Preliminary Survey Report on

Mahaweli Ganga Development Program

September 1978

Japan International Cooperation Agency

PREFACE

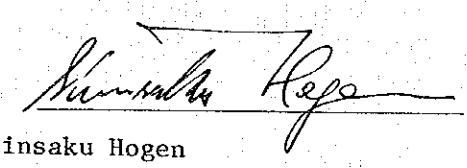
The Democratic Socialist Republic of Sri Lanka, which plans to develop the Mahaweli River aiming at self-sufficiency in rice production, increase of employment opportunities and saving of foreign currencies, is in need of a wide range of cooperation from donor countries, Against such a background, the government of Sri Lanka requested the Japanese government to cooperate in the Moragahakanda Project which forms a part of the Mahaweli River Plan.

Following the above request, the Japan International Cooperation Agency (JICA) dispatched a Preliminary Survey Team on the Mahaweli River Basin, headed by Mr. Akira Arimatsu, executive director of JICA for a period of 46 days from June 12, 1978.

The Survey Team conducted a necessary field survey and exchanged views with the Sri Lanka Authorities concerned to identify the role of this project in the proposed area and in the agricultural policy of the country. The Survey Team also sutdied the scope of work involved in making a feasibility study of the project. Based on the result of the above activities, this report has been prepared.

I hope this report will contribute to a better understanding of the proposed project and will serve for the expected feasibility study.

I wish to express my heartfelt appreciation to the Sri Lankan Authorities and officials concerned for their kind cooperation extended to the Survey Team.



Shinsaku Hogen
President,
Japan International Cooperation Agency

Weights & Measures and Abbreviations

1. Weights and Measures

1 mile = 1.6093 km

1 ft. = 0.3048 m

1 inch = 2.54 cm

1 ac. = 40.469 a.

1 ac. ft. = 1,233.495 m^3

1 ft^3 = 0.0283 m^3

1 gallon = 4.546 ℓ

1 ounce = 28.3495 g

1 pound = 0.4536 kg

1 bushel of paddy = 46 lb. (20.8 kg)

1 cwt. = 50.80 kg (112 lb.)

1 sq. miles = 2.5898 km^2

2. Abbreviations

IPH = Ministry of Irrigation, Power and Highways

CECB = Central Engineering Consultancy Bureau

MDB = Mahaweli Development Board

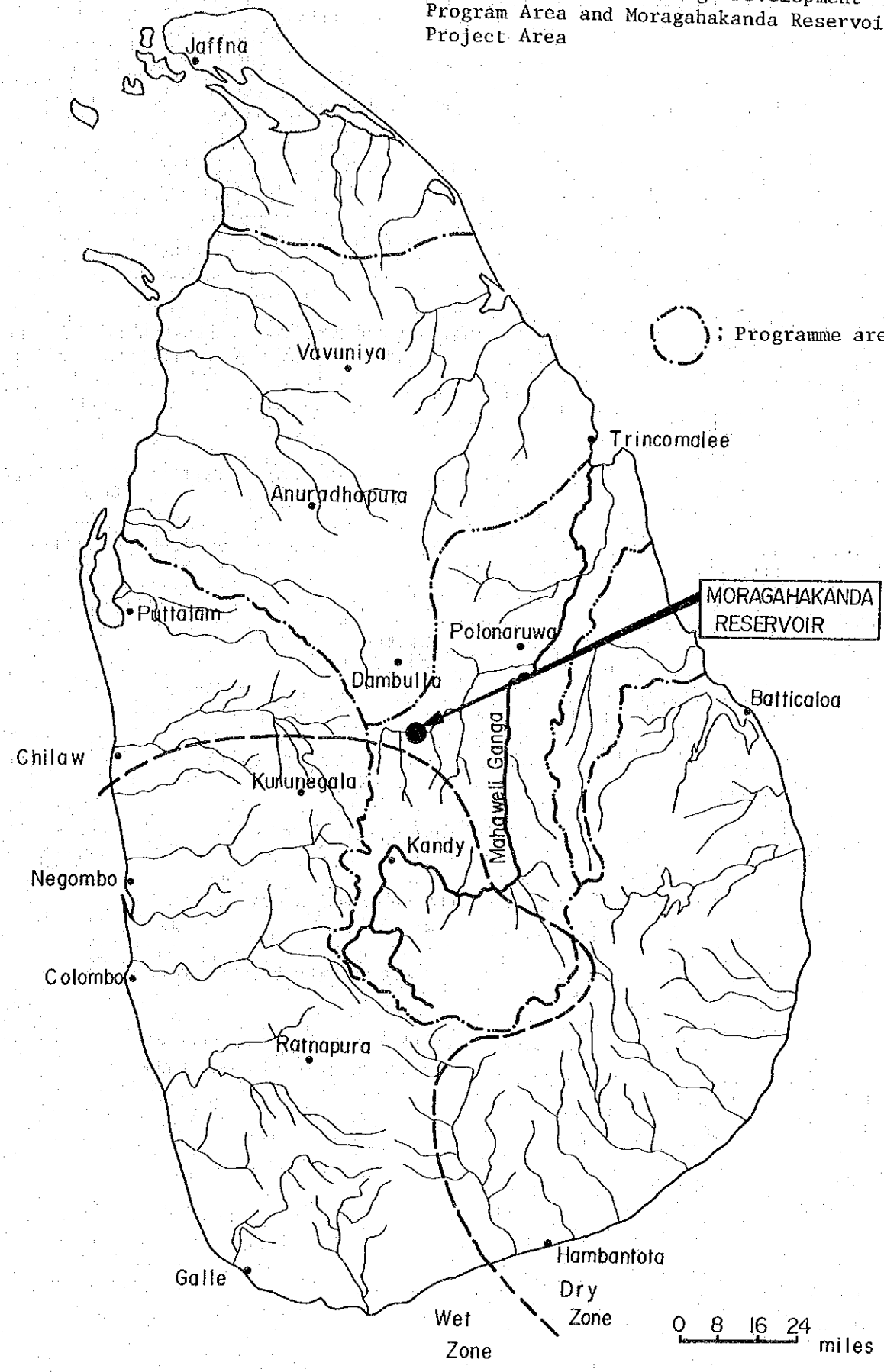
RVDB = River Valleys Development Board

ID = Irrigation Department

CEB = Ceylon Electricity Board (Sir Lanka E.B.)

SD & CC = State Development & Construction Corporation

Map of the Mahaweli Ganga Development Program Area and Moragahakanda Reservoir Project Area



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Chapter 1 Introduction

1-1 Background and Objective of the Survey

Under the leadership of Prime Minister J.R. Jayewardene who was inaugurated after the election held in July 1976, the Government of Sri Lanka has been moving ahead with the development of the Sri Lanka's largest river, the Mahaweli Ganga, placed as the highest priority in order to solve the two most important problems facing with the economy of Sri Lanka -- that is, unemployment and shortage of food grains. Unemployment has exceeded 1,000,000 as against its population of 14,000,000. Moreover, the working population is increasing at an annual rate of 250,000. On the other hand, it requires four billion Rupees ($270 million) a year to import rice and the other agricultural products. The Mahaweli Ganga Development Program aims at encouraging the settlement of farm households through the development of new farmlands and offering employment opportunities for dam construction works to the unemployed on the one hand, and boosting the production of price and the other agricultural products. This in order to save foreign exchange reserves through the realization of the self-susternance of food grains on the other.

The Mahaweli Ganga Development Program has been under way on the basis of a Master Plan worked out in 1969 as the result of a joint survey performed by an UNDP/FAO survey team and engineers of the Government of Sri Lanka from 1965 to 1968. The major objectives of the Program are to make the effective use of the Mahaweli Ganga's water resources for the development of irrigated farmlands of 360,000 ha. (including the existing cultivated lands), and to generate a hydro-electric power of 500 megawatts. According to the Master Plan, the period required for the implementation of the Program has been anticipated to last 30 years. In the light of the gravity and urgency of a reconstruction of the national economy with a solution to the problems of unemployment and food grains shortage, the Government of Sri Lanka selected priorities from among the various projects involved in the Mahaweli Ganga Development Program and formulated an accelerated program for the accomplishment of these priorities in five or six years (during which the present

Government will be in existence). At the end of 1977, the Government of Sri Lanka began to call for cooperation from the World Bank, which later expressed its intention of giving full support. In Paris, in May, 1978, a conference was held between the World Bank and the nations which were providing Sri Lanka with assistance. It was decided that these nations would render cooperation in the Mahaweli Ganga Development Program with the coordination of the World Bank.

Against this background, the Government of Sri Lanka began, at the beginning of 1978, to call for cooperation in the main projects of the development program from major advanced countries. Britain took the the lead in announcing its readiness to cooperate in a survey on the Victoria Dam construction project. Also at the beginning of 1978, the Government of Sri Lanka called on the Government of Japan to extend cooperation in a survey on the Randenigala Dam. But West Germany later presented to cooperate the offer of a fund under extremely favorable conditions (reportedly over a period of 50 years with an interest rate of 0.75%). As a result of the acceptance by the Government of Sri Lanka of this west German aid, Japan was requested by the Government of Sri Lanka to render cooperation in respect to the Moragahakanda Dam. Taking note of the fact that this dam would be just as important as the aforementioned two dams, and also of the postures taken by the World Bank and many countries, Japan has decided to grasp the significance of all aspects of the Mahaweli Ganga Development Program. And has carried out a current preliminary survey on the feasibility of cooperation in specific projects -- particularly, the Moragahakanda Dam Project. Depending on the outcome of this survey, it has been decided to get a definite idea about a feasibility study as the next step.

The purposes of the preliminary survey which has recently been conducted against the aforementioned background are as follows:

1) To check the feasibility of cooperation by the Government of Japan in the specific projects incorporated in the Mahaweli Ganga Development Program and hold negotiations with the Government of Sri Lanka in this respect.

2) To clarify the way in which the Mahaweli Ganga Development Program

as a whole will contribute to the economic development of Sri Lanka.

3) To select the aforementioned specific projects as well as collect data and carry out field reconnaissance to facilitate the formation of plans for a techno-economic survey (a feasibility study) that will have to be performed in respect to the project in future. In this case, it is to be taken into consideration that the Government of Sri Lanka has called for cooperation in the Moragahakanda Dam Project from Japan.

1-2 Organization of the Survey Team

Assignment	Name	Present Position
Leader	Mr. Akira ARIMATSU	Executive Director Japan International Cooperation Agency
Development Planning	Mr. Tadashi SAKAMOTO	Deputy Director Design Division Construction Department Agricultural Structure Improvement Bureau Ministry of Agriculture, Forestry and Fisheries
Cooperation Planning	Mr. Yasumi YAMAGUCHI	Senior Officer International Cooperation Division International Affairs Department Ministry of Agriculture, Forestry and Fisheries
Irrigation & Hydrology	Mr. Akihiko YASUDA	Section Chief Provincial Project Section Land Development Division Agricultural Structure Improvement Bureau Ministry of Agriculture, Forestry and Fisheries
Dam & Irrigation Facilities	Mr. Masamitsu FUJIOKA	Irrigation and Drainage Engineer Agriculture Development Consultants Association

Assignment	Name	Present Position
Geology	Dr. Noboru MIYAMOTO	Geologist Agriculture Development Consultants Association
Power Generation	Mr. Nobuo HIROSAWA	Electrician Mining & Industrial Planning and Survey Department Japan International Cooperation Agency
Agronomy & Soil Science	Mr. Kozo TOSHIMITSU	Senior Instructor Uchihara International Agriculture T Training Center Japan International Cooperation Agency
Coordination	Mr. Yoshihiko NISHIMURA	Officer Technical Affairs Division Agricultural & Forestry Planning and Survey Department Japan International Cooperation Agency

1-3 Survey Activities

Day	Date	Activities
1st	June 12 (Mon.)	First Group (Arimatsu, Sakamoto, Yamaguchi and Nishimura) leaves Tokyo
2nd	June 13 (Tue)	First Group arrives in Sri Lanka.
3rd	June 14 (Wed.)	Talks with the Japanese Embassy.
4th	June 15 (Thu)	Talks with the Soviet survey team and the NEDECO and holds a discussion among the group members.
5th	June 16 (Fri.)	Second Group (Fujioka, Miyamoto, Yasuda, Toshimitsu) arrives in Sri Lanka Confers with the Minister of Irrigation, Power and Highways.

Day	Date	Activities
		Discusses with CECB officials. Discusses with ID officials.
6th	June 17 (Sat.)	Confers with the Deputy Minister of Irrigation, Power and Highways.
7th	June 18 (Sun.)	Leaves for Kandy for the first field survey.
8th	June 19 (Mon.)	Proceeds to the Victoria and Randenigala Dam construction sites.
9th	June 20 (Tue.)	Proceeds to the Polgolla Dam, Ukuwela and Bowatenna Power Plants and System H Area.
10th	June 21 (Wed.)	Proceeds to the site for the construction of the Moragahakanda Dam.
11th	June 22 (Thu.)	Proceeds to the site for the construction of the Kotmale Dam and then on to Colombo.
12th	June 23 (Fri.)	Discusses with the Depty Minister of Irrigation, Power and Highways and officials of the CECB and MDB (reception).
13th	June 24 (Sat.)	Holds a discussion among the group members.
14th	June 25 (Sun.)	Holds a discussion among the group members, the group leader temporarily returning to Japan.
15th	June 26 (Mon.)	Collects data.
16th	June 27 (Tue.)	Starts the second field survey field-wise activities. 1st Subgroup: Carries out a survey on beneficiary areas and projects specified for cooperation (Sakamoto, Yamaguchi and Nishimura), the other members visiting Colombo for the

Day	Date	Activities
		collection of data.
17th	June 28 (Wed.)	1st Subgroup: Carries out a survey on the beneficiary area, the System G Area, covered by the Elahera-Minnerya Canal. 2nd Subgroup: Carries out a field survey on cultivation and soil in the northwestern area. (Toshimitsu), the other group members collect data in their respective fields and hold discussions among themselves.
18th	June 29 (Thu.)	1st Subgroup: Carries out a survey on the Beneficiary Areas D_1 and D_2. 2nd Subgroup: Carries out a survey on the Area H & Agricultural Research Station in Maha-Illupallama. 3rd Subgroup: Geological survey on the site for the Moragahakanda Dam. (Miyamoto) The other group members collect data in their respective fields and hold discussions among themselves.
19th	June 30 (Dri.)	1st Subgroup: Carries out a survey on the Yan Oya and Kapirigama Reservoirs. 2nd Subgroup: Carries out a survey on the under-developing Area H. 3rd Subgroup: Carries out a geological survey on the site for the Moragahakanda Dam.
20th	July 1 (Sat.)	1st Subgroup: Carries out a survey on the Malwatu Oya Reservoir. 2nd Subgroup: Carries out a survey on the under-developing Area H.

Day	Date	Activities
		3rd Subgroup: Carries out a geological survey for th site of the Moragahakanda Dam.
		The group member in charge of power generation (Hirosawa) arrives.
21st	July 2 (Sun.)	Holds a discussion among the group members.
22nd	July 3 (Mon.)	Hold talks with the Ministry of Irrigation, Power and Highways and the CECB. Also holds talks with the Japanese Embassy.
23rd	July 4 (Tue.)	Starts the third field survey.
		1st Subgroup: Carries out a geological survey on the Moragahakanda Dam. (Miyamoto)
		The group member in charge of cooperation and planning returns to Japan.
24th	July 5 (Wed.)	1st Subgroup: Carries out a geological survey on the Moragahakanda Dam.
		2nd Subgroup: Carries out a survey on the foundations of the Moragahakanda Dam and the materials for its dam body. (Fujioka and Yasuda)
		3rd Subgroup: Carries out a survey on cultivation and soil in the northeastern beneficiary area. (Toshimitsu)
		Holds talks with the Canadian team.
25th	July 6 (Thu.)	1st Subgroup: Carries out a geological survey on Moragahakanda.
		2nd Subgroup: Carries out a survey on the Moragahakanda Dam.
		3rd Subgroup: Carries out a survey on

Day	Date	Activities
		cultivation and soil in the beneficiary areas covered by the Moragahakanda Dam. 4th Subgroup: Carries out a survey on the Laxapana and New Laxapana Power Plants. (Hirosawa and Nishimura) The deputy leader of the group collects data and holds talks with the authorities concerned.
26th	July 7 (Fri.)	1st Sbugroup: Carries out a geological survey on Moragahakanda. 2nd Subgroup: Carries out a survey on the water balance of the Moragahakanda Dam. 3rd Subgroup: Carries out a survey on the Beneficiary Areas D and A/D. 4th Subgroup: Carries out a survey on power generation at Polgolla and Ukuwela. The deputy leader of the group collects data.
27th	July 8 (Sat.)	1st Subgroup: Carries out a geological survey on Moragahakanda. 2nd Subgroup: Carries out a survey on the water balance of the Moragahakanda Dam. 3rd Subgroup: Carries out a survey on the Beneficiary Areas M and I covered by the Moragahakanda Dam. 4th Subgroup: Carries out a survey on power generation at Moragahakanda. The deputy leader of the group collects data.
28th	July 9 (Sun.)	Holds discussions among the group members.

