

# MAHAWELI HYDROPOWER IS SRI LANKA'S KEY TO DEVELOPMENT

by

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## Abstract

This article is aimed at examining the performance of the Mahaweli Development Program to date, by comparing the total project cost with agricultural and hydropower benefits. An attempt was also made to show its contribution towards reducing unemployment in Sri Lanka. It demonstrates that, the total expenditure of the project has already been recovered through combined agricultural and hydropower benefits by mid nineties of the 20th century and that, the hydropower benefit alone would pay the total cost of the project by the early years of the 21st century. Therefore the need for a vision is emphasized at the end, since two third of the proposed agricultural area and one half of the potential hydropower stations of the Mahaweli development program is yet to be developed.

## 1. Introduction

The total expenditure of Mahaweli Development Project was Rs 72 billion by the end of 1997. This was the largest investment ever undertaken by the government of Sri Lanka on any development project of this nature. Many are wondering whether this project has already paid off or not. Since by the end of 20th century, Mahaweli Project was completing 30 years, it is the intention of this article to present a clear picture of total expenditure, benefits and achievements of this project to an average Sri Lankan.

When the UNDP/FAO master plan to develop the irrigation and hydropower potential of Sri Lanka's largest river, Mahaweli Ganga and its adjacent basins, was drawn up in 1968, its intention was to make the country self-sufficient in rice production, reduce unemployment from the then 20% to almost zero and provide hydro-electric energy for industry's needs up to the year 2000. Under this program, 15 multipurpose projects were identified on the Mahaweli Ganga, its tributaries and the adjacent rivers such as Maduru Oya. They were to provide water to 360,000 ha of irri-

gable land and generate 506 MW of hydroelectricity (see Table 1 and 3). First of the three project phases, started in 1970, was the construction of the Polgolla barrage with a diversion tunnel to divert Mahaweli waters to Ambanganga basin. The purpose of Bowatenna reservoir, which was built on the upper reach of Amban Ganga was to regulate and divert part of these waters into Kala Oya basin and to augment flows in the Elahera canal which feeds the ancient reservoirs at Giritale, Minneriya, Kaudulla and Kantale (Figure 1).

In the latter part of nineteen seventies, following several years of economic stagnation induced partly by the oil crisis, the government of Sri Lanka embarked on accelerating the Mahaweli Development Program with a view to achieving most, if not all, of those objectives in a much shorter time scale. Under the new program three major reservoirs were built across the upper reach of Mahaweli at Kotmale, Victoria, and Randenigala to regulate river flows and has started producing most of the hydropower with an installed capacity of 533 MW. This program has also provided water to 125,000 ha of irrigable land, on which over 400 thousand people were settled. A further 120,000 ha of irrigable land to the North were to be opened up between 1985 and the end of the 20th century when the accelerated program was scheduled for completion. However the latter has never taken place due to various problems such as ethnic, economic and donor withdrawals etc. The Rantembe reservoir built at the confluence of Uma Oya and Mahaweli Ganga was not included in the original master plan, but it was a new addition to the Mahaweli program by the consultants to the Randenigala hydropower project. This reservoir is capable of regulating the Uma Oya flows and Randenigala power releases and it generates 50 MW of hydropower. Below these reservoirs at Minipe, a

