Hydrologic Model for Selected Subcatchments in the Mahaweli Basin of Sri Lanka

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A hydrologic modeling study was carried out in the Mahaweli Basin of Sri Lanka. It comprises the analysis of six sub-catchments that feed water to Randenigala and Rantambe reservoirs viz.: Kehelella Ela, Unagolla Kandura, Maha Oya, Ma Oya, Medagama Oya and Mala Oya. A rainfall-runoff relationships quoted in the Flood Studies Report (FSR), developed by the National Environmental Research Council (NERC), UK (1975) was used for this study. The basic data were obtained from maps and reports available in the Government and research organizations of Sri Lanka. Many climatological relationships were calculated using parameters obtained from the tables of the FSR. This study provides synthetic unit hydrograph parameters, 200-year flood peak predictions and regional coefficients for the selected sub-catchments. The hydrographs show peak discharge within two to three hours from the onset of rainstorm and the time base shows an increment with the increasing catchment area. A positive relationship with catchment slope and discharge is observed. The 200-year return period flood peaks vary between 57.16 and 194.37 m^3/s. The average flood peak of the left-bank sub-catchments of the area is 127.35 m^3/s and is lower than the Mala Oya sub catchment in the right bank. The regional coefficients for discharge values vary within the range from 0.0024 to 0.0145 with an average value of 0.011. These synthesized results are to be compared and simulated with the observed data and/or long-term experimental data, so that they can be utilized as reliable tools in water management.

INTRODUCTION

This study was carried out during 1997 June to 1998 March (Dhanapala, 1998). It comprises field, laboratory and desktop studies, and aims to develop a hydrological model for some selected sub-catchments in the central Mahaweli region of Sri Lanka. Extensive field observations and measurements are limited in this study, however, desktop hydrologic analysis aided by empirical formulas are applied in obtaining necessary hydrological parameters. Major objectives are:

1. To obtain discharge values based on drainage parameters of small watersheds
2. To estimate flood peaks for a decided return period of years and
3. To derive a regional coefficient from flood studies.

Since the method developed in the Flood Studies Report (FSR) of the National Environmental Research Council (NERC), U.K. (1975) was chosen for the present study, the validity of applying this method in forecasting hydrologic conditions in the Sri Lankan context is also plan to be overview.

The study area belongs to the central Mahaweli region and is characterized by extremely complex and variable patterns of relief, agricultural land-use and forest cover. This study includes hydrologic analysis of six catchments (microbasins (mb) and inter-basins (ib)) which cover an area of about 150 km^2 (about 58 $mile^2$) within the central part of the country. Some of these catchments are located in the northern parts of the Central Highlands and in the southern part of the Knuckles Range. Five of these basins falls in the left bank of Mahaweli (Kehelella Ela, Unagolla Kandura, Ma Oya, Medagama Oya and Maha Oya (Lower) basins) are adjacent to each other and located within the coordinates 7° 10′ to 7° 20′ N and 80° 49′ to 80° 59′ E. The Mala Oya basin falls in the right bank and it is located within the coordinates 7° 06′ to 7° 11′ N and 80° 53′ to 80° 56′ E (*Fig. 1*). These basins discharge their waters to Mahaweli Ganga at various locations from Kimbulantota to Rantambe, so that they provide water for the two artificial reservoirs viz: Randenigala and Rantambe.

The sub-catchments were selected based on the available hydrologic data. We intend to use these results to develop more accurate hydrologic models for many other catchments that can be utilized as a tool for designing water management practices, engineering hydrologic and flood prevention structures.

RAINFALL PATTERN AND DISTRIBUTION

The study area lies in the rain shadow of the Knuckles Range and the main mass of the hill country. This area comprises a greater part of the intermediate climatic zone of Sri Lanka. The precipitation, controlled by ITCZ (Intra Tropical Convergence Zone) and orographic effects, show distinct bimodal distribution with peaks from December to February (northeast monsoon) and from May to September (southwest monsoon). The highest rainfall usually receive during the northeast monsoon and preceded inter monsoon convection rains.

Several rain-gage stations were selected to measure rainfall variation in the area, which provide sufficient data to describe variations within the valley. Based on these data, the average annual rainfall values obtained for the areas vary between 2000 to 3400 mm and generally increases northwards in many of the catchments (*Fig. 1*). The average annual temperatures vary between 20.0° and 22.5° C. It decreases towards the Central Highlands with the increase of the altitude.

PHYSIOGRAPHY AND DRAINAGE

The study area consists of a series of massive, steep-sided, north trending strike ridges and valleys. The basement comprises high-grade, lithologically and isotopically distinct, Proterozoic metamorphic rocks, belongs to the Highland Complex of Sri Lanka (Cooray, 1984; Almond, 1994; Kröner *et. al.*, 1991). Major rock types of this area are: Quartzites and quartz schists, Charnockitic Gneisses, Garnet-Biotite-Sillimanite Gneiss ± Graphite, Undefferentiated charnockitic biotite gneiss and Marble.

The tributary drainage within the selected basins flow along the prominent geological structures such as joints, fracture zones and lineaments, and along weak rocks such as marble and khondalite. In general most of the highest order streams usually follow the same trend. The elevation of these basins vary from 1000 feet close to the Mahaweli river and about 2,500 feet in the mountainous peaks (Anon., 1962). These basins therefore extended in the north south direction and bounded by elongated drainage divides. In addition, inter basin areas where drainage systems were not developed, but drain directly into the Mahaweli Ganga are also considered. Usually discharge along the first and second order streams depend on the seasonal rainfall while higher order streams are usually perennial (Suhail, 1997). Fifth order stream was encountered for the largest basin selected for the region. Based on point discharge observations, stream segments have discharge values ranging from 2.5 to 200 m^3/s. These values have been obtained from Uma Oya, Kurundu Oya and Belihul Oya basins during the dry season (March to end of September) (Suhail, 1997).

Several distinctive land-use patterns have been identified in the study area. The permanently cultivated lands are mainly confined to the western end. However, strips of land occupying the wetter, higher areas on the southern slopes of the Knuckles Range and in the northern slopes of the main hill country are also find to be cultivated. Recently established Victoria-Randenigala-Rantembe (VRR) Sanctuary is covered with moderate to dense forest so that these areas are devoid of land use. Intermediate dry evergreen forests are also present in the study area (Gunathilleke and Gunathilleke, 1990). Since, many parts of the study area being degraded by various man made practices, such as chena cultivation and forest fires, secondary forests have been later occupied the region. This sparsely distributed forests show open canopy with savannah grasslands at places, which may quite significant in terms of hydrologic analysis. Riverine vegetation is associated with the streams and rivers.

Major soil groups in the region are Red Brown Earths (RBE) and Low Humic Gley (LHG) (National Atlas of Sri Lanka, 1988). However, some areas consist of Red Yellow Podzolic (RYP) soils. The flood plains have five to nine meters thick alluvial soils. Colluvial soils are also found in certain parts, which usually formed uniform slopes, while hummocky and carved topography occurred in the eroded regions (Suhail, 1997).

METHODS OF STUDY

The study used the method developed by the National Environment Research Council (NERC) of UK (Flood Study Report (FSR) in 1975). Wilson (1990) quoted the fundamentals of precipitation-runoff relationship through synthetic unit hydrograph from catchment characteristics using the FSR method. The FSR method is applied in this study to construct a unit hydrograph for each selected catchment.

In this method, a unit hydrograph is synthesized using the basic parameters selected by Snyder (1938) as follows:

1. hydrograph base width (TB)
2. peak discharge (Q_p)
3. basin lag (T_p)

A number of fundamental meteorological, hydrological and geomorphological parameters were obtained from the available maps published by the different institutes and from other sources. The unavailable parameters were derived based on several assumptions. To compute TB, Q_p and T_p, a stepwise approach developed by Wilson (1990) has been used.

SYNTHESIS OF THE UNIT HYDROGRAPH FOR THE CATCHMENT

The flood peaks with a 200-year return period were estimated by means of synthetic unit hydrograph as discussed below.

Catchment Area (AREA) and Main Stream Length (MSL)

Catchment boundaries within the Mahaweli Ganga basin were outlined by the watershed divides. Subsequently, microbasins and interbasins of central Mahaweli region were established. The area of the catchment and the length along the longest stream on 1:63,360 scale topographic maps (Kandy, Hanguranketha, Nuwara Eliya) have measured.

The FSR recommended 1: 25,000 scale maps for obtaining AREA and MSL. However, using 1:63,360 scale maps have not created significant differences. The area was by OTT Planimeter (Type 31 L) in square miles. Subsequently these values were converted into square kilometers and used for this study.

The MSL parameter is also measured in miles and converted in to kilometers.

Channel Slope (S1085)

S1085 is the average slope in m/km between two points at 10 percent and 85 percent of the main stream length measured from the outlet.

The FSR suggests taking S1085 in m/km. The maps used for the present study (1:63,360 scale) show elevations in feet with contour interval of 100ft. The lengths were measured in miles. Therefore the slope was first measured as ft/mile and then converted into m/km.

