

171943

ව. 3000L

D
20/02/2004

EXAMINATION OF CERTAIN ASPECTS OF THE
MAHAWELI DEVELOPMENT PROGRAMME
IN ITS EXERCISE TO HARNESS
NATURAL RESOURCES
FOR DEVELOPMENT

CR

0.50
00002

DISSERTATION SUBMITTED BY
T.H. KARUNATILLEKE
M. A. (GEOGRAPHY) DEGREE - 1983
UNIVERSITY OF PERADENIYA
SRI LANKA

171943

ACKNOWLEDGEMENT

This study was done under the supervision of Prof. G.H. Peiris of the Department of Geography, University of Peradeniya. I am much grateful to him for the guidance and assistance he extended.

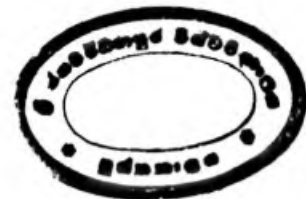
I am also grateful to the Ministry of Mahaweli Development, the Mahaweli Authority of Sri-Lanka and the many public institutions which helped me in the study. I wish to record my gratitude to Mr. R. G. Thilakasiri of the Ministry of Mahaweli Development who untiringly typed the script and helped in documentation work.

EXTRACT

The Mahaweli Development Programme is the major national effort to utilize the natural resources available for development in a large part of Sri-Lanka. Its objectives are many. Firstly, the expansion of the extent of irrigated land for cultivation. Secondly, the establishment of new human settlements. Thirdly, increase the capacity for hydro-power generation. The basis for expansion of power generation capacity would depend largely on the Mahaweli at least till the turn of the century. Other objectives are control of floods and regional development in general.

The economic and social developmental potential the MDP offers is extensive. It provides new opportunities for development of large regions in the dry zone which have hitherto remained neglected. It provides access to the development of new resources and also serves as a spring board for further progress across a wide geographical area.

In planning and implementing a project of large magnitude and complexity, the emergence of problems is inevitable. The problems which so occurred in developing System 'H' (Kalawewa Project) are identified and examined. These lessons and experiences should benefit the planners of new projects under the programme.



CONTENTS

<u>Chapter</u>		<u>Page/s</u>
	<u>Contents and list of figures and tables</u>	
I.	<u>Introduction</u>	2 - 9
1.1	Mahaweli Ganga	2
1.2	Mahaweli Development Programme (MDP)	3
1.3	Historical setting	4
1.4	Considerations	6
1.5	Approach to the study	7
II.	<u>Mahaweli Development Programme as an exercise in water resources development for irrigation</u>	10 - 122
2.1	Examination	10
2.2	Evolution of the Mahaweli Development Programme	12
2.2.1	Pre-modern phase	12
2.2.2	Modern period upto the MDP	12
2.2.3	Early studies on the Mahaweli basin	14
2.2.4	FAO/UNDP study	15
2.2.5	The accelerated MDP	17
2.3	Rationale of the MDP	19
2.3.1	The agro-climatic environment	19
2.3.2	The necessity of irrigation	29
2.3.3	Surface water resources	30
2.3.4	Groundwater resources	36
2.3.5	Adjustment of regional water balances	40
2.3.6	MDP as medium to adjust water imbalances	43
2.3.7	MDP as a regional water transfer exercise	44
2.3.8	Limitations to the development of only the local catchments	47
2.4	Evolution of the concept of transbasin development	49
2.4.1	The ancient irrigation system	49
2.4.2	Piecemeal restoration of ancient irrigation works	51
2.4.3	Planning for whole river basins	52
2.4.4	Planning for regional water resources development	54
2.4.5	Planning the MDP	56
2.5	Direction of diversions	58
2.5.1	Diversion studies	58
2.5.2	Alternative diversion directions	59

CONTENTS (Contd.)

<u>Chapter</u>		<u>Page/s</u>
2.5.3	Critical evaluation of diversion alternatives	61
2.5.3.1	Diversion towards the south-east dry zone	61
2.5.3.2	Diversion towards the north-west dry zone	64
2.5.3.3	Diversion towards the north-central basins	69
2.6	Irrigation duty and efficiency	71
2.6.1	Water duty	71
2.6.2	Actual use of water	72
2.6.3	Factors determining water duty	73
2.6.4	Low irrigation efficiency at present	73
2.6.5	Scope for improving irrigation efficiency	75
2.6.6	Methods to improve irrigation efficiency	77
2.7	Groundwater and associated soil problems	83
2.7.1	Evidence of destruction of land by salinity	84
2.7.2	Quality of irrigation water	85
2.7.3	Factors inducing salinity	85
2.7.4	Distribution of salinity	86
2.7.4.1	River valleys	87
2.7.4.2	Reservoirs	89
2.7.4.3	Estuarines	90
2.7.4.4	Micro-catchments	90
2.7.5	Implications	91
2.8	Irrigation systems and designs	92
2.8.1	The conventional model	92
2.8.2	Problems of the conventional model	93
2.8.3	System 'H' layout	94
2.8.4	Elements of an efficient irrigation system	95
2.8.5	The dry zone land	96
2.8.6	Groundwater fluctuations	98
2.8.7	Need to control the behaviour of groundwater	98
2.8.8	Limitations of the System 'H' model	99
2.8.9	Suggestions for improvement	100
2.8.9.1	Dual channels	100
2.8.9.2	Single channels with flexibility for change	102
2.8.9.3	Re-use of drainage water	102
2.8.9.4	Conjunctive use of water	105
2.8.9.5	Operation of the irrigation system	106

