2.2 HYDROLOGY

2.2.1 METEOROLOGY

(1) General Climate of Sri Lanka

The climate of Sri Lanka is classified as "Tropical monsoon" climatic zone. The monsoonal conditions are separated into two periods: from May to September is in the southwest monsoon period and from December to February is in the northeast monsoon period. The rainfall pattern is influenced by the monsoon winds. These winds bringing moisture and when these winds encounter the slopes of the mountains, they unload rains on there. At the southwest monsoon, the rainfall is exceptionally heavy. This climate condition generate dry zone in north and in southeast of Sri Lanka.

The average annual rainfall has considerable spatial variation. The higher rainfalls are on the central highlands. The maximum values are on the western slopes recording values exceeding 5,000 mm. The eastern slopes are less than 3,500 mm. The minimum annual rainfall values are on the northwestern and southeastern lowlands of less than 1,000 mm. See *Figure 2.6*.

The average annual temperature is about 28°C in the low lands and about 16°C in the Nuwara Eliya in central highland having an altitude of 1,800 m. For large parts of Sri Lanka, January is the lowest temperature month and May is the highest temperature month.

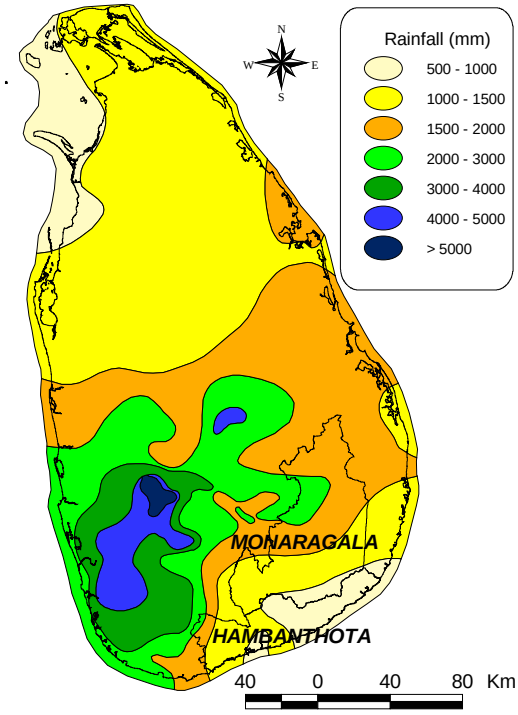


Figure 2.6 Annual Rainfall

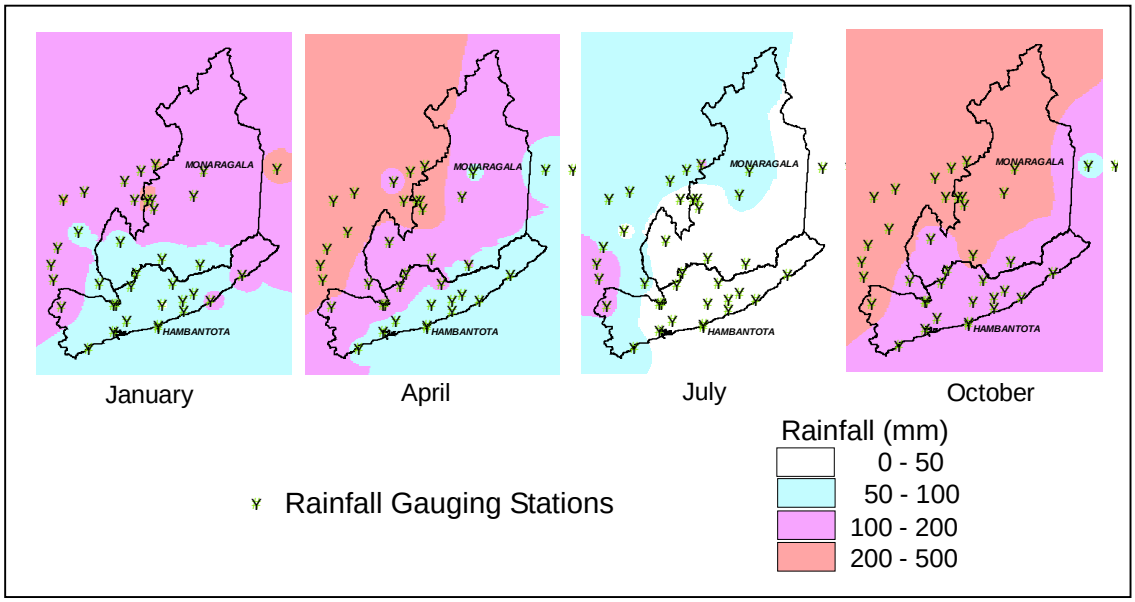
(2) Climate of the Study Area

The Study area (Monaragala and Hambantota district) is located in southeast quarter of Sri Lanka. Climate of the Study Area is characterized as northeast monsoon and dry area. Almost all of the Study area, except the northern part of Monaragala district, belongs to lowlands or hills with an altitude less than 150 m. The rainfall by a northeast monsoon is small in this area.

1) Rainfall

Based on the records on mean monthly rainfall from 1981 to 2001, distribution of rainfall depth is shown in *Figure 2.7*. This figure indicates that most shallow rainfall in July of the period of southwest monsoon from May to September.

Monthly rainfall at Hambantota and Monaragala gauging stations is shown in *Table 2.2*. The table shows a half of annual rainfall is concentrated in three months from October to December. In general, the rainfall depth of Monaragala is larger than that of Hambantota district.



Source: Meteorological Department and Irrigation Department.

Figure 2.7 Distribution of Rainfall Depth

Table 2.2 Monthly Rainfall

Month	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Hambantota (1951-2000) in mm													
Average	80.3	53.1	60.0	90.2	81.0	57.0	47.4	51.1	68.8	131.7	191.7	115.4	1026.4
Max.	277.8	176.2	213.5	291.3	349.8	187.8	223.7	185.6	287.9	361.8	469.0	485.3	1825.0
Min.	0.0	0.0	0.0	12.3	0.0	0.7	0.0	0.0	0.0	0.5	32.7	5.1	590.0
Monaragala (1989-2000) in mm													
Average	166.9	98.3	42.7	78.2	66.4	25.5	61.7	95.8	131.1	233.6	338.4	248.4	1551.9
Max	335.2	236.2	127.1	188.9	214.0	60.5	178.7	247.1	167.3	342.8	944.2	498.8	2364.1
Min	9.1	0.0	0.0	1.7	0.0	0.3	2.2	27.0	35.4	90.3	121.7	83.5	1166.5

2) Temperature

Mean monthly temperature at Hambantota gauging station from 1961 to 1990 is summarized in *Table 2.3*. The variation of the mean monthly value is small, it is only 2℃. The highest temperature of 31.2℃ is observed at April, meanwhile, the lowest one of 22.8℃ is observed at January. In the rainy season of October to February, the monthly temperature is slightly below this.

Table 2.3 Monthly Temperature, Hambantota (1961-1990)

Month	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Max	29.8	30.2	30.9	31.2	30.7	30.3	30.6	30.1	29.9	30.0	29.8	29.6	30.3
Min	22.8	23.0	23.9	25.0	25.5	25.2	24.7	24.6	24.5	24.2	23.6	23.3	24.2
Mean	26.3	26.6	27.4	28.1	28.1	27.8	27.7	27.3	27.2	27.1	26.7	26.4	27.2

3) Pan – Evaporation

Mean monthly Pan-Evaporation at Nakkala (Monaragala district) gauging station from 1992 to 1999, exclude 1993 to 1996, is shown in *Table 2.4*. The Pan-Evaporation is rather high from February to September. In these months, the double amount of Pan-Evaporation of dry season from November to December is recorded.

Table 2.4 Monthly Pan-Evaporation, Nakkala (1992-1999) in mm

Month	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Average	80.0	97.0	120.0	97.8	96.3	103.0	99.3	109.8	98.5	79.8	55.5	52.5	1089.3
Max	87.0	116.0	136.0	110.0	100.0	113.0	112.0	125.0	113.0	89.0	60.0	61.0	1112.0
Min	68.0	87.0	110.0	85.0	93.0	90.0	90.0	82.0	75.0	70.0	50.0	43.0	1053.0

4) Relative Humidity

Mean monthly relative humidity on average from 1995 to 2000 in Hambantota gauging station is shown in *Table 2.5*. The range of monthly humidity in daytime is 72% (March) to 79% (May), the range of monthly humidity in nighttime is 85 % (February) to 88% (November). Rather high relative tendency can be observed during the period of southwest and northeast monsoon.

Table 2.5 Monthly Humidity, Hambantota (1995 – 2000)

Month	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Mean Daytime	73	73	72	75	79	78	73	76	78	75	77	75	75
Mean Nighttime	85	85	85	86	88	88	86	87	88	87	88	87	87

Monthly variations of climates are shown in *Figure 2.8*. There is a tendency for the temperature and pan-evaporation to decrease as the rain increases. There is no obvious relationship between humidity and other parameter. Monaragala's rainfall is deeper than Hambantota in the period of northeast monsoon.

2.2.2 RIVER SYSTEM AND HYDROLOGICAL STATIONS

There are 23 river basins in the Study Area, having a total catchment area of 11,120 km^2. The rivers related to this study are listed in *Table 2.6.*

There are 34 available rainfall stations and eight river discharge gauging stations in and around the Study area. Major data and information collected from the Meteorological Department, Irrigation Department, NWSDB, the GND offices, the residents, and WRB are as follows:

- Hydrological stations (rainfall stations and runoff discharge gauging stations) and river systems related to the Study Area (refer to *Figure 2.9*),
- Monthly rainfall at 34 stations and monthly river discharge at eight stations located in and around the Study Area for the recent 12 years.
- Rainfall and runoff calculations of the river discharge stations in Sri Lanka, under present land use and water use conditions,
- Annual irrigation water consumption of major tanks (reservoirs) in the Study Area for the recent three years,
- Water supply conditions, problems with domestic water use, population of GND, etc.

