THE IMPACT OF THE CATCHMENT DEVELOPMENT OF MAHAKANADARAWA RESERVOIR

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AGRARIAN RESEARCH AND TRAINING INSTITUTE,
114, Wijerama Mawatha, Colombo 7.

SRI LANKA

THE IMPACT OF THE CATCHMENT DEVELOPMENT OF MAHAKANADARAWA RESERVOIR

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FOREWORD

There are over 25000 minor irrigation schemes in Sri Lanka. Out of these about 12000 tanks are in working condition and the others are abandoned. Over the last six years several national and international organizations helped Sri Lanka government to rehabilitate these tanks. Farmers irrigating from a minor tank naturally get benefitted when the tank is rehabilitated. However, this can reduce the irrigable area of a major tank located downstream.

Dr. C. Kariyawasam, one of the consultants attached to this Institute developed a model to estimate the reduction of yield of a major tank due to rehabilitation of minor tanks in its catchment area. With the help of two undergraduate students of Moratuwa University, Mr. A.D.C. Jayawardena and Mr. M.D.U.P. Kularatne, he used this model to evaluate the effect of rehabilitation of minor tanks in Mahakanadarawa tank. This is one of the five tanks rehabilitated under Tank Irrigation Modernization Project. This study reveals that about 40% of the minor tanks in the catchment of Mahakanadarawa can be rehabilitated without having a major effect on its irrigable area. However, once the number of tanks rehabilitated exceeds 60%, the irrigable area reduces substantially.

The model developed in this study can be used by policy makers in deciding on the minor tanks that need to be rehabilitated, specially in areas where there are successful large irrigation schemes.

This study was undertaken by Dr. C. Kariyawasam as a sub-study of the Project Impact Evaluation of TIMP. He was helped by Mr. W.A.T. Abeysekera Pesearch and Training Officer. My thanks are due to them for their valuable contribution.

T.B. Subasinghe
Director-ARTI.

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Authors wish to express their sincere gratitude to all those who helped them in producing this report. This report would not have been a possibility if not for this valuable assistance. Special mention has to be made on:

* *Mr. N. Kumarasamy, Senior Deputy Director of the Department of Irrigation for his valuable suggestions.*

* *Mr. Terrence Abeysekera, Research and Training Officer of the Agrarian Research and Training Institute, who identified this project for his programme with the intention of finding solutions to water shortages at Mahakanadarawa.*

* *The Director and the staff of the Meteorological Department for their assistance in collecting the rainfall data.*

* *The Irrigation Engineer, Mahakanadarawa Division for his help in obtaining physical and hydrologic data of Mahakanadarawa tank.*

* *Cultivation Officer of the Mihintale area for their help in obtaining the data pertaining to minor tanks in the catchment of Mahakanadarawa tank.*

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ABSTRACT

The main aim of the study was to investigate the reasons for the reduction of inflow to Mahakandarawa tank, which is one of five tanks in dry zone improved by T.I.M.P with the aid of world bank. From two reasons, i.e. change of rainfall pattern and the interception of runoff by large No of minor tanks in the catchment, the effect of minor tanks in the catchment was taken as most important one because the success of other nearby tanks ruled out the change of rainfall as the main reason.

Mahakanadarawa tank has an unusually large network of minor tanks in its catchment. Out of 218 minor tanks in the catchment area, 187 are working and balance is abandoned. Total acrerage cultivated during Maha under these tanks is about 8480 acres. This is in the same order of magnitude as the command area of Mahakanadarawa. Since the number of tanks in the catchment is relatively large, subtantial amount of water is intercepted by these tanks and as such yield into Mahakanadarawa is greatly affected by these upstream tanks.

The ultimate objective of this study is to evaluate the area that can be cultivated with the available water resources when different percentages of tanks are rehabilitated.

Out of four raingauge stations, only two stations had continueus records for thirty years. For other stations missing data was filled using percent normal method. The filled data can be assumed to be fairly accurate, since a high correlation existed between the pairs of rainfall data used in filling the data.

An in depth analysis will be carried out to estimate the effects of rehabilitation work on minor tanks. For this analysis data has been collected on the 218 minor tanks including any changes in status of these tanks that has taken place since 1960. A schematic diagram or the network of minor tanks was prepared. This will help the simulation study to estimate the change in yield since 1960.

The indepth analysis of minor tanks in the catchment requires computer programming. Due to the unavailability of computer facilities, the analysis was simplified for hand calculation. In that, monthly rainfall records for the past 30 years were analysed and inflow to the main tank was determined using the assumption that 10%, 15%, 20% and 21% of the precipitation in first, second, third and fourth months of the rainy season will contribute to the runoff. Areal distribution of rainfall was done by Thiesson Polygon method. Inflows were calculated for different percentages of rehabilitation of minor tanks. The percentages selected were 0%, 20%, 40%, 60% and 80%. In these cases, net inflow was obtained by deducting runoff intercepted by rehabilitated minor tanks in the carchment.

Using the computed inflow, crop water requirements and evaporationrates of a nearby station, the extent of cultivable area in both Yala and Maha were obtained separately for different percentages of rehabilitation of minor tanks. The maximum acrerage was selected so that active storage in Mahakanadarawa was always positive during the period of cultivation. From these results, two graphs of Cultivated area Vs percentage of rehabilitation were plotted for Yala and Maha to study the effect of rehabilitation.

CHAPTER I

Introduction :

Sri Lanka's climate is very suitable for year round crop production. However, the major constraint is water; in the wet zone there is some times too much while in the dry zone there is often too little.

These are some 180 major/tank irrigationschemes in Sri Lanka, serving a total cultivated area of about 400,000 acres. The tanks were originally constructed to provide supplemental irrigation during Maha Season. The emphasis placed on food self-sufficiency in recent years has promoted a re-examination of the irrigation potential of these tanks.

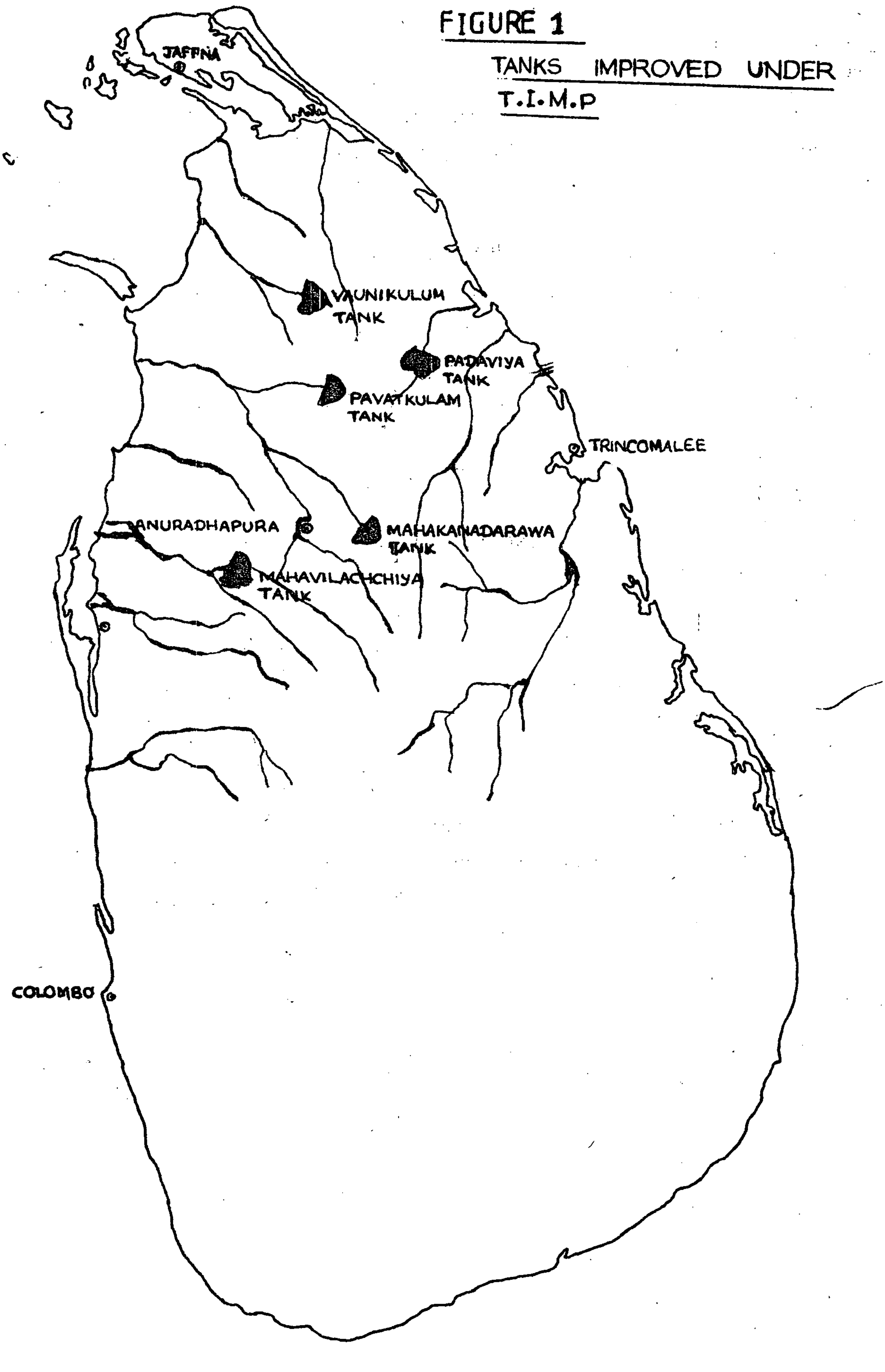
Mahakanadarawa tank is one of the major tanks in the Anuradhapura district. This was first constructed by King Mahasen and later restored by Irrigation Department in 1964's. This has been formed by impounding the water of Kanadara O which is a tributory of Malwatu Oya.

Before 1978, a World Bank team did an investigation of the irrigation potential of the five tanks shown in figure 1. They found that by improving these ancient tanks, distribution systems etc, more land could be cultivated due to efficient use of water.

The Tank Improvement & Modernization Project, funded by World Bank was commenced in 1978. The tanks selected for improvement are Mahakanadarawa, Mahawilachchiya, Pavatkulam, Padaviya and Vaunikulam.

FIGURE 1

TANKS IMPROVED UNDER T.I.M.P



Reason for the investigation

Until 1977, Mahakanadarawa tank received sufficient amount of yield for maha season. But, after the modernization scheme carried out by T.I.M.P , it was found that the tank did not receive adequate yield to irrigate its command area, which is about 8000 acres in extent. Cultivation under the tank was not possible for last six seasons due to the lack of water. Therefore it was necessary to carry out a detailed investigation to find out the reason for this reduction in yield.

The study was been divided into two stages, one as an undergraduate project which is the subject matter for this report, and a more detailed and accurate analysis will be done as a post graduate project under the supervision of Dr. Kariyawasam.

CHAPTER 2

Possible reasons for the reduction of inflow :

The reduction of inflow can be due to one or both of the following reasons:

1. Change of rainfall pattern in recent years
2. Interception of precipitation falling on the catchment by the large number of minor tanks which were recently rehabilitated.

But, there are reasons to believe that the change in rainfall pattern is not the main cause for the lack of water in Mahakanadarawa. First reason is the other main tanks closer to Mahakanadarawa (Mahawillachchiya, Padaviya, Pavatkulam and Vavunikulam) received substantial amounf of water while the water level of Mahakanadarawa was well below the **sluice level.** The above mentioned tanks are not far away and therefore the rain fall. is of the same order of magnitude as in Mahakandarawa area.

The only difference is the large number of small irrigation tanks in the Mahakandarawa catchment. These tanks intercept and hold water for paddy lands in the catchment.

Before 1977, most of these minor tanks were abondoned and that means the detention was less. At thet time, therefore, Mahakanadarawa has received substantially high inflows to cultivate its comand area.

After 1977, there was an increasing demand for water for the cultivation needs. Various government departments and other organizations began to rehabilitate the abandoned minor tanks in the dry zone. Now, 86% of the minor tanks in the Mahakanadarawa catchment are working tanks. That is 187 minor tanks (the total number of minor tanks in the catchment is 218).

Total . acrage cultivated during maha season under these minor tanks **is** about 8000 acres. This is of the same order of magnitude as the command area of Mahakanadarawa.

There is a common misconception that due to denudation of forests, rainfall has been reduced and that is the reason for lack of water in recent years. But we have stated earlier that reduced rainfall is not a fact for **this** because of the substantial amount of water received by other near by tanks. Therefore, it is important to see whether the denundation of forests can affect the inflow to the tank by some other means.

Of course, denundation of forests is not the reason for reduction of rainfall. The reduction in rainfall in recent years has primarily been due to changes in the major air movements over the whole region, including the **Middle East** and India.

However, once rain bearing clouds are brought over the island by the upper air movements, then the presence of forests, and the resulting local thermal air activity with rising currents of moist air can materially affect the location of precipitation and area upon rainfall precipitates; much in the manner that rainfall can be encouraged to take place by cloud seeding once the appropriate moisture and temperature conditions **prevails** overhead.

The major effects of forests, on the other hand, is to enable the earth to retain and store the water which falls as rain.

