An assessment of the small hydro potential in Sri Lanka

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1. Introduction

The south-western quarter of Sri Lanka is characterised by persistent rainfall that lasts for nearly nine months in some parts of the hill country. The mean annual rainfall varies from about 5500 mm, in the wettest parts of the island, to around 3000 mm in most parts of the central and south-west mountain ranges. Geologically, these mountain ranges are characterised by steeply dissected hilly and rolling terrain. This geo-climatic combination causes a large number of streams to radiate from the upper reaches of mountains. They merge downstream to form some of Sri Lanka's major rivers, such as Kelani Ganga, Mahaweli Ganga and Kalu Ganga. Small streams in the upper catchments as well as major rivers offer considerable potential to generate hydroelectric power.

Colonial planters, who established large-scale plantations in the south-western quarter of the island, were the first to tap hydro power in small streams to generate electricity and motive power for their plantation industries. It is estimated that around 500 such micro-hydro plants had been in operation in the early part of the 20th century. This paper presents a preliminary assessment of the small hydro potential in Sri Lanka, focussing largely on the plantation sector. It is based on a two-year research study conducted by the Sri Lanka Country Office of the Intermediate Technology Development Group.

2. Methodology and scope

The initial phase of the study was collection of information on old small hydro sites in Sri Lanka. Three sources of information were used for this purpose. They are: (a) Sri Lanka Mini Hydro Rehabilitation Project – Salford Civil Engineering Ltd. with Binnie & Partners – 1986 (referred to hereafter as ODA study); (b) Feasibility Study for the Rehabilitation of Mini Hydro Stations, Cansult Ltd, Canada – 1984 (referred to heareafter as Cansult study) and (c) the database of Gilbert Gilkes and Gordon on turbines supplied to Ceylon. The first two studies addressed the feasibility of rehabilitating abandoned micro-hydro plants in the plantation sector. The ODA study [ODA, 1986] was very much a feasibility report concerning eight selected small hydro sites and revealed very little about hundreds of other old hydro sites. The Cansult study [Cansult, 1984] has examined about forty sites for redevelopment and presents the technical details for nineteen sites. The database of Gilbert Gilkes and Gordon [GGG, undated] provided the most useful information about old micro-hydro sites in Sri Lanka.

On the basis of this information, old hydro sites, either abandoned or operational, were identified and located on the relevant one-inch (i.e., scale of 1 inch (2.54 cm) to 1 mile (1.61 km)) topographical map. Each site was then visited and the status of the existing hydro scheme was examined and the following data were recorded.

- Operational status, i.e., abandoned, not in operation or in operation.
- Location (latitude and longitude) and length of the weir.
- Channel cross-section (depth and width) and the length (length is only an estimate made while walking along the channel path).
- Dimensions of the forebay tank.
- Diameter and length of the penstock. Length was mostly estimated on the basis of the direct distance (measured using the distance measuring instrument – Ranger 400) between the powerhouse and forebay.
- Type of the turbine and its design flow and head.
- Generator rating.
- Exploitable downstream head.

In addition to the above, investigations were also made about other potential sites in the area. In such sites, the head was estimated using contour data given in the topographical map, and physical measurements were limited only to sites which allowed the use of Ranger 400, i.e., where visibility was clear and the distance was less than 400 m. Identification of potential sites was usually done before planning the site visits. As the contour interval of the map is only 30 m, *new sites having less than 30 m head were skipped to a large extent in the survey.*

In respect of both the existing schemes and new ones, the *exploitable power potential* was estimated on the basis of the average daily flow (ADF) and not the optimum design flow for the site, which will have to be determined through a detailed design analysis.

3. Data analysis

The study covered 292 sites covering both estate sites and non-estate sites. Streams in some of the sites, particularly where very small capacity hydro plants were in use, were no longer in existence. Thus, the total number of sites studied and entered into the database is 276. These could be categorised as:

- *Old estate sites.* These are sites where there are or had been hydro plants in the past. The current status of the hydro plants in this category is defined as:
  - *abandoned,* i.e., either no trace of the scheme is visible or some parts of the scheme are available but in a dilapidated state;
  - *not in operation,* i.e., the scheme is mostly in place but not being used – the scheme could be rehabilitated if necessary; or
  - *in operation,* i.e., the plant was in operation or under repairs at the time of visit.
- *New estate sites.* A new location found within the boundaries of the particular estate.
- *Non-estate sites.* A site located outside an estate, mostly on state land.