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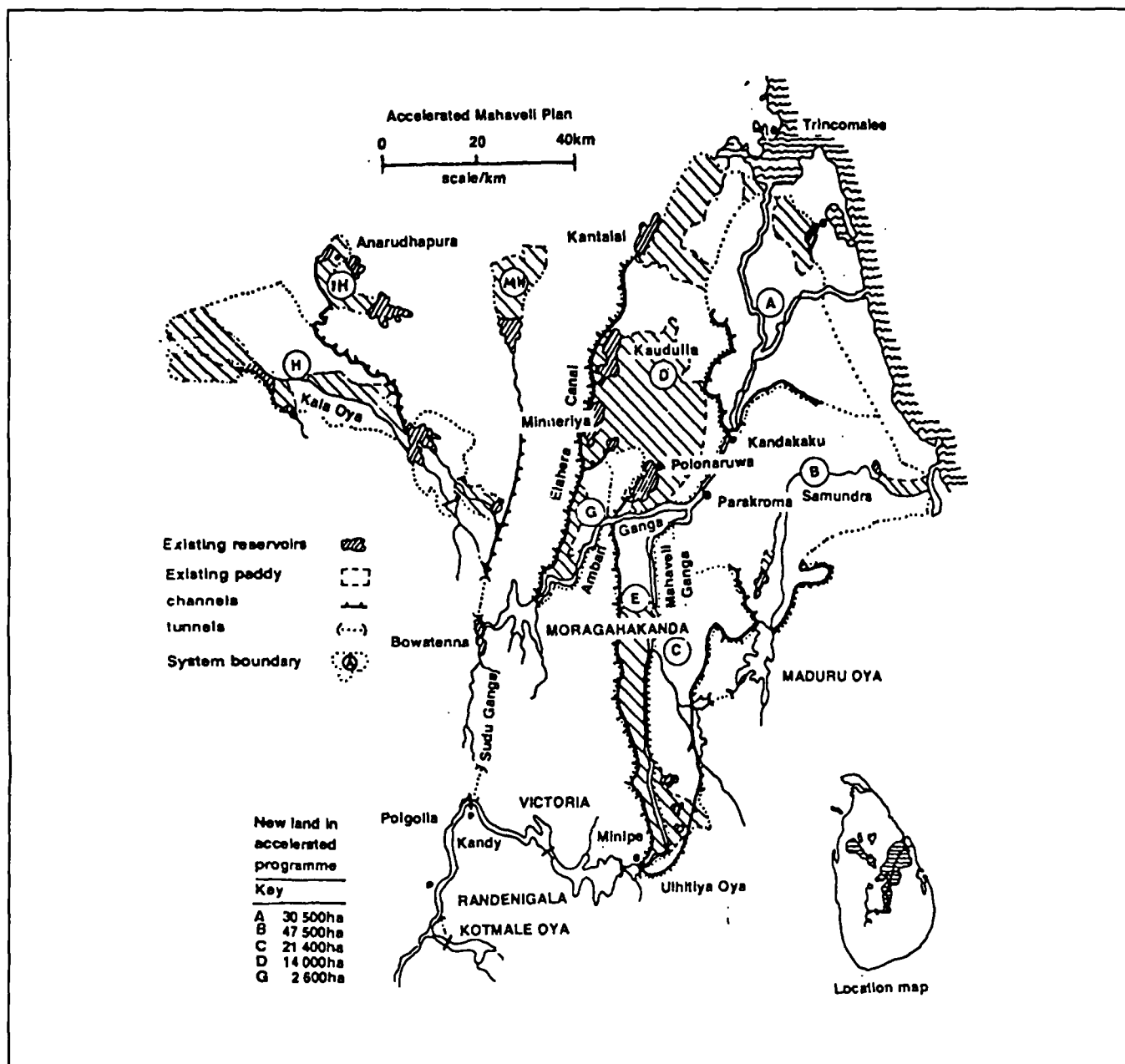


Figure 1 - Layout of Mahaweli Development Program

new weir was constructed across Mahaweli Ganga to divert a part of the releases from Rantembe reservoir eastward into the newly constructed Uthiya Oya and Maduru Oya reservoirs to irrigate new areas in system C and B.

Having outlined the status of the projects completed up to the end of the last century let us now try to estimate the energy and agricultural benefits of the project and its costs to date, and then evaluate its settlement and employment aspects.

## 2. Energy Benefits

The Mahaweli Development Program envisaged substantial energy benefits to the national economy through the development of hydropower. Therefore the key parameters of some of the hydropower projects were modified at the design stage to give optimum benefits from the hydropower generation and irrigation development. As a result the installed capacity of these plants exceeded the total installed capacity of all the plants under the UNDP/FAO Plan (see Table 1).