CONTENTS (Contd)

<u>Chapter</u>		<u>Page/s</u>
2.8.9.6	Other irrigation methods	108
2.8.10	Agronomic factors for irrigation efficiency	108
2.8.11	Village tanks	110
2.8.11.1	In retrospect	110
2.8.11.2	Relevance of village tanks to the MDP	112
2.9	MDP as a centralised means of water resources management	113
2.9.1	MDP transbasin diversion system	113
2.9.2	MDP is unique	116
2.9.3	Centralized water management	117
2.9.4	Implications of centralized operation	118
III.	<u>Mahaweli Development Programme as an exercise in Water Resources Development for hydro-power generation</u>	123-46
3.1	Examination	123
3.2	Examination of the significance of the MDP	123
3.2.1	The demand for power	123
3.2.2	Available alternative resources	124
3.2.3	The necessity to develop hydro-power	126
3.2.4	Assessment of hydro-power potential	127
3.2.5	Assessment of MDP potential	128
3.2.6	MDP's contribution to power generation capacity	129
3.3	Growth of a new region	132
3.4	Examination of alternative sites for reservoirs and power houses	132
3.4.1	Planning considerations	133
3.4.2	Study of hypothetical situations	135
3.4.2.1	Situation (I) - without river diversion	135
3.4.2.2	Situation (II)- development on the Dumbara cascade	137
3.4.2.3	Comparison of early proposals with the MDP	139
3.4.2.4	Diversion of Mahaweli into westward flowing rivers	142
3.4.3	Evaluation of alternatives	145
3.5	Significance of the MDP	146

CONTENTS (Contd)

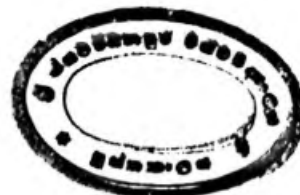
<u>Chapter</u>		<u>Page/s</u>
IV.	<u>MDP as an exercise in developing land resources</u>	147-96
4.1	Landuse policy	147
4.1.1	Examination	147
4.1.2	Landuse potential of the three diversion options	148
4.1.3	Significance of upland soils	149
4.1.4	Cropping to suit soil types	151
4.1.5	Development of highlands	151
4.1.5.1	In retrospect	152
4.1.5.2	Need for development	152
4.1.5.3	Approach to development	153
4.1.5.4	Highlands falling within the irrigation projects	154
4.1.5.5	Highlands falling outside the projects	157
4.1.5.6	Suggested lines of development	160
4.1.5.7	Socio-economic needs to develop the highlands	163
4.1.5.8	The size of land allotments (highland)	164
4.1.5.9	Layout of farms	165
4.2	Forestry development	167
4.3	Catchment area development	168
4.4	Flood control and reclamation of land	170
4.5	Loss of land by submergence	172
4.6	Reduction of wildlife	174
4.7	Inland fishery development	179
4.8	Expansion of agricultural land under the MDP	184
4.8.1	Examination	184
4.8.2	The period upto 1931	185
4.8.3	The period 1931-70	185
4.8.3.1	Historical setting	185
4.8.3.2	Achievement	187
4.8.4	The period 1931-70	189
4.8.4.1	Historical setting	189
4.8.4.2	Achievement	190
4.8.5	The MDP	192

CONTENTS (Contd)

<u>Chapter</u>		<u>Page/s</u>
V.	<u>Cost of land development and settlement in the projects under the MDP</u>	197-214
5.1	Early development	197
5.1.1	Responsibility of the Government	197
5.1.2	Early development model	197
5.1.3	Limits to investment by peasants	198
5.1.4	Main cost components	199
5.2	Economic analysis of pre-MDP projects	199
5.2.1	Limits to economic analysis	199
5.2.2	Low returns	200
5.2.3	Cost of land development	202
5.3	Economic evaluation of MDP projects	203
5.3.1	Considerations in benefit-cost analysis	203
5.3.1.1	Transbasin diversion	203
5.3.1.2	Multi-purpose objectives	203
5.3.1.3	Social infrastructure	204
5.3.1.4	Community development	204
5.3.1.5	Mahaweli as medium to enhance resources	205
5.3.2	Rate of return on MDP projects	206
5.3.3	Comparison of MDP costs with others	209
5.3.4	Economic returns investment	210
5.4	The question of cost reduction	211
5.5	Cost recovery	214
VI.	<u>MDP as an exercise in the development of human settlements and regions</u>	215-
6.1	Examination	215
6.2	Pre-MDP settlements	215
6.2.1	Village expansion schemes	216
6.2.2	Colonization schemes	217
6.2.3	Townships	217
6.3	Changes the MDP would effect	218
6.3.1	Outline of major changes	218
6.3.2	Implications	219
6.4	Analysis of spatial relationships	219
6.4.1	Adoptability of the central place theory	220