FIGURE 2 WITH FOREST COVER

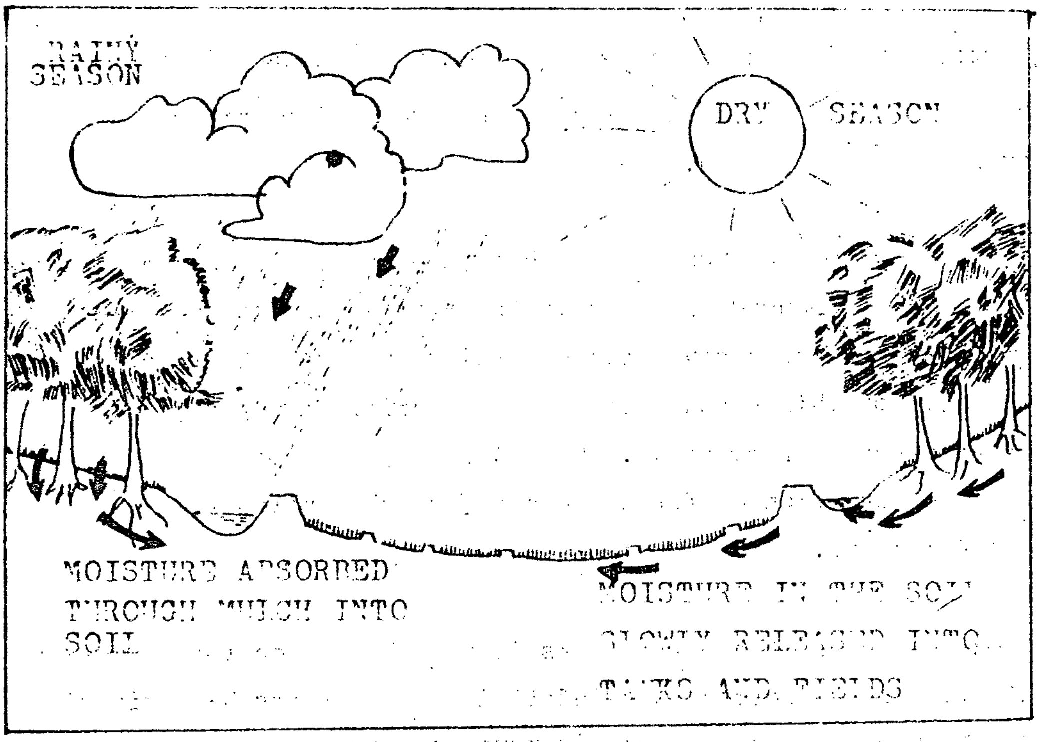


FIGURE 3 WITH OUT FOREST COVER

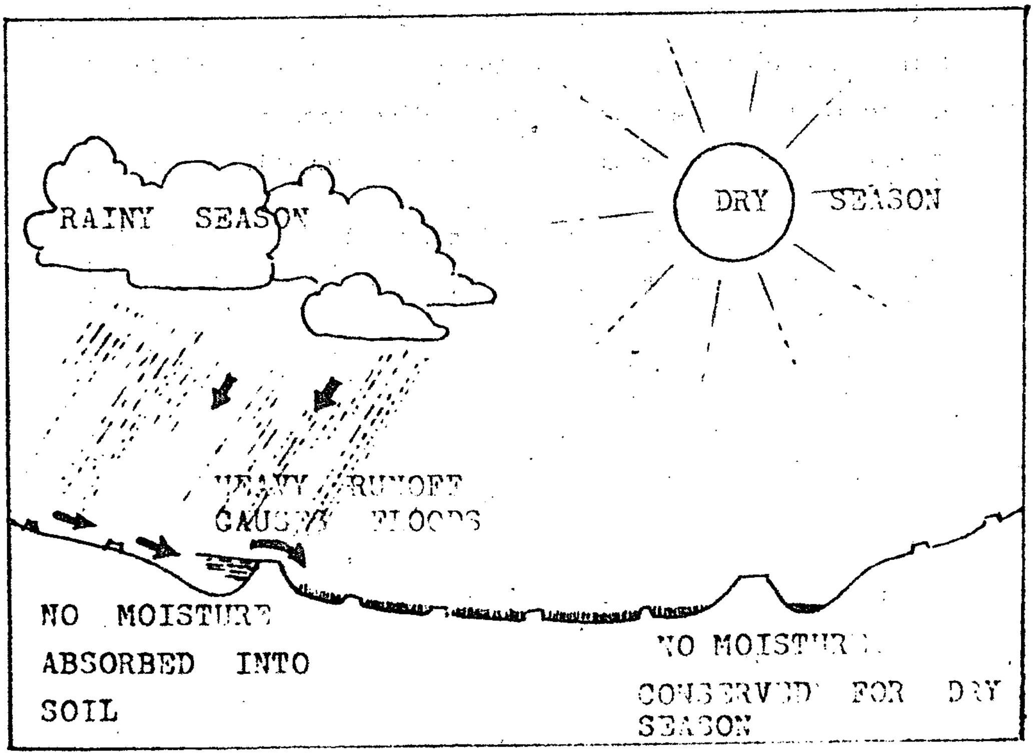


Figure 2 shows how rain falling on to forest much covered soil is rapidly absorbed (infiltrated in to the soil which is the primary reservoir of rainfall). During the following dry season, as shown on the right of figure two, these vast reserves of water now held within the soil gravitate slowly into the tanks, maintaining the flow for several months. With out forest cover, and its surface protecting mulch, as in figure three, most of the rainfall proceeds down the slope as run off due to sealing of the upper bare soil layers, thus blocking infiltration.

That is, if we consider our catchment area, the runoff would have been increased with out the forest cover.

Therefore it can be decided that

1. The reduced rainfall is not the main cause for reduced inflow, because of the reasons stated earlier.

2. The denundation of forests is not the reason for the reduced rainfall and also it has not any influence in reducing run off.

Therefore, the only reason that has to be considered is the influence of minor tanks in the catchment, and it is the main scope of our project.

CHAPTER 3

COLLECTION OF DATA

Period of study

Usually, hydrologic studies for tank irrigation schemes are done using at least 30 years of past records, in order to achieve reasonable accurate results. In this study the analysis the period selected was from 1953 to 1982.

Collection of data :

Our intention was to collect as much data as possible regarding the Mahakanadarawa project, even if some of the data are not necessary for our analysis. Those data will be used in the monthly simulation study of this project, which will be done as a post graduate project.

Necessary information can be very broadly classified as given below.

1. Tank parameters
2. Details of the minor tanks and their command areas in the catchment.
3. Nearby rainfall stations and past rainfall records.
4. Evaporation rates of a nearby station
5. Crop patterns, crop factors, evapo-transpiration rates etc.

Determination of the carchment area of Mahakanadarawa

The catchment boundary of the Mahakanadarawa tank is shown in the map attached.

Where contours are available, the boundary is a line drawn along the ridge of the land. The rainfall on the outside of this boundary does not reach the Mahakanadarawa. Drawing the catchment boundary is very difficult even in an up to date coloured and contoured map, specially because the land is fairly flat, and therefore contours are far apart. Due to this reason, the boundary is drawn by tanking into account the direction of facing of tanks within the catchment, the direction of flow of drainage lines, the layout of paddy fields and other such features. Much greater degree of accuracy can be obtained by field inspection, but such accoracy is not generally required.

Following points were considered when the catchment boundary is drawn.

(1) Catchment boundary always intersect contours at right angles at the ridge. Nowhere else will the catchment boundaries intersect contours.

(2) Catchment boundary never intersect drainage lines, except at the point of interest in the drainage line.

Catchment area can be measured by plainmetering, but the accuracy is very low. Therefore, catchment area was determined by counting squares.

<u>Details of minor tanks in the catchment area</u>

Minor tank details includes catchment areas, FSL and command areas, co-ordinates showing the exact location of the tank (co-ordinates of the left bank end of the dam is always specified), capacities, and most important whether the tank is working or abandoned.

From one inch to mile topographic maps produced by survey department, we were able to get some informations, but it does not give much reliable informations. As an exapmle, most of the tanks which were marked as abandoned in those sheets are now working tanks. Also, details obtained from these tanks about F.S.L. areas and command areas were not accurate.

Due to these reasons, our project superviser, Dr. Kariyawasam arranged a four day field investigation of the tank in the whole catchment area.

Lot of information regarding these tanks were obtained in these field investigation from cultivation officers, farmers and specially from elderly people who know every detail of the area in which they are living.

Following are some of the details which we obtained:

1. Name of the tank
2. Working or abandoned
3. F.S.L. area and command area
4. Whether it was rehabilitated recently
5. Any nearby tanks (This helped us to locate several tanks which were not in top sheets)
6. Opinions of villagers regarding rainfall in the past, reasons for the lack of water in Mahakanadarawa etc.

It was also found that some villagers have rainsed the spill level of their tank im order to store additional volume of water. Thiw will seriously affect the inflow to tanks which are in the lower part of the catchment, and ultimately Mahakanadarawa tank.

The minor tanks details are given in the table 1 and they are arranged in the alphabatical order of the name of the tank.

Some of the data tabulated in this table were obtained from tank data cards prepared under the guidance of Mr.H.Basnayake. A collection of these cards are available at the Mahaweli Development Board head office, which has details of about 10000 tanks in Sri Lanka.

Tank	Co-ordinates	P.S.L. area (acres)	Cultivated area (acres)	Capacity (Acft) Gross	Active	Reduced level Sluice	Spill	W/A	Catch. area (Sq.mls)
1. Agalawewa	F/10(10.6*6.0)	10	5		30	100	105	A	0.1
2. Aharayagema	F/5 (7.15*3.15)	10	32	36	36	100	104	W	0.30
3. Alut wewa	F/5 (4.15*0.9)	13	8	40	37	100	105	A	0.50
4. Ambagahawewa	F/10(8.2x9.2)	90	75		210	100	100	W	0.71
5. Ambagalawewa	F/5 (5.9x2.7)	80	28	240	214	100LB 101RB	107LB 108LB	W	0.30
6. Amuna wewa	F/10(19.2x6.7)	8			25	100	104	A	0.22
7. Amunukole	F/10(10.7x8.4)	27	23		70	1001	106	W	0.40
8. Bandara Ikiri gol ewa	F/5(3.9x4.2)	45	45	495	445	400 102	100	W	1.10
9. Betkewewa	F/5(9.8x4.5)	163.2	128	520	520	100 102.7	110	W	1.50
10. Bogahawewa	F/10(3.4x5.0)	8	-		24	100	105	A	0.2
11. Bogahawewa	F/5(7.85x2.7)							A	0.05
12. Bokalawewa	F/5(5.75x2.7)	15	15		44	100	104	W	0.15
13. Borawewa	F/10(10.2x3.2)	32	16		54	100	108	W	0.5

Tank	Co-ordinates	F.S.L. Area (Acres)	Cultivated area (Acres)	Capacity(Acft)		Reduced Level		W/A	Catch. area (Sq.mls.)
				Gross	Active	Sluice	Spill		
14. Bulankulan	F/4(12.7x1.0)	67	20		62	100	109	W	1.05
15. Dambakanda	F10(10.9x3.6)	11			33	100	104	A	0.30
16. Dematawewa	F/10(10.6x3.8)	77	34		102			W	0.62
17. Dematawewa	F/10(8.0x8.6)	40	88	90	90	100	108	W	0.30
18. Dematawewa	F/10(5.0x3.9)	36	38					W	0.50
19. Devilawewa	F/10(9.2x3.2)	25	20	18.6	54.4	100	105	W	0.25
20. Dhanukkara gahawewa	F/10(4.3x8.0)	15	10	33	30	100	105	W	0.25
21. Diganhammil -lewa	F/5(11.1.x2.0)	153	192		498	100	106	W	1.00
22. Dunwattegama	F/5(4.5x3.4)	57	61					W	0.90
23. Elapatagama	F/5(3.5x4.4)	32	36	99	99	100	107	W	0.40
24. Elapatagama	F/5(9.6x1.6)	70	75		224	100	108	W	0.50
25. Elapatawewa	F/10(10.3x8.0)	29			92	100	108	W	0.55
26. Elapatawewa	F/10(9.3x5.2)	21	25		61	100	106	W	0.77
27. Elapataw[illegible]a	F/5(10.3x3.6)	13	19		37	100	107	W	0.10
28. Elapankulama	F/10(0.11x6.2)	27	10		54	100	105	W	0.54
29. Ellewa Kuda -gama	F/5(8.7x2.3)	57	83	320		100	108	W	0.50

Tank	Co-ordinates	F.S.L. area (acres)	Cultivated area (acres)	Capacity(Acft) Gross	Active	Reduced level Sluice	Spill	W/A	Catch. area (Sq.mls)
30. Ellewewa	F/5(9.1x2.1)	323	384	200	2000	100	114	W	0.50
31. Etawetunuwewa	F/5(4.1x2.5)								1.00
32. Galapitawewa	F/10(8.1x4.0)	10			40	100	104	A	0.37
33. Galebendawewa	F/5(7.7x1.9)	29	52		176	100	112	W	1.00
34. Galenbindunu wewa	F/10(8.2x7.3)	66	43		230	100	109	W	1.00
35. Galkulama	F/10(3.7x5.8)	58			186	100	108	A	0.98
36. Galaguruwa	F/10(2.9x7.0)	48	28	110	99	100	106	W	0.50
37. Gangurewa	F/5(8.3x1.10)	147	211		640	100	111	W	1.00
38. Gonapitiyawa	F/5(3.65x3,75)	32	38		80	100	106	W	0.90
39. Halmillewa	F/4(13.4x0.5)	06	10		20	100	106	W	0.10
40. Himbutugollewa	F/10(9.1x5.6)	08			22	100	104	A	0.33
41. Ichchankulama	F/10(8.3x9.1)	78			210	100	110	W	0.71
42. Idigollewa	F/10(6.75x9.1)	20	20	92	54	100	105	A	0.25
43. Ihalagama	F/10(4.1x7.0)	56	45	156	144	100	108	W	0.40
44. Ihalagamawewa	F/10(11.2x3.5)	17	27		52	100	106	W	0.25
45. Ihalagalkulama	F/10(3,3x5.5)	18			30	100	104	A	0.30

Tank	Co-ordinates	F.S.L area (Acres)	Cultivated areas (Acres)	Capacity(Acft)		Reduced Level		W/A	Catch. area (Sq.mls)
				Gross	Active	Sluice	Spill		
46. Ihalahalmillewa	F/10(6.1x4.4)	40	65		190	100	112	W	0.75
47. Ihalahinguruwewa	F/10(4.2x4.5)	45	48		126	100	107	W	0.91
48. Ihala Karamban Kulama	F/5(3.0x1.3)	45	48		120	100	100	W	0.85
49. Ihalakayinattawa	F/10(10.3x6.1)				25	100	105	W	1.25
50. Ihala Ilikwewa	F/5([illegible]3x2.4)				35	100	106	A	0.45
51. Ihala Ollugollewa	F/5(11.2x1.4)							A	0.10.
52. Ihala Walawach-chiya	F/5(0.7x0.3)	32	35	65	55	100	106	W	0.75
53. Ihalawewa	F/10(10.6x7.7)	10	13		[illegible]	100	106	W	0.36
54. Ihala Wattewewa	F/10(0.8x9.3)	25			20	100	107	A	0.53
55. Iluk wewa	F/10(11.3x2.6)	10			30	100	105	W	0.30
56. Kadurugaspitiya	F/10(7.7x4.0)	24			50	100	106	W	0.32
57. Kahapatalagama	F/10(2.0x4.1)	38			65	100	106	W	0.50
58. Kahatagasdigiliya	F/5(11.6x5.3)	150	75					W	0.75
59. Kahatagollewa	F/5(9.3x6.15)		53	243	243	100	108	W	1.40
60. Kaluwaragaswewa	F/5(11.2x6.0)	30	6					W	0.10
61. Kaluwaragaswewa	F/10(4.4x6.4)	35	34	70	60	100	106	A	0.30

Tank	Co-ordinates	F.S.L. area (Acre)	Cultivated area (Acres)	Capacity (Acft)		Reduced Level		W/A	Catch. area (Sq.mls)
				Gross	Active	Sluice	Spill		
52. Kandubidunawewa	F/10(0.15x7.0)	26	10	75				W	0.25
53. Karadikulama	F/10(1.5x7.4)	125	90		400	100	110	A	0.67
54. Karakolawewa	F/10(8.5x6.7)	49	22		118	100	106	W	0.70
65. Kasanaduwewewa	F/10(6.9x6.5)	55	41		150	100	107	W	0.41
66. Katambugamawewa	F/10(4.8x4.7)	87	62		250	100	108	W	1.10
67. Katakeliyawa	F/9(13.2x7.9)	15	20		29	100	104	W	0.37
68. Katukeliyawa	F/10(7.2x6.3)	25	26	1125		100	108.5	W	3.65
69. Katukeliyawewa	F/5(10.1x5.8)	35	63	90	90	100	106	W	0.30
70. Katakelewa	F/5(9.2x3.8)	32	10	30	30	100	107	W	0.20
71. Katukeliyawa	F/5(11.1x6.4)	5	10		30	100	104	W	0.10
72. Katukeliyawa	F/10(4.1x3.9)	22	24	110	73	100	108.5	W	0.30
73. Katupotha	F/10(0.5 x6.9)	83	40		160	100	105.5	W	1.24
74. Kayangollewa	F/5(10.6x7.2)							W	0.03
75. Kayanwewa	F/5(8.9x1.0)	2	10	60		100	108	W	0.30
76. Kayipitiyawa	F/10(7.3x6.9)	65	57					W	0.91
77. Kidapolagama	F /10(1.2x4.9)	12	7		35	100	106	W	0.30
78. Kirimetiyawa	F/5(5.9x0.0)	38	45		95	100	106	W	1.70
79. Kirimetiyawa	F/5(9.5x5.3)	10						A	0.10

Tank	Co-ordinates	F.S.L area (A	Cultivated area Acres.	Capacity(Acft) Gross	Active	Reduced Level Sluice	Spill	W/A	Catch. Area (Sq.mls)
80. Kirimetiyawa	F/10(4.1x5.1)	10	--	-	-			A	0.22
81. Kohombagaswewa	F/5(7.4x1.1)							A	0.10
82. Kohemaduwa	F/5(10.9x5.7)	230	192	1200	1200	100	112	W	1.50
83. Konnayagama	F/5(10.85x7.7)	13	16	48	48	100	108.5	A	0.10
84. Konwegama	F/10(5.0x8.3)	16	6	28	24	100	105	W	0.30
85 Konwewa	F/10(6.9x5.1)	64	78		216	100	112	W	0.52
86. Konwewa	F/10(10.0x7.6)	25	23	70	70	100	107	W	0.15
87. Kolongaswewa	F/10(8.7x3.8)	35	26		90	100	106.5	W	0.52
88. Kottamankulam	F/5(3.2x0.6)	36	24	68	60	100	108.5	W	0.40
89. Kudagama	F/10(6.9x4.1)	51	45					W	0.80
90. Kudahimbutugol-lewa	F/10(10.2x4.7)	60	96	400	293	100	108	W	1.10
91. Kuda Kapirigama	F/5(6.1x3.8)	50	40	140	120	100	107	W	1.00
92. Kuda Kirindegama	F/10(0.4x8.3)	56	7					W	0.91
93. Kudamassalewa	F/5(11.5x4.3)	60	55	168	168	100	107	W	0.80
94. Kuda Moragahaw-ewa	F/5(9.1x4.70)	29	29		110	100	105	W	0.86
95. Kuda Nochchi-kulama	F/10(2.1x5.0)	19	-		42	100	105	A	0.56
96. Kuda Rambewewa	F/10(5.3x5.2)	12	12		30	100	104	W	0.25
97. Kuda Sippukulama	F/10(3.6x6.2)	9			25	100	104	W	0.46
98. Kudawewa	F/10(3.2x6.9)	10			30	100	105	A	0.40