Table 1- Mahaweli Hydro Power Plants

Hydro Plant	Installed Capacity (MW)		Energy Generation (Gwh/Year)		Date of commissioning of different units
	(UNDP)	(AS Built)	Planned (UNDP)	Avg. (1990-98)	
Kotmale	105	201	580	459	Apr 85, Feb 88, Feb 89
Ukuwela	36	38	269	172	Jul 76, Aug 76
Victoria	120	210	570	691	Sep 84, Oct 84, Jan 85
Randenigala	75	122	345	348	Aug 86, Sep 86
Rantembe	0	49	0	185	Mar 90, Apr 90
Bowatenna	44	40	210	62	Jun-81
Moragahakanda	40		206		
Upper Uma Oya	25		126		
Lower Uma Oya	30		148		
Taldena	14		72		
Pallewela	10		50		
Heen Ganga	7		35		
<b>Total</b>	<b>506</b>	<b>660</b>	<b>2611</b>	<b>1917</b>	

Table 2 - Mahaweli Energy Contribution to the National Grid

Calendar Year	Energy Generation (GWh)		Installed Capacity (MW)		Peak Power (MW)	Contribution as a % of the Total	
	Mahaweli	System Total	Mahaweli	System Total		Energy	Power
1976	96	1,133	40	574	223	8	7
1977	186	1,216	40	574	239	15	7
1978	200	1,386	40	574	273	14	7
1979	193	1,525	40	574	300	13	7
* 1980	196	1,668	40	574	328	12	7
* 1981	256	1,928	80	614	379	13	13
1982	307	2,109	80	614	415	15	13
* 1983	207	2,075	80	614	408	10	13
* 1984	519	2,228	115	649	438	23	18
1985	986	2,443	335	907	481	40	37
1986	1,280	2,648	382	955	521	48	40
* 1987	827	2,690	418	990	530	31	42
1988	1,365	2,788	535	1,110	549	49	48
1989	1,472	2,843	607	1,210	560	52	50
1990	1,713	3,138	652	1,257	618	55	52
1991	1,529	3,376	662	1,267	665	45	52
* 1992	1,560	3,547	662	1,297	698	44	51
1993	1,909	3,982	662	1,407	784	48	47
1994	2,209	4,368	662	1,407	860	51	47
1995	2,663	4,780	662	1,407	941	56	47
* 1996	1,809	4,354	662	1,472	857	42	45
1997	1,620	4,901	662	1,572	965	33	42
1998	1,952	5,554	662	1,626	1,093	35	41
2000	2,350	6,616	662	1,700	1,302	36	39
2005	2,350	9,107	662	2,100	1,792	26	32
2010	2,350	12,360	662	2,800	2,433	19	24
2015	2,350	16,619	662	3,600	3,271	14	18
2020	2,350	23,528	662	5,000	4,631	10	13

Note: 1) \* indicates years with power cuts

) Energy forecast is based on scenario: Base, pg 44, Table IM81.12;

Electricity Demand Forecast Volume A-4

Electricity Demand, Master Plan for the Electricity Supply of Sri Lanka.

) Peak power is computed assuming 0.58 load factor.

The estimation of benefits and costs of a multipurpose reservoir project is a difficult task. It involves a considerable share of joint benefits, which cannot be easily assigned to either irrigation or hydropower development. Therefore after tabulating the annual energy generation up to 1998 in Table 2 annual benefits were computed in Table 4 by valuing the electricity generation at 1998 prices. In Table 2 when Mahaweli energy and power contribution is compared with national requirements, it is clear that from 1976 to 1984 the Mahaweli contribution was marginal. But after 1984, Mahaweli contribution to the national grid increased substantially so that by 1990 its contribution was 55% of total generation and was meeting 52% of the peak power demand. The energy generation has continued to occupy above 50% of the total demand on average until 1995. Even though at present, the Mahaweli system is capable of generating 2,350 million Kilowatt Hours of energy annually on average, in the absence of developing the remaining potential hydropower projects (about 500 MW of medium to small scale) its contribution would drop to around 10% of the total by year 2020.

### 3. Agricultural Benefits

One of the main objectives of the Mahaweli Development Programme was to achieve self-sufficiency in rice production as early as possible. Since rice is the staple diet of the bulk of the population, the government of Sri Lanka wanted to achieve this goal for the long-term economic and political stability.

