WORKING PAPER 58

Developing Effective Institutions for Water Resources Management: A Case Study in the Deduru Oya Basin, Sri Lanka

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International Water Management Institute

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IWMI receives its principal funding from 58 governments, private foundations, and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR). Support is also given by the Governments of Ghana, Pakistan, South Africa, Sri Lanka and Thailand.

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Somaratne, P. G.; Jinapala, K.; Perera, L. R.; Ariyaratne, B. R.; Bandaragaoda, D. J.; Makin, I. 2003. *Developing effective institutions for water resources management: A case study in the Deduru Oya Basin, Sri Lanka*. Colombo, Sri Lanka: International Water Management Institute.

/ river basins / water resource management / irrigation systems / groundwater / water resources development / farming / agricultural development / rivers / fish farming / irrigation programs / poverty / irrigated farming / water shortage / pumps / ecology / reservoirs / water distribution / institutions / environment / natural resources / water supply / drought / land use / water scarcity / cropping systems / agricultural production / Indonesia / the Philippines / Nepal / China / Sri Lanka /

ISBN: 92-9090-5190

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Contents

Tables

Figures

Summary

This report is based on a research project financed by the Asian Development Bank (ADB) to conduct a regional study for the development of effective water management institutions (ADB-RETA no 5812). Research activities were conducted in five river basins in Indonesia, the Philippines, Nepal, China and Sri Lanka for a period of three years commencing from 1999. The river basin studied in Sri Lanka was the Deduru Oya river basin in the North Western Province of the country. This report contains the findings of the Deduru Oya basin study.

The overall objective of the case study conducted in Sri Lanka was to help the government of Sri Lanka to improve the institutions managing scarce water resources within the frame work of integrated water resources management. This case study included a comprehensive assessment of the existing physical, socio-economic and institutional environment in the river basin and also the long term changes that are likely to take place. The assessment was based on the following studies and aspects of the river basin:

- The physical characteristics of the river basin, including main features of land and water resources available, and an inventory of all infrastructures related to water management within the basin.

- The water accounting in the river basin in order to obtain a somewhat accurate assessment of the use of water resources, including past trends and the present water availability and its allocation among different water use sectors.

- Socio-economic and institutional analyses to understand the background of the different water users and the established groups, existing laws, policies and management organizations related to water management within the basin. This analysis was made with the participation of different stakeholders in order to identify the main problems, issues and prospects from the stakeholders' perspective.

- The performance assessment of irrigation systems within the river basin, to identify possible areas of performance improvement in the context of growing competition among different users for water resources in the basin.

The case study was carried out in two phases; diagnostic phase (Phase I), and action initiation phase for implementing institutional changes (Phase II). The different chapters of this report would provide information that help understand how the process of institutional change was initiated through this study. The steps followed in this process included:

Step 1 Data and information collection with the active participation of the stakeholders to identify the problems and causes.
Step 2 Making joint efforts to identify the shortcomings of existing institutions in solving current problems and the problems that are likely to emerge in the future.
Step 3 Developing proposals to fill such shortcomings in existing Institutions.
Step 4 Initiation of the process for institutional change (Researchers as facilitators, and stakeholders as implementers of change).

The action phase of this research project was supposed to be carried out jointly in collaboration with another project (Water Resources Secretariat – WRS) initiated with ADB financial assistance for improving the water resources management policy in the country. Since there was a delay in implementing the activities of WRS in the Deduru Oya basin (which had been selected as a pilot river basin for testing the institutional innovation of WRS) the IWMI researchers were compelled to initiate the action phase with the stakeholders of the basin. As a result of action initiation, the awareness of the stakeholders in the Deduru Oya basin on the importance of integrated water resources management and the need for institutional changes has significantly increased. This situation would definitely help WRS in implementing the proposed institutional changes in the basin.

Chapter 1

Introduction

This report is based on a research project financed by the Asian Development Bank (ADB) to conduct a regional study for the development of effective water management institutions (ADB-RETA No 5812). Research activities were conducted in five river basins: in Indonesia, the Philippines, Nepal, China and Sri Lanka, for a period of three years commencing from 1999. The river basin studied in Sri Lanka was the Deduru Oya river basin in the North Western Province of the country and the study comprised two phases: Phase I, a diagnostic phase to identify water resource management problems, and Phase II, to prepare an action plan for implementing interventions to address problems and help establish appropriate institutions for integrated water resources management. The diagnostic phase of the study was completed by the end of the year 2000, after which an action plan was prepared with stakeholder participation. The action phase of the project had been planned to be implemented with the proposed pilot project by the Water Resources Secretariat (WRS), the institution formed by the government with ADB assistance to initiate reforms in the water sector through appropriate policy and other institutional changes. As there were delays in implementing the pilot project by the WRS, the activities during action phase were limited to awareness creation among stakeholders on aspects such as integrated water resources management and the need for policy and other institutional reforms in the country for water resources management.

Objectives

The overall objective of the case study conducted in Sri Lanka was to help the government improve the institutions for managing scarce water resources within the frame work of integrated water resources management. For this purpose a comprehensive assessment was undertaken of the existing physical, socio-economic and institutional environment, and the long term changes likely to take place in the basin. The specific studies conducted in this assessment included:

- The physical characteristics of the river basin, including the main features of land and water resources available, and an inventory of irrigation systems in the basin.

- The water accounting in the river basin in order to obtain a more accurate assessment of the use of water resources, including past trends and the present situation of water availability and its allocation for main uses.

- Socio-economic and institutional analyses to understand the economic conditions and livelihood systems of different water users, and existing institutions for managing land and water resources in the basin.

- The performance assessment of irrigation systems within the river basin, to identify possible areas of performance improvement in the context of growing competition among different users for water resources in the basin.

Methodology

Different approaches, methods and techniques were adopted in data collection for the different studies referred to above. As a strategy for data collection and awareness creation on the existing situation related to water resources management and initiating actions for integrated water resources management, the study was conducted in close collaboration with the government institutions and organizations. For this purpose steering committees were established at National and Provincial levels and also support was sought from the Divisional Secretaries (DSs) of the respective DS divisions and the Divisional Officers (DOs) of the Agrarian Services Centers (ASCs) in the basin. The Deduru Oya basin was selected for the study on the suggestion made by the members of the National Steering Committee (NSC).

The methods adopted in data collection for the research included the following:

- The review of existing data and information on physical, socio-economic and institutional environment in the basin.

- Interviewing of key informants from water management institutions and organizations, and also resource users, on aspects related to water resource development and management. The interviews were mainly on socio-economic and institutional aspects, the performance of irrigation systems, and problems being encountered in water resources management.

- Stakeholder consultation through Focus Group Discussions (FGDs), with the officers of agencies managing water resources and beneficiary communities. (Separate group discussions with the agencies and community members were held initially and later, joint meetings were held). The purpose of these meetings during Phase I (Diagnostic Phase) was the further validation of data and information collected through interviews and other data collection methods. During Phase II, they were used for the joint analysis of problems and developing strategies and action plans for problem solving.

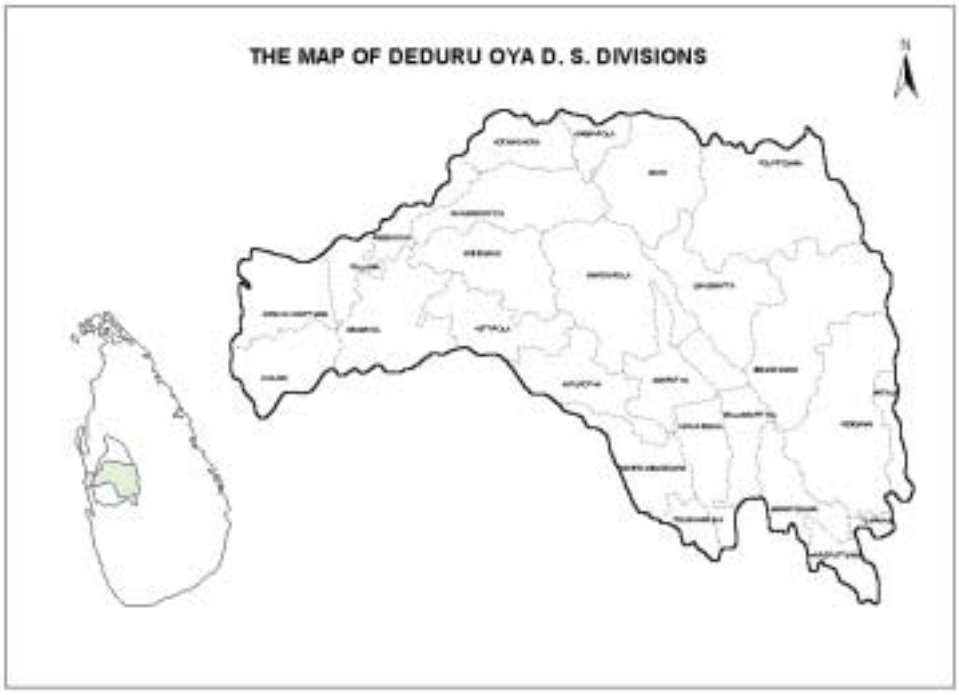
Sample Selection

There are a number of different administrative units such as the province, the district, the Divisional Secretary division and the Grama Niladari division useable as data collection units for the study. It was required to consider these as units for data collection as the secondary data and information were available at the offices of these administrative units. DS divisions were found to be appropriate for data collection, mainly because these units were manageable and they represented different agro-ecological zones in the basin. Also, there were offices of different line agencies at DS level that maintained data and information on resource use and utilization, population, and institutions related to water and other natural resources. On the other hand Divisional Secretary

is the officer who coordinates land and water resource development and management activities in the basin. On this basis it was hypothesized that the Divisional Secretary with delegated power and authority over land and other natural resources management would be the ideal person to act as the coordinator for improving the institutions for better management of water resources in the basin. The geographical spread of DS divisions in the basin is shown in figure 1. As indicated in figure 1 and table 1 there are twenty-two DS divisions within the Deduru Oya basin. The total land area of some divisions and only a portion of others fall within the basin.

Out of the 22 divisions in the basin, basic data were collected from 20 DS divisions. Polgahawela and Pallama DS divisions were excluded as only 20 percent of these 2 DS divisions fall within the basin.

Figure 1. Geographical distribution of DS divisions in the Deduru Oya basin.



In selecting sample DS divisions for the study, two types of variance were considered:

- Agro-ecological differences (The basin falls within two climatic zones: intermediate and dry. The annual rainfall in the intermediate zone is about 1,700 mm and in the dry zone it is about 1,300 mm. The water availability for cultivation, the land use pattern, and the performance of agriculture are heavily dependent on the climatic conditions.), and

- Variance in water resources development and management. (These factors include irrigation development, land use pattern, use and utilization of resources such as sand in the river, clay on river banks and agricultural development and management in the coastal areas of the basin).

The number of sample DS divisions selected for collecting socio-economic data and holding interviews, with key actors of agencies, and the basis for such selection are shown in table 1.

After the completion of socio-economic data collection and the interviews, it was understood that three DS divisions could be excluded in conducting focus group discussions as their physical and socio-economic characteristics are similar to those in the adjacent divisions in which socio-economic data were collected. Therefore, out of the 9 DS divisions in table 1, only 6 divisions—Ibbagamuwa, Ganewatte, Wariyapola, Kobeigane, Bingiriya and Chilaw—were selected for focus group discussions.

Non-uniformity of the data obtained from different sources and gaps in the available data were major problems encountered in data collection. In many cases, the available data had not been updated to be useful in the analysis of historical changes in resource use and utilization. Since a census had not been carried out in the country after 1981, there was no trusted source to compare the available data with, for accuracy. Agencies collecting data lacked systematic data collection and processing procedures.

General Information on the Deduru Oya Basin

The Deduru Oya river originating from the eastern boarder of the central province is the main water source in the basin. It runs across Kurunegala and Puttalam districts and enters the sea at Chilaw. The total length of the main stream of the river is about 115 km and the river comprises 9 tributaries. The total land area falling under the basin is about 2,600 square km out of which 3 percent is in the Central Province (Kandy and Matale districts) and the rest is in the North Western Province: 88 percent in Kurunegala and 9 percent in Puttalam districts.

Rainfall is the only source of water for the Deduru Oya river basin. Water users in this basin benefit from direct rainfall, stream flow consisting of direct runoff, and base flow or groundwater discharge, surface water storage in reservoirs and groundwater storage. In an average year the basin area receives a monthly rainfall ranging from 108 mm to 280 mm from September to December. This period known as *maha* (wet) season is the main cultivation season in the country. The period from March to June is known as *yala* (dry) season and is characterized by low rainfall. The basin area falls under two climatic zones: wet and intermediate, and its subgroups as shown in figure 3. There is a significant variation in rainfall in these three zones. The upper watershed area of the basin in the wet zone generates runoff which flows into the lower portion of the basin.

Water resource development in the basin has been traditionally for agriculture; mainly paddy farming, from ancient times. At present, there are four major irrigation systems, several medium schemes and nearly about 3000 minor tank systems in the basin to provide irrigation for about 50,000 ha which is nearly 18 percent of the developed land area in the basin. The major irrigation systems are confined to the middle portion of the basin where river diversion schemes have been constructed. The medium size schemes and minor systems spread out throughout the basin. Groundwater development is widespread in the basin in recent years. There are about 2,500 agro-wells. Owing to water scarcity, farmers resort to pumping water directly from the river and tributaries too. This is the most recent development related to agricultural water use in the basin. There are about 2,000–2,500 such pumps used by farmers in each season depending on water availability.

The total population in the basin is 970,911. The special characteristic is the concentration of the population in the head and tail-end areas. In the head-end area the population is concentrated

Table 1. Characteristics of sample DS divisions selected from the Deduru Oya basin.

Division	Group	% in the basin	Location			Climate			Agriculture				Irrigation					Major Population		
			H	M	T	W	I	D	Pd	Ex	Co	Rb	An	St	Maj	Med	Min	Rural	Town	Urban
Ridigama	1	100	*				*		*	*	*	*	*	*		*	*	*		
Mawathagama	1	100	*				*		*	*	*		*				*	*		
Polgahawela	1	20	*				*		*		*		*				*	*		
Ibbagamuwa	2	100	*				*		*	*	*	*	*		*	*	*	*		
Mallawapitiya	2	100	*				*		*		*		*				*	*		
Weerambugedara	2	100	*				*		*		*		*				*	*		
Kurunegala	2	100	*				*		*		*		*			*	*			*
Ganewatte	3	100	*				*		*		*		*		*	*	*	*		
Maspotha	3	100	*				*		*		*		*				*	*		
Polpitigama	3	90	*				*		*		*		*				*	*		
Wariyapola	4	100					*		*	*	*		*				*	*		
Katupotha	4	70		*			*		*		*		*				*	*		
Maho	4	100		*			*		*		*		*				*	*		
Nikaweratiya	5	75		*				*	*		*		*		*		*	*		
Kobeigane	6	100		*				*	*		*		*				*	*		
Hettipola	6	100		*				*	*		*		*				*	*		
Kotawehera	6	100		*				*	*		*		*				*	*		
Bingiriya	7	80			*			*	*		*		*				*	*		
Rasnayakapura	7	100			*			*	*		*		*				*	*		
Pal lama	7	20			*			*	*		*		*				*	*		
Arachchikattuwa	8	50			*			*	*		*		*				*	*		
Chilaw	9	50			*			*	*		*		*			*	*			*

Note: Key to the table:

H = head, M = middle, T = tail
W = wet, I = intermediary, D = dry
Pd = paddy, Ex = export crops, Co = coconut, Rb = Rubber
An = anicuts, St = streams, Maj = major, Med = medium, Min = minor

in and around the Kurunegala town, the main city of the Kurunegala district. In the tail-end, the Chilaw town located in the coastal belt has a high population density. Except for the people in the areas in these two major towns, the majority of the rest of the people are rural communities living in villages or small peasant towns.

Agriculture is the main livelihood of the people in the basin. About 40-50 percent of the people in all the DS divisions in the basin are engaged in farming. Public and private sector employment accounts for 10–22 percent and 7–25 percent respectively in the DS divisions. The other main income-generating activities in the basin are trade, self-employment, fishing and animal husbandry. Fishing is a main livelihood activity of the people in the DS divisions like Arachchikattuwa and Chilaw, located in the coastal part of the basin. Coconut and paddy are the main crops cultivated in the basin. Paddy is cultivated both under irrigated and rain-fed conditions while coconut, the main highland crop, provides a regular cash income to the people.

More than 60 percent of the families in the basin belong to the absolute poverty group assisted by the government, under the poverty alleviation program known as "Samurdhi." About 80 percent of families in some suburban areas and dry-zone areas of the basin come under the absolute poverty group.

Organization of the Report

Followed by this brief introduction, Chapter 2, River Basin Profile, provides basic information on the physical, socio-economic and institutional environment of the basin. Chapter 3 discusses the socio-economic situation in detail while Chapter 4 provides information on institutional arrangement for water resource management in the basin specifically, and in the country in general. Chapter 5 deals with water accounting and irrigation system performance in the basin. The final Chapter analyses water resource management problems and issues, and makes recommendations for sustainable and efficient management of the water resources in the basin.

Chapter 2

River Basin Profile

Introduction

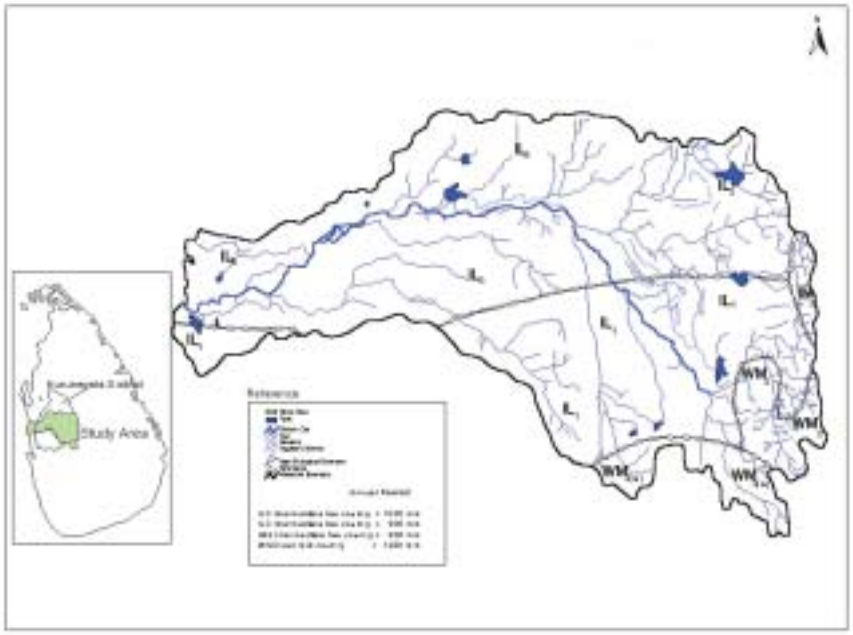
In this chapter, the general information on physical and socio-economic characteristics of the Deduru Oya river basin, and the institutions involved in the management of water resources are presented. Please see figure 2 (location of the basin in Sri Lanka), and figure 3 (agro-ecological map of the basin) for geographical and agro-ecological information. More detailed data and information on these aspects are found in the separate chapters on Water Accounting, Irrigation System Performance, Socio-economic Conditions and Water Resources Management Institutions.

Figure 2. Location of the Deduru Oya basin in Sri Lanka.

Physical System Characteristics

The components of the physical system described in this section include land and water resources and climatic conditions in the basin. The data on land use pattern highlights the different purposes for which the land in the basin is used and utilized. The information and data on water resources include both natural water resources (rainfall, surface water and groundwater resources) and man-made water storage infrastructures such as tanks, anicut systems and agro-wells.

Figure 3. Agro-ecological regions of the Deduru Oya basin.



Existing Natural Resources

Rainfall

As there are no trans-basin diversions to the Deduru Oya basin, rainfall is the only source of water. Average monthly rainfall in the basin presented in table 2 shows temporal variations of rainfall. High rainfall occurs in the basin area from March to April and September to December.

The occurrence of rainfall is not uniform throughout the basin. The data collected from rain-gauge stations (table 3) in different parts of the basin show that spatial variations of rainfall are very high within the basin.

Table 2. Average rainfall in the Deduru Oya basin.

Month	Average rainfall (mm)
January	66
February	65
March	72
April	217
May	159
June	87
July	81
August	56
September	108
October	268
November	283
December	146
Average (annual)	1,609

Table 3. Monthly long-term, average rainfall (mm).

Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wariyapola	122	89	72	212	135	112	113	85	127	288	308	236
Chilaw	39	49	94	232	193	69	70	25	92	277	260	125
Batalagoda	70	66	80	211	155	114	89	69	125	277	256	151
Hakwatuna Oya	66	63	19	218	178	36	81	86	107	210	314	175
Magalla	59	58	29	182	118	63	65	17	65	202	252	104
Kurunegala	59	73	124	262	211	160	112	85	156	359	334	132
Nikaweratiya	45	59	83	198	127	55	40	26	84	263	262	102

Note: Long term averages were calculated for Wariyapola and Chilaw based on data from 1950-1980, for Batalagoda on data from 1950-1999, for Hakwatuna on data from 1995-1999, for Magalla on data for 1996, and for Kurunegala and Nikaweratiya on data from 1971-1998.
Source: Department of Meteorology.

Temperature

Data on temperature for Kurunegala (table 4) show a slightly high temperature during the dry season falling between March and September.

Table 4. Monthly average temperature (°C) in Kurunegala.

Month	1990	1991	1992	1993
January	25.3	26.1	25.6	25.5
February	28.2	26.8	27.4	27.3
March	29.1	29.5	29.4	29.0
April	30.1	29.5	30.1	29.5
May	28.7	30.1	28.7	29.3
June	29.0	28.2	28.7	29.1
July	28.8	28.8	28.6	28.6
August	28.6	29.4	28.4	29.1
September	29.3	29.9	28.9	29.5
October	28.3	27.8	27.7	27.7
November	27.1	26.6	26.9	26.5
December	25.8	26.1	25.2	25.5

Rivers and streams

The Deduru Oya basin is the fourth largest river basin in Sri Lanka. The total river basin area has been estimated at 2622.5 sq. km by planimetering the basin map. The main river stream is 115 km long, starts bordering the Central Province (CP) and travels through the North Western Province (NWP) to discharge into the Chilaw lagoon. A very small area in the North Central Province (NCP)

also drains into the Deduru Oya. Details of the river branches and sub watershed areas are given in table 5 and figure 3.

The Deduru Oya is not a hydrologically closed system as illustrated by data on its long-term annual discharge of water at the river mouth in Chilaw (table 6).

Table 5. Basic features of the Deduru Oya.

Name of sub-watershed and no.	No. of meso-catchments	Drainage area (km^2)
Upper Deduru Oya (DE 1)	-	156.3
Delwita Oya (DE 2)	-	122.4
Batalagoda Kuda Oya (DE 3)	-	104.2
Melsiripura (DE 4)	-	93.9
Kimbulwana Oya (DE 5)	-	199.8
Hakwatuna Oya (DE 6)	1	179.8
Talagalla Oya (DE 7)	9	136.0
Mid Deduru Oya (DE 8)	15	216.2
Nabadewa Kuda Oya (DE 9)	8	116.4
Lower Deduru Oya (DE 10)	5	276.9
Kolamunu Oya (DE 11)	28	455.5
Rambukkan Oya (DE 12)	10	136.2
Magauru Oya (DE 13)	5	231.2
Wenuru – Wellawa (DE 14)	2	197.7
Deduru Oya (total)	14	2,622.5

Table 6. Deduru Oya run off (Deduru Oya long-term annual discharge at Chilaw).