The Standard Average Annual Rainfall (SAAR)

The SAAR was obtained by taking a weighted average over the catchment based on the monthly rainfall values. A number of rain gauging stations established in the study area by the Meteorological Department of Sri Lanka and monthly average rainfall in millimeters for 30 years are given in. The isohyets with 100 mm intervals have been drawn for the study area (*Fig. 1*). The average rainfall between two successive isohyets was calculated according to the proportion of area to obtain SAAR value for each catchment.

Rainfall less Soil Moisture Deficit (RSMD)

RSMD values have been calculated and plotted in different intervals for the British Islands. Since, such maps were not available for Sri Lanka, an alternative approach was applied. The relationships associated with different parameters, which are reasonably well suited for the British Islands, were initially obtained and assumed to be applicable to the present study.

(a) 2-day M5 Rainfall (average for the catchment)

There is a close relationship between SAAR and 2-day M5 value (identified from the maps reproduced by the NERC in the FSR, 1975). This relationship was applied to obtain the 2-day M5 values for the selected catchment.

$$\text{2-day M5 rainfall} \sim 0.0625\ \text{SAAR}. \qquad (1)$$

(b) Rainfall Ratio, r (average for the catchment)

$$\text{ratio } (r) = \frac{\text{60-minute M5}}{\text{2-day M5}} \ \text{(as a percentage)} \qquad (2)$$

Instead of finding 60-minute M5 values to calculate r, applying a relationship between 2-day M5 and r identified from the above maps is convenient. Therefore,

$$R \sim 0.45\ \text{2-day M5}\ \% \qquad (3)$$

(c) 24-h M5 Values

This value is obtained from the model for M5 rainfall for a duration upto 48 hours (*Table 1*).

(d) 1-day M5 Value

Because of the difference between rainfall hours and rainfall days, it is necessary to multiply the M5 values for the days by the factors given in *Table 2*. Therefore, 1-day M5 value is obtained by multiplying 24-h rainfall value by the factor 1.11.

(e) Effect of Aerial Reduction

An ARF value was obtained from *Table 3* considering the extent of the duration and the area. The effective 1-day M5 rainfall is given by:

$$\text{1-day M5 rainfall} \times \text{ARF} \qquad (4)$$

(f) Soil Moisture Deficit (SMD)

By deducting the soil moisture deficit (SMD) from the 1-day M5 rainfall (from step (e)), RSMD can be obtained.

$$\text{RSMD} = \text{1-day M5 rainfall} - \text{SMD} \qquad (5)$$

Because of the unavailability of SMD data for the selected catchments, it was assumed as 4.00 mm for each catchment of the study area.

Urban Development Fraction (URBAN)

The URBAN factor becomes zero when there is no significant urban development. This can be estimated from the available Land Use maps and found that URBAN = 0 for all the selected catchments.

Unit Hydrograph Parameters

The time to peak (T_p), peak discharge of the unit hydrograph (Q_p) and the time base (TB) were estimated by the empirical relationships presented by NERC in the FSR (1975).

$$T_p = 46.6\,(MSL)^{0.14}\,(S1085)^{-0.38}\,(1+URBAN)^{-1.95}\,(RSMD)^{-0.4} \text{ (measured in hours)} \quad (6)$$

$$Q_p = 220/T_p \text{ (measured in m}^3\text{/s per km}^2\text{)} \quad (7)$$

$$TB = 2.52\,T_p \text{ (measured in hours)} \quad (8)$$

These fundamental data were plotted to obtain the synthetic 1-h unit hydrograph (*Fig. 5 b*).

ESTIMATION OF FLOOD PEAKS OF A CATCHMENT.

Basic Data Interval

The basic data interval was determined by the time to peak (T_p) value.

$$T \sim T_p/5 \text{ (in hours)} \quad (9)$$

Storm Duration

The following equation was used to calculate the storm period. It is convenient to make D an odd integer multiple of the basic data interval (T).

$$D = (1 + SAAR/1000)\,T_p \text{ (in hours)} \quad (10)$$

Return Period of the Storm

The return period of storm will produce the appropriate return period peak flow. The recommended return periods from 10 to 1000 years can be obtained from the *Fig. 2* which illustrates the relationship between flood peak return period (in years) and the rain storm return period (in years). For this study, 200-year return period peak flow has been considered, hence the storm return period is 240 years.

M5 Rainfall during the Storm Period

Using the r and D values obtained in previous steps, net M5 rainfall value for the storm duration can be evaluated by *Table 1*.

Point Rainfall

This requires a growth factor to interpolate D-h M5 to D-h M240 because of the selected storm return period is 240 years. The tabulated growth factors for British Islands (from the FSR by NERC) are in *Tables 4 a and 4 b*. A reasonable value for this study have been assumed accordingly.

Catchment Average (Rainfall P)

Aerial Reduction Factor (ARF) is used in interpolating this value. *Table 3* provides the ARF values for different rainfall duration and different catchment sizes. An appropriate value was obtained using D and AREA parameters.

$$P = \text{D-h M240} \times \text{relevant ARF} \quad (11)$$

Catchment Wetness Index (CWI)

The recommended design values for CWI for different SAAR values can be obtained from *Fig. 3*.

SOIL Parameter and the Runoff Percentage Parameters - SPR and PR

In the FSR method (*Table 5*), this is expressed as SOIL, which is a composite index determined from soil survey maps and is derived from the formula:

$$SOIL = \frac{(0.15\,S_1 + 0.30S_2 + 0.40S_3 + 0.45S_4 + 0.5\,S_5)}{S_1 + S_2 + S_3 + S_4 + S_5} \quad (12)$$

Where $S_1.S_5$ denotes the proportions of the catchment covered by each of the soil classes. Although several soil classification maps of the study area are available, they cannot be applied directly for the present study. Therefore judgement based on the *Table 6* would give a reasonable value for the SOIL parameter.

The Standard Percentage Runoff (SPR)

$$SPR = 95.5\,SOIL + 0.12\,URBAN \quad (13)$$

For the designed event, the appropriate runoff percentage (PR)

$$PR = SPR + 0.22(CWI - 125) + 0.1(P-10) \quad (14)$$

Net Rain for the Unit Hydrograph

The net rain applied to the synthetic unit hydrograph can be obtained by P (PR/100) mm

Stepped Distribution Graph of Rain and the 1-h Unit Hydrograph

The net rain calculated at the previous step must be applied to the hydrograph in accordance with a 75 percent storm profile. This value was obtained from *Fig. 4*.

This distribution should take place over the time period D. Therefore a stepped distribution graph (*Fig. 5a*) is drawn with the basic data interval T. Each interval is approximately 100/D percent of the duration. These data are then tabulated as shown in *Table 7*.

This rain values that were shown in *Table 7* are now arranged symmetrically about the centerline and applied to the synthetic unit hydrograph (*Table 8*). The unit hydrograph ordinates were obtained from the plotted 1-h unit hydrograph with reference to the basic data intervals. Each increment of the table is 1-h rain is multiplied in turn by each hourly ordinate of the unit hydrograph. The successive products were moved successively 1-h to the right. The table may be continued to the right to provide further ordinates of the total hydrograph. The maximum total value was selected as the peak surface flow of the flood of 200-year return period, excluding the base flow.

Baseflow

The term average non-separated flow (ANSF) has been proposed and is calculated as follows based on catchment characteristics of a large number of British catchments. The baseflow was calculated from the following equation, which gives the flow in $m^3/s/km^2$.

$$\text{ANSF} = (3.26 \times 10^{-4})(\text{CWI} - 125) + (7.4 \times 10^{-4})\ \text{RSMD} + (3 \times 10^{-3}) \quad (15)$$

Hence,

$$\text{Baseflow} = \text{AREA} \times \text{ANSF (in } m^3/s) \quad (16)$$

By adding the baseflow to the peak surface flow, the peak flow of the flood of 200-year return period can be obtained.

DERIVATION OF A REGIONAL COEFFICIENT FOR PEAK FLOWS

This includes some of the catchment and meteorological parameters derived in previous steps. It also associates with the lake or reservoir fraction and the stream frequency of the catchment.

Fraction of Lake or Reservoir (LAKE)

The FSR method has defined a LAKE parameter, which is the fraction of catchment draining through lake or reservoir. Since there is no such significant area identified from the maps, LAKE = 0 for all the studied catchments

Stream Frequency (STRMFRQ)

Stream Frequency (STRMFRQ) was employed in the UK Flood Studies Report (Natural Environmental Research Council, 1975) reflecting the drainage density of a catchment. It was simply a measure by counting channel junctions on 1:25,000 maps and dividing it by the basin area.

$$\text{STRMFRQ} = \text{No. of Stream Junctions/AREA.} \quad (17)$$

Although the FSR recommendation is to count stream junctions per km^2 on 1: 25,000 scale maps, for the present study 1: 63,360 (1-inch) maps were used.

Relationship between Peak Flow and other Catchment Characteristics

This relationship has been defined by NERC (1975) in FSR as follows:

$$Q_p = C\,(\text{AREA})^{0.94}(\text{STRMFRQ})^{0.27}(\text{SOIL})^{1.23}(\text{RSMD})^{1.03}(\text{S1085})^{0.16}(1 + \text{LAKE})^{-0.85} \quad (18)$$

C is a regional coefficient specific to the catchment. It was calculated by substituting the values for each parameter.

