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MAHAWELI WATER MANAGEMENT TO MAXIMISE BENEFITS

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Executive Summary

The Mahaweli scheme is a comprehensive multipurpose water resources development project intended to harness the hydroelectric and irrigation potential of the Mahaweli Ganga and its tributaries.

The system consists of hydro-power plants, irrigation systems regulating reservoirs, diversion anicuts and conveyance canals and tunnels.

The rainfall pattern of the country is dominated by two monsoons, the South-West monsoon (May – July) and North-East monsoon (Nov-Jan). The geography of the central hills brings rainfall to the South-Western and Central hill regions during both monsoons while the rest of the country get its rainfall mostly from the North-East monsoon.

Anticipating the growth of competing water demands and the need for cooperative water management, the Mahaweli Authority of Sri Lanka (MASL), with the assistance of the other agencies and ministries involved, has established the Water Management Panel (WMP) and a Water Management Secretariat (WMS). The principal function of the WMP and WMS is to govern the management of the water resources of Mahaweli, Kelani and Walawe rivers to achieve optimum benefits. The WMS uses a computer model called Acres Reservoir Simulation Program (ARSP) in seasonal planning. Regular weekly meeting are held with the Irrigation Department, Ceylon Electricity Board, Mahaweli Economic Agency and Mahaweli Head Works unit to make bulk allocation of water in these 3 rivers for irrigation and power generation.

Water quality and sedimentation studies are done regularly to monitor the situation. This paper attempts to identify some options to optimise the benefits from the water resources from Mahaweli, Kelani and Walawe rivers and to show how these benefits were optimised during the construction period as well.

INTRODUCTION

The Mahaweli Ganga is the most important river in Sri Lanka with a basin area equivalent to fifteen percent of the country's land area and receives rain from both South-West and North-East monsoons. It carries the largest volume of discharge amounting to one seventh of the island's total runoff. The Mahaweli Basin covers an area of 10320 KM. A cascade of dams and power houses has been constructed for irrigation and hydro-power generation. The system consists of hydro-power plants, irrigation projects, regulating reservoirs, diversion anicuts and conveyance canals and tunnels. The Kelani Ganga, which is an independent river located to the West of the Mahawei Ganga basin, supports a complementary hydroelectric generating capability in Sri Lanka. The Walawe Ganga which is located South of Mahaweli Ganga basin has hydro-power and irrigation capabilities.

Water is indispensable for life on earth and also an essential natural resource for food production and many productive activities. Therefore continued availability of adequate fresh water of acceptable quality is needed for sustainable development of a country. Due to increasing demand and degradation of quality of water by pollution and saline intrusion, the availability of safe and adequate water is fast becoming one of the most important factors limiting social economic development and thus, creating local, regional, national and international conflicts. This situation calls for a comprehensive water resource management plan and compel us to treat water as an economic good and manage it to get the maximum benefits out of this limited scarce natural resource.

Fig 1 Illustrates the 3 hydrologic zones in Sri Lanka.

Fig. 2 Illustrates the stream flow volumes in the Mahaweli and Kelani Ganga systems.

The Mahaweli System

The Mahaweli Ganga development consists of multipurpose projects constructed in the Mahaweli Ganga and the Amban Ganga together with irrigation projects served by diversions from the principal rivers.

Fig. 3 shows the general layout of projects in two rivers, which together comprise the Mahaweli System.

Kotmale project consists of a concrete face rock fill dam and a hydropower station.
Polgolla diversion is a multipurpose project comprising a low, gated barrage across the Mahaweli Ganga and a power tunnel which diverts water from the Mahaweli Ganga to the Amban Ganga through the Ukuwela power station.

Victoria multipurpose projects comprising a concrete double curvature arch dam and hydropower station in the Mahaweli Ganga.

Randenigala multipurpose project comprising a rock fill dam and hydropower station in the Mahaweli Ganga.

Rantambe multipurpose project comprising a low concrete dam and a hydro power station in the Mahaweli Ganga, Minipe diversion weir permits diversion of Mahaweli Ganga flows to serve agricultural needs in irrigation system B and C on the right bank, and irrigation system E on the left bank.