Year	Discharge (MCM)	Year	Discharge (MCM)	Year	Discharge (MCM)
1951	NA	1961	1,035	1971	1,844
1952	792	1962	1,168	1972	2,014
1953	NA	1963	1,254	1973	795
1954	1611	1964	870	1974	796
1955	1563	1965	1,291	1975	741
1956	NA	1966	1,274	1976	969
1957	NA	1967	1,152	1977	1,620
1958	NA	1968	1,012	1978	966
1959	NA	1969	933	1979	NA
1960	NA	1970	1,545	1980	NA

Note: NA = Not calculated due to non-availability of relevant data.
Source: Long-term hydro meteorological data in Sri Lanka from the Department of Meteorology.

Groundwater

The western side of the basin, with a deep weathered profile and sandy soils, is capable of detaining a substantial amount of groundwater in the regolith. The north central part of the basin (i.e. Wariyapola, Nikaweratiya and Mahawa areas) has a comparatively thin regolith soil profile and less groundwater. A common feature is the poor quality in terms of salinity, hardness, fluoride and iron, due to the low circulation of groundwater.

Land use pattern

Table 7, Land use pattern in the Deduru Oya basin, illustrates that most of the lands are utilized for cultivation of coconut, highland crops, and paddy and settlement purposes. The forest area in the basin has been reduced to 3 percent of the total land area (including forest plantations) of the basin.

Table 7. Land use pattern in the Deduru Oya basin.

Land category	Usage	Extent (ha)	Land distribution
Developed lands		239,810	91%
	Build up lands	520	0.2%
	Homesteads	35,050	13.4%
	Tea lands	240	0.1%
	Rubber lands	4,680	1.8%
	Coconut lands	95,560	36.4%
	Mixed trees	1950	0.7%
	Paddy lands	48,655	18.6%
	Sparsely used croplands (chena and highlands)	50,500	19.3%
	Planted forests	2,655	1.0%
Undeveloped lands		22,440	9%
	Dense forest	4,225	1.6%
	Open forest	1,155	0.4%
	Scrub lands	4,035	1.5%
	Grasslands	55	0.02%
	Water bodies	11,410	4.4%
	Barren lands	1,420	0.5%
	Mangroves	90	0.03%
	Marshes	50	0.02%

Source: Land use maps, Survey Deparement, 1989.

Soil types

Table 8 provides information on soil types in the basin.

Table 8. Soil types in the basin.

Soil group	% of basin coverage	Average soil depth (m)	Available water (cm/m)
Alluvial soils	6.0	2.34	6
Old alluvial soils	8.0	2.68	8
Non calcic brown soils	36.0	1.32	11
Red yellow podzolic	38.0	0.89	15
Reddish brown latosolic	7.0	1.59	12
Reddish brown earth	2.0	0.82	14
Other soil complex	3.0	N/A	N/A

Source: Soil map of Sri Lanka, Survey Department, 1990.

Irrigation Systems

Major and medium systems (including major diversions)

There are four major and four medium irrigation schemes in different parts of the basin as indicated in table 9. Major schemes are confined to the middle part of the basin.

Table 9. Basic data on reservoirs (tanks) and diversions (anicuts).

Serial No.	Name of tank/anicut	Classification	Catchment area km^2
1	Batalagoda tank	Major reservoirs	12.9
2	Hakwatuna Oya tank	Major reservoirs	63.7
3	Kimbulwana Oya tank	Major reservoirs	98.4
4	Magalla wewa	Major reservoirs	54.4
5	Meddeketiya tank	Medium reservoirs	10.4
6	Wennoru wewa	Medium reservoirs	10.1
7	Hulugalla wewa	Medium reservoirs	NA
8	Karawita wewa	Medium reservoirs	NA

Note: NA = Data not available.
Source: Register of irrigation projects in Sri Lanka, Irrigation Department, 1975.

Minor irrigation systems (small tanks and diversions)

More than 3,000 minor irrigation schemes are scattered over the whole basin. Their distribution in sample DS divisions is illustrated in table 10. The density of these tank systems increases in the DS divisions Ibbagamuwa, Ganewatte, Wariyapola and Bingiriya, in the middle portion of the basin.

Table 10. Small tanks and diversions in the sample DS divisions in the basin.

DS division	Agrarian services center	Total No.	Command (ha)	No. of families	% of total families
Ridigama	Dodamgaslanda	35	123	1,409	-
	Karadagolla	18	319	1,315	-
	Ranbadagolla	49	341	2,995	26
Ibbagamuwa	Ibbagamuwa	83	1,364	1,903	-
	Melsiripura	102	542	1,880	20
Ganewatte	Ganewatte	40	332	973	-
	Kumbukgete	53	311	944	21
Wariyapola	Auleagama	192	1,236	3,830	-
	Wariyapola	193	1,595	3,571	42
Nikaweratiya	Nikaweratiya	124	74	3,231	-
	Divullagoda	105	583	2,332	57
Bingiriya	Bingiriya	150	1,143	3,318	-
	Tharana	95	627	2,194	41
Chilaw	Chilaw	17	486	534	10
Arachchikattuwa	Arachchikattuwa	36	-	1,013	10

Source: Agrarian service centers, Department of Agrarian Services.

Agricultural wells extracting groundwater

Data collected from the 20 DS divisions given in table 11 show that there are about 2453 agro-wells in the basin area. Data collected from sample 9 DS divisions illustrate the situation with regard to the agro-wells in the basin.

Table 11. Groundwater extraction (agricultural wells).

DS division	No. of Agro-wells	Cultivated extent (ha)
Kobeigane	275	80
Wariyapola	205	60
Nikaweratiya	106	25
Bingiriya	170	52
Chilaw	29	5
Ibbagamuwa	260	100
Ridigama	20	5
Ganewatte	110	15
Arachchikattuwa	170	32

Source: Agricultural Development Authority (Kurunegala)

Water pumps used for agricultural purposes

People in the basin pump river water for agricultural purposes as indicated in table 12 below. The number of people using pumps for irrigation shows an increase in the DS divisions (Ibbagamuwa, Ganewatte, Kobeigane, Nikaweratiya) in the middle of the river basin.

Table 12. Water pumps used for agricultural purposes.

DS division	Pump diameter (inch)	No. of pumps	Maha (ha)		Yala (ha)		No. of beneficiaries
			Paddy	OFC	Paddy	OFC	
Bingiriya	2	227	156	56	43	94	342
Bingiriya	3	1	2	0	1	1	1
Bingiriya	4	7	53	0	2	9	13
Bingiriya	6	2	41	0	21	21	102
Bingiriya	Tube well	3	7	0	0	2	3
Ganewatte	2	194	164	57	54	70	384
Ibbagamuwa	2	130		0	0	65	205
Kobeigane	2	776	346	75	32	575	869
Kobeigane	3	2	6	0	2	2	4
Kobeigane	6	2	24	0	4	28	70
Mawathagama	2	241	35	0	0	21	51
Polpitigama	2	787	81	261	7	431	880
Ridigama	2	160	113	4	45	61	185
Ridigama	4	1		0	2	6	6

Source: ECL field survey, 1999.

Socio-economic Characteristics

Population, its density and growth in the basin

Data related to population, population density and growth are presented in table 13. The growth rate varies from 1 to 3.3 in the sample DS divisions intensively studied. Population density per sq. km varies from 164 to 923 in the DS divisions in the basin.

Long term data on population growth in the Kurunegala district, the main part of which is within the basin were collected and analyzed as shown in table 14, figure 4 and table 15, figure 5. Both rural and urban populations are on the increase as shown in figure 4. Similarly, population density is on the increase over the years as shown in figure 5.

Income and poverty

Income levels of families in sample DS divisions are presented in table 16. More than 60 percent of the families earn less than Rs.2, 000 per month according to DS level data sources.

Table 13. Population density and growth in the river basin.

DS division	Population 1999	Area (km^2)	Population density	Population 1989	Population 1993	Population 1999	Growth
Ridigama	89,848	132	681	77,509	NA	89,848	1.6
Mawathagama	57,464	68	845	51,416	NA	57,464	1.2
Polpitigama	78,720	234	336	66,378	NA	78,720	1.9
Ibbagamuwa	84,486	194	435	Re-demarcated	NA	NA	NA
Mallawapitiya	43,835	47.5	923	New division	NA	43,835	NA
Kurunegala	87,645	107	819	Re-demarcated	NA	NA	NA
Weerambugedara	30,922	59.6	519	27,135	NA	30,922	1.4
Ganewatta	38,010	191.2	199	New division	NA	NA	NA
Maspotha	40,551	45.5	891	New division	NA	NA	NA
Maho	52,934	247.5	214	Re-demarcated	NA	NA	NA
Wariyapola	57,298	195.4	293	Re-demarcated	NA	NA	NA
Katupotha	28,389	99.4	286	New division	NA	NA	NA
Kotawehera	20,310	119.4	170	Re-demarcated	NA	NA	NA
Nikaweratiya	38,815	181	214	Re-demarcated	NA	NA	NA
Kobeigane	33,549	125.6	267	30,428	64,775	33,549	1.0
Hettipola	71,120	202.3	352	Re-demarcated	NA	71,120	1.6
Rasnayakapura	21,646	132	164	New division	NA	NA	NA
Bingiriya	70,101	185.9	377	52,755	NA	70,101	3.3
Chilaw	60,055	80	751	Re-demarcated	NA	NA	NA
Arachchikattuwa	38,860	115.2	337	Re-demarcated	NA	NA	NA
Total	1,044,558	2,762.5	378				

Note: NA = Data not available.
Source: DS offices.

Table 14. Population of Kurunegala district (X 1,000).

Census year	Total population	Urban population	Rural population
1871	207.1	NA	NA
1881	215.2	NA	NA
1891	230.2	4.7	225.5
1901	249.4	6.5	242.9
1911	306.8	8.2	298.6
1921	354.2	11.7	342.5
1931	397.2	11.9	385.3
1946	485.0	15.5	469.5
1953	626.9	20.5	606.4
1963	852.6	30.1	822.5
1971	1,025.6	42.2	9834
1981	1,211.8	43.5	1,168.3
1985	1,280.7	NA	NA

Figure 4. Population increase of Kurunegala district.

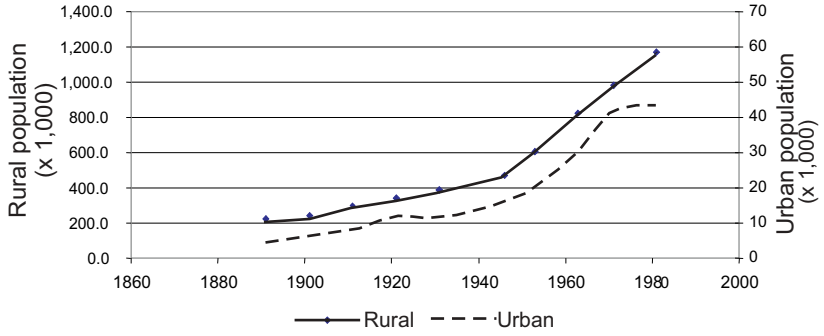


Table 15. Population density trend of Kurunegala district .

Census year	Population density (head/km^2)
1871	44
1881	46
1891	49
1901	53
1911	65
1921	75
1931	84
1946	103
1953	133
1963	181
1971	215
1981	252
1985	266

Figure 5. Population density of Kurunegala district.

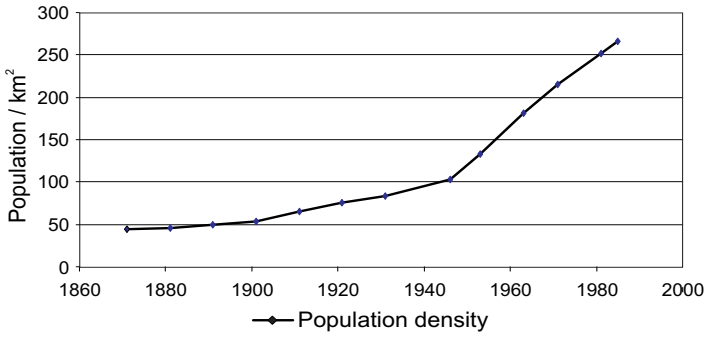


Table 16. Monthly income level of families.

DS division	Total no. of families	Below Rs 1,000		Rs1,001-2,000		Rs2,001-4,000		Rs 4,001-6,000		Above Rs6,000	
		No	%	No.	%	No.	%	No.	%	No.	%
Ridigama	21,783	13,625	63	1,748	8	1,630	7	2,400	11	2,380	11
Ibbagamuwa	19,187	11,301	59	3,591	19	1,940	10	1,450	8	905	5
Ganewatta	9,140	5,531	61	2,038	22	1,000	11	500	5	71	1
Hettipola	17,736	9,498	54	4,750	26	3,488	20	780*	4	-	-
Bingiriya	13,548	5,847	43	2,213	16	2,160	16	1,928	14	1,400	10

*Total above Rs4,000.
Source:DS offices.

Poverty

Data on families receiving poverty alleviation assistance from the government (table 17) indicate that more than 50 percent of families in sample DS divisions receive poverty alleviation assistance granted to absolute poverty groups. Poverty is widespread in DS divisions, Polpitigama and Mawathagama close to Kurunegala which is the main city of the basin, and in DS divisions like Ganewatte and Maspotha in the drier part of the basin.

Table 17. Number of families receiving government poverty alleviation assistance (Samurdhi).

DS division	Total no. of families	Samurdhi beneficiaries (No. of families)											
		Rs1,000		Rs500		Rs250		Rs200		Rs100		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Ridigama	21,783	101	0.46	9,310	42.74	3	0.01	2,625	12.05	1,687	7.74	13,726	63.01
Mawathagama	12,402	50	0.40	6,904	55.67	1	0.01	1,747	14.09	998	8.05	9,700	78.21
Polpitigama	15,313	109	0.71	3,446	22.50	7,148	46.68	1,406	9.18	926	6.05	13,035	85.12
Ibbagamuwa	19,187	127	0.66	8,664	45.16	2	0.01	1,675	8.73	960	5.00	11,428	59.56
Mallawapitiya	8,939	15	0.17	4,786	53.54	2	0.02	1,719	19.23	909	10.17	7,431	83.13
Kurunegala	19,755	0	0.00	7,380	37.36	0	0.00	1,664	8.42	1,220	6.18	10,264	51.96
Weerambugedara	8,473	76	0.90	2,851	33.65	94	1.11	662	7.81	499	5.89	4,182	49.36
Ganewatta	9,140	38	0.42	4,314	47.20	18	0.20	742	8.12	457	5.00	5,569	60.93
Maspotha	9,957	0	0.00	5,122	51.44	0	0.00	1,316	13.22	639	6.42	7,077	71.08
Maho	14,657	24	0.16	2,069	14.12	3,792	25.87	1,018	6.95	1,004	6.85	7,907	53.95
Wariyapola	17,442	27	0.15	2,925	16.77	3	0.02	5,719	32.79	1,621	9.29	10,295	59.02
Katupotha	6,526	14	0.21	1,445	22.14	1,788	27.40	838	12.84	0	0.00	4,085	62.60
Kotawehera	5,584	154	2.76	860	15.40	2,505	44.86	488	8.74	475	8.51	4,482	80.27
Nikaweratiya	9,733	121	1.24	1,424	14.63	3,107	31.92	682	7.01	589	6.05	5,923	60.85
Kobeigane	8,273	27	0.33	1,846	22.31	2,915	35.24	445	5.38	377	4.56	5,610	67.81
Hettipola	17,736	60	0.34	6,873	38.75	3	0.02	1,621	9.14	1,001	5.64	9,558	53.89
Rasnayakapura	5,374	68	1.27	406	7.55	2,180	40.57	657	12.23	477	8.88	3,788	70.49
Bingiriya	13,548	100	0.74	865	6.38	3,584	26.45	621	4.58	777	5.74	5,947	43.90
Chilaw	13,865	1	0.01	4,449	32.09	1	0.01	1,175	8.47	680	4.90	6,306	45.48
Arachchikattuwa	9,860	0	0.00	4,742	48.09	0	0.00	867	8.79	199	2.02	5,808	58.90
Total	247,547	1,112	0.45	80,681	32.59	27,146	10.97	27,687	11.18	15,495	6.26	152,121	61.45

Source: DS offices.

Employment and Livelihood Activities

Table 18 provides data on employment in the two districts of the basin and compares them with the national level data on employment. Agriculture is the major employment category in the two districts under the basin.

Data on main occupations at DS division level is presented in table 19. Agriculture is the major occupation in all DS divisions except in Arachchikattuwa, at the tail end of the river basin bordering the sea.

Table 18. Employed persons by major employment group, 1997.

Districts	Total	Agriculture.		Mining and quarrying		Manufacturing		Electric gas and water		Construction		Trade and hotel		Transport and communication		Other*	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Kurunegala	554,313	239,211	43.2	6,889	1.2	80,392	14.5	2,453	0.4	21,247	3.83	43,961	7.9	21,520	3.9	138,640	25.0
Puttalam	209,577	76,231	36.4	4,598	2.2	42,857	20.4	36	0.02	14,191	6.77	24,956	11.9	9,860	4.7	36,847	17.6
All Island	5,607,881	2,031,907	36.2	91,788	1.6	920,422	16.4	30,954	0.5	311,792	5.56	695,725	12.4	267,968	4.8	1,257,326	22.4

*Other activities include individual services, real estate, insurance and the miscellaneous.
Source: Dept of Census and Statistics: District profile of labor force, 1997.

Table 19. Main occupations at DS level in 1999.

DS division	Agriculture		Animal husbandary		Fisheries		Trade		Public sector		Private sector		Self-employed		Others		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Ridigama	14,530	44.38	1,600	4.89		0.00	3,028	9.25	4,610	14.08	4,417	13.49	355	1.08	4,200	12.83	32,740
Ibbagamuwa	18,500	46.97	1,550	3.94	135	0.34	2,750	6.98	4,320	10.97	10,825	27.48	950	2.41	358	0.91	39,388
Ganewatta	13,544	47.59		0.00		0.00	3,058	10.75	2,099	7.38	3,808	13.38	*		5,950	20.91	28,459
Nikaweratiya	6,850	39.22		0.00	216	1.24	2,350	13.45	4,465	25.56	2,101	12.03	*		1,484	8.50	17,466
Kobeigane	5,275	56.31	712	7.60		0.00	614	6.55	756	8.07	1,133	12.09	632	6.75	246	2.63	9,368
Bingiriya	10,140	42.93	3,040	12.87		0.00	904	3.83	1,784	7.55	997	4.22	6,318	26.75	436	1.85	23,619
Arachchikattuwa	2,050	22.29	250	2.72	650	7.07	1,020	11.09	850	9.24	2,100	22.83	1,213	13.19	1,065	11.58	9,198

*Self employment in Ganewatta and Nikaweratiya is included under others.
Source: DS offices.

Main Industries

The main industries in the river basin are either paddy or coconut based (table 20).

Table 20. Main industries in 1999.

DS division	Tile making	Brick making	Coconut industries[a]	Rice mills[b]	Shrimp farming
Ridigama	0	20	49	97	0
Mawathagama	1	NA	23	26	0
Ibbagamuwa	1	NA	44	118	0
Ganewatta	0	30	31	36	0
Wariyapola	0	NA	39	71	0
Nikaweratiya	1	NA	3	69	0
Kobeigane	0	NA	29	34	0
Bingiriya	4	13	126	197	0
Chilaw	NA	16	11	17	NA
Arachchikattuwa	8	25	9	21	165

[a] Coconut industries of large and small scale.
[b] Rice mills with small scale grinding mills.
Source: DS offices.

Infrastructure Facilities Available to People in the Basin

Number of urban centers and villages (including special markets for agricultural products)

The Number of urban centers and villages in the DS divisions in the basin is given in table 21. Many of these urban centers are small townships providing marketing facilities to the people and are agrarian in nature.

Table 21. Urban centers and villages.

DS division	Number of		
	Urban centers	Villages	GN divisions
Ridigama	01	272	113
Mawathagama	01	187	71
Polpitigama	01	194	62
Ibbagamuwa	01	187	74
Mallawapitiya	01	103	42
Kurunegala	01	138	43
Weerambugedara	01	104	28
Ganewatte	01	149	42
Maspotha	01	112	43
Maho	01	244	68
Wariyapola	01	203	60
Katupotha	01	84	26
Kotawehera	01	89	31
Nikaweratiya	01	103	42
Kobeigane	01	135	35
Hettipola	01	121	78
Rasnayakapura	01	85	28
Bingiriya	01	100	32
Pallama	01	11	03
Arachchikattuwa	01	98	33
Chilaw	01	45	22
Total	22	2,807	994

Drinking water facilities

The number of families having access to pipe borne water in the sample DS divisions of the basin are given in table 22.

Table 23 provides information on the sources of drinking water available to the people in the DS divisions of the basin.

Table 22. Information on access to pipe borne water.

DS division	No of families	Total no.of households	% of total households
Ridigama	1,100	21,783	5.04
Ibbagamuwa	50	19,187	4.0
Wariyapola	450	17,442	2.57
Nikaweratiya	NA	9,733	NA
Kobeigane	277	8,273	3.34
Bingiriya	80	13,548	6.1
Arachchikattuwa	1,186	9,860	12.02
Chilaw	NA	13,865	-

Note: NA = Not available .
Source: DS offices.

Table 23. Domestic water (drinking) supply schemes in the basin.

DS divisions	No. of pipe borne water supply schemes	Tube wells*
Kobeigane	1	54
Rasnayakapura	0	30
Hettipola	2	80
Polpitigama	0	NA
Wariyapola	1	126
Nikaweratiya	1	103
Kurunegala	5	14
Bingiriya	2	125
Chilaw	1	5
Ibbagamuwa	4	185
Maho	1	100
Maspotha	0	NA
Mawathagama	1	12
Pallama	0	9
Ridigama	16	226
Ganewatte	0	NA
Weerambugedara	0	3
Arachchikattuwa	1	94
Mallawapitiya	0	NA
Kotawehera	0	30

*Data available on administrative boundary basis of 1992.
Source: National Water Supply & Drainage Board (Kurunegala).

Seasonal cropping intensity of the basin (general)

Data on seasonal cropping intensity in the basin under different water regimes are given in table 24. Major irrigation systems have a higher cropping intensity, both in *yala* and *maha* seasons while in minor systems and rain-fed systems, this is slightly low in the wet *maha* and very low in the dry *maha* and *yala*.

Table 24. Cropping intensity under different water regimes.

System	Season and climatic condition								
	1994 yala dry	94/95 maha average	1995 yala wet	95/96 maha dry	1996 yala average	96/97 maha dry	1997 yala wet	97/98 maha wet	1998 yala wet
Major irrigation	0.77	0.98	0.78	0.96	0.53	0.91	0.52	0.98	0.66
Minor Irrigation	0.41	0.78	0.61	0.39	0.17	0.64	0.35	0.97	0.27
Rain fed	0.19	0.86	0.63	0.25	0.16	0.78	0.53	0.95	0.28
Overall	0.39	0.84	0.65	0.43	0.23	0.74	0.45	0.97	0.34

Performance of major irrigation schemes in the basin

Table 25 provides data on the cropping intensity in major irrigation systems. In some systems, the total command area cannot be cultivated due to water shortage; hence cropping intensity in them is below 2 as shown in table 25.

Table 25. Cropping intensity of major irrigation schemes in the basin.

Scheme	Gross extent (ha)	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99
Kimbulwana Oya	680	2.0	2.0	2.0	2.0	1.3	1.1
Batalagoda	3,091	1.6	1.6	1.8	1.6	0.9	1.6
Hakwatuna Oya	2,453	1.7	1.7	0.7	1.0	1.8	1.0
Magalla *	2,289	1.6	1.6	1.6	1.6	1.6	1.6

Sources: O&M branch, Department of Irrigation.
* IMD project manager, Magalla scheme.