In computing the agricultural benefits from the Mahaweli Development Program, the net income from the agricultural sector was computed depending on the crop cultivated on these lands. The net income from crops like Tomato and Banana is over Rs 100,000 per Hectare, while that of Onions and Beans is above Rs 50,000 per Hectare. The same from Chillies, Okra and Brinjal is above Rs 30,000 per Hectare. Only the net income from Paddy, Green Gram and Maize is around Rs 20,000 per Hectare. The cost of labour on paddy cultivation is about 35% of the total cost and in computing the benefits from the agricultural areas the cost of labour was deducted. But in reality cost of labour is a saving to the farmers as farmers belonging to a field canal or D-canal, work on each other's farm plots in a participatory manner. Therefore the actual income (agricultural benefits) from one Hectare is more than the above figures. Nevertheless Rs. 21,000 per hectare is assumed as benefit from paddy while Rs. 50,000 per hectare is assumed for other field crops in Mahaweli areas.

Table 3 shows the list of irrigation systems to be developed under the Mahaweli Master Plan together with planned extents and actual extents developed up to 1998. The development of systems H, C, and B was undertaken as new development in the Mahaweli program while the development of systems IH, MH, G and D1 could be considered as augmentation. Therefore in computing the extent cultivated in each year the extents shown under system H, C and B indicate the total extent cultivated during that year while extents shown under other systems were computed proportionate to the ratio of diverted volume of Mahaweli water to the irrigation system to total volume of water issued at the head sluice.(see Table 4).

(As can be seen from Table 4 the irrigation benefits were equal or higher than the energy benefits until the energy generation of accelerated Mahaweli program came into effect in 1984)

Sri Lanka became self sufficient in rice only in mid eighties. By then only the systems H and G were fully developed. The contribution from systems C and B came into effect little by little only after mid eighties. As a result, Sri Lanka was almost self sufficient in rice up to early nineties. The other contributing factors for this situation was the increased usage of fertilizer and cultivation of high yielding varieties of paddy.

Table 3 - Existing and New Lands Cultivated under Mahaweli Program

Irrigation System	Extent under Irrigation (ha)	
	(UNDP)	(Developed)
A	46,154	7,000
B	50,567	19,300
C	31,134	23,110
D1, G	40,688	28,100
D2	11,053	10,100
E	8,259	6,100
F	3,522	-
H	41,741	38,425
I	56,680	4,000
J	12,915	-
K	8,097	-
L	39,028	-
M	14,534	4,300
Total	364,372	140,435

Table 4 - Agricultural & Energy Benefits From Mahaweli Project (1998 prices)

Calendar Year	Extents cultivated (ha)				Upland	Agric. Benefits Rs billion	Energy		Total Cum Bene. Rs billion
	Paddy			B, C & H			Generation (GWh)	Benefit Rs billion	
	B, C & H	IH & MH	D1 & G		Total				
1976							96.0	0.3	0.3
1977	-	2,533	23,169	25,702	-	0.54	186.0	0.7	1.5
1978	12,749	6,038	12,114	30,901	-	0.65	200.0	0.7	2.9
1979	21,377	2,728	8,574	32,679	-	0.69	193.0	0.7	4.2
1980	21,992	8,911	7,129	38,032	-	0.80	196.0	0.7	5.7
1981	35,157	8,806	22,294	66,257	-	1.39	256.0	0.9	8.0
1982	30,392	7,800	22,920	61,112	-	1.28	307.0	1.1	10.4
1983	37,366	6,392	8,309	52,067	-	1.09	207.0	0.7	12.2
1984	50,300	7,262	-	57,562	5,800	1.50	519.0	1.8	15.5
1985	51,058	4,925	25,337	81,320	8,989	2.16	986.0	3.5	21.1
1986	59,900	6,553	20,992	87,445	12,880	2.48	1280.0	4.5	28.1
1987	62,355	4,429	6,991	73,776	8,660	1.98	827.0	2.9	32.9
1988	76,718	8,357	16,426	101,501	9,660	2.61	1356.0	4.7	40.3
1989	67,071	2,286	20,512	89,869	5,102	2.14	1472.0	5.2	47.6
1990	79,380	10,406	37,384	127,170	14,470	3.39	1713.0	6.0	57.0
1991	90,523	7,704	21,030	119,258	12,935	3.15	1529.0	5.4	65.5
1992	89,885	3,987	30,361	124,233	5,115	2.86	1560.2	5.5	73.8
1993	94,456	4,412	24,295	123,163	13,080	3.24	1909.0	6.7	83.7
1994	105,825	8,771	13,047	127,643	15,409	3.45	2208.5	7.7	94.9
1995	104,910	7,785	9,222	121,917	9,822	3.05	2663.3	9.3	107.3
1996	96,580	4,896	15,667	117,143	7,095	2.81	1809.3	6.3	116.4
1997	105,738	3,241	22,190	131,169	7,156	3.11	1619.8	5.7	125.2
1998	110,495	6,373	25,482	142,350	7,045	3.34	1951.6	6.8	135.4
		Total				47.74		87.7	135.4

