SOME HYDROLOGICAL ASPECTS OF THE KNUCKLES REGION

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Introduction

Knuckles region is the mountain mass which lies north–east of Kandy and separated from the rest of the Central mountains by Dumbara Valley. The main parts of this region are made up of Knuckles mountain range stretching from Laggala in the north–west to Medamahanuwara in the south–east. There are several high peaks along the length of this range, namely Gombaniya (6248′) the highest, Knuckles (6112′), Kehelpothdoruwegala (6016′), Kirigalpotta (5403′), Dumbangala (5385′), Kalupahana (5341′), Dotulagala (5164′), Wamarapugala (5110′), Telambugala (4368′), and Laggala (4342′), –(Cooray, 1956).

The Knuckles range acts as an effective barrier to both monsoonal winds. Western slopes receive a heavy rainfall with the South– west monsoon and during the North–east monsoon from October to January the whole area receives a very heavy rainfall accompanied by strong winds. The Knuckles region can be identified as the second highest rainfall area in the Mahaweli basin. There are several perennial streams originating from the Knuckles range and it forms a very important catchment area for Mahaweli Ganga Basin. Kalu Ganga in the north, Heen Ganga in the north–east and Hulu Ganga in the south of this region are important tributaries which contribute perennial waters to Mahaweli and its reservoirs.

The gross area of the the Mahaweli Development Scheme is 2.5 million ha. which is approximately 55% of the dry zone and 39% of the total area of the country. The non availability of irrigation water in the quantities needed and the under–utilisation of power station capacities resulting from the reduced dry season water flow and erosion caused siltation of reservoirs will seriously undermine the viability of such an important Irrgiation Project. Therefore it is important to look into the hydrological regime of this region and take necessary steps to conserve the forest vegetation in order to minimise erosion, maintain dry season flow and availibility of water in the reservoirs year around. Now it has been identified that the area above 3500 feet contour and the continuous forest area even below this, which makes the total extent around 22,000 ha. in the Knuckles range (Sketch I) is critical for conservation of the watershed and genetic resources of the region. These areas have to be declared as a forest reserve to provide legal status to afford better protection as an important watershed in the Mahaweli basin.

Geology and Soils

The rocks of the region belong to the Metamorphic Group and are predominantly quartzites, quartz schists and gneisses. Among the rock types commonly found in the region are Garnet – biotite – graphite gneisses, Garnet –sillimanite – granite schists and gneisses Crystalline limestone, Charnockites (Cooray, 1956). The soils in the region are mostly lateritic soils derived in situ from the metamorphic parent rock. They are generally well drained and deep except in places associated with steep terrain. The forest soils are

mostly dark brown with considerable humus accumulation in the wet montane forest zone (Rosayro, 1958).

Catchment Areas and Drainage Pattern

The main features of the drainage and catchment areas are shown in sketch II. There are several rivers draining the Knuckles region. They are :

(a) Kalu Ganga, which drains the northern section of the region flows in the direction of south to north. This forms the chief headwater stream of the Amban Ganga which is one of the major tributaries of the Mahaweli Ganga. The drainage basin of Kalu Ganga is confined mainly to the montane zone of the Knuckles region, generally over 4000' elevation. Halmini Oya and Karamana Oya form major tributaries of this river. Wamarapugala – Kalupahana ridge from the east, Selvakanda plateau from south and south–west and Kirigalpotta from the west demarcate the boundary of the Kalu ganga catchment, which covers approximately around 30% of the total area of the Knuckles region.

(b) Heen ganga drains the eastern section of the region and flows in the direction south to north–east. The main stream of this river is Maha Oya of which the upper reaches is known as Karambakktiya Oya. Head waters of Meemare Oya which is also a tributary of Heen ganga originate from Kalupahana ridge and it is separated from Kalu ganga by a distance of only 500 yards. Kalu ganga originates from the western slope of Kalupahana ridge and Meemare Oya from the eastern slope of the ridge. Other tributaries of Heen Ganga are Kakaliwatta Oya and Rawana Oya. Ridges of Kalupahana, Knuckles, Dumbanagala and peaks of Laggala and Kehelpothdoruwegala mark the boundary of the Heen Ganga catchment. These areas also cover approximately around 30% of the area of the Knuckles region.