Day	Date	Activities
29th	July 10 (Mon.)	Confers with the Deputy Minister of Irrigation, Power and Highways and officials of the Ministry of Irrigation and Highways. Holds talks with the Japanese Embassy.
30th	July 11 (Tue.)	Collects data. Holds discussions among the group members.
31st	July 12 (Wed.)	Collects data.
32nd	July 13 (Thu.)	Holds discussions among the group members and collects data.
33rd	July 14 (Fri.)	Ditto.
34th	July 15 (Sat.)	Ditto. (The leader of the group arrives at Clombo.)
35th	July 16 (Sun.)	Holds discussions among the group members.
36th	July 17 (Mon.)	Carries out the fourth field survey and a geological survey on the site for the Moragahakanda Dam.
37th	July 18 (Tue.)	Ditto. (Collects data). Confers with the Deputy Minister of Irrigation, Power and Highways (studies the minutes). Holds talks with the staff of the World Bank.
38th	July 19 (Wed.)	Prepares a report.
39th	July 20 (Thu.)	Signs and exchanges the minutes.
40th	July 21 (Fri.)	Submits the report (to the Government of Sri Lanka).
41st	July 22 (Sat.)	Holds a review meeting and collects the remaining data.

Day	Date	Activities
42nd	July 23 (Sun.)	The main group leaves Colombo.
43rd	July 24 (Mon.)	The main group arrives at Tokyo.
44th	July 25 (Tue.)	Conference of the World Bank (attended by the leader of the group and Toshimitsu, a group member).
45th	July 26 (Wed.)	Leaves Colombo.
46th	July 27 (Thu.)	Arrives at Tokyo.

Chater 2 Summary

2-1 Mahaweli Ganga Development Program

(1) Sri Lanka belongs to the group of Southeast Asian nations with low Gross National Product (GNP) and low annual real GNP growth rate during the last 10 years and is confronted with serious unemployment. This is attributed to the fact that although Sri Lanka is an agricultural country with its agricultural production accounting for about one-third of its GNP, not only is there stagnant rise in agricultural production, but the other sectors of the economy are less active.

The agriculture of Sri Lanka is of an extremely heterogeneous structure, as it is made up of plantation agriculture and non-plantation agriculture. This factor hinders its atriculture which evolves around rice crop, thus forcing Sri Lanka to import rice on a perpetal basis. This grave factor lies against the background of a long-term deficit in its international balance of payments.

According to the pattern of rainfall, the whole land of Sri Lanka may be divided into a wet zone, which accounts for about one-fourth, and a dry zone, which accounts for about three-fourth. Whether the agriculture of Sri Lanka may be developed depends on the development of the dry zone.

(2) In order that the self-sustenance of food grains, the eradication of the unemployed, and the development of the economy may be accelerated by boosting the agricultural production, the Government of Sri Lanka considers the Mahaweli Ganga Development Program as the highest priority and concentrates itself on an early accomplishment of the Program.

(3) This Program turns out to be the largest multi-purpose river development project in Sri Lanka. Its Master Plan was prepaved by an UNDP/FAO team and engineers in Sri Lanka after a 4-year

survey conducted by them from 1965 to 1968. The development concept is featured by irrigating about 900,000 acres of the dry zone (about 360,000 ha., of which 270,000 ha. will be newly developed) and generating an equipment capacity of about 500 MW for the development of electric power. It is also envisioned in the concept to employ about 800,000 people during the construction period and settle 225,000 families. As benefits from this project, it is hoped that the annual agricultural output will increase by 1,900 million Rupees[1/] and the value of power generation will rise by 325 million Rupees[2/]. For this purpose, a series of dams will be constructed in the basin of the Mahaweli Ganga in order to secure their principal water sources, and another series of dams (dry zone) equipped with regulating functions and also headrace channels will be constructed for the development of 14 irrigation systems.

The project is divided into three phases for its implentation. In Phase 1, the development of the Polgolla-Bowatenna Complex was started in 1970 and has been almost completed. But the other projects have not been started yet. When the Master Plan was prepared, the construction period was estimated at 30 years.

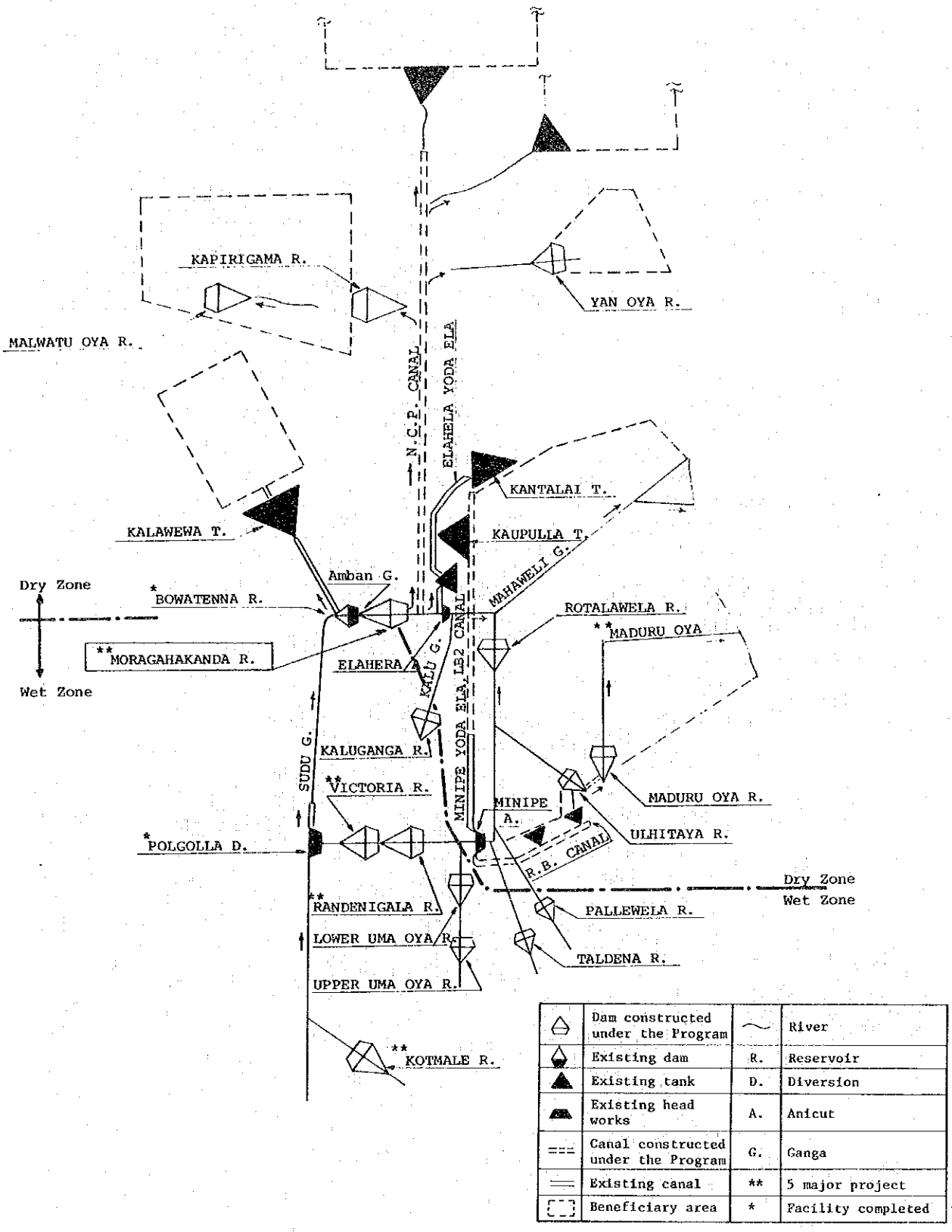
(4) The projects, which were to be started in December, 1977, were cut down to 12[1/] by the Government of Sri Lanka with an intention to complete all the projects in five or six years. The total construction cost at that time was estimated at 15,015 million Rupees[2/].

In this conjunction, survey activites were started in January, 1978, in the name of a strategic survey for the implementation of the projects by the NEDECO under a contract with the World Bank on the basis of a general agreement for the promotion of the projects reached between the Government of Sri Lanka and the World Bank in December, 1977.

1/, 2/ The values are based on the "Summary Report on Projects," issued by MDB in November, 1977.

3/ Also see Figs. 2-1 and 2-2.

Fig. 2-1 Model Plan for Mahaweli Ganga Development Program



	Dam constructed under the Program	~	River
	Existing dam	R.	Reservoir
	Existing tank	D.	Diversion
	Existing head works	A.	Anicut
	Canal constructed under the Program	G.	Ganga
	Existing canal	**	5 major project
	Beneficiary area	*	Facility completed

Fig. 2-2 Overall Irrigation Program

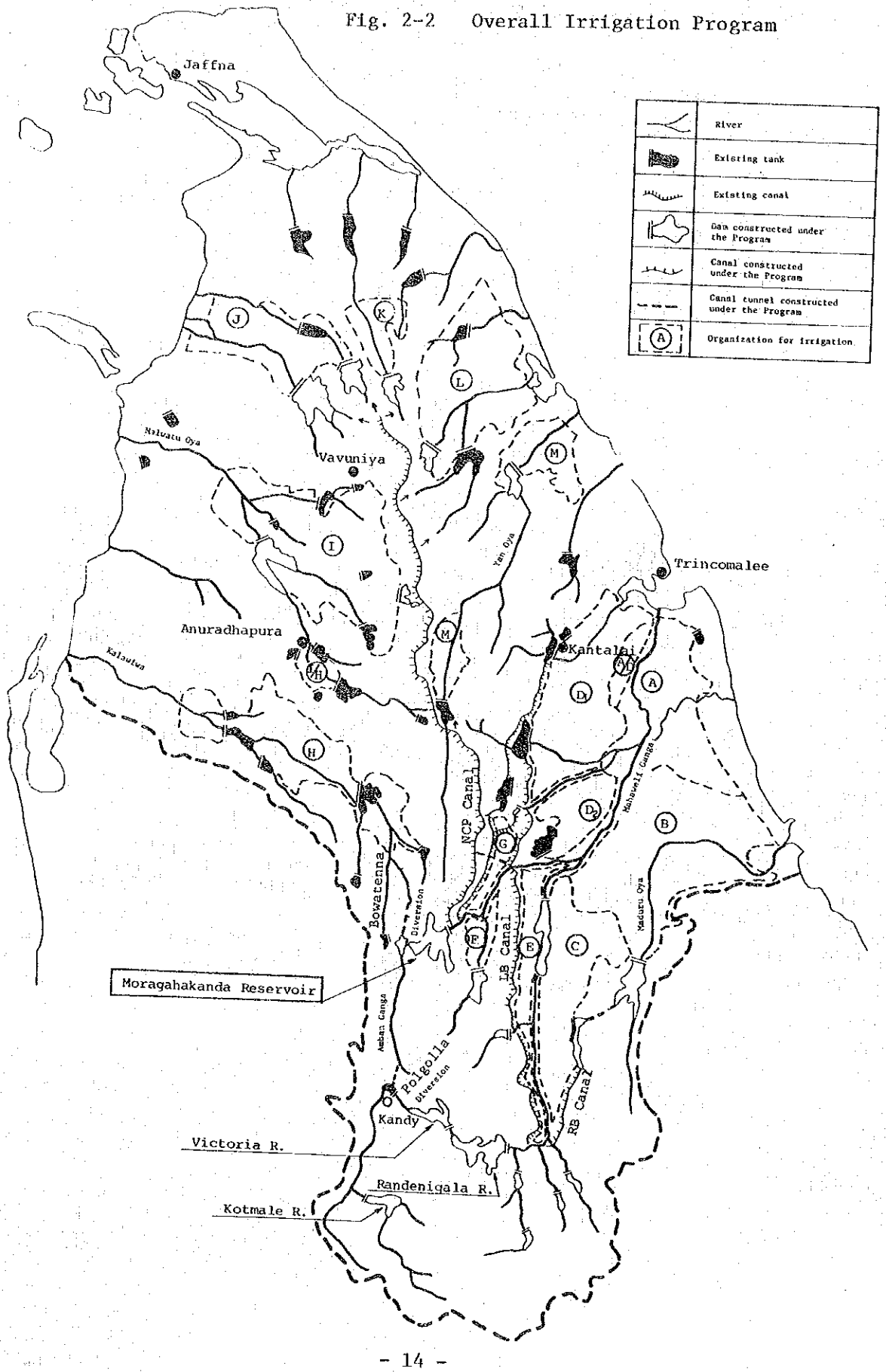


Table 2-1 Outline of the Mahaweli Ganga Development Program

	Project	Purpose	Beneficiary area		Power Generation	Dam						Construction cost
			Existing	Newly developed		Catchment area	Total storage capacity	Effective storage capacity	Height	Length	Type	
1	**Victoria Complex	Irrigation and power generation	$x10^3$ ha 7.5	ha 29.8	MW 120	km^2 1,895	$x10^6$ m^2 512	$x10^6$ m^2 481	m 103	m 428	Concrete-gravity, arch	(1 mil. Rupees) 2,025
2	**Moragahakanda Complex	Irrigation, power generation	-	18.7	40	816	853	580	74	1,540	Concrete-gravity rockfill, earthfill	*3) (1,350) 1,070
3	**Maduru Oya Complex	Irrigation	2.7	38.4	4.5	453	400	355	46	545	Earth	1,180
4	Taldena Complex	Irrigation, power generation	-	9.4	14.5	285	81	69	61	366	Earth, conrete-gravity	380
5	**Kotmale Complex	Power generation	-	-	150	563	394	366	108	588	Rock-fill	1,035
6	Kalu Ganga Complex	Irrigation, power generation	5.9	17.9	1.9	188	256	232	50	2,740	Earth	800
7	Rotalawela Complex	Irrigation	-	7.3	-	5,360	242	227	24	2,025		320
8	Pallewela Complex	Irrigation, power generation	-	14.9	10	208	107	57	61	1,652	"	695
9	Malwatu Oya Complex	Irrigation	7.8	3.6	-	2,110	278	252	27	4,580	"	335
10	Yan Oya Complex	"	1.2	6.4	-	1,310	256	232	27	3,650	"	3,830
11	**Randenigara & Part NCP Canal Complex	Irrigation, power generation	9.3	35.5	75	2,330	775	460	85	530	Concrete gravity	2,995
12	Bal: NCP Canal Complex	Irrigation, power generation	11.2	49.0	*1) 62.5	*1) Total for 9 dams other than those enumerated above						*2) 15,015
	Total	(AC:	112.4 45.6	570.4) 236.0	478.4							
(1)	*Polgolla Bar	Irrigation, power generation	{53.5}	{36.8}	40	1,420	2	1	26	288	Storage-type head works, concrete gravity	*4) 141
(2)	*Bowatenne	Irrigation			-	540	45	26	55	356	Concrete-gravity	*5) 271
	Total	(AC:	132.0 53.5	91.0) 36.8								412
	Grand Total		244.4 91.1	661.4 272.8	518.4							154,427

Notes: ** Denotes five major projects.
* Denotes a facility completed with its terminal facilities still under construction.
*2) Denotes the cost computed before a devaluation in November, 1977.
*3) Based on the status report of the Government of Sri Lanka and an AID group on May 5, 1978.
*4),*5) Denotes the value extracted from the statement of settlement.

o The specifications of the Victoria and Randenigala Reservoirs are being changed at present.

o The Victoria and Randenigala Reservoirs are larger in its beneficiary area than the Moragahakanda Reservoir in terms of unit storage capacity, because the other dams are included in the complex.

(5) In May, 1977, the Government of Sri Lanka decided to start the following five projects, including the construction of canals required for irrigating about 340,000 acres (about 138,000 ha.).