Bowatenna multipurpose project consists of concrete dam and a hydropower station in the Amban Ganga. This project permits the diversion of flows to irrigation system H,IH and MH to the north, and regulates flow to Elahera and Angamadilla irrigation diversion located downstream.

Elahera diversion is a low weir and intake structure which allows diversion of Amban Ganga flow to serve agricultural needs in irrigation system D1 on the left bank.

Angamadilla diversion consists of a low weir and intake structure which allows diversion of Amban Ganga flows to serve agricultural needs in irrigation system D2 in the left bank.

The water available in the Mahaweli Ganga is more than what is required for the development of the land in its own basin. Therefore the Master Plan recommended diversion of the surplus water into the adjacent basins of Kala Oya, Malwatu Oya, Yan Oya and Maduru Oya where a large part of the irrigable lands is located. The Mahaweli water is diverted at Polgolla and Minipe for irrigation .

Table 1 shows the irrigation area and the extent under cultivation.

Table 2 shows the Polgolla diversion to Amban ganga during last few years.

The schematic diagram of Mahaweli System is as shown in Fig 3.

The network of multipurpose reservoirs, diversion and irrigation facilities that are being developed under the Mahaweli Project become more complex with the completion of each new project. It is essential to establish appropriate operating policies to govern the releases and subsequent distribution of Mahaweli water. This will ensure that the maximum possible benefits are achieved from the Mahaweli scheme as it grows, and will provide a sound base on which to plan further development.

The operation of the Mahaweli system has three principal objectives.

1. To provide a reliable irrigation water supply to the crops for food production.
2. To get the maximum possible hydro electric benefits from the irrigation releases.
3. To provide an additional benefits to the electrical system through the release of water that is not required for irrigation purposes.

The task of meeting these objectives is complicated by the need to phase electrical outputs to complement the operation of other components of the electrical system. These systems are Kehelgamuwa-Maskeli oya complex (K-M complex) of reservoirs and power stations, the Samanalawewa reservoir and power stations and all the other thermal stations.

The studies to examine alternative operating policies are complex in nature. The physical description of the principal elements of the Mahaweli system and the important components of the natural electrical system has already given.

Operating Policy Alternatives

Scarcity of water and the variability of the water supply have governed the Mahaweli Development water management policy in the past. The addition of major multipurpose reservoirs under the accelerated Mahaweli Programme has provided a measure of improved flexibility and water supply reliability in certain systems. However, the reservoirs cannot provide complete regulation of the Mahaweli system. Therefore, water security and water supply variability will continue to dominate operational policies in future.

Before examining operating policies for the future it is useful to review present operating policy scenarios, as some elements of their policies will be incorporated into the future policies. Other factors that will influence future polices include.

- Commitments made to farmers in various irrigation projects.
- Practical limitations imposed by hydrology and by the characteristics of the reservoirs diversion facilities and land in the command areas.
- Reliability requirements for the national electrical system.
- The returns to investment.

Implications of new Developments

As irrigation and hydropower development proceed in the lower Mahaweli Ganga basin it has became less attractive economically to divert water at Polgolla from Mahaweli Ganga into the Amban Ganga. With the Victoria, Randenigala and Rantambe dam are completed, it will be more attractive economically generate energy at there 3 power houses than to generate energy at Ukuwela and they use the water for irrigation in system H. While this can be shown to be true in principle realistic alternatives diversion policies must be examined using simulation analysis.

It is necessary to consider the effect of wet, dry and average hydrological conditions and to develop realistic alternative operating polices that could potentially be used to govern diversion operations. An overall assessment of diversion policy, option can be then made, considering socio-economic and regional development factors, as well as broader economic criteria.

In addition to the effects of new system developments in diversion policies, it is necessary to consider the construction of new multi-purpose reservoirs since those reservoirs can provide an additional reliability to the irrigation water and power supply.

Planning for System Operation

Anticipating the growth of competing water demands and the need for cooperative water management, the Mahaweli Authority of Sri Lanka (MASL), with the assistance of the other agencies and ministries involved, has established the Water Management Panal (WMP) as a decision making body. The Water Management Secretariat (WMS) was formed under MASL to provide technical advice to WMP, and to co-ordinate operation throughout the Mahaweli system. One of the major responsibilities of WMS is managing, regulating and forecasting of the storage and distribution of water for multiple usage for and within all present and future components of the Mahaweli System.