(c) Head waters of Hulu Ganga are a number of small streams including Kota Ganga and Hini Oya. These streams drain the western face of the Knuckles region and flow in the general direction of South–west. The main ridge of mountains Kirigalpotta, Gombaniya and Knuckles running NW–SE forms the northern and eastern boundary of the drainage area of tributaries of Hulu Ganga. This drainage area covers about 35% of the total area of the region.

(d) Teligam Oya is another small stream originating from the Knuckles range. This forms the headwaters of Kambarawa Ganga which is a tributary of Amban Ganga.

The streams which originate from the main Knuckles range generally over 3500 feet elevation within the wet montane forests, are perennial and other streams which originate at lower elevations are seasonal.

Hydrological Importance of the Knuckles region

The Knuckles region has been identified as one of the most critical watersheds which requires immediate attention. The first interim report of the Land Commission of 1985 has specifically identified the Knuckles region as one of the major source regions of water for river systems in this country and the report recommends formulation of a Watershed Management Master Plan which should pay special attention to the conservation of stream source areas of Knuckles range and other identified areas. Hydrological importance of the Knuckles region can be discussed under the following headings :

(a) High Intensity Rains and the Steep Terrain

The rainfall distribution in the region exhibits a marked seasonal variation. Western slopes receive a heavy rainfall between May and August with the South–west monsoon. During the North–east monsoon from October to January northern slopes receive more rain but the whole region receives a very heavy rainfall accompanied by strong winds. Generally, these rains are of high intensities with a capacity to cause serious erosion problems. The mean annual rainfall of three major catchment areas in the region are given below (Madduma Bandara, 1985) :

Table 1

River Catchment	Mean Annual Rainfall (m.m.)	Mean no. of Rainy Days per Year
Hulu Ganga	3031.9	183
Kalu Ganga	2724.6	184
Heen Ganga	4281.9	184

In 1971, Madduma Bandara identified five hydrological regions of the Upper Mahaweli Basin based on the relationship between mean annual flood and the catchment area (sketch III). This classification provided an indicator of the rainfall and stream flow of the region. According to this classification, the Knuckles region comes under the category of Hydrological type 2 which is the second rainiest region in the Mahaweli Basin. Mean annual rainfall at gauging stations such as St. Martins (4470 m.m.) in the Knuckles range comes second only to Watawala, the rainiest part of the country.

As indicated earlier, the topography of the region is a rugged hill mass rising up to 6248 feet MSL forming a very steep terrain. This steep terrain together with high intensity rains makes the Knuckles region one of the most critical watersheds in the country.

The relationship of factors controlling soil erosion has been identified as :

A = RKSTCP (Universal Soil loss Equation)

A = Soil loss
R = Rainfall factor
K = Soil erodability factor
S.T = Slope length and gradient factor
C = Vegetative factor
P = Soil conservation

Among these factors affecting soil erosion we have very little or absolutely no control over factors such as rainfall, soil erodibility and slope. Only factors that we can alter are vegetation and soil conservation which we can consider together as land use. Therefore it is evident that in the face of high erosive rains and very steep terrain in the Knuckles region the only solution to the problem of erosion is a suitable land use system to protect the soil from erosive rains.

(b) As a Catchment Area of Victoria Reservoir

The useful storage capacity of Victoria reservoir is 698 MCM which could provide 210 MW of Hydro electric power and irrigation requirements for the development of 70,000 ha. of new lands in systems B and C. The total drainage area of the reservoir upstream of Victoria falls is 1891 sq.kilo metres of which Hulu Ganga catchment forms approximately around 9%. As indicated earlier, the drainage area of this river in the Knuckles region together with heavy rainfall provides a significant contribution to the waters of the Victoria reservoir. Hence it is important to protect the source areas of waters of Hulu Ganga in order to reduce siltating of the reservoir and maintain the requirements of water for irrigation and hydropower, particularly in the dry season.