RESULTS AND DISCUSSION

The peak discharge achieves between two and three hours from the start of the rainstorm. It takes different time periods i.e. time bases (TB) to reach its normal discharge conditions. The TB shows an increment with the increasing catchment area (*Figs 6a, b, c, d, e, f, g, h, i, j, k and l*).

The effect of catchment slope (S1085) on discharge can be clearly seen by comparing synthesized discharge values of Kehelella Ela and Mala Oya basins. Although both basins have almost similar parameters other than the slope, the high S1085 value for Mala Oya (ib) has resulted higher runoff than that of Kehelella Ela (mb).

The 200-year return period flood peak values for the selected catchments vary between 57.16 and 194.37 m^3/s (*Tables 9a, 9b, 9c, 9d, 9e and 9f*). The highest flood peak is obtained from

Kehelella Ela (mb). However, the largest catchment, Ma Oya (mb), which lies in a relatively high rainfall zone does not show the highest peak. Since this may be due to the fact that it has a lower stream frequency (STRMFRQ) and gentle catchment slope (S1085). Although it is not the smallest catchment of the study area, Medagama Oya has the lowest flood peak. The average flood peak of the left-bank sub-catchments of the area is 127.36 m^3. It is required further analysis on several right-bank sub-catchments to compare the flood peaks.

The baseflow values cannot be compared meaningfully by using surface features since many subsurface features such as fracture density heavily control it.

The regional coefficients for discharges based on the catchment characteristics vary within the range from 0.0024 to 0.0145. The highest value was resulted from Kehelella Ela (mb) and the lowest was from the Mala Oya (ib) of the right bank. An average figure for this region can be given as 0.011. However, this regional coefficient is not the same, which was defined in the FSR.

The tabulated results are shown in *Tables 10a and 10b*.

It may be important to notice that these results were based on the drainage characteristics of the region (obtained from the maps) before the impoundment of the Mahaweli reservoirs. Considerable portions of Unagolla Kandura and Medagama Oya basins are submerged by the impoundment of Randenigala reservoir so that the results may need adjustment. However, the results for other four subcatchments may not effect.

APPENDIX -CALCULATIONS

The calculation procedure is mentioned earlier in "Methods of Study". The calculations for the selected six catchments follow the same procedure. Therefore a master calculation is mentioned below for Kehelella Ela (mb).

Calculation of Unit Hydrograph Parameters

(a) AREA = 24.605 km^2 MSL=13.52 km

(b) S1085 = 55.61 m/km

(c) SAAR = 2477.00 mm

(d) RSMD :
2-day M5 rainfall ~ 0.0625 SAAR = 154.81 mm
r ~ 0.45 2-day M5 = 69.66 %
24-h M5 rainfall = 92/100 x 154.81 mm
= 142.43 mm (from *Table 1*)
1-day M5 rainfall = 142.43/1.11 mm
= 128.32 mm (from *Table 2*)
ARF =0.96 (from *Table 3*)
1-day catchment rainfall = 128.32 x 0.96 mm
= 123.19 mm
Soil moisture deficit ~ 4.00 mm
Therefore, RSMD = (123.19-4.00) mm
= 119.19 mm

(e) URBAN = 0

(f) $T_p = 46.6(MSL)^{0.14}(S1085)^{-0.38}(1+URBAN)^{-1.99}(RSMD)^{-0.4}$
$= 46.6\,(13.52)^{0.14}\,(55.61)^{-0.38}\,(1+0)^{-1.99}\,(119.19)^{-0.4}$
= 2.16 h
$Q_p = 220/T_p/100\ m^3/s/100\ km^2$
$= 220/2.16/100\ m^3/s/100\ km^2$
= 25.06 m^3/s
TB = 2.52 T_p = 5.5 h
(See *Fig. 6 a* for the derived unitgraph.)

Calculation for Estimation of Flood Peaks

(a) Basic data interval (T) = $T_p/5.5$ = 0.4 h

(b) Storm duration (D) ~ (1 + SAAR/1000) T_p
= 7.51 h (Take D as 7 h)

(c) 200-year peak flow return period =240 years (from *Fig.2*)

(d) r = 69.66 %
Therefore 69.66 % of 2-day M5 rainfall = 07.84 mm

(e) Growth factor=1.7 (Refer to *Tables 4 a and 4 b*)
Point rainfall = 107.84 mm x 1.7 mm = 183.33 mm

(f) ARF (from *Table.3*) = 0.94
Point rainfall (P) = 183.33 x 0.94 mm = 172.33 mm

(g) CWI (from *Fig. 3*) = 127

(h) SOIL: Slope = $\tan^{-1}(S1085/1000) = 3.18^0$
from *Table 5*, SOIL = 0.4
SPR = 95.5 SOIL + 0.12 URBAN = 38.2
PR =SPR + 0.22(CWI - 125) + 0.1 (P - 10)
= 38.2+0.22(127-125)+0.1(172.33 - 10)
= 54.87 %

The net rain applied to the unit hydrograph = P x PR
= 172.33 x 54.87%
= 94.56 mm

(i) Each hour rainfall percent = 14.3%

(j) Computation of Baseflow:

$ANSF = (3.26 \times 10^{-4})(CWI-125)+(7.4 \times 10^{-4})\,RSMD + (3 \times 10^{-3})$
$= (3.26 \times 10^{-4})\,(127 - 125) + (7.4 \times 10^{-4})\,119.19 + (3 \times 10^{-3})$
= 0.092 $m^3/s/km^2$

Baseflow for the catchment = AREA x ANSF
=24.605 x 0.092 m^3/s
= 2.264 m^3/s

Derivation of the Regional Coefficient

(a) STRMFRQ = No. of Junctions/ AREA
=57/24.605 = 2.32

(b) LAKE = 0

(c) $Q_p = C[(AREA)^{0.94}\,(STRMFRQ)^{0.27}\,(SOIL)^{1.23}(RSMD)^{1.03}(S1085)^{0.16}\,(1+LAKE)^{-0.85}]$

$25.06 = C\,(24.605)^{0.94}\,(2.32)^{0.27}\,(0.4)^{1.23}\,(119.19)^{1.03}\,(55.61)^{0.16}\,(1+0)^{-0.85}$
C = 0.0116

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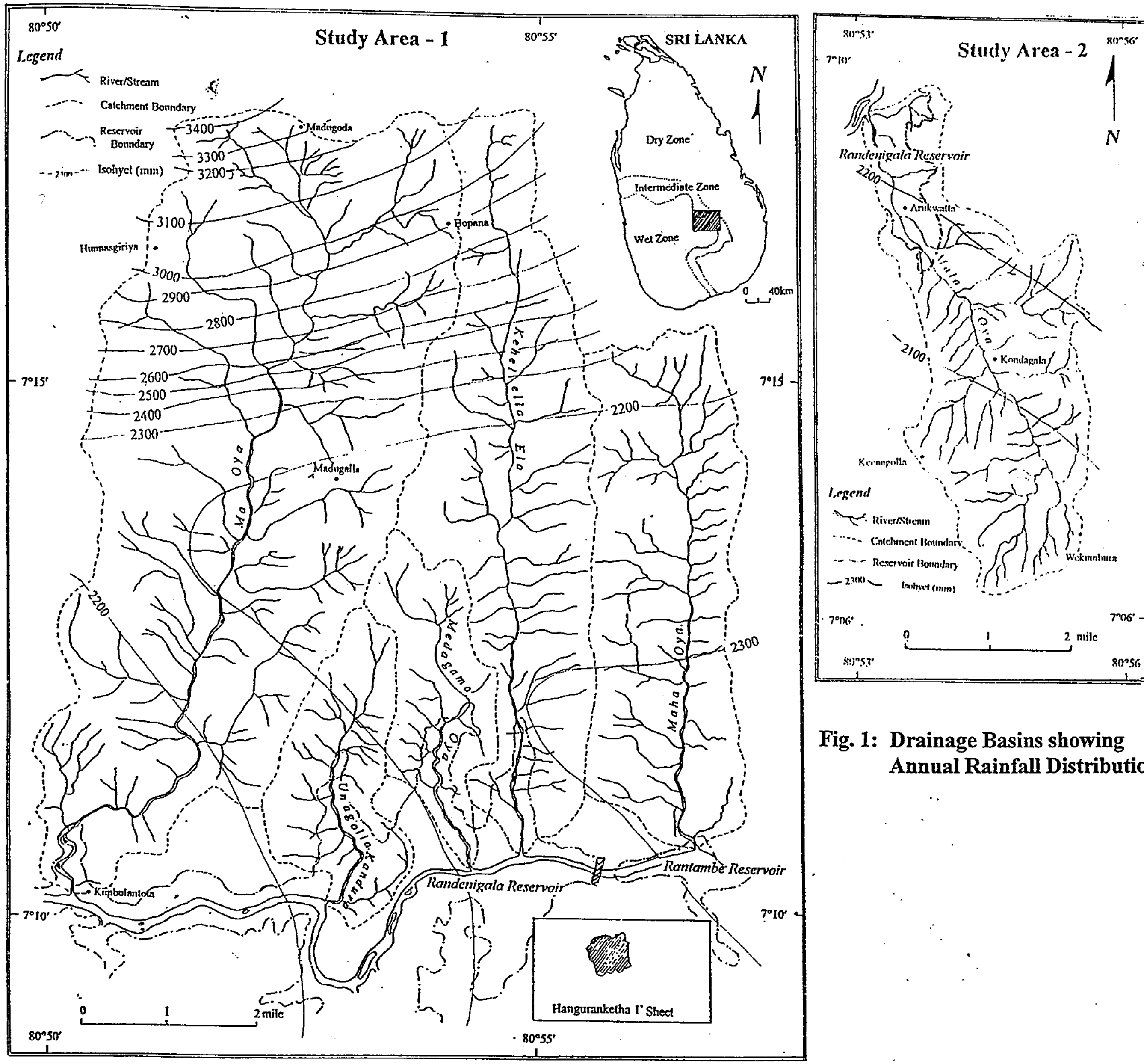

