Microhydro Power

Schemes in

Sri Lanka
MICROHYDRO POWER SCHEMES
IN SRI LANKA

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October 1982
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Introduction

This report describes an assessment of the river flow characteristics at two proposed microhydro sites in South West Sri Lanka. The most northerly site (Figure 1) is at the Alupolla tea factory (80°32' E, 6°42' N) about 20 kilometres east of Ratnapura at an altitude of 605 m. The catchment area draining to the site is 18.4 km². The other site is at (6°22' N, 80°32' E) located approximately 40 kilometres south east of Ratnapura at an altitude of 305 m. It has the smaller catchment area of 5.3 km². Both sites are ungauged and it has been necessary to infer the streamflow hydrograph from the flow characteristics of gauged catchments in the region. The study is based on data published by the Irrigation Department of Sri Lanka¹ and rainfall and daily flow data collected by the Intermediate Technology Development Group.

The flow duration curve (cumulative frequency diagram) has been used to summarise the discharge characteristics of each site. Average discharge has been estimated from the long term annual average catchment rainfall and a regional rainfall runoff relationship. The seasonal distribution of flows has been investigated by studying the average number of days in each month when the daily discharge is below a given threshold. The report concludes with a discussion of the errors in the estimation and recommendations as to how they may be reduced by further data collection and analysis. Metric units are used throughout the report with the exception of Figure 7 where the published units of acre feet per square mile are used (1 acre ft/sq ml = 0.476 mm).

Available Data

Details of the gauging stations used in this report and the available flow data are summarised in Table 1. Each station has been assigned a reference number. Three years of average daily flow data was available at each of five stations and eighteen years of average monthly flow data at a further two stations. The location of these gauges, their catchment boundaries, and those of the two proposed microhydro sites are shown in Figure 1. The daily flow data for each station was listed by computer as shown in Table 2 (Sitawaka Ganga (01)
Figure 1. CATCHMENT AND RAINGAUGE SITES

- Rain gauge
- Gauging station
- Microhydro catchments
- Gauged catchments (daily flow data)
- Gauged catchments (monthly data)

Scale

Kms

0 10 20 30
<table>
<thead>
<tr>
<th>Ref. No.</th>
<th>Gauging Station</th>
<th>Location</th>
<th>Area (Km²)</th>
<th>Data interval</th>
<th>Record length</th>
<th>Average annual runoff (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Sitawaka Ganga at Deraniyagala</td>
<td>80° 20' E 6° 55' N</td>
<td>154</td>
<td>Daily</td>
<td>Oct 1974 - Sept 1977</td>
<td>4218</td>
</tr>
<tr>
<td>03</td>
<td>Maskeli Oya at Laxapana</td>
<td>80° 31' E 6° 53' N</td>
<td>154</td>
<td>Daily</td>
<td>Oct 1966 - Sept 1969</td>
<td>4240</td>
</tr>
<tr>
<td>04</td>
<td>Gin Ganga at Jesmin Dam</td>
<td>80° 19' E 6° 20' N</td>
<td>377</td>
<td>Daily</td>
<td>Oct 1978 - Sept 1981</td>
<td>1952 *</td>
</tr>
<tr>
<td>05</td>
<td>Nilwala Ganga at Bingamahara</td>
<td>80° 28' E 6° 04' N</td>
<td>333</td>
<td>Daily</td>
<td>Oct 1975 - Sept 1979</td>
<td>1666 *</td>
</tr>
<tr>
<td>06</td>
<td>Mahaweli Ganga at Gurudeniya</td>
<td>80° 40' E 7° 16' N</td>
<td>1417</td>
<td>Monthly</td>
<td>Oct 1956 - Sept 1975</td>
<td>1736</td>
</tr>
<tr>
<td>07</td>
<td>Uma Oya at Thalawakanda</td>
<td>80° 58' E 7° 0' N</td>
<td>505</td>
<td>Monthly</td>
<td>Jan 1958 - Oct 1975</td>
<td>663</td>
</tr>
</tbody>
</table>

**Microhydro sites**
- Alupolla 80° 32' E 6° 42' N
  - 18.4
- Beverley 80° 32' E 6° 22' N
  - 5.3

* estimated from Figure 7.
in 1975) and each year of record was plotted as an annual hydrograph (see Figures 2.1 to 2.5). These plots assisted in the quality control of data prior to analysis.