The WMS does long term planning, annual planning , seasonal planning and weekly planning to maximise the benefits from water resource of Mahaweli, Kelani and Walawe river systems.

With the completion of Polgolla and Bowatenna projects in mid seventies the diversion policy at Polgolla was to divert maximum for generating at Ukuwela power house and to irrigate lands in system H and D. Since H area was not fully developed for irrigation at initial period maximum power release was made at Bowatenna power house and large portion of water was allowed to spill at Elahera anicut due to capacity limitation in Elahera, Minneriya and Yoda Ela. With the development of system H more water was diverted at Bowatenna to System H through the irrigation tunnel and the water duties in system H was very high due to cultivation of paddy even during Yala.

In 1979 NEDECO submitted a revised proposal to increase the Victoria reservoir capacity to 721 MCM and the long term average annual diversion at Polgolla to 875 MCM . These values were used by the consultants for the design of Victoria, Randenigala and Rantambe projects. The values of 875 MCM was the result of a series of studies carried out on the water balance in order to obtain maximum power benefits while satisfying the irrigation requirements in systems 'H', D and 'G'.

The rated heads for power generation under the Mahaweli cascade down stream of Polgolla are as follows.

Victoria	190 m
Randenigala	78 m
Rantambe	31.5 m

The rated heads of the power generation after Polgolla diversion are given below.

Ukuwela	78 m
Bowatenna	52 m

Only part of the flow diverted at Polgolla will pass through Bowatenna Power station.

All the irrigation systems have to be rehabilitated to increase the efficiency of the system to that suitable arrangements for the operation and maintenance of D-canal and field canal can be put in place.

Agro based industries as well as other industries have come up in these rural areas due to availability of water and electricity. Hundreds of hectares of land are cultivated with banana particularly in Walawe special area, where banana has been a traditional crop for many centuries.

The cost of the Mahaweli Project was recovered with hydro-power and agricultural benefits alone within 10 years.

At present the total paddy land acreage coming under WMP is 170,000 ha which is ¼ of the total paddy land in Sri Lanka. At present the plant installed capacity in Mahaweli System is 660 MW. Kelani and Samanalawewa total is 455 MW with 446 MW thermal capacity the total hydro and thermal availability is 1560 MW. It is recommended to increase the area under irrigation and hydropower generation to meet the future needs of the people.