(c) As a Catchment Area of the Proposed Reservoirs under the Mahaweli Project

Now that most of the work on the accelerated Mahaweli Programme has been completed, there are still a number of projects in the Mahaweli Development proposals which can be taken up for development. Two proposed Projects which associate with the Knuckles watershed are :

(a) Kalu Ganga Project : Irrigation and Hydropower Project, — Reservoir capacity 208,000 ac ft.

(b) Heen Ganga Multi–purpose Project : — Irrigation and Hydropower Project

When these projects are completed, the Knuckles region will form the major catchment area of the proposed two reservoirs.

Some Hydrological Aspects of Major River Basins in the Knuckles Region

Hydrology Division of the Irrigation Department had maintained stream gauging stations at Teldeniya, Uduwelwala and Wellewela to collect stream flow data from Hulu Ganga, Heen Ganga

and Kalu Ganga respectively. Stream flow data had been collected from these gauging stations only for a few years and are not functional at present.

(A) A summary of hydrological data collected from these stations is given below :

Table 2

Stream and Station	Catchment Area (km^2)	Mean ann. Runoff (m.m.)	Mean ann. Runoff rainfall ratio	Mean ann. Runoff (mcm)*
1. Hulu Ganga (Teldeniya)	160.58	1481.58	48.86	237.91
2. Kalu Ganga (Wellewala)	194.25	1636.77	60.07	317.94
3. Heen Ganga (Uduwelwala)	115.25	2357.88	55.06	271.75

Source : Some Aspects of the Hydrology of the Upper Mahaweli Basin – Madduma Bandara, 1985.
* Calculated by the Author (M C M –Million Cubic Metres)

Please see Table 1 for rainfall data.

Following observations were made from the data given above:

(a) Among the three catchments, Kalu Ganga has the largest catchment area out of which about 35–40% lies within the Knuckles region.

(b) Kalu Ganga carries the maximum volume of water among the three rivers originating from the Knuckles region.

(c) Greater Run off – Rainfall ratio indicates a relatively poor vegetative cover in the Kalu Ganga basin.

(B) Kalu Ganga gauging station at Wellewela was funcational from 1960 – 72. The data from this station was obtained from the Hydrology Division of the Irrigation Department and the following observations were made after analysing the data :

(a) Runoff – rainfall ratios calculated from annual values are considered as an indicator of land degradation. Runoff – rainfall ratio for the 10 year period from 1960 – 70 exhibits a gradual increase which is a clear indication of the land degradation in the upper catchment areas of Kalu Ganga within this period (Table 4). However, the annual stream flow during the period has ranged between 49% – 73% of the annual rainfall. (Mean annual value was around 60%).

(b) There is a marked seasonal variation in the stream flow with a maximum of 92.4 million cubic metres (MCM) in January and a minimum of 1.93 MCM in August (Table 3). Wet flow (October–April) contributed about 93.5% of the total flow, and the dry flow contribution (May) was only 6.5% of the total. This variation in stream flow and extremely high Runoff – rainfall ratios from December – February can be attributed to degradation of land in the catchment and high north–east monsoonal rains during the period of low evapotraspiration. Evapotraspiration during this period is significantly low due to the low temperature and sunshine hours at high altitudes in the Knuckles range. However, if the forest vegetation in source areas of water is protected and enriched, the dry flow can be significantly improved as a result of increased infiltration capacities of soils in the catchment area [Chunkao (1986), Coleman (1953)].

Recommendations

I – The Knuckles region is one of the most critical watersheds in Sri Lanka which requires immediate steps for conservation of soil and water and other environmental conditions. As indicated, a considerable amount of degradation has already taken place in this region and further degradation may lead to serious environmental and irrigation problems. Hence it is suggested that immediate steps should be taken to conserve the forests in the Knuckels region.

II – Appropriate soil conservation methods should be adopted in all arable lands including

tea plantations in the higher altitudes particularly over 3500 feet MSL. Strict implementation of the -Soil Conservation Act within the critical areas of the Knuckles region is necessary to achieve this objective.

III – Some action has to be taken to control indiscriminate felling in the privately owned forests in higher altitudes (over 3500 feet MSL) of this region.

IV – Finally, it is recommended that hydrological studies be carried out in this region to develop a better understanding of the distribution and disposal of water and process of soil erosion in the Knuckles watersheds.