The available rainfall data, in the form of monthly and annual totals, was limited to seven gauges each with an average of nine years of record. The location of the gauges is shown in Figure 1, and their annual rainfall totals summarised in Table 3.

In addition long term annual average rainfall and average runoff data was extracted from published records for some 70 stations and used to derive a simple rainfall runoff relationship for Sri Lanka. This is shown in Figure 3; units are as published, namely acre feet/square mile and inches, but can easily be converted to mm using the scales provided. The data set includes three stations with daily flow data, and it can be seen that one of these, the Maskeli Oya (03) plots as a distinct outlier. The abnormally high average runoff from this catchment (in some years exceeding rainfall), probably results from the presence of a large reservoir and associated imports of water by catchwaters from adjacent catchments. This catchment is therefore considered unsuitable for deriving the natural flow regime at the two microhydro sites.

Catchment characteristics were derived in order to compare the topography of the gauged catchments with the Alupalla and Beverley catchments and these are summarised in Table 4. The catchment area, length of longest stream, and the slope along this stream length (expressed as m/km), were extracted from 1 inch to 1 mile topographic maps. The dominant soil types in each catchment were assessed from the 8 miles to 1 inch scale soil map of Sri Lanka. The dominant soils are podzols associated with hilly and rolling terrain, although in the Sitawaka Ganga (01) and Maskeli Oya (03) catchments very steep rockland is present. An overall index of the flow regime at each of the five catchments was provided by the baseflow index. This index is calculated from the mean daily flow hydrograph and represents the proportion of baseflow or slow response runoff.
Figure 2.1  SITAWAKA GANNA AT DERANINYAGALA
            ANNUAL HYDROGRAPH  1975
Figure 2.3
MASKELI OTA AT LAXAPANA
ANNUAL HYDROGRAPH 1968

Daily Flow Cumes
Figure 2-4  GIN GANGA AT JESMIN DAM

ANNUAL HYDROGRAPH  1979
Figure 3. RAINFALL RUNOFF RELATIONSHIP FOR SRI LANKA

Annual average rainfall

Stations with flow data
### TABLE 3 RAINFALL DATA

**Annual rainfall (mms)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Alupolla</th>
<th>Ratnapura</th>
<th>Pelmadura</th>
<th>Hapugaseme</th>
<th>Panilkanda</th>
<th>Anningkanda</th>
<th>Dependene</th>
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<tbody>
<tr>
<td>1966</td>
<td>6709</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1967</td>
<td>4173</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1968</td>
<td>4791</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1969</td>
<td>3756</td>
<td></td>
<td></td>
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<tr>
<td>1970</td>
<td>3840</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1971</td>
<td>4342</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1972</td>
<td>4844</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1973</td>
<td>3437</td>
<td>3008</td>
<td>3353</td>
<td>3880</td>
<td>2940</td>
<td>3231</td>
<td>2894</td>
</tr>
<tr>
<td>1974</td>
<td>3827</td>
<td>3905</td>
<td>3421</td>
<td>5315</td>
<td>1752</td>
<td>2403</td>
<td>2373</td>
</tr>
<tr>
<td>1975</td>
<td>4275</td>
<td>4675</td>
<td>4020</td>
<td>6560</td>
<td>-</td>
<td>4295</td>
<td>2925</td>
</tr>
<tr>
<td>1976</td>
<td>2983</td>
<td>3380</td>
<td>2696</td>
<td>3984</td>
<td>-</td>
<td>2634</td>
<td>2129</td>
</tr>
<tr>
<td>1977</td>
<td>3201</td>
<td>3579</td>
<td>2991</td>
<td>4257</td>
<td>-</td>
<td>3334</td>
<td>2275</td>
</tr>
<tr>
<td>1978</td>
<td>3733</td>
<td>3743</td>
<td>4437</td>
<td>5095</td>
<td>-</td>
<td>3895</td>
<td>2523</td>
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<tr>
<td>1979</td>
<td>3237</td>
<td>3491</td>
<td>3009</td>
<td>4836</td>
<td>2714</td>
<td>3219</td>
<td>3217</td>
</tr>
<tr>
<td>1980</td>
<td>3043</td>
<td>3271</td>
<td>2338</td>
<td>3813</td>
<td>2783</td>
<td>2720</td>
<td>2910</td>
</tr>
<tr>
<td>1981</td>
<td>3742</td>
<td>3098</td>
<td>2233</td>
<td>4135</td>
<td>2581</td>
<td>2678</td>
<td>2309</td>
</tr>
</tbody>
</table>