Fig. 1: Drainage Basins showing Annual Rainfall Distribution

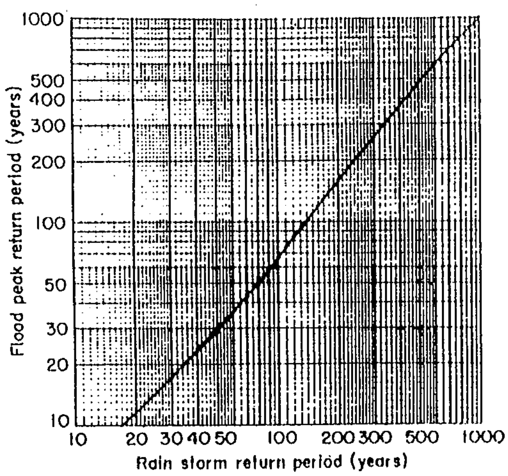

Fig. 2: Recommended storm return period to yield a flood peak of required return period by the design method.

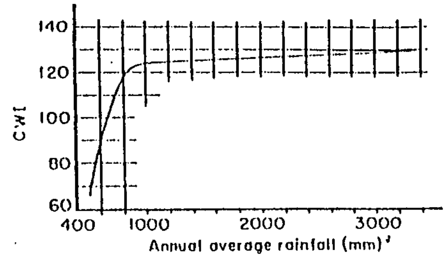

Fig. 3: Recommended design values for catchment wetness index (CWI)

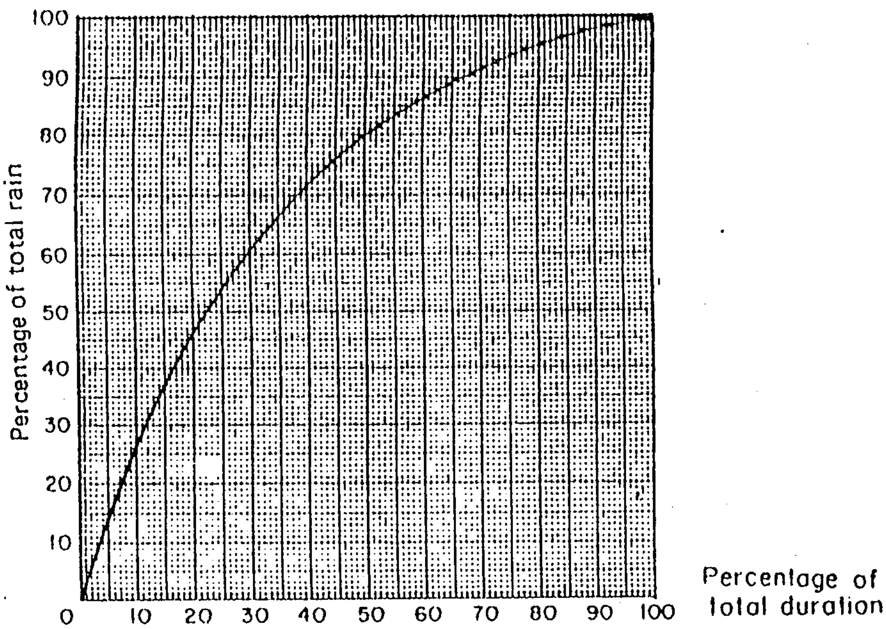

Fig. 4: The '75 percent' storm profile

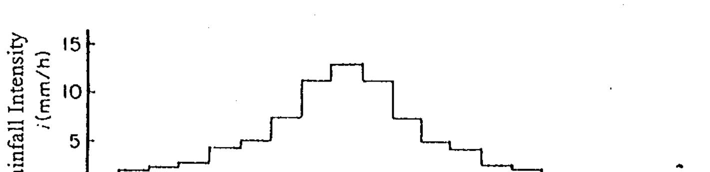

Fig. 5 a: Rainfall Distribution Graph (Hyetograph) for Table 7

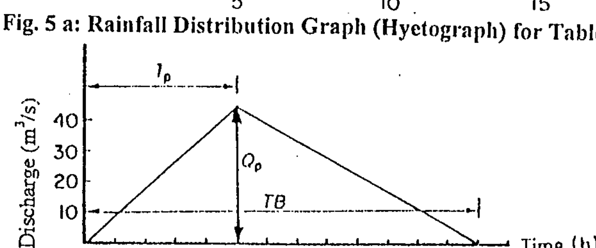

Fig. 5 b: Synthetic 1-h unitgraph for Table 7

(Source : Flood Studies Report by NERC, UK)

