

HYDROLOGICAL CALCULATION RATIONAL METHOD (HP # 5 - 1989)

PROJECT : catchment 12 (During logging activity)
Tabung Haji, Pahang

A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :
Area of catchment, A_c = 1.68 sq. km
Length of mainstream, L = 1.88 km
Percentage developed, = 75.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i \cdot \sqrt{s_i}$
1.88	40.00	2.13	2.74
1.88	40.00	2.13	2.74

$$s = \frac{\sum (l_i \cdot \sqrt{s_i})}{\sum l_i}$$

$$= \frac{2.74}{1.88}$$

$$= 2.13 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
Region 2 - Kuala Lumpur
Region 3 - Johor
Region 4 - Kelantan, Terengganu, Pahang

C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 2 years (HP # 1)

$$T_c = \{1.286 \times L\} / \{A^{0.223} \times S^{0.263}\}$$

$$= \frac{\{1.286 \times 1.88\}}{\{1.68^{0.223} \times 2.127659574^{0.263}\}}$$

$$= 1.77 \text{ hours}$$

$$= 105.94 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 0.5) = 40 \text{ mm}$
 $x(20, 0.5) = 70 \text{ mm}$
 $x(2, 3) = 80 \text{ mm}$
 $x(20, 3) = 140 \text{ mm}$

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with $T = 2$ years.

$x(T, 0.5) = 75.00 \text{ mm}$
 $x(T, 3) = 120.00 \text{ mm}$

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

With $T_c = 1.77 \text{ hours}$
and $T = 2 \text{ years}$.
 $x(2, 1.77) = 68.17 \text{ mm}$
 $x(20, 1.77) = 119.29 \text{ mm}$
 $x(T, 1.77) = 106.69 \text{ mm}$

8. Confidence limits

$$D = x(20) - x(2)$$

$$= 119.29152 - 68.166585$$

$$= 51.124939$$

$$0.43 D = 21.983724 \text{ mm}$$

$$9. \text{Max } x(T) = x(T) + 0.43 D$$

$$[T = 2] = 106.68741 + 21.983724$$

$$= 128.67 \text{ mm}$$

D. FLOOD ESTIMATION

1. From step C,

$$\text{Max } x(T) = 128.67113 \text{ mm}$$

$$\text{Therefore, } i(2) = x(100) = 128.67113$$

$$2. \text{ From Figure 4 with, } T_c = 72.87 \text{ mm/hr} \quad 1.7656986$$

$$\text{Region} = 4$$

$$T = 2 \text{ years.}$$

$$C_{10} = 0.38$$

$$C_t / C_{10} = 0.712$$

$$\text{Therefore } C_t = 0.27$$

$$3. \text{ Percentage developed} = 75 \%$$

$$\text{Land use factor, } F = 1.2$$

THEREFORE

$$Q_{\max} = F \times 0.278 \times C_t \times i(T) \times A$$

$$= 11.05 \text{ cu. m/s}$$

E. DETERMINATION OF THE FLOOD WATER LEVEL AND VELOCITY

1. Plot cross-section of the river.
2. consider the recorded flood level as our first trial
3. Divide into sub-section
4. Stream slope at bridge site,

From the river survey plan :

Number of Part	= 4 Section			
Part	BedL1	BedL2	Length	Slope
1	6.880	6.544	60.000	0.006
2	6.544	6.067	25.000	0.019
3	6.067	6.037	25.000	0.001
4	6.037	5.604	20.000	0.022
5				
6				
7				
Average Slope, S _o	0.0118825			

5. Calculation of V_m and Q_c

$$V_i = R_i^{2/3} \times S_o^{1/2} / n_i$$

$$\text{TRY Flood Level} = 7.700 \text{ m} \quad \text{OK}$$

Sc.	Level	Chng.	Roughness	Area, A	Wetted	Hydraulic	Velocity	Q=V _i A _i
	(m)	(m)	n _i	Sq. ft	perimeter	Radius	(m/s)	(cu. m)
					(pi) (m)	R _i = A _i / P _i		
						(m)		
0	9.200	0.000	0.045					
1	7.000	4.000	0.045	-1.600	4.565	-0.350	#NUM	
2	6.741	18.000	0.045	11.613	14.002	0.829	2.138	24.832
3	5.857	23.100	0.045	7.145	5.176	1.380	3.003	21.458
4	5.792	27.000	0.045	7.314	3.901	1.875	3.684	26.944
5	5.272	33.600	0.045	14.309	6.620	2.161	4.049	57.941
6	6.344	38.000	0.045	8.325	4.529	1.838	3.635	30.261
7	6.659	42.500	0.045	5.393	4.511	1.196	2.729	14.717
8	7.000	50.500	0.045	6.964	8.007	0.870	2.207	15.370
9	9.200	54.000	0.045					
10								
			TOTAL	59.4634			TOTAL	191.52328