**Annual average (mms)**

|        | 4027 | 3572 | 3166 | 4653 | 2704 | 3157 | 2617 |

**Long term annual average (mms)**

|        | $3453^1$ | $3861^2$ | $3422^1$ | $5030^1$ | $3362^2$ | $3413^1$ | $2829^1$ |

Based on adjusting short term rainfall using long term rainfall from Ratnapura gauge

*From Year Book*
<table>
<thead>
<tr>
<th>Catchment Number</th>
<th>Area (Km$^2$)</th>
<th>Main Stream length (Kms)</th>
<th>Slope (m/Km)</th>
<th>BFI</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>154</td>
<td>22.7</td>
<td>72.4</td>
<td>0.462</td>
<td>28% steep rockland; 72% red yellow podzolic soils on steep hilly terrain.</td>
</tr>
<tr>
<td>02</td>
<td>220</td>
<td>41.0</td>
<td>13.5</td>
<td>0.469</td>
<td>98% red yellow podzolic and mountain soils on steep hilly terrain.</td>
</tr>
<tr>
<td>03</td>
<td>154</td>
<td>24.0</td>
<td>45.8</td>
<td>0.543</td>
<td>25% steep rockland; 75% red, yellow podzolic soils on steep hilly terrain.</td>
</tr>
<tr>
<td>04</td>
<td>377</td>
<td>49.7</td>
<td>22.9</td>
<td>0.494</td>
<td>45% red yellow podzolic soils on steep, hilly terrain; 55% podzolic soils on rolling terrain.</td>
</tr>
<tr>
<td>05</td>
<td>333</td>
<td>43.8</td>
<td>17.0</td>
<td>0.437</td>
<td>98% red yellow podzols on steep, hilly terrain.</td>
</tr>
<tr>
<td>Alupolla</td>
<td>18.4</td>
<td>7.6</td>
<td>76.1</td>
<td></td>
<td>100% red yellow podzolic soils on steep hilly terrain.</td>
</tr>
<tr>
<td>Beverley</td>
<td>5.3</td>
<td>3.6</td>
<td>129.5</td>
<td></td>
<td>100% red yellow podzolic soils on rolling terrain.</td>
</tr>
</tbody>
</table>
Estimation of flow duration curves

Figures 4.1 to 4.5 show the flow duration curves for each of the five gauged catchments. Discharge, expressed as a percentage of the average daily flow (ADF) is plotted on a logarithmic scale and frequency on a normal probability scale. (Thus if the data plots as a straight line the daily flow data has a log-normal frequency distribution). From each figure the discharge exceeded for a given percentage of the time can be estimated. For example, Figure 4.1 indicates that for 90% of the days on record the discharge will be greater than 7% ADF, or conversely, that the discharge will be less than this rate for 10% of the time or on average 37 days each year. The 10 day curve on Figure 4.1 is derived from passing a 10 day moving average through the daily flow data. The curve thus shows the proportion of 10 day periods when the average flow is above a given discharge.