Of the 276 sites surveyed, data on the exploitable small hydro potential is available only for 257 sites. Hence, further analysis was confined to the 257 sites. The distribution of

Table 1. Distribution of surveyed sites by status of site

Site classification	Number of sites	% composition
Old estate sites	137	53.3
New estate sites	71	27.6
Non-estate sites	49	19.1
Total	257	100.0

Table 2. Number of sites, utilised capacity and exploitable potential in old estate sites

Classification of sites	Number of sites	Utilised capacity (kW)	Exploitable potential (kW)
In operation	49	3,343	10,367
Not in operation	14	544	2,555
Abandoned	74	2,228	10,746
Total	137	6,115	23,668

Table 3. Distribution of new estate sites by district

District	Number of sites	Exploitable potential (kW)	Average site potential (kW)
Nuwara Eliya	37	12,496	338
Kegalle	7	2,888	412
Ratnapura	8	2,457	307
Kandy	9	1,697	188
Badulla	9	1,093	121
Galle	1	92	92
Total	71	20,723	

Table 4. Distribution of non-estate sites by district

District	No. of sites	Capacity (kW)	% composition of capacity
Ratnapura	22	26,800	51
Kegalle	11	9,972	19
Kandy	5	6,850	13
Nuwara Eliya	8	5,847	10
Badulla	1	3,067	6
Matara	2	479	1
Total	47	53,016	100

the surveyed sites among the three categories is presented in Table 1.

3.1. Old estate hydro sites

Of the total number of surveyed sites 53.3 % (137 sites) fall into the category of old estate sites. The combined installed capacity at these sites is around 6115 kW and they include sites belonging to the three classifications *abandoned, not in operation* and *in operation.* The distribution of capacity, both utilised and exploitable, among these three types of sites is presented in Table 2. The analysis shows that the capacity of hydro plants currently in operation could be increased from the present installed capacity of 3,343 kW to over 10,000 kW while the combined capacity of sites (of all three classifications) could increase nearly four-fold.

The distribution of these sites by district is shown in Figure 1, according to which the highest number of old sites are found in Nuwara Eliya district (42 %) followed by Kandy (21 %) and Ratnapura (12 %).

3.2. New estate sites

During visits to estates having abandoned or operational hydro plants, further investigations were conducted to locate new sites within the same estate. A few of the new estate sites include those which have not had used hydro-power in the past. The distribution of new estate sites by district is presented in Table 3, which shows that the highest exploitable potential of nearly 12,500 kW is found in Nuwara Eliya district. The highest average site potential of 412 kW is found in Kegalle district. The total exploitable potential at new sites in the estate sector is over 20,000 kW.

3.3. Non-estate sites

Distribution of non-estate sites by district is presented in Table 4, according to which the highest potential of 26,800 kW is found in Ratnapura district, followed by Kegalle district with 9,972 kW. Almost all non-estate sites are found on state land, often interspersed with village settlements, some bordering forest reserves. Therefore, development of these sites is likely to face social and environmental issues to some extent.

4. Total potential of the surveyed sites

The total estimated small hydro potential at the 257 surveyed sites is 97.4 MW (see Table 5), which is distributed among the three site categories as: 24.4 % in old estate sites, 21.2 % in new estate sites and the remaining 54.4 % in non-estate sites. The highest potential encountered in the study is 5,192 kW on Kuru Ganga while the lowest capacity of 5 kW was found in one of the old estate sites, Maria division of Waltrim Estate. Capacity utilised in old estate sites is estimated as 6.1 MW.

Distribution of all sites by the estimated exploitable small hydro potential is presented in Figures 2 and 3 for two ranges of capacity, viz., 0-500 kW and 500-4000 kW. According to these, in 81 % (209 sites) of the surveyed sites, the potential lies in the range 0-500 kW. Within this range, 22 % of sites have a capacity of less than 50 kW and 25 % lie between 50 kW and 100 kW. In the range of 500 kW to 4000 kW (48 sites) nearly 70 % of sites have capacities between 500 kW and 1500 kW. ■