CONTENTS (Contd)

<u>Chapter</u>		<u>Page/s</u>
6.4.2	Principles of the central place theory	221
6.5	Settlements in relation to the region	222
6.5.1	Pre-MDP colonization schemes and the region	222
6.5.2	Size of homesteads and of villages	226
6.5.3	Need of a model for town and country planning	227
6.6	System 'H' micro-regional planning	228
6.6.1	System 'H'	228
6.6.2	System 'H' is different to other MDP projects	229
6.6.3	System 'H' pattern of settlements	230
6.6.4	Problems of System 'H' model	233
6.6.4.1	Size of hamlets	234
6.6.4.2	Townships	236
6.7	MDP settlements in relation to the broader region	242
6.7.1	Need to consider the outer regions	242
6.7.2	Errors in regional planning	242
6.8	Pattern of macro-regional growth	245
6.8.1	The general pattern	245
6.8.2	Central importance of Trincomalee	248
6.8.3	Regional planning - a new perspective	251
6.9	Potential to develop areas around reservoirs	256
6.10	Other aspects of settlement planning which need re-consideration	258
6.10.1	Size of land allotments and farms	258
6.10.2	Origin of Settlers	260
6.10.3	Development of natural resources and politics	263
VII.	<u>CONCLUSION</u>	266-69
	<u>BIBLIOGRAPHY</u>	270-79
	Appendix 1	280
	Appendix 2	281
	Appendix 3	282



FIGURES

<u>No.</u>		<u>Page</u>
1.	Mahaweli Development Programme - Irrigation Systems and Reservoirs per FAO/UNDP and alternative trans-basin study proposals	9
2.	Annual reliable rainfall (95 per cent probability).	20
3.	Mean annual potential evapotranspiration	21
4.	Annual rainfall coefficient	22
5.	Regional water supply pattern	25
6.	Spatial adjustment of water supply - mean wet season-potential	26
7.	Spatial adjustment of water supply - mean dry season potential	27
8.	March of precipitation and potential evapotranspiration	28
9.	Mean annual water balance as a comparison of mean annual water surplus and deficiency	32
10.	Wet season (October-January) water surplus	33
11.	Dry season (May-September) water deficiency	34
12.	Annual water surplus and deficit according to drainage divisions	35
13.	Dry zone - hydro-geology	38
14.	Simplified map showing mean annual groundwater re-charge in the dry zone	39
15.	Spatial adjustment of water supply - mean annual potential	42
16.	Transbasin diversions undertaken and proposed	68
17.	Sketch map of Kala Oya valley which has been modified by the irrigation system	88
18.	Undulating terrain and associated drainage members	97
19.	Mahaweli Development Programme - Water distribution diagramme	115
20.	Regional concentration of the main hydro-power generation systems	134
21.	Diagrammatic (long profile) presentation of (i) high dam proposal by Huntings '62 and (ii) the three projects of the MDP, on the Dumbara cascade	140
22.	Sketch map showing the upper reaches of the Mahaweli in relation to the Maha, Rambukkan and Deduru Oyas	143
23.	Wildlife reserves	176
24.	Nested hierarchial pattern of settlements and services in System 'H'	231
25.	System 'H' and the central position of Trincomalee in its regional context	237
26.	Significance of Trincomalee in relation to other Mahaweli projects and the region as a whole	247
27.	Regional context of reservoirs on the Dumbara cascade and of Maduru Oya	259
28.	Kotmale - regional context	260