A comparison of Figures 4.1 - 4.5 indicates that station (01), the Sitawaka Ganga, has the greatest flow variability with the one day 95 percentile discharge (Q95) equal to 6% ADF. The equivalent discharge for the Way Ganga (02) and Maskeli Oya (03) is 16% ADF and 15% ADF with the Gin Ganga (04) and Nilwala Ganga (05) having the least variability with Q95 equal to 23% ADF and 21% ADF respectively. An analysis of the flow duration curves for individual years showed a small between year variation and gave greater confidence in interpreting these results. In order to test how representative the short (and different) periods of records were of the long term flow variability, the analysis was extended by deriving monthly flow duration curves for the two monthly flow stations with 18 years of data (Table 1). Figure 5 shows a comparison of these two monthly curves with the five curves derived by passing a 30 day moving average through the daily flow data (equivalent to calendar month curves). The close agreement between the curves suggests a general similarity in the pattern of flows over this region. This is further confirmed by the small variation in the base flow indices (Table 4) for the five catchments.
Figure 4.1
FLOW DURATION CURVE - SITAWAKA GANGA [01]

PERCENTAGE OF TIME DISCHARGE EXCEEDED

<table>
<thead>
<tr>
<th>STATION</th>
<th>YEAR</th>
<th>START</th>
<th>FIN</th>
<th>AVERAGE</th>
<th>AVERAGE DAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>1974</td>
<td>1977</td>
<td>18.793</td>
<td>18.793</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>1974</td>
<td>1977</td>
<td>18.793</td>
<td>18.450</td>
<td>10</td>
</tr>
</tbody>
</table>

PERCENTAGE OF AVERAGE DISCHARGE
Figure 4.2
FLOW DURATION CURVE - WAY GANGA [02]

<table>
<thead>
<tr>
<th>STATION</th>
<th>YEAR START</th>
<th>YEAR GIVEN</th>
<th>SAMPLE NO.</th>
<th>AVERAGE DAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1978</td>
<td>1981</td>
<td>12.898</td>
<td>1</td>
</tr>
</tbody>
</table>

PERCENTAGE OF AVERAGE DISCHARGE

PERCENTAGE OF TIME DISCHARGE EXCEEDED
Figure 4.3

FLOW DURATION CURVE - MASKELI OYA [03]

STATION YEAR START YEAR GIVEN SAMPLE NO. OF AVERAGE AVERAGE DAYS
0 3 1966 1969 26.695 26.695 1
Figure 4.4
FLOW DURATION CURVE - GIN GANGA

<table>
<thead>
<tr>
<th>Station</th>
<th>Year</th>
<th>Year Given</th>
<th>Sample No. of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1978</td>
<td>1981</td>
<td>37.35:137.35:1</td>
</tr>
<tr>
<td></td>
<td>1978</td>
<td>1981</td>
<td>37.35:137.30:10</td>
</tr>
</tbody>
</table>

PERCENTAGE OF AVERAGE DISCHARGE

PERCENTAGE OF TIME DISCHARGE EXCEEDED
Figure 4.5
FLOW DURATION CURVE - NILWALA GANGA [05]

STATION YEAR YEAR GIVEN SAMPLE NO. OF
START FIN AVERAGE AVERAGE DAYS

○ 5 1975 1979 15.0 11 15.0 11 1
△ 5 1975 1979 15.0 11 14.8 35 10

PERCENTAGE OF TIME DISCHARGE EXCEEDED

PERCENTAGE OF AVERAGE DISCHARGE

0.0 0.05 0.1 0.2 0.5 1 2 5 10 20 30 50 60 70 80 90 95 99 99.3 99.9 99.99 99.999

0.01 0.001 0.0001 0.00001
The estimation of the most appropriate curve to use at each microhydro site is difficult because of the small number of flow records analysed, their relatively short record and their very small catchment areas in relation to the gauged catchments. With such small catchments local hydrogeological conditions (for example the presence or absence of a spring line) can have a marked control on the natural flow regime of a catchment. Such features cannot be identified in a preliminary desk study and require site investigations.