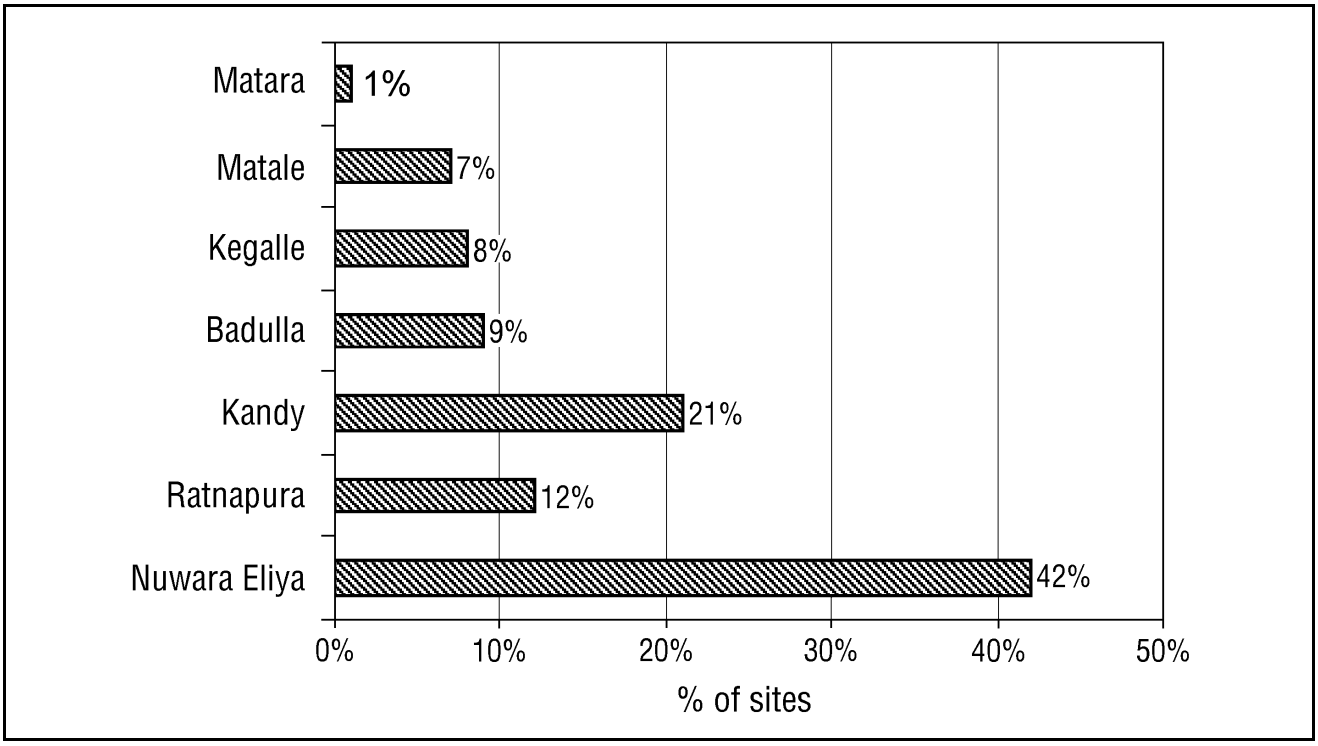

Figure 1. Distribution of old hydro sites by district

Table 5. Distribution of all sites by classification and capacity

Site classification	Number of sites	Utilised potential (MW)	Exploitable potential		Highest site capacity (kW)	Lowest site capacity (kW)
			MW	% of the total		
Old estate sites	137	6.1	23.668	24.4	1,665	5
New estate sites	71	-	20.723	21.2	1,127	8
Non-estate sites	49	-	53.016	54.4	5,192	44
Total	257		97.407	100		