Type of bed material (Code) = 7 Rock

Therefore,

$$\text{Mean velocity, } V_m = \frac{E(V_i A_i)}{E(A_i)}$$

$$= \frac{191.523277}{59.4634}$$

$$= 3.220859839 < 5.18 \text{ m/sec}$$

Therefore OK

$$\text{Discharge capacity, } Q_c = \frac{V_m \times E(A_i)}{191.523277}$$

$$= 11.05 \text{ cu. m}$$

Therefore OK

CODE	BED
1	Clay
2	Sandy Clay
3	Very fine sand
4	Fine sand
5	Fine Gravel
6	Rocky soil
7	Rock
8	Grass-lined

12.2 HP5 catchment 12 Tabung Haji (Q during logging activity)

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A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

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Length of mainstream L = 1.88 km
Percentage developed, = 75.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
1.88	40.00	2.13	2.74
1.88	40.00	2.13	2.74

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{2.74}{1.88} = 2.13 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
Region 2 - Kuala Lumpur
Region 3 - Johor
Region 4 - Kelantan, Terengganu, Pahang

C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 5 years (HP # 1)

$$T_c = \frac{1.286 \times L}{1.68^{0.223} \times 2.127659574^{0.263}}$$

$$= \frac{1.286 \times 1.88}{1.68^{0.223} \times 2.127659574^{0.263}}$$

$$= 1.77 \text{ hours}$$

$$= 105.94 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 0.5) = 40 \text{ mm}$
 $x(20, 0.5) = 70 \text{ mm}$
 $x(2, 3) = 80 \text{ mm}$
 $x(20, 3) = 140 \text{ mm}$

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with $T = 5$ years.

$x(T, 0.5) = 98.94 \text{ mm}$
 $x(T, 3) = 176.59 \text{ mm}$

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

12.2 HP5 catchment 12 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 &\text{With } T_c = 1.7656986 \text{ hours} \\
 &\text{and } T = 5 \text{ years.} \\
 &x(2, 1.77) = 68.17 \text{ mm} \\
 &x(20, 1.77) = 119.29 \text{ mm} \\
 &x(T, 1.77) = 153.62 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 119.29152 - 68.166585 \\
 &= 51.124939 \\
 0.43 D &= 21.98 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[T = 5 \right] &= x(T) + 0.43 D \\
 &= 153.61995 + 21.983724 \\
 &= 175.60 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x \left(\begin{array}{c} 5 \\ \text{Therefore, } i(10) \end{array} \right) &= 175.60367 \text{ mm} \\
 &= x(100) = 175.60367 \\
 &\quad T_c = 1.7656986 \\
 &= 99.45 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region} &= 4 \\
 T &= 5 \text{ years.}
 \end{aligned}$$

$$\begin{aligned}
 C_{10} &= 0.38 \\
 C_t / C_{10} &= 0.88
 \end{aligned}$$

$$\text{Therefore } C_t = 0.3344$$

$$\begin{aligned}
 3. \text{ Percentage developed} &= 75 \% \\
 \text{Land use factor, } F &= 1.2
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 18.64 \text{ cu. m/s}
 \end{aligned}$$

12.2 HP5 catchment 12 Tabung Haji (Q during logging activity)

HYDROLOGICAL CALCULATION RATIONAL METHOD (HP # 5 - 1989)

PROJECT : catchment 12 (During logging activity)
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A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 1.68 sq. km
Length of mainstream L = 1.88 km
Percentage developed, = 75.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
1.88	40.00	2.13	2.74
1.88	40.00	2.13	2.74

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{2.74}{1.88}$$

$$= 2.13 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
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C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 10 years (HP # 1)

$$T_c = \frac{1.286 \times L}{1.68^{0.223} \times 2.127659574^{0.263}}$$

$$= \frac{1.286 \times 1.88}{1.68^{0.223} \times 2.127659574^{0.263}}$$

$$= 1.77 \text{ hours}$$

$$= 105.94 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 0.5)$ = 40 mm
 $x(20, 0.5)$ = 70 mm
 $x(2, 3)$ = 80 mm
 $x(20, 3)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 10 years.