Note:

- 1) Net benefits from agriculture paddy= Rs 21,000, Upland=Rs 50,000 per Hectare (1998 prices)
- 2) Net benefits from Hydro-power = Rs 3.50 per KWh (1998 prices)
- 3) Benefits from B, C & H are direct while that from system IH, MH, D1 & G are incremental.

**Table 5 - Total Expenditure of Mahaweli Project**

Calendar Year	Foreign Aid Rs billion	Domestic Expendi- -ture Rs b	Total Expendi- -ture Rs b	Total Cost as per 1998 prices		
				@ 4% dr	@ 8% dr	@12%dr
1980	1.521	1.755	3.276	6.636	13.090	25.190
1981	2.227	1.851	4.078	7.943	15.087	27.997
1982	2.644	3.242	5.886	11.025	20.167	36.086
1983	4.590	2.221	6.811	12.265	21.604	37.278
1984	4.073	4.493	8.566	14.833	25.160	41.863
1985	2.688	2.999	5.687	9.470	15.467	24.817
1986	3.298	0.782	4.080	6.532	10.273	15.894
1987	2.154	2.654	4.808	7.401	11.210	16.724
1988	2.436	0.772	3.208	4.749	6.926	9.964
1989	1.485	1.618	3.103	4.416	6.202	8.604
1990	0.611	1.237	1.848	2.529	3.421	4.576
1991	2.360	2.065	4.425	5.823	7.583	9.782
1992	1.175	1.495	2.670	3.378	4.237	5.270
1993	2.745	1.955	4.700	5.718	6.905	8.283
1994	0.895	1.916	2.810	3.287	3.823	4.422
1995	1.174	1.667	2.841	3.196	3.579	3.992
1996			1.712	1.851	1.997	2.147
1997	1.601	1.665	1.729	1.793		
1998						
Total Rs Billion			72.108	112.72	178.46	284.68

Note : 1)The cost of project includes the cost of projects under Accelerated Mahaweli Programme and cost of Uda Walawe since 1981.  
2) Rantembe Power Project was constructed by the CEB and hence it is not included here.

#### 4 The Comparison of Cost and Benefits

The estimate of the total cost of the Mahaweli Development programme up to end of year 1998 is not very easy to compute. However Table 5 shows the total expenditure of Mahaweli Authority of Sri Lanka (MASL). Thus the figures shown are somewhat over-estimated due to the work handled by MASL other than that under the Mahaweli program, namely the expenditure on Uda Walawe rehabilitation project. This Table also shows the cost of Mahaweli project in constant 1998 prices at 4, 8 and 12 percent discount rates. Since the major share of expenditure on this project has come as foreign aids, consisting of grants and soft loans a 4% discount rate is considered to be more suitable when the cost of the project is compared with the benefits.