1) Victoria Reservoir-Minipe Diversion Complex

2) Randenigala Reservoir and Power Plant

3) Maduru Oya Reservoir

4) Kotmale Resrvoir and Power Plant

5) Moragahakanda Reservoir and Power Plant

Sri Lanka hopes to complete all these projects by 1983. The total construction cost has been estimated at about 9,000 million Rupees (about $600 million) in terms of 1978 prices, or about 12,000 million Rupees in terms of the prevailing prices[3/]. Of this amount, the foreign exchange component accounts for about 50%. As for the financial sources, the Government of Sri Lanka contemplates that about 8,000 million Rupees in terms of 1978 prices, or about 11,000 million Rupees in terms of reprevailing prices, may be provided by foreign aids, etc.

(6) Policy for the Mahaweli Ganga Development Program will be determined by a Cabinet subcommittee, which will be chaired by the President and the principal members including the Minister of Planning and Economic Affairs and the Minister of Irrigation, Power and Highways.

The Mahaweli Ganga Development Task Force will be chaired by the Minister of Irrigation, Power and Highways, the principal members including the Deputy Minister of Irrigation, Power and Highways, Deputy Minister of Planning and Economic Affairs, President of the United National Party (UNP), Director-General of MDB, Director-General of CECB, Director-General of ID and Director-General of CEB. In weekly meetings, the task force will study the implementation of the projects, coordinate the executing agencies and discuss internal coordination and the other matters.

3/ The total amount of expenditures for each year concerned.

The MDB is responsible for the implementation of the projects in all aspects, whereas the OECB, ID and RVDB coordinate with one another to step up a smooth implementation of the projects.

In order to secure middle-class engineers required for the implementation of the Mahaweli Ganga Development Program, the Government of Sri Lanka has called many drained brains to return to the country, and requested assistance of foreign engineers.

(7) The Government of Sri Lanka has called for technical and financial aids from various countries. The Government has called for assistance separately from advanced countries, but the points common to the requestes are presumably as follows:

1. A grant basis, if feasible.
2. Not only foreign but also local portions should be included in case the assistance comes in the form of a loan.
3. As early a commitment as practicable.
4. In addition to a bilateral one, a coordination loan will be available.

(8) In light of the project scale of the Mahaweli Ganga Development Program and the large effects which are to be brought about by the projects, it is conceivable that the implementation of these projects will form the basis for an economic reconstruction of Sri Lanka.

2-2 Moragahakanda Project

2-2-1 Outline of the Project

(1) Moragahakanda Project has high priority for its strategic position and functions which can play a critical role for development of the Northern Dry Zone among the entire Mahaweli Ganga Development Program, as taken up in No. 3

Project*1) of Phase I in the Master Plan prepared by the UNDP/FAO Team.

(2) The major objective of this Project is to construct the Moragahakanda Dam with an effective storage capacity of 470,000 ac. ft. (approx. 580 million tons) at 30 miles upstream from the mouth of the Amban Ganga, tributary of the Mahaweli Ganga. This would irrigate a newly developed area of 46,200 acres (18,700 ha) and control irrigating water for the Elahera area, and establish a power plant with an equipment capacity of 40 MW.

(3) The reservoir water of the Moragahakanda Dam originates from the outflow from its own catchment area and the water diverted from the Mahaweli Ganga at the Polgolla head works.

(4) This dam is a complex one consisting of a concrete gravity dam (constructed across the rain steam of the Amban Ganga) as a main one and rockfill and earth dams as auxiliary ones.

The total construction cost for the dams is estimated to be Rs. 1,350 million (US$90 million) at current rate, of which Rs. 900 million is estimated to correspond to the foreign exchange component.

2-2-2 Irrigation

(1) According to the Master Plan, the beneficiary area covered the Moragahakanda Dam is 46,200 acres (18,700 ha) and the whole beneficiary area is newly developed under the Project, concerning with irrigation systems D1, D2 and A/D.
See Fig. 2.

*1) No. 1 Project of Phase I: Polgolla-Bowatenna Complex
No. 2 Project of Phase I: Victoria-Minipe Complex
No. 3 Project of Phase I: Moragahakanda Complex

(2) The proposed cropping pattern covers 28,500 acres (about 62%) for the double cropping of paddy rice, 4,300 acres 9%) of paddy crop and upland crop, and 13,400 acres (about 29%) of upland crops.

(3) The irrigation water system takes the following course: discharge from the Moragahakanda Dam → intake at the Elahela head works (existing) → existing canals → existing tanks (reservoirs) → distribution to peripheral areas (See Fig. 2-1).

Partially, direct distribution from the existing canals is utilized.

There are the following 4 tanks covered by the Moragahakanda Dam:

Kaudulla Tank	128×10^6 tons
Minneriya Tank	138×10^6 tons
Kantalai Tank	134×10^6 tons
Parakrama Samudra Tank	136×10^6 tons
Total:	536×10^6 tons

The proposed unit irrigation requirement is 2.06 ft. in the Maha season and 4.02 ft. in the Yala season for rice, and 5.53 ft. for upland crop (sugar cane).

(4) The reservoir water of the Moragahakanda Dam originates from the outflow from its own catchment area (816 km^2) and the diversion from the Mahaweli Ganga at the Polgolla Head Works. The effective storage capacity is about 580 million tons, and the regulated flow is about 1,400 million tons per year, of which that of its own catchment area is about 900 million tons. After the construction of the Kotmale Dam, the regulated flow is anticipated to be increased up to about 1,700 million tons.

(5) Since it can be pointed out that the outflow is irregular due to the large annual and seasounal fouctuations of rainfall in the dam catchment area, the possible regulated flow of the dam should be examined according to the diversion conditions at the Polgolla Head Works, by newly adding the data of the past 10 years.

(6) It would be deemed necessary to examine comprehensively the unit water requirement of rice planting characterized by plenty of evaporation, earth canals, shallow tanks and plot-to-plot irrigation, and include the method of deciding it, too.

(7) After the construction of the Moragahakanda Dam, the Elahera irrigation system (73,200 acres of the existing paddy field, and 20,000 acres of newly reclaimed agricultural land, respectively covered by No. 1 Project of Phase I, and an unreclaimed land of 46,200 acres; total 139,400 acres) will be functionally combined with the dam, and will be placed under the control of this dam. Therefore, the whole water planning, etc. must be examined. In this case, it is also necessary to discuss the necessity of treating the beneficiary by the above No. 1 project as unspecified benefits.

(8) For the effective use of water, the dam groups must be closely linked in order to minimize the ineffective discharge of water. For this purpose, comprehensive water management system must be examined.

2-2-3 Dam

(1) The Moragahakanda Dam is a complex one consisting of three types of dams i.e. a concrete dam (across the main stream of the Amban Ganga), a rockfill dam (the first auxiliary one) and an earth dam (the second auxiliary one) respectively arranged from the right bank side. The salient features of

the dam are as follows:

Total Storage Capacity:		853 million tons
Effective Storage Capacity:		580 million tons
Normal Maximum Water Surface Elevation:		EL640 ft (195 m)
Minimum Water Surface Elevation (Power Generation):		573 ft (173 m)
Tailrace Elevation:		470 ft (142 m)
Dam Height:	Concrete	242 ft (73.8 m)
	Rockfill	183 ft (55.7 m)
	Earth	101 ft (30.8 m)
Crest Height:		660 ft (200 m)
Crest Length:	Concrete	1,660 ft (506 m)
	Rockfill	1,350 ft (411 m)
	Earth	2,160 ft (658 m)

(2) Geology

Progress of Geological Surveys

The data available for geologic surveys in the vicinity of the Moragahakanda Dam site are a geological map of reservoir area of 1 inch to 1/2 mile, and a geological map of 1 inch to 200 ft, and geological section prepared by the UNDP/FAO in 1968. The records of test boring at that time are kept in the ID and can be used. The ID has restarted and is still conducting test boring at the sites of the main and the first auxiliary dams including the site proposed for the power plant from 1978.

Geology of Reservoir Area

The geology in the vicinity of the Moragahakanda Dam comprises the alternation of gneisses and crystalline limestones, and its general strike is from south to north. Its dip varies repeatedly, and on the upper reaches of the dam site, there exist axes of anticline and syncline.

The mountainous slopes observed on the reservoir bed are stable, and do not show any consierable collapse and landslide configuration.

In the reservoir area, gneisses are distributed widely, whereas crystalline limestones in relatively limited ranges. In this distribution, a large crystaline limestone with about 350 ft thickness is observed from the reservoir bed of the left bank at the dam site toward the downstream side.

Fresh gneisses form a solid and impermeable bedrock and have no problem in leakage.

Fresh crystalline limestones are also solid and imperable, but occasionally have characteristic erosion cavities, and these were confirmed to exist also at the am site as the results of surface reconnaissance and test boring. However, the cavities which happened to be observed at the outcrops of crystalline limestones are small and discontinuous. Among many test borings, only one boring on the left bank of the first auxiliary dam (rockfill dam) site, has been encountered with the cavities. Their distribution seems to be far scattered. In addition, the fact that the ground-water level observed in the bored holes near the first auxiliary dam is about 30 ft higher than the river water level of the Amban Ganga nearby shows that the cavities and cracks in the crystalline limestones near the dam site are not so continuous as to be directly connected to the nearby cliff surface and the Amban Ganga.

According to the results of the surveys made so far, there are very few continuous cavities in crystalline limestones, and even if continuous cavities were found, they would be deemed possible to be treated, due to the limited distribu-tion ranges of crystalline limestones.

Geology of Dam Site

The present proposed highest reservoir level is 640 ft in elevation, and it is necessary to construct a main dam on the

Amban Ganga and two auxiliary dams on the two topographic saddles on the left bank side.

a. Main Dam

The proposed main dam is of concrete gravity-type with its height of 242 ft. Topographically, the present proposed dam axis is in an almost proper position.

The foundation bedrock is generally comprised of gneisses, and the fresh bedrock is favorable as foundation for a concrete gravity-type dam. The surface soil and weathered belt on both bank sides are 30 to 38 feet thick.

There seems to be minor faults on the right abutment slope and sound bedrock does not extend to the maximum high water level under the upper portion of the left abutment. An appropriate foundation treatment should be applied for these portions of the bedrock.

The thickness of riverbed sediments and weathered bedrock underneath as well as existence of faults in the riverbed portion should be investigated in the future, since a boring test has not been made on the rivebed portion.

b. First Auxiliary Dam (Rockfill Dam)

The first auxiliary dam is designed as a rockfill one with its height of 183 ft, and present dam axis is in an almost proper position, topographically.

The foundation rock is comprised of gneisses on the right bank side, while crystalline limestones from the saddle to the left bank.

The fresh facies of these rocks are solid and sound for foundation.

The thickness of weathered belt on the right bank is not clear due to few surveys conducted, but the portion from the saddle to the slope of left bank is covered with about 30 feet surface soil and weathered belt. On the upper

portion of the left bank where the existence of faults is expected, the weathered belt is thicker.

The existence of void like cavern in crystalline limestone was confirmed by 4 borings concentrically made near the dam, but such void was not found by boring conducted further around the area. For this reason, it is considered that there is no large continuous cavity. However, it is necessary to know in future the nature of such void and to confirm the possibility of refilling.

c. Second Auxiliary Dam (Earth Dam)

The second auxiliary dam is designed as an earth fill type with its height of 101 ft and constructed on a topographic saddle, but the lcoation of its dam axis and its type must be contestable.

The foundation ground will remain almost unchanged in its location even if the dam axis is changed a little, composed of crystalline limestones on both banks and gneisses on the riverbed portion (saddle) and according to the results of investigations done so far, the fresh bedrock is solid and low in permeasibity, and can be said to be favorable foundation. The surface soil and weathered belt near the riverbed are 30 to 40 feet thick.

According to the preliminary investigation results, made by UNDP/FAO and on-going studies by ID, the dam construction project seems to be feasible. But there remain matters to be discussed, such as the identification of foundation bedrock location, confirmation of the nature of faults and void, shearing strength of bedrock, etc.

d. Materials for Dam

Concrete aggregate must be collected from a guarry since gravel is not avilable in rivers nearby. But there

exist well-qualified gneissic stones within 2 miles on the upper reaches of the dam site, and should be examined for quality and quantity.

Sand would be deemed obtainable in the Amban Ganga, but will have to be collected from a very wide area, since thick deposition cannot be expected.

The stones required for the construction of the rockfill dam are obtainable in a large quantity in a mountainous area of about 1,500 feet on the upper reaches on the left bank of the second auxiliary dam.

For core mater ial, it was planned to collect it near the dam through the investigation by the UNDP/FAO, but due to thin soil layer, its actual use is difficult. For its substitutable collection, the area on the upper reaches from about 2 miles up the dam site is expected.

(3) The size of the dam would be considered to remain almost unchanged even after the full-scale investigation to be made in future. But further discussion will be necessary because of new hydrological data such as fluctuation of discharge, and frequency of dry years, and to study the correlation with the size of the dam and the diversion quantity at the Polgolla point.

(4) The locations of the concrete and rockfill dam axes are deemed appropriate, but re-examination of the earth dam axis would be considered necessary in relation with the abutment topography.

(5) Of the materials required for the dam construction, earthy material to be used is economically questionnable from its quantity-point-of-view, because the soil layer thickness on the bedrock surface is small. It would be deemed necessary to identify an appropriate dam type by conducting a detailed survey.

(6) In view of the conditions of location of the dam site, special discussion is considered to be required on the following matters in relation with the construction schedule.

1. Simultaneous execution of the construction of three dams
2. Location and scale of diversion channel during construction.
3. Working days per annum

(7) The reservoir water is anticipated to submerge large quantities of houses, agricultural land, etc., and the countermeasures for this will be taken by the Government of Sri Lanka.

The length of the road substituted by the reservoir is anticipated to be considerably long.

2-2-4 Power Generation

Hydraulic power is the sole energy resource in Sri Lanka, and because the petroleum, etc. imported are expensive, only the development of hydraulic power generation is being made. While the equipment capacity of the existing power plant is 332 MW by hydraulic power and 50 MW by steam power, all the power generation equipment based on the Mahaweli Ganga Development Program provides 518 MW, of which the capacity covered by 5 major projects amounts to 390 MW, including 40 MW by the Maragahakanda Power Plant. In addition, there is 190 MW hydraulic power generation which is being developed separately, and all the projects are expected to be completed in short periods of 5 to 6 years.

The demand for electric power has increased to 1.9 times in the last 10 years, and the maximum generated energy shows an annual average increase of 7.6%. Its demand is expected to increase further in future. According to the estimate of the Ministry of I.P.H., the supply of electric power will be excessive during several years when the above-mentioned power plants are completed as scheduled, but from about 1989, the outlook for sufficient

supply of electric power will not be promising. To construct a thermal power plant as a countermeasure for the storage of electric power, the power generation cost will be about 50 cts/ KWH, being very expensive compared to the present average sales unit price of 16 cts. Therefore, the construction of hydraulic power plants is required to be planned continuously.

The Moragahakanda Power Plant is a dam-type power plant constructed near the left bank immediately below the concrete dam, and is planned to provide the maximum output of 40 MW, the firm output of 18.9 MW and the annual firm possible power generation of 165.4 million KWH. These must be sufficiently discussed in future, teogether with hydrological data.

As for the main equipment such as hydraulic turbines and generators, initially 4 sets of 10 MW each were planned to be equipped but the plan has been changed to 1 set of 40 MW recently. A negative plan of equipping 2 sets must be also studied from the standpoints of the firm output of 18.9 MW in the power plant and their operation & maintenance.

The 132 KV transmission line newly installed for this power plant is designed to be connected to 132 KV transmission line through the nearby Bowatenne power plant.

Of the total construction cost of Rs. 560 million estimated initially, Rs. 195 million is allocated to the electric power section, including Rs. 24 million appropriated for the building of the power plant and the main equipment. These sums must be carefully examined, since great changes occurred due to the later change of design and an increase in the rate of inflation.

2-2-5 Agriculture

(1) The cropping pattern of 46,200 acres newly developed by the Moragahakanda Project is mainly based on the double cropping of paddies as described in the Paragraph for irrigation. In this land, the settlement of 17,500 families is scheduled, and the standard land allotment is 2.5 acres of

paddy field and 0.5 acres of upland field per family. For these settlers, the Government will grant subsidies and agricultural materials for farming, and will establish public facilities in proportion to the number of settlers. The funds for agricultural mangement will be provided by financial institutions.

(2) According to the soil investigation data of a partial beneficiary area the land has been judged to be suitable for rice culture, but the addition of survey points and the investigation of soil fertility, etc. would be deemed necessary, since the land is newly developed and the chemical properties depend on soil. In order to determine an appropriate cropping pattern, these data and water use conditions should be combined.