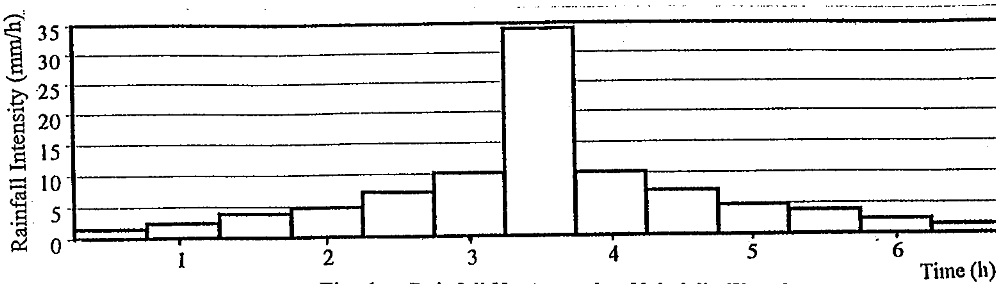

Fig. 6 a: Rainfall Hyetograph – Kehelella Ela mb

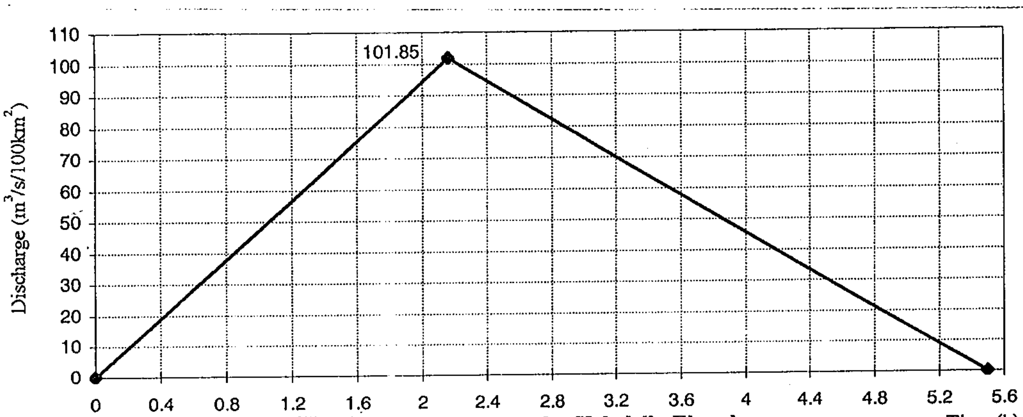

Fig. 6 b Unit Hydrograph - Kehelella Ela mb

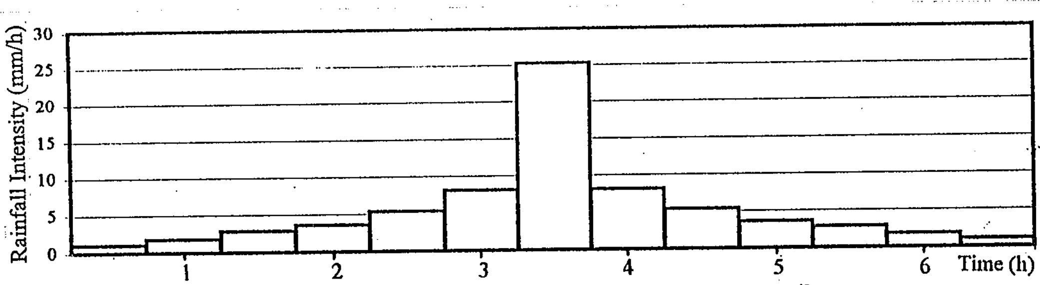

Fig. 6 c: Rainfall Hyetograph – Unagolla Kandura ib

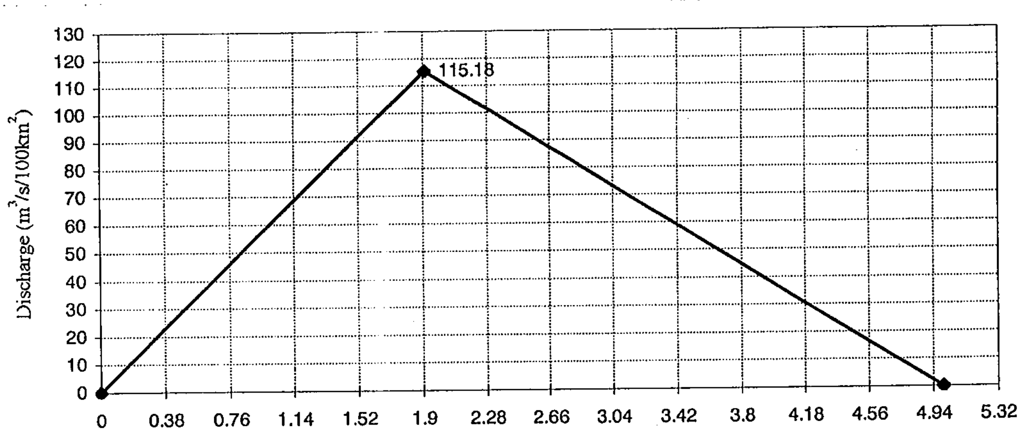

Fig. 6 d: Unit Hydrograph - Unagolla Kandura ib

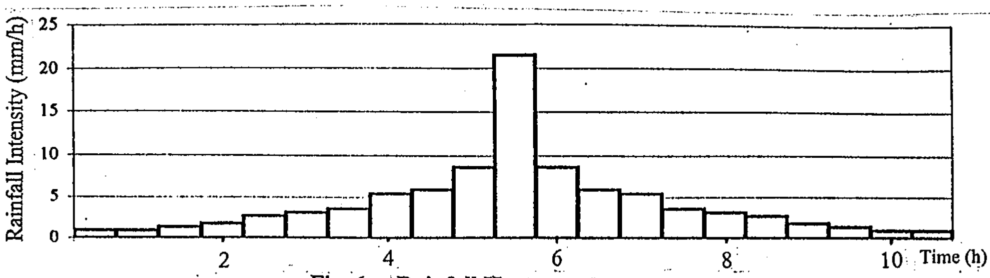

Fig. 6 e: Rainfall Hyetograph - Ma Oya mb

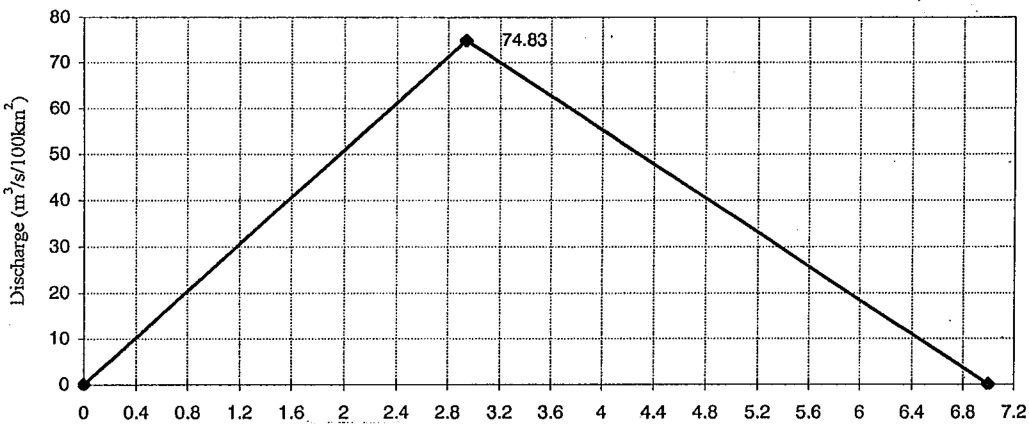

Fig. 6 f: Unit Hydrograph - Ma Oya mb

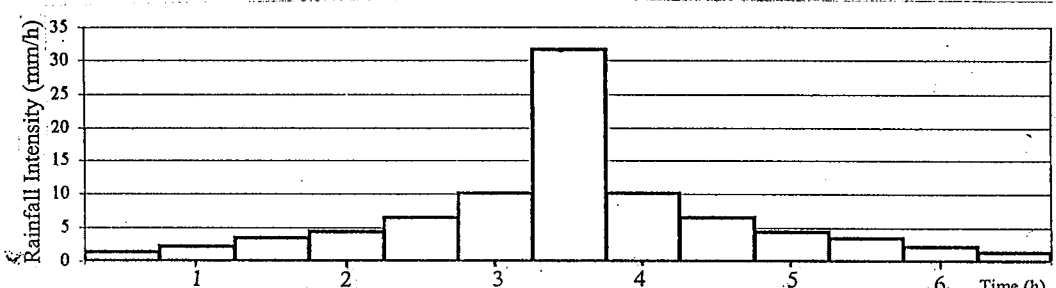

Fig. 6 g: Rainfall Hyetograph - Medagama Oya mb

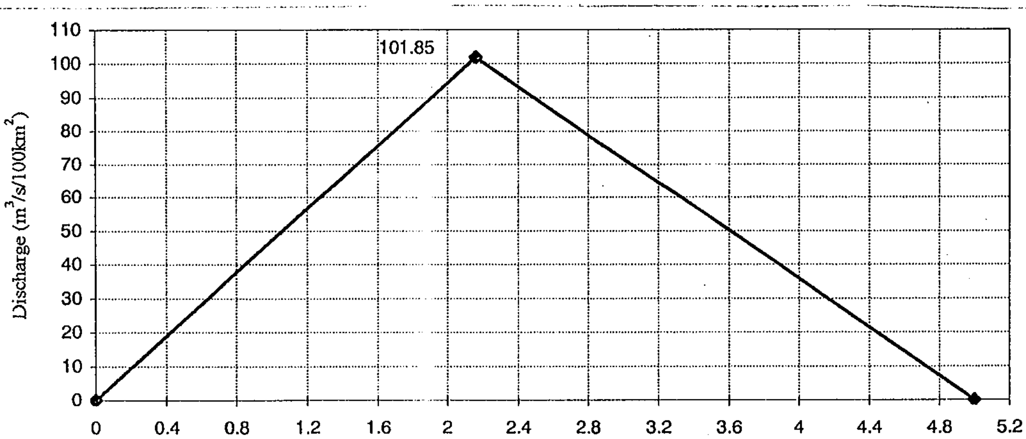

Fig. 6 h: Unit Hydrograph - Medagama Oya mb

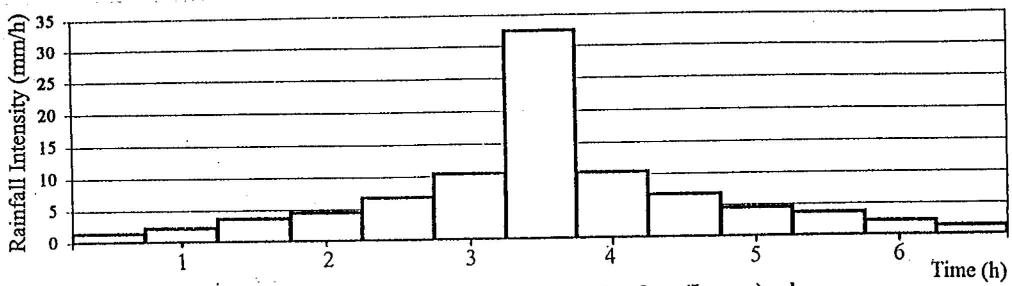

Fig. 6 i Rainfall Hyetograph - Maha Oya (Lower) mb

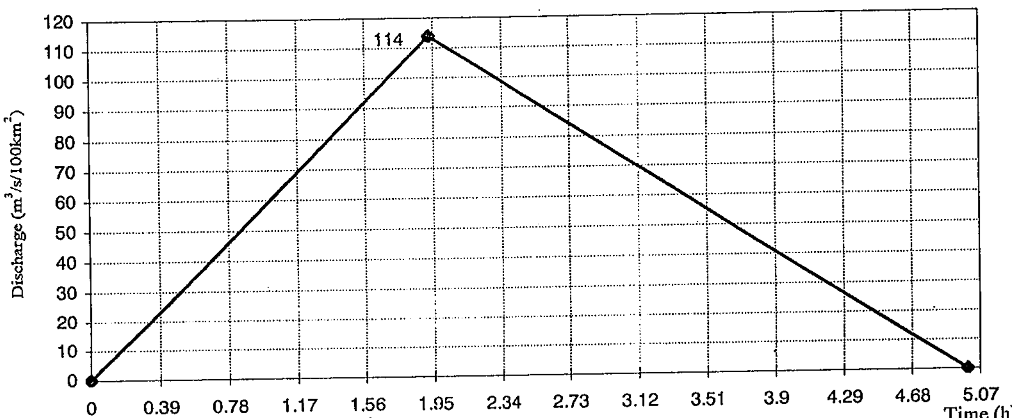

Fig. 6 j Unit Hydrograph - Maha Oya (Lower) mb

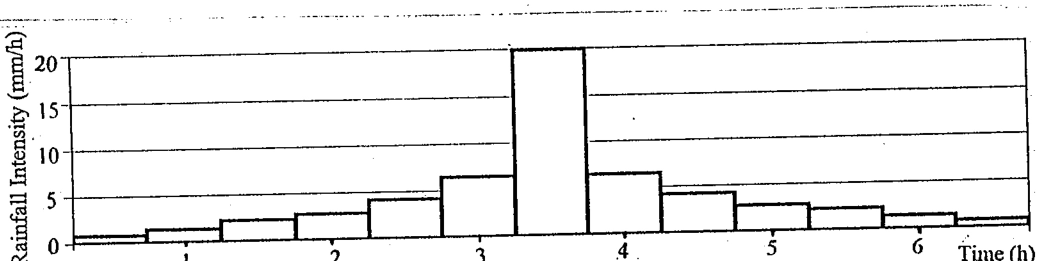

Fig. 6 k Rainfall Hyetograph - Mala Oya ib

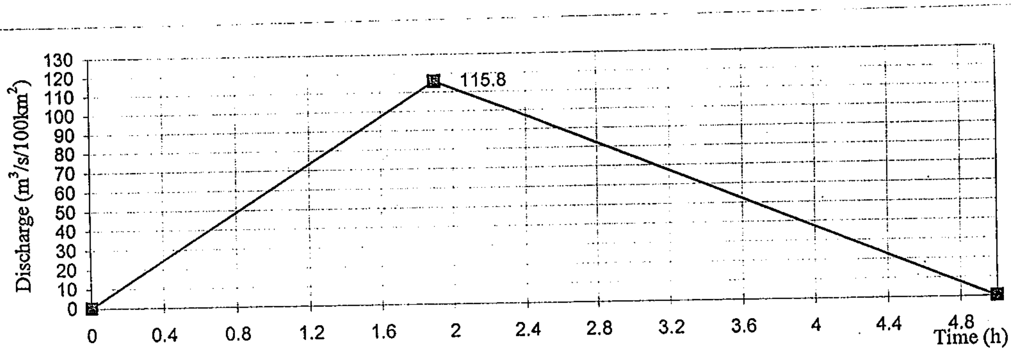

Fig. 6 l Unit Hydrograph - Mala Oya ib

r (per cent)	M5 rainfall (amounts as percentages of 2-day M5)												
	1 min	2 min	5 min	10 min	15 min	30 min	60 min	2 h	4 h	6 h	12 h	24 h	48 h
12	0.8	1.4	2.7	4.2	5.4	8.1	12	18	26	33	49	72	106
15	1.2	2.1	3.8	5.8	7.2	10.5	15	21	30	37	53	75	106
18	1.6	2.8	5.0	7.4	9.2	12.9	18	25	34	41	56	77	106
21	2.1	3.5	6.3	9.2	11.2	15.5	21	28	38	45	60	80	106
24	2.5	4.3	7.6	11.0	13.3	18.1	24	31	41	48	63	82	106
27	3.0	5.0	9.0	12.9	15.5	20.7	27	35	44	51	65	83	106
30	3.3	5.7	10.3	14.8	17.7	23.3	30	38	48	55	68	85	106
33	3.8	6.5	11.7	16.7	19.9	26.0	33	41	51	57	71	87	106
36	4.1	7.2	13.0	18.6	22.2	28.7	36	44	54	60	73	88	106
39	4.6	8.0	14.5	20.6	24.5	31.5	39	47	57	63	75	89	106
42	5.0	8.7	16.0	22.7	26.9	34.2	42	50	60	66	77	91	106
45	5.4	9.5	17.4	24.7	29.2	37.0	45	53	63	68	79	92	106

Table 1: Model for M5 rainfall for durations up to 48 hours.

Rainfall days	1	2	4	8
Multiplying factor	1.11	1.06	1.03	1.015
Rainfall hours	24	48	96	192

Table 2: Factors to give M5 values for hours from rainfall days.

Duration D	Area A (km^2)									
	1	5	10	30	100	300	1000	3000	10 000	30 000
1 min	0.76	0.61	0.52	0.40	0.27	–	–	–	–	–
2 min	0.84	0.72	0.65	0.53	0.39	–	–	–	–	–
5 min	0.90	0.82	0.76	0.65	0.51	0.38	–	–	–	–
10 min	0.93	0.87	0.83	0.73	0.59	0.47	0.32	–	–	–
15 min	0.94	0.89	0.85	0.77	0.64	0.53	0.39	0.29	–	–
30 min	0.95	0.91	0.89	0.82	0.72	0.62	0.51	0.41	0.31	–