In Table 6 the costs and benefits are compared and this analysis is graphically represented in Figure 2. It's evident from this analysis that the cost of the project

had been already paid off by year 1996 and the forecast reveals that the cost of the project will be paid off by hydropower benefits alone by year 2004. It is also evident that even the agricultural benefit alone is going to catch up the project cost in years to come. Initially, the cumulative agricultural benefit of this project was higher than the cumulative benefit of energy (from 1981 to 1984, see Table 6). But after 1985 the cumulative benefit of energy is always higher than that of agriculture. According to Figure 2 the gap between cumulative benefit of energy and agriculture is widening year by year. Therefore the Mahaweli Development Programme could no longer be treated as an agricultural and Irrigation Project after considering the present status of development.

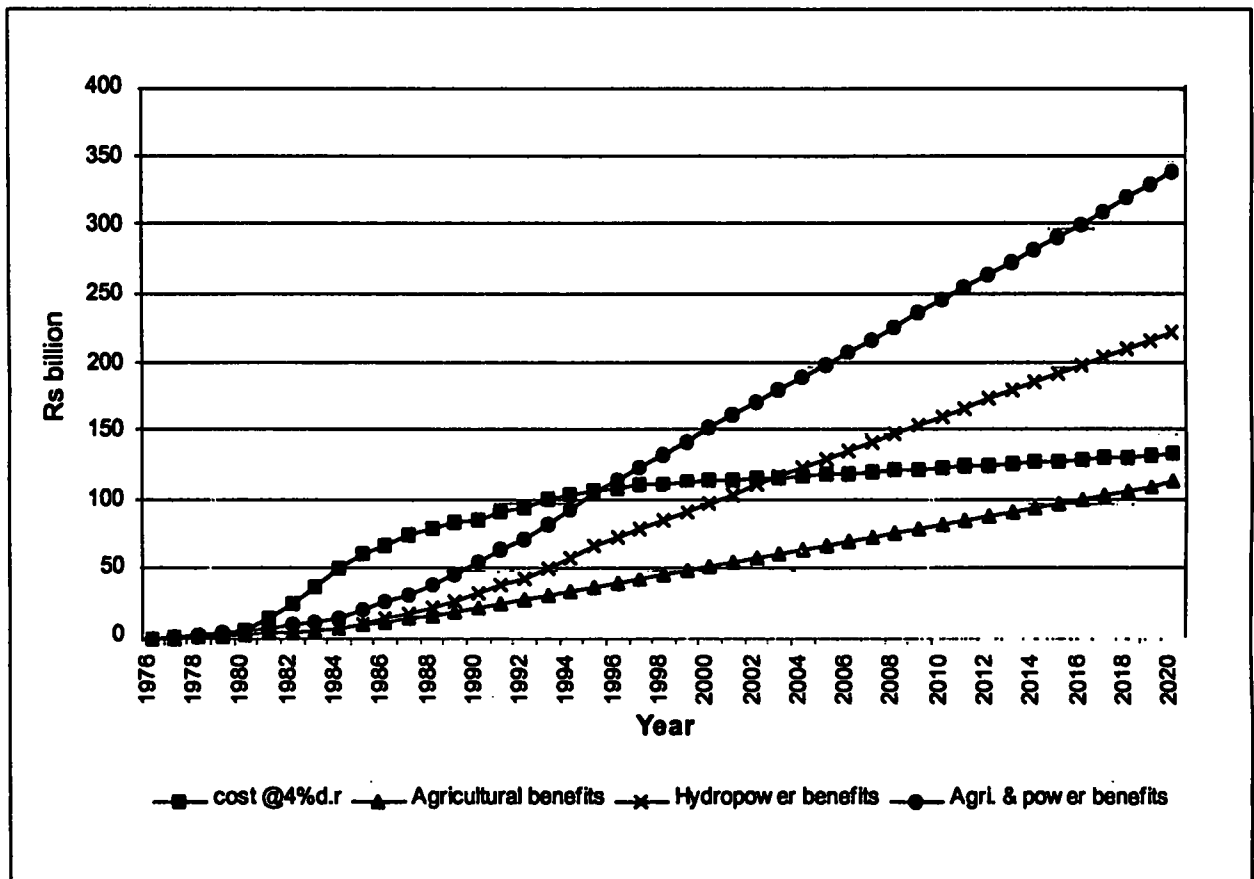


Figure 2 - Cumulative Cost & Benefits of Mahaweli Program



## 5 Employment Generation

Last of the objectives of Mahaweli Development Programme was to reduce the unemployment that prevailed during the seventies and eighties. The agricultural development in Mahaweli areas had generated adequate employment opportunities not only in the agricultural sector, but also in other sectors like trade, agro industries, health, postal, education, construction industries etc. This is evident from the fact that in pre Mahaweli era people migrated from Mahaweli areas to urban areas for employment and education. This trend has already stopped and at present, people migrate from non-Mahaweli areas to Mahaweli areas for employment in trade, industries, tourism, banking etc. In early days the ancient city of Dambulla, which is situated at the junction of four main routes to Colombo, Kandy, Trincomalee and Anuradhapura was only equipped to support the needs of these travelers on the major trunk routes. But it has now become a major trade centre in Sri Lanka not only for Mahaweli produce but also for other produce as well. In this regard, the peripheral urban development, which has taken place in cities like Anuradhapura, Polonnaruwa and Mahiyangana are not second to that in any other cities in Sri Lanka.