(3) In the System H area which has been partly completed as a part of the Mahaweli Ganga Development Program, the average yield of 80 bushels per paddy field acre has been attained from the initial year. This corresponds to the yield expected to be attained at the completion of the development. In this project, the target yield must be newly set by conducting appropriate investigations.

(4) Even in the areas where land productivity can be secured by the sufficient supply of irrigation water, it is pointed out that in recent years the yields have been diminished because the optimum planting time was missed due to the shortage of draught power, etc. or that productivity has been decreased due to imperfect storing facilities and transportation system, etc. Regarding this matter, detailed investigation on the actual conditions must be made to take any necessary measures in relation with the problem of a decrease in the repayment rate of cultivation loan to the existing farmers (27% in 1976/77), etc.

(5) In light of cultivation techniques for rice, techniques for increasing yield do not spread widely among the existing farmers, and decreased yields are caused by the considerable weed luxuriance due to cultivation by durect sowing, and by inadequate measures against disease and inset drainage. Furthermore, the application dose of fertilizers is small, and the methods of agricultural extension and farmers' education must be examined.

(6) Executing agencies for farming under this project are as follows:

MDB: Settlement, management and operation of irrigation facilities, agricultural development, coordination of the authorities concerned with agriculture.

Extension Bureau, Ministry of Agriculture and Land:

Extension of farming techniques, farmers' education, distribution of seeds and seedlings, etc.

2-2-6 Economic Evaluation

Economic evaluation can be seen in Vol. II of the UNDP/FAO Report, but this was for 1968. Therefore, required is the evaluation, considering various changes occurring in the last ten years (change in the order of development, technical progress, etc.).

For evaluation, the following must be taken into consideration.

(1) Since the land suitable for development is large, the scale of the dam should be determined by the possible storage capacity, not by the irrigated region with a specific area.

(2) The production per unit area has considerably increased by technical progress in agriculture since 1968. Therefore, indexes for benefit calculation must be changed.

(3) Power generation is executed according to the discharge schedule to be made by taking into consideration this matter.

(4) As for the expenses, the cost of dam and related structures, compensation expenses, and those required for land reclamation should be summed up. And on the other hand, it is considered possible to introduce the benefits caused by using the existing facilities such as head works, headrace channels, and tanks.

(5) There is possibility of anticipating the effect as regard to a partial area of the irrigated region covered by Phase I of the Elahera irrigation system as an unspecified benefit.

Chapter 3 Present Situation

3-1 Climate and Hydrology

(1) Climate

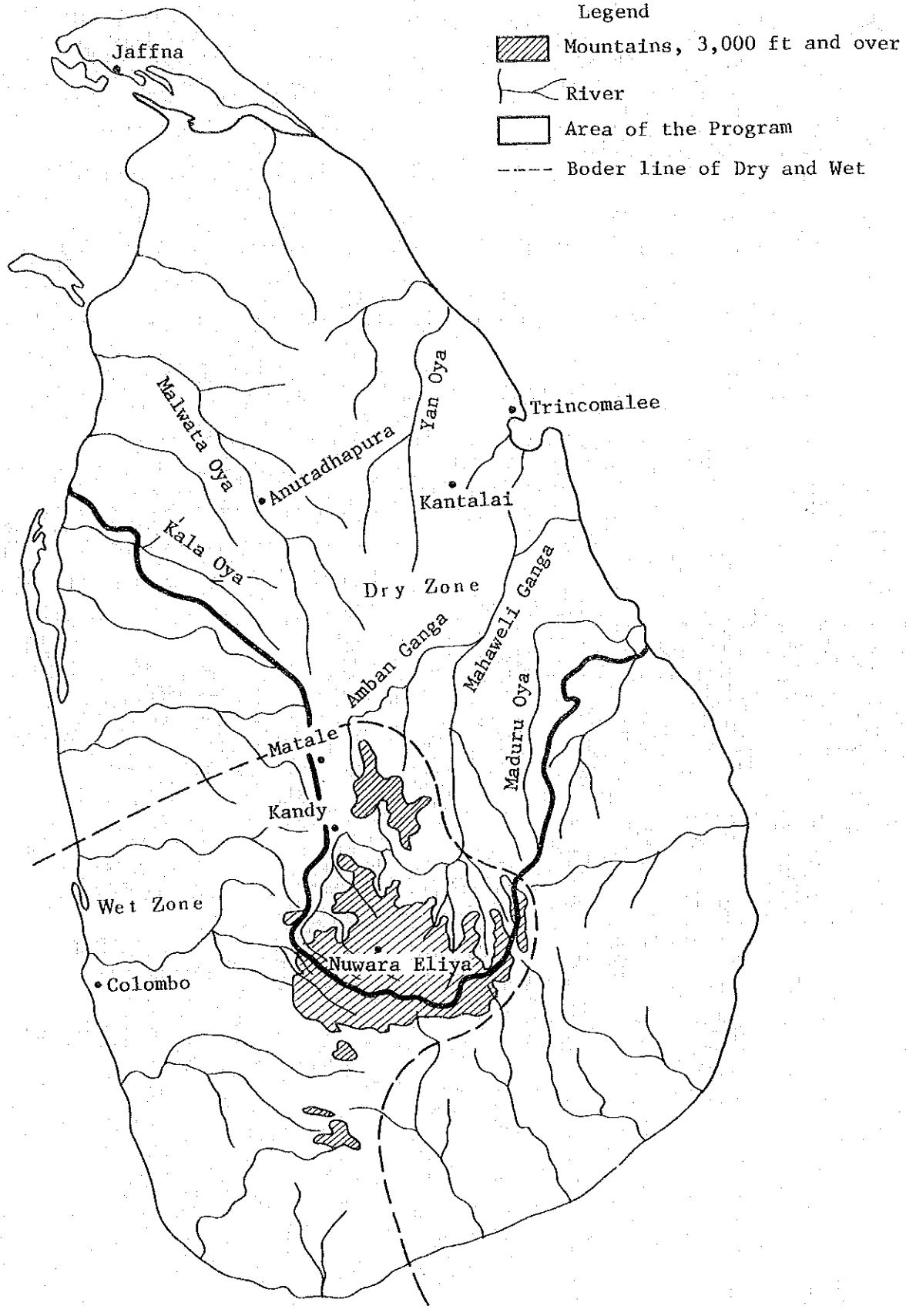
The island of Ceylon, situated in latitude 5°55' to 9°50' N., belongs to the tropical zone. As Sri Lnaka is seagirt, the monthly average temperature on the plains stands at 27°C ± 2°C throughout the year and the precipitation exceeds 40 inches (1,000 mm) in all parts. However, because of the existence of mountains (including 2,524 mm Mt. Pidurutalagala, Sri Lanka's highest peak) in the vicinity of Nuwara Eliya situated in the central south of the island the tropical monsoon brings rain on one side of the mountains and dry air on the other side, so that this island is divided into dry and wet zones. (Fig. 3-1)

During the Maha season (November to March), northeastern monsoons (continental) get wet as they churn across the Bay of Bengal, and brings rainfall on the entire part of the island. During the Yala season (May to September) with the onset of southwestern monsoons (oceanic), on the other hand, the southwestern part of the island has heavy rainfall, whereas the area, which extends from the north to the southeast of the island and occupies three-fourth of the island, has a dry season due to a Föhn phenomenon.

It follows that the southwestern part of the island turns out to be a wet zone, while the southeastern part a dry zone with an annual rainfall of roughly 75 inches (1,800 mm) as the borderline*. Substantial differences in geographical conditions, secular changes and irregularities of such rainfall patterns are featured by the rainfall brought by monsoons. -- for example, there is

* The borderline between the dry and wet zones is set at 75 mm in Sri Lanka (1) because the annual rainfall for the entire island averages 756 inches and (2) because the areas with an annual precipitation of less than 75 inches have a dry season during the Yala season.

Fig. 3-1 Climate and Demarcation of Mountain Areas



much difference in annual rainfall between the maximum rainfall of 137 inches (3,470 mm) and the minimum rainfall of 37 inches (940) mm) with its average rainfall recorded at 79 inches (2,000 mm) according to the past 30-year data available at Matale near the Moragahakanda Reservoir. (Tables 3-2 and -4, Figs. 3-2 and -3)

In April and October, the months sandwiched between the Maha and Yala seasons, the monsoons' impact becomes less significant and convective rain is generated by a difference in temperature between the land and the seas. There are showers on the coast in the early morning and in the inland areas in the afternoon.

On the other hand, the amount of evaporation on the water surface is great. Particularly in the dry zone, the Yala season coincides with a season of gales of strong monsoons (the average wind velocity recorded at 6.7 m per second at Jaffna). In Kantalai, for example, the daily average evaporation reaches 0.22 inch (6 mm) and the monthly average one 6.9 inches (174 mm), indicating that the amount of evaporation is 2.5 times as large as the average precipitation during the Yala season. (Table 3-5)

Fig. 3-2 Annual Average Precipitation (1931-1960)

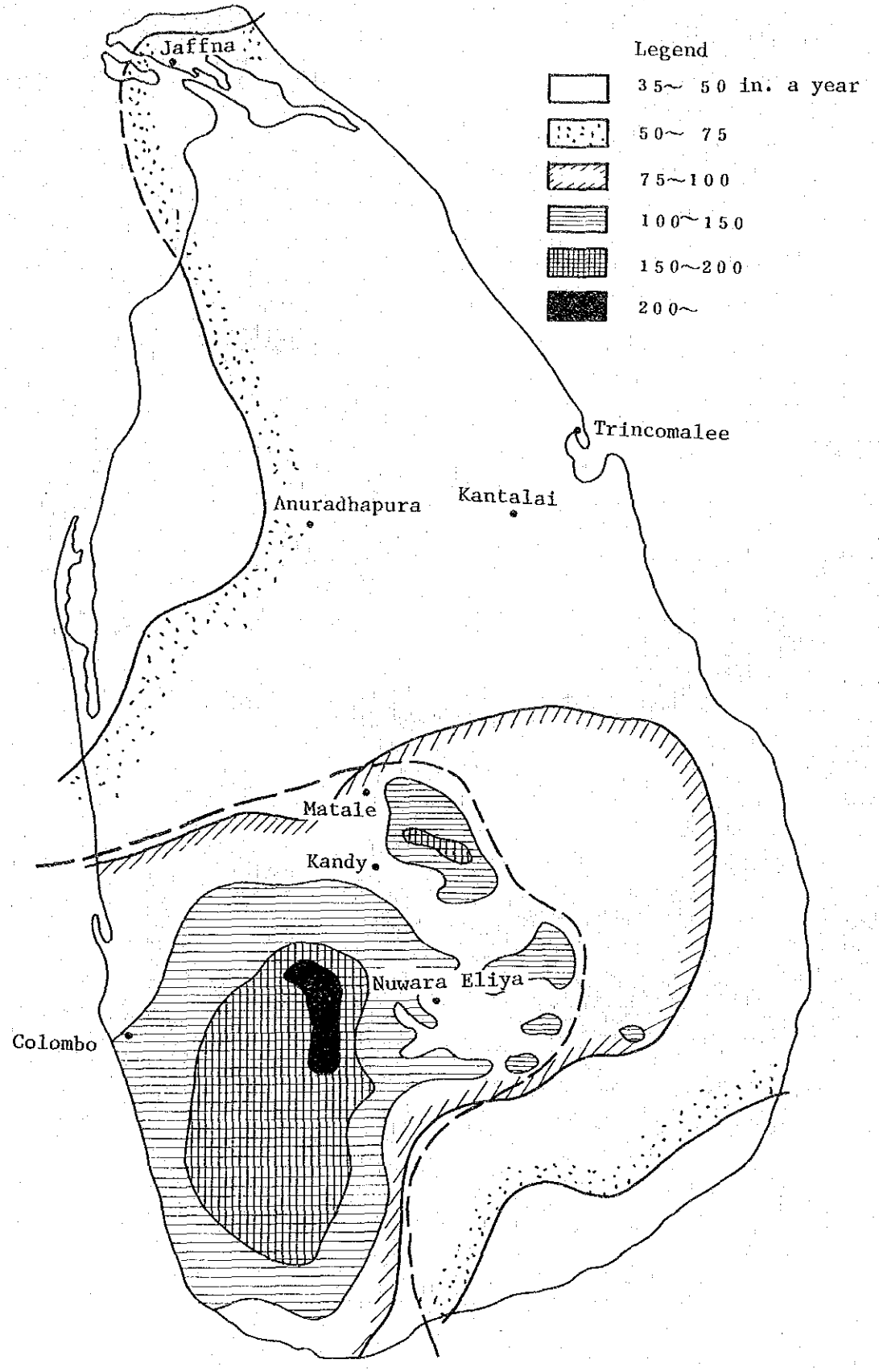


Fig. 3-3 Average Precipitation During Yala Season
(May-September)

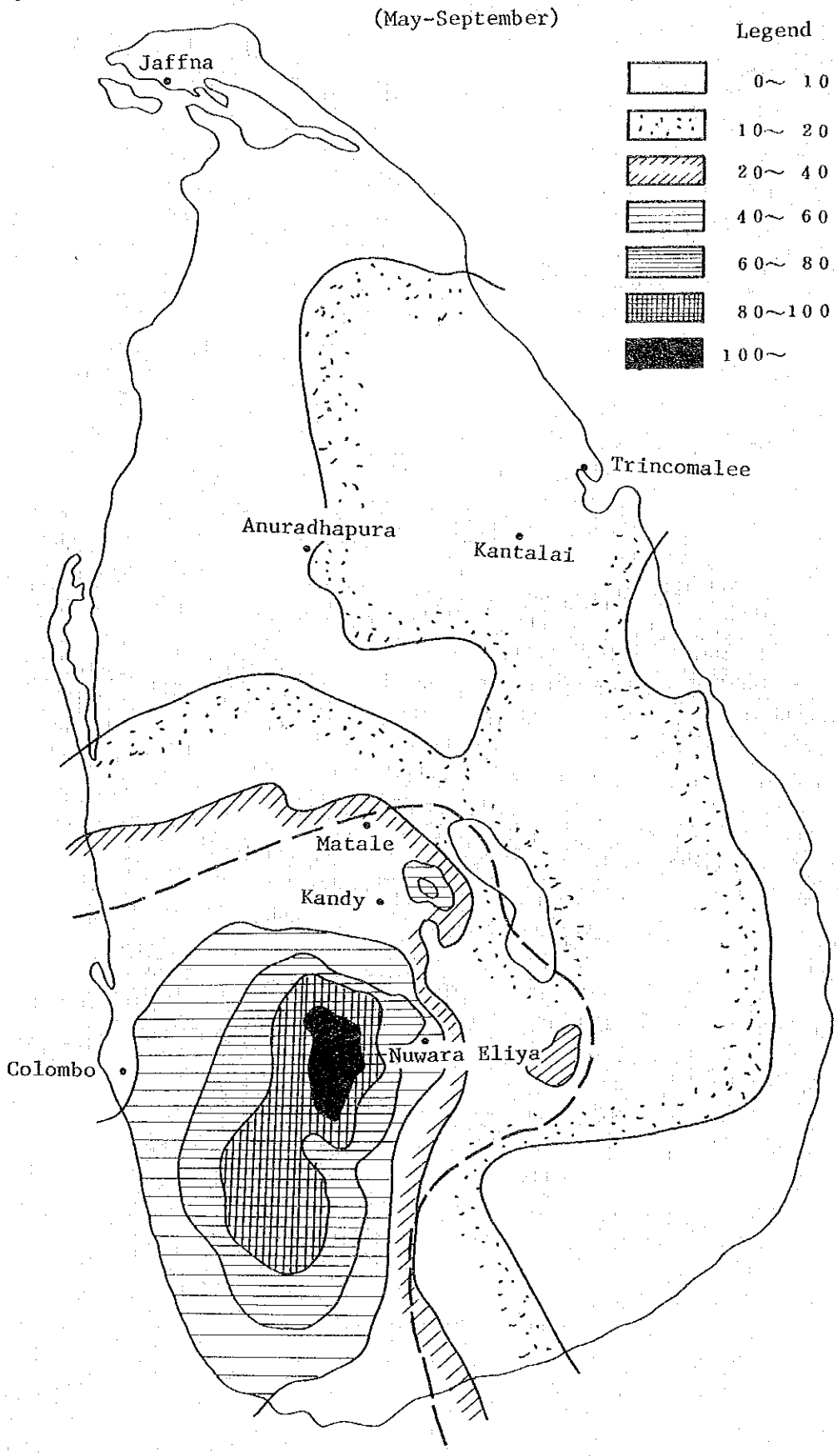


Table 3-1 Temperature (Monthly Average, 1961-77)

place \ Month		1	2	3	4	5	6	7	8	9	10	11	12	Average
Colombo	°F	79.4	80.2	81.5	82.3	82.6	82.3	81.4	81.6	81.4	80.3	79.9	79.5	81.0
(Wet Zone)	°C	26.3	26.8	27.5	27.9	28.1	27.9	27.4	27.6	27.4	26.8	26.6	26.4	27.2
Nuwara Eliya	°F	58.5	59.4	61.4	62.7	62.6	60.9	60.2	60.2	60.4	60.3	60.2	59.4	60.5
(〃)	°C	14.7	15.2	16.3	17.1	17.0	16.1	15.7	15.7	15.8	15.7	15.7	15.2	15.9
Anuradhapura	°F	76.8	79.0	82.5	84.1	83.3	83.5	83.5	83.6	83.4	81.4	79.3	77.3	81.5
(Dry Zone)	°C	24.9	26.1	28.1	28.9	28.5	28.6	28.5	28.7	28.5	27.4	26.3	25.2	27.5
Trincolmalee	°F	78.5	80.1	82.0	84.5	86.5	86.9	86.2	85.5	85.2	82.4	80.1	78.6	83.1
(〃)	°C	25.8	26.7	27.8	29.2	30.3	30.5	30.1	29.7	29.6	28.0	26.7	25.9	28.4

