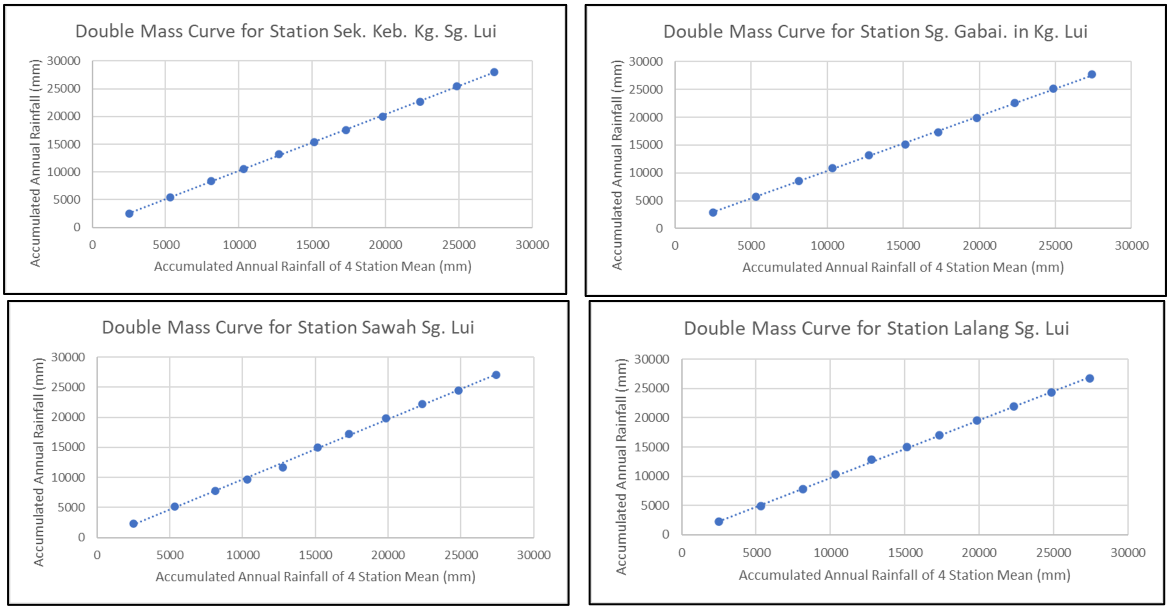


**Figure 7.** Double Mass Curve for all Four Rainfall Stations in Lui River

### 3.1.4 Hydrological Procedure 1 (HP1)

The estimation of rainfall intensity values using IDF curves uses an empirical equation to minimise estimation errors. The IDF parameter for the catchments area of Lui River and the rainfall intensities for various storm durations that range from 15 minutes to 3 days using Appendix 1 of HP1 (Generalized Isopleths Maps) is utilized. In the next part, the rainfall intensity calculated is then used to compute the design rainfall in Table 5.

**Table 5.** Design Rainfall for 50ARI and 100ARI using HP1 for Lui River

| Duration (hr) | Design Rainfall, P (mm) | |
|---|---|---|
| | **50 ARI** | **100 ARI** |
| 0.25 | 60.9885 | 68.4257 |
| 0.5 | 82.2731 | 92.3058 |
| 1 | 102.7260 | 115.2527 |
| 3 | 132.5316 | 148.6930 |
| 6 | 150.7493 | 169.1322 |
| 12 | 169.5153 | 190.1866 |

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| **Duration (hr)** | **Design Rainfall, P (mm)** | |
|---|---|---|
| | **50 ARI** | **100 ARI** |
| 24 | 189.4924 | 212.5998 |
| 48 | 211.1877 | 236.9406 |
| 72 | 224.8410 | 252.2589 |

3.2 Peak Discharge for 50ARI and 100ARI

The best design hydrograph for the design stage is the HEC-HMS model's highest peak hydrograph. The design storm that produces the highest output will serve as a guideline for any designing matter. A 100-year ARI requirement for the major design storm has been implemented by several nations, and in some cases, it has even been written into the law (MSMA, 2012). This is in line with the 100-year ARI requirement that is currently in place for river engineering and flood mitigation. Although previous practise has frequently been predicated on one level of operation, it is often reasonable to design for several performance levels. Thus, another ARI value of 50-year is chosen as a requirement for flood damage avoidance in severe or uncommon occurrence.

3.2.1 Result from HEC-HMS

Based on results from HEC-HMS, it appears that, the increase of rainfall event from 50 years to 100 years causes an increment of discharge in the river. The peak discharge for 50ARI and 100ARI are both on 6hr duration with the value of 213.9 $m^3/s$ and 243.4 $m^3/s$ respectively. This establishes that a rise in the ARI precipitation event increases the river's discharge or flood considerably. Figures 8 illustrate the flood hydrographs for 50ARI and 100ARI for the Lui River watershed using HEC-HMS. The higher the time, the greater the discharge for each period of hydrographs until the curve reaches its peak value, at which point it will drop. The period of 6 hours means that it took around 6 hours for the water to reach its maximum discharge before flooding happened or else it will decrease.