Finally Table 7 shows the number of new settler families settled in various systems in the Mahaweli project and their population by 1997. Since there are no recent surveys conducted in these areas to estimate the number of employment opportunities created in these areas, the table shows the percentage employed from the surveys done in 1992-93 period. Out of the 445,314 only 189,770 were employed. This figure covers agricultural (self and wage) employment, but does not cover self-employed traders (migrant or otherwise). Therefore this category could be considered as belonging to the permanent employment cadre created as a result of the Mahaweli Project. Nevertheless, this figure is very important, if one consider Mahaweli as an employment generation project. The cost of each new job created is Rs 0.6 million at 1997 prices. (Rs. 112.7 billion / 189,770 = Rs. 0.6 million). Therefore it could be rated as a very costly one. Moreover, the new employment created represents only 3.1% of the estimated labour force (3.1% =  $189,770 \times 100 / 6,229,000$ ) in Sri Lanka as of 1997 Ref. Central Bank Annual Report, 1998 page 107, Table 7.4.

Table 6 -Cost Benefit of Mahaweli Project @ 1998 prices

Calendar Year	Cummulative Cost of Project @different discount rates Rs b			Cummulative Benefit Rs billion		
	4%	8%	12%	Agricul-tural	Hydro-Power	Cumu-lative
1976				0.0	0.3	0.3
1977				0.5	1.0	1.5
1978				1.2	1.7	2.9
1979				1.9	2.4	4.2
1980	6.6	13.1	25.2	2.7	3.0	5.7
1981	14.6	28.2	53.2	4.1	3.9	8.0
1982	25.6	48.3	89.3	5.3	5.0	10.4
1983	37.9	69.9	126.6	6.4	5.7	12.2
1984	52.7	95.1	168.4	7.9	7.6	15.5
1985	62.2	110.6	193.2	10.1	11.0	21.1
1986	68.7	120.8	209.1	12.6	15.5	28.1
1987	76.1	132.1	225.8	14.6	18.4	32.9
1988	80.9	139.0	235.8	17.2	23.1	40.3
1989	85.3	145.2	244.4	19.3	28.3	47.6
1990	87.8	148.6	249.0	22.7	34.3	57.0
1991	93.6	156.2	258.8	25.9	39.6	65.5
1992	97.0	160.4	264.0	28.7	45.1	73.8
1993	102.7	167.3	272.3	32.0	51.8	83.7
1994	106.0	171.2	276.7	35.4	59.5	94.9
1995	109.2	174.7	280.7	38.5	68.8	107.3
1996	111.1	176.7	282.9	41.3	75.2	116.4
1997	112.7	178.5	284.7	44.4	80.8	125.2
1998	113.7	179.5	285.7	47.7	87.7	135.4
2000	119.2	185.5	291.7	66.3	125.3	191.6
2005	124.7	189.5	295.7	78.6	150.4	229.1
2010	127.7	193.5	299.7	91.0	175.5	266.5
2015	131.2	197.5	303.7	103.4	200.7	304.0
2020	135.7	201.5	307.7	115.7	225.8	341.5