	Tank	Co-ordinates	F.S.L... area (Acres)	Cultivated area (Acres)	Capacity(Acft)		Reduced Level		W/A	Catch. area (Sq.mls)
					Gross	Active	Sluice	Spill		
99.	Kudawewa	10(11.5x2.7)	12			26	100	104.5		0.20
100.	Kudawewa	10(10.3x3.1)	33	16		50	100	106	W	0.91
101.	Kudawewa	F/10(2.9x4.3)	20	29		45	100	105	W	0.71
102.	Kudawewa	F/10(2.1x4.4)	18	22		59	100	106	W	0.41
103.	Kudawewa	F/5(2.55x0.85)							A	0.20
104.	Kudawewa	F/5(11.3x3.4)							A	0.10
105.	Kudawewa	F/10(6.4x4.4)	15	12		60	100	107	W	0.10
106.	Kudawewa	F/10(9.9x6.5)							W	0.31
107.	Kudawewa	F/5(8.35x2.35)	13	15	40	40	100	106	W	0.60
108.	Kukulewa	F/5(6.8x3.8)	57	83	320		100	108	W	0.50
109.	Kumukwewa	F/10(10.6x4.3)	45	30		110	100	107	W	0.50
110.	Kumbukwewa	F/5(3.8x0.5)	41	40	86	80	100	107	W	0.80
111.	Kunuragama	F/5(4.3x0.5)	32	54		95	100	106.5	W	1.0
112.	Kunuragama	F/5(8.4x4.5)	13	20	55		100	106	W	0.30
113.	Kurunjankulama	F/5(2.9x0.5)	25	28	64	60	100	108	W	0.20
114.	Kurupayiyawa	F/10(9.1x4.1)	6						W	0.21
115.	Lokuruwewa	F/5(9.5x5.45)		10	34	34	100	105	W	0.20
116.	Lulnewa	F/5(9.7x4.2)	89	51					W	2.75

Tank	Co-ordinates	F.S.L. area (Acres)	Cultivated area (Aces)	Capacity(ACFT) Gross	Active	Reduced Level Sluice	Spill	W/P	Catch. area (Sq.mls.)
117. Mahahimbu[illegible]o-llawa	F/10(8.7x4.5)	163	120	204	136	100	106	W	0.50
118. MahaKiribbewa	F/5(11.2x7.1)	58	106		300	100	110	W	0.60
119. MahaKirindegama	F/10(1.3x8.3)	75	93	880		102.25		W	6.00
120. Maha Messalewa	F/5(10.7x4.7)	87	51		160	100	109	W	0.60
121. Maha Nochchik-ulama	F/ (2.2x5.5)	68	78		234	100		W	1.50
122. MahaSiyablawewa	F/10(10.8x2.7)	10			30	100	104	A	0.52
123. Manakulama	F/10(1.3x6.6)	26	35		90	100	105	W	0.40
124. Manakulama	F/10(2.3x6.2)	50	35		105	100	107.5	W	0.67
125. Maradankada-wela	F/10(1.1x5.9)	75	80	300		100		W	1.35
126. Marasinghegama	F/10(6.7x7.3)	22						A	0.50
127. Mawatawewa	F/10(7.8x4.1)	50	38		116.2	100	109	W	0.40
128. Mayilagaswewa	F/10(9.6x4.25)	51	38	174	116	100	108	W	0.40
129. Mayilagaswewa	F/10(7.2x7.7)	35	16			100	108	W	0.40
130. Mayilawewa	F/5(8.8x1.80)		12	39	39	100	104	W	0.30
131. Medawewa	F/5(4.7x2.3)	88	50	280	260	100	109	W	0.90
132. Mekichchewa	F/5(9.8x4.2)	34	53					W	3.00

Tank	Co-ordinates	F.S.L. area	Cultivated area	Capacity(acft) Gross	Active	Reduced Level Sluice	Spill	W/A	Catch. area (Sq.mls)
133. Mekichchewa	F/5(6.45x2.75)	90	95	285	285	100	109	W	1.75
134. Mekichchewa	F/10(8.5x8.6)	14	20		60	100	106.5	W	0.20
135. Messagahapuwewa	F/10(9.2x8.3)	24	35	90	90	100	108	W	1.00
136. Migahadivula	F/5(10.0x1.1)							W	0.60
137. Mudirippuwa	F/10(2.9x4.8)	36	46		120	100	107	W	1.10
138. Murutambewa	F/5(5.85x2.0)	14	10	55	48	100	107	W	0.40
139. Nabadawewa	F/10(5.5x5.9)	74	48		220	100	108	W	0.40
140. Namalluwewa	F/5(10.2x0.6)	74	80	225	210	100	110	W	1.00
141. Natiyagama	F/5 (5.8x7.0)	85	70	320	300	100	110	W	0.70
142. Natiyagama	F/10(7.1x6.5)	57	65		190	100	106	W	0.42
143. Nekatunewewa	F/10(6.7x8.75)							W	0.40
144. Nekatunuwewa	F/5(7.3x0.15)	141	114	600	600	100	112	W	1.50
145. Nelugollakada	F/5(10.9x0.0)	102	70		290	100	109	W	1.20
146. Nitulgehewa	F/10(6.0x8.3)	17	14		35	100	104	W	0.72
147. Nitulgaswewa	F/5(6.6x4.5)		10	21	21	100	103.5	W	0.25
148. Nivitigama	F/10(5.4x6.9)	52	30		90	100	104.5	W	1.20
149. Nochchikulama	F/10(2.1x5.5)	53	49		100	100	105	W	0.73

	Tank	Co-ordinates	F.S.L area	Cultivated area (Acft)	Capacity(Acft)		Reduced Level		W/A	Catch. area (Sq.mls)
					Gross	Active	Sluice	Spill		
150.	Nugapalliya	F/10(1.2x 4.7)	26			42	100	104.5	W	1.10
151.	Padiketuwewa	F/10(9.2x3.5)	45	38	150	150	100	105	W	0.40
152.	Pahalagammillwea	F/10(6.3x5.5)	60	83		216	100		W	1.5
153.	Pahalakarambankulama	F/5(2.5x1.3)	38	10					W	0.35
154.	Pahalakayinattawa	F/10(9.2x6.0)	87	83		216	100		W	0.59
155.	Pahalaolluyollewa	F/5(10.6x1.8)	58	77	210	210	100	107.5	W	1.0
156.	Pahalapattilewa	F/5(6.9x0.7)	35	36	112	112	100	108	W	1.0
157.	Pahalapotana	F/5(2.0x0.5)	21	19		45	100	104.5	W	0.15
158.	Pahalawalachchiya	F/5(1.2x0.4)	21	10		30	100	105	W	0.40
159.	Pahalawewa	F/10(2.0x7.3)	10	20		70	100	107.5	W	0.21
160.	Pallankulama	F/10(3.2x4.0)	39			80	100	107	W	1.52
161.	Palugaswewa	F/10(5.2x6.5)	15	14	40	35	100	104	W	0.60
162.	Palugaswewa	F/5(3.8x 1.1)	13	12	30	30	100	106	W	0.20
163.	Palugaswewa	F/5(5.1x4.7)	5	15		30	100	104	W	0.08
164.	Paluketuwewa	F/5(10.8x3.7)	115	102		315	100	113	W	1.30
165.	Paluwewa	F/5(6.7x1.5)	154	130		654	100	111.5	W	3.63

Tank	Co-ordinates	F.S.L. area (Acft)	Cultivated area (Acft)	Capacity(Acft) Gross	Active	Reduced Level Sluice	Spill	W/A	Catch. area (Sq.mls
156. Panichchikalla	F/10(2.9x6.6)	65	43	145	130	100	106	W	0.30
137. Panaalawewa	F/10(4.3x8.3)	19	12	40	36	100	106	W	0.30
158. Periyakulama	F/10(7.6x5.1)	112	65		190	100	111.5	W	1.10
169. Potanegama	F/5(9.1x1.8)		28	70	70	100	107	W	0.30
170. Pudukkulama	F/10(3.3x7.1)	77	80		250	100	109	W	0.74
171. Puhudiwala	F/5(10.2x4.8)	26	17		52	100	105	W	0.12
172. Punchihamillewa	F/5(7.52.4.6)	70	70		220	100	108.5	W	1.10
173. Punchikulama	F/10(1.2x7.5)	7	10		235	100	104	W	0.20
174. Rajanganawewa	F/5(11.5x2.8)	10			30	100	103	A	0.4
175. Rambawewa	F/10(5.5x4.8)	19	15		40	100	104	W	0.41
176. Rambewa	F/10(5.3x4.3)	56	26		80	100	105	W	0.54
177. Rampathwila	F/5(8.4x3.5)		60		1700	105	115	W	2.0
178. Ranurawewa	F/10(10.3x8.4)	24						A	0.32
179. Ranuwarawewa	F/5(7.5x2.2)	19.2	10		55	100	104.5	W	0.40
180. Ratmale	F/5(9.2x0.1)	141	243		525	100	115.	W	1.75
181. Ratmawattawewa	F/5(4.0x1.2)	26	13	50	45	100	105	A	0.20
182. Ratmalwetiyawewa	F/5(7.2x2.0)	35.2			130	100	106	W	0.75

	Tank	Co-ordinates	F.S.L. Area (Acft)	Cultivated (Acft) Area (Acft)	Capacity(Acft)		Reduced Level		W/A	Catch. Area (Sq.mls)
					Gross	Active	Sluice	Spill		
183.	Rotapokuna	F/5(8.0x4.25)	74	75			100	109	W	0.70
184.	Rotawewa	F/5(5.2x4.3)	64	80	182	175	100	110.5	W	0.65
185.	Sandigewewa	F/5(10.5x2.5)	38	58		160	100	107	W	1.00
186.	Sapugala	F/10(2.4x6.8)	25	20	100				W	0.40
187.	Seeppukulama	F/5(4.8x1.9)	90	62	200	180	100	107	W	0.30
188.	Siyambalagas-wewa	F/5(2.7x1.85)	6	3		15	100	103	W	0.30
189.	Siyambalagas-wewa	F/10(5.1x6.4)	21	12	40	36	100	105	W	0.30
190.	Siyambalagas-wewa	F/10(10.9x2.8)	45	96	5160	3780	100	111.5	W	1.30
191.	Siyabalagas wewa	F/10(5.7x5.8)	9	20	60	60	100	105.5	W	0.30
192.	Siyabalagas-wewa	F/5(9.2x5.25)	15	25		40	100	104.5	W	0.50
193.	Surukkulama	F/10(3.4x7.6)	36	40	130	122	100	108.5	W	0.40
194.	Tambaragollawewa	F/10(10.7x7.8)	7	–		30	100	104	W	0.31
195.	Tammannagama	F/10(9.2x3.3)	13			25	100	104	W	0.63
196.	Tammannagoda	F/10(7.6x8.5)	35	14	60		100	106	W	0.30
197.	Tammannagoda	F/5(10.3x0.1)							W	0.50
198.	Tammannagoda	F/5(9.6x3.0)	15	20		65	100	104	W	0.50

	Tank	Co-ordinates	F.S.L Area (Acres)	Cultivated ARea (acres)	Capacity(Acft) Gross	Active	Reduced Level Sluice (Ft.)	Spill (Ft)	W/A	Catch. area (Sq.mls)
199.	Tammannewa	F/5(5.5x1.35)	67	64		190	100	106.5	W	1.10
200.	Taranagollewa	F/10(10.9x4.3)	45	58		180	100	110	W	0.60
201.	Thenkittiyawewa	F/10(1[illegible]7)	26	10		35	100	103.5	W	0.90
202.	Thirapane	F/10(4.0x5.5)	128	100		321	100	110.5	W	0.93
203.	Thurukkaragama	F/5(10.9x7.3)	19	32		85	100	105.5	W	0.60
204.	Tihagama	F/10(8.7x8.3)	39	4[illegible]	140	140	100	110	W	0.35
205.	Timbiriwewa	F/10(9.8x8.5)	16						A	0.30
206.	Ulpathgama	F/10(3.7x7.95)	25	26	122.4	81.6	100	105.5	W	0.30
207.	Ulpathwewa	F/5(3.4x2.5)	35	22		70	100	106	W	0.75
208.	Usgallewa	F/10(10.8x4.8)	35	40	204	136	10[illegible]	108	W	0.50
209.	Vallywewa	F/10(7.4x5.[illegible])	12			39	100	103.5	A	0.43
210.	Walaswewa	F/5(4.8x4.5)	60	145	150	145	100	107	W	0.30
211.	Waliamuna	F/5(4.8x3.7)	93	112		460	100	112.5	W	0.80

Tank	Co-ordinates	F.S.L Area (Acres)	Cultivated Area (Acres)	Capacity(Acft)		Reduced Level		W/A	Catch. Area (Sq.mls)
				Gross	Active	Sluice	Spill		
212. Walapaluwagama	F/5(8.6x1.3)	15	20	45	45	100	108	W	0.25
213. Wambatuwagama	F/5(0.9x3.8)	19	13		45	100	104	W	0.50
214. Watarakwewa	F/5(11.0x5.0)	89	76		230	100	109	W	2.00
215. Welankulam	F/5(0.7x1.2)	32	16		125	100	106	[illegible]	1.20
216. Wellamorana	F/9(13.7x7.5)	30	40		135	100	105.5	W	0.50
217. Weruppankulam	F/10(4.8x8.5)	210	310	820	770	100	111	W	2.00
218. Yakadutuwewa	F/5(4.2x4.0)	62	35	163	158	100	110	W	0.60

Rainfall data :

Monthly rainfall data for the study were collected from the Meteorogical department, Colombo. There are four rain gauge stations around the catchment; Mihintale, Nachchaduwa, Kahatag sdigiliya, and Huruluwewa. The stations Mihintale and Kahatagasdigiliya are situated inside the catchment boundary. Nachchaduwa and Huruluwewa rain gauge stations are situated within two miles from the catchment boundary. Therefore, the use of rainfall records of these stations will give a fairly accurat values for the rain fall over the whole catchment.

In cases of Nachchaduwa and Mihintale, continuous records are available up to 1982. Continuous records are not available for Huruluwewa and Kahatagasdigiliya. Table 2 shows the lengths of monthly rainfall records available and the number of missing records for each station.

Table 2 Available Rainfall Data

Station	From	To	Number of years	Number of missing records
Mihintale	1953	1982	30	-
Nachchaduwa	1953	1982	30	-
Kahatagasdigiliya	1953	1962	10	20
Huruluwewa	1954	1967	14	18

The available rainfall records of the four stations are given in the next four pages.