Comparison of the catchment characteristics of the gauged and ungauged catchments can however assist in selecting the most appropriate analogue catchment from which the flow regime of the ungauged site can be estimated.

It is considered that the Sitawaka Ganga (01) and Maskeli Oya (03) are unsuitable analogue catchments for Alupolla. Flows at the Sitawaka Ganga show a much greater variability than other catchments (Figure 5) and this is thought to reflect the large area of bare rock (Table 4), not present at either Alupolla or Beverley. This increases the rapid response flood runoff and reduces the available natural soil water storage which maintains low flows in dry weather. The Maskeli Oya (03) was rejected as flows are affected by artificial controls. The Way Ganga (02) is recommended as the best analogue for Alupolla due to its similar soil type and close geographical location. The Gin Ganga (04) (which encloses the Beverley site) and Nilwala Ganga (05) have very similar flow duration curves, and either of them would be suitable analogues for the Beverley site.

Both microhydro sites are however on small and steep headwater tributaries where the flow regime may be expected to show greater variability than the larger gauged catchments. This has been allowed for by steepening the 'best' analogue curves by an amount equivalent to a reduction in discharge of 5% ADF at the 95 percentile frequency. The final curves to use for Alupolla and Beverley are shown on Figure 6.
Figure 6
FLOW DURATION CURVES FOR MICRONHYDRO SITES

Beverley
Alupolla


Estimation of average discharge

In order to scale the flow duration curves derived for the Beverley and Alupolla catchments (Figure 6) it was necessary to obtain an estimate of the average discharge at each site.

Two approaches were possible. Firstly the annual average runoff for each catchment could be obtained directly from a runoff map, produced by the Irrigation Department, Sri Lanka\(^1\) and reproduced here as Figure 7. This annual value could then be simply converted to an average discharge. The runoff isolines are expressed in acre feet/square mile (1 acre foot/sq. mile = 0.476 mms). A second approach is to obtain an estimate of the annual average rainfall for each catchment and use the rainfall runoff relationship in Figure 3 to give an annual runoff value, which could be converted to an average daily flow as before. The second of the two approaches was preferred, since it was felt that the runoff map was insufficiently detailed to allow accurate interpolation to small catchment areas and did not make use of local rainfall data.

With the exception of the Alupolla raingauge, only nine years of rainfall data was available at each gauge on which to base an estimate of the annual average rainfall (Table 3). Comparison with longterm averages based on a 50 year record was possible for two raingauges at Ratnapura and Pannilkanda using a climate map of Ceylon\(^4\), and revealed that short term values were lower than the long term averages. The short term averages were therefore adjusted on the basis of the Ratnapura gauge, as shown in Table 3.

This data is plotted on Figure 8, together with isohyets of annual average rainfall. In view of the relatively sparse raingauge coverage, use was also made of a detailed rainfall map for the Mahaweli Ganga basin\(^5\), located just north of the study area. This map enabled the general trends of the isohyets to be established with greater confidence.
Figure 8. ISOHYETAL MAP

Rain gauge with mean annual rainfall in mm's

Scale

0 5 10 15 Kms

Beaverley

Alupella
Table 5 shows the average annual rainfall for each catchment, and the average daily flows in cumecs calculated using Figure 3.

Table 5 AVERAGE RUNOFF FOR MICROHYDRO SITES

<table>
<thead>
<tr>
<th>Site</th>
<th>Average annual rainfall (mms)</th>
<th>Average annual runoff (mms)</th>
<th>Average daily flow (cumecs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alupolla</td>
<td>4000</td>
<td>2689</td>
<td>1.568</td>
</tr>
<tr>
<td>Beverley</td>
<td>3500</td>
<td>2166</td>
<td>0.364</td>
</tr>
</tbody>
</table>

Seasonal variation

The seasonal variation in discharge was examined by calculating the average number of days in each calendar month when the discharge was below Q50, Q70 and Q90. Figures 9.1 - 9.5 illustrate the results of this analysis. A comparison of the histograms and Table 1 suggests that the catchments with the highest annual average runoff depth (Sitawaka Ganga, (4218 mm) and Maskeli Oya, (4240 mm)) have the greatest proportion of low flows in January to March. The drier catchments (May Ganga, (1301 mm) and Nilwala Ganga, (1663 mm)) have a more even distribution with the peak number of low flows occurring in both January to March and July to October.