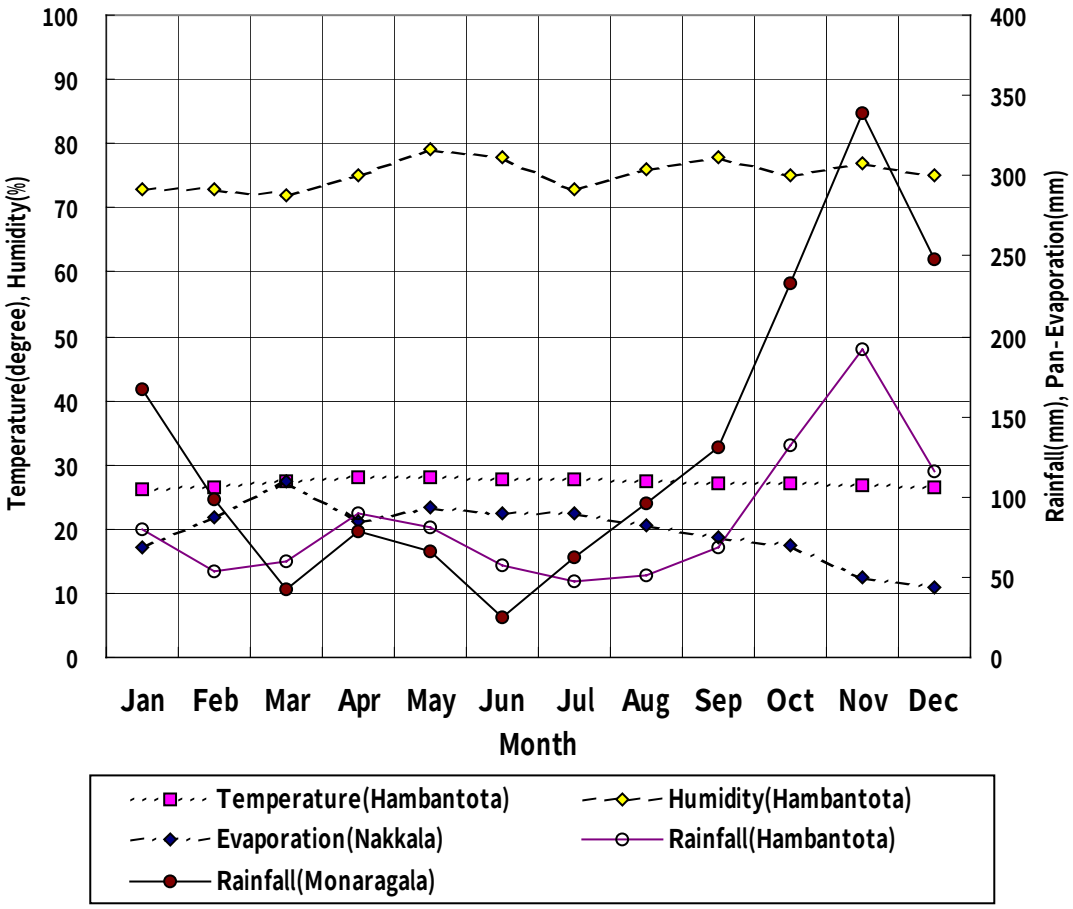


Figure 2.8 Monthly Variation of Meteorological Data

Table 2.6 Rivers in the Study Area

No	Name of River	Catchment Area (km^2)	Number of Tanks in the Catchment	Related Districts and Areas
13	Sinimodera Oya	39	9	Hambantota
14	Kirama Oya	225	206	Hambantota
15	Rekawa Oya	76	113	Hambantota
16	Urubokka Oya	352	182	Hambantota
17	Kachchigala	223	150	Hambantota
18	Walawe Ganga	2471	777	Hambantota, Monaragala
19	Karagan Oya	58	28	Hambantota
20	Malala Oya	404	378	Hambantota, Monaragala
21	Embilikala Oya	60	20	Hambantota
22	Kirindi Oya	1178	334	Hambantota, Monaragala
23	Banbawe Ara	80	27	Hambantota, Yala National Park
24	Mahasiliwa Oya	13	5	Hambantota, Yala National Park
25	Butawa Oya	39	18	Hambantota, Yala National Park
26	Menik Ganga	1287	294	Hambantota, Monaragala, Yala National Park
27	Katupila Ara	87	45	Hambantota, Yala National Park
28	Kurundu Ara	132	35	Hambantota, Yala National Park
29	Nabadagas Ara	109	9	Hambantota, Yala National Park
30	Karamba Ara	47	2	Hambantota, Yala National Park
31	Kumbukkan Oya	1233	61	Monaragala, Yala National Park
32	Bagura Oya	93	19	Monaragala, Yala National Park
35	Wila Oya	490	65	Monaragala
36	Heda Oya	611	55	Monaragala
44	Gal Oya	1813	91	Monaragala
Total		11,120	2,923	

Data Source: Irrigation Department

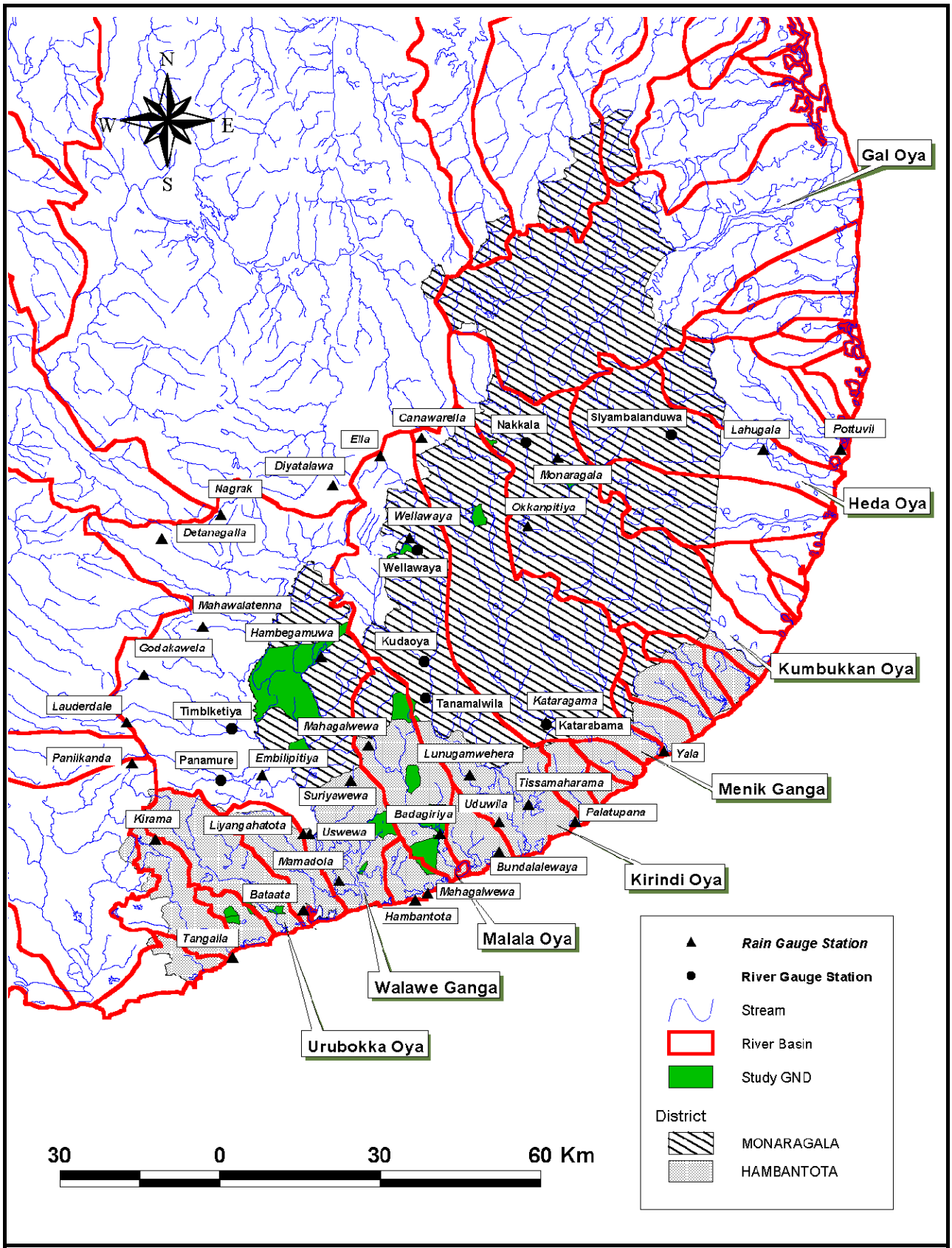


FIGURE 2.9 RIVER SYSTEMS AND HYDROLOGICAL STATIONS IN THE STUDY AREA

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2.2.3 HYDROLOGICAL CHARACTERISTICS

Hydrological characteristics of the Study Area such as rainfall distribution, river flow conditions, and irrigation condition were studied through topographic maps and the collected data. River flow and reservoir water conditions during the dry season were confirmed by a two-week field reconnaissance of the Study Area in the dry season of 2001.

(1) Distribution of Rainfall

The Study Area is affected mainly by the northeast monsoon. Mountain areas where rainfall is larger than that of the flat areas are located in the west and the north. Almost all of the Study Area, except the northern part of Monaragala District, is flat with an altitude less than 150 m.

1) Rainfall Distribution in the Study Area

Distribution of average annual rainfall in the Study area is shown in *Figure 2.10* and its major features are summarized as follows:

- The mountain slope areas facing to the northeast have a large rainfall depth with an average annual rainfall of 3,000 mm or less, while the slopes facing to the southwest have smaller rainfall depth of less than 2,000 mm.
- The southern coastal area has a small average annual rainfall of 1,100 to 800 mm.
- Average annual rainfall in the inland flat areas ranges from 1,500 to 1,000 mm.

2) Yearly Rainfall Distribution:

Annual rainfall depths from October to September were calculated using monthly rainfall records as shown in *Table 2.7*. Major features are as follows:

- At Hambantota Station, in the years 1988/89 (625 mm), 89/90 (706 mm), 95/96 (737 mm) and 82/83 (800 mm) were dry (average 982 mm, maximum 1,350 mm).
- Dry years in the upper river basins were 82/83, 84/85 and 88/89 for the Menik Ganga, 86/87, 91/92 and 88/89 for the Kirindi Oya. Judging from the river discharge data, the year 88/89 was the driest.

(2) Major Hydrological Findings

The Walawe Ganga has ample water even in the dry season because of its large catchment area and the large rainfall in its western basin. The river waters flow through three large reservoirs and irrigate a vast area of paddy fields.

The Kirindi Oya and the Menik Ganga do not have enough water in the dry season due to small rainfall in the basin, except small mountain areas in the north. Small rivers in Hambantota, except Urubokka Oya, do not have enough surface water.

There are many tanks (reservoirs) for irrigation in the Study Area. Some rivers were observed to have no flow in the dry season.

Most of the Pilot 15 GNDs are located in hilly areas with elevation of 30 to 375 m for Monaragala and 25 to 40 m for Hambantota. In these areas, dug wells usually dry up during the dry seasons.