HYDROLOGICAL STUDY OF MAHAKANADARAWA PROJECT

MONTHLY AVERAGE RAINFALL AT NACHCHADUWA

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1953	4.45	1.41	0.07	14.68	0.00	0.00	5.27	4.66	1.94	15.64	7.11	8.83
1954	3.94	0.04	6.99	12.11	1.21	0.00	4.70	1.70	0.30	5.51	4.90	17.15
1955	7.27	0.84	2.08	9.71	4.29	0.00	0.63	3.10	4.41	4.95	4.04	5.03
1956	1.82	0.64	4.03	6.25	0.03	2.91	0.10	2.33	0.06	8.69	9.17	5.80
1957	2.35	4.49	1.43	6.91	6.61	0.71	0.31	0.13	0.25	11.34	21.69	37.90
1958	2.34	0.70	3.33	2.35	5.02	0.00	0.00	2.61	0.00	7.37	10.16	2.30
1959	2.90	0.40	2.15	5.54	3.85	0.75	0.00	0.00	3.40	4.91	6.43	3.80
1960	3.34	2.27	0.68	5.50	2.30	0.23	5.80	0.00	1.45	4.50	16.05	3.20
1961	4.10	2.20	0.50	2.30	0.40	2.70	0.00	0.10	0.80	9.15	3.13	4.39
1962	2.75	0.52	2.98	7.12	7.45	0.25	1.10	2.55	1.25	23.10	5.83	5.63
1963	10.76	4.11	6.82	4.82	1.05	0.35	0.10	0.40	0.60	8.50	17.15	19.41
1964	1.62	1.75	2.95	4.35	3.65	0.16	3.25	0.47	2.55	10.31	3.18	5.55
1965	1.10	2.35	10.10	8.50	7.60	0.20	0.38	8.75	0.00	11.17	13.76	12.10
1966	4.29	0.40	3.20	9.91	0.48	0.10	0.60	2.22	9.45	8.26	10.92	6.32
1967	0.47	5.69	3.28	2.17	1.61	0.31	0.03	0.34	0.72	11.97	9.74	12.90
1968	1.47	0.08	4.02	4.16	1.26	0.53	0.13	0.00	2.74	7.71	6.22	5.30
1969	2.90	2.20	2.49	7.76	2.03	0.00	0.19	2.85	3.07	17.68	5.20	13.10
1970	4.22	3.47	0.81	4.39	4.07	0.00	0.11	0.10	2.71	11.43	12.59	9.14
1971	7.79	5.51	0.03	6.95	1.98	0.66	1.17	10.54	1.53	6.73	4.60	18.38
1972	2.05	0.00	0.00	7.89	6.98	0.20	2.08	0.00	2.21	13.82	4.74	5.08
1973	0.00	0.34	1.25	2.63	2.82	0.19	0.80	2.16	2.52	4.20	7.70	17.23
1974	0.00	0.13	1.66	4.74	1.93	0.00	0.21	0.33	2.92	1.93	5.07	9.28
1975	1.75	0.41	5.67	5.91	1.50	0.14	1.09	0.19	1.20	7.57	9.96	3.08
1976	0.15	0.20	3.06	7.47	0.31	0.00	0.04	0.04	0.36	14.58	12.78	4.94
1977	0.52	1.06	1.41	7.95	5.79	0.51	1.85	2.34	1.22	15.85	15.80	6.00
1978	0.83	0.17	1.07	2.42	5.67	0.00	1.00	0.00	3.19	5.37	14.31	6.10
1979	0.65	1.39	0.76	5.31	1.25	0.00	0.40	1.58	5.15	15.00	9.75	2.08
1980	0.00	0.00	0.45	2.51	2.14	0.00	0.80	0.37	3.91	9.02	5.21	2.60
1981	1.74	0.92	0.62	4.44	1.39	0.00	1.33	1.00	2.33	6.09	4.22	2.20
1982	0.00	0.00	1.27	3.51	4.07	0.00	0.31	0.00	1.46	9.40	13.05	4.22

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MONTHLY AVERAGE RAINFALL AT MIHINTALE

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1953	4.11	0.75	1.30	9.65	0.00	0.30	3.99	1.87	2.81	12.53	9.35	9.82
1954	4.76	0.13	4.89	12.25	1.75	0.00	1.20	2.65	0.01	6.89	3.21	17.64
1955	6.61	1.57	1.07	10.56	4.14	0.00	1.25	5.26	10.40	5.99	4.40	1.94
1956	3.61	1.32	2.60	1.94	0.13	2.20	0.24	2.37	0.00	7.89	8.07	4.20
1957	3.10	5.00	0.02	9.06	6.76	0.47	0.23	0.00	0.90	15.03	10.56	28.25
1958	2.43	0.53	5.92	9.65	5.46	0.00	0.22	3.41	2.00	8.28	5.74	3.72
1959	5.94	0.57	0.15	8.13	6.20	2.01	0.18	0.50	*****	6.93	12.45	5.76
1960	4.70	7.75	0.79	4.69	3.56	0.00	6.93	0.00	1.48	3.97	18.95	2.06
1961	14.00	5.33	2.44	5.75	4.15	2.02	2.89	0.06	0.92	9.01	7.27	10.55
1962	9.70	1.56	2.55	9.40	9.05	0.15	0.00	1.22	1.57	15.92	4.25	7.67
1963	14.88	3.79	9.03	8.84	1.11	0.09	1.24	0.83	2.86	10.46	15.80	17.52
1964	1.68	1.81	2.64	3.18	2.28	0.00	2.44	0.56	2.71	11.81	7.31	5.90
1965	0.95	3.75	6.42	8.50	2.62	0.03	0.38	7.82	1.65	11.46	13.87	13.01
1966	5.14	0.27	4.31	10.30	0.00	0.00	0.50	2.10	8.43	10.48	12.63	6.02
1967	0.55	3.10	1.52	2.20	7.17	0.01	0.01	0.06	1.30	9.27	7.97	12.10
1968	0.77	0.00	1.33	2.01	1.80	0.00	0.00	0.47	3.23	5.12	5.21	6.75
1969	1.33	0.75	2.23	7.08	2.56	0.00	0.83	2.46	1.52	16.23	4.85	13.30
1970	2.17	5.42	1.77	10.07	5.14	0.00	0.02	2.20	3.15	9.48	14.86	7.74
1971	6.35	3.01	3.71	9.09	0.79	0.15	1.39	8.28	[illegible]	7.42	10.32	20.85
1972	0.71	0.00	0.25	10.21	6.63	0.26	1.22	0.00	2.47	21.30	11.04	7.66
1973	0.30	0.45	4.64	3.81	0.71	0.00	6.22	2.19	2.52	4.54	5.16	20.59
1974	0.04	2.22	1.58	5.43	1.06	0.00	0.03	0.77	2.73	0.99	3.04	11.56
1975	1.09	0.38	6.08	4.50	5.54	0.26	3.93	1.57	2.35	6.32	13.11	2.05
1976	0.42	0.03	1.92	7.01	0.00	0.30	0.06	0.08	2.92	11.08	14.26	5.56
1977	0.82	2.77	1.45	0.00	6.18	0.42	3.24	2.57	1.77	15.72	15.01	7.11
1978	1.15	0.22	1.10	3.89	6.05	0.00	6.29	0.00	9.21	5.25	14.90	7.10
1979	0.77	1.44	0.78	1.77	1.38	0.00	1.29	2.42	9.11	10.37	15.00	9.94
1980	0.00	0.00	0.00	7.10	2.95	0.42	0.11	0.00	3.87	7.59	12.44	6.85
1981	0.00	3.55	2.44	3.69	2.29	0.13	2.69	5.85	5.16	6.47	5.18	4.84
1982	0.00	0.00	2.07	3.21	5.29	0.88	0.07	0.00	3.07	12.18	8.98	6.03

HYDROLOGICAL STUDY OF MAHAKANADARAWA PROJECT

MONTHLY AVERAGE RAINFALL AT HURULUWEWA

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1954	7.08	1.02	3.79	6.42	1.36	0.00	2.17	6.05	0.00	8.18	5.80	19.92
1955	9.17	2.45	1.19	6.56	2.43	0.00	0.00	4.42	8.53	3.84	3.45	3.59
1956	2.08	1.74	1.42	6.06	0.00	1.73	1.88	0.34	0.00	8.81	15.50	3.35
1957	3.02	5.72	0.00	0.85	4.00	0.06	0.39	1.50	1.04	14.14	13.55	51.67
1958	4.38	2.29	4.36	6.13	4.52	0.00	0.23	4.09	0.32	8.16	10.72	5.36
1959	9.20	0.06	0.00	6.26	4.89	1.41	0.29	0.28	5.51	3.23	15.40	9.78
1960	7.30	8.95	2.18	7.86	4.49	0.35	9.47	0.00	4.00	4.68	13.30	1.20
1961	12.24	6.15	1.99	4.06	2.60	1.64	0.25	0.00	0.49	7.53	5.75	15.06
1962	7.70	1.40	2.76	10.04	9.02	0.00	0.08	3.55	4.86	10.20	18.85	9.30
1963	15.08	4.63	9.22	10.34	1.04	0.10	2.88	0.00	5.44	9.91	3.80	16.33
1964	4.57	4.00	0.00	1.50	4.50	0.00	1.84	0.00	0.00	5.45	12.89	0.00
1965	0.00	3.96	2.02	9.28	1.60	0.00	2.30	5.52	0.14	6.50	12.59	18.12
1966	5.38	0.37	6.41	7.52	0.05	0.00	0.11	4.84	6.21	19.42	13.43	8.37
1967	1.04	0.00	3.27	4.41	2.15	0.27	0.00	0.34	4.36	13.97	13.43	12.51

THE LAG ONE SERIAL CORRELATION COEFFICIENT IS0.2703

HYDROLOGICAL STUDY OF MAHAKANADARAWA PROJECT

MONTHLY AVERAGE RAINFALL AT KAHATAGASDIGILIYA

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1953	7.40	0.00	0.01	2.75	0.00	0.21	7.36	2.15	2.40	0.75	5.76	8.41
1954	1.38	0.00	5.68	5.20	1.35	0.00	1.86	8.40	0.00	6.39	2.90	25.31
1955	7.79	3.03	1.53	5.64	3.20	0.00	0.82	5.43	6.27	2.18	3.86	5.55
1956	2.38	1.37	0.66	5.01	0.07	3.07	0.88	3.38	0.00	6.49	12.60	5.35
1957	3.90	6.52	0.00	2.23	4.97	0.00	0.00	0.00	2.96	7.41	11.61	37.06
1958	0.58	0.24	7.94	8.90	8.69	0.00	0.00	7.67	5.18	5.77	4.13	8.84
1959	5.05	0.97	0.00	4.12	2.70	2.34	0.00	0.38	1.88	6.14	12.35	11.43
1960	6.28	8.10	3.31	1.03	1.92	0.00	5.23	0.00	1.24	6.11	12.04	1.87
1961	27.40	5.91	2.10	0.60	5.57	1.66	3.07	0.00	1.13	7.87	15.66	16.48
1962	8.54	2.04	4.53	6.01	4.50	0.00	0.00	3.60	0.67	10.54	0.00	5.30

0.0000

CHAPTER 4

Calculation of missing rainfall data :

There are mainly two methods which can be used for rainfall calculations.

1. Using past records of the same station :

   To use this method, there should be a good serial correlation between past data. The serial correlation is said to be exist if the lag one serial correlation for the past records is closer to unity.

Lag one serial correlation co-efficient =

$$\frac{\sum_{i=1}^{n-1} x_i x_{i+1} - \frac{1}{n-1}\left[\sum_{i=1}^{n-1} x_i\right]\left[\sum_{i=2}^{n} x_i\right]}{\left[\sum_{i=1}^{n-1} x_i^2 - \frac{1}{n-1}\left[\sum x_i\right]^2\right]^{0.5}\left[x_i^2 - \frac{1}{n-1}\left[\sum x_i\right]^2\right]^{0.5}}$$

If the lag one correlation coefficient is close to one, statistical models such as Markov model can be used to calculate missing rainfall data.

For the data available, the coefficients were around 0.2 - 0.3 and the above method can not be used.

2. The other method that can be used is by using rainfall values of a nearby station where continuous data are available. For this, cross correlation coefficient should be close to unity. That is a good correlation between data of two stations is required.

Cross correlation

$$\frac{\frac{1}{n}\sum (x-\bar{x})(y-\bar{y})}{\sqrt{\left(\frac{x^2}{n} - \bar{x}^2\right)\left(\frac{yi^2}{n} - \bar{y}^2\right)}}$$

Since the four rain gauge stations are close to each other the rainfall values are of the same order. Therefore, the cross correlation coefficient between any two stations was found to be in the range 0.8 - 0.9 which is very close to unity.

This method was therefore used to calculate the missing rainfall values.

Calculation is done by simply assuming that

$$\frac{\text{monthly rainfall of a station}}{\text{Average rainfall of that station}}$$

– is constant for stations where a good correlation exists between data.

Specimen calculation :-

Huruluwewa values are calculated using Nachchaduwa records and Kahatagasdigiliya values using Mihintale records.

Average rainfall for the month of January for available records at

Nachchaduwa = 2.58

Huruluwewa = 6.23

$$\frac{\text{Monthly rainfall at Huruluwewa}}{6.23} = \frac{\text{Monthly rainfall at Nachchaduwa}}{2.58}$$

$$(\text{Rainfall})_{\text{Huruluwewa}} = 2.414 \text{ X } (\text{Rainfall})_{\text{Nachchaduwa}}$$

In year 1968; Rainfall of January at Nachchaduwa = 1.47

$$(\text{Rainfall})_{\text{Huruluwewa}} = 2.414 \text{ X } 1.47$$

$$= 3.55 \text{ inches}$$

Therefore, the rainfall in the month January in a particular year at Huruluwawa is calculated by multiplying the corresponding Nachchaduwa value by 2.414 Similar procedure was adopted for other months as well. The completed rainfall values of four stations are given in next few pages.

HYDROLOGICAL STUDY OF MAHAKANADARAWA PROJECT

MONTHLY AVERAGE RAINFALL AT KAHATAGASDIGILIYA

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1953	7.40	0.00	0.01	2.75	0.00	0.21	7.36	2.15	2.40	9.75	5.76	8.41
1954	1.38	0.00	5.86	5.20	1.35	0.00	1.86	8.40	0.00	6.08	2.90	25.31
1955	7.79	3.03	1.53	5.64	3.20	0.00	0.82	5.43	6.37	2.18	3.86	5.55
1956	2.38	1.37	0.66	5.91	0.07	3.07	0.88	3.38	0.00	6.49	12.60	5.35
1957	3.80	6.52	0.00	2.23	4.97	0.00	0.00	0.00	2.96	6.49	11.61	37.06
1958	0.58	0.24	7.84	8.90	8.69	0.00	0.00	7.67	5.18	7.41	4.13	8.84
1959	5.05	0.97	0.00	4.12	2.70	2.34	0.00	0.38	1.88	6.14	12.35	11.43
1960	6.28	8.10	3.31	1.03	1.92	0.00	5.23	0.00	1.24	6.11	12.04	1.87
1961	27.40	5.91	2.10	0.60	5.57	1.66	3.07	0.00	1.13	7.87	15.66	16.48
1962	8.54	2,04	4.53	6.01	4.59	0.00	3.00	3.60	0.64	0.53	0.00	5.30
1963	29.41	5.65	7.70	5.32	1.17	0.16	1.68	1.36	1.99	7.61	13.15	21.85
1964	3.32	2.69	2.53	1.90	2.41	0.00	3.30	0.92	1.89	8.60	6.08	7,36
1966	1.87	5.59	6.15	5.12	2.77	0.06	0.51	13.06	1.15	8.34	11.54	16.23
1966	10.16	0.40	4.13	6.20	0.00	0.00	0.67	3.61	5.38	7.63	11.34	8.63
1967	1.08	4.75	1.45	1.38	2.30	0.02	0.01	1.58	0.97	6.75	6.63	15.09
1968	1.52	0.00	1.27	1.75	1.90	0.00	0.00	0.75	2.25	3.72	4.33	8.43