TABLES

<u>No.</u>	<u>Page</u>
I. The average annual water surplus	45
II. The average annual run-off	45
III. Extent of land irrigated	46
IV. The average annual water balance	62
V. The average seasonal water supply	62
VI. Yala water requirement	76
VII. Yala water requirement on Red Brown Earths	76
VIII. Increase in salinity in a micro-catchment	91
IX. FAO/UNDP planned and subsequently revised hydro-power capacity	130
X. The expansion of hydro-power under the Mahaweli Development Project	132
XI. Projected requirement and availability of paddy	150
XII. Water surface and capacity for fish production under the accelerated Mahaweli Development Programme	182
XIII. Inland fishery potential in the MDP area	182
XIV. Extent of land under major crops	188
XV. Cultivated land and population in the peasant agricultural sector	188
XVI. Extent of land under major crops (1931/71)	190
XVII. Development of irrigated land under major settlement schemes	191
XVIII. Extent of land under major and medium irrigation schemes (1970-2000)	193
XIX. Extent of land under the Mahaweli Development Programme and under major/medium/minor irrigation works and under rain-fed conditions	194
XX. Benefit and cost estimates of projects falling under the Mahaweli Development Programme	208
XXI. System 'H' social infrastructure	232

MAHAWELI DEVELOPMENT PROGRAMME (MDP) AS
AN EXERCISE IN RESOURCES DEVELOPMENT

INTRODUCTION

In terms of its concepts, magnitude and implications, the Mahaweli Development Programme marks itself in a pre-eminent position among the many exercises in the development of land and water resources which have been hitherto undertaken in Sri-Lanka. It is based mainly on the utilization of the Mahaweli Ganga water resources.

1.1 MAHAWELI GANGA

The Mahaweli is a peculiar river in many ways. It is the longest (206 miles), and traverses both the wet and dry zones in a direction 'anomalous' to the general relief of the land. With the exception of the rivers which flow southwards the southern mountain wall and the Kehelgamu and Maskeli Oyas, tributaries of the Kelani river, the drainage of the central highlands is accomplished by the Mahaweli and its tributaries. Geomorphically, it is considered a composite and a polygenetic drainage system. Its denudation chronology suggests the parasitic growth of this system, at the expense of other rivers by a series of river captures. Thereby, it has diverted into itself the surface runoff of a large area of land.

It has been suggested that the Mahaweli, by a series of geological and geo-tectonic ...

processes has captured the waters of the westward flowing rivers in the Hatton plateau and those in the Kandy plateau and in the Uva basin and runs in an anomalous direction to ultimately empty itself into the Bay of Bengal in the north-east. (Kularatnam, K. '62, pp. 86-87).

The postulate that widespread river capture resulting from large-scale diastrophic movements has been, however, challenged.

Whatever the differences are, the fact that the Mahaweli river has unique characteristics among the rivers of Sri-Lanka remains the most fundamental fact which forms the basis of the MDP. It is this direction of its flow, its geographic relation to the adjacent river basins and the fact that it is benefitted by both the south-west and north-east monsoons that have made possible the utilization of the Mahaweli river for the MDP.

1.2 THE MAHAWELI DEVELOPMENT PROGRAMME

The distinct characteristic of the MDP is the development of land and water resources in a large number of river basins in the country by the transbasin diversion of Mahaweli water. It is multi-purpose in objectives and is essentially a large-scale exercise in the development of natural resources.



The MDP broadly consists of (i) the development of resources in the upper reaches of the river by way of construction of a series of reservoirs for the regulation of downward flow of water and for generation of hydro-electricity, and (ii) the development of projects in the downstream, in the dry zone by way of establishing irrigated land settlements. Expansion of land for irrigated agriculture, establishment of new human settlements, generation of hydro-electric power, control of river floods and developing the potential of aquatic wealth are the main benefits which have been conceived in this development effort.

1.3 HISTORICAL SETTING

Examination of the MDP in a setting of historical growth of the ancient irrigation civilization in Sri-Lanka shows that the planned area for development generally covers four of the five major irrigation areas which existed in ancient Sri-Lanka. (Brohier '33, Vol. I, p.4). The only area lying outside is the north-western part of the country which is drained by the Mi Oya and the Deduru Oya. Even this area is being considered as an area for part diversion of Mahaweli water in preference to the north-central region of the country. In addition to these areas served by the ancient irrigation systems, the MDP embodies within itself a large area lying outside. Within the ...

ambit of the MDP. falls almost the entirety of the dry zone except the north-western and northern Miocene limestone belt and the dry zone roughly south of a line Minipe-Gal Oya.

The ancient irrigation systems were mostly based on reservoirs of different sizes and were generally confined to single river basins. There were ingenious works for transbasin diversion, but they were limited in extent and in scope in the sense of modern technology, e.g., the Elahera-Minneriya-Kantale Yoda Ela, the Kalawewa Yoda Ela and the Minipe Yoda Ela. All these had contributed much to enhance the prosperity of the ancient dry zone civilization. However, in magnitude, the MDP ranks distinct and largest of all the ancient and modern attempts to utilize the water resources of the Mahaweli.

The ancient irrigation system was a growth through a chequered history of about 1,700 years ending in the 13th century A.D. Even then it is doubted as to whether all the ancient irrigation systems functioned together at any point of time. (p. 112). The MDP, on its eventual completion within the planned period of three decades would develop a larger area at an unprecedentedly rapid pace. ...