Table 3

Kalu Ganga
Mean Monthly Data – Runoff and Rainfall

Month	Mean Rainfall (M.M.)	Mean Rainfall (M.C.M.)	Mean Runoff (M.C.M)	Runoff as a % of Total	Runoff/Rainfall Ratio
January	413.33	80.29	92.40	28	1.15
February	307.39	59.71	60.65	18	1.02
March	136.30	26.48	24.20	7	0.91
April	211.96	41.17	18.53	6	0.45
May	94.31	18.32	11.90	4	0.65
June	82.58	16.04	3.34	1	0.21
July	79.12	15.37	2.24	0.7	0.15
August	109.58	21.29	1.93	0.6	0.09
September	114.38	22.22	1.98	0.6	0.09
October	293.34	56.98	6.13	2	0.11
November	431.22	83.76	30.53	9	0.36
December	479.09	93.06	75.50	23	0.81

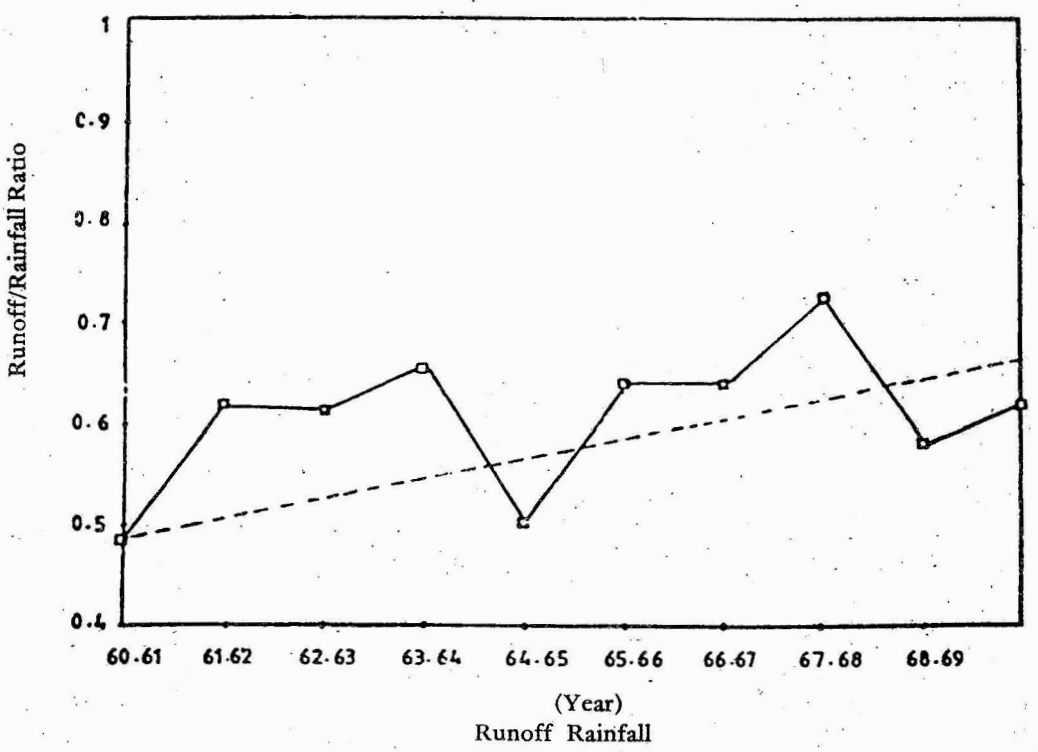
% to annual rainfall – 60
% evapotraspiration – 40
Wet flow % – 93.5 (October – April)
Dry flow % – 6.5 (May – September)