Institutional Characteristics

Government institutions in development and management of water resources

Basic information on institutions involved in the basin is given in table 26. National and provincial ministries and departments (public/sector organizations) are involved in the development and management of water resources in the basin.

Table 26. Basic information on institutions in the basin.

Name of agency	Type of agency*	Area of jurisdiction**
Irrigation Department (ID)	National	Irrigation Engineer's (IE) division
Irrigation Management Division (IMD)	National	Irrigation scheme
Agrarian Services Department (ASD)	National	Divisional Officer's division (administrative division)
National Water Supply and Drainage Board (NWS&DB)	National	District level
Central Environmental Authority (CEA)	National and provincial	National and provincial levels
Water Resources Board (WRB)	National	National
Coast Conservation Department (CCD)	National	National
Pradesheeya Sabha (PS)	Local government body	Provincial

* National line agency/state/provincial/local government/other.
** Country/state/province/basin/water district/administrative region/ village/scheme /other.

In addition to these agencies, there are many different organizations involved in agricultural and natural resource management activities. They include District Secretaries at District level and Divisional Secretaries at DS level with authority over land and irrigation management activities. Others include the Department of Agriculture (DOA), the Department of Animal Production and Health (DAPH), the Samurdhi Authority attached to the DS office), the Coconut Cultivation Board, the Agricultural Development Authority (ADA), the Forest Department, the Department of Inland Fisheries, the Cashew Corporation and the Minor Export Crop Development Department.

Institutions in sample DS divisions (within the basin)

Institutions and organizations working in the sample DS divisions are given in table 27.

Table 27. Institutions located in the basin and their numbers.

DS division	Number of offices						
	DS	ASC	PS or MC	Vet surgeon	ID	IMD	Fisheries
Ridigama	01	03	01	01	N/A	N/A	N/A
Ibbagamuwa	01	02	N/A	01	01	01	N/A
Ganewatte	01	02	N/A	N/A	N/A	N/A	N/A
Wariyapola	01	02	01	01	N/A	N/A	N/A
Nikaweratiya	01	02	01	01	01	01	N/A
Kobeigane	01	01	01	N/A	N/A	N/A	N/A
Bingiriya	01	01	01	01	N/A	N/A	N/A
Arachchikattuwa	01	01	01	N/A	N/A	N/A	N/A
Chilaw	01	01	02	01	N/A	N/A	01

Notes: ASC – Agrarian Service Centers: There can be one or several Agrarian Service Centers in a DS division depending on the size of the division. Field-level officers of agencies like Agrarian Services Department, Department of Agriculture, Department of Animal Production and Health, the Cashew Corporation and the Coconut Cultivation Board are housed in the center managed by the Agrarian Service Committee of the Agrarian Service area.
N/A = In these locations, branch offices have not been established. DS = Divisional Secretary; PS = Pradeshiya Sabha; MC = Municipal Council; ID = Department of Irrigation IMD = Irrigation Management Division.

Provincial level arrangement for land and water resource management

Provincial Governments have been delegated authority to manage lands and water resources, except those that come under major irrigation schemes, by the 13th amendment to the Constitution of Sri Lanka. A provincial level Environmental Authority has been set up to handle environment related issues.

District and divisional level arrangement for land and water resource management

DSs have authority over crown lands and can take decisions on the management of such lands. Forest lands come under the Forest Department functioning at district level. There are District Agricultural Committees and DS level agricultural committees to coordinate work on agriculture-related issues, including seasonal water issues in tank systems. IMD project committees are the mechanism for coordination in major irrigation schemes. In medium schemes, the project committees established under the Management of National Irrigation Systems (MANIS) scheme are responsible for the coordination required in agricultural plan implementation, and operation and management (O&M).

Chapter 3

Socio-economic Conditions and Issues in the Deduru Oya River Basin

Introduction

The objective of the socio-economic study was to gain a deeper understanding of the socio-economic conditions in the river basin to evaluate institutional options that would match the specific socio-economic needs of the community and society at large. The socio-economic analysis offered in this paper elaborates on the specific socio-economic environment in the Deduru Oya river basin. The aspects discussed in this chapter mainly include demographic characteristics, economic and livelihood activities, income, poverty, and industrialization.

Demographic Characteristics of the River Basin

The total population of the river basin, according to demographic information available at the time of this study, was 1.04 million. High population densities are observed both at the head end and the tail end (Annex 1, table 1). In the head-end, the population density is high around the Kurunegala town and its adjoining suburban DS divisions. A high population density is reported again in Chilaw, an urban center in the western coastline located in the tail end of the basin. The population density is low in the middle of the river basin which is drier than the head and tail ends. The reason for the high population density in the two urban centers is in-migration of people in seeking livelihood opportunities like wage work, employment and business. The population is less in the dry zone areas as they do not attract people due to the lack of such opportunities and hard climatic conditions. Out-migration, especially of youths for employment in urban centers are observed in these areas.

The population growth in seven representative DS divisions is analyzed and presented in Annex 1, table 1. The rate of population growth in them is 1.5 which is equal to the national average of Sri Lanka. The lowest rate of population growth of 1.0 is reported from Kobeigane. The population growth is as high as 3.3 in the Bingiriya DS division. There are no definite reasons for this high growth rate. According to the people of the area it is mainly due to non-adoption of birth control practices by an ethnic community in the area, whose religious beliefs are against such practices. It is remarkable that the population growth rate in the basin shows a declining trend when compared with that of the previous decades.

The analysis of gender composition presented in Annex 1, table 2 shows that the total number of females is little higher than that of males. The male population exceeds that of females in six DS divisions. The highest ratio of 54 percent male population was observed in the Bingiriya DS division. The comparison of the growth rates of males and females shows that the growth rate of females has exceeded that of males during the last 10 years.

The household survey conducted in minor tank communities in the basin shows that the average family size is 4-5. The majority of the population (39 percent) is in the labor productive age group of 19-45 years. In the absence of private and public sector employment or opportunities for involvement in agriculture, these people resort to exploiting natural resources for livelihood. The activities such as unregulated sand and clay mining that has serious negative impacts on land and water resources is an indication of this situation.

As shown in Annex 1, table 3, the education level of the majority population (44 percent) is between years 5 and 10 (Dept. of Statistics – 1994) in the basin. In comparison, the education levels of the population in Kurunegala, the main town in the North Western Province and adjoining DS divisions are little higher than those of the other DS divisions in the basin. This difference could not be observed among other DS divisions or between the two districts, Kurunegala and Puttalam in the basin. There is at least one school with required facilities in each DS division, for the children in these rural areas to have their education.

Economic Activities

Agriculture is the main employment category in Kurunegala and Puttalam districts as shown below in table 5 (Dept. of Statistics 1997). Out of the total employed people in Kurunegala, 43 percent are employed in agriculture while in the Puttalam district it is around 36 percent. These figures show that employment in the agricultural sector in Kurunegala exceeds the national rate (36 percent) of agricultural sector employment. In the Puttalam district too the employment in the agricultural sector is equal to the national rate of 36 percent. The next main employment category in the two districts in the basin is the manufacturing industry in which 15 percent of those employed in Kurunegala and 20 percent in Puttalam are engaged as shown in table 18. The figures for Kurunegala are slightly lower than the national values for the employment in manufacturing industry while the figures for Puttalam are slightly higher.

Data on the main occupations for 1999 are available only in seven DS divisions. Agriculture is the major occupation in all of them except in Arachchikattuwa, which is in the tail-end of the river basin, bordering the sea (table 19).

The Kobeigane DS division, situated in the middle of the river basin and in the dry zone area has the highest rate (56 percent) of employment in agriculture as illustrated in table 29. Private sector employment is higher than the public sector employment in all the DS divisions excluding Nikaweratiya which has 26 percent of employment in the public sector. The reason for this difference in Nikaweratiya may be the location of many government agencies in the Nikaweratiya town. The private sector employment is 27 and 23 percent respectively in Ibbagamuwa and Arachchikattuwa DS divisions. This is mainly due to the fact that the two DS divisions are suburban areas with small scale industries. In Arachchikattuwa, the private sector employment is higher than that of the agricultural sector too. Trading as employment is higher in Nikaweratiya, Ganewatta and Arachchikattuwa DS divisions which have small townships with trade centers and shops. Also, there is a high proportion of self employment (26 percent) and employment in animal husbandry (13 percent) in the Bingiriya DS division. Employment in fisheries is 7 percent in the Arachchikattuwa DS division located in the coastline.

When the data presented in table 6 is compared with those in table 28 illustrating the employment pattern in four DS divisions in 1990, it appears that agriculture as employment is in the decline in all the four DS divisions. As revealed in the focus group discussions in the basin,

this situation is due to the people's withdrawal from farming which is less profitable with the increase in costs. However, the sharp drop in the number engaged in agriculture in Nikaweratiya from 67 percent to 39 percent is not due to this reason alone. The re-demarcation of the DS division in recent times leaving aside some rural areas may too have contributed to the decline. A similar drop in public sector employment, and an increase in private sector employment are observed in all the DS divisions except Nikaweratiya.

The survey carried out under minor irrigation systems too confirms this change in the employment pattern as shown in table 29. The decline in the agricultural sector is as high as 21 percent according to the survey data. The increase in private and public sector employment from 11 percent to 27 percent shows the tendency of people to withdraw from agriculture to find employment in other sectors that provide them a reliable income.

Table 28. Main occupations in DS divisions in 1990.

DS Divisions	Agriculture		Fisheries		Trade		Pubic		Private		Other		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Ibbagamuwa	11,902	49.72	94	0.39	1,840	7.69	3,550	14.83	1,612	6.73	4,941	20.64	23,939
Nikaweratiya	6,802	66.58	216	2.11	335	3.28	1,352	13.23	306	3.00	1,206	11.80	10,217
Kobeigane	4,937	61.90	4	0.05	344	4.31	799	10.02	258	3.23	1,634	20.49	7,976
Arachichikattuwa		35.00	-	5.00	-	5.00	-	12.00	-	11.00	-	-	-

Source: DS offices.

Table 29. Main income generation sources of the sample householders.

Main income source	10 years ago %	Present %
Agriculture	76	45
Wage labor	10	14
Government/ private sector employ.	11	27
Livestock	1	1
Foreign employment	1	2
Self employment	6	17
Government welfare assistance	0	1

Agricultural sector in the river basin

The economy of the Deduru Oya river basin is predominantly agricultural as shown in tables 28 and 29. Most of the area in the Deduru Oya river basin falls within the coconut triangle, the three corners of which are Chilaw, Negombo and Kurunegala. All the DS divisions in the Kurunegala district within the Deduru Oya river basin are main coconut growing areas. The percentage of the land area under coconut cultivation is between 50 percent to 64 percent in the DS divisions of Bingiriya, Mawathagama, Kurunegala, Wariyapola, Kobeigane and Katupotha (Annex 1, table 4). The extent under coconut cultivation is less in the DS divisions such as Nikaweratiya, Maho, Polpitigama and Rasnayakapura located in the dry zone area of the basin when compared

with that in the DS divisions of the intermediate zone. The area under coconut cultivation in these three divisions is 6545 ha, which is only 19 percent of the total land area in them (Source – Coconut Cultivation Board).

Most of the coconut landholdings within the sample DS divisions are below 2 acres as shown in Annex 1, table 5. The number of small coconut land holdings below 2 acres is very high in the DS divisions around Kurunegala. For example it is over 90 percent in Ibbagamuwa and over 80 percent in Mawathagama, Mallawapitiya, Kurunegala and Ridigama. Every home garden in these DS divisions has at least a few coconut trees. The household survey under small tanks gives a similar but clearer picture of the distribution of coconut lands in home gardens as shown in table 30. Sixty percent of the home garden coconut cultivations is less than 1 acre.

Table 30. Distribution of coconut cultivated home gardens.

Land size (acres)	No. of households	%
0-0.25	10	7
.25-.5	32	21
.5-1	49	32
1-2.5	43	28
2.5-5	15	10
5-7.5	3	2
7.5 or more	3	2

Coconut cultivation is the main livelihood activity of the majority of the people in the river basin. It provides some regular cash flow throughout the year. The household survey carried out in small tank villages reports that a significant supplementary income is generated from the home gardens in which coconut is the major crop. About 69 percent of households mentioned that they received an annual income up to Rs15,000 from their home gardens.

The other economic benefit from coconut cultivation is that it favours inter cropping and animal husbandry. There are a large number of coconut based industries in the basin due to the large scale coconut production in the area. These industries provide employment and livelihood for a large number of rural households. Besides these economic benefits, coconut cultivation provides shade, and arrests soil erosion.

As revealed in the interviews held with the farmers and agency officers, coconut cultivation in the basin area is affected due to various reasons, particularly, due to the drought as well as the drop in the groundwater table with the deepening of the river as a result of excessive sand mining. Fragmentation of coconut land by auctioneers for building of houses and the unrestricted felling of coconut trees for timber also have seriously affected the coconut cultivation in the basin.

Paddy Cultivation

Paddy is a main crop cultivated in the river basin. In some DS divisions such as Nikaweratiya, Rasnayakapura and Kotawehera located in the dry zone, paddy is the major crop (36 percent, 33 percent and 22 percent, respectively). Paddy is cultivated under irrigated conditions as well as

rain-fed conditions. The extent of paddy lands cultivated under irrigated conditions is more than that cultivated under rain-fed conditions in 11 DS divisions out of the total of 15 divisions in which data were available on crops cultivated. (Annex 1, table 6). The total land area under irrigated paddy cultivation accounts for 64 percent of the total paddy cultivated area in these 15-DS divisions. The irrigated paddy cultivation area is over 80 percent in the Bingiriya and Kobeigane DS divisions.

Irrigated agriculture is practiced both under major and minor irrigation schemes. The area receiving irrigation water supply under major and medium irrigation schemes is given in table 31.

Table 31. Major and medium reservoirs in the Deduru Oya basin.

Name of tank / anicut	Classification	Total irrigable area (acres)
Batalagoda	Major reservoir	5,054
Hakwatuna Oya	Major reservoir	4,400
Kimbulwana Oya	Major reservoir	1,200
Magalle Wewa	Major reservoir	4,154
KarawitaWewa	Major reservoir	856
Meddeketiya	Medium reservoir	178
Wennoru Wewa	Medium reservoir	432
Hulugalla Wewa	Medium reservoir	198

Source: Department of Irrigation.

The major reservoirs, Batalagoda, Hakwatuna and Kimbulwana are in the up-stream of the river. Administration wise, they belong to Ridigama, Ibbagamuwa and Ganewatta DS divisions. Magalle Wewa in the middle of the river basin comes under the Nikaweratiya DS division.

Hakwatuna Oya Scheme is a water short system and it is rarely cultivated in *yala* seasons due to water shortage. Cropping intensity in both Batalalgoda and Ridi Bendi Ela schemes under Magalle Wewa is about 1.75. In these schemes the entire command area is cultivated in *maha*, but only 75 percent is cultivated in *yala* due to water shortage. The average yield in these schemes is above 100 bushels per acre.

Initial command areas of these schemes have increased due to the development of encroachments and highland by farmers for irrigated agriculture, particularly in the schemes like Hakwatuna Oya. Though there are no serious water shortage problems in the Batalalgoda scheme, it has water distribution problems due to the lack of a proper canal system to convey water to individual allotments. The Kimbulwana Oya scheme is better managed with the active participation of farmers. It is a water abundant system. The Ridi Bendi Ela Scheme under Magalle Wewa is also a water abundant scheme. However, farmers in the tail-end face irrigation difficulties. Most of the canals and structures are damaged, controlling gates are missing, and canal roads are dilapidated in this scheme.

The impact of Ridi Bendi Ela on the downstream areas is a much discussed issue. Downstream farmers pointed out that almost all the inflow in the Deduru Oya was diverted to Ridi Bendi Ela making the river almost dry for about 15 km beyond the diversion. Consequently, the people in downstream areas resort to sand mining in the almost dry riverbed. The riverbed has deepened and the riverbank, eroded due to unregulated sand mining.

The Karawitawewa tank, a medium level reservoir, is situated in Chilaw in the tail end of the river basin. The cropping intensity in the Karawitawewa scheme is 100 percent in *maha*, and about 50 percent in *yala*.

Paddy Cultivation under Minor Irrigation Schemes

Most of the irrigated lands in the river basin are in minor irrigation schemes (Annex 1, table 7). It can be observed that the number of small tanks gradually increases in the middle of the river basin and decreases in the tail-end. Similarly, the number of farmer families under small tanks increases in the middle and decreases in the tail-end. The highest number of families engaged in cultivation under minor irrigation schemes is found in Nikaweratiya, Wariyapola and Bingiriya DS divisions.

According to the household survey in small tank villages, small land holding is one main feature in minor irrigation schemes. About 60 percent of the irrigated land holding under minor irrigation schemes is below 1 acre. Even the small extents of land held by farmers are scattered in several small tank commands. The survey shows that 80 percent of the householders are owner cultivators in terms of tenure status. Cultivation of the total area under these minor irrigation schemes is possible only during *maha* season. In *yala*, lands under 60 percent of small tanks are not cultivated due to water scarcity. Even when the total area is cultivated in *maha*, there are instances of partial or total crop failures due to water shortage towards the end of the season. Farmers view that they face water shortage in *yala* mainly due to the reduction of the water holding capacity of tanks caused by silting and sedimentation.

The area cultivated in *yala* season under minor irrigation schemes, differs from one DS division to the other. It is generally between 40 and 50 percent of the total area in Ridigama, Ibbagamuwa and Ganewatte DS divisions. In the Wariyapola DS division, it is 30–40 percent; in Nikaweratiya, 10–20 percent; in Bingiriya, 40 percent; and in Arachchikattuwa, 20 percent.

The paddy yield under minor irrigation schemes also varies from area to area. It is between 3.09 mt and 4.12 mt per hectare in minor irrigation schemes in Ridigama and Ibbagamuwa in the up-stream area, 2.57–3.09 mt per hectare in Ganewatta and Wariyapola, 2.06 mt per hectare in Nikaweratiya in the middle, and 3.61–4.12 mt per hectare in Bingiriya, Chilaw and Arachchikattuwa in the tail.

According to the household survey, the gross seasonal income from paddy farming for 45 percent of households is between Rs10,000 and 20,000 during *maha* seasons. For 25 percent of households, the gross seasonal income is between Rs5,000 and 10,000. The gross seasonal income during *yala* season is very much below that of *maha* season.

With the changes in the eco-system and socio-economic conditions, farmers in minor irrigation systems too experience many difficulties that affect their livelihood. Water scarcity is one main problem encountered by them who point out that this is due to the decrease of rain fall, sedimentation and silting of tank beds, deterioration of the physical system of tanks, and the reduction of inflow into tanks due to blocking of natural water courses. Soil erosions due to the development of catchments for cultivation and residential purposes are the main reason for tank sedimentation. Salt water intrusion into tanks and paddy lands, from shrimp farms too was reported as a serious problem by the farmers in coastal areas like Chilaw. Paddy lands in the tail-end areas are used for clay mining for brick and tile making, reducing the land area available for paddy farming.

Rain-fed Cultivation

There is not much information on the rain-fed paddy cultivation. However, it was learnt that rain-fed paddy lands are cultivated only during *maha* seasons. Also, farmers cultivate them exclusively for consumption. The average yield from rain-fed paddy farming is about 1.5 to 2.6 mt per hectare which is very low compared to that from irrigated rice farming which is about 4.5 mt.

General Problems of Paddy Farmers

Water shortage for cultivating two paddy crops a year is one major problem common to most of the paddy farmers in the basin. Moreover, they encounter non-water related problems in their production process. The high cost of production is one such problem. The cost of paddy production has increased due to the high cost of agricultural inputs, labor and machinery, and the withdrawal of subsidies. Low quality of inputs such as seed, fertilizer and agro-chemicals available in the market is also a serious problem. In our discussions with farmers, they repeatedly pointed out that they had low yields mainly due to the quality-related problems associated with inputs. The lack of adequate knowledge on new farming technologies was also reported as a problem. In farmers view, they do not have adequate technical assistance from the Department of Agriculture after the abolition of the field level agriculture extension officers known as Krushi Viyapthi Sevakas (KVSs). It was understood that there is a gap between the Central Government level that carries out research related to technology development and the provincial level responsible for extension at the provincial level. Consequently, there are delays in transferring new technologies from the center to the periphery. This creates problems for the farmers requiring new technology in agriculture.

Cultivation with Agro-wells and Lift Irrigation

According to the Agricultural Development Authority, the agency involved mainly in matters related to agro-well development, there are 2453 agro-wells in the 20 DS divisions coming under the basin. The crops cultivated under agro-wells are mainly other field crops (OFCs) that require less water. The total area supposed to be cultivated under them with OFCs is around 678 ha. However, the data collected from farmers and agencies reveal that the majority of agro-wells are not used for agriculture on various reasons. Cultivation with agro-wells involves high costs for operating water pumps and hence not profitable. Farmers cultivating OFCs are vulnerable to the problems of marketing too. Due to these reasons some farmers use agro-wells for more profitable activities such as brick making.

Water pumps are extensively used along the river from Ridigama down to Chilaw for agricultural purposes. Both paddy and other field crops are cultivated with them. Small pumps are used to provide supplementary irrigation for paddy in the head and middle, and for cultivating vegetables and other OFCs in the tail end areas of the river basin.

There are three lift irrigation schemes in Kobeigane and Bingiriya. Each scheme serves about 25 acres under them and the main crop cultivated is paddy. The lift irrigation scheme in Kobeigane

is better managed with some assistance from an NGO while the other two lift irrigation schemes in Bingiriya have difficulties in sharing water owing to the increase of water users in them.

Small water pumps are used in Bingiriya and Chilaw DS divisions, especially for vegetable and banana cultivation. This is the area that provides leaf vegetables to the Chilaw town. According to the farmers, the deepening of the river bed as a result of sand mining causes them difficulties. They now require more powerful pumps to lift water from the riverbed, which has sunk deep. Also, farmers state that vegetable and other cultivations in Chilaw and Bingiriya have been affected by the sea water intrusion along the river after the deepening of the riverbed.

The general problems faced by the farmers cultivating OFCs with agro-wells and lift irrigation are high production costs and marketing problems. In addition, those who use river-lift irrigation face water shortage during dry periods, and salinity due to sea water intrusion as a result of excessive sand mining. Construction of agro-wells by farmers without due consideration for groundwater availability and quality etc. is seen as a threat to the eco-system by agency officials as well as knowledgeable farmers and farmer leaders.

Livestock Farming

Livestock farming is another livelihood and an income generating activity carried out in the river basin. The officers involved in livestock farming were of the view that availability of coconut lands in the river basin help farmers keep livestock. Poultry farming and cattle farming are the two major types of livestock development in the river basin (table 32). Large-scale farms are found in coconut estates. Poultry farming is prominent in Bingiriya, Chilaw and Ibbagamuwa Veterinary Surgeon divisions. In Bingiriya the total number of chicken exceeds 1,270,700. Cattle farming is prominent in Ibbagamuwa, Nikaweratiya and Wariyapola Veterinary Surgeon divisions.

Possibilities exist in many DS divisions in the basin for further development of livestock farming. However, institutional and resource constraints are the major barriers against such developments.

Table 32. Livestock farming.

DS division	Type of livestock and numbers					
	Cattle	Poultry	Goats	Pigs	Sheep	Other
Ridigama	13,030	31,500	1,731	-	-	-
Ibbagamuwa	30,900	139,550	1,437	-	-	-
Wariyapola	24,631	38,492	1,649	-	-	-
Nikaweratiya	28,509	-	6,675	-	-	-
Kobeigane	12,000	70,000	1,500	600	-	-
Bingiriya	16,650	1,270,700	4,600	-	-	-
Arachchikattuwa	18,850	63,000	1,540	2,000	15	301
Chilaw	14,000	157,000	2,600	-	-	-

Note: Each livestock farming division includes several DS divisions.
Source: Department of Animal Production and Health.