MONTHLY AVERAGE RAINFALL AT KAHATAGASDIGILIYA

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1969	2.43	1.11	1.94	4.27	2.71	0.00	1.12	4.05	1.06	11.81	4.03	16.70
1970	4.29	8.08	1.69	6.61	5.45	0.00	0.02	3.77	2.19	6.17	12.37	9.65
1971	12.55	4.33	2.59	5.92	0.81	0.33	1.88	8.70	4.29	5.40	8.59	26.01
1972	1.40	0.00	0.23	6.15	7.03	0.50	1.65	0.00	1.68	15.51	9.19	9.53
1973	0.77	0.68	4.45	2.29	0.75	0.00	8.42	3.61	1.75	3.30	5.12	25.68
1974	0.07	3.31	1.51	3.27	1.12	0.00	0.04	1.27	1.90	0.72	2.53	14.42
1975	3.91	0.56	5.83	2.71	5.87	0.54	5.32	2.58	1.64	4.60	10.91	3.68
1976	0.83	0.04	1.72	4.76	0.08	0.00	0.00	0.13	0.57	8.72	13.53	6.93
1977	1.62	4.13	1.39	5.42	6.55	0.88	3.03	4.23	1.23	11.44	13.99	8.87
1978	2.27	0.29	1.05	2.33	6.41	0.00	8.52	0.00	6.42	3.82	12.40	8.85
1979	1.52	2.44	0.74	1.06	1.46	0.00	1.74	3.99	6.35	7.55	12.48	12.40
1980	0.00	0.00	0.00	4.27	3.12	0.88	0.14	0.00	2.70	5.52	10.35	8.54
1981	0.00	2.31	2.34	2.21	2.42	0.27	3.60	9.64	3.60	4.71	4.31	6.06
1982	0.00	0.00	1.98	1.93	6.67	1.85	0.09	0.00	2.14	8.87	7.47	7.52

HYDROLOGICAL STUDY OF MAHAKANADARAWA PROJECT

MONTHLY AVERAGE RAINFALL AT HURULUWEWA

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1954	7.08	1.02	3.79	6.42	1.36	0.00	2.17	6.05	0.00	8.18	5.80	18.92
1955	9.17	2.45	1.19	6.56	2.43	0.00	0.00	4.42	8.53	3.84	3.45	3.59
1956	2.08	1.74	1.42	6.06	0.00	1.73	1.88	0.43	0.00	8.81	15.50	3.35
1957	3.02	5.72	0.00	0.85	4.00	0.06	0.39	1.50	1.	14.14	13.55	51.67
1958	4.38	2.29	4.36	6.13	4.52	0.00	0.23	4.09	0.32	8.16	10.72	5.36
1959	8.20	0.06	0.00	6.26	4.89	1.41	0.29	0.28	5.51	3.23	15.40	9.78
1960	7.30	8.95	2.18	7.86	4.49	0.35	8.47	0.00	4.00	4.68	13.30	1.20
1961	12.24	6.15	1.99	4.06	2.60	1.64	0.25	0.00	0.49	7.35	5.75	15.06
1962	7.70	1.40	2.76	10.04	9.02	0.00	0.08	3.55	4.86	10.20	18.85	9.30
1963	15.08	4.63	9.22	10.34	1.04	0.10	2.88	0.00	5.44	9.91	3.80	16.33
1964	4.57	4.00	0.00	1.50	4.50	0.00	1.84	0.00	0.00	5.45	12.88	0.00
1965	0.00	3.96	2.02	8.28	1.60	0.00	2.30	5.52	0.14	6.50	19.59	18.12
1966	5.38	0.37	6.41	7.52	0.05	0.00	0.11	4.84	6.21	19.42	13.43	8.37
1967	1.04	0.00	3.27	4.41	2.15	0.27	0.00	0.34	4.36	13.97	13.43	12.51

MONTHLY AVERAGE RAINFALL AT HURULUWEWA (INCHES)

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEP	OCT	NOV	DEC
1968	3.55	0.12	5.22	4.12	1.31	0.51	0.16	0.00	3.72	7.19	8.21	7.74
1969	7.00	4.33	2.63	7.20	2.12	0.00	0.23	3.68	5.40	16.48	6.86	19.13
1970	10.19	6.83	0.86	7.35	4.24	0.00	0.14	0.13	3.68	10.67	16.62	11.88
1971	44.85	10.85	0.98	6.89	2.06	0.63	1.49	13.62	2.08	6.27	6.07	26.83
1972	4.95	0.00	0.00	7.74	7.28	0.19	2.66	0.00	3.00	12.88	6.26	7.42
1973	0.00	0.87	1.33	2.61	2.94	0.18	1.02	2.79	3.42	3.91	10.17	25.16
1974	0.00	6.16	1.76	4.70	1.91	0.00	0.27	0.43	3.97	1.81	6.62	12.09
1975	4.22	0.81	6.01	5.86	1.56	0.13	1.39	0.24	1.63	7.06	11.83	4.50
1976	0.39	0.00	4.20	7.41	0.32	0.00	0.05	0.05	0.49	17.59	16.87	7.21
1977	1.49	2.09	1.49	7.89	6.04	0.48	2.36	3.02	1.66	14.78	20.86	8.76
1978	2.00	0.33	1.13	3.40	5.91	0.00	3.82	0.00	4.33	4.94	18.48	8.74
1979	1.42	2.66	0.81	5.19	1.28	0.00	0.51	2.00	6.89	14.65	12.87	2.98
1980	0.00	0.00	0.50	2.46	2.20	0.00	1.02	0.46	5.10	8.78	6.62	3.79
1981	4.20	1.80	0.66	4.40	1.44	0.00	1.69	1.29	3.17	6.50	5.57	4.67
1982	0.00	0.00	1.35	3.48	4.24	0.00	0.39	0.00	1.98	7.83	17.23	6.16

CHAPTER 5

AREAL DISTRIBUTION OF RAINFALL AND CONTRIBUTION TO RUNOFF

Determination of precipitation falling on the catchment

Areal distribution of rainfall

There are three methods available for areal distribution of rainfall.

1. Arithmetical mean method
2. Theisson polygon method
3. Isohyetal method

Arithmetic mean method :-

The simplest procedure is to average arithmetically the amounts measured by the gauges within the area. If the gauges are distributed uniformely and if the variation of individual gauge catches from the mean is not too large, this procedure is probably as accurate as any other method. But the non uniform distribution of gauges may give rise to large errors in our case and this was not used.

Thiessen Method :-

This gives weight to the areal distribution of stations. A Thiesson network is constructed by locating the stations on a map and drawing the prependiculat bisectors to the lines connecting the stations. The polygons thus formed around each station are the boundaries of the effective area assumed to be controlled by the station, i.e. the area which is closer to the station than any other station.

In taking the weightage, the area governed by each station is measured and expressed as a percentage of the whole area. Weighted average rainfall for the basin is computed by multiplying each station precipitation amount by its assigned percentage area, and totaling.

Isohyetal method

This method is the most accurate one for computing average rainfall. Isohyetal map is constructed by plotting on a suitable base the precipitation for each station and then drawing, in proper relative position, the contours of equal precipitation (isohyets). The average precipitation between contours (usually taken as one half the sum of the two contours values) by the area between contours, totaling these values, and dividing by the total area.

Factors affecting the choice of method between Theisson and Isohyetal methods :

1. If the basin is quite rugged and hilly, Isohyetals should be used
2. If the area is of intermediate size upto 5000 sq.Km Theisson polygon method should be used.
3. If the number of gauging stations are few compared to the size of the area, Thiesson polygon method.
4. If the network of rainfall stations within the storm area is sufficiently dense, the isohyetal map will give a reasonably accurate indication of the rainfall distribution.

According to these, the Thiesson polygon method is the best suited for our purpose.

Amount of precipitation contributing to runoff

Precipitation falling on the earth surface is either retained where it falls, passes through the soil surface as infiltration, or finds its way into the surface channel systems of the basin, whence it becomes surface runoff, For an exact analysis, all these effects should be considered to determine the runoff.

Instead of considering each of these separately an empirical method often adopted by the Irrigation Department of Sri Lanka was used in our calculations. This method is to assume that the following percentages of rain fall contributes runoff in each month of the raining season.

	Percentage of rain fall contributing runoff
1st month of rainy season	10%
2nd month of " "	15%
3rd month of " "	20%
4th month of " "	21%

This is a reasonable assumption because in the first month of the raining season, the earth surface had been considerably dry and therefore absorbs large amount of precipitation with out allowing run off. The percentage of precipitation contributing runoff increases with the raining season, and after 4th month, there will be no runoff because there will be hardly any rain. (usually raining season will not last for more than four months.)

Determination of the inflow to Mahakanadarawa tank

Precipitation falling on a particular area of the catchment will be firstly collected in minor tanks and any excess will be flowing down the cascade.

Considering about a minor tank which is situated at the catchment boundary, the inflow to it will be only from the precipitation falling on its own catchment. Part of this water will be evaporated and part will be infilltrated. Knowing the issues from sluices and the detention in the tank, the amount of water spilled from that tank can be determined.

This amount of spilled water will be flowing into the next tank in the cascade, so that it receives water from its own catchment as well as from the spills of above tank / tanks. In this tank also, the excess fof water after all the above mentioned outflows will be spilled into the next tank in the cascade. Similar process happens from tank to tank until water flows finally to Mahakanadarawa tank.

This calculation can be done easily for a small number of tanks using hand calculation. But the problem arises because of we are having about 218 minor tanks in the catchment. This is very difficult to do with out using a computer. Therefore a method had to be deviced which can be used in a computer analysis.

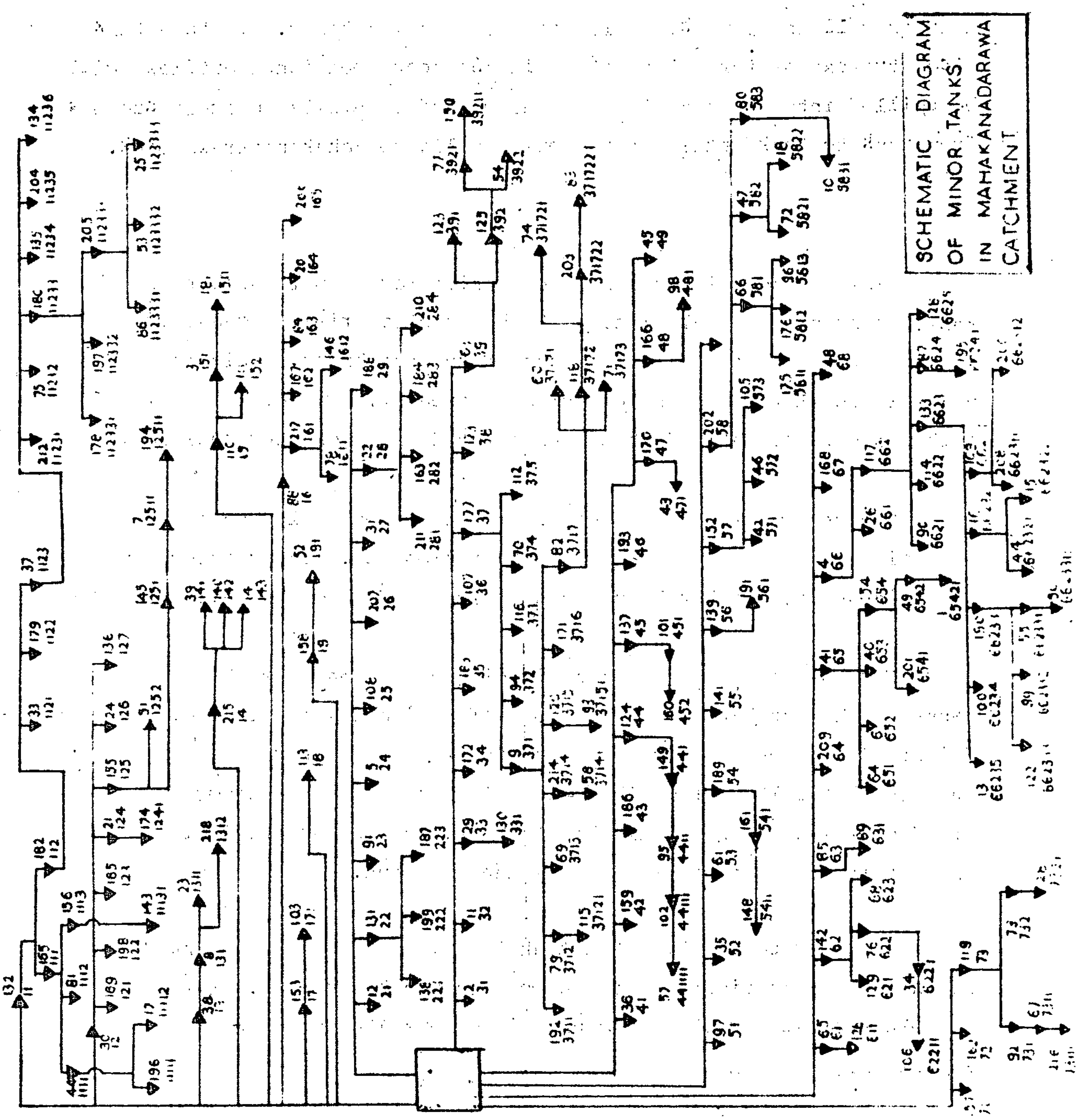
Necessary data of each minor tank has been collected to determine the inflow, detension, evaporation etc. The sequence of drainage from tank to tank should also be fed to the computer.

For this purpose, a schematic diagram of the network of minor tanks in the catchment showing order of drainage was prepared. (Figure 4 on page 45) The top numbers are given according to the alphabetical order of the manes of tanks, for the purpose of identifying a tank easily by its name. Bottom number indicates the way in which water flows from tank to tank.

In order to identify the tank to which a particular tank drains; the last figure of the number should be removed. For example tank 1241 will be draining into tank 124 and then to 12 and finally to Mahakanadarawa tank.

This numbering system can be easily used to inform the computer the way in which drainage takes place.

In this analysis, the computer analysis will not be done because of the lack of time and the difficulty of obtaining computer facilities for undergraduate students.


SCHEMATIC DIAGRAM
OF MINOR TANKS
IN MAHAKANADARAWA
CATCHMENT

An indepth analysis will be carried out to estimate the effects of rehabilitated minor tanks in the catchment area, as a post graduate project of this university, under supervision of Dr.Kariyawasam. The simulation study will estimate the change in the yield that has taken place since 1960.

Simplified Analysis :

The scope of this analysis is to determine the acrage that can be cultivated when different percentages of minor tanks are working tanks.

The analysis is done as an average for thirty years. Since there are two cultivating seasons Yala and Maha (Yala from February to July inclusive and Maha from August to January inclusive), analysis will be done for Yala and Maha seasons separately.

Firstly, for each raingauge station, seasonal rainfall contributing runoff is determined as an average for thirty years, for both Yala and Maha seasons.

[illegible]sibilities of the number of working tanks are considered.

(1) With no working tanks in the catchment.
(2) With 20% of the tanks are working
(3) With 40% of the tanks are working
(4) With 60% of the tanks are working
(5) With 80% of the tanks are working

In each of the above cases, the inflow to Mahakanadarawa was calculated for the two seasons Yala and Maha separately.
It was assumed here for simplicity that the precipitation falling on a catchment of a minor tank is completely retained and will not be spilled. This assumption had to be done to avoid a complex computer analysis.

Selection of different percentages of tanks were done by generating random numbers.

Tanks selected randomely for 20% rehabilitation

Tanks within each region of the Thisson polygon are shown separately.

Kahatagasdigiliya

Tank No.	Catch. Area
2	0.30
12	0.15
25	0.55
29	0.30
53	0.36
58	0.75
64	0.70
74	0.03
91	1.00
108	0.50
112	0.30
118	0.60
129	0.40
135	1.00
147	0.25
163	0.80
177	2.00
192	0.50
213	0.50
	10.27

Mihintale

Tank No.	Catch Area
8	1.10
31	1.00
39	0.10
47	0.91
67	0.37
84	0.30
96	0.25
141	0.70
159	0.21
161	0.60
173	0.20
188	1.10
199	1.10
202	0.93
206	0.30
215	2.90
	12.37

Huruluwewa

Tank No.	Catch Area
15	0.30
49	1.25
90	1.10
109	0.50
127	0.40
133	3.00
151	0.40
190	1.30
	8.25

Nachchaduwa

Tank No.	Catch. Area
72	0.30

Tanks selected randomely for 40% rehabilitation

Kahatagasdigiliya

Tank No:	Catch area
2	0.30
6	0.22
9	1.50
25	0.55
33	1.00
34	0.60
37	1.00
51	0.10
58	0.75
64	0.80
70	0.20
71	0.10
79	0.10
81	0.10
86	0.15
91	1.00
94	0.80
108	0.50
316	0.60
120	1.30
132	1.75
136	0.60
147	0.25
155	1.00
164	1.00

Kahatagasdigiliya

Tank No.	Catch. area
165	1.10
180	1.75
183	0.70
184	0.65
196	0.30
197	0.50
198	0.50
203	0.60
205	0.30
212	0.25
	22.82

Huruluwewa

Tank No.	Catch area
4	0.70
15	0.30
42	0.25
44	0.25
49	1.25
50	0.45
55	0.30
85	0.52
100	0.91
105	0.10
114	0.21

Huruluwewa

Tank No.	Catch area
122	0.52
127	0.40
154	2.59
190	4.30
	10.05

Nachchaduwa

Tank No.	Catch area
102	0.41

Mihintale

Tank No.	Catch area
1818	0.50
20	0.25
22	0.90
23	0.40
28	0.54
39	0.10
65	0.41
73	1.24
78	1.70
88	0.40
96	0.25
103	0.20

Tanks selected for 40% rehabilitation.