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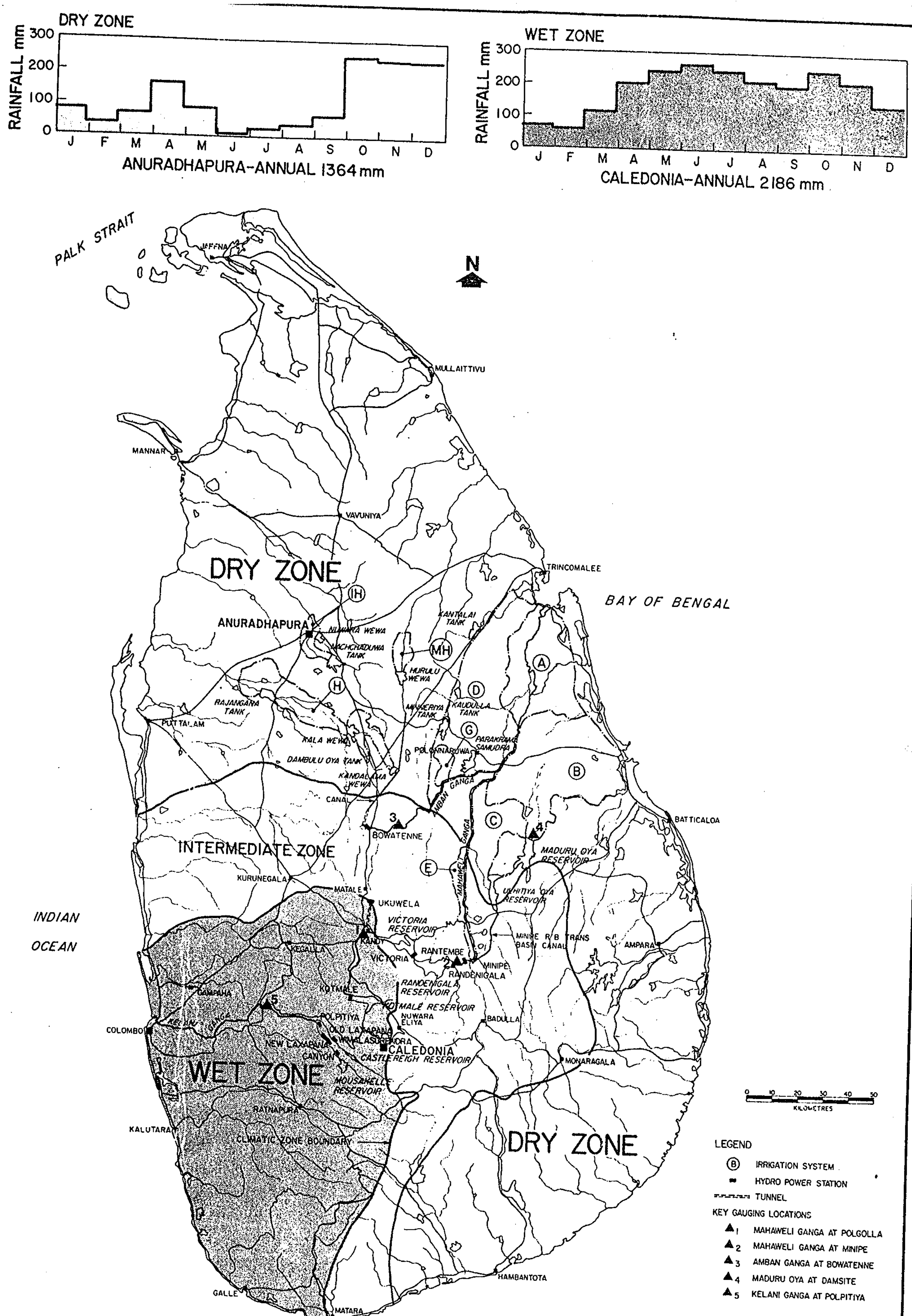

Figure 1 HYDROLOGICAL REGIONS OF SRI LANKA

The 875 MCM diversion policy started with Victoria project in 1984, but average annual Polgolla diversion has been maintained around 1000 mcm to increase the total benefits from irrigation and hydro power generation. This was due to power demands at that time was less than the availability till end of eighties and the system B,C,A was not fully developed as planned earlier.

At present the Polgolla diversion is maintained to give full extent of paddy cultivation in System H, D, G in Maha season and the extent in yala season is planned between 40% - 80% of the total available extents depending on the water availability and to maintain the limit 875 mcm diversion.

Conclusions and Recommendations

Due to Bowatenna irrigation tunnel capacity constraints it is not possible to increase the extent cultivated is system H to more than 60% even in a very wet year. The income of farmers in system H is maximised by cultivation of mostly other field crop in Yala season and action has been taken to improve a marketing of these products.

Annually more than 500 mcm spills at upper Mahaweli and Kelani reservoirs. To increase the benefits it is suggested to reduce the tariff on power during November and December, so that the spill water can be used for power generation due to increase of power demand. If we have good storage like Moragahakanda in the Ambanganga system part of the water that spills now can be diverted at Polgalla and stored in Moragahakanda reservoir.

If the Moragahakanda reservoir is constructed the cropping extents in System H,D,G can be increased to two since a proposed new NCP (North Central Province) canal starting from Moragahakanda reservoir can take water to Anuradhapura city tank as well as to Huruluwewa tank.

By constructing a new canal just up stream of Minipe LB canal water can be taken to Minneriya and other tanks in System D1. Still only 1/3 of the extent has been developed down stream of Minipe for irrigation and water is lost.

In future Maduruoya RB, System A Kaudulla has to be developed for agriculture and few more reservoirs like Upper Kotmale, Moragahakanda, Kaluganga, Uma Oya projects to be constructed to meet the future power and irrigation demands of the country.