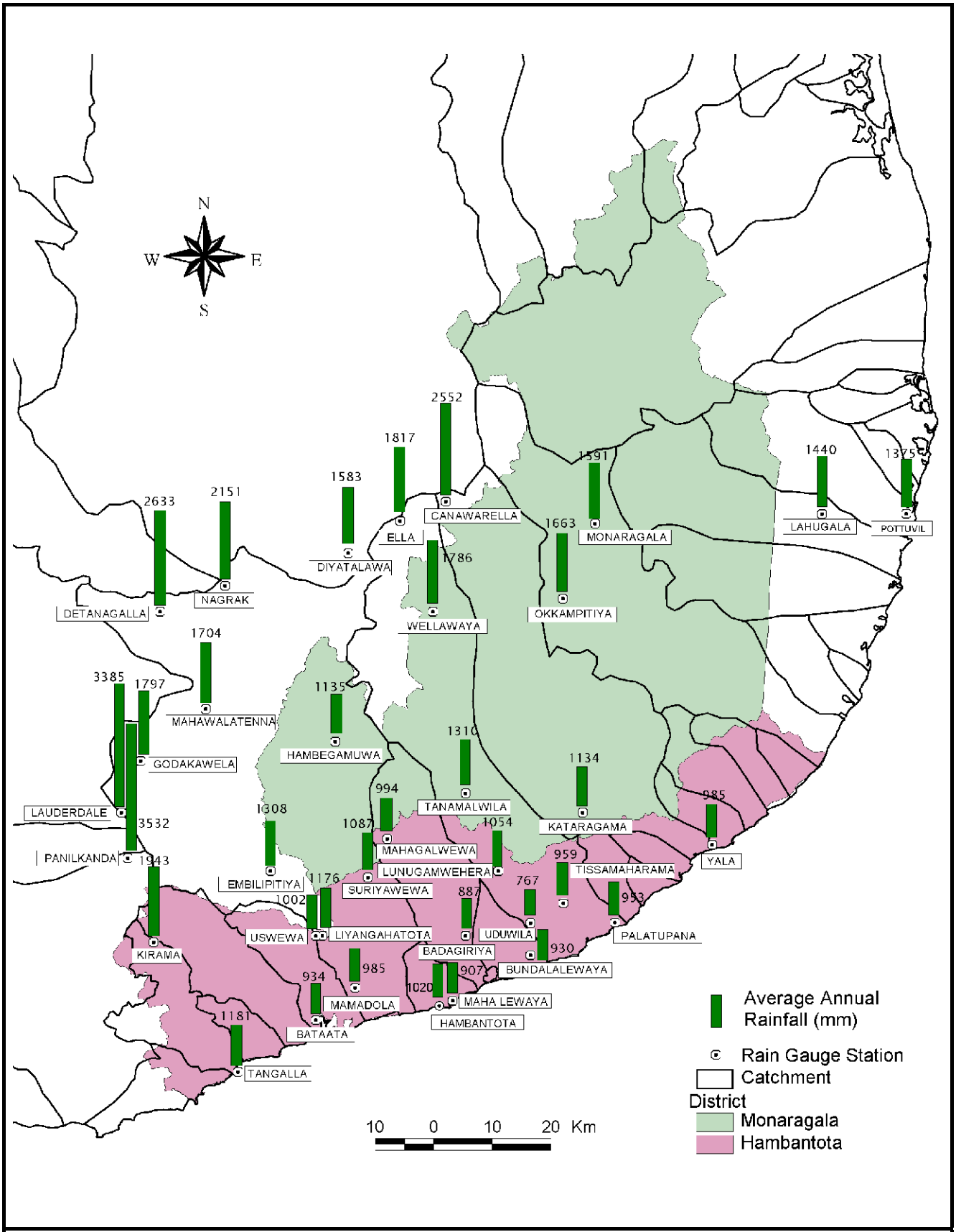

FIGURE 2.10 DISTRIBUTION OF AVERAGE ANNUAL RAINFALL

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The river waters in the Study Area are used mainly for irrigation. Average annual irrigation water volumes released from major tanks and "anicuts" in total are 135 million m^3 for Monaragala and 502 million m^3 for Hambantota.

Table 2.7(a) Yearly Rainfall in Upper/Middle Basin (mm)

Year	Name of Rainfall Stations												
	Cannavella	Monaragala	Okampitiya	Hambegamuwa	Ella	Tanamalwila	Wellawaya	Detanagalla	Embilipitiya	Gudakawela	Lauderdale	Nagarak	Panilkanda
81/82	2181.5		1258.6		1600.3	995.6				1939.0	3638.1		3914.9
82/83	1791.4		1276.2	1299.4	1389.6	1392.4		1690.7	995.9	1394.7	2513.4		
83/84	2872.0		2184.4	1858.8	2493.7	1211.6		4460.1		2281.3			
84/85	1852.2		1321.5		1453.7		1568.2	2210.9		2143.5	3570.2		3595.1
85/86	2534.2		1454.9	1511.2	2142.3		1952.6	2005.1	1402.8	2162.6	3441.7	2037.5	3676.9
86/87	2077.3		1351.2	535.2	1467.7		961.9	1644.9	1011.9	1322.4	2183.1	2598.7	
87/88	2874.9			992.3	1967.0		1894.6	2581.4		2066.9		3199.3	
88/89	1931.6			748.6	1465.0		1386.4	2324.7	1355.2	1721.1		2185.0	
89/90		1264.5		628.4	1760.3		2090.7	2574.0		1440.0	2826.3	1943.0	
90/91	2718.4	1433.0	1654.4		1529.5		1829.1	2929.2		2483.0	3197.1	2148.8	2942.9
91/92	2130.6	1166.5	1545.3		1268.6			2332.6	1054.4	1512.3	2572.2	1663.7	
92/93	2075.8	1669.4	1285.0	1044.8	1657.5		1593.3		1045.7	1770.4	2795.9	1733.6	
93/94	2809.5	2001.3	1964.4	1524.0	2118.8		1864.7	2872.6	1333.8				
94/95	3286.9	1052.4	1861.8	1203.2	2314.0		1737.5	3388.7	1292.5	1719.8			
95/96	2572.2	1741.9	1621.3		1942.9		1516.9	2131.2	1054.5	1204.2	3385.0		
96/97	3099.2	1240.7	1285.0		1912.7		2053.9	2628.2	1100.4		2795.9		
97/98	3318.6	2364.1	2093.7		2024.5		2025.4	3137.7	1558.1			2773.4	
98/99	2868.6	1745.6	1753.4		2437.9		2596.0	3254.7	1429.1			2193.5	
99/00		1351.7	1465.1		2127.6		1726.9	2634.5	1346.1			2034.8	
00/01			1389.5		1270.0			2596.8	917.8			1301.8	
Average	2552.0	1591.4	1663.0	1134.6	1817.2	1309.6	1786.5	2633.2	1307.6	1797.2	3367.7	2151.1	3532.5
Maximum	3318.6	2364.1	2184.4	1858.8	2493.7	1392.4	2596.0	4460.1	1558.1	2483.0	3638.1	3199.3	3914.9
Minimum	1791.4	1052.4	1258.6	535.2	1268.6	995.6	961.9	1644.9	917.8	1204.2	2183.1	1301.8	2942.9

Source: Meteorological Department, except Monaragala which is from Irrigation Department)

Table 2.7(b) Yearly Rainfall in Lower Basin (mm)

Year	Name of Rainfall Stations															
	Badagoroua	Batata	Bundala	Kirama	Liyangaha	Lunugam	Mahagal	Mahalewaya	Mamadola	Palatupana	Suriyawewa	Tangalla	Tissamaharama	Uduwila	Uswewa	Yala
81/82	1382.1	1137.6		2110.8				1116.1						678.4		
82/83	1542.8	1062.9		1909.1				939.5	1057.2			1183.8	1060.8	939.0		
83/84		1317.1		1950.0					932.0	1289.7		1204.3		1132.4		1329.7
84/85		913.1		1928.8				899.0	680.0	861.5		1111.2	957.0	611.6		900.3
85/86		1346.1		2071.1		1076.0		1214.3		924.7		1315.6	1106.3	1097.6		1060.1
86/87	601.1			1466.6		735.4		820.8		836.9		926.6	624.8	459.0		602.7
87/88	905.3		946.6	1716.8		975.1		960.4		938.5		1378.0	921.6	670.6		1092.1
88/89			653.2			988.0		629.8			1038.3	956.8	902.0	840.7		
89/90	608.4		685.3			1069.0		591.4	528.6	529.5	960.6			470.5	558.2	640.7
90/91	1030.3	1022.0	1091.5	897.0		1303.9		1153.0		995.6	1217.5	1290.2			787.1	1154.0
91/92	459.7	498.4	993.5	1407.2		1002.2	792.6	842.0	1031.0	1023.2	758.5		662.3		623.7	1000.4
92/93	657.9	1112.1	632.4					696.3	970.4	676.0	939.1		729.2			703.6
93/94	1032.4	1224.9	1164.7		1439.3	1544.0	1361.9	909.9	1398.4	1092.5	1561.1		1156.3			1385.9
94/95	1040.6	782.7	1113.3	2251.9	1115.2	1090.1	1091.5	956.3	1085.4	1103.2	1099.9				1116.0	1042.5
95/96	729.2	702.9	982.5	2073.7	1000.6	1000.0	729.0	669.9	933.9	861.2	840.3	1195.4			945.4	875.6
96/97		1151.6	734.3	2590.0	951.2	856.8		907.1	775.1	735.3	1077.8	1245.9			1301.5	
97/98	1235.7	1341.5	1236.1	2445.7	1284.3	1337.2		1039.9	1369.7	1254.4					1380.0	
98/99	799.6	1354.5			1278.0	792.1			1218.8	1151.0	1358.2		1114.4		1086.8	
99/00	816.8	1209.3		2385.2				1100.3		979.2	1362.7		1539.8			1009.9
00/01	457.2					990.8			819.3		829.6		730.7		1217.7	987.5
Average	886.6	1078.4	930.3	1943.1	1178.1	1054.3	993.8	908.6	984.6	953.3	1087.0	1180.8	958.8	766.6	1001.8	984.6
Maximum	1542.8	1354.5	1236.1	2590.0	1439.3	1544.0	1361.9	1214.3	1398.4	1289.7	1561.1	1378.0	1539.8	1132.4	1380.0	1385.9
Minimum	457.2	498.4	632.4	897.0	951.2	735.4	729.0	591.4	528.6	529.5	758.5	926.6	624.8	459.0	558.2	602.7

Source: Meteorological Department

2.2.4 POTENTIAL RECHARGE TO GROUNDWATER

In this study, the potential groundwater recharge was regarded the runoff in the drought year as a potential groundwater recharge. This estimation was made under the assumption that almost all river discharge in a drought year could be flowed out from groundwater, considering the balance between rainfall and infiltration as discussed and explained in detail in Supporting 2 of the Supporting Report. As the result, the annual recharge potential for the dry area in Hambantota and Monaragala are estimated to be 100 mm to 200 mm in a drought year. A value of minimum runoff was given by the following manners.

- In Hambantota, a lower value of 100 mm was given by considering that it is dry area.
- In Monaragala, a higher value of 200 mm was given to the area located at high elevation where annual rainfall is comparatively high, whereas a lower value of 100 mm was given to the area located at lower elevation.