Mihintale

Tank No.	Catch Area	Tank No.	Catch. ARea
119	0.50	162	0.20
125	1.35	173	0.20
131	0.90	175	0.20
137	1.10	176	0.54
141	0.70	180	0.30
142	0.42	199	1.10
146	0.72	206	0.30
153	0.35	210	0.30
157	0.15	215	2.90
161	0.60	216	0.70
		218	0.45
			21.78

Tanks selected randomly for 60% rehabilitation

Tank No.	Catch area	Mihintale Tank No.	Catch area	Mihintale Tank No.	Catch area
Mihintale		84	0.30	152	150
8	1.10	88	0.40	157	0.15
10	0.20	92	0.91	161	0.60
14	1.05	96	0.25	162	0.20
18	0.50	103	0.20	167	0.30
20	0.25	110	0.80	170	0.74
23	0.40	111	1.00	175	0.41
28	0.54	113	0.29	181	0.20
31	1.00	123	0.40	186	0.40
36	0.50	124	0.67	187	0.30
39	0.10	125	1.35	188	0.30
45	0.30	131	0.90	189	0.30
65	0.41	137	1.10	191	0.30
66	1.10	140	1.00	199	1.10
67	0.37	142	0.42	207	0.75
73	1.24	148	1.20	210	0.30

Tank No.	Catch. area
Mihintale	
211	0.80
215	2.90
218	0.45
	31.56
Kahatagasdigiliya	
5	0.30
9	1.50
12	0.15
17	0.30
21	1.00
25	0.55
29	0.30
33	1.00
37	1.00
53	0.36
60	0.10
69	0.30
70	0.20
71	0.10
74	0.03
79	0.10
81	0.10
83	0.10
86	0.15
93	0.80
94	0.80
104	0.10
112	0.30
116	1.00
118	0.60
129	0.40
130	0.30
132	1.75

Tank No.	Catch area
Kahatagasdigiliya	
136	0.60
144	1.50
145	1.20
147	0.25
156	1.00
169	0.30
172	1.10
174	0.40
178	0.32
179	0.60
180	1.75
182	0.75
194	0.31
198	0.50
203	0.60
204	0.35
205	0.30
212	0.25
213	0.50
214	1.20
	27.17
Nachchaduwa	
54	0.53
57	0.50
72	0.30
77	0.30
101	0.71
102	0.41
150	1.10
160	1.52
	5.37

Tank No.	Catch area
Huruluwewa	
1	0.10
4	0.70
15	0.30
26	0.77
40	0.33
41	0.71
42	0.25
46	0.75
48	0.85
50	0.45
55	0.30
68	3.65
85	0.52
99	0.20
100	0.91
109	0.50
114	0.21
133	3.0
154	2.59
168	1.10
195	0,63
200	0.60
208	0.50
	19.42

TANKS SELECTED RANDOMBY FOR [illegible]% REHABILITATION

Tank No.	Catch area	Tank No.	Catch area	Tank No.	Catch area
Kahatagasdigiliya		Kahatagasdigiliya		Mihintale	
2	0.30	132	1.75	8	1.10
5	0.30	134	0.20	10	0.20
7	0.40	135	1.00	14	1.05
9	1.50	136	0.60	18	0.50
11	0.05	143	0.40	20	0.25
12	0.15	144	1.50	23	0.40
17	0.30	145	1.20	28	0.54
21	1.00	147	0.25	31	1.00
24	0.50	156	1.00	36	0.50
27	0.10	163	0.08	38	0.90
29	0.30	164	1.00	39	0.10
30	0.50	169	0.30	47	0.91
34	0.60	174	0.40	48	0.85
37	1.00	177	2.00	52	0.60
51	0.10	178	0.32	61	0.30
53	0.36	179	0.60	65	0.41
70	0.20	180	1.75	66	0.10
71	0.10	182	0.75	67	0.37
74	0.03	183	0.70	73	1.24
76	0.91	184	0.65	78	1.00
81	0.10	185	1.00	80	0.22
83	0.10	194	0.31	88	0.40
86	0.15	196	0.30	92	0.91
91	1.00	197	0.50	95	0.56
93	0.80	198	0.60	96	0.25
94	0.80	204	0.35	110	0.80
104	0.10	205	0.30	111	1.00
107	0.60	212	0.25	113	0.20
108	0.50	213	0.50	119	0.50
112	0.30	214	1.20	124	0.67
118	0.60			125	1.35
120	0.60		42.63	126	0.50
129	0.40				

Tank No.	Catch area	Tank No.	Catch area	Tank No.	Catch area
Mihintale		Huruluwewa		Nachchaduwa	
137	1.10	1	0.10	57	0.50
139	0.40	4	0.40	72	0.30
140	1.00	16	0.62	77	0.30
142	0.42	26	0.77	101	0.71
146	0.72	32	0.37	102	0.41
148	1.20	41	0.71	150	1.10
152	1.50	42	0.25	160	1.52
153	0.35	44	0.25		
159	0.21	46	0.75		4.84
161	0.60	49	1.25		
162	0.20	50	0.45		
167	0.30	56	0.32		
173	0.20	68	3.65		
176	0.54	85	0.52		
181	0.20	87	0.52		
186	0.40	89	0.80		
188	0.30	90	1.10		
190	1.30	99	0.20		
191	0.30	100	0.91		
193	0.40	106	0.31		
199	1.10	114	0.21		
202	0.93	117	0.50		
206	0.30	122	0.52		
211	0.80	127	0.40		
215	2.90	128	0.40		
216	0.70	133	0.30		
217	2.00	151	0.40		
	42.47	154	2.59		
		168	1.10		
		195	0.63		
		201	0.90		
		208	0.50		
		209	0.43		
			23.73		

CHAPTER 6

DETERMINATION OF YIELD

Determination of inflow to Mahakanadarawa tank

After analysing the rainfall data of four rain gauge stations, it was found that rainy season for Maha starts in September and continues till the end of December. For Yala season, rainy season commences in February and continues till the end of May. The four months mentioned above were used to compute the runoff.

Average monthly rainfall of each of the four rain gauge stations are as follows :

Table 9. Average monthly rainfall for Yala

Rain gauge station	Average rainfall for Yala (inches)			
	Feb.	March	April	May
Nachchaduwa	1.55	2.63	6.21	2.92
Kahatagasdigiliya	2.48	2.55	4.69	3.12
Mihintale	1.86	2.52	6.82	3.26
Huruluwewa	2.74	2.76	6.16	3.046

Maha

Rain gauge Station	Average monthly rain fall (inch)			
	Sep.	Oct.	Nov.	Dece.
Nachchduwa	2.152	9.75	9.147	9.880
Kahatagasdigiliya	2.780	6.979	8.708	12.270
Mihintale	3.485	9.530	10.300	9.870
Huruluwewa	2.92	[illegible]	11.50	12.390

Catchment area of Mahakanadarawa tank is divided into four regions by Theisson Polygon. Areas coming under each rain gauge station are as follows.

Rain gauge station	Area (Sq.Mls)
Mihintale	55.85
Nachchaduwa	3.57
Huruluwewa	18.81
Kahatagasdigiliya	47.973

$$\text{Inflow to the main tank} = \sum_{i=1}^{4} R_i \times A_i \times P$$

Where R_i = Average monthly rainfall of station i

A_i = Area coming under rain gauge station i

P = Percentage of rainfall contributing to runoff

The value of P varies from month to month. P is equalled to 10% 15%, 20%, and 21%, for the 1st, 2nd, 3rd and 4th month of rainy season respectively.

The above expression gives inflow to the Mahakanadarawa tank when there are no working tanks in the catchment. If there are working minor tanks in the catchment, to calculate yield to the main tank, the runoff intercepted by these minor tanks should be deducted. The runoff intercepted by minor tanks can be determined by computing the total catchment area of minor tanks in each region of the Thiesson Polygon. And average rain fall of the corresponding raingauge station.

In our analysis, we considered 0%, 20%,40%,60%, and 80% of rehabilitation of minor tanks in the catchment. The tanks selected in each case and their catchment area are in next few pages.

The total area of minor tanks inside the region of each rain gauge station are shown below.

Rain gauge station	% of rehabilitation			
	20%	40%	60%	80%
Mihintale	12.37	21.78	31.56	42.47
Kahatagasdigiliya	10.27	22.82	27.17	42.63
Huruluwewa	8.25	10.05	19.92	23.73
Nachchaduwa	0.30	0.41	5.37	4.84

The all areas mentioned above are in square miles.

Table 11 Yield of Mahakanadarawa in each month

Month	Yield in Acft				
	%	20%	40%	60%	80%
Aug.	0	0	0	0	0
Sep.	2083	1568	1178	722	236
Oct.	8548	6423	5922	2795	871
Nov.	13248	9894	7463	4289	1239
Dec.	15732	11781	8753	5211	1404
Jan.	0	0	0	0	0
Feb.	1493	1111	1123	485	121
Mar.	2595	1949	1462	851	243
April.	79[illegible]	5959	4521	2615	833
May.	4474	3372	2525	1517	466
June	0	0	0	0	0
July	0	0	0	0	0

From these results, total for each season can be found. Table 12 shows the total inflow to Mahakanadarawa in each season.

Table 12 Total inflow to Mahakanadarawa in Yala and Maha

Season	Inflow in Acft				
	0%	20%	40%	60%	80%
Yala	16497	12391	9631	5468	1663
Maha	39611	29666	23316	13017	3750

CHAPTER 7

Crop water Requirement

The crop water requirement or tank duty is determined as follows:

Farm water requirement (F.W.R.) = Water for land preparation

+ Evapo-transpiration + Farm losses

Effective rainfall (ER) = 0.67 (R-1) with a ceiling of ER [illegible] 9 inch

R = Monthly rainfall in inches

Field Irrigation Requirement (FIR) = FWR - ER

After FIR is determined, Tank duty (TD) can be computed assuming a coveyance loss in the channel. Normally, Conveyance loss in the channel = 30%

$$FIR = TD - 0.3\ TD$$

$$TD = 1.43 - FIR$$

Computation of TD for each season requires following data:

Evapo-transpiration :-

Evapo-transpiration for lowland paddy is obtained by multiplication of Evapo-transpiration of Reference crop (ETO) by the crop factors for that stage of growth.

In the computation of tank duty, we used ETO values which have been developed at Maha Illuppallama Agricultural Research Station.

Table 13

Evapo-transpiration rates of reference crop (in inches)

Month	Evapotranspiration (inch)
October	6.2
November	4.3
December	4.5
January	4.7
February	5.0
March	6.2
April	5.9
May	6.4
June	6.9
July	7.5
August	7.6
September	7.5

Table 14 Growth stages and crop factors

Crop		Growth stages			
		Initial	Development	Mid	Late
Low land paddy	Days	30	40	45	20
(135 days)	C.F	1.00	1.15	1.20	0.90
Lowland paddy	Days	20	30	30	25
(105 days)	C.F.	1.00	1.15	1.20	0.90

Water requirement for land preparation

For first 15 days, the water requirement for land preparation is taken as seven inches. This value is same for both yala and maha seasons.

Farm losses :

According to Irrigation Department Specification farm losses in Yala and Maha seasons are as follows.

Season	Farm loss/month
Maha	4.0 inches/month
Yala	6.0 2 "

Tank duty for Maha season

Let us consider lowland paddy of 135 days. The land preparation for Maha season starts on 15th October. Land preparation requirement = 7.0 inches

Stage	Period	Evapotranspiration
Initial stage	30 days starting from 1st Nov.	1.0 x 4.3 = 4.3 "
Development	40 days from 1st of December	$1.15\frac{(4.5+4.7)}{3}=6.97"$
Mid	45 days from 11th January	1.20(4.7x2/3+5/6X5.0) = 8.76"
Late	20 days from 16th February	0.90(5.0/6+6.2/2) = 3.54

Farm losses = 5 x 4.0 = 20"

FWR + =7.0 +(4.3+6.97+8.76+3.54) + 20 = 50.57 inches

The effective rainfall over the command area was calculated using rainfall data of Mihintale station hich is the closest station to the command area.

Determination of effective rainfall - Maha season

Month	average monthly Rainfall (inch)	Effective rainfall (inch)
October	9.53	½x(9.53-1)x0.67 = 2.86
November	10.30	0.67x(10.33-1) =6.23
December	9.87	0.67x(9.87-1) = 5.94
January	3.26	0.67x 3.26 , = 1.51
February	1.86	0.67x(1.86-1) = 0.57
March	2.52	½x0.67x(2.52-1) = 0.51
		17.62

FIR + = FWR-ER = 50.57 - 17.62 = 32.95 inches

Tank Duty $= \frac{1.43 \times 32.95}{12}$ ACft/Acre = 3.92 Acft/Acre

Tank duty for Yala season :

Let us consider lowland paddy of 105 days to be the main crop. Also assume land preparation for Yala season to be started by 1st April.

Water requirement for first 15 days of land preparation = [illegible].0 inches

Stage	period	Evapotranspiration
Initial	20 days from 15th April	1.0x(5.9x½ =6.4xi/6) = 4.02 inch
Development	30 days from 6th May	1.15(5/6 x 6.4 +1/6x6.9) = 7.46 inch
Mid	30 days from 6th June	1.20 (5/6x6.9+1/6x7.5) = 8.40 inch
Late	25 days from 6th July	0.90 (5/6x7.5) = 5.625 inch
		25.505 inches

Farm losses = 4 x 6.0 = 24 inches

FWR = 7.0 + 25.505 + 24.0 = 56.505 inches

Effective reinfall during Yala season

Month	Average monthly rainfall (inch)	Effective rainfall (inches)
April	6.82	0.67(6.82-1) = 3.89
May	3.26	0.67(3.26-1) = 1.51
June	0.25	0
July	1.60	0.67(1/60-1) = 0.582
		5.982 inches

FIR = FWR - ER

= 56.505 - 5.982 = 50.52 inches

Tank duty = $\frac{1.43}{12}$ x 50.52 Acft / acre = 6.02 Acft / Acre

In a similar way, computing field water requirement (FWR) and effective rainfall (ER), field water irrigation requirement (FIR) can be calculated for every month of the year.

Table 15 Field water requirement for command area in each month of the year.

Month	Average rainfall (inches)	Effective rainfall (inches)	F.W.R. (inches)	Tank Duty Acft/Acre
August	1.80	0.54	0	0
September	3.485	1.66	0	0
October	9.53	5.71	14.10	0.9575
November	10.30	6.23	8.62	0.285
December	9.87	5.94	9.21	0.389
January	3.265	1.52	9.64	0.9675
February	1.85	0.57	9.00	1.004
March	2.52	1.02	0	0
April	6.82	3.89	15.95	1.437
May	3.26	1.51	13.20	1.392
June	0.25	0	14.22	1.694
July	1.60	0.40	13.125	1.516

In the above table, tank duty is obtained by

$$\text{Tank duty} = \frac{1.43 \times (\text{F.W.R.} - \text{E.R.})}{12} \quad \text{/Acre}$$

Where both F.W.R. and ER are in inches

CHAPTER 8

RESULTS

Variation of tank storage during the year and cultivable area in each season

Using the tank duty for the month, evapotranspiration rates, area-capacity curve of Mahakanadarawa tank and average inflow during the month, the tank storage in each month is calculated. At the beginning of Maha season the water level in the tank is taken to be at still level of the sluice.