- Note
- 1) Assuming 1997 expenditure to remain constant since 1998
  - 2) Assuming average of 1996-98 benefits to continue since 1998
  - 3) Agricultural benefits = Rs 21,000 per hectare for paddy & = Rs 50,000 per hectare for other field crops (OFC are mainly Chillies & Onions)
  - 4) Forecasted figures are shown thus : 
  - 5) Benefit : Cost comparisons are shown thus : 

Another method of computing this component is separating the cost of agricultural development, which is 50% of the total cost and considering that as the direct investment for employment generation. Rs 0.3 million is the new figure, but still this is costly. A major component of the expenditure on agricultural development was spent on various other physical and social infrastructures like roads, schools, post offices, hospitals, and townships etc., and hence it is not reasonable to assume that the latter is spent entirely on the development of agricultural land. However if one considers Mahaweli as a hydro-power project having only 120,000 ha of developed land and another 220,000 ha of land yet to be developed it would not be reasonable to consider the total cost of the project as

contributing to generation of new employment in Mahaweli areas. Yet hydropower benefits are not limited to Mahaweli areas alone but for the entire country. Therefore if one separates total cost according to the ratio of benefits generated from Agricultural sector to benefits generated from Power sector, the share of agriculture is only Rs 40 billion (112.7 \* 44.4 / 125.2). Then the cost per employment is only Rs. 211,000 (40 billion / 189,770), which is reasonable. Therefore a project, which has spent Rs 40 billion on creating job opportunities for 189,000 people resulting Rs 44.4 billion as agricultural benefits to the national economy, is a great achievement.

Table 7 - New settlements and Employment Generation (by end of 1997)

System	No. of new settler families	Total new settler population	Estimate of new employment created	
			%	No.
B (LB)	19,782	98,738	52%	51,442
C	26,529	124,151	36%	44,198
G	5,675	27,316	49%	13,385
H	31,799	160,386	43%	69,287
Upper Mahaweli	7,173	34,723	33%	11,459
Total	90,958	445,314		189,770

## 6 The Need for a Vision

When it is said that the Mahaweli energy benefits alone is going to exceed the total cost of the project by year 2004, the other major outcomes of this project namely, all the economic, social and urban development which has taken place in the project area and its periphery, supply of Mahaweli waters for domestic, industrial and irrigation purposes, development of about 80,000 ha of new lands for agricultural purposes, settlement of over 80,000 families in the new areas, creation of employment opportunities for over 180,000 people in the project area, over Rs 50 billion benefit from agricultural produce by year 2000 etc. could be considered as secondary benefits or as a free gift. Also when it is said that Mahaweli Hydropower is Sri Lanka's key to development, it would be useful to spell out the likely scenario that would have unfolded without this project. A sum of Rs 171 billion (Rs 100 billion x Rs 6.00 / Rs 3.50) has to be spent up to year 2000 to replace the Mahaweli hydropower contribution through thermal energy at the rate of Rs 6.00 per Kilowatt Hour. In addition, none of the above listed outcomes would be realized. Instead, the inflation, social unrest, under development, droughts, unemployment and the likes would persist.

Thirty years after the commencement of the project and twenty five years after benefits of the project started to come in, if one looks back and asks after spending Rs. 72 billion, whether we have achieved our objective, the answer is yes. Sri Lanka had achieved self-sufficiency in rice in mid eighties to which Mahaweli had made a major contribution. Another 2/3 of the irrigable area is yet to be developed, and for which, the major reservoirs across the main Mahaweli river are already constructed. The energy generation in Sri Lanka was dominated by hydro energy (95%) until mid nineties, of which 55% of the energy came from the Mahaweli system. At a time when the cost of the project has been already recovered through agricultural and power benefits, one has to note that this project has also played a major role in reducing unemployment in Sri Lanka at a minimum

cost. The Mahaweli Program, yet unfinished has potential for developing another 500 MW medium to small-scale hydro power stations and another 2/3 of its agricultural area. Thus Mahaweli could be considered as one development project undertaken by the government of Sri Lanka, of which, every Sri Lankan could be proud.

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