The recharge potentials evaluated are estimates, but they are considered as reasonable. However, the recharge amount is also influenced by the potential of water head, which will vary depending on the scale of groundwater pumping. Therefore, if the project is implemented, it is necessary to examine the groundwater recharge by the long term monitoring of the groundwater head.

2.3 SOCIO-ECONOMIC CONDITIONS

2.3.1 ADMINISTRATIVE SETTINGS

In Sri Lanka, administrative unit consists of Provinces, Districts, Divisional Secretary's Division (DSD), Grama Niladhari Divisions (GND) and villages. There are 9 Provinces and 25 Districts in the country. The GND is considered the smallest administrative unit provided with statistical data. Therefore, GND was defined as a unit for groundwater development plans concerning the "Pilot GND".

The Study covers two districts, Monaragala and Hambantota districts. The former belongs to Uva Province and the latter to Southern Province. The two districts occupy the country's southern part where water shortage is significant in the dry season.

(1) Monaragala District

Monaragala district, which is one of the two districts of Uva province, consists of 11 DSDs. These DSDs are further divided into GND. In Monaragala district, each DSD has a Pradeshiya Sabhas and there is no Urban Council in any DSD.

The GND is considered the smallest administrative unit provided with statistical data. Therefore, GND is defined as a unit for groundwater development plans concerning the "Pilot GND". There are seven Pilot GNDs in Monaragala district.

Location of the DSD and the Pilot GNDs are shown in the figure on the first page of the Report, and the numbers of GND are shown in *Table 2.8*.

Table 2.8 Number of GND in DSD of Monaragala District

Name of DSD	Number of GND
BIBILE	40
MADULLA	38
MEDAGAMA	35
BADALKUMBURA*	41
MONARAGALA*	27
SIYAMBALANDUWA	48
BUTTALA*	29
WELLAWAYA*	31
KATHARAGAMA	6
SEVANAGALA*	14
TANAMALWILA*	14

*: DSD that has Pilot GND(s)

(2) Hambantota District

Hambantota district, which belongs to Southern province, consists of 11 DSDs. These DSDs are further divided into GNDs that are the smallest administrative units. In Hambantota district, each DSD has a Pradeshiya Sabha which is the local authority. Hambantota and Tangalla DSD have an urban council. There are eight Pilot GNDs in Hambantota district.

Locations of the DSDs are shown in the figure on the first page of the Report, and numbers of GNDs are shown in *Table 2.9*.

Table 2.9 Number of GND in DSD of Hambantota District

Name of D.S. Division	Numbers of G.N. Division
AMBALATHOTA	55
ANGUINUKOLAPELESSA	51
BELIATTA	71
HAMBANTHOTA*	30
KATUWANA	84
LUNUGAMWEHERA*	36
OKEWELA	27
SURIYAWEWA*	21
TANGALLE*	72
TISSAMAHARAMA	44
WEERAKETIYA	85

*: DSD that has Pilot GND(s)

2.3.2 POPULATION, ETHNIC AND RELIGIOUS COMPOSITIONS

Based on the census of population and housing which was conducted on July 2001, the population of the Sri Lanka was estimated as 18,730,000. The population density is 285 person/km^2, which can be classified as a densely populated region. The average annual growth rate is estimated to be 1.14% during the period of 1990 to 2000 (past 10 years average). The annual growth rate is as high as 1.8% at Monaragala, as low as 1.1% at Hambantota.

In Sri Lanka, there are three major ethnic groups: Singhalese (74% of the total population), Tamils (18%) and Sri Lanka Moor (8%). Regarding the religions, the majority (69%) are Buddhists consisting of mainly Singhalese, 15% are Hindu (mainly Tamils) and the rest are Christians and Muslims. Authorized national languages are Singhalese and Tamil while English is popular in schools in urban area. The literacy rate is high. It is 90%.

(1) Monaragala District

According to the Census of Population and Housing, 2001, the populations of each DSD in Monaragala district are estimated as shown in *Table 2.10*.

Table 2.10 Population of D.S. Divisions in Monaragala District

Name of D.S. Division	Population
Badalkumbura	36,693
Bibile	35,435
Buttala	47,086
Katharagama	16,372
Madulla	28,302
Medagama	32,083
Moneragala	42,575
Sevanagala	36,683
Siyambalanduwa	47,437
Thanamalvila	23,158
Wellawaya	50,349
District Total	396,173

Source: The results of Census of Population and Housing, 2001, Department of Census and Statistics, Sri Lanka, (http://www.statistics.gov.lk/Documents/census2001/resultindex.htm)

The annual population growth rate from the last census in 1981 of the district is 1.8%, while the one for the whole country is 1.2%. It is the third highest growth rate among 18 districts.

In Monaragala, Sinhalese, Sri Lanka Tamil, Indian Tamil and Sri Lanka Moor population comprises of 94.5%, 1.4%, 1.9% and 2% respectively, while those for Sri Lanka are 81.9 %, 4.4 %, 5.1 % and 8.0 % respectively. Predominance of Sinhalese to other ethnic groups is significant in the district.

The religious affiliations in the district show that out of the total population 94.4% are Buddhists, 3% are Hindus, 2.1% are Muslims, 0.4% are Roman Catholics and 0.2% are other Christian sects. The Buddhist distribution of the district is considerably higher than that of Sri Lanka. This may reflect the higher percentage of Sinhalese group in the district.

(2) Hambantota District

According to the Department of Census and Statistics (2001), the populations of each DSD in Monaragala district are estimated as shown in *Table 2.11*.

Table 2.11 Population of DSD in Hambantota District

DSD	Population
Ambalantota	63,930
Angunakolapelessa	42,420
Beliatta	52,280
Hambantota	46,777
Katuwana	62,222
Lunugamvehera	25,148
Okewela	18,204
Sooriyawewa	35,620
Tangalle	62,804
Thissamaharama	60,941
Weeraketiya	55,024
District Total	525,370

Source: The results of Census of Population and Housing, 2001, Department of Census and Statistics, Sri Lanka, (DCS, 2001)

An annual population growth rate from the last census in 1981 of the district is 1.1%, while that of the whole country is 1.2%. It is considerably lower than the annual growth rate for Monaragala district.

Sinhalese, Sri Lanka Tamil, Indian Tamil and Sri Lanka Moor population comprises of 97.1%, 0.4%, 0.1% and 1.1% respectively, while those for Sri Lanka are 81.9%, 4.4%, 5.1% and 8.0%, respectively. Predominance of Sinhalese to other ethnic groups is significant in the district.

The religious affiliations in the District show that out of the total population 96.9% are Buddhists, 0.3% are Hindus, 2.5% are Muslims, 0.2% are Roman Catholics and 0.2% are other Christians. The Buddhist distribution of the district is considerably higher than that of all Sri Lanka. This may reflect the higher percentage of Sinhalese group in the district.

2.3.3 ECONOMY

The government started basic social structural changes with the assistance of IMF and the World Bank. As a result, the actual GDP growth rate rose from the low level of 2% and has maintained a level of 5% since 1990. Reasons for this include an increase of capital from foreign countries, growth of domestic demand and steady export business. However, in 1999, actual GDP declined to the 4% level due to the showing down of industrial growth and the reduced tea market activities.

According to the Household Income and Expenditure Survey, shown in *Table 2.12*, median monthly household income for the rural sector of Sri Lanka was about 4,000 Rupee in 1995/1996.

Table 2.12 Mean and median household income per month by sector 1995/96

Sector	Mean	Median	(Mean - median)*100 / Mean
	Rs.	Rs.	%
All Island*	6476	3793	41.4
Urban	11240	6308	43.9
Rural	5852	3621	38.1
Estate	4059	3377	16.8
Uva Province	3888	2620	no data
Monaragala Distirict	4231	2813	no data
Southern Province	5540	3548	no data
Hambantota District	4397	2770	no data

Source: Household Income and Expenditure Survey 1995/1996, Department of Census and Statistics, Ministry of Finance and Planning

(1) Monaragala District

Employment composition in Monaragala district was examined by the questionnaire survey conducted in this Study. The employment in the agriculture sector accounts for 51.5%. This is higher than that of the whole country, which is 36%; thus, the main employment of Monaragala district is considered to be agriculture.

Monthly income distribution of the district was obtained by the questionnaire. Families with monthly income less than 4,000 Rupee exceeded 60% of the total households. The median for the district inferred from the questionnaire survey result is apparently lower than that of national level of five years ago. Therefore, the district is considered to be a poor area in the country.

(2) Hambantota District

According to the results of questionnaire survey, major employment in Hambantota district is agriculture. The percentage of agricultural employment, which is more than 80%, is higher than that of Monaragala district.

Monthly income distribution of the district was analysed by the questionnaire survey. The percentage of families of which income is less than 4,000 Rs/month, which is around 80%, is higher than that of Monaragala district. The result reveals that the income level in Hambantota district is lower than Monaragala district.

CHAPTER 3 WATER SUPPLY CONDITIONS AND WATER USAGE

3.1 EXISTING WATER SUPPLY SCHEME

In the study area, water supply schemes have been mainly operating under NWSDB. NWSDB operates 269 water supply schemes throughout the Island. In the year 2000, the amount of 332 million m^3 of water was produced (NWSDB 2001). In Hambantota district, the monthly production amount is 822,250 m^3 (the surface water is main source), which is only 3% of the total production amount of whole Sri Lanka. In Monaragala district, the monthly production amount is less than that of Hambantota.

In the study area, 30 water supply schemes are operated by NWSDB and local administrative organization (Pradeshiya Sabha). These schemes supply water to about 234,000 people in both districts.

3.1.1 HAMBANTOTA DISTRICT

In Hambantota district, 19 water supply schemes are operated by NWSDB. The local authorities, namely the Pradeshiya Sabha operate two water supply schemes. Details of these schemes are given in *Table 3.1*. Total population served by these water supply schemes is at least 170,851, which corresponds to 33% of the total population of Hambantota district.

There are five schemes sourcing water by wells and two schemes sourcing water by springs with partial treatment. These schemes depend on groundwater sources. The groundwater covers only 10% of total population supplied water by schemes.

The locations of water supply schemes in the Hambantota district are shown in *Figure 3.1*. The covered areas of five schemes of Hambantota, Ambalantota, Hungama, Ranna and Tangalla are also shown *Figure 3.1*. For the other schemes however, since the data of coverage areas are not available, only the locations of water treatment plants are presented.

Figure 3.2 shows the coverage rate by water supply schemes at each GND. In Hambantota district, the covered area is mainly distributed along the coastal area. The others are distributed in the east and west part of the district.

3.1.2 MONARAGALA DISTRICT

In Monaragala district, six water supply schemes are operated by NWSDB. The local authorities, namely Pradeshiya Sabha operate three schemes. Details of these schemes are given in *Table 3.2*. Total population served by these water supply schemes is at least 63,394, which corresponds to 16% of the total population of Monaragala district.