$x(T, 0.5)$ = 114.79 mm
 $x(T, 3)$ = 214.06 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

12.2 HP5 catchment 12 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 &\text{With } T_c = 1.7656986 \text{ hours} \\
 &\text{and } T = 10 \text{ years.} \\
 &x(2, 1.77) = 68.17 \text{ mm} \\
 &x(20, 1.77) = 119.29 \text{ mm} \\
 &x(T, 1.77) = 184.69 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 119.29152 - 68.166585 \\
 &= 51.124939 \\
 0.43 D &= 21.98 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[T = 10 \right] &= x(T) + 0.43 D \\
 &= 184.69338 + 21.983724 \\
 &= 206.68 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(10) &= 206.6771 \text{ mm} \\
 \text{Therefore, } i(10) &= \frac{x(100)}{T_c} = \frac{206.6771}{1.7656986} \\
 &= 117.05 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region} &= 4 \\
 T &= 10 \text{ years.} \\
 C_{10} &= 0.38 \\
 C_t / C_{10} &= 1 \\
 \text{Therefore } C_t &= 0.38
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ Percentage developed} &= 75 \% \\
 \text{Land use factor, } F &= 1.2
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 24.93 \text{ cu. m/s}
 \end{aligned}$$

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HYDROLOGICAL CALCULATION RATIONAL METHOD (HP # 5 - 1989)

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A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 1.68 sq. km
Length of mainstream, L = 1.88 km
Percentage developed, = 75.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
1.88	40.00	2.13	2.74
1.88	40.00	2.13	2.74

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{2.74}{1.88}$$

$$= 2.13 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
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Region 4 - Kelantan, Terengganu, Pahang

C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 20 years (HP # 1)

$$T_c = \frac{1.286 \times L}{\{1.68^{0.223} \times 2.127659574^{0.263}\}}$$

$$= \frac{1.286 \times 1.88}{1.68^{0.223} \times 2.127659574^{0.263}}$$

$$= 1.77 \text{ hours}$$

$$= 105.94 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 0.5)$ = 40 mm
 $x(20, 0.5)$ = 70 mm
 $x(2, 3)$ = 80 mm
 $x(20, 3)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 20 years.

$x(T, 0.5)$ = 130.00 mm
 $x(T, 3)$ = 250.00 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

12.2 HP5 catchment 12 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 & \text{With } T_c = 1.7656986 \text{ hours} \\
 & \text{and } T = 20 \text{ years.} \\
 & x(2, 1.77) = 68.17 \text{ mm} \\
 & x(20, 1.77) = 119.29 \text{ mm} \\
 & x(T, 1.77) = 214.50 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 119.29152 - 68.166585 \\
 &= 51.124939 \\
 0.43 D &= 21.98 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x(20) &= x(T) + 0.43 D \\
 [T = 20] &= 214.49975 + 21.983724 \\
 &= 236.48 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(20) &= 236.48348 \text{ mm} \\
 \text{Therefore, } i(20) &= \frac{x(100)}{T_c} = \frac{236.48348}{1.7656986} \\
 &= 133.93 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region} &= 4 \\
 T &= 20 \text{ years.}
 \end{aligned}$$

$$\begin{aligned}
 C_{10} &= 0.38 \\
 C_t / C_{10} &= 1.128
 \end{aligned}$$

$$\text{Therefore } C_t = 0.43$$

$$\begin{aligned}
 3. \text{ Percentage developed} &= 75 \% \\
 \text{Land use factor, } F &= 1.2
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 32.17 \text{ cu. m/s}
 \end{aligned}$$

12.2 HP5 catchment 12 Tabung Haji (Q during logging activity)

HYDROLOGICAL CALCULATION RATIONAL METHOD (HP # 5 - 1989)