Due to availability of Mahaweli water in dry zone, districts like Anuradhapura, Polonnaruwa and Trincomalee have been benefited a lot. If not for the Mahaweli Project these people would have migrated to the wet zone areas and created a lot of problems in these areas and this therefore is of some benefit to the country overall.

Due to regulation of water, flood damage in downstream areas has been reduced and the reliability of water supply has been granted not only for irrigation but for the domestic needs of urban and rural population living in these areas.

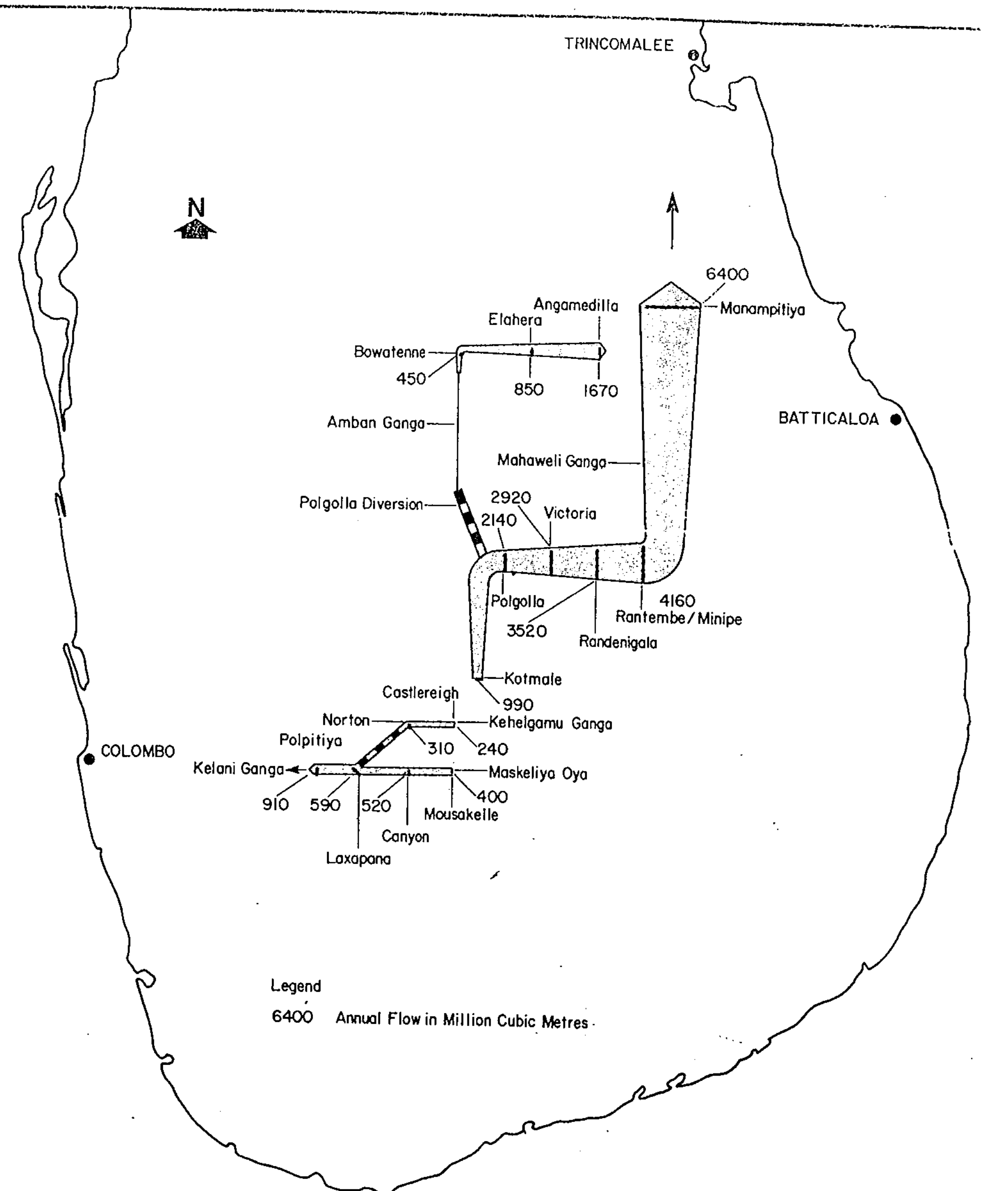

Figure 2
STREAMFLOW VOLUMES IN THE MAHAWELI AND KELANI GANGA SYSTEMS

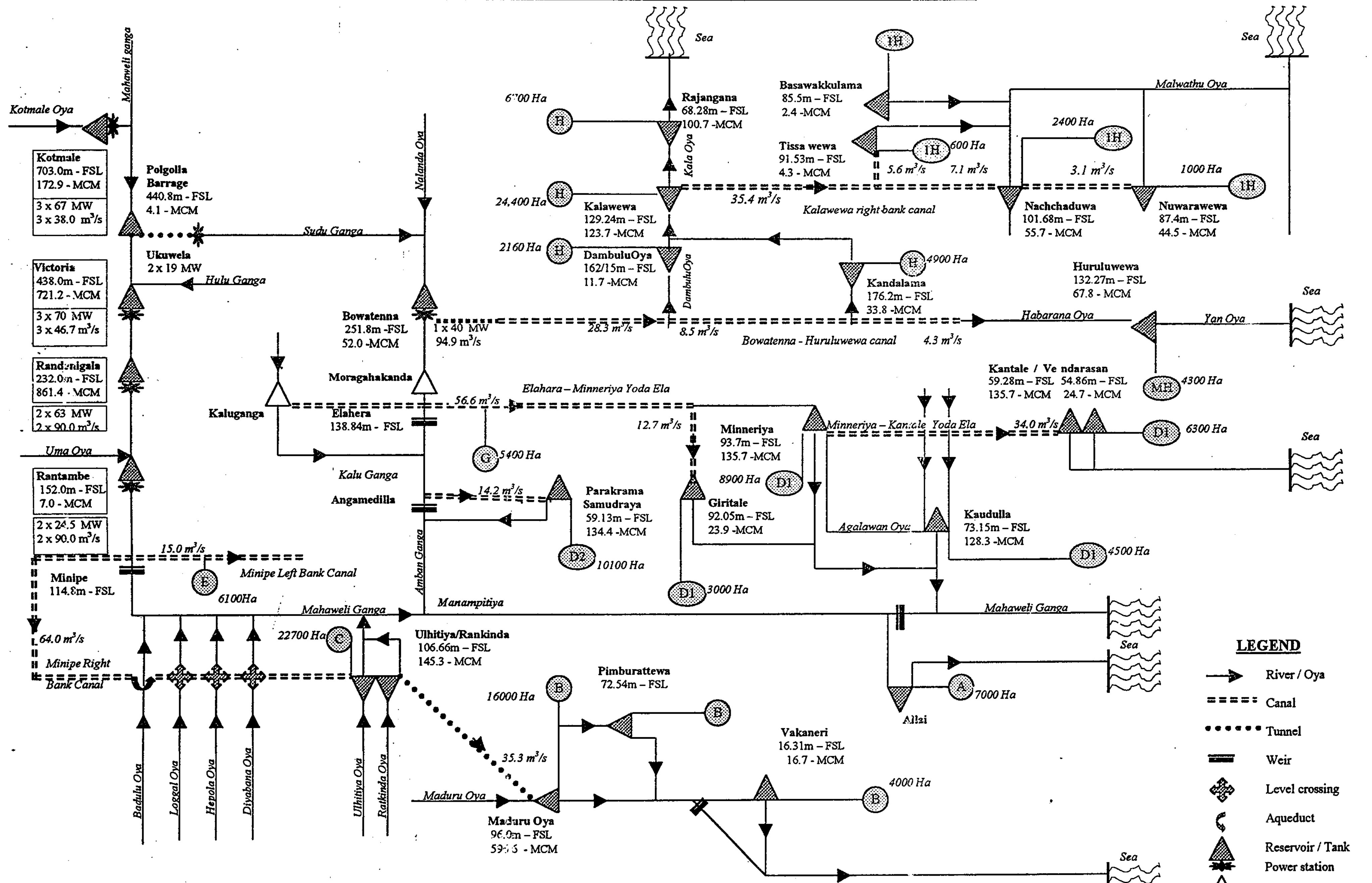

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Table 1 : **SUMMARY OF CROPPING DATA**