Table 3-2 Rainfall (Monthly Average, 1961-77)

place \ Month		1	2	3	4	5	6	7	8	9	10	11	12	Total
Colombo	ins	2.18	2.97	5.13	11.50	17.13	7.00	5.90	4.89	9.25	17.53	12.38	7.34	103.20
(Wet Zone)	mm	55	75	130	292	435	178	150	124	235	445	314	186	2621
Nuwara Eliya	ins	3.99	3.41	2.87	6.88	6.59	5.85	6.37	6.44	6.84	9.05	8.30	9.09	75.68
(〃)	mm	101	87	73	175	167	149	162	164	174	230	211	231	1922
Anuradhapura	ins	3.55	1.99	2.60	6.10	3.46	0.35	0.88	1.80	2.24	11.24	8.77	9.22	52.20
(Dry Zone)	mm	90	51	66	155	88	9	22	46	57	285	223	234	1326
Kantalai	ins	5.26	3.18	1.83	3.44	2.20	0.83	2.05	3.73	3.68	8.41	11.55	15.41	61.57
(〃)	mm	134	81	46	87	56	21	52	95	93	214	293	391	1564

Table 3-3 Rainfall

Unit: inch (1 inch = 25.4 mm)

place \ Year	Average, 1931-60	1973	1974	1975	1976
Colombo	94.31	88.41	99.20	100.90	82.48
Jaffna	52.34	41.85	22.61	56.35	39.24
Trincomalee	67.98	66.68	43.85	50.22	43.72
Hambantota	42.34	44.03	29.66	56.57	31.70
Ratnapura	153.06	118.44	153.73	184.08	133.00
Anuradhapura	56.98	39.94	33.99	40.34	47.07
Kandy	79.70	57.28	68.60	84.21	56.59
Diyatalawa	68.10	53.96	56.27	70.40	56.46
Nuwara Eliya	85.15	52.00	85.33	81.64	51.01

Reference: Statistical Pocket Book, 1977

Table 3-4 Annual Rainfall (Matale, 1946-75)

Year	ins	Year	ins	Year	ins	Year	ins	Year	ins	Year	ins
1946	77.35	1951	113.15	1956	68.39	1961	76.15	1966	67.30	1971	93.62
47	77.98	52	80.75	57	136.62	62	79.22	67	84.62	72	74.01
48	70.48	53	65.14	58	74.89	63	79.24	68	73.43	73	44.28
49	79.13	54	86.69	59	79.33	64	80.09	69	70.80	74	41.34
50	62.34	55	76.24	60	89.34	65	80.99	70	83.01	75	36.96

Table 3-5 Evaporation (Pan Evaporation, Monthly Average)

place \ Month		1	2	3	4	5	6	7	8	9	10	11	12	Total	Remarks
Nachchduwa	ins	4.85	5.40	7.33	6.11	6.30	6.66	6.70	7.32	7.20	5.28	4.41	4.70	72.26	1951～
Anuradhapura's periphery	mm	123	137	186	155	160	169	170	186	183	134	112	119	1,835	1957
Kantalai	ins	4.20	4.06	5.36	4.95	6.09	7.21	7.20	7.10	6.67	5.61	4.05	3.80	66.28	1957～
	mm	107	103	136	126	155	183	183	180	169	142	103	97	1,684	1969

Table 3-6 Evaporation (Values Measured at Kantali)

(Unit: inch)

Year measured	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1957	4.85	4.87	5.62	5.86	5.68	7.67	7.31	7.79	7.42	5.46	3.32	3.83	69.68
1958	3.85	3.68	4.84	4.42	6.10	7.61	7.55	6.41	6.75	5.52	3.35	3.50	63.58
1959	3.59	3.82	5.95	4.66	5.94	5.88	7.47	7.78	6.87	5.89	3.87	3.93	65.65
1960	4.19	3.47	5.34	4.17	5.73	7.36	6.44	7.47	6.63	7.06	5.15	5.05	68.06
1961	4.13	3.66	5.13	5.18	6.41	6.64	6.28	6.41	5.76	5.70	5.42	3.44	64.16
Average	4.12	3.90	5.38	4.36	5.97	7.03	7.01	7.17	6.69	5.93	4.22	3.95	66.23
1966	5.26	5.39	5.62	6.06	6.33	7.82	8.46	6.12	6.55	4.73	3.39	3.40	69.13
1968	4.01	4.20	3.86	4.59	6.09	7.12	7.35	8.42	6.76	4.82	2.50	3.27	62.99
1969	3.68	3.39	6.50	4.68	6.41	7.60	6.71	6.36	6.59	5.69	5.42	3.95	66.98
1974	—	—	—	—	—	—	8.54	—	6.77	7.63	—	—	—
1975	—	—	5.60	—	8.12	8.50	8.20	7.21	6.73	5.80	—	3.31	—
1976	3.30	5.11	5.40	7.78	9.05	8.72	8.35	7.85	6.43	5.91	—	—	—
1977	4.99	4.14	4.66	5.61	5.85	7.64	8.60	6.99	7.54	5.15	2.64	2.43	
1978	4.10	4.81	5.69										

(2) Hydrology

The island of Ceylon measures 65,609 square kilometers and is practically oval in shape. As the crow flies, it measures 354 km from north to south and 183 km from east to west.

Plains of 30-150 m in height stretch around the mountain area of the central south of the island and they are connected with the lowlands which extend along the seacoast. Particularly in the north of the island, vast plains are developed.

As there is much rain in the wet zone which includes the mountains of Ceylon's central southern part, must major rivers running from the middle part of the island to its southern part originate from the mountains of the central southern part. Fanning out across the plains around the mountains, these rivers flow into the seas. In the northern part which constitutes a dry zone, the rivers originate from the watershed which stretches northward from the mountains of the central southern part, so that many small rivers in the north are waterless during the dry season.

The Ceylon's biggest river is the Mahaweli Ganga, which originates from a point, about 2,400 m in height, deep in the mountains of the central south. Running down northwestward, the river drains into the Bay of Kodia in the south of Trincomalee and also into the Bay of Bengal on the eastern coast.

The length of this river is 207 miles (333 km). The annual average river dischange is 7.2 million AC-ft (8,900 million tons, or over 20% of the total dischanges of all rivers on the island of Ceylon) and its basin measures 4,034 square miles (10,448 square kilometers, or 16 percent of Ceylon's total area). The average rainfall in the basin is high with 75-217 inches (1,900-5,500 mm) in the west zone, which measures 820 square miles (2,124 square kilometers) and is situated along the upper stream, but low with 65-75 inches (1,650-1,900 mm) in the dry zone, which measures 3,214 square miles (8,324 square kilometers) and is located along the lower stream. As the potential and rainfall concentrated in the upstream portion, it might be said that there

exist great potentialities for the development of irrigation and power generation.

The Mahaweli Ganga has, in its basin, the Amban Ganga (the upper stream of which is formed by the Sudu Ganga), which is its biggest branch, and the site proposed for the Moragahakanda Dam is situated at the mid-stream portion (48 km up from the Amban's estuary). The Amban Ganga originates from a highland as its water source, about 1,200 m in height, between Kandy and Matale. The catchment area at the Moragahakanda Dam site measures 315 square miles (816 square kilometers) and the annual average dischange is about 720 ac-ft (900 million cubic meters). Discharged from the Polgolla Deversion, the main stream of the Mahaweli Ganga, a maximum of 1,000 Cusec (28.3 m^3/s) may be additionally received through the Bowatena Dam.

As for dischange data observed in the Mahaweli Ganga basin, the data for the past over 30 years are available on the Polgolla Diversion and the vicinity of the proposed site for the Moragahakanda Dam, but the fluctuations in the amount of dischange, depending on the irregularity of yearly and hourly rainfall, are so great that much attention should be paid to the use of these data. The annual amount of river dischange is shown in Table 3-8 as a general yardstick.

Table 3-7 Humidity (Monthly Average, 1961-77)

(Unit: %)

Month / classification	1	2	3	4	5	6	7	8	9	10	11	12	Average
Colombo	78	79	81	83	83	82	82	81	82	84	83	81	81
Nuwara Eliya	78	72	71	82	84	84	86	86	85	87	86	85	82
Anuradhapura	84	81	78	80	82	77	76	75	76	82	86	87	80
Trincomalee	76	75	77	77	71	67	67	69	70	77	81	81	74

On the other hand, there are smaller rivers in the north dry zone, but they are smaller in their annual and unit discharges than the Mahaweli Ganga and the Amban Ganga. For this reason, much hope cannot be pinned on the discharge of river water from their own basin.

Table 3-8 Amount of River Discharge

Classification		Polgolla		Moragahakanda		Remarks
		Annual river discharge	Year	Annual river discharge	Year	
Maximum	10^3AC·Ft	3,047	56/57	1,092	41/42	Polgolla (499 square miles = 1,292 km^2) at Garudeniya, October 1944 - September 1976
	100 mil.t.	37.6		13.5		
Minimum	10^3AC·Ft	974	47/48	138	55/56	Moragahakanda (315 square miles = 816 km^2) at Elahera, October 1941 - September 1976
	100 mil.t.	120		1.7		
Average	10^3AC·Ft	18.85		647		
	100 mil.t.	23.3		8.0		

Table 3-9 Comparative Studies on River Water Discharges

Classification	Total catchment area	Gauging Station			
		Gauging points	Catchment area	Annual river discharge	Unit river discharge
Mahaweli Ganga	4,034 sq.Mls	Gurudeniya	547 sq.Mls	1986.57 FAC.Ft	3,632 AC.Ft/sq.Mls
Maduru Oya	602	Welikanda	410	496.76	1,212
Yan Oya	594	Pangurugaswewa	506	317.19	627
Malwatu Oya	1,268	Kappachchi	819	335.76	410
Kala Oya	1,083	Nochchiyagama	752	403.40	536

3-2 Agriculture

The arable lands of Sri Lanka account for one-third (about 5,000,000 acres) of its country and 50 percent of the working population are engaged in agriculture. The share of the agricultural sector in the national income (on the five-year average from 1972) is 32 percent. The share of tea, rubber, coconuts and the other plantation agricultural products in the exports is high and accounts for 70 percent of the total exports, although their export has somewhat decreased in recent years.

Their share has reached 70 percent. On the other hand, the share of food in the import values is high, standing at over 30 percent. Of this share, rice accounts for 13.5 percent (on the five-year average standing at 350,000 tons) and wheat 15.7 percent (371,200 tons). (Table 3-12)

The proportion of plantation to agriculture is high. The black tea, rubber and coconut plantations account for 50 percent of all lands under cultivation. Following it, the cropped area for paddy in both the Maha and Yala seasons is 1,719,000 acres (1975). Aside from coconuts, the output of tea/and rubber has not increased. The output of rice is 30 percent higher than in 1961, but it has been leveling off in recent years. (Table 3-10)

Table 3-10 Key Indicators of Principal Agricultural Crops, 1968-1977

	1968	1969	1970	1971	1972	1973	1974	1975	1976(a)	1977(a)
Production										
Tea (Mn. lbs.) ...	496	484	468	480	471	466	450	471	433	460
Rubber (Mn. lbs.) ...	328	333	351	312	309	341	291	328	335	333
Coconut (Mn. nuts) ...	2601	2440	2510	2610	2963	1935	2031	2398	2330	1900
Paddy (Mn. bushels) ...	64.6	65.9	77.4	66.9	62.9	62.9	76.3	55.3	60.0	80.4
Acreage										
Tea — Total ...	597,490	596,514	597,499	597,171	597,645	598,740	598,466	597,691	594,481	598,000
Replanted Annual ...	5,266	6,500	6,857	6,640	6,418	5,953	4,282	4,356	2,756	3,067
Replanted Cumulative ...	26,928	33,428	40,285	46,925	53,343	59,296	63,578	67,934	70,690	73,757
Rubber— Total ...	569,207	568,633	568,900	567,994	567,060	565,000	563,406	562,494	560,872	559,850
Area under Tapping ...	488,121	493,712	496,210	494,355	491,324	475,529	475,165	477,110	474,626	469,626
Replanted Annual ...	13,047	12,084	10,214	8,476	8,722	4,964	7,076	7,980	6,298	6,464
Replanted Cumulative ...	264,042	276,126	286,340	294,816	303,538	308,502	315,578	323,558	329,856	336,320
Coconut—Total ...	(1962)	(1,152,418)								
Paddy — Total ('000 Acres) ...	1,742	1,709	1,876	1,794	1,795	1,792	2,038	1,719	1,789	2,046
Area harvested ('000) ...	1,634	1,539	1,776	1,714	1,579	1,660	1,969	1,476	1,570	1,933
High yielding varieties ('000)	1,083	1,108	1,325	1,204	1,252	1,284	1,647	1,285	1,381	
Yield per acre										
Tea ...	830.1	811.4	811.0	833.0	816.0	805.0	882.0	920.0	839.1	899.5
Rubber ...	671.7	673.5	707.2	657.0	658.0	694.0	634.0	691.1	705.0	708.8
Coconut ...	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Paddy ...	46.49	50.33	51.30	45.91	46.87	44.58	45.65	44.04	44.91	48.92

(a) Provisional

Sources: Tea Commissioner's Department,
Rubber Control Department,
Department of Census & Statistics,
Coconut Marketing Board,
Central Bank of Ceylon.

° Annual Report 1977, Central Bank of Ceylon.

Table 3-11 District-wise Performance in the 1975/76 Cultivation Year[a] Paddy Sector[b]

Zone and District	Gross Extent Sown Acres		Gross Extent Harvested Acres		Area Under Improved Varieties-Acres		Fertilizer Issues Tons		Yield per Acre Bushels	
	Maha 1975/76	Yala 1976	Maha 1975/76	Yala 1976	Maha 1975/76	Yala 1976	Maha 1975/76	Yala 1976	Maha 1975/76	Yala 1976
Wet Zone										
Colombo ...	64,762	47,850	57,403	44,267	52,785	35,482	3,746	2,311	43.24	30.19
Kalutara ...	50,185	49,366	45,800	46,271	21,643	17,257	2,000	1,889	31.56	27.04
Galle ...	58,448	56,856	53,522	52,710	16,403	10,669	1,677	1,727	29.87	23.56
Matara ...	50,195	47,354	46,258	44,301	37,234	32,753	1,622	1,700	38.50	29.94
Kegalle ...	28,129	24,750	27,190	17,958	24,208	17,834	1,325	1,058	51.96	34.51
Ratnapura ...	37,880	34,076	36,414	33,118	23,859	13,490	1,513[c]	1,665[c]	38.29	38.28
Kandy ...	48,672	25,802	48,229	23,476	46,933	17,716	2,644	933	55.49	51.23
Nuwara-Eliya ...	18,165	11,723	18,135	11,547	17,643	8,396	482	212	58.97	59.90
Badulla ...	37,977	15,931	37,209	15,608	34,272	16,408	993	496	59.08	45.58
Sub Total	394,413	313,708	370,160	289,256	274,980	170,005	16,032	11,991	45.22	37.80
Dry Zone										
Puttalam ...	20,710	8,748	17,604	4,245	18,879	6,719	518	474	33.44	31.44
Kurunegala ...	127,644	104,547	119,555	23,162	104,301	66,228	6,012	4,279	45.65	31.89
Matale ...	27,980	10,727	27,074	9,415	17,285	7,138	635	295	53.87	39.87
Moneragala ...	25,573	4,341	21,470	4,163	15,937	4,206	485	301	46.47	46.36
Jaffna ...	73,191	10,612	66,269	10,056	63,106	10,460	3,541	1,443	35.44	37.96
Vavuniya ...	32,461	746	22,405	746	32,482	572	641	235	27.59	32.50
Mannar ...	9,160	2,044	2,331	1,823	7,485	950	144	1,954	59.12	53.28
Anuradhapura ...	63,060	18,750	48,966	16,868	68,495	16,232	374	438	54.61	69.34
Polonnaruwa ...	62,845	45,211	62,356	44,279	54,609	41,279	4,847	3,536	80.77	57.62
Trincomalee ...	47,828	3,187	43,459	2,927	49,758	3,494	744	239	42.17	44.36
Batticaloa ...	94,379	19,263	87,204	17,320	89,355	17,949	3,121	1,043	43.10	50.92
Amparai ...	99,820	63,408	98,415	62,623	94,291	60,832	3,203	3,418	45.94	49.38
Hambantota ...	47,118	18,517	43,969	14,968	40,223	15,255	1,488	1,076	58.60	45.21
Uda-Walawe ...	20,780	18,120	20,706	16,187	15,298	13,167	439[d]	114[d]	82.10	52.16
Sub Total	752,549	328,221	681,783	229,082	671,504	264,481	26,191	18,845	50.63	45.88
Sri Lanka ...	1,116,962	611,929	1,051,943	518,338	916,484	434,486	42,223	30,836	47.17	40.30

Sources: Department of Census and Statistics, Ministry of Agriculture and Lands.