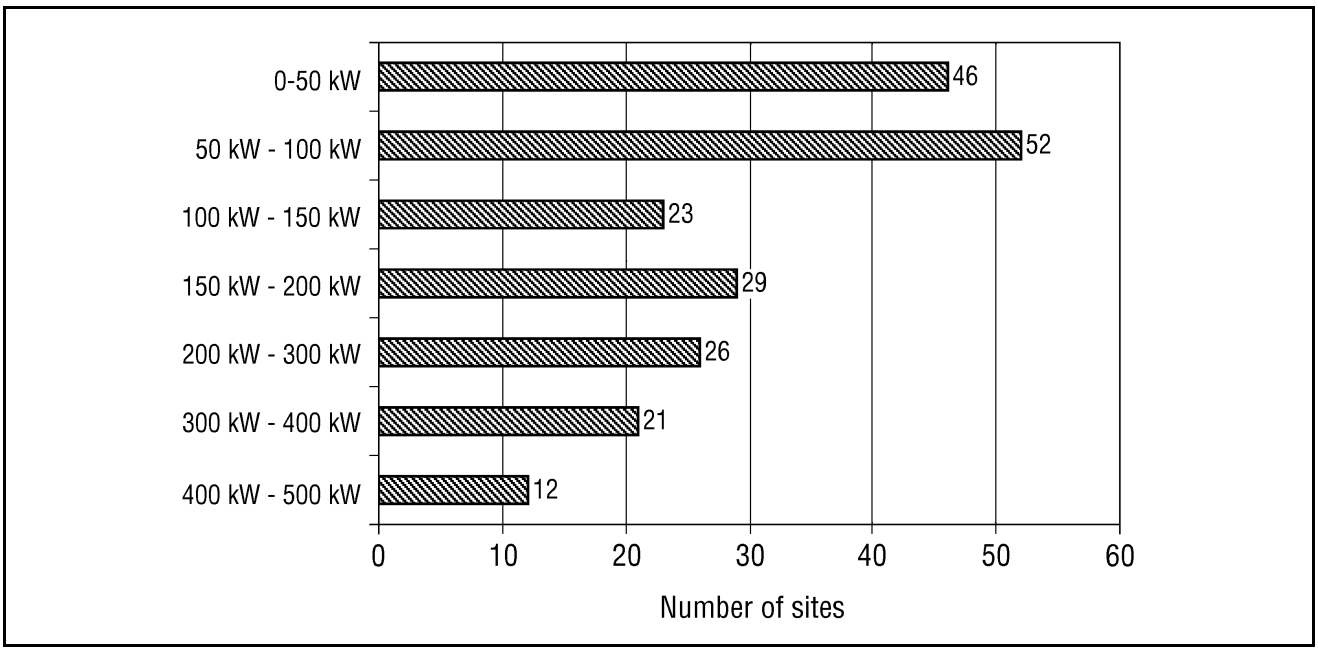

Figure 2. Distribution of exploitable power – site capacity < 500 kW

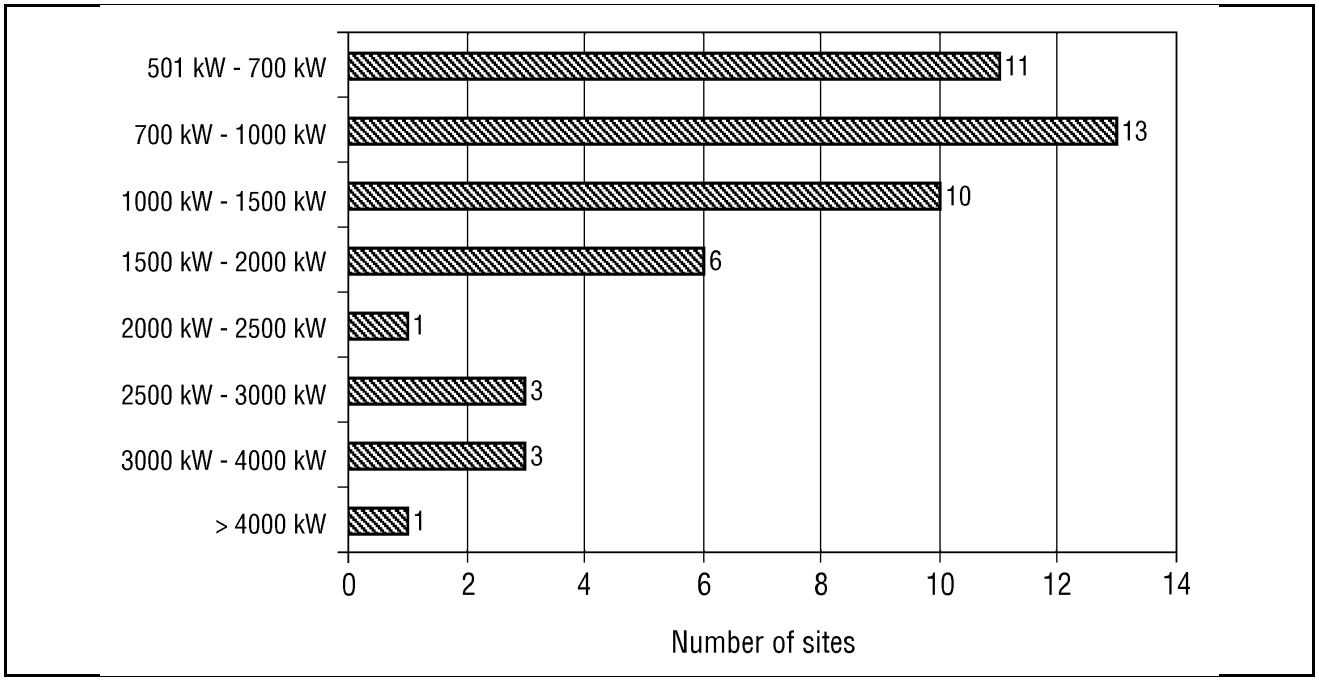

Figure 3. Distribution of exploitable power – site capacity > 500 kW

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References

Overseas Development Administration (ODA), 1986. *Sri Lanka Mini Hydro Rehabilitation Project* conducted by Salford Civil Engineering Ltd. with Binnie & Partners, carried out under assignment by the Overseas Development Administration, UK.

Cansult, 1984. *Feasibility Study for the Rehabilitation of Mini Hydro Stations*, carried out by Cansult Ltd.

GGG, undated. *Gilbert Gilkes and Gordon in Sri Lanka* – List of hydro plants supplied to Ceylon by Gilbert Gilkes & Co. Ltd. from 1887 to 1960.