Table 4

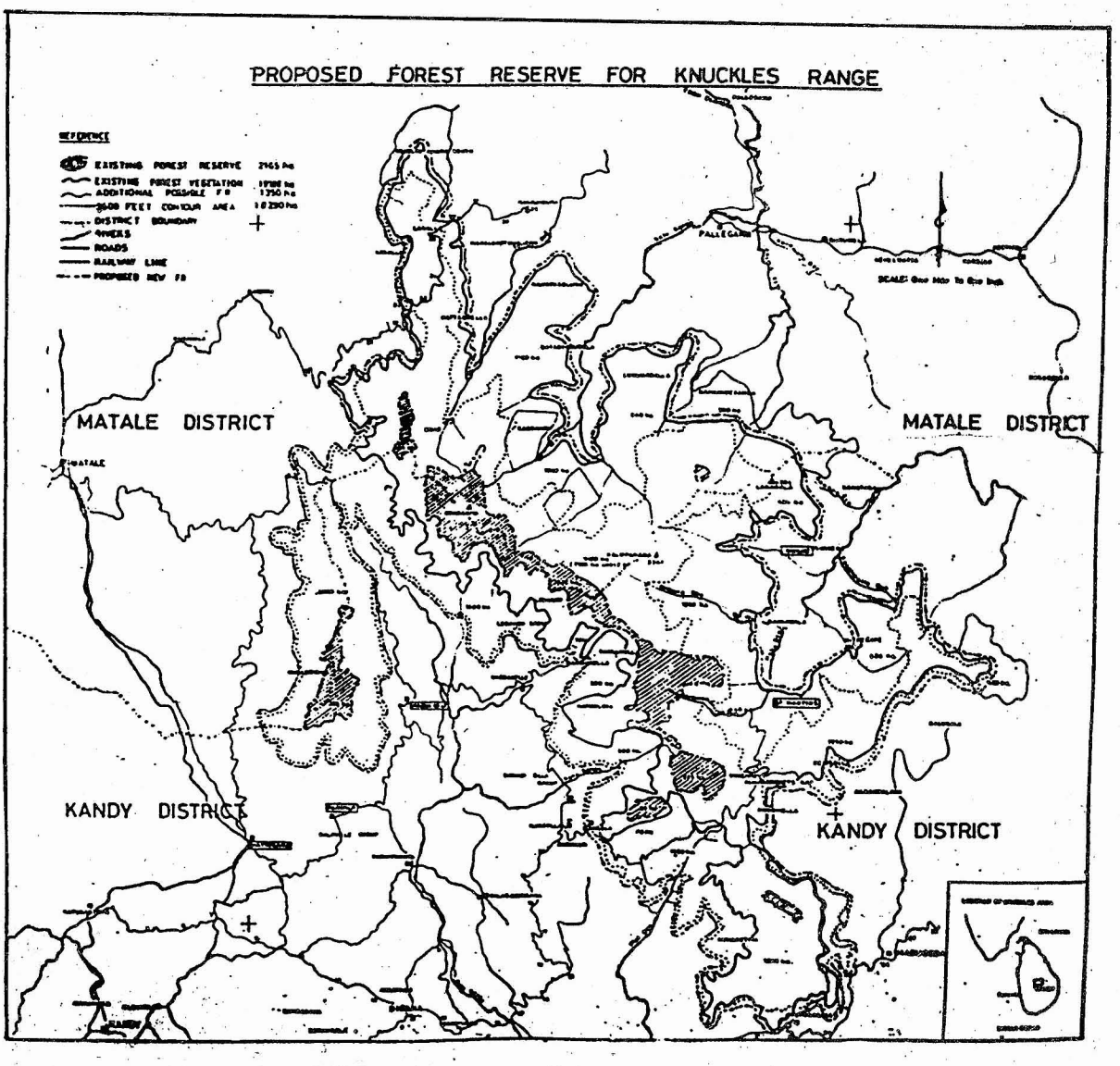
Runoff Rainfall Ratio – Kalu Ganga

Year	Rainfall (M.M.)	Rainfall (MCM)	Runoff Volume (MCM)	Runoff/Rainfall Ratio
60–61	2377.17	461.77	225.16	0.49
61–62	3232.90	627.99	390.46	0.62
62–63	3342.38	649.26	399.68	0.62
63–64	3145.52	611.02	403.90	0.66
64–65	2325.62	451.75	228.63	0.51
65–66	2340.36	454.61	293.32	0.65
66–67	2308.60	448.45	288.93	0.64
67–68	2744.71	533.16	389.40	0.73
68–69	2613.68	507.71	298.26	0.59
69–70	3094.99	601.20	375.50	0.62