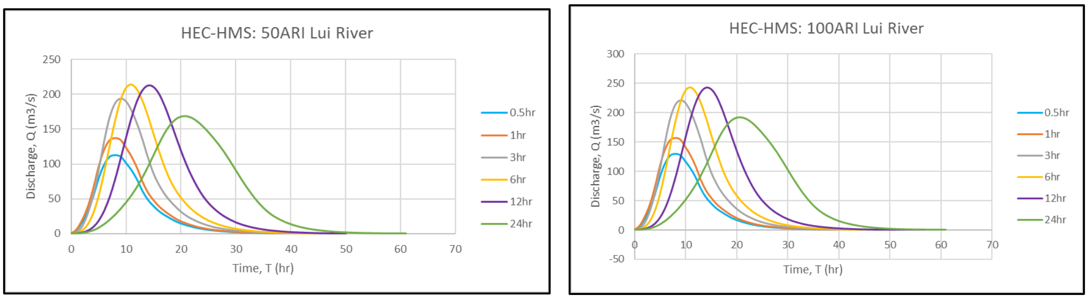


**Figure 8.** Flood Hydrograph for 50ARI and 100ARI using HEC-HMS for Lui River

3.2.2 Result from HP11

Based on Table 6, the peak discharge for 50ARI and 100ARI are 190.71 $m^3/s$ and 225.71 $m^3/s$ respectively using HP11 for Lui River catchment with the lag time value of 1.11hr. The same concept as HEC-HMS can be applied here where the higher the ARI, the higher the value of discharge in the river.

**Table 6.** Peak Discharge, Q for 50ARI and 100ARI from HP11

| River | Lag Time, Lg (hr) | Base flow $Q_B$, (m3/s) | Qp for 50 ARI ($m^3/s$) | Qp for 100 ARI ($m^3/s$) |
|---|---|---|---|---|
| Lui River | 1.11 | 4.14 | 190.71 | 225.71 |

3.3 Comparison between HEC-HMS with HP11

3.3.1 Result on Calibration Process

All the results obtained from HP11 and HEC-HMS are summarized in Table 8 and Table 9. Since the watershed is ungauged, HEC-HMS findings are compared to HP11 values. According to Abdullah et al. (2019), the performance of the model to determine peak discharge, time to peak, and volume may be evaluated using the following metrics of Relative Percentage Difference (RPD) and classified according to Table 7.

$$RPD = \frac{|Qsimulate - Qobserve|}{Qobserve} \times 100\% \qquad (21)$$

Where,

$$RPD = \frac{|Q_{HEC-HMS} - Q_{HP11}|}{Q_{HP11}} \times 100\%$$

**Table 7.** Relative Percentage Difference (RPD) (Abdullah et al.,2019)

| RPD value (%) | Performance Status |
|---|---|
| RPD < 10% | Very Good |
| 10% < RPD < 15% | Good |
| 15% < RPD < 25% | Fair / Satisfactory |

3.3.1.1 Before Calibration

With initial CN values of 79, it was calculated that the duration of the temporal pattern of rainfall is 12 hours. As depicted in Table 8, the peak discharge values for both 50 and 100 ARI are larger in the result obtained from HP11. The percentage difference for 50ARI is 25.21% while for 100ARI is 27.98%, indicating that the model is not calibrated to a sufficient level. This is due to the fact that a simulated value by HEC-HMS should be greater than the data from HP11, as we are predicting future conditions for which we must assume the worst.

**Table 8.** Percentage Difference for HEC-HMS and HP11 before Calibrate

| 50ARI | | | 100ARI | | |
|---|---|---|---|---|---|
| Peak Discharge (m3/s) | | | | | |
| HEC-HMS | HP11 | Relative Percentage Difference, RPD (%) | HEC-HMS | HP11 | Relative Percentage Difference, RPD (%) |
| 205.6 | 274.92 | 25.21 | 233.8 | 324.62 | 27.98 |

3.3.1.2 After Calibration

The model is calibrated and validated with CN values of 80, which resulted in a 6-hour temporal pattern of precipitation. Since the HEC-HMS results depend on the topography and characteristics of the basin, it follows that the smaller the size of river, the shorter the duration to attain the peak discharge. As seen in Table 9, the peak discharge values for both 50 and 100 ARI are now lower in result of HP11. The difference in percentage for 50ARI is 12.16%, suggesting that the RPD is good, whereas the difference for 100ARI is 7.84%, indicating that the model's performance is very good. Thus, the result obtain from HEC-HMS are validated by HP11 results with no further calibration process are needed.

**Table 9.** Percentage Difference for HEC-HMS and HP11 after Calibrate

| **50ARI** | | | **100ARI** | | |
|---|---|---|---|---|---|
| **Peak Discharge (m3/s)** | | | | | |
| **HEC-HMS** | **HP11** | **Relative Percentage Difference, RPD (%)** | **HEC-HMS** | **HP11** | **Relative Percentage Difference, RPD (%)** |
| 213.90 | 190.71 | 12.16 | 243.4 | 225.71 | 7.84 |

## 4. Conclusion

This study was carried following the recent severe flood with the purpose of determining the maximum flow and design hydrograph of selected river, Lui River, Hulu Langat. Hydrological modelling of HEC-HMS is used to produce the Lui River's peak flow hydrograph. The hydrographs produce shows the simulated peak flow for Lui River flood event using a calibrated and verified HEC-HMS model is higher in comparison with HP11's hydrograph. Since we anticipate the worst-case scenario in the future, it is expected that the actual outcome to match the simulation. As a result, the hydrologic model is suggested to use for future flood modelling and risk assessment studies in the study region along with more updated procedure. The assessment of the flood's severity will also be able to offer a useful general portrayal of the flood's condition over the course of the Lui River basin's discharge data. Moreover, it can benefit individuals involved in Malaysia's river management and water supply. Thus, this study is significant because the Lui River basin serves as a catchment region, assisting in the maintenance of water storage to ensure the river's continuity of flow.

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**Declaration of Conflicting Interests**

All authors declare that they have no conflicts of interest.

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