60 min	0.96	0.93	0.91	0.86	0.79	0.71	0.62	0.53	0.44	0.35
2 h	0.97	0.95	0.93	0.90	0.84	0.79	0.73	0.65	0.55	0.47
3 h	0.97	0.96	0.94	0.91	0.87	0.83	0.78	0.71	0.62	0.54
6 h	0.98	0.97	0.96	0.93	0.90	0.87	0.83	0.79	0.73	0.67
24 h	0.99	0.98	0.97	0.96	0.94	0.92	0.89	0.86	0.83	0.80
48 h	–	0.99	0.98	0.97	0.96	0.94	0.91	0.88	0.86	0.82
96 h	–	–	0.99	0.98	0.97	0.96	0.93	0.91	0.88	0.85
192 h	–	–	–	0.99	0.98	0.97	0.95	0.92	0.90	0.87
25 days	–	–	–	–	0.99	0.98	0.97	0.95	0.93	0.91

Table 3: Aerial reduction factor (ARF)

M5 (mm)	Partial duration series		Annual maximum series						
	2M	1M	M2	M10	M20	M50	M100	M1000	M10 000
0.5	0.55	0.68	0.76	1.14	1.30	1.51	1.71	2.54	3.78
2	0.55	0.68	0.76	1.15	1.31	1.54	1.75	2.65	4.01
5	0.54	0.67	0.76	1.16	1.34	1.62	1.86	2.94	4.66
10	0.55	0.68	0.75	1.18	1.38	1.69	1.97	3.25	5.36
15	0.55	0.69	0.75	1.18	1.38	1.70	1.98	3.28	5.44
20	0.56	0.70	0.76	1.18	1.37	1.66	1.93	3.14	5.12
25	0.57	0.71	0.77	1.17	1.36	1.64	1.89	3.03	4.85
30	0.58	0.72	0.78	1.17	1.35	1.61	1.85	2.92	4.60
40	0.59	0.74	0.79	1.16	1.33	1.56	1.77	2.72	4.16
50	0.60	0.75	0.80	1.15	1.30	1.52	1.72	2.57	3.85
75	0.62	0.77	0.82	1.13	1.26	1.45	1.62	2.31	3.30
100	0.63	0.78	0.83	1.12	1.24	1.40	1.54	2.12	2.92
150	0.64	0.79	0.84	1.10	1.20	1.33	1.45	1.90	2.50
200	0.65	0.80	0.85	1.09	1.18	1.30	1.40	1.79	2.30
500	0.66	0.80	0.86	1.08	1.14	1.20	1.27	1.52	–
1000	0.66	0.80	0.86	1.07	1.12	1.18	1.23	1.42	–

Table 4 a: Growth factors MT/M5 for England and Wales.

M5 (mm)	Partial duration series		Annual maximum series						
	2M	1M	M2	M10	M20	M50	M100	M1000	M10 000
0.5	0.52	0.67	0.76	1.14	1.30	1.51	1.70	2.52	3.75
2	0.49	0.65	0.74	1.16	1.32	1.53	1.74	2.60	3.94
5	0.45	0.62	0.72	1.18	1.35	1.56	1.79	2.75	4.28
10	0.43	0.61	0.70	1.21	1.41	1.65	1.91	3.09	5.01
15	0.46	0.62	0.70	1.23	1.44	1.70	1.99	3.32	5.54
20	0.50	0.64	0.72	1.23	1.45	1.73	2.03	3.43	5.80
25	0.52	0.66	0.73	1.22	1.43	1.72	2.01	3.37	5.67
30	0.54	0.68	0.75	1.21	1.41	1.70	1.97	3.27	5.41
40	0.56	0.70	0.77	1.18	1.37	1.64	1.89	3.03	4.86
50	0.58	0.72	0.79	1.16	1.33	1.58	1.81	2.81	4.36
75	0.63	0.76	0.81	1.13	1.27	1.47	1.64	2.37	3.43
100	0.64	0.78	0.83	1.12	1.24	1.40	1.54	2.12	2.92
150	0.64	0.78	0.84	1.11	1.21	1.33	1.45	1.90	2.50
200	0.64	0.78	0.84	1.10	1.20	1.30	1.40	1.79	2.30
500	0.65	0.79	0.85	1.09	1.15	1.20	1.27	1.52	–
1000	0.66	0.80	0.86	1.07	1.12	1.18	1.23	1.42	–

Table 4 b: Growth factors MT/M5 for Scotland and Northern Ireland.