(a) The Cultivation year comprises Maha (September/October - March/April) and Yala (April/May - August/September).
(b) Provisional Estimates.
(c) Includes fertilizer issues to Uda-Walawe.
(d) Includes fertilizer issues by River Valley Development Board.

° Review of the Economy 1976, Central Bank of Ceylon.

Table 3-12 Imports of Rice, Flour and Sugar - Food Commissioner's and Customs Data

	Food Commissioner's Data							Customs Data (Food Commissioner's Imports and Imports of Others Recorded by Customs)						
	1970*	1971	1972	1973	1974	1975	1976	1970	1971	1972	1973	1974	1975	1976
Rice														
Quantity : Th. Tons	526	334	262	338	297	450	419	472	290	294	335	293	458	372
Value : Rs. Mn.	353	188	142	322	798	964	724	318	195	161	270	720	1,062	642
C & F Price : Rs. Mn. per ton	671.15	563.11	544.25	953.18	2,685.82	2,141.32	1,730.28	672.70	673.78	547.27	807.47	2,461.56	2,319.06	1,725.61
Flour														
Quantity : Th. Tons	369	330*	324	365	442	455	380	419	318	301	396	402	432	325
Value : Rs. Mn.	225	212	218	458	938	1,024	781	260	206	193	453	856	1,002	671
C & F Price : Rs. Mn. per ton	611.44	630.79	667.26	1,254.20	2,124.04	2,249.65	2,056.68	621.48	649.93	639.92	1,144.14	2,131.63	2,319.33	2,065.14
Sugar														
Quantity : Th. Tons	240	283*	214*	190	42	61	45	279	287	223	193	67	55	24
Value : Rs. Mn.	152	242	255	334	231	268	128	170	243	248	321	190	248	64
C & F Price : Rs. Mn. per ton	633.71	844.65	1,168.16	1,752.16	5,485.75	4,370.24	2,792.86	608.46	845.87	1,111.55	1,663.44	2,846.94	4,526.25	2,645.94
Total Value : Rs. Mn.	730	642	615	1,114	1,967	2,256	1,633	748	644	602	1,044	1,766	2,312	1,377

* Not adjusted for imports of others.

° Review of the Economy 1976, Central Bank of Ceylon.

Source: Food Commissioner's Department; Customs, Sri Lanka.

Table 3-13 Performance of the Subsidiary Food Crop Sector in the 1974/75 and 1975/76 Cultivation Years(a)

Crop	Extent Cultivated (Acres)		Percentage Change	Production (cwts)		Percentage Change	Yield per Acre (cwts)	
	1974/ 1975(b)	1975/ 1976(c)		1974/ 1975(b)	1975/ 1976(c)		1974/ 1975(b)	1975/ 1976(c)
Manioc (Cassava) ...	195,696	211,455	+ 8.1	15,093,080	15,237,014	+ 1.0	77.1	72.1
Maize ...	99,040	77,345	- 21.9	680,114	627,287	- 7.8	6.9	8.1
Chillies ...	81,640	109,185°	+ 33.7	364,932	598,349	+ 64.0	4.5	5.5
Red Onions ...	15,635	22,211	+ 42.1	1,433,349	1,809,841	+ 26.3	91.7	81.5
Ground Nuts ...	19,209	19,359	+ 0.8	149,670	120,279	- 19.6	7.8	6.2
Green Gram ...	22,866	28,789	+ 25.9	124,484	146,223	+ 17.5	5.4	5.1
Sorghum ...	9,283	6,794	- 26.8	127,486	92,164	- 27.7	13.7	13.6
Soya Bean ...	2,818	3,125	+ 10.9	22,874	27,580	+ 20.6	8.1	8.8
Potatoes ...	4,978	14,201	+185.3	537,400	1,466,520	+172.9	108.0	103.3
Bombay Onions ...	349	873	+150.1	26,261	49,129	+ 87.1	75.2	56.3
Kurakkan (Finger Millet) ...	66,289	54,587	- 17.7	404,604	352,454	- 12.9	6.1	6.5
Gingelly (Seasame) ...	57,658	69,761	+ 21.0	211,568	342,704	+ 62.0	3.7	4.9
Meneri (Fox-tail Millet) ...	2,501	5,951	+137.9	9,651	42,568	+341.1	3.9	7.2
Cowpea ...	21,578	41,427	+ 92.0	148,809	242,396	+ 62.9	6.9	5.9
Thanahal ...	1,050	1,386	+ 32.0	3,368	8,780	+160.7	3.2	6.3
Black Gram ...	5,026	12,213	+143.0	20,593	48,806	+137.0	4.1	4.0
Dhal ...	594	156	- 73.7	3,801	547	- 85.6	6.4	3.5
Sweet Potatoes ...	52,492	62,902	+ 19.8	4,435,820	3,561,233	- 19.7	84.5	56.6

Source: Ministry of Agriculture and Lands.

(a) The Cultivation year comprises Maha (Sept./Oct. - March/April) and Yala (April/May - Aug./Sept.).
(b) Revised.
(c) Provisional.

° Review of the Economy 1976, Central Bank of Ceylon.

The agriculture of Sri Landa may be divided into the field husnbandry, which centers around rice cropping, the plantations and their forms of farm management are entirely different. With the annual rainfall of 75 inches as the borderline, it is also classified into wet and dry zones. In the wet zone, both the southeaster monsoons (Yala) from May to July and the northeaster monsoons (Maha) from November to March bring rainfall (the annual rainfall ranging from 100 to 200 inches), making it possible to develop the plantation agriculture in this area. The rainfall also makes it possible to carry out the double cropping of rain-fed paddy and cultivate upland crops and vegatables all the year round. In this context, the southwestern part of the island is well developed. In the dry/zone, it rains only during the Maha season, and paddy rice is planted with irrigation water discharged from traditional tanks. Chillier, pulse, cereds and tabacco are cultivated as upland crops. The wet zone occupies only one-third of the country, but a little less than 70 percent of all lands under cultivation exist and 75 percent of the total population are living in this zone. In the dry zone, however, there are many portions of land that have not cultivated yet, and the land used for cultivation would be a mere 15 percent.

To clarify the forms of agriculture in Sri Lanka, the typical districts for the dry and wet zones (Kandy and Colombo for the wet zone and Polonnaruwa and Hambanteta for the dry zone) are compared as follows:

Land ownership: The percentage of owner farmers is high in the dry zone with the average area of paddy fields registered at four acres. In the wet zone, the percentage of tenant farmers is high with the average area of paddy standing at about two acres. With respect to the tenant right and the rent for tenancy, the Paddy Land Act was stipulated in 1958. The rent for tenancy is fixed or one-fourth of the value of a crop. In the wet zone, however, there are many cases in which half of a rent for tenancy is paid by share cropping. Under the Land Reform Act of 1972, the farmland holding is restricted to 25 acres for paddy fields and 50 acres for upland fields (including the plantations).

Irrigation: In the wet zone, irrigation facilities are not developed and there are many rain-fed fields. In the dry zone, irrigation water is supplied by tanks and the percentage of areas using major or minor irrigation facilities is high. A yielding difference of 20-35 percent is observed, depending on the dimensions of the irrigation facilities and the rain-fed fields.

Varieties: In the dry zone, the use of new high yielding varieties (NHYV) is high in percentage. In the wet zone, however, many traditional varieties are still put to use. (Tables 3-11 and 3-17) In Polonnaruwa, the average yield of new high-yield varieties (NHYV) is 84 bushels and the old high yielding varieties (OHYV) 56 bushels.

Fertilizer: The use of fertilizer has increased in recent years. Basal dressing is applied for only 50 percent of the area covered by major irrigation facilities and 20 percent of miner irrigation facilities and rain-fed fields. The application of fertilizer is small in quantity in the wet zone (Tables 3-11 and 3-15):

In addition to single-element manure, urea (or ammonium sulfate), superphosphate of lime and murate of potash are blended at a rate suitable for a given crop, depending on the crop, or basal dressing and side dressing. Fertilizer is supplied by the Ceylon Fertilizer Corporation mainly by way of the Agricultural Cooperative Association. As the government subsidy for the Ceylon Fertilizer Corporation was dropped from 75 percent to 50 percent on July 7, 1978, the prices were raised by 60 percent on the average (Table 3-14).

Plowing: Plowing is done with hoes, buffalos and tractors. As there is a shortage of tractors, however, optimum operations are not carried out. As water is constantly available in the irrigated fields and the wet zone, buffalos are mainly used. In areas where the water supply is not stable, the sowing season is confined, so that plowing is done by tractors in a concentrated operation. In cases where plowing cannot be performed and there is a delay in sewing and transplanting there will be a drop of 25 percent in yield.

Transplanting: Outlays are required for planters. Generally in the irrigated areas of the dry zone, the random transplanting system is

done about 50 percent during the Maha season, and an yield increase of 20-28 bushels per acre is observed due to the transplanting. (Table 3-16)

Production cost and agricultural income: In Polonnaruwa and the other improved agricultural districts, the labor input is great, the labor cost exceeds 50 percent of the production cost with the employment of 90-100 man-day per acre for a paddy production. The percentage of hired labor work is high in the dry zone (about 70 percent) and low in the wet zone (50 percent). Tractors, fertilizer and pesticides are used in the dry zone in bigger amount. (Table 3-18)
The production cost for the dry zone is 800-1,100 Rupees per acre and 500-700 Rupees for the wet zone, but the unit cost per bushel is lower in the dry zone. In terms of profitbility, the agricultural income in the dry zone is higher than that in the wet zone, as the lands under cultivation are large in area and the average yield is high in the dry zone, whereas in the wet zone, the lands under cultivation are small in area, most of them being tenant, and the average yield is low.
The sales of products are high in the dry zone with 55-70 percent, whereas most of the products in the wet zone are set aside for self-consumption (Table 3-19, -20, -21, -22 and -23).

Agricultural Extension: The Krushikarma Viyapthi Seyaka (KVS) provides guidance on agricultural technology, animal production, management, marketing and the other matters under the direction of the Department of Agriculture. The guidance on the extention of high yielding varieties has been more effective, but many problems are posed for the extension of the other agricultural technologies and the levels of farmers' education.

Agricultural Cooperative Associations: The agricultural cooperative associations are in charge of living, the supply of necessaries of life agricultural materials and equipment, purchase of products and advance of agricultural loans. Farmers constitute the majority of their membership but the utilization of the agricultural cooperative associations in the wet zone is low in percentage. Seven percent of the farmers use facilities of the agrucultural cooperative associations, whereas the rest are dependent upon individual entreprenurs. The rate of

Table 3-14 Price of Fertilizer (Ceylon Fertilizer Corporation, 1978)

Fertilizer (Name)	Component			Selling Price to Customers per M.T.	
	N	P_2O_5	K_2O	Old	New
Urea				1,044 Rs.	1,835
NPK 5-15-15				1,057	1,695
NPK 3-30-10				1,057	1,695
V I	A.S. (15)	S.P. (73)	P.C. (24)	1,186	1,581
V II	A.S. (15)	R.P. (73)	P.C. (24)	495	954
V III	A.S. (15)	S.P. (79)	P.C. (18)	1,230	1,609
TDM I	U (3)		P.C. (1)	943	1,685
TDM II	U (2)		P.C. (1)	909	1,635
TDM III	U (1)		P.C. (1)	842	1,535
General Vegetable	A.S. (4)	R.P. (3)	P.C. (2)	560	1,057
Onion	A.S. (2)	R.P. (2)	P.C. (1)	516	985
Beans & Cowpea				550	1,044
Potato				576	1,088
Chillie	A.S. (27)	R.P. (8)	P.C. (11)	643	1,197

* A.S. : Ammonia Sulphate, S.P. : Con. Super Phosphate
U. : Urea R.P. : Rock Phosphate (29%)
P.C. : Potashium Chloride

Table 3-15 Fertilizer Application, by Type and Amounts per acre

Maha 1976/77

Type of Fertilizer	Polonnaruwa (cwt.)	Hambantota (cwt.)	Kegalle-Kandy (cwt.)	Colombo (cwt.)
1. Basal Mixture	1.44	0.52	0.96	0.74
2. Urea	2.02	0.94	1.00	0.41
3. Top Dressing Mixture	0.01	0.44	0.24	0.33
Total	3.47	1.90	2.20	1.48

◦ Profitability and Resource Characteristics of Paddy Farming Agrarian Research and Training Institute (ARTI)

Table 3-16 Transplanting & Broadcasting (1972-3)

Item	Hamban-tota	Polonna-ruwa	Elahara	Kurunagala	Kandy	Colombo
Transplanting	36.6	76.9	88.5	37.8	89.3	11.3
Broadcasting	63.4	23.1	11.5	62.2	10.7	88.7

∘ Cost of Production of Paddy. ARTI.

Table 3-17 Area Planted According to Varieties
- Maha 1976/77
(Percentage of the Total Extent Cultivated)

Variety	Plonnaruwa (%)	Hambantota (%)	Kegalle-Kandy (%)	Colombo (%)
Traditional[1]	3	12	16	69
OHYV[2]	4	25	54	5
NHYV[3]	93	63	30	26

[1]Traditional : Indigenous Varieties

[2]OHYV : Old High Yielding Varieties such as H-4

[3]NHYV : New High Yielding Varieties such as BG 11-11, BG 34-8 and BG 34-6, etc.

∘ Profitability and Resource Characteristics of Paddy Farming. ARTI.

Table 3-18 Adoption of Some Important Farm Practices - Maha 1976/77

	Polonnaruwa	Hambantota	Kegalle-Kandy	Colombo
	(Percentage of total sample)			
a) Farmers Who Had Used Certified Seed (%)	40	35	10	7
b) Area Transplanted (%)	88	38	93	16
c) Farmers Who Applied Agro-chemicals (%)	79	83	67	62
d) Farmers Who Applied Some Kind of Fertilizer (%)	95	96	93	62
e) Amount of Nitrogen Applied (lbs/ac)	107	66	63	36
f) Average Yield (bu.ac)	76	56	48	32

◦ Profitability and Resource Characteristics of Paddy Farming. ARTI.

Table 3-19 Operating Costs Classified According to Cash and Non-Cash Inputs
(Rupees per Acre)

Maha 1976/77

	Polon-naruwa (Rs.)	Hamban-tota (Rs.)	Kegalle-Kandy (Rs.)	Colombo (Rs.)
Cash Inputs[1]:				
Labour	613	352	327	184
Buffalo	41	10	130	77
Tractor	135	211	1	54
Speed Paddy	58	63	22	24
Fertilizer	223	111	143	100
Agro-chemicals	52	55	31	37
Crop Insurance, Acreage Tax	16	12	13	6
Transport	24	8	15	3
Sub total	1,162	822	682	485
Non-Cash Inputs:				
Labour	210	109	228	202
Buffalo	118	1	12	7
Tractor	30	30	-	6
Speed Paddy	29	31	44	49
Sub total	387	171	284	264
Total Operating Costs	1,549	993	966	749
Average Acreage	3.59	3.53	0.76	0.73
Average Yield per Acre (Bushels)	76	56	48	32
Percentage of Sales	70	55	22	13

Source: Profitability and Resource Characteristics of Paddy Farming.