Main Industries in the River Basin

The main industries in the river basin are either paddy or coconut-based (table 20). They include a large number of rice mills and coconut-related industries scattered over the whole basin. Coconut related industries are less in number in the dry zone areas of the basin. A large number of rice and coconut-based industries, (197 and 126 respectively) are in the Bingiriya DS division

Brick making is one main industry depending on river-resources. It is practiced excessively in small scale along the river, damaging the land along river banks. Trees in river reservations are used as firewood for brick making. The government offices in the area do not have data on the exact number of brick industries, though this is one important income earning activity. The clay required for tile factories operating in the tail end part of the Ma Oya basin is supplied from the Chilaw area.

Shrimp farming is a major income earning industry in the tail end of the river basin along the coastal belt in Chilaw and Arachchikattuwa. There are 165 shrimp farms of different scales in Arachchikattuwa alone.

Sand mining is another main industry depending solely on the river and its tributaries (table 33). The number of permits issued for sand mining in 1998, according to the information available with the DS offices is 113. However, the actual number of people engaged in sand mining is higher than the number of people holding permits. A large number of people could be observed sand mining illegally. For example, though it is stated that only six permits had been issued in the Nikaweratiya DS division, there were 14 individual sand mining locations operated by different individuals, within a radius of 8 km down from the main bridge over the Deduru Oya in Nikaweratiya on the Puttalam road.

Table 33. Issue of permits for sand mining, 1998.

DS division	No. of permits
Ridigama	02
Mawathagama	12
Ibbagamuwa	25
Ganewatta	3
Maho	4
Wariyapola	2
Nikaweratiya	6
Kobeigane	8
Rasnayakapura	2
Bingiriya	35
Chilaw	2
Arachchikattuwa	12
Total	113

Source: DS offices.

Moreover, the number of permits issued to people for sand mining does not give an indication of the magnitude and scale of sand mining. It is an unregulated activity being implemented by some individuals without any supervision by law enforcing authorities. It is said that sand from

the Deduru Oya is transported to distant places like Batticaloa and Colombo. Even cooperative societies have been formed for the sole purpose of sand mining, as it is a lucrative business. It was also pointed out at the PRA session that authorities fail to regulate sand mining due to the heavy involvement of politicians in it.

Impact of Main Industries on Natural Resource Base of the River Basin

Rice mills and coconut Industries, the main industries in the basin area were reported not to have serious negative impacts on the water resources of the basin. However, isolated cases of waste water from coconut and rice mills affecting water bodies and paddy fields were reported from some areas. This situation can be managed by local authorities through monitoring and environmental law enforcement.

However, industries like brick and tile making, shrimp farming and sand mining were reported as activities having serious negative impacts on land and water resources in the basin. Due to the use of lands in river banks for clay mining for these industries, river banks have eroded. As a result of using paddy lands for clay mining, there is serious soil degradation in them. The areas under paddy cultivation have declined. Health hazards due to mosquito breeding in clay pits are also reported from these clay mining areas.

In coastal areas, shrimp farming is observed to have the most serious negative impacts on the environment, water, and land resources. It was reported that natural resources like lagoons, water bodies, paddy fields and lands in these areas degenerate due to the discharge of waste water from shrimp farms. An increase of salinity in groundwater was also reported from shrimp farming areas.

Sand mining is the activity having very serious negative impacts on the river and river resources as well as the water resources in the basin. The stakeholders consulted in this study reported that the river bed has considerably deepened due to sand mining. As a result, problems like sea water intrusion, loss of natural ponds along the river, depletion of groundwater, loss of soil fertility due to non-occurrence of floods, erosion of river banks, increase of the salinity level in groundwater etc. have emerged. Roads and bridges in the area have been damaged due to their overuse by vehicles transporting sand. Social life in the area too has been disturbed due to the rivalries and clashes between those competing for sand mining.

Income Level and Living Standard of People

The monthly income level of about a half of the total number of families in five sample DS divisions is below Rs. 1000 (Annex 1, table 8). There is a significant number whose income is from Rs. 1000 to 2000. Except in Bingiriya, the income of more than 80 percent of the families in DS divisions is below Rs. 2000 per month.

Level of poverty

Families earning below Rs.1500 per month are regarded by the government as absolutely poor, and in need of government assistance for poverty alleviation. Out of all the families in the basin, more than 61 percent receive assistance under the government poverty alleviation program,

indicating widespread poverty in the basin (Annex 1, table 9). Poverty is as high as 80 percent in Mawathagama, Polpitigama, Mallawapitiya and Kotavehera. Mawathagama and Mallwapitiya are urban areas close to the Kurunegala city while Polpitigama and Kotawehera are dry zone areas. The Bingiriya DS division has the lowest number of families (44 percent) in the absolute poverty group and can be regarded as the economically strongest one. This is mainly due to the success of agriculture, chiefly paddy and coconut, and the availability of opportunities for other income generating activities such as livestock keeping.

The average rate of unemployment in 13 DS divisions in 1999 was 42 percent (Annex 1, table 10). In some DS divisions rate of unemployment is over 50 percent. The rate of unemployment was comparatively high in urban areas.

When the available data on the rate of unemployment in 1990 in 09 DS divisions are compared with those of 1999, it is found that the rate of unemployment has increased over the last 10 years in these DS divisions (Annex 1, table 11). For example, in Ridiyagama the rate of unemployment had increased from 30 percent in 1990, up to 50 percent in 1999. In Chilaw, the increase is from 47 percent in 1990 to 55 percent in 1999.

Pockets of poverty

According to available data, pockets of high poverty could be identified in two areas in the river basin: one within the urban area of the central city of Kurunegala, and the other, within the dry zone of the basin. The pockets of poverty in urban areas are Mallawapitiya, Mawathagama and Maspotha DS divisions and in rural areas, they are Kotawehera, Polpitigama and Rasnayakapura DS divisions in the dry zone.

A high population density, a high unemployment rate and small land holdings characterize the pockets of poverty around the main cities. In the dry zone areas, such pockets are characterized by a low population density, dependence on paddy cultivation as the major economic activity, paddy cultivation mostly under minor irrigation schemes, low productivity and low cropping intensity, and high water scarcity.

Urban centers

There are two main urban centers in the Deduru Oya river basin; Kurunegala and Chilaw. Apart from them, each DS division has a small town of its own. There are 22 such small towns in the basin.

Kurunagala is the capital of the North Western Province. It is the center of provincial administration, trading and service supply in the district. The Kurunegala city is managed by an Urban Council. The DS divisions of Mawathagama, Mallawapitiya and Maspotha are the suburban residential areas of the Kurunegala town with a high population density.

The other main city in the river basin is Chilaw located in the tail-end of the basin. It is one of the main cities on the Western Coast. Unlike Kurunegala, Chilaw is more than a trading and service center. It has industries and enterprises like shrimp farming, fishing, clay related industries and tourist hotels. This town too is managed by an Urban Council. Arachchikattuwa located on the Colombo-Puttalam coastal highway also has the characteristics of a typical small coastal town.

Ridigama, Nikaweratiya, Wariyapola, Maho and Hettipola towns are small-scale trading and service centers. However, Nikaweratiya is a major marketing center for agricultural production

in the area. All these towns have their own weekly village fair, which provides villagers the opportunity for marketing. They are managed by respective local administrative bodies, mainly Pradesheeya Sabas.

Towns and urban centers in Sri Lanka are industrially less developed. Many of them have evolved as trading and service centers. Cities and towns in the Deduru Oya river basin too have similar characteristics. They are predominantly peasant cities and towns oriented towards service supply, trading and marketing. Industrial pollution is minimal in these towns due to these reasons.

The situation in the towns of Chilaw and Kurunegala are somewhat different. Environmental pollution due to shrimp farming, the use of river reservations for brick and tile making, and sand mining in the river, have negative impacts on the Chilaw town. Its lagoon is polluted from oils and waste matter from the boats. The Chilaw town experiences floods during rainy periods as the lakes and low lying areas in the town that stored storm water in the past have been filled up with garbage. Many natural drains in the area have been blocked or earth filled. This has created storm water drainage problems in the town. A similar situation is observed in Kurunegala with regard to storm water drainage.

Garbage disposal and drainage problems are serious in both towns. The pollution of surface and groundwater resources due to the discharge of sewage and waste matter into the two main irrigation and drainage canals running through the town, is reported from Kurunegala. Also, the discharge of pollutants to irrigation canals and paddy fields is reported from the Ridi Bendi Ela in Nikaweratiya and the Wennoruwa tank in the Kurunegala town. The garbage disposal problems are not yet serious in small towns in the basin.

The expansion of towns is a major problem having serious impacts on lands under cultivation in the vicinity of the Kurunegala and Chilaw towns. The coconut cultivation and paddy lands in these areas are utilized for the construction of houses and buildings. Also, paddy fields and wetland areas are being earth filled for housing and other urban infrastructure facilities.

The local government authorities in Arachchikattuwa, Kobeigane and Ridigama face the problem of providing good quality drinking water to the people in their jurisdictions. Water salinity is reported from the Chilaw and Arachchikatuwa towns in the tail-end of the basin. The salinity level in groundwater and surface water resources has increased due to the seawater intrusion into the river, the extraction of groundwater and shrimp farming. Further, the people in areas like Ridigama, Kobeigane and Wariyapola are faced with water shortages during dry periods. Providing drinking water is a problem in Ridigama as the river is polluted due to sand mining.

Conclusions

The Deduru Oya basin is distinct in that the wetter parts of the basin are located at the head reach and the tail-end of the river while the midstream area is in the drier parts of the basin. The main urban centers in the basin are located in the head and tail areas. Urbanization, in these centers is marked by the high level of population density. The population density is low in the middle of the river basin, particularly in the areas with dry zone climatic conditions. The drier area of the river basin is characterized by poverty, water scarcity and dependence on small tank-based paddy cultivation, low productivity, and the lack of alternative employment opportunities.

It can be assumed that the population growth is not a serious problem in the river basin but the interesting feature in the basin demography is the high growth rate of the females over the males. Anyway, this has been projected in the population growth in the country by the Department

of Census and Statistics. The drop in the number of males over females may not be a problem in the near future but may create some social and economic problems if the trend continues.

There is a high incidence of poverty in the basin, especially among the farming population. The main reasons are water scarcity and dependence on paddy cultivation based on small tanks, low productivity, and the lack of alternative employment opportunities.

Agriculture is the main source of employment in the basin. The majority of people depend on coconut cultivation as it provides some regular cash income throughout the year. Paddy cultivation is the major livelihood activity of the people living in the dry zone part of the basin. However, a decline in the extent under paddy cultivation is observed, especially under minor irrigation schemes. The major problem the farmers in this region are faced with is the scarcity of water due to low rainfall, the silting of tank beds, lack of proper irrigation structures, reduced inflow into tanks and the pollution of water. The cultivation of vegetables and OFCs is a major source of income for the people residing in the downstream area of the river basin. Salinity due to the intrusion of saltwater is a serious problem for farmers engaged in vegetable cultivation in the downstream areas. Salinity control is urgently needed to continue these economic activities on a long-term basis.

The potential for the development of animal husbandry in the river basin is very high. The coconut land available in some areas facilitates livestock keeping. Institutional and management improvements, and resources are required for the further development of this sector.

The industries in the river basin are mostly associated with the two main agricultural products, coconut and paddy. These industries do not pose serious environmental threats if they are carried out properly. Sand mining along the river, and shrimp farming in the tail of the basin are the major causes of environmental degradation in the basin. These activities are carried out with the blessing of politically powerful people. Immediate attention of the relevant authorities is required to regulate these activities through institutional, legal and other measures.

Urban areas are predominantly service centers. Industrial development is low, and hence, industrial pollution is not a major problem in the basin at present. Drainage problems, and the use of the river for domestic waste disposal as it flows through the towns, pose serious environmental threats to water resources in urban areas. These need be considered when formulating strategies for the river basin management and related institutional reforms.

Chapter 4

Water Resource Management Institutions

Introduction

The main objective of this chapter is to analyze the existing institutional arrangements for water resource management in the Deduru Oya river basin in the North Western Province (NWP) of Sri Lanka, and propose institutional interventions for improving the water resource management efforts in the basin, within and responsive to a framework for integrated water resource management (IWMI 1999:3). The specific objectives of the study are to:

- describe the present and previous institutional arrangements for water resources management;
- describe the roles and functions of the government, Non-Government Organizations (NGOs) and the Community Based Organizations (CBOs) involved in water resources management;
- describe briefly the historical perspectives of water resources development and management;
- assess the present functioning, the strengths, the areas needing further strengthening and the impediments to improvement of the water resource management institutions at the provincial, divisional and the resource users' level; and
- develop and initiate the implementation of institutional strengthening programs leading to improved water resource management in agriculture.

Definition of Terms

Both organizations and institutions are involved in water resource management. Institutions are, "the roles of the game in a society, or more formally, are the humanly devised constraints that shape human action" (North 1990). They include laws, rules and regulations, codes of conduct, conventions and values providing structure and regularity to everyday life by reducing uncertainty and providing a guide to human interaction (Wester *et al.* 2000).

Organizations can be defined as, "groups of individuals bound by some common purpose to achieve objectives" (North 1990). "Organizations are created intentionally and reflect the opportunity set resulting from existing institutions. Hence, what type of organizations exists and how they evolve are fundamentally influenced by institutions, and in turn, organizations influence how institutions evolve" (Wester *et al*. 2000).

Historical Perspectives of Water Resource Development and Management

Ancient hydraulic civilization in the country

Sri Lanka is a country which claims a glorious past based on a hydraulic civilization in the dry zone areas of the country. The vast system of major irrigation works, and a network of large and small canals, that in some cases carried water many miles over precisely calculated gradients in the dry zone, demonstrate the extraordinary engineering skills of this ancient civilization. It is believed that irrigation works had been in the country even prior to the establishment of Aryan settlements in the 5th century BC. There is evidence that Aryans who first settled along the river banks, gradually developed intricate irrigation engineering skills which led to the development of colossal and complex systems of inter-related dams, and networks of canals and tanks. The settlers who preceded the Aryans are believed to have some knowledge of tank construction; however, it is the king Pandukabaya who reigned in 437 BC, who is recorded in history as the first king to construct a tank, the Abaya tank, in Anuradhapura. The kings who ruled after him were preoccupied with the construction of major tanks and canal systems for the socio-economic development of the country.

There were strict rules and regulations for managing water in these irrigation systems in the past. A very effective and powerful bureaucracy appointed by the king imposed these rules and regulations, the transgression of which resulted in deterrent punishment and heavy fines. The Kondavatuwana inscription found in the Gal-Oya valley (924-935 AD), while ensuring the rights of cultivators, clearly defines their obligations with regard to water-use, and adherence to the cultivation calendar. The inscription dictates fines and punishment for violating the cultivation calendar, and over irrigation of fields.

The other mode of irrigation systems that prevailed in Sri Lanka was the tank cascade system in the ancient kingdom of Rajarata and in the dry zone of the south called Ruhuana. These were village level land and water management systems, based on the tank catchments. A cascade is a connected series of tanks organized within a micro-catchment of the dry-zone landscape, storing, conveying, and utilizing water from an ephemeral rivulet. Water that is used for irrigation from one tank is passed on to the next tank through a drainage line for re-use. It needed a considerable degree of coordination, inter-dependence and intensive management for the different tanks in a cascade system to operate together. Ecologically, the cascade system appears to be a logical response to the challenges posed by the natural environment in the dry zone (Madduma Bandara). The water management in these village irrigation systems was based not much on rules and regulations but on customs, traditions and rituals.

The fall of this ancient hydraulic civilization, due to various reasons such as invasions, political turmoil, ecological degradation, climatic change and the spread of malaria, resulted in the shift of population into more secure areas in the intermediate zone (Kurunegala, Panduwasnuwara, Yapahuwa and Dambadeniya in the Kurunegala district), and to the hill country and wet zone areas of the island in the 13th century, leaving the ancient irrigation works to ruin. The institutions associated with the ancient irrigation systems too collapsed and were forgotten.

Development during Colonial Period

There were colonial powers in the coastal areas of the island from the beginning of the 16th century, and the whole country became a British colony in 1815. The British were more concerned with

the development of the plantation sector, especially tea and rubber in the wet zone areas, and invested from 1870 onwards on irrigation development activities such as the restoration of ancient irrigation systems. For example, a great deal of useful work was done in the period from 1870 to 1914 during which around hundred major schemes were either restored or constructed (Farmer 1957). The thrust for food production came to the fore in the early 20th century as a result of war due to which food could not be imported, and later, due to the depression in the estate industries. The food production campaign during this period led to the experiment of Nachchadduwa Settlement Colony, the first irrigation settlement colony in the country

It should also be mentioned that the various kinds of legislation such as the Crown Land Ordinance, the Land Development Ordinance, the Irrigation Ordinance and the Waste Land Ordinance, relating to the management of water and land resources were passed from time to time during the British Period. Further, institutions like the Irrigation Department, the Kachcheri system headed by the Government Agents, and the Land Commission were established during the British period for general administration, agricultural crop production, and land and water resource management.

Development after Independence

In the post independence period, the dominant ideology has been the preservation of the peasantry, which was believed to have degenerated due to the colonial impact (Moore 1992). This ideology is said to have led to the establishment of settlement colonies in the dry and intermediary zones in order to regenerate the peasantry. Also, the dry zone settlements were the major solution to the problems of the poverty of the peasantry, overcrowding of the wet zone, and the food deficiency in the country. There are accusations in many quarters against pursuing a policy of creating a peasantry oriented towards subsistence farming through the establishment of peasant colonization schemes. Though the concept of dry zone settlements and the creation of a favorable policy environment for its implementation have their origin in the British period, the country's national elite has been the target of attack for championing the dry zone settlement programs aimed at the regeneration of a small holding peasantry of this nature, for their political gains (Moore 1992). The idea of the existence of a self-sufficient peasantry in the past was a myth in the opinion of some scholars. However, whatever the problems associated with the settlement schemes may be, they have been the main source of food supply in the country and also the chief livelihood system of the millions of people living in them.

The introduction of the green revolution technologies in 1960s contributed to attaining near self-sufficiency in rice production, but had its negative impacts on the peasantry. Firstly, these new technologies were not accessible to all the farmers alike. The resource poor farmers were in a highly disadvantageous situation regarding the acquiring of these new technologies. Therefore, the commoditization of the paddy economy through the introduction of new technologies compelled many farmers to sell or mortgage their lands to wealthy farmers and become agricultural wage laborers or sharecroppers in their own paddy farms. Also, the newly developed seed varieties required the use of fertilizer and agrochemicals, which too had negative impacts on the soil, surface and groundwater resources and the environment. The impact of these green revolution technologies on the peasantry has been discussed in detail in a large number of studies in the Mahaweli and other settlement schemes in Sri Lanka. For example, "Some farmers using recommended levels of inputs have obtained yields above 100 bushels per acre. About 20 percent, obtained less than

40 bushels while 28 percent got above 80 bushels per acre. Field inquiries reveal that it is the poorer group of settlers who generally fall into the low yield category" (Wickramasekara 1985).

More and more emphasis on commoditization of agriculture through the cultivation of OFCs could be observed in 1980s. The involvement of the private sector in all the spheres of agriculture including input and other service supply started from 1977 onwards with the acceptance of the open market policy by the government. A gradual withdrawal of the public sector from the input supply, marketing, and other service supply activities in the agricultural sector, started during the same period. Above all, the withdrawal of fertilizer and other subsidies provided for agriculture, especially for paddy, marks a major shift from the approaches of the successive governments after independence. This made paddy farming less profitable and less affordable to the poor farmers. There were a lot of institutional changes such as the creation of a unified Grama Niladari system to attend to all the matters relating to general administration, agricultural extension provision of other agriculture-related services, enforcement of regulations etc. at the same time. This situation created an institutional vacuum in the sphere of agricultural extension and the enforcement of regulations related to the management of common property resources at the farmer level.

The returns from the construction of new irrigation settlement schemes appeared low and the set objectives such as employment generation could not be realized through them. (Aluwihare and Kikuchi 1991). Also, almost all the irrigation systems deteriorated due to the lack of proper maintenance, and the government had to rehabilitate them with financial assistance from donor agencies. The involvement of the farmers in O&M was sought, as an attempt to overcome irrigation management problems in major irrigation schemes through an experiment made in the Gal Oya irrigation and settlement scheme. The success of this experiment later led the government to implement programs for joint management of irrigation schemes with farmers from 1960s onward. By now the government has handed over to farmers the tertiary system, which includes Distributory Canals (DCs) and Field Canals (FCs) in irrigation systems. However, the involvement of the farmers in management activities in the irrigation schemes is not at a satisfactory level to deal with many socio-economic and institutional problems.

Challenges of the Present and Future

As discussed above, the successive governments after the independence, pursued irrigation development as a strategy for the socio-economic development of the people. The different agencies set up to execute different tasks in water resource development and management , implement their programs to achieve their sectoral goals and objectives. The authority on the planning and implementation of these activities was mainly at the central government level. Though there were attempts for integration through various committees such as the District Agricultural Committees (DAC), and the Project Committees of the Irrigation Management Division (IMD), the work of these committees too was confined to the realization of some specific objectives like agricultural planning. There was less concern for the integrated planning of water resources and much less interest in environmental aspects. Though there were legislations passed from time to time to arrest some problems, there were no clear policies for water resource management in an integrated manner. The devolution of power at the provincial level has been attempted through the setting up of provincial councils, but it is still lagging behind. This situation has led to various water resource problems such as the pollution of water, the sedimentation of tanks and reservoirs, the depletion of groundwater, and water salinity. In the face of these problems the government has

set up new policies and institutional arrangements for water resource management in the country. The new policy to be implemented through the National Water Resource Authority emphasizes the development of river basin plans for major river basins of the country and managing them through Water Resource Councils to be set up later. This study attempts to grasp the present functioning of the institutions managing the water resources in the Deduru Oya river basin to provide a feed back to those who are involved in policy planning in water resource development and management.

General Administrative and Institutional Mechanisms Available for Water and Other Natural Resource Management, Their Roles and Functions

Administrative and management structures

In spite of the administrative and management changes since independence from the colonial rule, the responsibility over the management of natural resources like land and water in Sri Lanka still depends mainly on the national administrative bodies and legal structures based on the country's constitution of 1978. The most important national administrative bodies and institutions involved in the management of water and other natural resources include ministries such as the Ministry of Irrigation and Power, the Ministry of Agriculture and Lands, the Ministry of Forestry and Environment, the Ministry of Mahaweli Development and the Ministry of Fisheries and Aquatic Resources at the central government level. The most important departments and government bodies functioning under these ministries at the central government level are the Department of Irrigation (ID), the Department of Agrarian Services (ASD), the Irrigation Management Division (IMD), the National Water Supply & Drainage Board (NWS&DB), the Water Resources Board (WRB), the Agricultural Development Authority (ADA), the Forest Department, the Inland Fisheries Development Authority, The Cost Conservation Department (CCD) and the Geographical Survey and Mines Bureau (GS&MB).

For administrative and management purposes, the country has been divided into 9 provinces and 25 districts. Each district has further been divided into a number of DS divisions which are made up of a large number of grass roots level units popularly known as Grama Niladari Divisions (GNDs). Before the setting up of provincial governments, administrative functions and law enforcement for natural resource management were implemented by the central government representatives at the district level. Government Agent (GA) represented the central government at the district level and was the administrative head of the district. He was assisted by Assistant Government Agents (AGAs) assigned to AGA divisions under the district. At the grass roots level, there were Grama Sevakas (Grama Seva Niladaris – GSNs) responsible for village level administrative functions. There were grass roots level officers like Krushi Viyapthi Sevakas (KVSs), the field level extension officers of the Department of Agriculture (DOA) and Cultivation Officers (CUOs), and the field level officers of ASD.