System	Scheme	Avail Area (ha)	Proposed Crop			Water Issue	
			%	Type	Area (ha)	1st Date	Last Date
H,IH,MH	Dambulu Oya	2160	95	Paddy	2060	Oct 15	Mar 15
			5	Upland	100	Oct 15	Mar 15
	Kandalama	4900	95	Paddy	4650	Oct 15	Mar 15
			5	Upland	250	Oct 15	Mar 15
	Huruluwewa	4300	100	Paddy	4300	Oct 15	Mar 15
	Feeder Canal`	1500	100	Upland	1500	Jan 01	Apr 30
	Kalawewa RB	13565	95	Paddy	12890	Oct 01	Feb 28
			5	Upland	675	Oct 01	Feb 28
	Kalawewa YE	4700	95	Paddy	4450	Oct 15	Mar 15
			5	Upland	230	Oct 15	Mar 15
	Kalawewa LB	6100	95	Paddy	5800	Oct 15	Mar 15
			5	Upland	300	Oct 15	Mar 15
	Nachchaduwa	2500	100	Paddy	2500	Oct 10	Feb 28
	Nuwarawewa	972	100	Paddy	972	Oct 10	Feb 28
	Tissawewa	600	100	Paddy	600	Oct 10	Feb 28
D1 & G	Elahera	5400	96	Paddy	5100	Oct 15	Mar 15
			4	Upland	300	Oct 15	Mar 15
	Giritale	3036	100	Paddy	3036	Oct 15	Feb 28
	Minneriya	8900	100	Paddy	8900	Oct 15	Feb 28
	Kaudulla	4500	100	Paddy	4500	Oct 15	Feb 28
	Kantale	6143	100	Paddy	6143	Oct 15	Feb 28
D2	Parakrama Sam	10100	100	Paddy	10100	Oct 10	Feb 28
E	Minipe LB	6100	100	Paddy	6100	Oct 10	Feb 28
	Ulhitiya	22700	96	Paddy	21800	Oct 01	Feb 28
	Maduruoya	16000	95	Paddy	15300	Oct 01	Feb 28
	Vakeneri	4000	100	Paddy	4000	Oct 15	Feb 28
A	Allai	7000	100	Paddy	7000	Oct 15	Feb 28
Z	Udawalawe RB	11900	66	Paddy	7902	Sep 21	Feb 28
			34	Upland	4050	Sep 21	Feb 28
	Udawalawe LB	5820	62	Paddy	3630	Sep 25	Feb 28
			38	Upland	1947	Sep 25	Feb 28
	Liyangastota LB	2554	100	Paddy	2554	Sep 20	Jan 30
	Liyangastota RB	2455	100	Paddy	2455	Oct 20	Feb 28
	Kaltota	915	100	Paddy	915	Oct 01	Mar 30