◦ Profitability and Resource Characteristics of Paddy Farming. ARTI.

Table 3-20 Distribution of Farmers Owning Tractors and Buffaloes

(Percentage of the Sample)

Item	Polonnaruwa (%)	Hambantota (%)	Kegalle-Kandy (%)	Colombo (%)
Tractors	9	8	-	2
Buffaloes	60	8	20	6

∘ Profitability and Resource Characteristics of Paddy Farming 1977, ARTI.

Table 3-21 Hire Rates for Four-Wheel Tractors by Operation

Operation	Polonnaruwa (Rs. per ac.)	Hambantota (Rs. per ac.)
Land Preparation	200	175
Threshing	60	40
Winnowing	40	21

∘ Profitability and Resource Characteristics of Paddy Farming 1977, ARTI.

Table 3-22 Hire Rates for Buffaloes by Operation

(Rupees per pair per day)

Operation	Polonnaruwa (Rs.)	Kegalle-Kandy (Rs.)	Colombo (Rs.)
Land Preparation	20.00	15.00	15.00
Threshing	-	12.00	12.00

∘ Profitability and Resource Characteristics of Paddy Farming 1977, ARTI.

Table 3-23 Daily Wage Rates of Hired Labour in Paddy Cultivation

Area	Wages per day		
	Men (Rs.)	Women (Rs.)	Children (Rs.)
Polonnaruwa	10.00	8.00	7.50
Hambantota	10.00	8.00	7.00
Kegalle-Kandy	9.00	7.00	4.00
Colombo	6.50	5.00	4.00

∘ Profitability and Resource Characteristics of Paddy Farming 1977, ARTI.

Table 3-24 Cost of Cultivation per Acre Classified on the Basis of Major Inputs Used

Crop		Labour	Machinery & Equipment	Purchased* Inputs	Seed	Miscel-laneous	Total	Yield/Acre (cwt.)	Price per CWT.
									(Rs.)
Chillies									
Elahera	Rs.	829.00	76.00	232.00	22.00	8.00	1,167.00	7.16	873.78
	%	71	7	20	2	-	100		
Polon-naruwa	Rs.	1,400.00	125.00	209.00	33.00	33.00	1,800.00	12.45	923.74
	%	78	7	11	2	2	100		
Green Gram									
Elahera	Rs.	527.00	78.00	11.00	75.00	-	691.00	5.86	221
	%	77	11	1	11	-	100		
Dewahuwa	Rs.	502.00	79.00	69.00	41.00	70.00	761.00	4.67	236
	%	67	10	9	5	9	100		
Ground Nut									
Elahera	Rs.	431.00	77.00	14.00	149.00	29.00	700.00	10.67	83
	%	62	11	2	21	4	100		
Dewahuwa	Rs.	835.00	63.00	51.00	112.00	74.00	1,135.00	8.63	124
	%	73	6	4	10	7	100		
Red Onions									
Elahera	Rs.	1,977.00	51.00	136.00	1,532.00	7.00	3,703.00	54.50	97
	%	54	1	4	41	-	100		
Dewahuwa	Rs.	1,348.00	128.00	196.00	1,212.00	281.00	3,165.00	33.00	100
	%	43	4	6	38	9	100		
Bombay Onions									
Elahera	Rs.	871.00	60.00	89.00	58.00	-	1,078.00	53.36	140
	%	82	5	8	5		100		
Polon-naruwa	Rs.	1,139.00	159.00	75.00	75.00	62.00	1,510.00	63.81	134
	%	75	11	5	5	4	100		

*Purchased Inputs: Includes mainly cost of fertilizer and agro-chemicals used.

◦ Source: Production of Other Crops in Paddy Fields in Yala 1972. ARTI.

Table 3-25 Cultivation Loans Granted under Rural Credit Schemes* - (as at 31st December, 1977)

Amount in Rupees Million

Cultivation Year	Loans Granted			Recoveries			Percent of Recoveries		
	Paddy	Other Crops	All Crops	Paddy	Other Crops	All Crops	Paddy	Other Crops	All Crops
1967/68 - 1969/70 ...	180.1	19.4	199.5	128.4	15.5	143.9	71.3	79.9	72.1
1970/71 - 1972/73 ...	88.2	24.8	113.0	57.2	19.0	76.2	64.8	76.6	67.4
1973/74 ...	111.1	26.2	137.3	59.2	15.2	74.4	53.3	58.0	54.2
1974/75 ...	85.4	27.8	113.2	41.9	15.7	57.6	49.1	56.5	50.9
1975/76 ...	74.3	29.6	103.9	41.1	14.1	55.2	55.3	47.6	53.1
1976/77 ...	99.2	76.3	175.5	34.3	14.1	48.4	34.6	18.5	27.6
Total ...	638.3	204.1	842.4	362.1	93.6	455.7	56.7	45.9	54.1
1977/78** ...	292.6	8.9	301.5	0.4	...	0.4	0.1	...	0.1

* Loans upto 1973 were granted under the New Agricultural Credit Scheme. Since then, loans have been granted under the Comprehensive Rural Credit Scheme, which replaced the former scheme.

** Incomplete data, Maha Season only.

° Annual Report 1977, Central Bank of Ceylon.

Source: People's Bank, Bank of Ceylon, Hatton National Bank Limited.

Table 3-26 Comparison of Actual Cash Costs and Approved Credit Ceilings According to Field Operations (Rupees per acre)

Item	Approved Credit Ceiling (Rs.)	Cash Production Cost	
		Polonnaruwa (Rs.)	Hambastota (Rs.)
Land Preparation	150	239	219
Seed Paddy	45	58	63
Fertilizer Application	195	231	113
Transplanting/Sowing	100	206	119
Pest, Disease & Weed Control	700	84	69
Harvesting & Post Harvesting Operation	75	326	228
Other	-	18	11
Total	765	1,162	822

° Profitability and Resource Characteristics of Paddy Farming 1977. ARTI.

Table 3-27 Change of paddy price G.P.S. purchases.

(Rs/Bushel)

1948	1951	1952	1967 (Feb)	1973 (Feb)	1973 (Nov)	1974	1974 (July)	1977
8	9	12	14	18	25	30	33	40

utilization is high at Polonnaruwa (dry zone) with 58 percent.

Agricultural finance: Agricultural finance is composed of short-term loans classified by feed, fertilizer and operation for each crop, medium-term loans for the purchase of agricultural machinery and long-term loans for the acquisition of warehouses, vehicles and rice milling facilities. The cultivation loans are obtainable through the Agricultural Service Center or the Cooperative Rural Bank by the Comprehensive Rural Credit Scheme which is organized by the Bank of Ceylon, People's Bank and Hatton National Bank. Loans worth 100 million Rupees a year on the average have been advanced in the past 10 years. The repayment rate, which had accounted for move than 70 percent in the early years, dropped year by year to 27.6 percent in 1976/7 (Table 3-25). Loans are used mainly for paddy cultivation. In general, the loan utilization rate is high in the dry zone. With respect to upland crops, loans are advanced in many cases for chilles, onions and potatoes.

Guaranteed Price: A guaranteed price system was established for specified products in 1942 to stabilize the agricultural income and boost incentives for higher production. Unhulled rice is purchased by the Paddy Marketing Board.

The guaranteed price is 2.60 Rupees for green gram, 2.00 Rupees for black gram, 1.60 Rupees for cowpeas and 2.50 Rupees for soybeans per pound in the pulses clacification of beans and peas. In the cereals, the guaranteed price is 1,500 Rupees for sarghum and 1,250 Rupees for maize per long ton (2,240 pounds).

The consumer's purchase price is 4.20-4.75 Rupees for ordinary rice per pound, and that of beans and peas is almost double the guaranteed price.

3-3 Irrigation

(1) The history of irrigation in Sri Lanka is old, dating back to the eras before Christ. It has developed along with the history of the Shinhalese.

Vijayu, taking 700 Aryans with him, came from the north of India and landed on Ceylon to become the island's first king. As the

core of his monarchy's influence was situated in the north and northeastern part of Ceylon which formed a dry zone, irrigation techniques were developed as a matter of course, enabling Ceylon to become a prominent civilized nation blessed by irrigation techniques till the downfall of the monarchy.

With the East India Company making inroads into the island, however, the agriculture of Sri Lanka began to evolve around estate farming, such as black tea, with the consequence that the development of irrigation techniques for paddy rice came to a standstill in the meantime.

(2) As one of the features of Sri Lanka's irrigation facilities, greater numbers of tanks and long tank-connecting channels were constructed from the 3rd century B.C. to the 12th century, and many of them are still in use, after they have been repaired on many occasions.

In the dry zone, tanks are installed for practically every usable water source. Legend says that as many 1,000 tanks were constructed in the reign of King Parakrama (1153-1186A.D.), who built the Parakrama Samdra, the Sri Lanka's largest tank.

Of all these tanks, some have been abandoned due to the fall of the Shinhalese and the pile-up of earth and sand, and the paddy fields in these areas have once again turned into jungles.

However, the Parakrama Samudra and the other representative tanks at Kalawewa and Kaudulla have been partially repaired and still functioning as basic facilities for irrigation.

Irrigation channels, on the other hand, have been constructed for dam linkage and regional irrigation to store rain water in an effective manner in the monsoon areas where there is a marked fluctuation in the availability of water.

A typical example is the Elahera Channel, which was constructed in the first century B.C. Without any improvements since then, this channel still supplies water from the Amban River to the irrigated area covered by the Moragahakanda Dam. The area covered by this channel is the district in which representative tanks

are located. From the old days, channels have been constructed to link these tanks. For this reason, this area may be described as the one accompanied with the Sri Lanka's most developed irrigation system.

Another typical example is the Minipe Channel (constructed in 459, A.D.), which still supplies water from the Mahaweli Ganga to its basin.

(3) These facilities have been consturcted to cope with extraordinary meteorological conditions in the dry zone, and it might be said that agriculture in the dry zone is not viable unless it depends on irrigation.

Even in cases where facilities are available at present, only single cropping is feasible in many districts during the Maha season, and this is in sharp contrast to the wet zone where double cropping prevails in many paddy fields with abundant rain water.

For this reason, the rehabilitation and improvement of the old reservoirs are carried out to boost the agricultural productivity of the dry zone in Sri Lanka.

(4) With respect to the irrigation system used in a field, the plot-to-plot irrigation system, which does not use terminal irrigation-cum-drainage channels, is put to general use. This system consumes large quantities of water, as water is constantly discharged during the growing period of paddy rice. Terminal irrigation-cum-drainage channels have not been developed, because the paddy fields are small in lot, the secondary channels are sharply slanted and their number is great, as the farmbands are sprend over on a relatively sharp mountain slope and reclaimed in a long and narrow shape along the main canal.

Table 3-28 Main Constructed Works

Annicut	Length (ft.)	Height (ft.)	Year of Construction	Remarks
Elahara	618	13.5	1887 - restored 1945 - recommission 1976 - raised	455.5 Crest Elevn.
Angamadella	90'	10	1934 -	226.4 Crest
Minipe	735	14	1941 -	Planked Bay opening

Canal	Length (Miles)	Max. Discharge (Cusecs)	Year of Construction	Remarks
Elahara Minneriya Yoda Ela	22 miles	1,500	1953 - restored	BW = 60' Upto 6M 17 Cha capacity over load - 2000
Kantalai Yoda Ela	20 miles	2,800	1952	BW = 80'
Inlet Channel	3M 42 Ch	1,000	1934	BW = 50
Minipe Yoda Ela	17 miles	500 approx.	1941 - restored	

Tank	Gross Cap. T.AC. FT.	Active Cap. T.AC. FT.	Tank Area at F.S.L. AC.	Year of Construction	Remarks
Giritale	19.0	19.0	800	1905	300 M.S.L.
Minneriya	110.0	106.0	6,300	1903	307.4 M.S.L.
Kaudulla	104	98.7	(3,800)	1958	228 M.S.L.
Kantalai	110.0	110.0	3,500	1868 restorate	194 M.S.L.
Vendras ankulam	20.0	20.0	1,200	1868	180 M.S.L.
Parakrama Samudra	96.0	81.0	5,300	1952	216 M.S.L.

3-4 Power Generation

(1) General Conditions

The Government of Sri Lank purchased electric services in 1927 and established the Department of Government Electric Undertaking (DGEU). In 1951, the Government of Sri Lank mergered DGEU to provide consistent services from development to distribution, and further in 1969, the name was changed to Ceylon Electricity Board (C.E.B.) by a law, and remains so until today.

The rainfall amount as the base for hydraulic power generation greatly changes seasonally between rainy season and dry season, and regionally. Approximately, the southwest district has much rain, while the other districts are dry. Particularly at the center a little to the south, there is a mountainous district of 2,000m class, with the annual rainfall of about 5,000m depending upon places, and heads for power generation can be obtained easily. Therefore, it provides land suitable for hydraulic power generation. The Mahaweli Ganga is the largest river with its source in the mountainous district.

In Sri Lank, there exist no other energy resources than hydraulic power, and fuels such as petroleum and coal are imported and expensive. Therefore, they are in a position to rely on hydraulic power generation inevitably also in future.

(2) Present Situations of Electric Power Facilities

As of the end of 1977, the equipment capacity of power plants belonging to C.E.B. is 332MW for hydraulic power and 50MW for steam power. There are diesel power plants for 20MW, but most were built in 1956 and are superannuated, being used only for emergency. Of these hydraulic power plants, those with reservoirs supply 67MW and those with regulating reservoirs supply 225MW. The regulating capability for daily load would be deemed sufficient, but seasonal regulating capability would be a little insufficient. Steam power plants are used only for supply at the time of drought to the minimum extent, since the fuels are imported and expensive.

Also on the occasion of the field survey, it was observed that generators were being repaired in two power plants. It is presumed that there may be many cases where main equipment of the existing power plants is suspended for a long period of time due to a trouble or maintenance, and it is necessary to investigate this matter and to clarify the influence.

Transmission lines are provided with 132KV and 66KV, and distribution lines, with 33KV, 11KV and 3.3KV. They develop in and around the capital, Colombo, but since there are many regions where lighting is not provided, it is a future problem to increase power supply and to complete transmission and distribution facilities. For the outline of transmission lines, see Fig. 3-4 for outline of transmission lines and Fig. 3-5 for skeleton diagram for generation and transmission.

(3) Present Situations of Demand and Supply of Electric Power

The result of electric energy sold, by type of industry, has increased to about 1.9 times in recent ten years in the respective types of industry as shown in Table 3-30, and among the types, industrial use accounts for about a half of the entire consumption. Since raw materials are generally imported, there are no specially large factories, and it is surmised that there is no trend of sudden increase.

The maximum generated output in 1968 was 135MW, and the generated energy was 626 million KWH, while those of 1977 were 261MW and 1,217 million KWH, showing the annual average increase rate of 7.6%, respectively (see Table 3-30). The situations of power generation in recent years are shown in Table 3-31 "Generated Energy by Type of Motive Power", Table 3-32 "Monthly Generated Energy by Power Plant" and Table 3-33 "Maximum Generated Output by Power Plant". Since it is presumed that generated output changes considerably monthly and yearly also from these values, examination and discussion are required to be made also on the seasonal regulation capability of power generation of respective power plants. The daily load curve shows a typical lamp load type, in which its peak load appears concentrically in about

two hours from 6 pm to 8 pm every day, and the secondary peak load involved in the operation of factories, etc corresponds to about 70% of that at the time of lamp lighting. This situation remains almost unchanged throughout the year, and this trend is supposed to continue also in future.