In 1987, the thirteenth amendment was introduced to the constitution, devolving power and authority enjoyed by the central government to the newly established provincial councils, and the administrative bodies, organizations and institutions formed under the provincial administration. After these changes were made, the provincial level departments under the provincial ministries carry out the water and other resource management tasks within the powers and authority vested in them. For example, the provincial Irrigation Department is responsible for carrying out designing,

planning, implementation and maintenance of all the irrigation work in irrigation systems other than inter-provincial ones managed by the central Irrigation Department. The provincial Agriculture Department provides extension services, and transfers agriculture-related technologies to the farmer in the areas under the provincial government. Further, the local government bodies like municipal councils and pradesheeya sabhas too handle some natural resource management tasks for which they have regulatory and executive power under the existing acts. Also, these institutions can seek the assistance of the provincial council for additional powers to deal with natural resource management in case of necessity. A provincial Environment Authority too has been established in the North Western Province in which the Deduru Oya river basin is located.

After the establishment of the provincial administrative set up, the power and authority vested on the GA who had played a dominant role at the district level as the representative of the central government was reduced in order to devolve power and authority on the provincial administrative bodies and institutions. For this purpose, AGAs (Divisional Secretaries at present) who were formerly under the GA were made to function under the provincial secretaries. However, due to various legal and institutional problems that cropped up later, the designation of GA was changed as District Secretary, and he was still made to play an important role at the district level as the representative of the central government, while devolving more authority and power to provincial administration. The Divisional Secretaries (DSs) who were formerly known as AGAs were brought again under the supervision of District Secretaries, making them more responsible to the central government under which they work.

There have been significant changes in the village level administration which too has some impacts on the water and resource management. The Grama Seva Niladari division was made smaller, and a unified village level administrative service was set up, bringing together all these village level officers like KVSs, COs and GSNs into the rank of Grama Niladari (former Grama Seva Niladari or Grama Sevaka). Grama Niladaris were supposed to attend to all the functions attended to by the former field level officers of different agencies. However, departments like ASD and DOA faced serious problems in implementing their activities, as this unified service did not work as expected. In recent times a new field level officer named Govi Seva Niyamaka was appointed to assist DOs of ASD working at Agrarian Service Centers (ASCs) to implement their field programs. These officers have now been made permanent with the new designation, Agricultural Research and Production Assistant and they now work under the direct supervision of DOs. Also, the Samurdhi Authority of recent origin too has appointed field level officers called Samurdhi Niyamakas to implement its field level programs at village level.

Thus the country has an institutional and organizational structure for the water and natural resource management function at several levels: the central government level, provincial level, district level, divisional level and the village level. They are mainly the ministries, departments, corporations, authorities and boards under the central government; the provincial level ministries and institutions established under the provincial administration; and the District Secretaries representing the central government at the district level and the DSs working under them at the DS level. DSs are assisted by Grama Niladaris working at the village level. There are different coordinating committee systems such as District Agricultural Committees, District Level Development Committees, DS level Agricultural Committees, Electorate Level Development Committees, Project Committees of IMD in major irrigation schemes, and Agrarian Service Committees etc., which are supposed to achieve inter-agency coordination at respective levels.

Legal structure, policy measures and water rights

Legislation on water and other natural resources in Sri Lanka dates back to mid 19th century. There are a large number of ordinances and acts introduced from time to time to regulate the use and utilization of natural resources. Legislation directly relevant to the water resource use and utilization, the key provisions provided in them and the agencies responsible for implementing the rules and regulations are given in table 37.

In addition, there are acts and ordinances such as the Forest Ordinance of 1907, the Fauna and Flora Protection Ordinance of 1937, the Mines, Quarries and Minerals Ordinance of 1947 and the National Aquatic Resource Act of 1981 which are relevant to the natural resource management. The enforcement of laws under them, rest with a large number of government institutions with overlapping roles and functions.

As for water rights, there is no formal or adequate water allocation system in the country. At the local level, water allocation is carried out by the public water service agencies like ID, NWS&DB, and in rural areas, through a system of traditional allocation procedures and rights. These allocation mechanisms have failed to ensure water allocation, recognizing the rights of the existing users with a flexibility to meet the needs of the new users (National Water Resources Policy 2000).

If we examine the present government policies, we will find a shift of focus from the earlier approaches for water resource development and management in two different important directions. Following the footsteps of many countries faced with water-related problems such as water pollution, the withdrawal of fresh water, and water scarcity, Sri Lanka too has changed its strategy from irrigation management to basin management in order to achieve water conservation and quality preservation for agricultural and other uses. Also, the government is concerned with the handing over of the resource management responsibilities completely to the beneficiaries of irrigation systems, even though the emphasis in the past had been the joint management with them. The following policy measures denote the shift of government focus in these new directions (Water Resource Council and Secretariat, Sri Lanka 2000).

- Setting up of a Water Resource Secretariat and establishment of a Water Resource Council eventually, in order to address all the matters related to water in a holistic manner. This process is in progress at this stage.

- Development of a master plan for water use. Steps are also being taken to develop a water allocation policy to make optimum use of the available water resources to cater to competing demands of different sectors like irrigation and power generation.

- Establishment of water rights.

- Development of comprehensive river basin plans for major river basins.

- Handing over of larger responsibilities concerning operation and maintenance of irrigation systems to farmers, and improving efficiency in irrigation water management in existing irrigation systems through farmer participation.

- Increasing of productivity in existing irrigated land through crop diversification and higher cropping intensities.

- Rehabilitation of irrigation systems.

- Groundwater development for agriculture and domestic use, and development of criteria for assessing groundwater resources.

- Expansion of programs for water supply and sanitation to provide adequate drinking water and sanitation facilities.

Roles and functions of water resource management institutions

ID which is a national level agency, is responsible for O&M of the main and secondary systems in major irrigation systems. It has an Irrigation Engineer (IE) at each irrigation division. There may be several IE divisions in a district. It may extend over several DS divisions and include several major and minor irrigation schemes. The Farmer Organizations (FOs) formed and initiated by IMD are responsible for O&M at the tertiary system, which includes DCs and FCs of an irrigation system. IMD has appointed Project Managers (PMs) to each major irrigation scheme to achieve inter-agency coordination and enhances farmer participation at scheme level for O&M of the irrigation system. In medium irrigation systems, institutional development activities as well as O&M is handled by Technical Assistants (TAs) of ID appointed as PMs to such schemes for obtaining farmer participation. ID appoints TAs as project managers to such schemes for joint management of them.

Farmer Organizations in small tank systems are responsible for the operation and management functions of the small tank system. However, major repairs and rehabilitation work etc. are handled mainly with funds under special projects for tank rehabilitation and modernization. On such occasions, provincial Irrigation Department is involved in designing, planning and implementing rehabilitation and modernization projects. ASD is responsible for the farmer level institutional development activities in small tank systems. ASD is further responsible for securing tenurial rights of tenants and land lords, holding cultivation meetings, and taking legal action against damage to crop by stray cattle etc., under the Agrarian Service Act. The authority and power over the registration of FOs too lies with ASD. There is an office of an Assistant Commissioner or a Deputy Commissioner of Agrarian Services at each district to implement the activities of the department. ACs are assisted by DOs working at ASCs functioning at agrarian service divisions. ASCs are occupied by the field level officers of different line agencies like the Department of Agriculture (provincial level), the Coconut Cultivation Board, the Department of Animal Production and Health (DAPH) and the Cashew Corporation working in the respective agrarian service areas. ASCs provide various kinds of services required for executing agricultural activities by the farmers in their jurisdiction.

NWS&DB is also a national level agency concerning domestic and industrial water supply and sewage and surface drainage. It helps urban councils and pradesheeya sabhas to construct pipe-borne water supply schemes and also operates and maintains large-scale water supply schemes of its own in urban areas. NWS&DB handles activities such as testing, drilling and installation of tube wells, drilling of common wells for drinking water supply on the request of pradesheeya sabhas, and municipal and urban councils, which pay the cost of construction on such occasions. Water Resources Board is the agency responsible for groundwater exploration and development, and it is also responsible now for the coordination of government water resource functions, and the formulation of national policies for control and use of water resources.

Table 34. Existing laws and regulations concerning surface water and groundwater usage and pollution control.

Enactment	Date	Key provisions	Agency/agencies responsible for implementing legal provisions
The Irrigation Ordinance No. 32.	1946	The Irrigation Ordinance provides for the regulations for DSs to prepare plans for new minor irrigation schemes or introducing changes to the existing ones. The approval of the Minister is required to prepare plans for the major irrigation schemes in terms of this ordinance. Also, the ordinance provides for the regulations for holding cultivation meetings in major irrigation schemes and for taking seasonal cultivation decisions at a special meeting of an IMD Project Committee attended by DS.	Minister of Irrigation, DS, IMD PC.
The Crown Land Ordinance (The State Land Ordinance).	1947	The right to use, flow management and control of any public lake is vested in the state under this ordinance. It makes a distinction between public and private waters. Part IX of the ordinance provides for the regulation and control of public waters and streams through a system of permits. Water for irrigation is exempted from license requirements.	DS.
The Electricity Act No. 19 (as amended).	1950	This Act provides for the licensing or installation for the generation of electricity. These licenses confer all rights necessary for the purpose of electricity generation, including rights to use water.	Ministry of Irrigation and Power.
The Soil and Water Conservation Act.	1951	This Act empowers the Minister of Agriculture to declare areas subjected to soil erosion as erodible areas. The Minister may make regulations applicable to these areas, requiring the owners of land to take measures to afforest the banks or watercourses, or to maintain a strip of land along the banks of water courses free from cultivation.	Minister of Agriculture.
The Agrarian Services Act (amendment to and continuation of the Paddy Lands Act No. 1 of 1958).	1979	Provides for tenure security in irrigated lands, and the sound management of agricultural activities and water in small tank systems, through Agrarian Service Committees and Farmer Organizations etc.	Commissioner of Agrarian Services.
The Mahaweli Authority of Sri Lanka Act No 23 (as amended).	1979	This Act empowers the Mahaweli Authority to use and develop the water resources of the Mahaweli river.	The Mahaweli Authority.
The National Water Supply and Drainage Board Act No. 2 (as amended).	1974	This act empowers NWS&DB to direct and use water to provide water supply for public, domestic and industrial purposes without other approval.	NWS&DB.
The National Environment Act (as amended).	1988	Provides for environmental pollution control including the pollution of water, and the protection of sensitive habitats like lagoons and lakes.	The National Environmental Authority. (Authority over some activities has been delegated to provincial Environmental authority.)
Participatory Irrigation Management Policy.	1988	Provides direction for handing over of full responsibilities over O&M and resource mobilization below distributroy canals to farmer organizations.	Irrigation Management Division and Irrigation Department.
Mines and Minerals Act.	1992	Section 30 of the act provides for imposing restrictions on the issuance of mining licenses if the mining is to take place in the proximity of water bodies.	Geographical Survey and Mines Bureau.

The National Environment Authority (NEA) is the institution responsible for the enforcement of laws, rules and regulations of the Environmental Act to control the pollution of water and other natural resources. The power vested in NEA has been delegated to the provincial council at present enabling the provincial authority to play an important role in environmental protection. CCD is the agency responsible for the protection of natural resources and environment in the coastal areas.

DOA providing agricultural extension services to farmers is one major agency involved in agriculture plan implementation. It is responsible for enforcing rules and regulations in the Soil Conservation Act. DOA functions both at central government level and provincial level and is the key agency for development and dissemination of agriculture-related technologies, including those for on-farm water management, and water and soil conservation.

In addition to these, there are DSs whose major function is the management of crown lands. DSs have authority under the Land Ordinance to take legal action against encroachments and are responsible for land regularization and land alienation. In addition, the DS is the officer coordinating agriculture as well as other development activities in a DS division. Table 27 below shows the line agencies working in 9 DS divisions selected for this study.

ADA was one main coordinating body in the past involved in agricultural development activities. However, its activities are now limited to the construction of agro-wells. ADA managers have been appointed on the basis of one for several DS divisions to carry out agro-well programs and other agriculture related functions.

Since the institutions involved in water resource management and agriculture are numerous, coordination mechanisms are required at different levels to plan and implement water and agriculture-related activities successfully. The coordinating committees functioning at present include the following:

Agrarian Service Committee – This committee is a legal body established under the Agrarian Services Act. The committee comprises five field level officers of different agencies attached to the Agrarian Service Center and a limited number of farmer representatives from FOs. The main functions of the committee is to prepare and update the land tenement list, management of the activities implemented by ASC (input and credit supply) and the coordination of agricultural plan implementation at ASC level. ASC is directly involved in initiating cultivation meetings in small tank systems, and also help timely cultivation through the supply of seed and other inputs to farmers. DO is the Executive Secretary of this committee. Each ASC center prepares an annual agricultural plan for the area under its jurisdiction with the involvement of line agency officers and farmer representatives representing the committee.

AMA Committee – these committees have been established at each ASC level to achieve inter-agency coordination and farmer participation to plan and implement agricultural activities effectively. This has been set up mainly because Agrarian Service Committees are not well represented by the farmers. AMA committee is attended by the field level officers of line agencies involved in agriculture, and two representatives from each FO in the jurisdiction of ASC. However, these committees do not function in a large number of ASCs as they have failed to offer solutions to farmers' problems satisfactorily.

DS level Agricultural Committee (DSAC) – This committee presided over by the DS is the forum for inter-agency coordination for agricultural plan implementation at DS level. It is attended by a limited number of farmer representatives and line agency officers working in the DS division. It prepares an annual agricultural plan for the DS division. At monthly meetings of the committee, progress achieved by the agencies in implementing the agricultural program is reported. This committee initiates cultivation meetings in small tank systems in time, and also finds solutions to

input supply and marketing problems of the farmers. However, the committee has no legal authority or power to attend to water and other resource management tasks effectively.

District Agricultural Committee (DAC) –This is the coordination mechanism at district level for agricultural plan implementation. This committee is chaired by the District Secretary and is attended by line agency officers working at district level and the farmer representatives from major, medium and minor irrigation systems. Agriculture related problems, which could not be solved by the DS level agricultural committee is forwarded to this committee for solutions. The decisions over holding cultivation meetings, making arrangements for input supply, encroachments on tank reservations, cultivation in tank bed area etc. are discussed by this committee. Since authority for crown land management and holding cultivation meetings etc. is vested in the District Secretary under Land and Irrigation Ordinance, he is able to solve such problems presented to this committee.

Forest Protection and Law Enforcement Committees (Environmental Committee) at DS and District levels – These committee meetings are held after the monthly meeting of DSAC and DAC, with the participation of officials attending those two committees. The major function of the committee is the protection of forest resources.

In addition to DAC and DSAC, there is a district level and electorate level development committee with the participation of government officials and political leaders to oversee the infra structure development activities such as the construction of roads, public buildings and irrigation infrastructure work. The district level committee is headed by the Chief Minister of the province while the electorate level one is headed by the relevant Member of Parliament (MP).

IMD Project Committees established in major irrigation schemes are also coordinating bodies bringing together the relevant line agency officers and farmer representatives for agricultural plan implementation and joint management of irrigation projects. Monthly meetings of IMD project committees provide a forum for farmer representatives and farmers to discuss water and agriculture related problems and find solutions for them. Also, planning, implementation and monitoring of seasonal agricultural programs are done at these committees with the involvement of farmer representatives.

Though different kinds of coordinating arrangements exist at various levels such as district, division, and project, for sectoral water use, there is no legal or institutional arrangement allocating water between different sectors in the basin. No institutional mechanism is available in the country for integrated water resources management at basin level.

Water Resource Management in the Deduru Oya Basin

Water resource management institutions

The government institutions, organizations and various committee systems discussed in the previous section, function at basin level to perform sectoral roles and functions, and to achieve interagency coordination required for planning and implementing various development and resource management activities. As the basin falls mainly within the two districts, Kurunegala and Puttalam, the DACs in the two districts are involved in agricultural plan implementation in the basin. There are about 23 DS divisions within the basin. The DSACs in these DS divisions are responsible for agricultural plan implementation within the divisions. There are Agrarian Service Committees functioning in each Agrarian Service division to coordinate agricultural plan implementation at ASC level.

In addition to these, there are a significant number of local NGOs as well as International Organizations like CARE, World Vision, and GTZ, working in the districts, Kurunegala and Puttalam in the Deduru Oya basin. Among the local NGOs, Sarvodaya and SANASA are the main organizations having their village level organizations all over the basin. In addition to these NGOs, donor funded projects like Wayamba Water Resource Development Project and IFAD are involved in water resource development, soil conservation and agricultural development activities in some DS divisions within the basin.

The community based organizations functioning in the 9 DS divisions intensively studied under this research project are given in table 35.

Table 35. Community-based organizations.

DS division	1	2	3	4	5	6	7	8	Active	Not active	Active %
Ridigama	113	02	06		113				150	140	51
Ibbagamuwa	94	02	03		74	10			208	46	82
Ganewatta	55						02		14	43	25
Wariyapola	95		74		60	20	02	13	139	131	51
Nikaweratiya	59		10	06	42	03		06	101	14	88
Kobeigane	58	01	53	01	35		01	06	58	96	38
Bingiriya	56	01	51	08			01		50	67	43
Arachchikattuwa	38						01	01	27	13	68
Chilaw	36			02			01	07	43	03	93

Note: 1. Farmer organizations 2. Cooperative societies 3. Rural development societies
4. Milk societies 5. Samurdhi groups 6. Praja mandala
7. Kapruka societies 8. Environmental associations

Source: DS offices.

The community based organizations functioning in the basin are mainly FOs in major, medium and small tank systems; Kapruka societies formed recently by the Coconut Development Board; multipurpose co-operative societies; milk producers cooperatives; cooperative societies formed by farmers engaged in poultry farming; Samurdhi associations formed by Samurdhi Authority; and the environmental associations formed recently by the Environmental Development Assistant, working in the DS office. Though there were rural development societies in the past they do not function at present. In addition, there are various community-based organizations like funeral associations, which are not involved in natural resource management tasks. They have been excluded in our study. A farmer company too has been formed by the farmers in the Ridi Bendi Ela scheme on the initiation of IMD. It is still in the formative stage depending on funds provided by IMD. In our interview with the officers and the PRA sessions with farmers, it was revealed that many of these CBOs are not strong enough to attend to resource management tasks effectively.

Different Sectors Utilizing Water and Other Natural Resources

Though the Deduru Oya basin is not a very large one, it has a significant number of different users, utilizing its surface water and groundwater resources as well as those depending on minerals

from the Deduru Oya and its tributaries as described in the working paper on socio-economic conditions in the Deduru Oya river basin. The most significant water users in the basin are the farmers using surface water and groundwater for agriculture. They include those who cultivate under the major irrigation schemes Batalagoda, Magalla, Hakwatuna and Kimbulwana; under the medium irrigation schemes such as, Karawita Wewa, Meddekatiya, Wennoruwewa and Hulugalle Wewa; and in the 3596 minor irrigation systems scattered all over the basin.

Farmers depending on lift irrigation from the Deduru Oya and its tributaries are also very significant even though the exact number is not known due to the illegality of their operation. There are lift irrigation schemes like Kalugala and Wellangiriya schemes managed by the central Irrigation Department. In addition to these schemes there are a large number of farmers along the Deduru Oya, especially on locations like Kobeigane, Bingiriya and Chilaw.

Another important water user category in the basin is the people using groundwater for agriculture. There are about 2453 agro-wells in the basin. However, many of them are not effectively used for agriculture. Data collected from 9 sample DS divisions presented in table 36 below show that the groundwater use by farmers is not much significant.

Table 36. Number of groundwater users for agriculture and percentage of total water user families in the basin.

DS division	Families using agro-wells	Area cultivated (ha)	Total no. of water user families	% of families using agro-wells
Rideegama	20	5	21,783	0.09
Ibbagamuwa	260	100	19,187	1.35
Ganewatta	110*	15	9,140	1.20
Wariyapola	205	60	17,442	1.17
Nikaweratiya	106	25	9,733	1.08
Kobeigane	275	80	8,273	3.32
Bingiriya	170	52	13,548	1.25
Arachchikattuwa	170	32	9,860	1.72
Chillaw	29	5	13,865	0.20

* 15 wells out of 110 are used for brick making.
Source: The Agricultural Development Authority and the Agriculture Department.

The industries and enterprises operating in the basin are yet another group of water users in the basin. A detailed description of them is offered in the section on the socio-economic conditions in the Deduru Oya basin. The main industries are rice and coconut-related industries, shrimp farms, sand mining and carpentry shops. Since they are small industries and enterprises requiring less water for their operations, there is no much competition from them for water.

People using water for drinking and other domestic purposes are a significant group extracting both groundwater and surface water. There are pipe borne water supply schemes operated and maintained by NWS&DB, urban councils and pradesheeya sabhas for this purpose. The number of pipe borne water supply schemes, including village level small schemes operated by the communities in the basin is 37, while the tube wells extracting groundwater for domestic purposes are 1199. However, there are about 1150 common wells used by the people. In addition, there exists a large number of privately owned wells of which statistics are not available at any office.

In addition to these water users, there are people engaged in livestock keeping and inland fisheries. They use both surface water and groundwater. Since small tanks are mainly used for fisheries while being used for agricultural purposes, there is no competition for water from this sector.

The details on ownership, and the operation of water utilities mentioned above are given in table 41 below. All the surface irrigation systems are state-owned. As indicated above in the roles and functions of government organizations and institutions, agencies like ID and FOs hold operational responsibilities in them. Domestic water supply schemes may be owned either by local government bodies, communities themselves, or NWS&DB, depending on the size and complexity of the schemes. Most of these facilities too are operated either by the state or the local government bodies in respective areas. The operation of utilities is the responsibility of NWS&DB in the case of the larger drinking water supply schemes owned by it while in some other cases, the operation responsibilities are held by local government authorities. The utilities handed over to the water users are managed by the water user groups or associations. The legal status of the operators too varies from one utility to the other as indicated in table 37.

Table 37. Main types of water utility in the basin.

Type of utility	Number	Who owns utility	Who operates utility	Legal status of operator
Surface irrigation systems	Major - 03 Medium - 04 Minor - 3596	Government	Major-government agency and WUAs Medium-government agency and WUAs Minor-WUAs	Major-government department and WUAs Medium-government department, WUAs Minor-WUAs
Groundwater schemes	Agricultural shallow wells-465	Individual land owners	Individual land owners	Individual land owners
Domestic water supply schemes	Pipe borne-37 Tubewells-1199	Local government body, government organizations and users	Local government body, Water Supply and Drainage Board, WUAs	Local government body or government organization or WUAs
Hydropower plants	Not available	-	-	-
Waste water treatment plants	Data not available: There are no significant industries or enterprises requiring waste water treatment plants.	-	-	-
Wetlands and other water bodies	Water bodies cover 11,410 ha = 4.4 % of the total land area in the basin. 140 ha of wetlands comprising mangroves and marshes = 0.05% of total land area.	Government	Government	Government

Note: WUSs = Water Users` Associations.

Water Users' Rights and Responsibilities

In irrigation schemes, the farmers owning lands may have different rights over land and water use, depending on the nature of the schemes. Different rights are attached to lands under different ownership categories like Sinnakkara (freeholding), Paraweni (inherited), Swarna Bhoomi and Jayabhumi with LDO permits, and holding on encroachment. Owners of freeholding and Paraveni lands have the right to sell their land while those in irrigation settlement schemes (those with LDO permits), and also those occupying encroached lands cannot sell their lands in the open market. Since water in irrigation systems in Sri Lanka is a common pool resource, the entitlement of each individual has not been defined in quantity or other measure. In old irrigation schemes like the small tanks in old villages, and in some old medium scale systems in Sri Lanka, water rights have been defined traditionally. However, the tank, irrigation canal system, and the catchment area are entirely a government property. In new schemes, the allottees have equal rights over water. However, under water scarcity conditions, the proprietors can take decisions at a cultivation meeting held for the purpose, as to which part of the irrigation system is entitled for water in a given season.