Runoff/Rainfall Ratio – Kalu Ganga

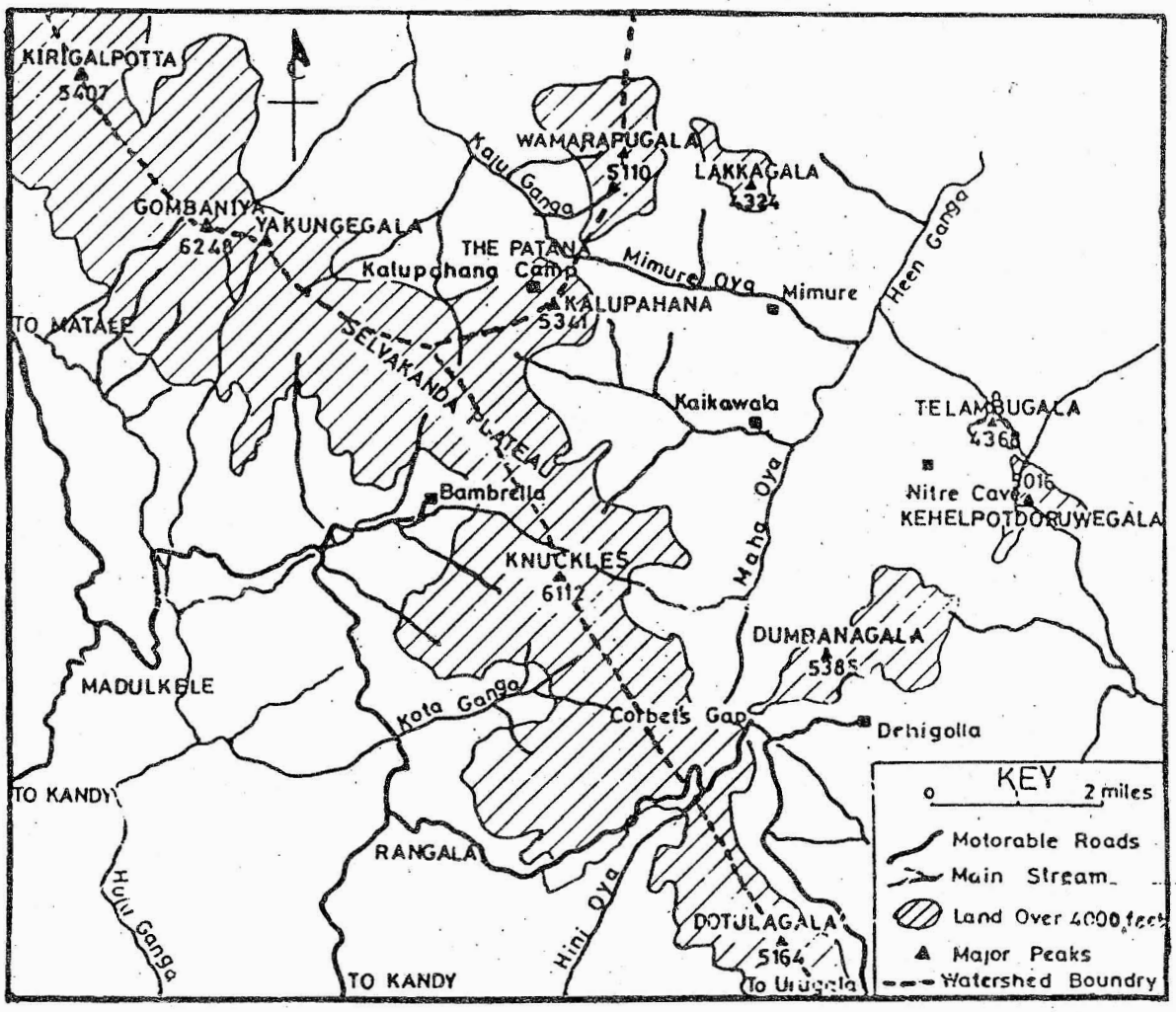


Sketch I


PROPOSED FOREST RESERVE FOR KNUCKLES RANGE
MATALE DISTRICT
MATALE DISTRICT
KANDY DISTRICT
KANDY DISTRICT