The water sources of the schemes are rivers and tanks except in Buttala WSS. Only the scheme in Buttala has extracted water from a river and two wells since 1992. Each scheme has a treatment facility for distribution. Out of seven Pilot GNDs, only a part of Yalabowa in Wellawaya DSD, is covered by the water supply scheme.

In Monaragala district, locations of covered areas are dispersed as shown in *Figure 3.1*. The numbers of GND covered by schemes is less than that of Hambantota (See, *Figure 3.2*).

Table 3.1 Existing Water Supply Systems in Hambantota District

No.	Local Authority	Scheme	Maintenance Authority	Year of Construction	Population Surveyed	Supply Hours	Source	Non Revenue Water %	Treatment	Remarks
1	Ambalantota	Ambalantota	NWSDB	1976	9,000	24	Walawe Ganga	22	Full Treatment	Rehabilitated in 1981, 1985
2	Beliatta	Beliatta	NWSDB	1983	6,130	14	Ambala Spring	31	Partial Treatment	Rehabilitated in 2000
3	Hambantota	Bundala	NWSDB	1982	2,800	12	Borehole	10	Partial Treatment	
4	Tissamaharama	Tissamaharama	NWSDB	1981	6,615	24	Kirindi Oya	27	Partial Treatment	Rehabilitated in 2001-2002
5	Hambantota	Hambantota	NWSDB	1960/1981	11,000	8	From Ambalantota	24	Full Treatment	
6	Ambalantota	Hungama	NWSDB	1983	11,000	24	Kattakaduwa Tank (from Ranna WSS)	44	Partial Treatment	
7	Katuwana	Katuwana	NWSDB	1985	8,500	24	Nambili, Ethwalakanda, Beerideniya Dola	20	Partial Treatment	
8	Katuwana	Kirama	NWSDB	1979	1,340	10	Sapugaha Dola	20	Partial Treatment	Rehabilitated in 2000
9	Katuwana	Kirinda	NWSDB	1980	8,615	4	Borehole	49	Partial Treatment	Rehabilitated in 2000
10	Tangalle	Kudawella	NWSDB	1980	3,500	10	From Mattala	38	Full Treatment	
11	Lunugamwehera	Kirindi Oya	NWSDB	1992	53,875	8	Lunugamvehera Tank	39	Slow sand	Rehabilitated in 1994
12	Tangalle	Ranna	NWSDB	1980	15,641	24	Kattakaduwa Tank	49	Partial Treatment	
13	Ambalantota	Ridiyagama	NWSDB	1980	420	24	Ridiyagama Tank	28	Partial Treatment	
14	Tangalle	Talunna	NWSDB	1985	400	4	Borehole	15	Partial Treatment	
15	Tangalle	Tangalle	NWSDB	1953	14,830	8	Borehole/Kirama Oya	30	Full Treatment	Rehabilitated in 1995
16	Tangalle	Unakuruwa	NWSDB	1983	200	6	Borehole	10	Partial Treatment	
17	Ambalantota	Suriyawewa	NWSDB	1997	6,405	no data	Gal Wewa	no data	Full Treatment	
18	Tangalle	Angunakolapelessa	NWSDB	2001	1,300	10	Eraminiyaya	no data	Full Treatment	
19	Weeraketiya	Walasmulla	NWSDB	1953	2,2,80	8	Urubokka Oya	11	Partial Treatment	
20	Katuwana	Mideniya	P/Sabha	1992	3,000	10	Spring	no data	Partial Treatment	
21	Weeraketiya	Weeraketiya	P/Sabha	1973	4,000	12	Udukiriwala Wewa	no data	Partial Treatment	

Source : 1) NWSDB (1997) Rural Water Supply and Sanitation Project/Final Report, Volume 4 District Report Hambantota, modified by JICA Study Team
2) NWSDB Uva Province(2002) Present Situation of the Drinking Water Supply on Hambantota District