Change in storage = Inflow - tank issue - evaporation

Evaporation for the month is calculated using evaporation rates of Nachchaduwa station. And water spread area of the tank at the beginning of the month.

Tank issue is determined by multiplying tank duty by cultivable area for the season. Here, optimum cultivable area is used so that active storage of the tank during the season is positive. The maximum area is taken as the cultivable area for the season.

The above computation was followed for all the percentages of rehabilitation of minor tanks. For each percentage graphs of tank storage vs time was plotted. Using the cultivable area for each percentage, the graphs of cultivated area vs percentage of rehabilitation were drawn separately for Yala and Maha.

Evaporation rates for the Nachchaduwa station are shown below

Table 16 Evaporation rates (inches)

Month	Evaporation
October	4.42
November	3.52
December	3.76
January	3.88
February	4.32
March	5.86
April	4.89
May	5.05
June	5.33
July	5.36
August	5.86
September	5.76

Variation of tank storage with time

(1) 0% of rehabilitation of minor tanks

Sill level of the tank sluice = 293.12 ft

Dead storage = 2500 acres

Assumed areas that can be cultivated in

Maha season = 8000 acres

Yala season = 3250 acres

Month	Yield (Acft)	Water area (Acres)	Evapo-ration (Acft)	Tank issue	Storage (Acft)
Aug.	0	500	293	0	-293
Sep.	2083	500	240	0	1550
Oct.	8548	820	302	7998	1798
Nov.	13248	860	252	7278	12516
Dec.	15732	2060	645	3177	24486
Jan,	0	2750	889	7741	15856
Feb.	1493	2300	723	8037	8484
Mar.	2595	1580	771	0	10306
April.	7935	1830	741	4670	12830
May	4474	2070	871	4526	11907
June	0	1800	866	5506	5535
July	0	1300	581	4926	28

20% rehabilitation of minor tanks

Assumed areas that can be cultivated in

Maha season = 700(acres

Yala season = 1850 acres

Month	Yield (Acft)	Water area (Acres)	Evapo-ration (Acft)	Tank issue (acft)	Storage (Acft)
Aug.	0	600	293	0	-293
Sep.	1568	500	240	0	1035
Oct.	6423	720	265	6994	199
Nov.	9894	600	176	1995	7922
Dec.	11781	1580	495	2724	16484
Jan.	0	2430	782	6773	8729
Feb.	1111	1700	612	7029	2199
March	1949	900	439	0	3709
April	5959	1100	448	2587	6633
May	3372	1420	597	2506	6902
June	0	1500	666	3049	3187
July	0	1020	456	2728	3

40% rehabilitation of minor tanks in the catchment

Assumed areas that can be cultivated in

Maha Season = 6000 acres
Yala season = 1100 acres

Month	Yield (Acft)	Water Area (Acres)	Evapo-ration (Acft)	Tank issue (Acft)	Storage (Acft)
Aug.	0	600	293	0	- 293
Sep.	11[illegible]	500	240	0	1035
Oct.	5922	680	250	5995	322
Nov.	7463	620	182	1710	5893
Dece.	8753	1360	426	2335	11885
Jan.	0	1960	636	5805	5447
Feb.	1123	1310	472	6025	73
Mar.	1462	600	293	0	1242
Apr.	4521	620	253	1583	3928
May	2525	1100	462	1531	4460
June	0	12.0	530	1863	2069
July	0	900	400	1665	2

60% rehabilitation of minor tank

Assumed areas that can be cultivated in

Maha season = 2500 acres

Yala season = 830 acres

Month	Yield (acft)	Water area (Acres)	Evapo-ration (Acft)	Tank issue (Acft)	Storage (Acft)
Aug.	0	600	293	0	- 293
Sep.	1568	500	240	0	1035
Oct.	6423	720	265	6994	199
Nov.	9894	600	176	1995	7922
Dec.	11781	1580	495	2724	16484
Jan.	0	2420	782	6773	8729
Feb.	1111	1700	612	7029	2199
March	1949	900	439	0	3709
April	5959	1100	448	2587	6633
May	3372	1420	597	2506	6902
June	0	1500	666	3049	3187
July	0	1020	456	2828	03

80% rehabilitation of minor tanks

Assumed areas that can be cultivated in

Maha season = 500 acres

Yala season = 225 acres

Month	Yield (Acft)	Water area (Acres)	Evapo-ration (Acft)	Tank issue (Acft)	Storage (Acft)
Aug.	0	600	293	0	- 293
Sep.	236	500	240	0	- 297
Oct.	871	500	184		390
Nov.	1239	600	161	5[illegible]0	928
Dec.	1404	660	207	173	1952
Jan.	0	800	258	502	1694
Feb.	121	760	274	561	1541
March	233	750	366	546	1418
April	833	740	302	303	1626
May	466	800	337	313	1442
June	0	760	338	381	723
July	0	600	268	341	114