(Source : Flood Studies Report by NERC, UK)

Drainage class	Depth to impermeable layer (cm)	Permeability of overlying soil								
		rapid, slope 0-2°	medium, slope 0-2°	slow, slope 0-2°	rapid, slope 2-8°	medium, slope 2-8°	slow, slope 2-8°	rapid, slope more than 8°	medium, slope more than 8°	slow, slope more than 8°
Rarely water-logged within 60 cm (well and moderately well drained)	> 80	1	1	2	1	2	2	1	2	3
	40-80	1	1	2	2	2	3	3	3	4
	< 40	NOT APPLICABLE								
Commonly water-logged within 60 cm during winter (imperfect and poor drainage)	> 80	2	2	3	3	3	4	N/A	4	5
	40-80	2	3	3	3	4	4	4	4	5
	< 40	3	4	4	4	4	4	4	5	5
Commonly water-logged within 60 cm winter and summer (very poorly drained)	> 80	4	4	5	5	5	5	N/A	5	5
	40-80	4	5	5	5	5	5	N/A	5	5
	< 40	5	5	5	5	5	5	5	5	5

Upland and peaty soils are Class 5; urban areas unclassified. Class 1, very low runoff; Class 5, very high runoff.

Table 5: The relationship between soil class and rain acceptance-runoff intensity

Soil Class	Winter Rain Acceptance	Runoff
1	Very high	Very low
2	High	Low
3	Moderate	Moderate
4	Low	High
5	Very low	Very High

Table 6: The relationship between soil class and rain acceptance-runoff intensity

Duration (%)	6	18	30	42	54	66	78	90	100
Rain (%)	16	43	61	73	83	89	94	98	100
Increment Rain (%)	16	27	18	12	10	6	5	4	2
Increment rain (%)	13.4	22.7	15.1	10.0	8.4	5.0	4.2	3.4	1.6

Table 7: Derivation of stepped distribution graph figures

(considering net rain = 84 mm, D = 17 h, T = 1 h, each interval ~ 6 percent of D).

Hour	Net rain (cm)	Hour from origin and 1 h unit hydrograph ordinates × (area/100) (m³/s)																
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 (h)
		0	4.44	8.87	13.31	17.74	22.18	19.40	16.63	13.86	11.09	8.32	5.54	2.77	0	0	0	0 (m³/s)
1	0.08	0	0.4	0.7	1.1	1.4	1.8	1.6	1.3	1.1	0.9	0.7	0.4	0.2	0	0	0	0
2	0.17		0	0.8	1.5	2.3	3.0	3.8	3.3	2.8	2.4	1.9	1.4	0.9	0.5	0	0	0
3	0.21			0	0.9	1.9	2.8	3.7	4.7	4.1	3.5	2.9	2.3	1.8	1.2	0.6	0	0
4	0.25				0	1.1	2.2	3.3	4.4	5.6	4.8	4.2	3.5	2.8	2.1	1.4	0.7	0
5	0.42					0	1.9	3.7	5.6	7.5	9.3	8.2	7.0	5.8	4.7	3.5	2.3	1.2
6	0.50						0	2.2	4.4	6.7	8.9	11.1	9.7	8.3	6.9	5.6	4.2	2.8
7	0.75							0	3.3	6.7	10.0	13.3	16.6	14.6	12.5	10.4	8.3	6.2
8	1.14								0	5.1	10.1	15.2	20.2	25.3	22.1	19.0	15.8	12.6
9	1.34									0	6.0	11.9	17.8	23.8	29.7	26.0	22.3	18.6
10	1.14										0	5.1	10.1	15.2	20.2	25.3	22.1	19.0
11	0.75											0	3.3	6.7	10.0	13.3	16.6	14.6
12	0.50												0	2.2	4.4	6.7	8.9	11.1
13	0.42													0	1.9	3.7	5.6	7.5
14	0.25														0	1.1	2.2	3.3
15	0.21															0	0.9	1.9
16	0.17																0	0.7
17	0.08																	0
	8.38	0	0.4	1.5	3.5	6.7	11.7	18.3	27.0	39.6	55.9	74.5	92.3	107.6	116.2	116.6	109.9	99.5
															Base flow	3.3		
																119.9		

Peak flow of the flood of 200-year return period is 120 m³/s

Table 8 : Convolution of the unit hydrograph wih net rain (for Table 7 and Fig 5 b)

(Source : Flood Studies Report by NERC, UK)

Hour	Net Rain (cm)	Hour from Origin and Unit Hydrograph Ordinates x (AREA/100) m³/s													
		0	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2
		0	4.61	9.23	13.840	18.45	23.07	22.91	19.99	17.22	14.15	11.23	8.3	5.23	2.31
0.5	0.142	0	0.655	1.311	1.965	2.620	3.276	3.253	2.839	2.445	2.009	1.595	1.179	0.743	0.000
1.0	0.237		0	1.093	2.188	3.280	4.373	5.468	5.430	4.738	4.081	3.354	2.662	1.967	1.240
1.5	0.378			0	1.743	3.489	5.232	6.974	8.720	8.660	7.556	6.509	5.349	4.245	3.137
2.0	0.473				0	2.181	4.366	6.546	8.727	10.912	10.836	9.455	8.145	6.693	5.312
2.5	0.709					0	3.268	6.544	9.813	13.081	16.357	16.243	14.173	12.209	10.032
3.0	1.008						0	4.647	9.304	13.951	18.598	23.255	23.093	20.150	17.358
3.5	3.404							0	20.302	40.649	60.951	81.254	101.600	100.896	88.036
4.0	1.008								0	4.647	9.304	13.951	18.598	23.255	23.093
4.5	0.709									0	3.268	6.544	9.813	13.081	16.357
5.0	0.473										0	2.181	4.366	6.546	8.727
5.5	0.378											0	1.743	3.489	5.232
6.0	0.237												0	1.093	2.188
6.5	0.142													0	0.655
	9.298													194.366	

200-year Peak Surface Flow (m³/s) = 194.37

Table 9 a: Computation of surface peak flow – Kehelella Ela mb

Hour	Net Rain (cm)	Hour from Origin and Unit Hydrograph Ordinates x (AREA/100) m³/s													
		0	0.38	0.76	1.14	1.52	1.90	2.28	2.66	3.04	3.42	3.80	4.18	4.56	5.00
		0	2.64	5.63	7.85	10.41	13.05	11.62	9.98	8.39	6.76	5.13	3.50	1.86	0
0.5	0.105	0	0.277	0.591	0.824	1.093	1.370	1.220	1.048	0.881	0.710	0.539	0.368	0.195	0
1.0	0.175		0	0.462	0.985	1.374	1.822	2.284	2.034	1.747	1.468	1.183	0.898	0.613	0.326
1.5	0.280			0	0.739	1.576	2.198	2.915	3.654	3.254	2.794	2.349	1.893	1.436	0.980
2.0	0.350				0	0.924	1.971	2.748	3.644	4.568	4.067	3.493	2.937	2.366	1.796
2.5	0.525					0	1.386	2.956	4.121	5.465	6.851	6.101	5.240	4.405	3.549
3.0	0.805						0	2.125	4.532	6.319	8.380	10.505	9.354	8.034	6.754
3.5	2.520							0	6.653	14.188	19.782	26.233	32.886	29.282	25.150
4.0	0.805								0	2.125	4.532	6.319	8.380	10.505	9.354
4.5	0.525									0	1.386	2.956	4.121	5.465	6.851
5.0	0.350										0	0.924	1.971	2.748	3.644
5.5	0.280											0	0.739	1.576	2.198
6.0	0.175												0	0.462	0.985
6.5	0.105													0	0.277
	7.000												68.785		

200-year Peak Surface Flow (m³/s) = 68.79

Table 9 b: Computation of Surface Peak Flow - Unagolla Kandura ib

Hour	Net Rain (cm)	Hour from Origin and Unit Hydrograph Ordinates x (AREA/100) m³/s														
		0	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00	4.40	4.80	5.20	5.50
		0	1.62	3.22	4.84	6.43	8.06	8.11	7.08	6.06	4.97	3.95	2.89	1.84	0.81	0
0.5	0.132	0	0.214	0.425	0.639	0.849	1.064	1.071	0.935	0.800	0.656	0.521	0.381	0.243	0.107	0
1.0	0.220		0	0.356	0.708	1.065	1.415	1.773	1.784	1.558	1.333	1.093	0.869	0.636	0.405	0.178
1.5	0.351			0	0.569	1.130	1.699	2.257	2.829	2.847	2.485	2.127	1.744	1.386	1.014	0.646
2.0	0.439				0	0.711	1.414	2.125	2.823	3.538	3.560	3.108	2.660	2.182	1.734	1.269
2.5	0.658					0	1.066	2.119	3.185	4.231	5.303	5.336	4.659	3.987	3.270	2.599
3.0	1.009						0	1.635	3.249	4.884	6.488	8.133	8.183	7.144	6.115	5.015
3.5	3.157							0	5.114	10.166	15.280	20.300	25.445	25.603	22.352	19.131
4.0	1.009								0	1.635	3.249	4.884	6.488	8.133	8.183	7.144
4.5	0.658									0	1.066	2.119	3.185	4.231	5.303	5.336
5.0	0.439										0	0.711	1.414	2.125	2.823	3.538
5.5	0.351											0	0.569	1.130	1.699	2.257
6.0	0.220												0	0.356	0.708	1.065
6.5	0.132													0	0.214	0.425
	8.775													57.156		