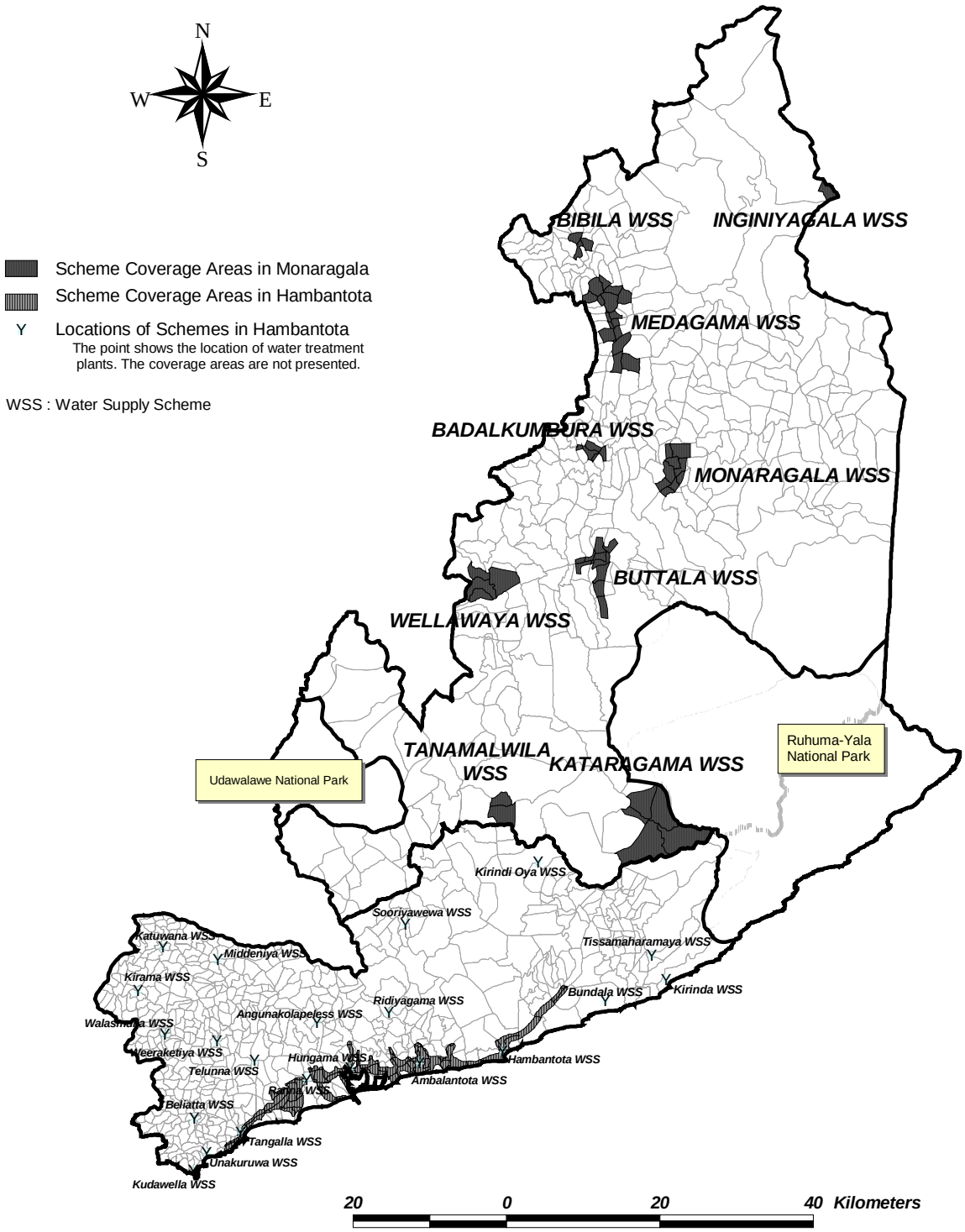

FIGURE 3.1 COVERED AREA BY EXISTING WATER SUPPLY SCHEME

THE STUDY ON COMPREHENSIVE GROUNDWATER RESOURCES DEVELOPMENT	*JICA*

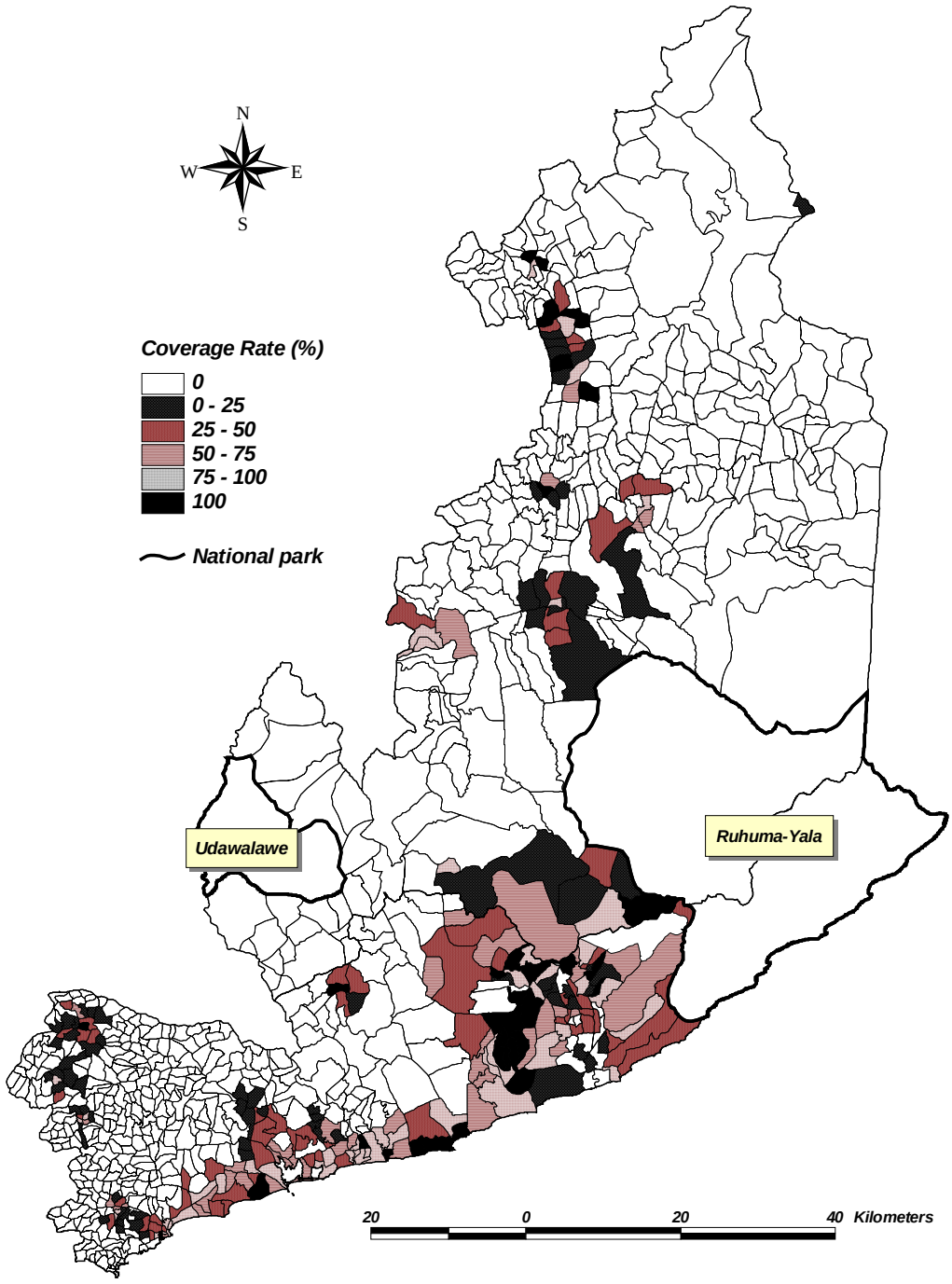

FIGURE 3.2 COVERAGE BY EXISTING WATER SUPPLY SCHEME AT GND

THE STUDY ON COMPREHENSIVE GROUNDWATER RESOURCES DEVELOPMENT	JICA

Table 3.2 Existing Water Supply System in Monaragala District

No.	Local Authority	Scheme	Maintenance Authority	Year of Construction	Population Surveyed	Supply Hours	Source	Non Revenue Water %	Treatment	Remarks
1	Buttala	Buttala	NWSDB	1992	8,000	16	Two(2) Boreholes and Menik Ganga	35	"Dolomite Filter for Fe+, Razin Filter for Hardness	-
2	Monaragala	Monaragala	NWSDB	1992	11,340	24	Stream(gravity scheme)	49	Razin Filter for Hardness"	-
3	Thanamalwila	Thanamalwila	NWSDB	1992	6,000	14	Kirindi Oya	no data	Slow sand filtration	-
4	Inginiyagala	Inginiyagala	NWSDB	1944	2,000	10	Senanayake Samdraya Tank	68	Chlorination	-
5	Kataragama	Kataragama	NWSDB	1975	21,580	24 except dry period	Menik Ganga	20	Infiltration laterals and Slow sand filtration	Rehabilitated in 1987
6	Medagama	Medagama	NWSDB	2000	5,000	24	Gala Oya, gravity	25	Rafine sand filter, Chlorination	-
7	Bibile	Bibile	Pradeshiya Sabha	no data	2,000	6	Naya Kandura Oya, gravity scheme	61	Slow sand filtration	-
8	Wellawaya	Wellawaya	Pradeshiya Sabha	no data	5,200	10	Ice Phillа Gravity Scheme	60	Horizontal flow roughing filtration and Slow sand filtration	-
9	Badalkumbura	Badalkumbura	Pradeshiya Sabha	no data	2,274	no data	no data	no data	no data	-

Source: 1) NWSDB (1999) Surface Water Potential for Drinking Water in Monaragala District/Preliminary Assessment (Abstract).

2) NWSDB UVA PROVINCE OFFICE (2002) PRESENT SITUATION OF THE DRINKING WATER IN UVA PROVINCE

3.2 IRRIGATION AND INDUSTRIAL USE

3.2.1 IRRIGATION

In Hambantota and Monaragala districts, with a total area of 8,284 km^2, a considerable portion is used for forestry and agricultural purposes such as tea, rice and crop cultivation. Surface water such as river and tank water is mainly used for irrigation of rice and other crops. The areas for these purposes are 2,038 km^2 (36%) in Monaragala and 1,024 km^2 (39%) in Hambantota (NWSDB, 1999 and PIU, 2000). The total amount of water consumption for irrigation purpose in Monaragala is twice that of Hambantota.

There are two major rivers in Hambantota district and five major rivers in Monaragala district. The annual irrigation water amount released from major tanks for the recent three years, are shown in *Table 3.3*. The largest reservoir of Lunugamvehera tank, that is located on the border between Hambantota and Monaragala district, has utilized approximately 200 million m^3 of water every year. Generally, water in the reservoir is utilized during less rainfall season in these districts.

3.2.2 INDUSTRY

In Hambantota district, the amount of 1,000 m^3/day of water is consumed by the industrial sector. This amount corresponds to about 4% of water produced by NWSDB in the district. The water is distributed by pipe with 48 connections in the district.

On the other hand, there is no industrial water consumption in Monaragala district. According to NWSDB, the production amount in the district is not enough to supply water to the industrial sector.

3.3 TYPE OF DOMESTIC WATER SOURCE

Water sources for water supply scheme can be classified as groundwater and surface water. The groundwater, which is extracted from tube wells, dug wells and springs, is mainly utilized for the domestic purposes. The surface water, which is extracted from rivers, streams and tanks, is mainly utilized for an irrigation purpose. Surface water is also used for bathing and washing purposes by local inhabitants.

NWSDB (1997a, 1997b) classified water sources for drinking purpose in Hambantota and Monaragala districts, based on the results of demographic survey done by Department of Census and Statistics (1994).

In Monaragala district, the ratio of population served by “House Connection and Stand Post” is 12%. This ratio is lower than Hambantota district of 28% (as shown in *Figure 3.3*). On the other hand, the ratio of population served by “others” sources that includes river, tank and stream, is higher than Hambantota district. There is no significant difference of the ratio served by tube wells between the two districts. This result reveals that the water supply condition of Hambantota district is rather more advanced than Monaragala, in terms of adoption rate of pipe water supply condition. However, the ratios of dug wells are the same in both districts.

In Hambantota district, there are four DSDs that include Pilot GNDs. Among these, the three DSDs of Tangalle, Hambantota and Lunugamwehera show relatively high ratio of population served by pipe (See, *Table 3.4(1)*). On the other hand, Sooriyawewa has a very low ratio of pipe supply. The majority of residents depend on dug wells to obtain domestic water.

Table 3.3 Annual Irrigation Water Amount Released from Major Tanks and Anicuts (Intakes)

MONARAGALA DISTRICT					
River Basin & Name of Tank or Anicut	Capacity	Annual Irrigation Release (MCM)			
	MCM	1998	1999	2000	Average
HEDA OYA					
Muthukandiya Tank	30.33	24.66	25.89	29.59	26.72
WILA OYA					
Ethimale Wewa	6.78	6.17	6.29	6.41	6.29
Kotiyagala Wewa	2.59	2.47	2.47	2.56	2.50
Sub-total	9.37	8.63	8.75	8.97	8.79
KUMBUKKAN OYA					
Kumbukkan Anicut	0.00	19.73	19.97	20.22	19.97
Hulandawa Anicut	0.00	3.08	3.17	3.21	3.15
Sub-total	0.00	22.81	23.14	23.43	23.13
MENIK GANGA					
Buttara Anicut	0.00	18.50	18.86	19.73	19.03
Yudaganawa Tank	0.97	5.55	5.80	6.17	5.84
Karawila-Maila Wewa	1.72	7.89	8.08	8.61	8.19
Kukurampola Anicut	0.00	3.95	4.32	4.44	4.23
Polwatta Anicut	0.00	3.45	3.58	3.70	3.58
Halmillapillewa Tank	1.48	2.96	3.08	3.21	3.08
Horabokka Anicut	0.00	2.96	3.08	3.21	3.08
Sub-total	4.17	45.25	46.79	49.05	47.03
KIRINDI OYA					
Handapanagala Wewa	7.15	5.67	5.80	5.92	5.80
Sudupanawela Anicut	0.00	4.93	5.06	5.18	5.06
Mallatawela-Radapola A.	0.00	2.40	2.47	2.59	2.49
Debara Ara Tank	1.20	1.97	2.03	2.07	2.03
Dambe Wewa	1.44	1.05	1.11	1.13	1.10
Balaharuwa Tank	0.78	2.00	2.03	2.07	2.03
Sub-total	10.57	18.03	18.50	18.96	18.50
WALAWE GANGA					
Hambegamuwa Tank	4.16	5.67	5.80	5.83	5.76
Kandiyapita Wewa	1.38	1.60	1.73	1.78	1.70
Kahakulullanpelessa Wewa	0.37	2.07	2.10	2.16	2.11
Maha Wewa	0.76	1.13	1.25	1.29	1.22
Sub-total	6.68	10.48	10.86	11.05	10.80
HAMBATOTA DISTRICT					
KIRINDI OYA					
Lunugambehera Res.	226.00	243.55	205.20	174.02	207.59
Debara Wewa	7.93	12.66	13.94	15.34	13.98
Tissa Wewa	4.32	18.39	19.76	18.82	18.99
Yoda Wewa	9.74	23.26	21.62	20.84	21.91
Weerawila Wewa	12.95	45.17	41.86	33.85	40.29
Sub-total	260.94	343.03	302.39	262.86	302.76
MALALA OYA					
Bandagiriya Tank	11.16	16.36	16.06	16.03	16.15

Source: Irrigation Department of Monaragala and Hambantota

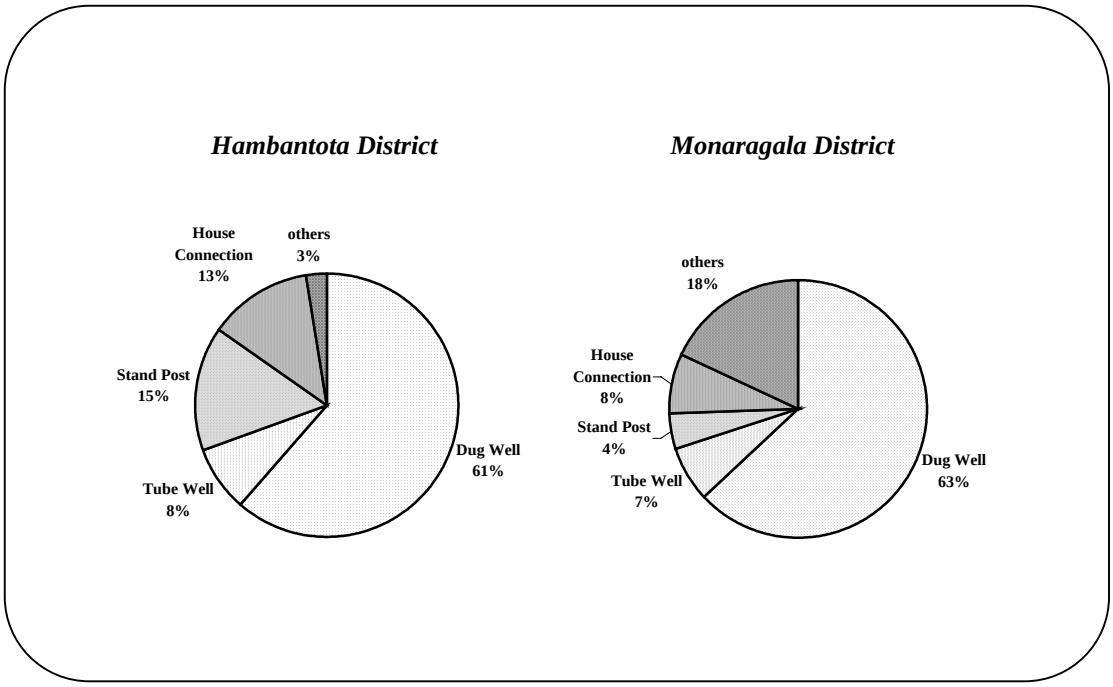

Figure 3.3 Ratio of Water Source in Hambantota and Monaragala

Source: Department of Census and Statistics (1996) Demographic Survey 1994 Sri Lanka, Report on Housing and Basic Amenities, Release 2

In Monaragala district, six (6) DSDs include the Pilot GND. A similar proportion of water source type is observed at each DSD (See, *Table 3.4(2)*).