The Agrarian Services Act has provisions to acquire cultivable but uncultivated lands in a given Agrarian Service Center area by the Agrarian Service Committee on a temporary basis if such lands have not been put to proper use by the owners. Also, the Act provides provisions regarding tenure rights in irrigated lands to secure the rights of the tenants as well as landlords. The State Land Ordinance of 1947 gives a person who occupies land on the bank of any public lake or stream, the right to use water in that lake or stream for domestic and livestock or agricultural purposes provided that it is extracted by manual means. The owners of private lands can extract groundwater in their lands without any restrictions. There are no rules or regulations to control their water use.

To have water rights in a domestic water supply scheme managed by a local government authority or NWS&DB, water users have to pay a water fee jointly or as individual water users. However, there can be free riding irrespective of these in many systems jointly used by water users.

Most of the people tapping water from the Deduru Oya using water pumps are illegal operators. Though there are provisions in existing ordinances to take action against them, it is very difficult for institutions to take legal action against a large number of farmers scattered along the river, tributaries, and sometimes in feeder canal areas of major irrigation systems. They tap water in the river and streams without any restriction.

As indicated in the section on socio-economic conditions in the Deduru Oya basin, a large number of people utilize the river and streams for sand mining, river bank areas for brick and tile making, and wet land areas in the coast for shrimp farming. The authority over sand mining in the river and streams is with the Bureau of Geographical Survey and Mines, which issues permits for sand mining in certain areas along the river. However, there exist a large number of people involved in sand mining as illegal operators. The use of the riverbank areas for brick making is a complicated issue. Though the lands along the river and streams are government property, there are instances in which people hold freehold titles to such lands. When a land is privately owned, DSs can not do much to control the behavior of the landowners by using the rules and regulations in the Land Ordinance. However, they can take action to evict people occupying state lands. The behavior of farmers in privately owned lands can be controlled only by using the regulations in the Soil Conservation Act, which is not implemented at all at present.

This applies to other reservations like immediate catchments of tanks and canals, and stream reservations. Though they are the property of the government, there are instances in which such lands have been allocated to people occupying those lands. Since the tank and reservation areas have not been clearly demarcated in maps through land surveys, it is very difficult to take legal action to evict occupants.

Institutional Problems in Management of Land and Other Natural Resources in the Basin

Resource management problems affecting the productivity of land and water resources, and the institutional factors, relevant to them are reviewed in this section. The resource management and institutional problems, and issues related to different sectors will be separately discussed and analyzed.

Agricultural sector

The agricultural sector is the main water user in the basin. It includes major, medium, and minor irrigation systems; lift irrigation systems; and agro-wells. The major irrigation schemes are Ridi Bendi Ela, Batalagoda, Kimbulwana and Hakwatuna Oya, out of which three are water abundant. The two main schemes, Batalagoda and Ridi Bendi Ela fed from the Deduru Oya through diversions, receive an abundant water supply and there is sufficient evidence from these systems that water is not properly managed. Also, due to the problems in the physical system which lacks field canals to feed many individual allotments, water management in Bathalagoda is extremely difficult. In spite of water abundance, tail-end farmers of the Batalagoda irrigation system face water shortage problems due to this reason. The irrigation community in Batalagoda is very different from those of the dry zone settlements. They are old villagers living in different villages scattered over the area. Their residential pattern is a real constraint on interaction among members of the farming community sharing water from the same source of irrigation. It is difficult to form organisations based on the irrigation system, as the canal system lacks DCs & FCs on which IMD irrigation organizations have been designed. FOs have become less effective due to this problem. The IMD project committee is reported to be very weak in obtaining farmer participation which is the main tool of IMD for efficient management of an irrigation system.

The Ridi Bendi Ela scheme under Magallawewa is also physically dilapidated and requires rehabilitation. Water management is reported to be poor in this scheme too, and farmers in the tail-end experience irrigation difficulties. Hakwatuna Oya depends on the water from Hakwatuna Oya, which is a tributary of the Deduru Oya. It is an extremely water-short system, and hence, farmers cannot cultivate the lands under the scheme in *yala*. The major problems faced by Hakwatuna Oya are the development activities in the catchment areas for settlements, and the encroachment of the foreshore area for cultivation. Small tank development activities in the catchment areas of this tank were reported at the time of the field study for this research. Such activities would definitely aggravate the water scarcity problems of this already water-short system. In the face of severe water scarcity, there have been attempts in this scheme for the cultivation of OFCs requiring less water. However, the farmers' preference is for paddy, due to marketing and other socio-economic problems associated with OFCs.

The other major scheme, Kibulewana, is fed from Kimbulwana Oya, which too is a tributary of the Deduru Oya. This is a water-abundant scheme, and FSL of the reservoir was raised by 2 feet recently to bring in additional irrigation to feed the ever-increasing command area under this tank. It is better managed than the other major systems in the basin. This system is managed under the MANIS system. Under this system, TA in charge of the scheme works as the project manager and is responsible for the coordination of project activities and farmer level institutional building.

Except in Hakwatuna, the cropping intensity of the other three major schemes is between 75 and 100 percent, and the yield per acre is around 100 bushels on the average. There are no serious problems with regard to the productivity even though the potential exists for increasing the productivity of the irrigated land through interventions such as the use of organic fertilizer which has resulted in higher yields in the fields in the area.

However, the commonly stated problems in these systems are the poor farmer participation in O&M. It was pointed out at the PRA sessions that FOs are weak to handle O&M responsibilities even though the management at DC level and below it has been handed over to them. The present experiment to hand over the entire irrigation system to a farmer company, as an alternative strategy for obtaining farmer participation deserves a careful study.

Another problem commonly experienced by farmers is the pollution of irrigation water, especially due to the disposal of waste matter in the irrigation canal systems in urban areas, and the sedimentation of tanks due to development activities in the tank catchments. From the point of view of the stakeholders, the existing institutional mechanisms are not effective to arrest these environmental problems detrimental to both groundwater and surface water resources.

Similar problems were reported in medium tank systems operating in the basin, under the MANIS system. It was revealed that medium systems like the Karawita tank in the tail-end of the basin, have serious water shortage problems similar to those in the Hakwatuna Oya. Also, some medium systems depending on anicut systems built across streams face water shortage problems due to rainfall variations. Farmer participation in irrigation management activities was reported to be low in these systems too.

As for coordination at the project level, both INMAS and IMD management systems in operation, respectively in major and medium irrigation schemes, are effective in the coordination of agriculture-related activities in the scheme. The Hakwatuana and Ridi Bendi Ela schemes attend to coordination functions effectively. However, water abundant schemes do not manage water properly as there is no necessity for water saving at present. System managers as well as farmers are concerned only with the water availability for the lands in the system and not anything beyond it. Further, the problems such as water pollution in the catchment areas and urban areas etc. cannot be solved at IMD PCs because pollution may not be occurring in the project area and therefore not within the jurisdiction of the project authorities.

The problems in minor tank systems highlighted at the interviews and PRA sessions held with farmers, included water shortage in y*ala* season, the reduction of tank capacity due to sedimentation and weed growth, the deterioration of the physical system, the encroachment on tank reservations for cultivation and residential purposes, the lack of farmer participation in O&M, the tank water pollution due to industrial and other waste, and the development done in tank catchment areas without due consideration for the tank eco-system. The data collected substantiate that FOs are weak to attend to the resource management tasks in these tank systems, and their participation in O&M is not satisfactory. This situation could be observed even in the tank systems rehabilitated recently by the Wayamba Water Resource Development Project, in spite of the emphasis in the project to turn over the rehabilitated systems completely to FOs for self-management. It was also

evident that the enforcement of regulations against encroachments, damage to crops by stray cattle, damage to structures, and the violation of cultivation meeting decisions do not take place due to institutional weaknesses such as poor coordination, weaknesses of FOs, and the lack of enthusiasm and commitment on the part of field level officers. It could also be observed that minor irrigation schemes are oriented towards subsistence paddy farming due to various socio-economic reasons. One main reason is the withdrawal of subsidies, the increase of the cost of paddy production, and the low prices paid for paddy. The practice among the farmers holding paddy lands above 2 -3 acres is to have share cropping arrangements with other villagers, mostly, with those without paddy lands. The landowner receives one fourth of the share as land rent while the sharecropper is entitled to the rest. These pre-capitalist production relations are special features of the paddy sector under minor tank systems.

Considering the water shortage problems in medium and minor tank systems, a larger storage reservoir has been proposed in the upstream area of the basin to provide supplementary irrigation to those systems. The proposed system is likely to increase the cropping intensity of water-short medium and minor systems, and provide subsistence for the poor people in the villages. However, the construction of the proposed reservoir would demand efficient water management in systems like Ridi Bendi Ela and Batalagoda to which abundant water supply is available at present.

Though there are a large number of farmers tapping water from the Oya and its streams using water pumps, there is no institutional mechanism to deal with them and control their conduct in irrigation. Some farmers experience water shortage due to their unregulated tapping. Conflicts over irrigation water could be observed between highland farmers tapping water from Ridi Bendi Ela, and the farmers in irrigation systems with rights over water. Similar problems were observed in DS divisions like Kobeigane and Bingiriya where a large number of pumps were used for tapping water in the Deduru Oya river.

Institutional problems associated with agro-wells are complex, too. The construction of agro-wells and tapping of groundwater are not guided by any rules or regulations. Various donor funded projects and government initiated programs promote the construction of agro-wells to increase agricultural production. Due to this reason, a large number of agro-wells have come in to existence. But data are not available on the exact number, at any office. It was pointed out at PRAs with farmer leaders that most of the agro-wells constructed with government or project funds are not properly utilized. This is mainly due to the fact that funds have not been provided to the real farmers. People who are better endowed with resources and outside contacts have been able to obtain funds for agro-wells, depriving the real farmers in need of such assistance. The recommended cropping patterns have not been adopted even in the agro-wells being utilized at present. In the Ganewatte area some agro-wells have been used for brick making. In many cases such wells in paddy lands are used for supplementary irrigation of the paddy crop. OFC cultivation with agro-wells is limited due to marketing problems associated with OFCs.

It was also revealed at the PRAs held in the Chilaw area in the tail end of the basin that salinity has developed in agro-wells due to excessive extraction of groundwater. This is a new phenomenon,according to farmers. The vegetable and banana cultivation depending on tube wells, has been threatened due to this problem. Farmers in some parts of the system, especially those in Nikaweratiya and Kobeigane experience groundwater depletion, which they perceive to be associated with the deepening of the riverbed due to sand mining. All these problems in one way or other reflect the weaknesses of existing institutions or absence of institutions able to regulate the utilization of water and other natural resources.

Domestic and industrial water supply

NW&SDB, urban councils and pradesheeya sabhas are the institutions involved in water supply for domestic purposes and the industrial sector. One major problem faced by NWS&DB is the supply of water to urban areas in drought periods in which the Deduru Oya runs dry. For example NWS&DB supplies water to the Kurunegala urban council area by tapping water from the Deduru Oya. In dry periods, the river runs dry. The situation is aggravated by the fact that all the water in the Deduru Oya is diverted to the Batalagoda irrigation scheme through a diversion structure located above the point from which water is tapped for the drinking water supply scheme. There are no formal arrangements, or rules and regulations, over how much water should be allocated to the drinking water supply scheme. However, there are informal arrangements with ID to get water at the time of water scarcity.

The NWS&DB can pump water from rivers and streams without obtaining permits or permission from any authority. However, it needs the permission of ID to pump water from irrigation canals, tanks and reservoirs. Also, it does not require such permission for tapping groundwater resources for water supply schemes.

Since obtaining good quality drinking water is a problem in the towns and the villages in some parts of Kurunegala and almost throughout Chilaw and Arachchikattuwa in the Puttalam districts, NWS&DB has plans to supply water to the towns through water supply schemes based on tanks and reservoirs. This has become necessary because the water extracted through tube wells is not sufficient to meet the ever-increasing demands of towns and urban areas.

As there is no coordination mechanism over the use and utilization of water resources, a water supply and sanitation coordination committee has been formed in the North Central Province on the suggestion made by NWS&DB. This committee is chaired by the Provincial Secretary and is attended by the Manager of NWS&DB, the Manager of WRDB, Director of the provincial Environmental Authority, District Secretaries and DSs in the province. This committee meet twice a year; however, it attends only to the coordination of matters related to domestic and industrial water supply.

Water pollution in streams, through the disposal of waste matter is a serious problem faced by some pradesheeya sabhas planning to supply domestic water to their constituencies. This type of problems could be observed in many areas. In the Kurunegala town wastewater from hospitals, hotels and houses has been diverted to Wan Ela and Bu Ela, two main drainage and irrigation canals in the town area, without being treated. These two canals are used by downstream farmers for bathing and many other domestic purposes. In the Wariyapola area, the pradesheeya sabha is faced with the problem of water supply to the town area because the stream that can be utilized for this purpose is contaminated with pollutants from the Kurunagala hospital. No action has been taken by the law enforcing authorities to arrest the widespread water pollution in the whole basin.

Other sectors

As indicated in the section on socio-economic conditions in the Deduru Oya basin, there are a large number of people utilizing riverbank areas for brick and tile making and wet land areas in the coast for shrimp farming, and the river for sand mining. Sand mining has caused serious environmental problems according to the participants at PRA sessions. Groundwater depletion, seawater intrusion, soil fertility decrease due to the non-occurrence of floods etc. were the problems highlighted at PRA sessions. Seawater intrusion along the river has endangered the livelihood of a large number of farmers in the tail end of the basin, tapping water in the Deduru Oya for their

cultivation activities. Also, according to the inhabitants of the area, the tail end which was once a habitat for different kinds of bird, and species of fauna and flora has been devastated due to seawater intrusion.

The problem associated with sand mining is a matter related to the devolution of authority. Though some DSs have attempted to regulate sand mining, they have not been successful due to insufficient authority. The total authority over sand mining is with the Geological Survey and Mines Bureau (GSMB) under the Mines and Minerals Act. Permits for sand mining are issued by GSMB. However, DS, as the officer collecting revenue on behalf of the government can lay down some conditions when issuing permits. Miners have to pay DS, the state share for each cube of the sand mined. However, there is no officer to supervise how much sand is mined by each permit holder. In some areas, responsibility has been handed over to pradesheeya sabhas. Some DSs have attempted to lay down conditions such as the use of only manual means for mining, thus confining mining activities to less harmful areas. When miners were arrested for violating these conditions, DSs have been challenged at courts that they have no authority to implement regulations in the Mines and Minerals Act.

Unregulated shrimp farming also has affected the eco-system in the Chilaw and Arachchikattuwa areas, and has already damaged the environment and its scenic beauty. Authorities of the local government body in the Chilaw municipal area repented over the vast changes taking place in the town area due to sand mining and shrimp farming, and noted that the regulations in the age-old Municipal Council Act are not sufficient to arrest those problems. In addition, they pointed out that the power and authority over these matters were still with provincial and central government bodies, and hence, they are helpless in the face of the present situation.

The use of the riverbank areas for brick making is a complicated issue. Though the lands along the river and streams are government property, there are instances of people holding freehold titles to such lands. When a land is privately owned, DSs can not do much to control the behavior of the landowners, using the rules and regulations of the Land Ordinance. However, they can take action to evict people occupying state lands. The behavior of farmers in privately owned lands can be controlled only by the regulations in Soil Conservation Act, which is not implemented at all at present.

Institutional problems

The causes of the various resource management problems discussed above, reflect institutional deficiencies such as the lack of resources, skills, accountability, authority in existing organizations and in coordinating arrangements as well as the loopholes in the present policies and regulations. For example, the field level officers of agencies like DOA pointed out that they have no field staff to implement their extension programs successfully. Though they were supposed to use the unified GN service for their extension activities, they failed as most of GNs lacked the technical skills required. The former KVSs were directly under Agricultural Instructors, but GNs were under the supervision of DSs and had to attend to the duties assigned to them by DSs. DOs of ASD too had similar problems as the cultivation officers too have been absorbed into the unified GN system. However, at present, the DOs have a supporting staff to help them in their field work. They are known as the Agricultural Production and Research Assistants.

This change from the central government administration to the provincial administration has created a lot of problems: the number of training opportunities provided to the staff has been reduced; there are delays in the transfer of technology developed at the central government level to the provincial level; and hence the extension staff lacks new technologies developed in the

center. Also, the sale of some seed farms of DOA to the private sector has restricted the supply of good quality seeds by DOA to the farmers.

Further, the changes due to the introduction of the open market economy have their repercussions on Agrarian Service Centers. Earlier, ASCs had a monopoly on fertilizer and other input supply. Under the open market system, it has to compete with the growing private sector, within the rigid government rules and regulations that set limits to the flexibility required in business and enterprises. Many ASC centers have failed to meet these challenges and have become namesake and less attractive to farming communities. However, since the private sector is also weak in some areas, farmers face problems in acquiring good quality inputs in time.

ASC and AMA Committees at ASC level, which were supposed to achieve inter agency coordination in the planning and implementation of agricultural activities too are not successful for many reasons. One main problem is that no effort is made at ministry level for integrated planning. Departments and ministries are highly compartmentalized; hence the field level officers of line agencies, though work under the same roof with ASC, work separately in achieving the individual goals of their departments. DOs who head the center have no supervisory or advisory power over the field level officers of other agencies. If they fail to attend coordinating committee meetings, DOs cannot do much to get their participation. Committees like AMA formed to obtain farmer participation have no solutions to farmers' problems involved in irrigation, input supply, credit, and marketing. Though farmers had attended AMA meetings held initially, they avoided them later for this reason.

DS level Agricultural Committees are somewhat active, but they lack resources, authority and power, to attend to resource management activities successfully. They have to seek the assistance of various line agency heads with authority and power on different Ordinances and Acts to take action with regard to law enforcement in common property management activities. As in the case of ASC, officers of different line agencies attending these committees too are not responsible or accountable to DSs. Though an agricultural plan is prepared for the DS division, monitoring of the field implementation process does not occur. There is no monitoring system attached to the plan. Each agency reports its achievements to the committee for DS to include in his reports. Some agency officers working at DS level are isolated from the centers of power (head quarters or provincial offices) and work independently. They are less supervised. Since there is no systematic job evaluation procedure, this situation encourages many officers to do their minimum or to idle. For this reason it requires some mechanism at DS level to supervise and coordinate the activities of different agencies for this reason. The newly established Environmental Committees were very weak in many DS divisions at the time of this study. However, in the areas like Chilaw, there was a significant number of environmental organizations carrying out some activities for the protection of the environment.

The district level Agricultural Committee headed by the District Secretary has been useful on many occasions to solve some crucial problems like foreshore cultivation in Hakwatuna Oya and input related problems. Though many activities related to irrigated agriculture is attended to at this committee, it has no mandate or objective of attending to water resource management activities even in the district, in a holistic way.

Conclusions and Recommendations

The major resource management problems observed in the basin include surface water and groundwater pollution, depletion of groundwater, erosion of river banks and stream reservations, soil erosion in tank catchments and sedimentation. Surface water is polluted as a result of the discharge of wastewater and pollutants to irrigation canals, streams and watercourses. This is mainly an urban phenomenon. Authority for enforcing regulation relating to this aspect is vested with central and provincial Environmental Authorities, urban councils, and municipal councils depending on the scale of industries or enterprises causing such pollution. Groundwater pollution is reported mainly in coastal areas due to seawater intrusion along the river due to sand mining, and excessive extraction of groundwater using tube wells. The lack of clear policies, rules and guidelines for groundwater extraction is a major institutional constraint, leading to groundwater pollution.

The major cause for groundwater depletion is unregulated sand mining. It is understood that the regulations in the Mines and Minerals Act are sufficient to arrest this problem, but a problem in implementing regulations is evident at the central bureaucracy level and not with the agencies operating at the field level. This highlights the necessity of devolving power and authority to institutions at provincial and DS levels in order to attend to natural resource management activities effectively.

Common properties like stream reservations and tank catchments are mainly state owned property even though there may be some privately owned lands among them. DSs have power and authority to take action against the encroachments on such property. But various political and social pressures and resource constraints hinder them from attending to these activities. Also, there are no special programs to encourage community members to take over and manage these common properties through tree planting and other soil conservation measures.

In addition to these resource management problems, inefficient water management is reported from major and medium irrigation systems. If the proposed reservoir is constructed, Batalagoda and Ridi Bendi Ela schemes cannot expect an abundant supply. This requires better water management efforts on the part of the irrigation managers and farmers in these schemes. In minor tank systems, there are no special efforts to encourage farmers to use water efficiently through management innovations to avoid crop failures and low yields caused by water scarcity, towards the end of the season.

Apart from these, there are no serious problems such as competition from industrial and domestic sectors for water, or serious water scarcity problems observed in a basin. Most of these problems occur due to the following deficiencies in the institutions:

- The existing coordinating bodies like the DS level agricultural Committee has been established to coordinate agricultural plan implementation. There is no institutional mechanism to attend to water and other natural resource management activities in a holistic way.

- The existing committees have no power and authority or resources to attend to water and other natural resource management activities. Authority is vested on individual agencies.

- Line agency officers attending ASC and DS level committees are not accountable to the committee or to the officer presiding over the committee.

- There are no mechanisms at these committee levels to monitor the progress and achievements of the plans prepared. Further, the agencies have no clear procedures to evaluate the officers working in them (Some agencies like Animal Production and Health have developed indicators to measure the performance of the employees and these agencies show significant achievements in NWP).

It is argued that basin-level institutions are required for the effective management of water resources. However, the experience of the river basin authorities suggests that they are difficult to be sustained (Wester 2000). The existing institutional arrangements based on administrative or political boundaries and the basin institutions based on hydrological boundaries, differ. Once a basin council is established, it requires bringing the officers serving in different administrative divisions together, which is an enormously difficult task. Also, there is grave difficulty in bringing them together without some really valid reasons. Water scarcity and water-related problems in the Deduru Oya basin are not so serious as to demand basin level institutions. Therefore, the best suited institutions for the management of the Deduru Oya basin are the existing ones, empowered and strengthened to face the challenges of water and other natural resource management. The following institutional reforms are proposed to the existing institutions in order for them to attend to water and other natural resource management activities, effectively at these levels. However, this does not contradict the proposal for the establishment of an institution with authority at national level or basin level, to formulate rules and regulations over the use and utilization of water, water rights etc. and implement them. But such an authority needs to devolve authority and power to the DS level for implementing the following resource management tasks.

- Strengthening of district and DS level agricultural committees as coordinating bodies, for water and other natural resource management by introducing necessary amendments to existing rules and regulations.

- Introduction of provisions to make the line agencies concerned, to be accountable to the committees.

- Establishment of a monitoring cell at district and DS levels, to monitor the progress of resource management activities.

- Introduction of clear procedures for evaluating the performance of line agency officers.

- Introduction of necessary amendments to the Acts and Ordinances for the smooth functioning of the proposed committees.

- Efficient water management in water abundant schemes.

- Institutional development at ASC level for better O&M at minor irrigation systems.

- Demarcation of reservations through surveys.

- Handing over of common properties like tank catchments, reservations etc. for conservation, to the farmer communities.

Chapter 5

Water Accounting and Performance of Irrigation Systems

Introduction

This chapter includes two sections; the first section, which provides an analysis of the water use in the basin through a water accounting, and the second section, which evaluates the performance of the irrigation systems in the basin. The water accountings help understand water consumption by different water use sectors and whether the water in the basin is fully utilized, and also the possibilities existing in the basin for further development of water resources. The section on the performance of irrigation systems evaluates the utility and efficiency of water use in the irrigated agricultural sector to explore the possibilities of increasing water use efficiency and productivity in facing the future challenges from the other contending water use sectors in the basin.