VARIATION OF TANK STORAGE DURING THE YEAR

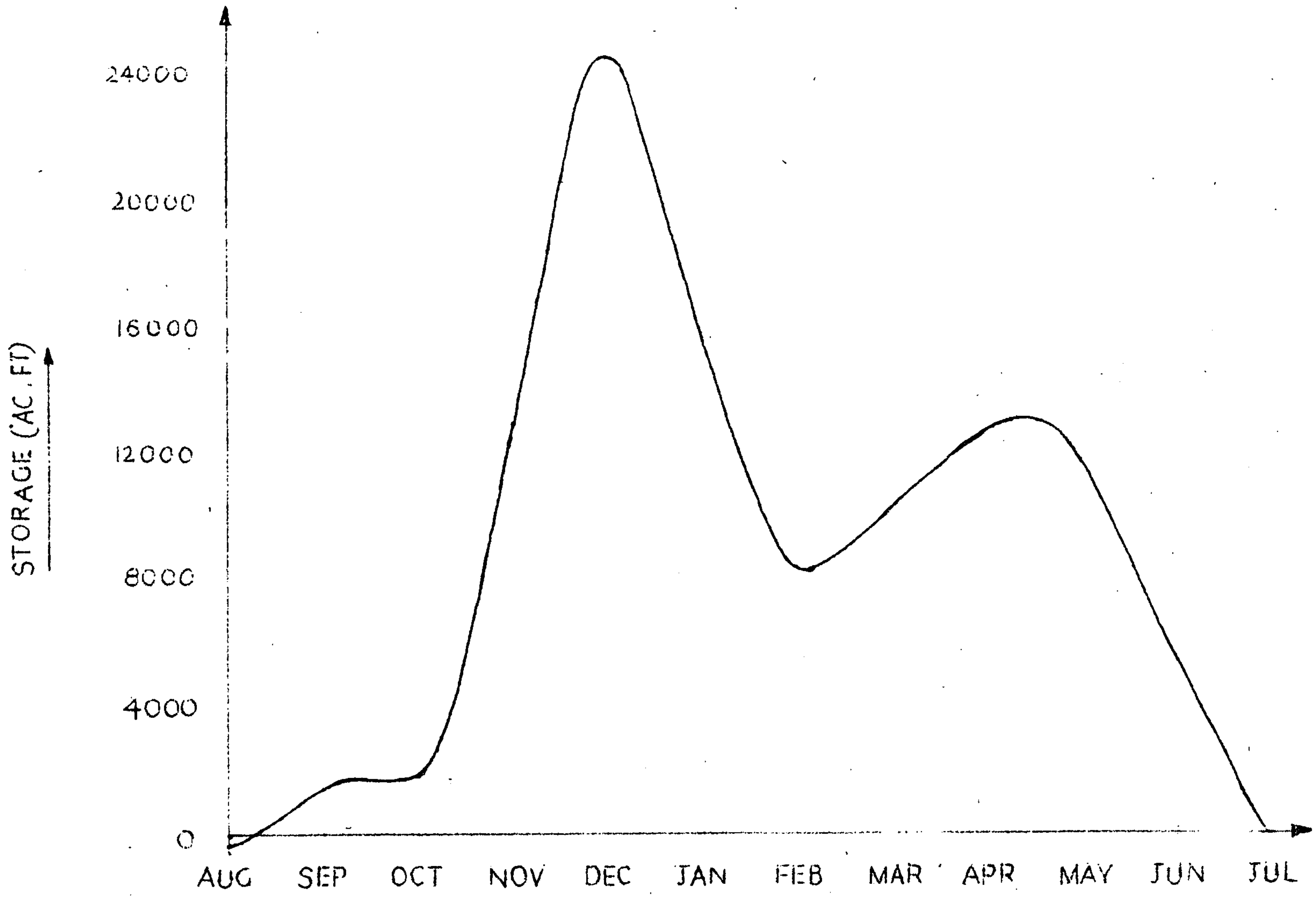


FIG 5A: WITH NO MINOR TANKS

VARIATION OF TANK STORAGE DURING THE YEAR

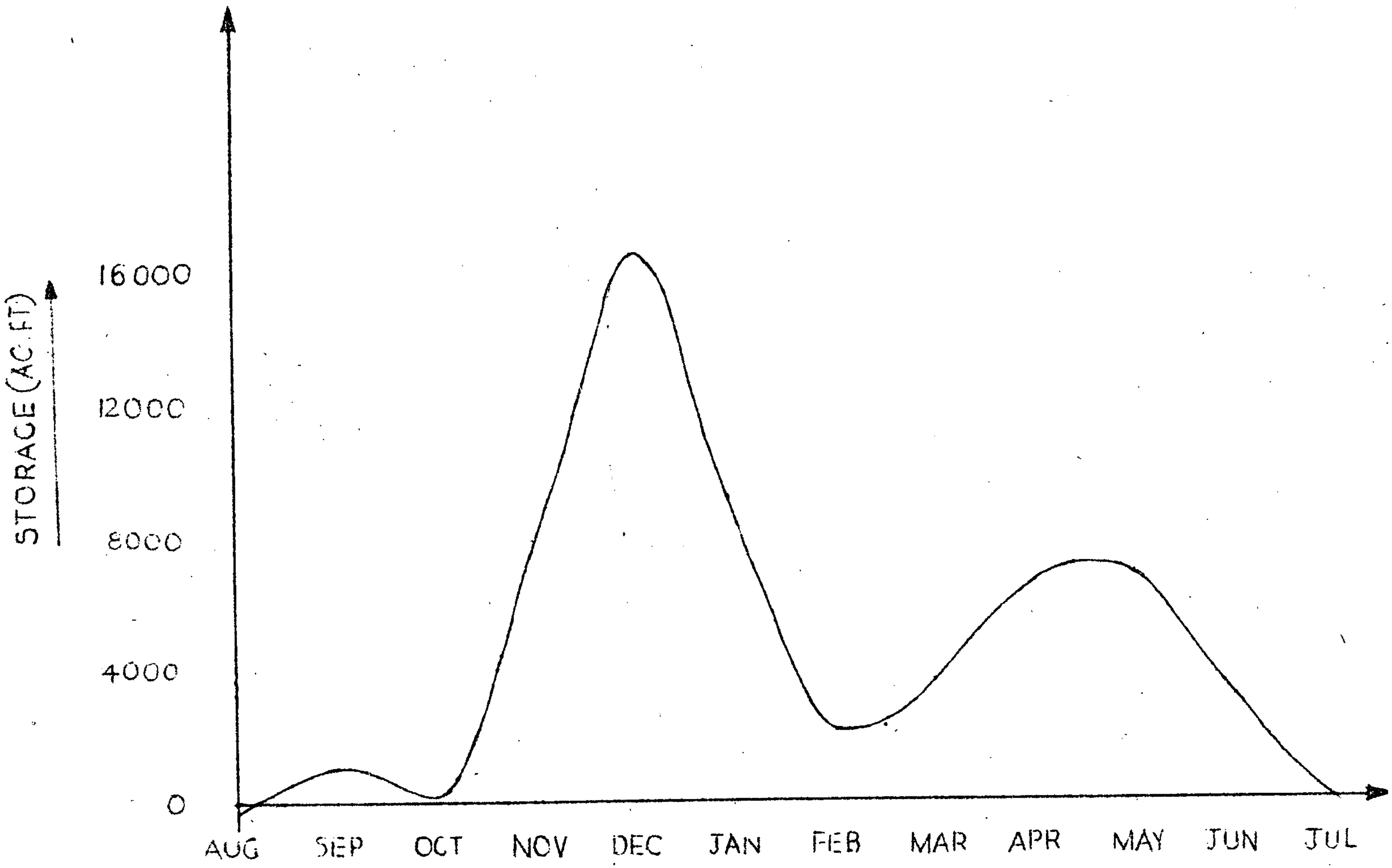


FIG 5B: WITH 20% MINOR TANKS

VARIATION OF TANK STORAGE DURING THE YEAR

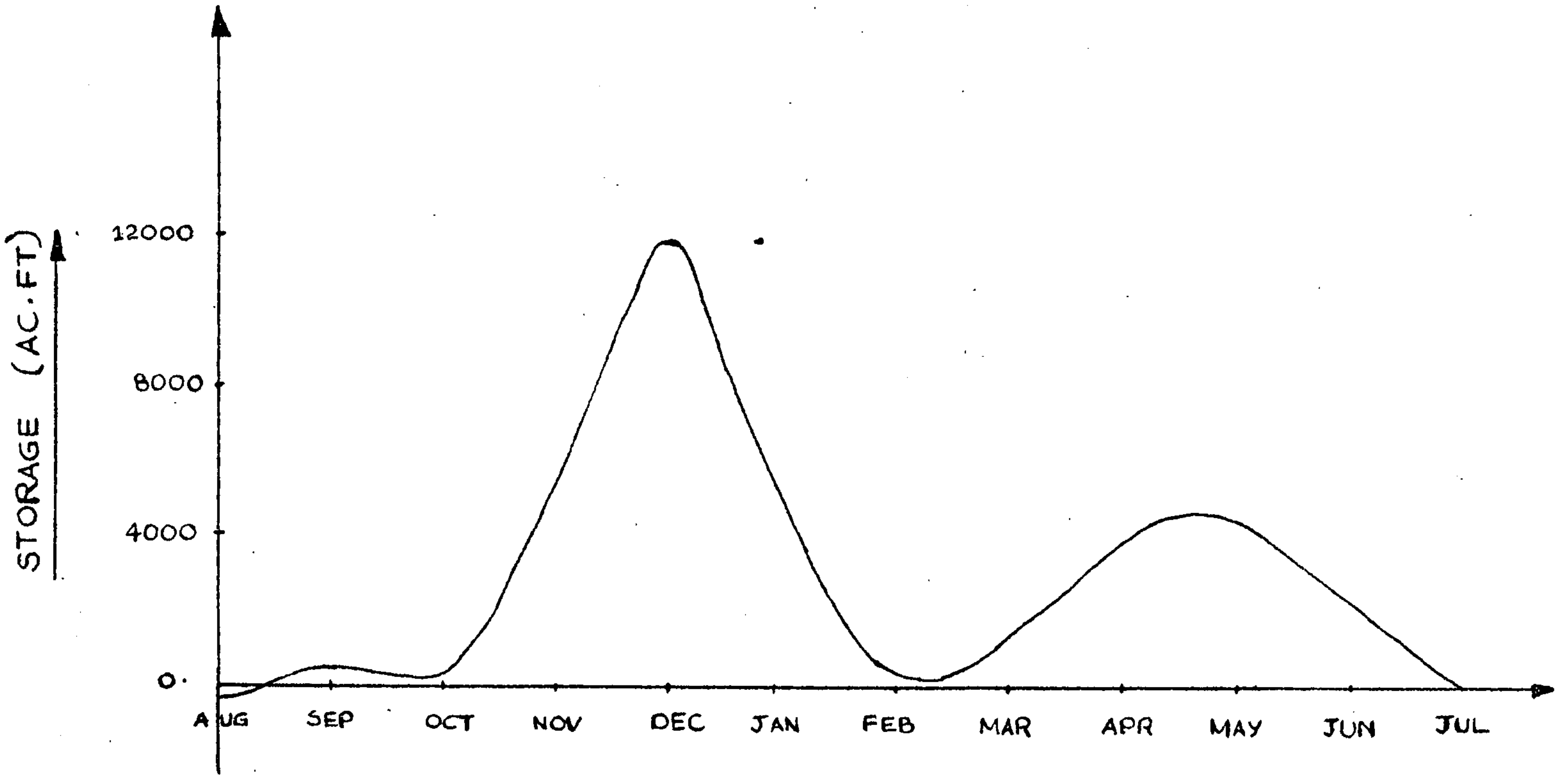


FIG 5C : WITH 40% MINOR TANKS

VARIATION OF TANK STORAGE DURING THE YEAR

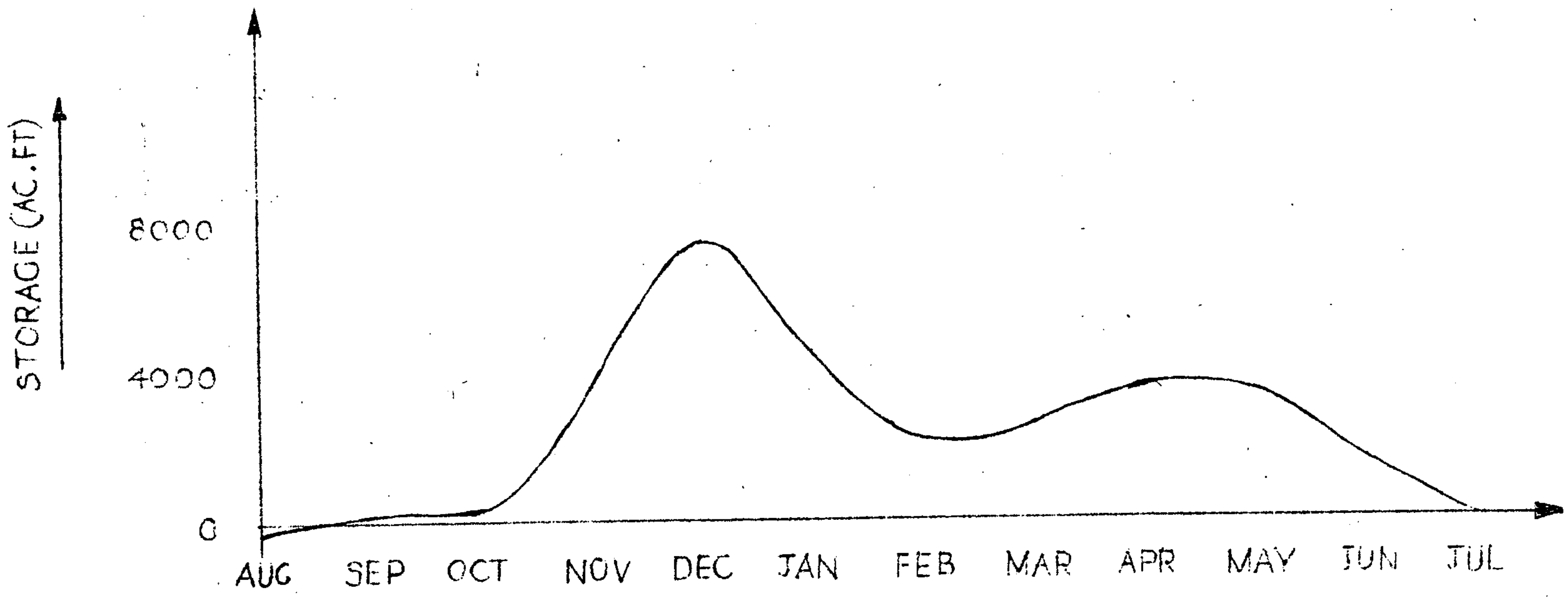


FIG 5D: WITH 60% MINOR TANKS

VARIATION OF TANK STORAGE DURING THE YEAR

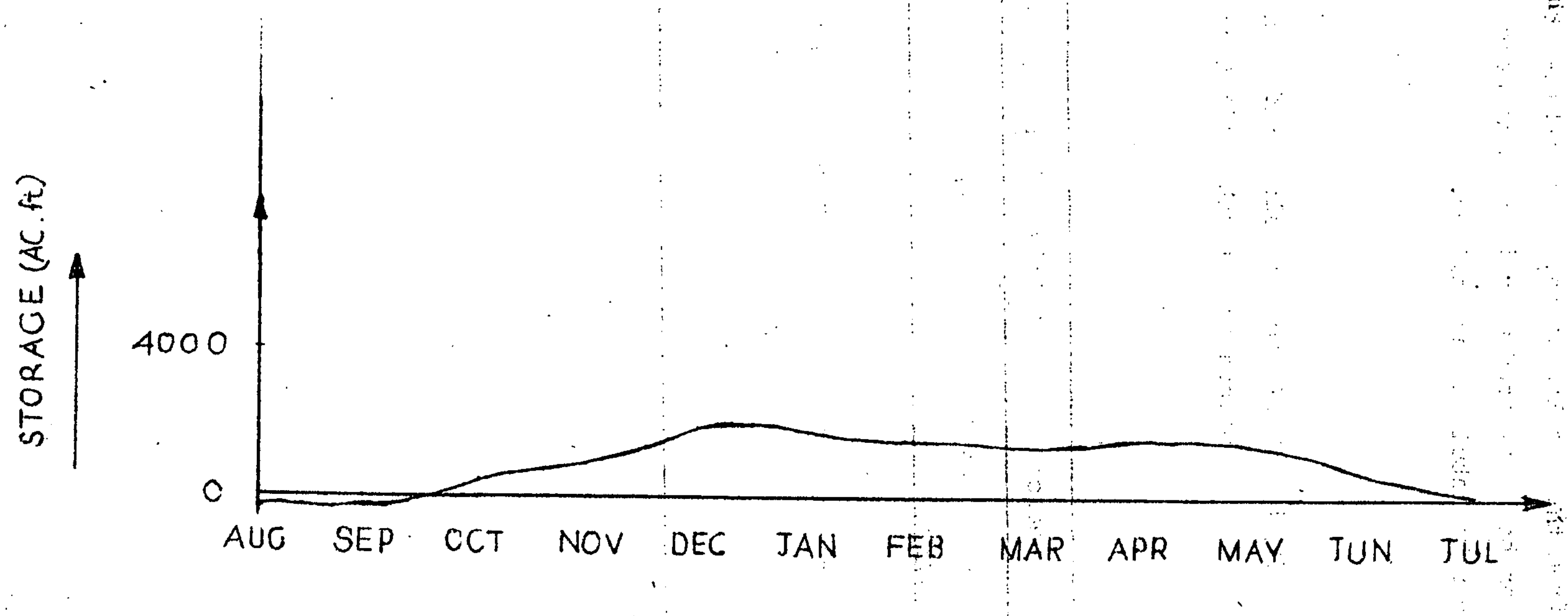


FIG 5E : WITH 80% MINOR TANKS

From the results of the above tables, the variation of area that can be cultivated with increasing percentage of rehabilitation, can be tabulated as follows.

Table 18 Variation of Cultivated area with increasing percentage of rehabilitation of minor tanks.

Season	Cultivated area (acres)				
% of working tanks	0 %	20%	40%	60%	80%
Maha	8000	7000	6000	2500	
Yala	3250	[illegible]	100	830	

EFFECT OF REHABILITATION OF MINOR TANKS ON COMMAND AREA OF MAHAKANADARAWA TANK

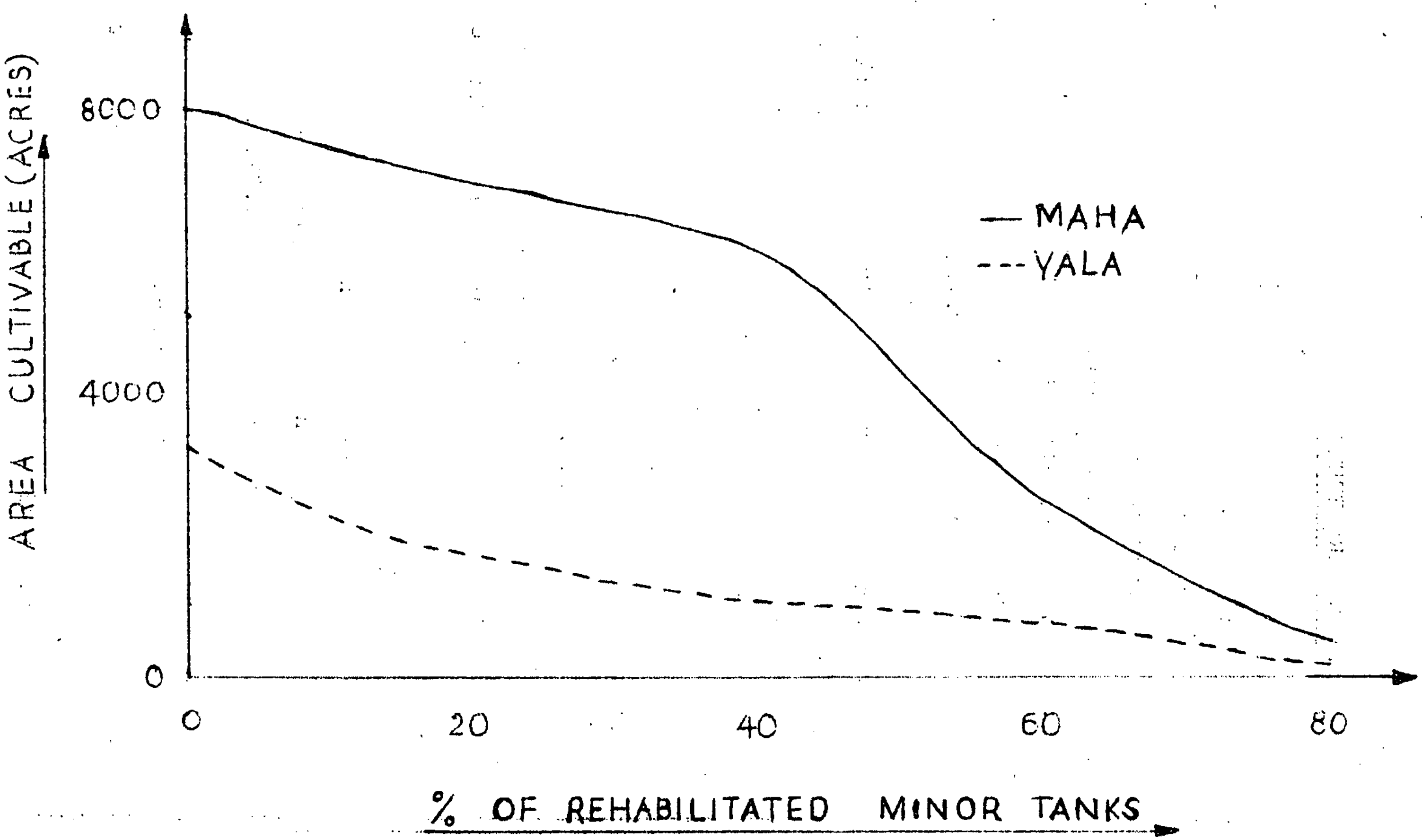


FIGURE 6

APPENDIX

TANK PARAMETERS

General :-

Location	:- F/5(0.20x2.10)
Catchment area	= 126 Sq.mls
Mean annual rainfall	= 62 inches
Lower quartile yield	= 50,000 Ac.ft
Irrigated area	= 8000 Acres
Area irrigated per Sq.mile of the catchment	= 47.6 Acres

Runoff ; 60000 cusecs 100 year peak flood
48000 cusecs 50 year peak flood

Tank ;

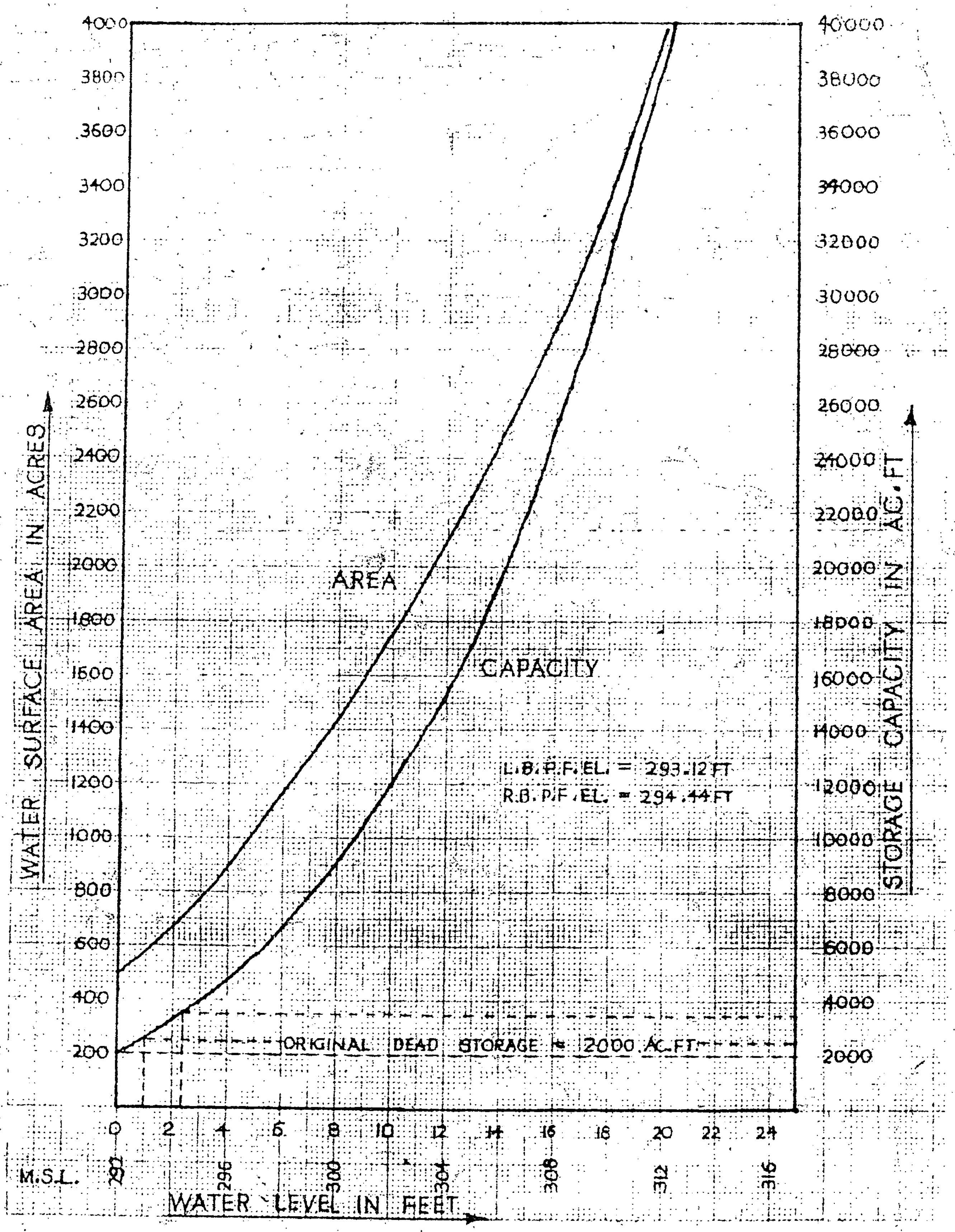
Capacity gross	= 32500 Ac.ft
Capacity Net	= 30250 Ac.ft
Area at FSL	= 3600 Acres
Area at HFL	= 4900 Acres
F.S. Level	= 311.0 M.S.L.
Present Capacity	= 36250 Ac.ft

For Area - Capacity curves, refer Appendix

Bund :-

Nature - Earthen
Length = 2 miles 1700 ft
Bund top level = 321.0M.S.L
Top width = 20 ft
Sides slopes : 1 on 3 upstream
1 on 2½ down stream

No. of sluices = 2
Depth at sluices = 19 ft



ELEVATION - CAPACITY AND AREA CURVES OF MAHAKANADARAWA TANK