3.4 FUTURE PLAN (ONGOING PROJECT)

In Hambantota and Monaragala districts, the small-scale water supply project has been implemented by NWSDB. The GNDs that were not covered by existing water supply schemes were selected prior to others. The types of water source in the project are house connection, tube well and dug well. After the implementation of the project, water supply coverage will be increased. This increase of coverage by implementation of ongoing project will be taken into consideration in the future water demand projection.

NWSDB has a policy in connection with water supply, which is that the all of residents should be supplied water through piped water. Therefore, the coverage by pipe supply will be taken into consideration of water demand projection.

In Hambantota district, 78 GNDs will be covered by pipe water supply by the end of year 2004. In Monaragala district, residents in 68 GNDs will be supplied water by the project by the end of year 2002. Out of these GNDs, house connection water supply is planned for 27 GND. “Population covered by house connection in 2002” is calculated by using “the number of household covered by house connection in 2002” that is provided by NWSDB.

Table 3.4 (1) Ratio of Water Source at DSD in Hambantota District (%)

		Dug Well	Tube Well	Stand Post	House Connection	others
1	Ambalantota	67.0	1.9	8.0	19.7	3.4
2	Angunakolapelessa	90.6	4.0	3.0	0.3	2.1
3	Beliatta	85.8	4.2	1.6	8.4	0.0
4	Hambantota*	32.0	10.7	25.3	31.4	0.7
5	Katuwana	60.2	13.5	8.9	7.9	9.5
6	Lunugamwehera*	20.2	6.6	57.9	11.5	3.8
7	Okawela	90.6	7.0	0.6	1.7	0.0
8	Sooriyawewa*	87.1	7.5	0.0	1.2	4.3
9	Tangalle*	37.6	7.7	28.4	25.9	0.3
10	Tissamaharama	46.9	4.5	32.1	14.7	1.8
11	Weeraketiya	75.8	19.8	1.2	2.3	1.0
	Hambantota District	61.3	8.0	15.3	12.7	2.6

Note : 1) DSD* includes Pilot GNDs
2) "others" includes river, tank and stream

Source: Department of Census and Statistics (1996) Demographic Survey 1994 Sri Lanka, Report on Housing and Basic Amenities Release 2

Table 3.4 (2) Ratio of Water Source at DSD in Monaragala District (%)

		Dug Well	Tube Well	Stand Post	House Connection	others
1	Badalkumbura	68.9	6.3	8.6	2.4	13.8
2	Bibile	70.7	5.5	4.7	6.6	12.4
3	Buttala	63.8	9.7	2.8	4.4	19.3
4	Kataragama	8.2	2.5	10.9	68.0	10.3
5	Madulla	71.1	9.2	0.9	5.1	13.6
6	Medagama	78.9	4.1	0.3	0.0	16.7
7	Monaragala	56.7	4.1	1.3	18.6	19.4
8	Siyambalanduwa	85.5	6.5	0.0	0.0	8.0
9	Tanamalwila	49.5	8.2	5.9	3.1	33.3
10	Wellawaya	51.9	10.3	9.1	8.3	20.3
	Monaragala District	62.9	7.1	4.3	7.6	18.1

Note: 1) DSD* includes Pilot GNDs
2) "others" includes river, tank and stream

Source: Department of Census and Statistics (1996) Demographic Survey 1994 Sri Lanka, Report on Housing and Basic Amenities Release 2

3.5 WATER USAGE

3.5.1 GENERAL CONDITIONS OF WATER SUPPLY IN RURAL AREA

Through the study, it was found that in areas outside of NWSDB water supply scheme, residents obtain water from dug wells and tube wells and/or surface water sources. Even in areas covered by NWSDB water supply scheme, people often have to rely on other water sources during the dry season. Common water activity is that one of family members goes to a well located in their own premise or nearby places to bring water by a bucket, pot or some other containers several times in a day. The water brought into the home is used mainly for drinking and cooking purposes, while washing and bathing mostly rely on other water sources.

Dug wells often dry up during the dry season, and the people who rely on them change their water source to nearby tube wells or other available water source such as irrigation channels and tanks. Therefore, the distance to a daily water source ranges from 1 m to over 1 km, according to the questionnaire survey. The water usage conditions of the rural area of the districts are summarized below.

(1) Hambantota District

According to the results of questionnaire survey, average water consumption rate is 19 liter/day/capita in Hambantota district, which is lower than that of Monaragala district of 35 litre/day/capita. Under such water supply conditions, 28.5% of surveyed people felt satisfaction and 71.5% dissatisfaction, in terms of quantity of water supply. The number of the persons who are dissatisfied with the current water supply are twice the group of satisfied, although the average water consumption rate of these two groups are almost same.

Willingness to pay for water supply was analyzed in the results of questionnaire survey. In Hambantota, the peak is a range of 21 to 80 Rs/month at monthly income of less than 4,000 Rs. It can be characterized as a middle range, while the Monaragala district is lower, less than 40 Rs/month. The result suggests that the willingness to pay highly depends on the availability of water, since the water consumption rate of Hambantota is lower than that at Monaragala.

(2) Monaragala District

Average water consumption rate estimated from the questionnaire survey is 35 liter/day/capita in Monaragala district. For the above water supply conditions, 46% of surveyed people felt satisfaction and 54% dissatisfaction, in terms of quantity. However, there is no significant difference between the two groups.

The range of the willingness to pay for the water supply in Hambantoa is less than 40 Rs/month at monthly income of less than 4,000 Rs/month. Very low willingness to pay is observed in the income level of less than 2,000 Rs/month which is the majority group in the district.

3.5.2 WATER CONSUMPTION

Water consumption rate during rainy season for domestic purpose shows a range between 11 to 33 liter/day/capita at each Pilot GND in Hambantota district, and a range between 15 to 36 liter/day/capita at each Pilot GND in Monaragala district. On the other hand, water consumption rate during dry season for domestic purpose shows a range between 11 to 28 liter/day/capita at each Pilot GND in Hambantota district, and a range between 16 to 33 liter/day/capita at each Pilot GND in Monaragala district (See, *Figure 3.4*). These results reveal that the condition of water

consumption at Pilot GNDs in Hambantota district is worse than that of Pilot GNDs in Monaragala district.

According to the Design Criteria provided by NWSDB, designed rate of domestic use for the "stand post" is 45 liter/day/capita. The water consumption rate obtained by this survey in the Pilot GNDs in Hambantota and Monaragala districts shows one-quarter to three-quarter of the design rate.

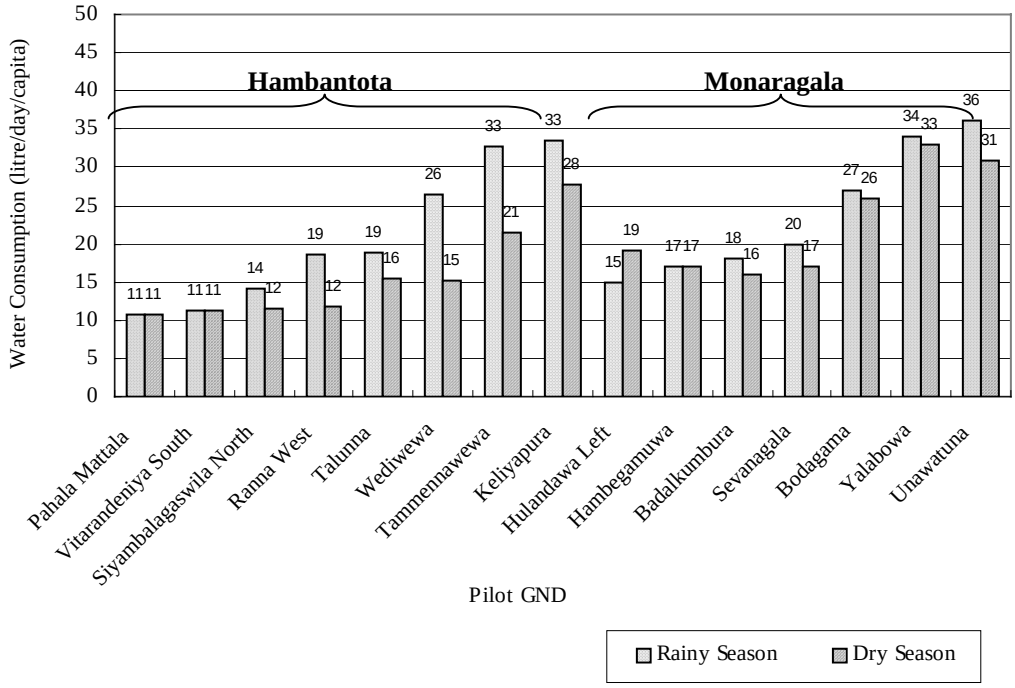

Figure 3.4 Water Consumption Ratio in Rainy and Dry Season

Source: Results of Questionnaire survey in this study

3.5.3 DISTANCE TO MAJOR DOMESTIC WATER SOURCES

The relationship between distance to the water source and water consumption rate in each Pilot GND in Hambantota and Monaragala districts is examined in the results of the questionnaire survey.

The water consumption rate decreases as distance to the water source increases (See, *Figure 3.5*). The distances to the water source at Hambantota district are generally longer than that at Monaragala district. This result suggests that the accessibility to the water source at Hambantota district is lower than that at Monaragala district with minor exceptions.

Figure 3.6 shows the ratio of distance to the water source. The Figure clearly shows that the ratio of short distance to the water source is larger in Monaragala and smaller in Hambantota. This result also suggests that better accessibility to the water source is needed in Monaragala.