PROJECT : catchment 12 (During logging activity)
Tabung Haji, Pahang

A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 1.68 sq. km
Length of main stream, L = 1.88 km
Percentage developed, = 75 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
1.88	40.00	2.13	2.74
1.88	40.00	2.13	2.74

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{2.74}{1.88}$$

$$= 2.13 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
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From figure 1 of HP # 5
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C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 50 years (HP # 1)

$$T_c = \frac{1.286 \times L}{1.68^{0.223} \times 2.127659574^{0.263}}$$

$$= \frac{1.286 \times 1.88}{1.68^{0.223} \times 2.127659574^{0.263}}$$

$$= 1.77 \text{ hours}$$

$$= 105.94 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 0.5)$ = 40 mm
 $x(20, 0.5)$ = 70 mm
 $x(2, 3)$ = 80 mm
 $x(20, 3)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 50 years.

$x(T, 0.5)$ = 149.68 mm
 $x(T, 3)$ = 296.52 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

12.2 HP5 catchment 12 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 &\text{With } T_c = 1.7656986 \text{ hours} \\
 &\text{and } T = 50 \text{ years.} \\
 &x(2, 1.77) = 68.17 \text{ mm} \\
 &x(20, 1.77) = 119.29 \text{ mm} \\
 &x(T, 1.77) = 253.08 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 119.29152 - 68.166585 \\
 &= 51.124939 \\
 0.43 D &= 21.983724 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[T = 50 \right] &= x(T) + 0.43 D \\
 &= 253.08105 + 21.983724 \\
 &= 275.06 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(50) &= 275.06478 \text{ mm} \\
 \text{Therefore, } i(50) &= \frac{x(100)}{T_c} = \frac{275.06478}{1.7656986} \\
 &= 155.78 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region} &= 4 \\
 T &= 50 \text{ years.} \\
 C_{10} &= 0.38 \\
 Q / C_{10} &= 1.296 \\
 \text{Therefore } Q &= 0.49
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ Percentage developed} &= 75 \% \\
 \text{Land use factor, } F &= 1.2
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times Q \times i(T) \times A \\
 &= 43.00 \text{ cu. m/s}
 \end{aligned}$$

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Length of mainstream, L = 1.88 km
Percentage developed, = 75 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
1.88	40.00	2.13	2.74
1.88	40.00	2.13	2.74

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{2.74}{1.88} = 2.13 \%$$

B. LOCATION OF SITE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
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C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 100 years (HP # 1)

$$T_c = \{ 1.286 \times L \} / \{ A^{0.223} \times S^{0.263} \}$$

$$= \frac{\{ 1.286 \times 1.88 \}}{\{ 1.68^{0.223} \times 2.127659574^{0.263} \}}$$

$$= 1.77 \text{ hours}$$

$$= 105.94 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 0.5)$ = 40 mm
 $x(20, 0.5)$ = 70 mm
 $x(2, 3)$ = 80 mm
 $x(20, 3)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 100 years.

$x(T, 0.5)$ = 164.43 mm
 $x(T, 3)$ = 331.38 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

12.2 HP5 catchment 12 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 &\text{With } T_c = 1.77 \text{ hours} \\
 &\text{and } T = 100 \text{ years.} \\
 &x(2, 1.77) = 68.17 \text{ mm} \\
 &x(20, 1.77) = 119.29 \text{ mm} \\
 &x(T, 1.77) = 281.99 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 119.29152 - 68.166585 \\
 &= 51.124939 \\
 0.43 D &= 21.98 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x &= x(T) + 0.43 D \\
 [T = 100] &= 281.99231 + 21.983724 \\
 &= 303.98 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(100) &= 303.98 \text{ mm} \\
 \text{Therefore, } i(100) &= \frac{x(100)}{T_c} = \frac{303.97603}{1.7656986} \\
 &= 172.16 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region} &= 4 \\
 T &= 100 \text{ years.} \\
 C_{10} &= 0.38 \\
 Q / C_{10} &= 1.46
 \end{aligned}$$

$$\text{Therefore } Q = 0.5548$$

$$\begin{aligned}
 3. \text{ Percentage developed} &= 75 \% \\
 \text{Land use factor, } F &= 1.2
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times Q \times i(T) \times A \\
 &= 53.53 \text{ cu. m/s}
 \end{aligned}$$