200-year Peak Surface Flow (m³/s) = 57.16

Table 9 c: Computation of Surface Peak Flow - Medagama Oya mb

Hour from Origin and Unit Hydrograph Ordinates x (AREA/100) m^3/s

Hour	Net Rain (cm)	0	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00	4.40	4.80	5.20	5.60	6.00	6.40	7.00	
		0	6.32	12.64	19.28	24.97	32.24	38.57	44.89	44.26	39.51	34.77	35.28	25.60	21.18	16.12	11.38	6.64	0.00	
0.5	0.092	0	0.581	1.163	1.774	2.297	2.966	3.548	4.130	4.072	3.635	3.199	3.246	2.355	1.949	1.483	1.047	0.611	0	
1.0	0.092		0	0.374	0.721	1.128	1.483	1.861	2.239	2.594	2.484	2.268	2.001	1.704	1.466	1.210	0.931	0.599	0.384	0
1.5	0.137			0	0.557	1.074	1.680	2.209	2.772	3.335	3.863	3.698	3.378	2.979	2.538	2.183	1.802	1.386	0.892	0.572
2.0	0.183				0	0.744	1.435	2.244	2.950	3.702	4.454	5.160	4.940	4.512	3.980	3.390	2.916	2.406	1.851	1.192
2.5	0.275					0	1.118	2.156	3.373	4.434	5.564	6.694	7.754	7.424	6.781	5.981	5.094	4.381	3.616	2.782
3.0	0.320						0	1.301	2.509	3.925	5.159	6.474	7.789	9.023	8.639	7.890	6.959	5.928	5.098	4.208
3.5	0.366							0	1.488	2.869	4.489	5.901	7.405	8.908	10.320	9.881	9.024	7.960	6.780	5.831
4.0	0.549								0	2.232	4.304	6.733	8.851	11.107	13.363	15.480	14.821	13.537	11.940	10.170
4.5	0.595									0	2.419	4.665	7.298	9.593	12.037	14.482	16.777	16.063	14.671	12.940
5.0	0.869										0	3.532	6.813	10.658	14.010	17.581	21.151	24.503	23.460	21.427
5.5	2.146											0	8.723	16.825	26.321	34.598	43.416	52.234	60.511	57.933
6.0	0.869												0	3.532	6.813	10.658	14.010	17.581	21.151	24.503
6.5	0.595													0	2.419	4.665	7.298	9.593	12.037	14.482
7.0	0.549														0	2.232	4.304	6.733	8.851	11.107
7.5	0.366															0	1.488	2.869	4.489	5.901
8.0	0.320																0	1.301	2.509	3.925
8.5	0.275																	0	1.118	2.156
9.0	0.183																		0	0.744
9.5	0.137																			0
10.0	0.092																			
10.5	0.092																			
	9.102																			179.872

200-year Peak Surface Flow (m^3/s) = 179.872

Table 9 d: Computation of Surface Peak Flow - Ma Oya mb

	Hour from Origin and Unit Hydrograph Ordinates x (AREA/100) m^3/s														
	Net	0	0.39	0.78	1.17	1.56	1.95	2.34	2.73	3.12	3.51	3.90	4.29	4.68	5.00
Hour	Rain (cm)	0	4.15	8.36	12.51	16.73	20.01	18.05	15.34	12.74	10.11	7.46	4.81	2.11	0
0.5	0.135	0	0.560	1.129	1.689	2.259	2.701	2.437	2.071	1.720	1.365	1.007	0.649	0.285	0.000
1.0	0.225		0	0.934	1.881	2.815	3.764	4.502	4.061	3.452	2.867	2.275	1.679	1.082	0.475
1.5	0.360			0	1.494	3.010	4.504	6.023	7.204	6.498	5.522	4.586	3.640	2.686	1.732
2.0	0.450				0	1.868	3.762	5.630	7.529	9.005	8.123	6.903	5.733	4.550	3.357
2.5	0.675					0	2.801	5.643	8.444	11.293	13.507	12.184	10.355	8.600	6.824
3.0	1.035						0	4.295	8.653	12.948	17.316	20.710	18.682	15.877	13.186
3.5	3.240							0	13.446	27.086	40.532	54.205	64.832	58.482	49.702
4.0	1.035								0	4.295	8.653	12.948	17.316	20.710	18.682
4.5	0.675									0	2.801	5.643	8.444	11.293	13.507
5.0	0.450										0	1.868	3.762	5.630	7.529
5.5	0.360											0	1.494	3.010	4.504
6.0	0.225												0	0.934	1.881
6.5	0.135													0	0.560
	9.000												136.585		

200-year Peak Surface Flow (m^3/s) = 136.59

Table 9 e: Calculation of Surface Peak flow - Maha Oya (Lower) mb

	Hour from Origin and Unit Hydrograph Ordinates x (AREA/100) m^3/s														
	Net	0	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00	4.40	4.80	5.00
Hour	Rain (cm)	0	6.31	12.63	19.03	25.26	29.24	25.35	21.45	17.56	13.67	9.77	5.88	2.08	0
0.5	0.083	0	0.524	1.048	1.579	2.097	2.427	2.104	1.780	1.457	1.135	0.811	0.488	0.173	0.000
1.0	0.139		0	0.877	1.756	2.645	3.511	4.064	3.524	2.982	2.441	1.900	1.358	0.817	0.289
1.5	0.221			0	1.395	2.791	4.206	5.582	6.462	5.602	4.740	3.881	3.021	2.159	1.299
2.0	0.277				0	1.748	3.499	5.271	6.997	8.099	7.022	5.942	4.864	3.787	2.706
2.5	0.415					0	2.619	5.241	7.897	10.483	12.135	10.520	8.902	7.287	5.673
3.0	0.636						0	10.323	20.663	31.133	41.325	47.837	41.473	35.092	28.728
3.5	1.991							0	12.563	25.146	37.889	50.293	58.217	50.472	42.707
4.0	0.636								0	4.013	8.033	12.103	16.065	18.597	16.123
4.5	0.415									0	2.619	5.241	7.897	10.483	12.135
5.0	0.277										0	1.748	3.499	5.271	6.997
5.5	0.221											0	1.395	2.791	4.206
6.0	0.139												0	0.877	1.756
6.5	0.083													0	0.524
	5.533												147.178		

200-year Peak Surface Flow (m^3/s) = 147.18

Table 9 f: Computation of Surface Peak Flow - Mala Oya ib

Name of the Basin	AREA (km^2)	MSL (km)	SAAR (mm)	S1085 (m/km)	RSMD (mm)	SOIL	URBAN	LAKE	STRMFRQ (Junctions/ km^2)
1. Kehelella Ela mb	24.605	13.52	2476.94	55.61	119.19	0.4	0	0	2.32
2. Unagolla Kandura ib	11.655	5.6	2329.11	58.06	113.03	0.4	0	0	2.23
3. Ma Oya mb	63.222	18.9	2617.38	25.79	126.00	0.3	0	0	1.90
4. Medagama Oya mb	8.651	6.88	2391.61	44.30	116.17	0.4	0	0	1.85
5. Maha Oya (Lower) mb	18.052	10.08	2416.67	68.54	117.43	0.4	0	0	3.10
6. Mala Oya mb	25.951	11.04	2181.04	80.89	104.51	0.4	0	0	2.62

Table 10 a: Derived fundamental basin parameters for FSR method

Name of the Basin	T_p (h)	TB (h)	Q_p (m^3/s) for 200 km^2	Q_p (m^3/s) for the Basin	ANSF ($m^3/s/km^2$)	Baseflow for Catchment (m^3/s)	200-year flood peak (m^3/s)	Regional Runoff Coefficient
1. Kehelella Ela mb	2.16	5.5	101.85	25.06	0.092	2.264	194.37	0.0116
2. Unagolla Kandura ib	1.91	5.0	115.18	13.4	0.088	1.026	68.79	0.0133
3. Ma Oya mb	2.94	7.0	74.83	47.31	0.097	6.133	179.87	0.0145
4. Medagama Oya mb	2.16	5.0	101.85	8.81	0.090	0.780	57.16	0.0123
5. Maha Oya (Lower) mb	1.93	5.0	114.00	20.58	0.090	1.625	136.56	0.0120
6. Mala Oya mb	1.90	5.0	115.80	30.05	0.081	2.100	147.18	0.0024

Table 10 b: Summarized results