Given this link between the seasonal flow distribution and runoff depth the station having the nearest annual average runoff depth to Alupolla and Beverley was used to indicate the seasonal variation in runoff. Thus Figure 9.3 is proposed as the best indicator of the seasonal variation of the number of days below the given threshold discharges. From this figure it can be seen for example that on average there are 33 days when the flow is below Q90 between January
MONTHLY DISTRIBUTION OF FLOWS LESS THAN GIVEN THRESHOLD DISCHARGE

Figure 9.1

SITAWAKA GANGA AT DERANIYAGALA [01]

Threshold Discharges

- Q 50
- Q 70
- Q 90

Average no. of days/month

Figure 9.2

MASKELI OYA AT LAXAPANA [03]

Average no. of days/month
MONTHLY DISTRIBUTION OF FLOWS LESS THAN GIVEN THRESHOLD DISCHARGE

**Figure 9.3**

**GIN GANGLA AT JESMIN DAM [04]**

Threshold Discharges

- Q 50
- Q 70
- Q 90

**Figure 9.4**

**NILWALA GANGLA AT BINGAMAHARA [05]**
MONTHLY DISTRIBUTION OF FLOWS LESS THAN GIVEN THRESHOLD DISCHARGE

Figure 9.5

WAY GANGA AT DELA [02]

Threshold Discharges

Average no. of days/month

J F M A M J J A S O N D

Q 50
Q 70
Q 90
and March. This will therefore be a critical time for supplying power. A second critical period will occur in October to November. This seasonal variability of run-off reflects the monthly rainfall distribution of the region.

The seasonal distribution of flows other than Q30, Q70 and Q50 could be estimated by interpolation between these points. This should be done by plotting on log-normal graph paper the threshold discharge (expressed as a percentage of ADF) against the percentage of days in each month that this discharge is exceeded. This will enable twelve monthly flow duration curves to be very approximately estimated.

Summary and Recommendations

Estimation of the discharge exceeded for any given percentage of time for the Alupolla and Beverley microhydro sites can be made by reference to the appropriate flow duration curve on Figure 6. This must then be scaled by the estimated average daily flow (1.57 cumecs for Alupolla and 0.36 cumecs for Beverley). The seasonal distribution of low flows can be inferred for both sites from Figure 9.3.

The largest errors in the estimation procedure are in the validity of extrapolating data from the large gauged catchments to the small ungauged headwater catchments and in the estimation of average catchment rainfall from insufficient rainfall data. It may be possible to reduce the first of these errors by analysing additional daily flow records from smaller catchments in the region. The second error (which results in incorrect estimation of the average runoff) may be reduced by analysing more long term annual average rainfall data and producing an improved annual rainfall isohyet map. This could be done in conjunction with the Irrigation Department of Sri Lanka or the appropriate Meteorological Organisation.
Improvements could also be made by using longer flow records and by incorporating spot gaugings from the two microhydro sites. The latter approach would involve plotting discharge (measured at the site by a current meter or portable weir) against percentage exceedence derived on the same day from a nearby gauging station. The dry season from January to March and October to November would be the most appropriate time for this fieldwork.
References


Survey Department, Ceylon, 'Ceylon - Climate map Scale 1:1,000,000', 1972


Irrigation Department, Sri Lanka (Land Use Division) 'Ceylon - General Soil Map. Scale 8 miles to 1 inch'. 26 January, 1967.