The annual average unit prices of electric power sold are as shown in Fig. 3-6, which shows that the average unit price was raised from 14 cts to 16 cts per KWH as a result of the revision of rate in May, 1972. In this case, the actual unit prices (cts/KWH) by type of industry are as follows:

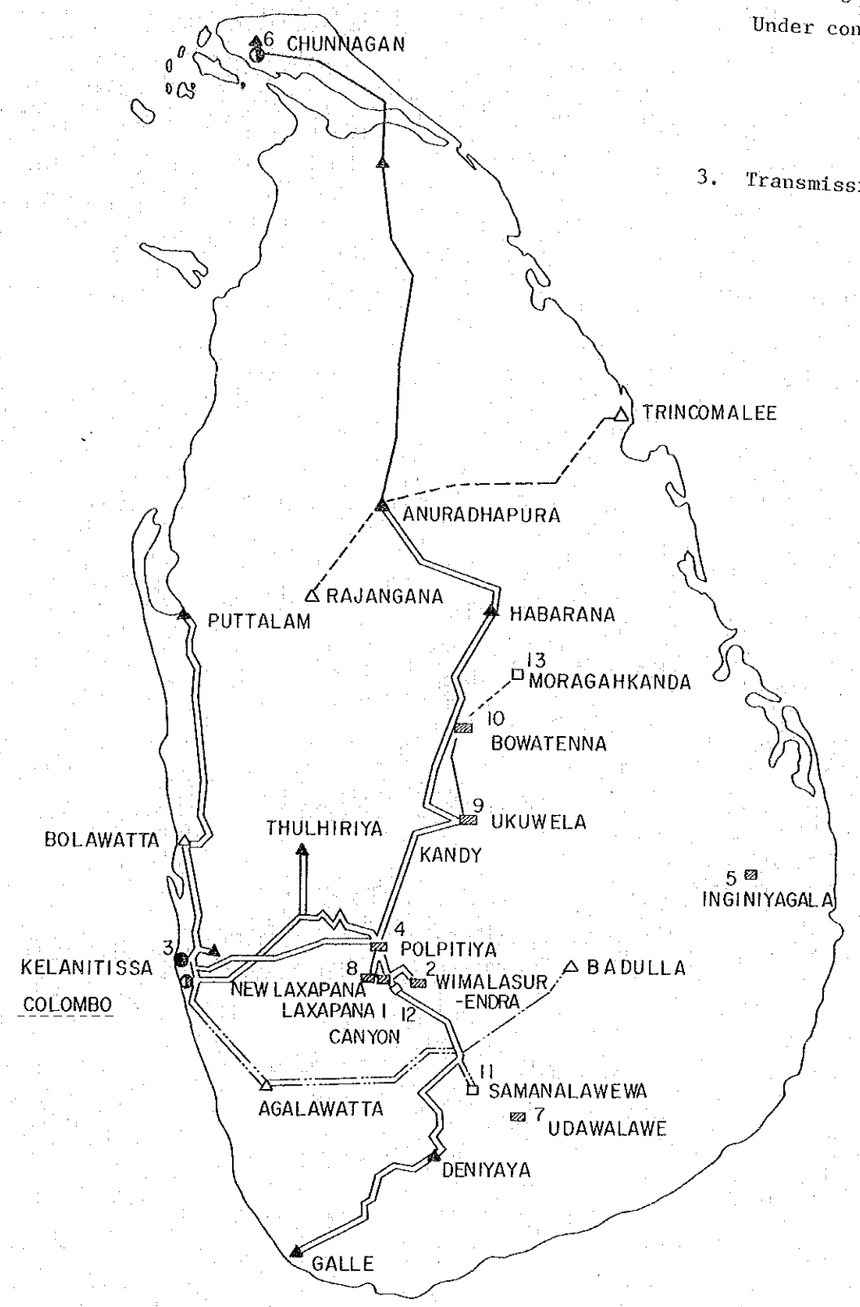
Home use	20
Commercial use	24
Industrial use: Small contract	17
Medium contract	15
Large contract	12
Religious use	20
Air conditioning and refrigeration use	16

Since the general election held in 1977, currency float system has been employed, resulting in sharply lowering the foreign exchange rate, and therefore, the construction cost of hydraulic power plants now being constructed has increased greatly. The power generation cost is estimated to rise to about 20 cts/KWH, and the impact on the electric power rates in future is worried about.

Table 3-39 Existing Power Plants of C.E.B.

Type	Name of power plant	Year of completion	Output (KW)		Annual possible power generation		Effective (ft)	Effective storage capacity (10^3 AC·ft)	Construction cost Rs/KW
			Max.	Firm	Average	Firm			
Hydraulic power	LAXAPANA	1950 1959	50	26		221	1550 1528	(Regulating) 0.320	2,120
	WIMALASURENDRA	1965	50	12		99	746	(Ordinary) 43.1	2,600
	POLPITIYA	1969	75	48		420	850	(Regulating) 0.164	2,100
	NEW LAXAPANA	1974	100	57	492	490	1704	(Regulating) 0.750	1,360
	UDAWALAWE	1960	6	-		-	46	(Ordinary) 217.0	
	INGINIYAGALA	1960	11	4		33			
	UKUWELA	1976	40	21	186	180	269		3,750
	Sub-total		332	168		1,443			
Steam power	Kelanitissa	1962	50						
Diesel	CHUNNAGAM	1956 1964	10 4						
	PETTAH	1956	6						
	Sub-total								
	Grand-total		4,091						

Fig. 3-4 Outline of Transmission Lines



1. Power plants

	Hydro	Steam	Diesel
Existing and under	▨	◍	◐
Under construction	□		

2. System substrations

Existing ▲

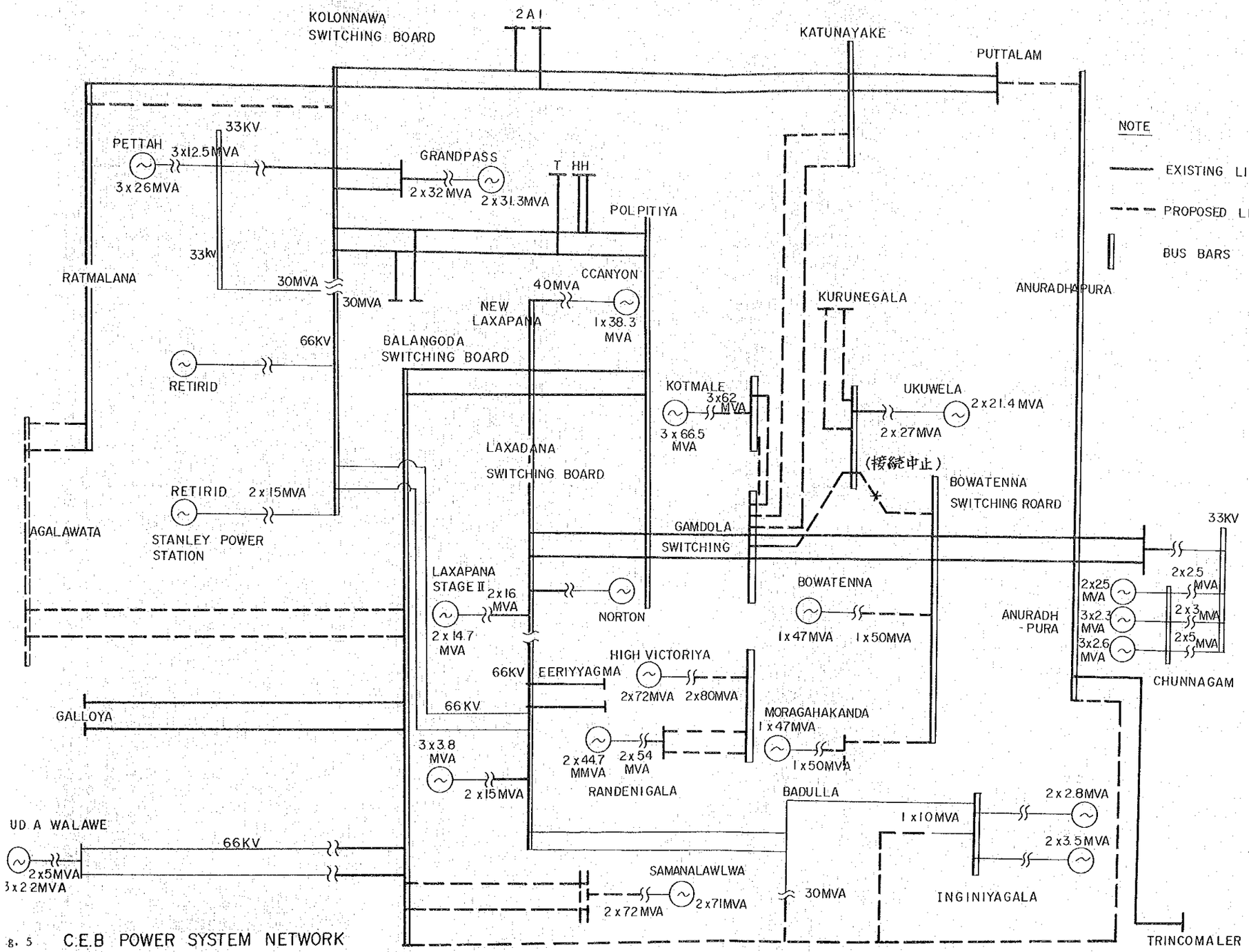
Proposed △

3. Transmission lines

	Single circuit	Double circuit
(1)	———	═══ Existing and under construction 132 KV
(2)	—·—·—	═══ Proposed 132 KW lines under Samanalawewa
(3)	- - - - -	Proposed 132 KW lines under Mashallya Oya Project III

List of power stations

1.	LAXAPANA (OLD)	50 MW	▨
2.	WIMALASURENDRA	50MW	▨
3.	KELANITISSA	50 MW	◍
4.	POLPITIYA	75 MW	▨
5.	INGINIYAGALA	11 MW	▨
6.	CHUNNAGAN	14 MW	◐
7.	UDAWALAWE	6 MW	▨
8.	NEW LAXAPANA	100MW	▨
9.	UKUWELA	40 MW	▨
10.	BOWATENNA	40 MW	▨
11.	SAMANALAWEWA	120 MW	□
12.	CANYON	30 MW	□
13.	MORAGAHAKANDA	40 MW	□



8. 5 C.E.B POWER SYSTEM NETWORK

Table 3-30 Sold Electric Energy, Gross Generation and Maximum Generated Output by Type of Industry

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1977/1968	Average (%)
Home use	55	59	62.5	64.6	72.5	81.5	82.6	84.9	93.0	10.4	1.89	
Street lighting	9.5	10	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.7	1.55	
Industrial use	272	302	329.2	373.2	436.2	466.4	477.2	492.3	513.6	515	1.89	
General supply	81	82	85.6	92.8	96.8	107.6	118.1	132.5	139.6	154	1.90	
Local special	138.5	151	167.1	180.4	193.1	198.6	201.9	222.2	237.3	257	1.86	
(million KWH) Total	556	604	648.9	722.0	810.1	866.1	892.3	944.9	997.0	1,047.7	1.88	
Transmission (%)	11.2	13.1	17.4	14.6	14.4	11.6	11.8	12.4	120	14.1		13.3
Gross generation (million KWH)	626	695	785.8	845.2	944.3	979.5	1,011.4	1,078.8	1,132.8	1,216.6	1.94	
Increase rate of above (%)		11.0	13.1	7.6	11.7	3.7	3.3	6.7	5.0	7.4		7.6
Annual load factor (%)	52.9	54.0	55.0	55.8	55.0	56.2	53.5	56.3	53.8	53.2		54.6
Maximum generated output (MW)	135	147	163	173	185	198.8	215.6	218.9	240.3	261	1.93	
Increase rate of above (%)		8.9	10.9	6.1	6.9	7.5	8. 5	1.5	9.8	8.6		7.6

Table 3-31 Generated Energy by Type of Motire Power

(Unit: million KWH)

	1970	1971	1972	1973	1974	1975	1976	1977
Hydraulic power	740.47 (94.2)	825.39 (97.7)	846.59 (89.7)	698.06 (71.3)	997.23 (98.6)	1,077.50 (99.9)	1,108.59 (97.9)	1,214.44 (99.8)
Steam power	1.97 (0.3)	13.87 (1.6)	87.85 (9.3)	261.14 (26.7)	12.54 (1.2)	1.16 (0.1)	23.87 (2.1)	1.79 (0.2)
Diesel	43.32 (5.5)	5.89 (0.7)	9.84 (1.0)	20.30 (2.0)	1.60 (0.2)	0.11 (0)	0.38 (0)	0.39 (0)
Total	785.76 (100)	845.15 (100)	944.28 (100)	979.50 (100)	1,011.37 (100)	1,078.77 (100)	1,132.84 (100)	1,216.62 (100)

Note: Figures in the parentheses show composition rates in percentage.

Table 3-32 Monthly Generated Energy by Power Plant (1977)

(Unit KWH)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Hydro	LAXAPANA	17,503	15,548	19,237	19,219	23,743	18,915	18,087	23,760	17,807	21,680	16,353	23,648	
	POLPITIYA	25,905	25,278	30,723	26,070	23,859	26,037	22,605	28,578	29,073	30,195	28,050	31,944	
	WIMALASURENDRA	6,883	6,347	8,302	7,607	7,580	5,017	5,416	7,884	5,430	6,367	8,342	9,819	
	NEW LAXAPANA	35,092	38,804	43,847	32,659	16,010	17,808	23,844	32,714	37,442	26,998	30,908	27,846	
	INGINIYAGALA	2,556	1,993	760	660	159	725	821	160	—	15	194	277	
	UDA WALAWE	1,448	1,051	167	6	217	803	974	409	474	84	541	391	
	UKUWELA	6,876	2,711	3,450	10,682	25,785	23212	23,734	7,537	13,490	25,449	24,385	18,463	
	Total	96,263	91,732	106,486	96,903	97,353	92,516	95,481	101,042	103,716	111,786	108,773	112,394	1,214,445
Steam	KELANITISSA	2	—	—	1	159	—	1,612	—	13	—	—	—	1,787
Diesel	PETTAH	—	—	—	—	—	6	2	3	—	—	1	—	12
	CHUNNAGAM	10	10	9	6	2	161	9	5	—	9	31	82	334
Total		96,275	91,742	106,495	96,910	97,514	92,683	97,104	101,050	103,729	111,795	108,805	112,476	1,216,578
Monthly peak	Daytime (MW)	161.8	167.0	176.5	173.9	169.4	167.9	170.6	174.7	176.7	179.3	187.3	183.5	
	Night (MW)	240.0	242.9	247.5	239.3	241.5	236.0	240.6	244.5	252.3	258.0	259.4	261.0	
	Daytime/night (%)	67.4	68.8	71.3	72.7	70.1	71.1	70.9	71.5	70.0	69.5	72.2	70.3	Average 70.5

Table 3-33 Maximum Generated Output by Power Plant (by Daytime or Night)

(Unit: MW)

Motive power	Name of power plant	Kind of peak	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Hydraulic power	LAXAPANA	Daytime	50.0	43.9	35.4	38.7	46.1	46.0	42.0	42.0	48.6	49.3
	〃	Night	53.2	50.0	48.5	49.5	52.9	47.4	49.5	49.3	49.4	50.3
	POLPITIYA	Daytime	–	41.0	74.5	60.0	75.0	70.0	75.0	75.0	66.0	75.0
	〃	Night	–	60.5	75.0	75.0	82.0	80.0	80.0	75.0	80.0	80.0
	WIMALASURENDRA	Daytime	44.5	25.0	32.0	43.0	30.9	25.0	50.0	35.0	43.0	35.0
	〃	Night	53.0	46.0	48.0	50.0	54.0	50.0	45.0	40.0	49.0	48.0
	NEW LAXAPANA	Daytime	–	–	–	–	–	–	75.0	88.0	86.0	89.0
	〃	Night	–	–	–	–	–	–	80.0	96.0	103.0	103.0
	INGINIYAGALA	Daytime	4.5	4.5	–	6.4	4.7	4.2	5.7	4.8	7.8	5.4
	〃	Night	4.5	6.0	5.6	6.4	4.7	5.0	5.7	4.8	7.8	5.7
	UDA WALAWE	Daytime	–	1.9	–	3.9	1.8	1.8	2.9	1.9	2.0	1.8
	〃	Night	–	3.9	–	3.9	1.8	1.9	2.8	2.0	2.0	1.8
	UKUWELA	Daytime	–	–	–	–	–	–	–	–	37.2	42.0
	〃	Night	–	–	–	–	–	–	–	–	37.0	38.0
Steam power	KELANITISSA	Daytime	25.0	–	–	–	–	41.5	–	–	–	–
	〃	Night	25.0	–	–	–	–	20	18.5	–	–	–
Diesel	PETTAH	Daytime	–	–	–	–	2.2	–	–	–	–	–
	〃	Night	2.9	–	–	–	4.7	2.5	2.4	–	–	–
	CHUNNAGAM	Daytime	4.9	6.3	–	–	–	1.2	–	–	–	–
	〃	Night	8.3	9.1	–	–	–	5.4	3.0	–	–	–
General		Daytime	96.6	108.7	122.9	143.1	151.7	154.9	159.7	176.7	167.2	197.3
		Night	134.7	146.7	163.1	173.4	185.3	198.8	215.6	218.9	240.3	261.0

Fig. 3-6 Average Unit Prices of Sold Electric Power