Information on Physical System

The Deduru Oya basin is the fourth largest river basin in Sri Lanka. The total basin area has been estimated at 2622.5 sq. km by planimetering the basin map. The main river stream is 115 km long and starts in the border of the Central Province (CP) and travels through the North Western Province (NWP) to discharge into the Chilaw lagoon. A very small area in the North Central Province (NCP) also drains into the Deduru Oya. The details on the areas falling within the basin are given in table 38.

Table 38. The Extent of the Deduru Oya basin.

Province	District	Area covered (%)
Central Province (CP)	Kandy	1.85
	Matale	1.22
North Western Province (NWP)	Kurunegala	87.27
	Puttalam	9.6
North Central Province (NCP)	Anuradhapura	0.06

There is a great diversity of physiographic features within the basin from the mountainous region in the eastern boundary, moderately sloping western peneplain with dominant inselbergs and monadnocks in the central part, to the coastal flat plain in the western boundary. At the outfall of the Deduru Oya, the barrier spits forming a barrier beach. Lunu Oya from the South and Sengal Oya from the North form two small neighboring basins, a confluence with the Deduru Oya to form the Chilaw lagoon. Behind the barrier beach and the barrier island is a zone of flats, and

part of it is occupied by stretches of marsh and mangrove swamps. The alluvial flood plain near the coast is extremely flat and the Deduru Oya meanders in the flood plain for about 3 km wide. It has natural levees along some portions of the banks. In the western peneplain, the basement is bounded by the coastal plain from the west and by the mountainous region from the east. Its surface is gently undulating in the western part and rolling in the eastern part with inselbergs and undulating dome shaped outcrops. The mountainous region is in the extreme eastern part of the basin where elevation rises to about 700 m. This region falls within the wet zone.

Agro-ecological regions

Sri Lanka is divided into 24 Agro-ecological Regions (AERs) based on annual precipitation, elevation and monthly rainfall distribution (Panabokke 1996). The Deduru Oya basin lies on five of these AERs as shown in figure 3. The basin area under each AER and percentage of the coverage is given in table 39.

Table 39. Agro-ecological regions (AERs) in the Deduru Oya basin.

Name of Agro-ecological region	Symbol	Extent under Deduru Oya basin (km^2)	Percentage covered
Wet zone mid-country category 3	WM3	107.95	4
Wet zone mid-country category 3 sub group "a"	$WM3_{(a)}$	1,23.90	5
Intermediate zone mid-country category 3	IM3	50.95	2
Intermediate zone low-country category 1	IL1	755.15	29
Intermediate zone low-country category 3	IL3	1,584.55	60
Total		2,622.50	100

Data Analysis

Monthly rainfall data for the period from 1989 to 1998 were obtained from ten rainfall measuring stations of the Department of Meteorology representing different AERs in the basin. Data on extents cultivated in different seasons, production and demographic aspects were obtained from the DS divisions. Some DS divisions coming under the basin were fully within it while some were partially within it. Data segregation for DS divisions falling partially within the basin were done proportionately to the area included in the basin. Paddy cultivation activities on a particular season start in different parts of the basin at different times. In this study, a common cultivation period was considered for calculating ET values using the CROPWAT program. Recorded data were not available for soil moisture and surface storage of minor tank systems. Therefore general data and information on soil moisture available at the Agricultural Research Stations and qualitative data for minor tank storage are used in the report for computing water storage.

The Department of Irrigation is responsible for measuring and maintaining river flow data. The data for the Deduru Oya are available for the period of October 1971 to September 1979 and October 1990 to September 1998.

The data related to demography, cultivation and production collected from the Department of Census and Statistics too have been used in this study in situations such data were not available at the DS division level.

Land use data reflecting the current situation in the basin are not available, and hence land use maps of the Department of Survey updated in 1986 were used in this study.

Precipitation and Cultivation Seasons

Water enters into the basin through precipitation. The average rainfall in the basin is given in Annex 1, table 1. Based on the rainfall pattern, the year has been divided into two main agricultural seasons, *maha* (wet) and *yala* (dry) seasons. *Maha*, which is the major cultivation season starts in October and continues up to the end of March during which the basin receives a mean rainfall of 950 mm. The period from April to September, known as *yala* is the minor cultivation season, during which the basin receives 700 mm of rainfall. In classifying the seasons, the criteria given in table 40 have been used in this study.

Two out of ten *maha* seasons are dry, water from the rainfall and surface storage hardly suffices for the agricultural activities in the season. Dry y*ala* season receives comparatively low rainfall in the months of April, May and June. Three out of ten y*ala* seasons are wet seasons. Except in dry *maha* seasons, all surface and sub-surface (ground) water bodies get recharged to their full capacity (saturated) in the middle part of the normal season. The excess water drains as runoff in to the natural streams.

Most of the *yala* seasons are dry, and drought conditions prevail in the latter part of the season. Natural streams having base flows at the beginning of the season disappear by the end of the season. Minor tanks become dry in the middle part of a normal *yala* season. It is only the farmers with supplementary sources of water like agro-wells and water pools on streamlets can complete the cultivation successfully under extreme water scarcity conditions in minor tank systems.

According to the above classification, the seasons from 1994 *yala* to 1998 *yala* are classified as dry, wet or average as shown in tables 40 and 41.

Table 40. Classification of maha and yala seasons.

Season	Rainfall range	Classification
Maha	Above 1100 mm	Wet
	1100mm to 750 mm	Average
	Less than 750 mm	Dry
Yala	Above 750 mm	Wet
	750mm to 600 mm	Average
	Less than 600 mm	Dry

Table 41. Classification of seasons from 1994 yala to 1998 yala.

Season	Rainfall (mm/season)	Classification
1994 yala	458	Dry
1994/95 maha	790	Average
1995 yala	764	Wet
1995/96 maha	602	Dry
1996 yala	665	Average
1996/97 maha	594	Dry
1997 yala	828	Wet
1997/98 maha	1,156	Wet
1998 yala	766	Wet

Data on Land Use

The land use pattern of the basin has been computed by using the land use data from the maps of the Department of Survey, given in table 42 and figure 6. The maps have been updated finally in 1986. Agricultural sector data for the districts available in the publications of the Department of Census & Statistics have been used for this analysis. In the Kurunegala district the extent of paddy lands under major, medium and minor irrigation systems remains unchanged as shown in figure 7. The extent of paddy lands in the Puttalam district (figure 8) shows a slight variation after 1992. This is mainly due to the development of paddy lands under the newly established Inginimitiya major irrigation scheme in the Mee Oya basin.

Table 42. Deduru Oya basin land use data (final update, 1986).

Land use category	Area (ha)			
	Status	Area (ha)		% of total
Urban		520		0.20%
	Built-up land	520		0.20%
Agricultural land				
	Homestead	35,050		
	Tea	240		
	Rubber	4,680		
	Coconut	95,560		
	Mixed perennial	1,950	236,635	90.0%
Cropland				
	Paddy	48,655		
	Sparsely used land	50,500		
Forest land				
	Dense forest	4,225		
	Open forest	1,155	8,035	3.0%
	Planted forest	2,655		
Range land				
	Scrub land	4,035	4,090	1.6%
	Grass land	55		
Water bodie		11,410	11,410	4.45%
Barren land		1,420	1,420	0.50%
Wet land				0.05%
	Mangroves	90		
	Marshes	50	140	
Total			262,250	

Figure 6. Land use pattern in the Deduru Oya basin.

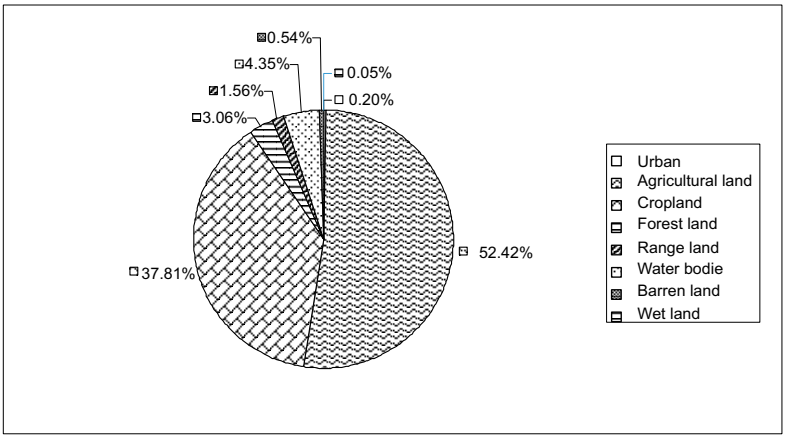
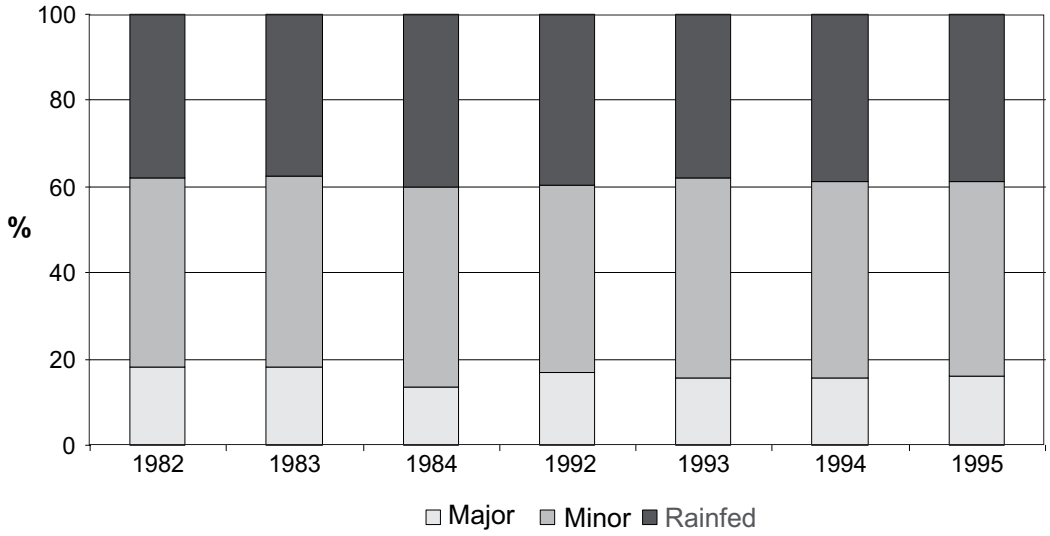
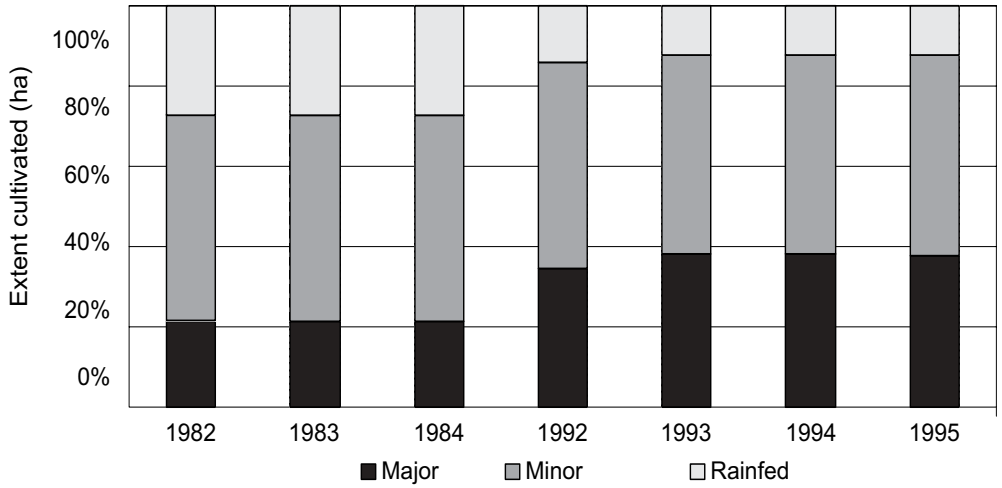


Figure 7. Progress of paddy cultivation, Kurunegala district.



It is assumed that the Deduru Oya basin has the same land use pattern at present.

Figure 8. Progress of paddy cultivation, Puttalam district.



Water Accounting

Water accounting procedures described by Molden and Sakthivadivel (1998) were adopted in this report. Using the data mentioned above, the summary of the results obtained for the cultivation seasons of 1994 *yala* to 1998 *yala* is given in table 43. An analysis on each season is given in tables 4-12 in Annex 3.

Table 43. Seasonal water accounting summary.

Component	1994 yala	94/95 maha	1995 yala	95 /96 maha	1996 yala	96/97 maha	1997 yala	97/98 maha	1998 yala
Climatic condition	Dry	Average	Wet	Dry	Average	Dry	Wet	Wet	Wet
Gross inflow	1,202.11	2,070.78	2,004.56	1,577.77	1,744.64	1,557.96	2,172.40	3,030.58	2,009.53
Storage Changers	258.77	-179.43	71.00	9.14	39.88	-39.88	-9.35	-150.34	150.34
Net inflow	1,406.88	1,891.35	2,075.56	1,586.91	1,784.52	1,518.08	2,163.05	2,880.24	2,159.87
Process Depletion	614.86	984.53	1,018.58	841.78	840.35	967.93	966.94	1,108.57	968.52
Non process depletion (beneficial)	245.40	304.88	386.20	204.50	401.16	204.50	392.46	319.08	392.46
Non process depletion (nonbeneficial)	243.06	195.57	254.90	192.01	485.20	115.70	349.84	134.64	298.97
Uncommitted outflow	357.58	406.37	415.87	348.62	84.81	229.95	453.81	1317.95	499.91

Performance Indicators and Concluding Remarks on Water Accounting

Performance indicators described by Molden and Sakthivadivel (1998) were calculated for the seasons indicated in table 44.

Table 44. Performance indicators for 1994-98.

Season and climatic	1994 yala	94/95 maha	1995 yala	95 /96 maha	1996 yala	96/97 maha	1997 yala	97/98 maha	1998 yala
	Dry	Average	Wet	Dry	Average	Dry	Wet	Wet	Wet
$DF_{(gross)}$	0.92	0.72	0.83	0.78	0.97	0.83	0.79	0.52	0.83
$DF_{(net}$)	0.76	0.79	0.80	0.78	0.95	0.85	0.79	0.54	0.77
$DF_{(avail)}$	0.76	0.79	0.80	0.78	0.95	0.85	0.79	0.54	0.77
$PF_{(depleted)}$	0.56	0.66	0.61	0.68	0.49	0.75	0.57	0.71	0.58
$PF_{(avail)}$	0.51	0.52	0.49	0.53	0.47	0.64	0.45	0.38	0.45

According to the above indicators DF (net) < 1 basin is open and some utilizable water flows out of the basin. Available water is fully utilized only in two seasons *yala* 1994 and *yala* 1996. PF (depleted) indicates the efficiency of water use in the basin.

Process fraction in the range between 0.49 – 0.75 means that there is a possibility for the development of water utilization in the basin. But this gives only the holistic feature of the basin. Qualitative information gathered during the field data collection and under the actual field condition, shows more runoffs in headwater areas located in the wet zone. Middle and tail-end parts of the basin located in the intermediate zone face water shortage problems in dry periods. As the Deduru Oya runs through this area at the bottom of the valley, it does not offer a satisfactory solution to the water shortage in this part of the basin. These spatial variations in the basin should be considered in the plans for increasing water use efficiency in the basin.

The Deduru Oya drainage flow, measured and published in Hydrological Annuals by the Irrigation Department is given in Annex II. Data show that the runoff has been over evaluated. This is very clear when runoff ratio calculated in table 3, Annex II is examined. The gross inflow calculated in water accounting and in Annex II is more or less the same. The runoff ratios resulting from the water accounting are within the realistic range.

Based on water accounting, the Deduru Oya average water resource availability is summarized in table 45.

In *yala* seasons, surface storage and soil moisture released for maintaining the environment in the basin is around 102.1 MCM. Rainfall in *maha* season refills the quantity released in *yala* and neutralizes possible effects of stress on soil moisture.

Table 45. Water availability in the Deduru Oya basin (in MCM).

Component	Yala season	Maha season
Gross inflow	1,826.6	2,059.3
Storage changers	102.1	(-90.1)
Net inflow	1,928.8	1961.1
Total depletion	1,571.8	1,393.4
Outflow	357.0	575.7

Performance of Irrigation Systems

In this section, an evaluation on the performance of irrigation systems in the basin is provided along with the general information such as the types of irrigation system in the basin, their location, extent cultivated in them under different water availability conditions, the yield and the income from irrigated agriculture.

Classification of Basin Irrigation Systems

In Sri Lanka, the size of the command area is used as a criterion for classifying irrigation systems. The types depending on the size of the command area include small or minor system, medium systems and major systems. The extent of command areas used in this typology is given in table 46.

Irrigation systems are also classified according to the mode of irrigation. Based on this, irrigation systems can be classified as reservoir or tank systems, diversions or anicut systems, and lift or pump operating systems. Classification of main irrigation systems in the Deduru Oya basin using both these typologies are given below in table 47.

It can be observed from table 48 that a large number of small tanks, anicuts, pumps and agro-wells operate in the basin. Command areas of these minor irrigation systems vary from 0.1 ha up to 81 ha. According to the typology based on the size of the command area all these small systems come under the "minor" category.

Table 46. Extent of command areas under different types of irrigation systems.

Class	Size of command area	
	In acres	In hectares
Minor system	Less than 200	Less than 81
Medium system	200 to 1000	81 to 405
Major system	Above 1000	Above 405

Table 47. Classification of main irrigation systems in the Deduru Oya basin.

Name	Mode of irrigation	Storage capacity (MCM)	Command area (ha)	Class
Batalagoda reservoir	Diversion / reservoir	6.00	3253	Major
Hakwatuna Oya reservoir	Reservoir	23.5	2,461.5	Major
Kimbulwana Oya reservoir	Reservoir	7.8	680.2	Major
Magalla reservoir	Diversion / reservoir	9.3	2429	Major
Meddaketiya tank	Reservoir	0.8		Medium
Wennoru wewa	Reservoir	1.8		Medium
Hulugalla wewa	Reservoir	1.9		Medium
Diyathure anicut	Diversion	N/A	415	Medium
Karawita anicut	Diversion	N/A		Medium
Hiriyala settlement scheme	Lift irrigation	N/A	101	Medium
Wellangiriya settlement scheme	Lift irrigation	N/A	85	Medium

Note: N/A = not applicable.
DNA = data not available.

Table 48. Minor irrigation systems in the Deduru Oya basin.

Description	Mode of irrigation	No. of units	Cumulative area (ha)	Class
Small tank	Reservoir	3743	22720	Minor
Anicut	Diversion	356	2592	Minor
Pump	Lift irrigation	2333	2833	Minor
Agro well	Lift irrigation	2062	153	Minor

The major and medium irrigation systems are jointly managed by the farmers and irrigation agencies under the participatory irrigation management policies adopted in the country. Minor tanks, popularly known as village tanks are managed by the farmer communities. Lift irrigation systems in the basin are either community managed or managed by the individual farmers themselves. Almost all the agro-wells are managed by the individual farmers.

Location of Irrigation Systems

As pointed out in the introductory section, the Deduru Oya flows from east to west across NWP of Sri Lanka. The mountainous region is in the extreme eastern part of the basin where elevation rises to about 700m. The characteristic feature of this region is the dominance of strike ridge running in the north- south direction with U shape valleys. The slope of the mountainous region ranges from steep to moderate from north to south. This region falls within the wet zone.

The Deduru Oya basin has four major tank irrigation systems. Three out of the four are located in the eastern geographical boundary of the basin, spatially distributed along north to south. Those are namely the Hakwatuna Oya tank, the Kimbulwana Oya Tank, the Batalagoda Tank and the Magalla Tank which is in the outer layer of the four located in the middle part of the basin. Bathalagoda and Magalla tanks have been augmented by diverting water from the Deduru Oya. For this purpose two diversion structures have been constructed, one in the upstream to feed the Batalagoda Tank, and the other at " Ella" to feed the Magalla tank.

The distribution of different tank systems in different parts of the basin is shown in table 49 below:

Table 49. Distribution of different tank systems in the basin.

Basin area	Climatic zone	Topography	Irrigation type
Head	Wet and intermediate	Steep to moderate slope	Major tank and anicut system
Middle	Intermediate	Moderate slope to flat	Minor tank and lift irrigation
Tail	Intermediate	Flat	Lift irrigation

Land Area under Irrigation

The major sources of the irrigation water in the basin are major and minor tank systems, anicut systems, lift irrigation and agro-wells as shown in table 50. Data show that more than 61 percent

of irrigated lands are under minor irrigation systems and this situation highlights the importance of minor irrigation as a major means for supporting rural livelihood systems.

Table 50. Land area under different irrigation systems.

Description	No. of units	Extent (ha)
Major irrigation systems (reservoirs)	4	8,824
Minor irrigation systems (small tanks)	3,743	22,720
Water diversion systems (anicut)	356	2,592
Lift irrigation systems (pumps)	2,333	2,833
Agro-wells	2,062	153
Total		37,122

Major Crops Cultivated under Irrigation

Paddy is the major crop cultivated under irrigation. Land use figures for Paddy cultivation is 48,655 ha, including the extent under rain-fed conditions. Vegetables like brinjal (egg plant), tomato, capsicum, okra, pumpkins, cucumber, sweet potato, ash plantains and green leaf vegetables are commonly cultivated under lift irrigation systems and agro-wells. Average extents cultivated with these crops are summarized below in Table 51.

Table 51. Crops cultivated under different irrigation systems.

Description	Extent	Yala (ha)				Maha (ha)			
	(ha)	Paddy	%	OFC/veg	%	Paddy	%	OFC/veg	%
Major irrigation systems (reservoirs)	8,824	3,124	35	1,233	14	6,165	70	1,068	12
Minor irrigation systems (small tanks)	22,720	8,634	38	340	1	17,040	75	568	2
Water diversion systems (anicuts)	2,592	596	23	60	2	1,944	75	104	4
Lift irrigation systems (pumps)	2,833	0	0	1,983	70	0	0	2,266	80
Agro-wells	153	0	0	77	50	0	0	138	90
Total	37,122	12,354		3,693		25,149		4,144	

Note: OFC = other field crops veg = vegetables

Farm Income

According to table 38, out of the total area under the basin, 87.27 percent is in the Kurunegala district. Therefore, the general seasonal agricultural pattern in the Kurunegala district was considered as the seasonal agricultural pattern of the entire basin. Farm income from lands under major irrigation systems calculated for this district by the Department of Agriculture is given below in table 52.

Table 52. Income from lands under major irrigation systems (Kurunegala).

Season	Average production kg/ha	Price of produce Rs/kg	Gross income Rs/ha	Profit including imputed cost Rs/ha	Profit excluding imputed cost Rs/ha
1996 Yala	3,450.76	11.04	38,094.74	10,417.82	20,545.21
1996/97 Maha	4,402.37	9.31	40,964.16	6,841.33	21,696.41

Note: Rs97 = US$ 1.

Contribution to National Agricultural Production

As mentioned earlier, the available production data were collected from district levels and they were segregated, based on the proportion covered by the basin. Major portion (87.27%) of the basin area is under the Kurunegala district, 9.6 percent under the Puttalam district and 1.85 percent, 1.22 percent and 0.06 percent, under the Kandy, Matale and the Anuradhapura districts respectively. Hence, the Kurunegala district production data are used here to represent basin figures. About 48 percent of the Kurunegala district production can be considered as equal to the total production in the basin as shown in table 53.

According to the Statistical Abstract 2000, published by the Department of Census and Statistics, contribution of the Deduru Oya basin to national paddy production is given in table 54.