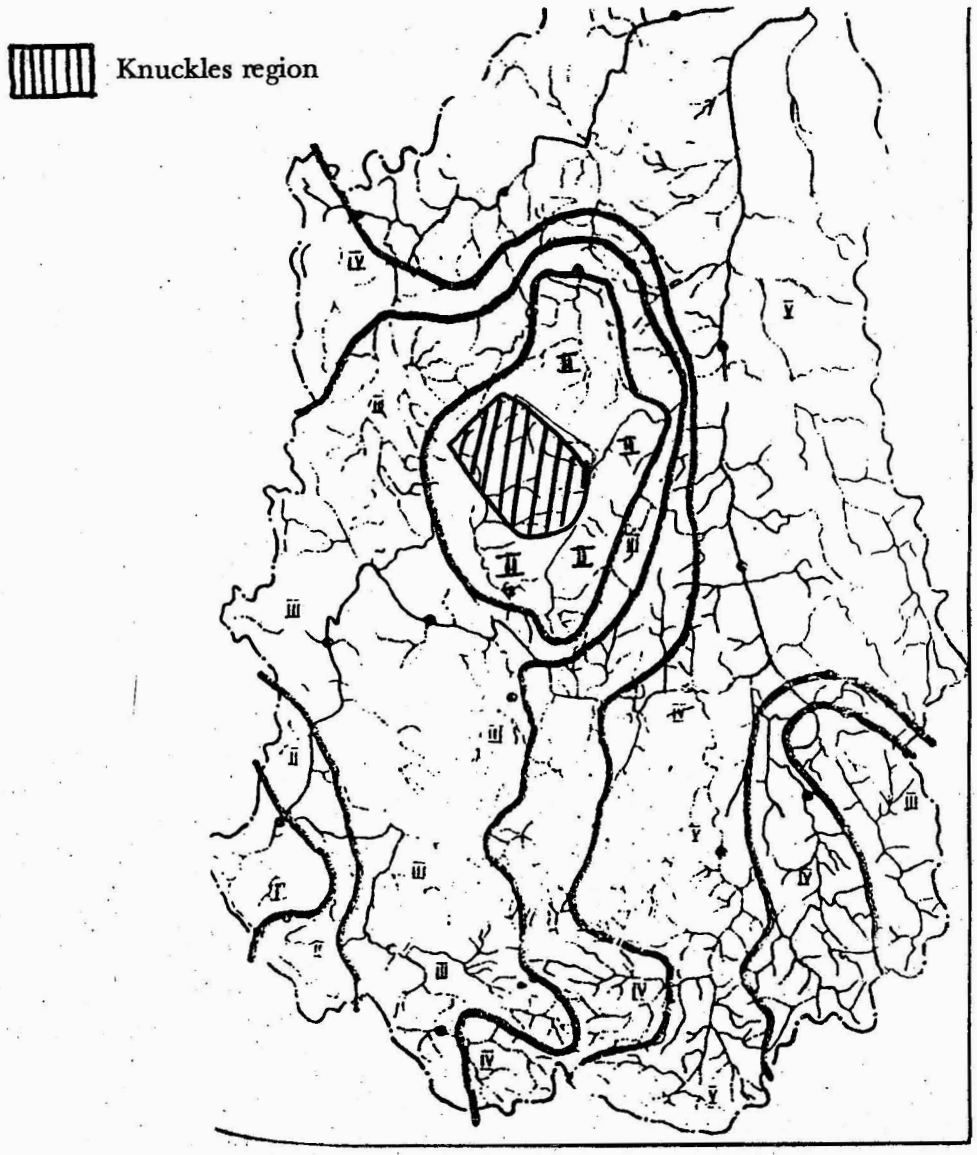
Sketch II

SKETCH MAP OF THE KNUCKLES REGION SHOWING MAJOR CATCHMANT AREAS



Sketch III

Division of Upper Mahaweli Basin in to Hydrological Regions



Source : Madduma Bandara (1985)