Table 2 - Polgolla Power and Spill Releases

Spill Release (mcm) — POLGOLLA BARRAGE — Historic data

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1984	63.6	49.5	40.6	109.6	18.4	149.2	471.1	78.9	118.0	171.3	49.3	27.1	1346.6
1985	40.5	8.0	8.9	21.0	94.2	720.9	419.2	137.4	22.5	179.9	285.9	64.5	2002.9
1986	301.7	93.0	111.9	172.5	102.2	50.2	33.5	151.6	204.4	356.7	212.6	2.8	1793.1
1987	1.6	4.3	1.8	1.9	26.3	54.3	52.3	62.2	228.2	326.9	207.6	43.9	1011.3
1988	3.4	4.8	21.1	76.6	47.1	67.2	228.6	294.1	366.7	179.4	193.5	24.3	1506.8
1989	20.8	0.4	3.6	5.9	57.1	319.0	573.6	277.4	217.4	181.0	359.6	91.4	2107.2
1990	148.9	12.3	17.0	0.1	66.5	95.0	101.2	90.4	35.8	60.0	98.8	21.2	747.0
1991	42.3	1.8	0.4	5.0	0.0	82.7	27.3	23.0	25.8	87.0	53.0	70.1	418.4
1992	39.7	4.9	0.0	16.8	32.5	83.1	171.0	217.4	120.8	156.0	135.3	92.4	1069.9
1993	4.8	0.2	0.0	0.0	84.2	296.7	238.9	79.0	6.0	136.4	213.8	217.1	1277.1
1994	131.3	89.9	9.6	5.6	19.4	17.4	12.7	81.6	59.5	214.2	305.7	155.2	1102.0
1995	21.7	30.7	10.0	68.6	274.8	207.8	57.0	75.3	135.6	229.0	215.0	28.6	1354.1
1996	2.9	3.8	4.0	60.5	4.5	71.0	81.3	95.2	202.8	251.6	64.9	46.2	888.6
1997	4.2	0.2	3.5	35.4	99.0	12.8	55.9	39.5	187.4	168.6	260.4	165.1	1032.0
1998	45.2	3.9	13.0	0.0	11.7	35.7	89.6						
AVG	59.1	21.7	16.6	41.4	66.2	159.1	180.2	121.6	137.9	192.7	189.7	75.0	1261.2
STD	80.9	31.4	28.5	49.3	67.0	181.0	177.0	81.7	99.4	77.9	94.1	61.2	456.4
MAX	301.7	93.0	111.9	172.5	274.8	720.9	573.6	294.1	366.7	356.7	359.6	217.1	2107.2
MIN	1.6	0.2	0.0	0.0	0.0	12.8	12.7	23.0	6.0	60.0	49.3	2.8	418.4

Power Release/Polgolla Div. (mcm) — POLGOLLA BARRAGE — Historic data

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1984	142.1	123.4	126.0	132.4	115.7	144.8	145.9	90.7	75.2	139.7	131.3	74.7	1441.9
1985	74.9	24.0	15.1	50.2	79.5	115.3	139.5	130.8	120.0	124.0	117.8	107.5	1098.6
1986	64.7	53.2	39.9	35.6	87.5	118.6	124.3	105.7	72.9	62.6	63.6	91.3	919.9
1987	60.2	53.9	23.6	46.7	52.3	83.8	51.3	58.0	0.0	0.0	80.2	124.9	634.9
1988	98.1	74.1	54.1	32.3	100.2	120.5	81.2	49.6	0.0	14.0	65.6	121.2	810.9
1989	99.0	78.1	56.5	38.0	57.9	63.5	85.1	110.3	114.2	112.6	80.4	82.1	977.7
1990	38.5	104.0	101.9	61.3	91.7	134.2	129.4	129.7	113.4	64.1	103.9	84.9	1156.8
1991	52.5	92.1	60.8	42.5	42.9	116.9	122.6	129.3	104.0	92.0	124.8	68.1	1048.5
1992	47.4	69.4	32.1	8.5	12.8	87.1	110.0	115.6	111.3	144.8	123.8	60.6	923.4
1993	72.8	60.3	17.4	24.3	59.9	105.2	148.1	138.0	140.0	114.2	75.9	13.4	969.3
1994	12.8	19.0	54.0	59.2	109.7	119.6	89.4	121.7	94.8	84.7	18.3	7.2	790.2
1995	60.8	34.2	59.6	44.3	32.6	82.5	133.0	117.8	97.9	124.2	69.3	99.2	955.4
1996	83.8	57.0	19.4	37.2	25.2	20.8	66.6	82.2	92.2	123.8	133.4	103.1	844.7
1997	75.3	57.5	12.8	38.4	53.0	65.5	103.5	91.1	43.3	116.0	73.2	28.2	757.7
1998	31.2	54.7	63.9	25.9	66.1	101.7	120.0						
AVG	70.2	64.3	48.1	46.5	65.8	98.5	109.3	105.0	84.2	94.0	90.1	76.2	952.1
STD	29.7	28.1	32.1	27.1	31.0	32.0	29.4	26.4	41.1	42.9	32.1	36.1	191.1
MAX	142.1	123.4	126.0	132.4	115.7	144.8	148.1	138.0	140.0	144.8	133.4	124.9	1441.9
MIN	12.8	19.0	12.8	8.5	12.8	20.8	51.3	49.6	0.0	0.0	18.3	7.2	634.9