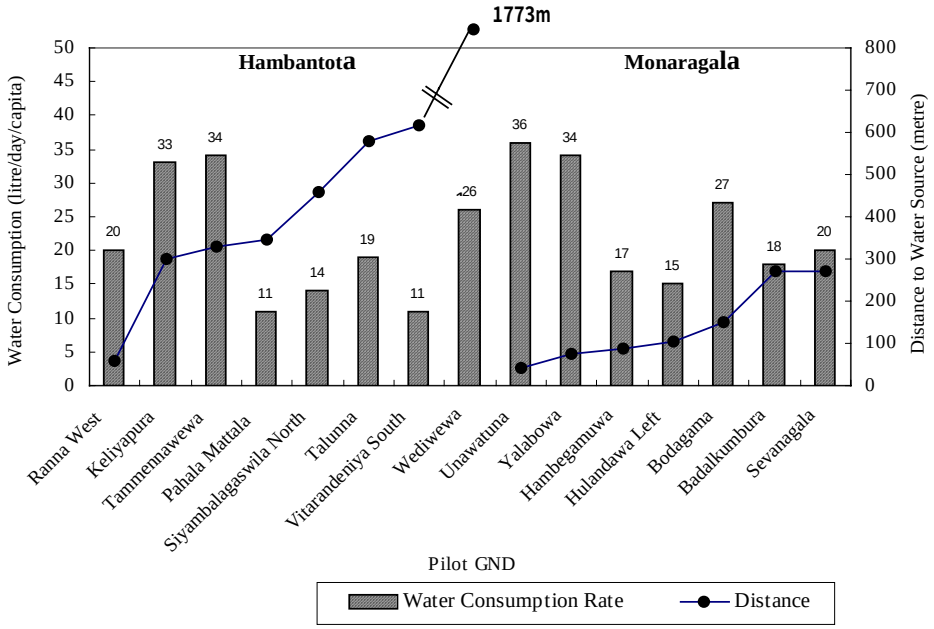

Figure 3.5 Relationship between Distance to Water Source and Water Consumption Rate

Source: Results of Questionnaire survey in this study

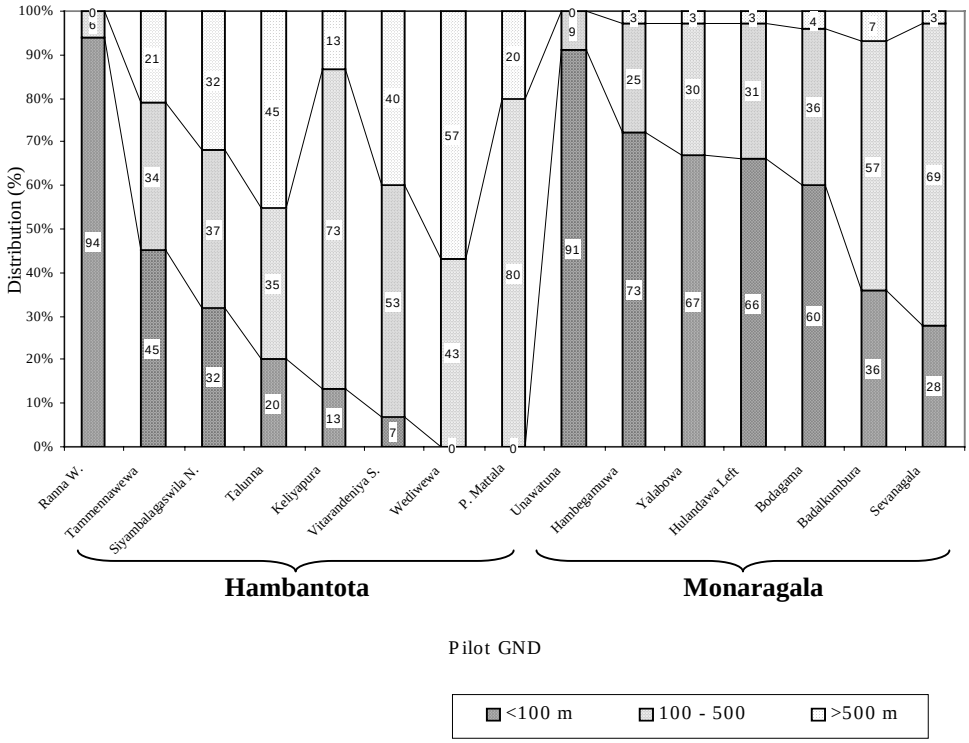

Figure 3.6 Distribution of Distance to Major Water Source

Source: Results of questionnaire survey in this study

3.5.4 WATER SOURCES

The distribution of five major types of water source (namely, dug well, tube well, stand post, house connection and others) are examined at each Pilot GND. The "others" includes surface water such as river, stream and tank, and bowser water supply.

In Hambantota district, more than 80% of families in three GND (Ranna West, Pahala Mattala and Tammennawewa) depend mainly on stand post. On the other hand, the majority of the water source at other GNDs is dug well. Especially in the case of Talunna and Siyambalagaswilla North, percentage of dug well is more than 90%.

The poor accessibility to the water source is noted at Wediwewa where the percentage of "others" in the GND is 20%, which is apparently higher than other GNDs.

In Monaragala district, more than 70% of families depend for their water source on dug well, except in Yalabowa. In Yalabowa, about 60% families are supplied domestic water through stand post, but the ratio of dug well is not small; it is still over 40%.

3.5.5 CONDITION OF WATER SOURCE IN DRY SEASON

To understand the condition of water source in dry season, the ratio of the service interruption and "dried up" is examined based on the results of questionnaire survey. As shown in the *Figure 3.7*, the ratio of service interruption and dried up in the Pilot GNDs in Hambantota district is higher than that of Monaragala district.

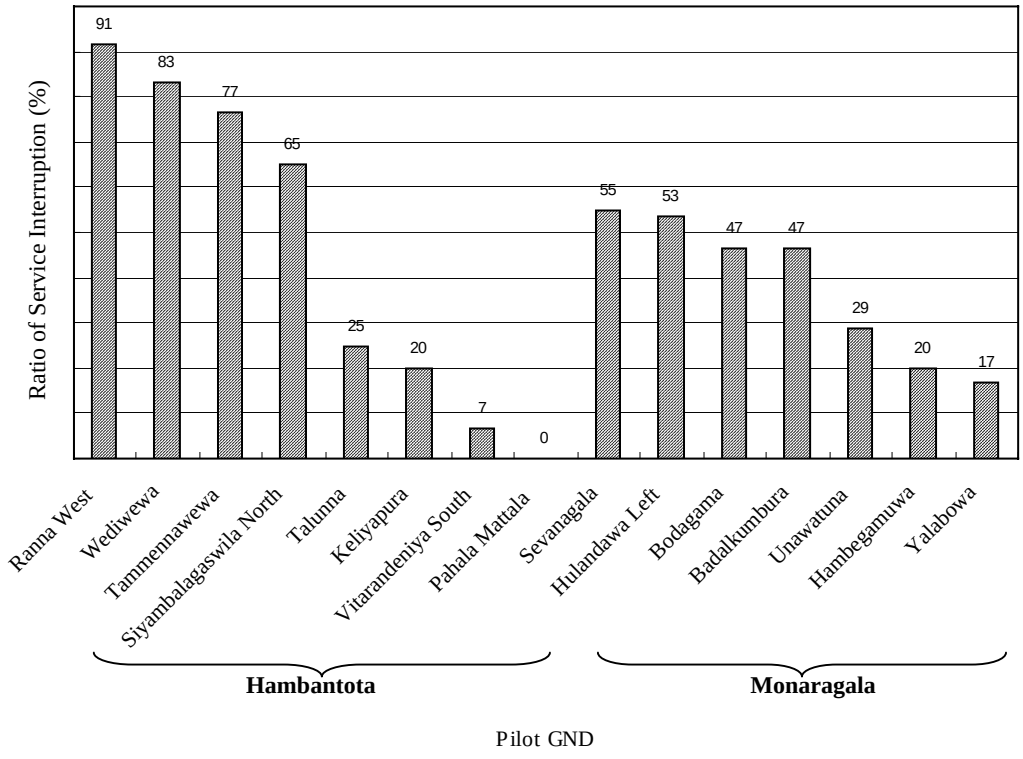

Figure 3.7 Ratio of Service Interruption and Dried Up of Water Source

Source: Results of questionnaire survey in this study

In Hambantota district, the ratio of service interruption and dried up in two GNDs (Ranna West and Tammennawewa) exceeds 80%, although the major water source is stand post. On the other hand,

in the Pahala Mattala, there is no service interruption and dried up at either stand post and dug well. This fact suggests that the stability of the service for the water supply scheme depends largely on its water source.

CHAPTER 4 HYDROGEOLOGY

4.1 GENERAL

This chapter describes the results of the hydrogeological study. Based on the results, two hydrogeological maps have been prepared: namely, the hydrogeological map for the upper fractured aquifer, *Figure 4.1(1)*, and the hydrogeological map for the lower and deeper fractured aquifer, *Figure 4.1(2)*. The maps contain the information about groundwater yield, quality (EC), depth to groundwater, existing well location, geological structure and physiographic information such as surface water and contour lines. In addition to the above information, the hydrological data, such as the catchment of the areas where the test wells were constructed and the watershed of the main rivers, were inputted to GIS database that was the basis of the hydrogeological maps. The supporting report described the details of GIS database.

4.2 AQUIFER CATEGORIES AND YIELD

4.2.1 CATEGORY OF AQUIFER

There are two types of aquifer in the area. One is the shallow aquifer occurring in the subsurface deposits overlying the basement rock. The other is the aquifer occurring in the fractured or weathered zone in the basement rock. The above results show the aquifers can be practically classified into three categories to consider a future groundwater development in the area, though a network of fractures in the basement rock, or a fractured aquifer system, is not clear yet. These categories are;

(1) Shallow Aquifer in Subsurface Deposits

In the inland area, aquifers have generally been exploited with dug wells for domestic use. Almost all houses seem to have their own well in some districts. Additionally there are some communal dug wells for village people. The depth varies from a few meters to about 10 m. The yield or extracting volume has not been recorded. The water level fluctuates widely from season to season. Further development potential is practically limited.

In the coastal area where alluvium deposits are thickly distributed, some tube wells have been constructed with a submersible pump to extract water from the aquifer in NWSDB water supply schemes. Several tube wells about 15 m deep have extracted 300 to 700 liters/min. from a sand layer along the Kirama Oya in Tangalla. These wells also are affected by seasonal conditions.

(2) Aquifer in Basement Rocks

Aquifers in basement rocks have been exploited mainly by tube wells installed with a hand pump. *Figure 4.2* shows the correlation between the depth of tube well and well yield. The figure indicates the average yield clearly decreases below the depth of 70 m. It increases between the depth of 80 m and 90 m and decreases again below the depth of 90 m. The bar charts of the median yield also show the same tendency. The graph usually suggests that a main exploited zone of groundwater is fractured and/or weathered zone occurring above the depth of 70 m in hard rocks. In addition, the graph indicates that a relatively large scale water bearing zone may occur around the depth between 80 and 90 m.