Table 53. Areas of Kurunegala and Puttlam districts coming under the Deduru Oya basin.

Description	Kurunegala	Puttalam	Total
Total area (ha)	481,580	307,240	788,820
Area under Deduru Oya basin (ha)	230,393	23,077	253,469
% of area under the basin	48%	8%	32%

Table 54. Paddy production in the Deduru Oya basin.

Season	Production in ‘000 MT			
	Total of Sri Lanka	Kurunegala	Deduru Oya basin	%
Maha 1994/95	1,759	233	112	6.37
Yala 1995	1,049	146	70	6.67
Maha 1995/96	1,330	102	49	3.68
Yala 1996	731	39	19	2.6
Maha 1996/97	1,457	193	93	6.38
Yala 1997	782	90	43	5.5
Maha 1997/98	1,781	250	120	6.74
Yala 1998	911	83	40	4.39

Performance Assessment

Choice of performance indicators

Though a large number of indicators are available to measure the performance of irrigation systems, indicators proposed by Molden and Sakthivadivel (Research Report 20, IWMI: 1998) are used here for the analysis in this report depending on the data availability at the irrigation systems studied under this project. The indicators used in the analysis include the following:

- Output per cropped area (Rs/ ha) = Production / irrigated cropped area
- Output per unit command (Rs/ha) = Production / command area
- Output per unit irrigation supply (Rs/m^3) = Production / diverted irrigation supply
- Cropping intensity = Extent cultivated per year / command area

Choice of schemes

Based on the data availability, three major irrigation systems in the Deduru Oya basin were selected for comparison. Those are the Hakwatuna Oya, the Kimbulwana Oya and the Batalagoda tank system.

These three systems are located in a line from north to south, towards the eastern border of the basin. Three main tributaries of the Deduru Oya have been dammed to build these reservoirs. The Batalagoda tank system is augmented from the main stem of the Deduru Oya.

Comparison of Performance of Schemes Directly Depending on the Deduru Oya, Result, and Discussion

Overall performance of irrigation systems in the basin

Cropping Intensity (CI) is a good indicator to measure the overall performance of different types of irrigation systems grouped in the basin. CI is comparatively high in *maha* season (table 55) when compared with water short *yala* seasons (table 56). It can also be observed that major irrigation systems have higher CIs when compared with minor irrigation systems without reliable water supply.

As the comparison shows, the highest CI is reported from the Kimbulwana Oya system for both years considered (figure 12) in the analysis. The Hakwatuna Oya system has a moderate CI and low temporal variation compared with the Batalagoda system. Land productivity is high in the Kimbulwana Oya when compared with the other two systems (figures 9 and 10). The lowest productivity is reported from the water short Hakwatuna Oya system. However, when the productivity of water is considered (figure 11) it is the Hakwatuna Oya scheme that shows the highest output per unit of water.

Table 55. Seasonal cropping intensity (Paddy cultivation), maha season.

Season	Scheme	
	Major	Minor
1981/82 maha	88%	57%
1982/83 maha	93%	66%
1983/84 maha	73%	79%
1992/93 maha	85%	96%
1993/94 maha	99%	99%
1994/95 maha	98%	78%
1995/96 maha	96%	39%
1996/97 maha	91%	64%
1997/98 maha	98%	97%

Table 56. Seasonal cropping intensity (paddy cultivation), yala season.

Season	Scheme	
	Major	Minor
1982 yala	65%	38%
1983 yala	61%	10%
1984 yala	71%	82%
1993 yala	63%	31%
1994 yala	77%	41%
1995 yala	78%	61%
1996 yala	53%	17%
1997 yala	52%	35%
1998 yala	66%	27%

Figure 9. Output per cropped area.

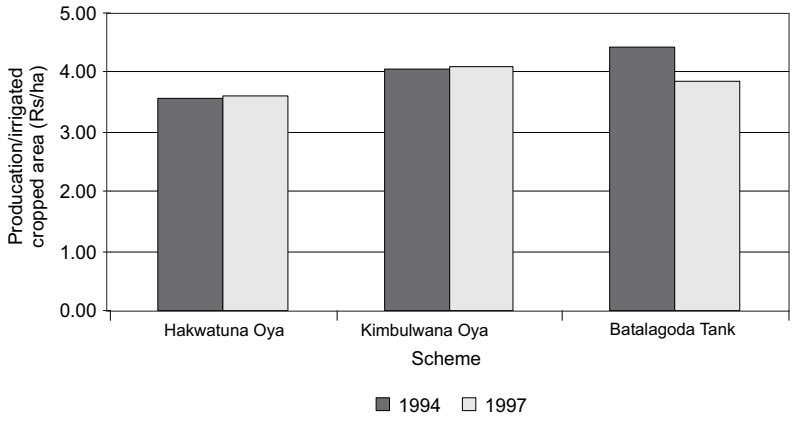


Figure 10. Output per unit command area.

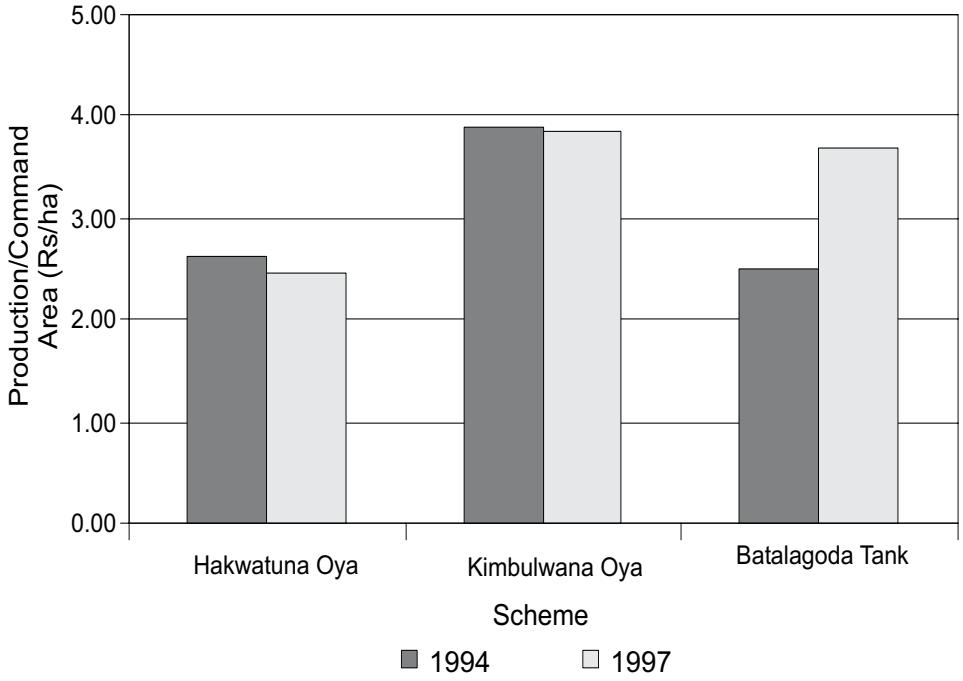


Figure 11. Output per unit irrigation supply.

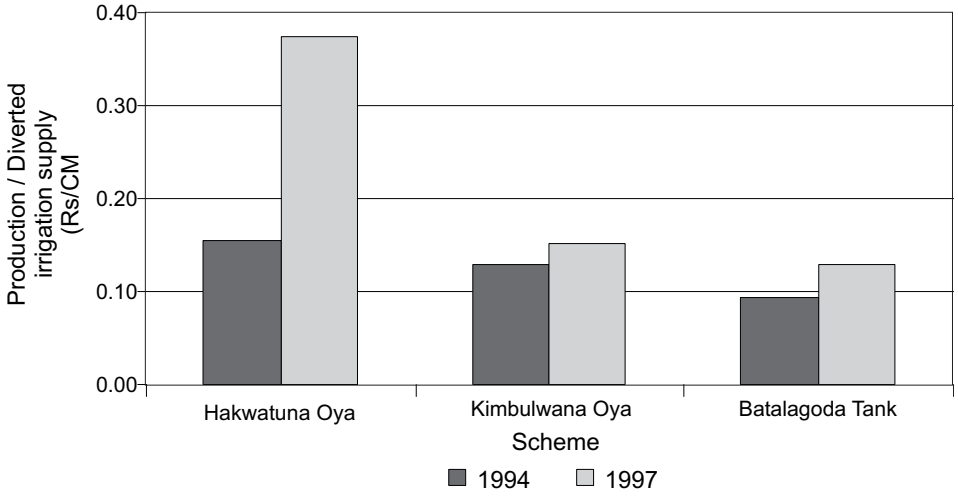
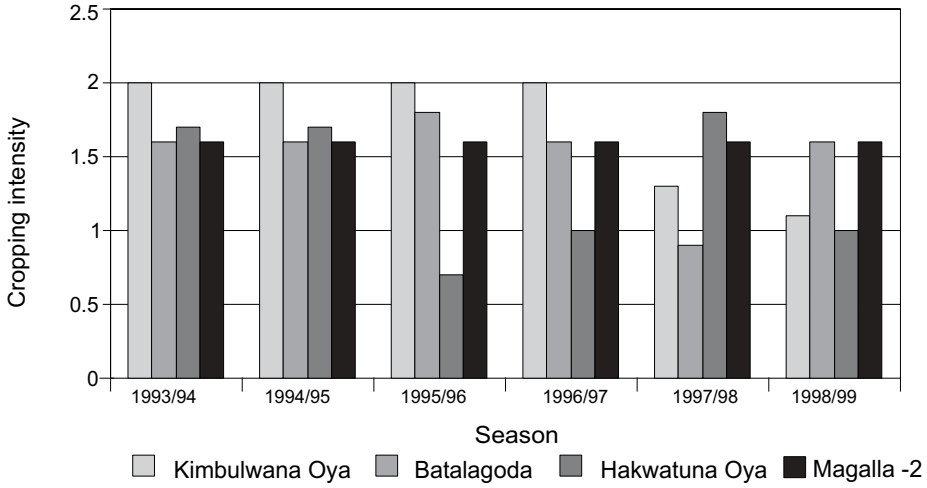


Figure 12. Cropping intensities in major irrigation schemes.



Performance of FMIS Vs Jointly Managed Systems

As described above, the small village tank systems in the basin can be considered farmer-managed even though some bureaucratic involvement can still be observed in them. Major and medium schemes in the basin are jointly managed. However, due to the lack of data on irrigation performance in these systems, especially in minor tank systems, it is difficult to compare their performance with that of the jointly managed major and medium irrigation systems. If we use CI as an indicator, almost all the minor systems report low CIs when compared with major systems. This is mainly due to the lack of reliable water sources for minor systems that generally depend on rainfall alone in their small catchments.

However, it could be understood at group meetings with farmer leaders in the small tank systems that they face water shortage problems even in *maha* towards the end of the season. This can be avoided through management efforts like regulating water issues and the maximum use of rainfall. In some small tank systems, farmers pay the turn out operator for managing water while in some, a farmer representative operates the system without a payment. Water management activities were understood to be effective in small tank systems in which an incentive is available for the system operator.

The four major schemes, Batalagoda, Kimbulwana, Ridi Bendi Ella and Hakwatuna Oya are jointly managed. Except Kimbulwana Oya which is a MANIS system, the other three are under INMAS program. The assessment of the performance of the three systems, Batalagoda, Kimbulwana and Hakwatuna Oya has been attempted in the previous section. The water abundant Kimbulwana Oya system has the highest CI and productivity, the Batalagoda system, a moderate CI and productivity, and the Hakwatuna Oya system , the lowest CI and productivity. However, as far as productivity per unit of water is concerned the highest productivity is reported from the water scarce Hakwatuna Oya. As our data and information show, the Kimbulwana Oya can be considered a better-managed system. There have been attempts in the past for effective management

of water resources in this scheme. Evidence is there that farmers participate in system management activities effectively even at present through the joint management committee system. However, though performance of Batalagoda scheme reports moderate CI and productivity, it is a poorly managed system. There are many reasons for management problems in this system. One main problem is the physical system, which lacks field canals to feed many individual allotments. Under such circumstances, water management in a system like Batalagoda is extremely difficult. In spite of water abundance, tail-end farmers of Batalagoda face water shortage problems due to this reason. Also, the physical system is highly dilapidated. On the other hand, irrigation community in Batalagoda is also very different from those of the other dry zone settlements. They are old villagers living in different villages scattered over the area. Their residential pattern is a real constraint for interaction among the farming community, sharing water from the same source of irrigation. There is a difficulty in forming organizations based on an irrigation system as the canal system lacks DCs and FCs on which the IMD irrigation organizations have been designed. FOs have become less effective due to this problem. The IMD project committee is reported to be very weak in obtaining farmer participation, which is the main tool of IMD for efficient management of an irrigation system. Low productivity in Hakwatuna Oya is mainly due to water scarcity. There are efforts to grow OFCs in water short seasons. As far as water productivity is concerned the Hakwatuna Oya system excels in the basin.

However, the commonly stated problem in these systems is the poor farmer participation in O&M. It was pointed out at the PRA sessions that FOs are weak to handle O&M responsibilities even though the management of DC level and below it has been handed over to them.

Conclusions

Performance of irrigation systems in the Deduru Oya basin is constrained by various socio-economic, institutional and physical factors. In minor and medium tank systems, water shortage is the main factor influencing low performance even though there are possibilities for further improvement through management efforts such as the control of water issues and the maximum use of rainfall etc. by the irrigation communities. Many of these systems are highly dilapidated and require the effort at the government and community level to bring them to proper functioning to improve their performance. Also, it should be explored whether supplementary irrigation to these systems is possible from the Deduru Oya and its tributaries.

Except in water short Hakwatuna Oya, cropping intensity and productivity are high in major schemes like Batalagoda and Kimbulwana but they perform poorly as far as water productivity is concerned. Excessive use of water is reported from these water abundant systems, especially from Batalagoda. However, water management in this system is constrained by the design of the physical system as well as institutional factors. Also, the deterioration of the physical system is a major problem in effective management of water. Rehabilitation and renovation of the physical system is required to improve the performance of this system. However, in systems like Kimbulwana Oya, water productivity can be improved through management efforts alone.

Chapter 6

Water Resource Management Problems, Issues, and Remedial Action

Introduction

Based on the findings of the studies discussed in previous chapters, this chapter summarizes the water resource management problems and issues, and recommends interventions and action for introducing institutional changes for integrated water resource management in the Deduru Oya basin. It should be emphasized however that creating a favorable institutional environment for water resource management is a difficult task, involving a long process. It requires political will, and a better understanding of its importance by the different stakeholders such as resource users, and the institutions and organizations involved in development and management of water, financial and other resources for the development of infrastructure, conservation of land and water resources, and the livelihood enhancement of the poor. Attempts for such institutional changes should cover various hierarchical geo-political levels of the country. These levels include national levels responsible for policy formulation as well as the translation of such policies into national programs, and other geo-political levels such as province, district, division and grassroots, implementing projects and programs under the national level policy initiatives. The Government of Sri Lanka is initiating policy changes and other institutional reforms for efficient and sustainable management of water resources in the country through a project financed by the Asian Development Bank (ADB). A water resources policy document was developed in the year 2000 under the initiation of this project, and approval of the cabinet was obtained for its implementation. But due to objections by the environmental organizations, NGOs and opposition political parties, the government failed to proceed with the introduction of institutional and other reforms proposed in the policy document. Due to these problems, the process of policy formulation and development of legal framework for improved water resources management had to be restarted. At present, the Interim National Water Resources Authority (INWRA) established under the ADB project for policy formulation has proposed some changes in the policy formulated by its involvement in the year 2000 through a process of stakeholder consultation. This chapter intends to provide a feedback to the INWRA and the agencies involved for consideration in policy formulation based on the studies carried out in the Deduru Oya river basin. Therefore, the institutional changes proposed in this report reflect real water resource management problems and institutional problems in a river basin context. The national level institutional changes required for facilitating basin level institutional changes for water resources management are also briefly discussed in the paper.

Major Issues and Problems

Water resource constraints and issues

Surface water used for irrigated agriculture

Seasonal and spatial scarcity of water in the river is the main problem for agriculture and other livelihood activities in the basin. Except in Kimbulwana Oya scheme, the cropping intensity in all major schemes is less than 1.8. Shortage of water is the main reason for low cropping intensity. Out of 4 major systems, Hakwatuna Oya suffers more than the other schemes, due to this problem. This trend may continue unless action is taken to improve water management while introducing changes to the cropping patterns adopted in the scheme.

The situation in many small tank systems is serious regarding water availability. At present, the cropping intensity, even during *maha* season, is less than .7 in many small schemes located in the dry portion of the basin. Silting and sedimentation of tank beds has further aggravated this problem. The Government does not have a clear policy or program for desilting small tanks. This would create serious water scarcity problems in many small tank systems in future.

Lift irrigation systems along the river too are faced with severe water scarcity problems due to the sinking of water levels in the river during dry periods. When river water level goes down, farmers have to increase the length of the pipes used for water tapping. Also, they have to use more powerful pumps (deep well pumps with higher horsepower) to extract water. On many occasions, water is not available in the river for pumping out even with such alterations. This situation prevails in the dry zone areas of the basin where water is the critical factor affecting cultivation activities. Also, this is the area where suitable lands are available along the riverbanks for cultivation. This situation would aggravate due to intensive sand mining that leads to further deepening of the river.

Groundwater resources used for agriculture

The pressure on the existing land resources has tremendously increased due to the population explosion in the 20th Century. There has not been a significant increase in paddy lands to match the population pressure. As a result, people have to turn to highland cultivation for which extraction of groundwater is required. This has already led to the increase of agro-wells in the basin. Many of the agro-wells constructed in the dry zone areas of the basin lack sufficient water for agriculture. Therefore, cultivation activities under agro-wells are carried out only in *maha* season with supplementary water from rain. Cultivation in *yala* season with agro-wells is limited to small patches of land. In spite of this fact, the construction of agro-wells still continues. It was also reported that agro-wells in the basin are under utilized (0.27 ha per well), mainly due to the marketing problems faced by the farmers. The agro-wells are being constructed under donor funded water resources development projects, NGO supported projects or by the farmers themselves with their own funds. Clear policies, procedures, rules or regulations over groundwater extraction are not available in the country. Due to this institutional vacuum, over-exploitation of groundwater resources that would finally lead to serious ecological problems is possible.

Domestic sector

Currently, about less than 6 percent of the total families in the basin have access to pipe borne water. They are mainly the residents in urban centers of the basin. Others depend on other sources of groundwater and surface water. With the rapid fragmentation of lands for home gardens, the construction of wells to obtain water for domestic needs would be a problem. Further, due to the negative impacts of urbanization and industrialization, both surface and groundwater resources are being polluted. This also would create serious problems in finding good quality water for domestic use in the near future. Therefore, the government will have to implement various programs and projects for providing domestic water to the people in different parts of the basin. For this purpose, the sources such as the river and its tributaries, and irrigation tanks and groundwater will have to be tapped. At present some tributaries have already been used for domestic water supply schemes. During the dry season, the Magalla domestic water supply scheme is faced with problems due to inadequate water in the sources. It is extremely difficult to find locations in the basin to construct wells for groundwater for domestic needs in sufficient quantities throughout the year. There is a proposal for obtaining water for domestic water supply from the Magalla tank. It may lead to conflicts among farmers.

Lift irrigation sector

There is no legal restriction on water tapping from natural water bodies like rivers and streams. As in many other rivers and streams, the tapping of water in the Deduru Oya and its tributaries occurs and there is no institution responsible for managing the water extraction from these common resources. Farmers who pump water from the river are much concerned about the time taken for pumping water mainly due to the cost involved in pump operation. Therefore, wastage of water is not a problem. But these farmers need some technical inputes for improving the productivity. These inputs include agricultural technology and extension services etc. As our discussions with the water users revealed, there would be a significant increase in the use of water pumps in future.

Industrial sector

The existing small scale industries — mainly rice milling, brick making etc., are confined to locations close to natural or man-made water bodies like the Deduru Oya or irrigation canals or tank systems. Therefore, water shortage is not a problem at present in general for these industries. But during some dry months, these industries too are faced with problems due to inadequate water. When water levels go down in the river and its tributaries, the brick makers in the dry zone part of the basin have serious problems. The rice millers also have problems due to inadequate water in their wells (close to irrigation canals) during the off-cultivation seasons. The government is keen on promoting industries in the area, and in future, such programs will be constrained due to inadequate water for industrial use in many parts of the basin, especially a large area coming under the dry zone.

Livestock farming

Except a few medium scale livestock farms located in the Deduru Oya basin, other livestock keepers operate in small-scale, and practice livestock keeping as a cottage industry. The water required for animals is obtained from wells in the home garden or small tanks located in the village.

Feeding animals, especially cattle, is a real problem for livestock farmers. During off-seasons, the paddy fields are open for the cattle to roam about and graze. However, under fallow, they get dried up in the dry zone part of the basin leaving nothing for the cattle to feed on. Providing water for the cattle also becomes a problem when the village tanks dry up in the dry periods of the year. There is no sufficient water even in the wells for the use of the animals. The people living close to the river and its tributaries can obtain water for their animals. These water and fodder scarcity problems set limits to the expansion of livestock farming, especially cattle farming in the basin. Therefore poultry farming has become very popular in dry-zone areas like the Kobeigane DS division in the basin.

Freshwater fishery

Serious problems are less likely to occur in fishing activities in major tanks due to water availability throughout the year. Fishing activities in the small tanks may not be possible under the present water scarcity situation. At present, fishing is a seasonal activity in many small tanks. It starts in small tanks at the end of *maha* cultivation. In many tanks, water available for *yala* paddy cultivation is not sufficient and therefore, farmers in them decide to leave water in the tanks for the fish. If there is no cultivation, farmers in the villages catch fish for several months from the *yala* season till tanks get filled up with *maha* rains. In some tanks, farmers do paddy cultivation in a portion of the command area (bethma system) in *yala*. On such occasions tank water levels go down leaving no water in the tanks for the fish to survive. Though farmers have customary rules prohibiting fishing during cultivation seasons, they are allowed to do fishing if the tank gets dried up. However, villagers cannot do fishing for a longer time period on such occasions due to the non-availability of water for fish breeding and survival. Fishing activities in *yala* under such circumstances are limited to a day or two. There are interventions by the government to increase the cropping intensity in *yala* by the cultivation of OFCs. This would really affect fishing in the small tanks due to water scarcity problems.

Water quality

Water quality deterioration is not a serious problem for cultivation in the major part of the basin. However, seawater intrusion is a problem in the tail part. The cultivation in such areas gets affected. The major cause for seawater intrusion is excessive sand mining. If the current system of sand mining continues, this problem would be aggravated in the near future. The government has understood the problems related to unregulated sand mining and has made attempts to control sand mining. If these strategies work, the problem may not be very serious in future. Shrimp farming has also contributed to fresh water pollution in the tail part of the basin. The Government has made a decision to stop issuing new permits for shrimp farming in the coastal areas of NWP. If this decision is implemented the negative impact of shrimp farming on water resources can be arrested.

Poor quality of water is a serious problem for domestic water users in the tail-end of the basin. Water salinity is reported from shallow wells in some areas in the middle portion of the basin too. This may be due to the condition of the soil in such areas. Pollution of water in some tributaries is also a problem, as such sources cannot be used to establish domestic water supply schemes. Maguru Oya is one such tributary polluted due to the discharge of wastewater and sewage from the Kurunegala town and hospital. The people in the Wariyapola town need a pipe borne water

supply scheme, but Maguru Oya which is the potential water source, can not be tapped to provide water to these people due to water pollution in this stream.

Riverine and coastal resources

Due to the practices like sand mining in the river bed and brick making along river banks, the river has been deepened and widened. Deepening of the river is reported to have serious consequences such as groundwater depletion in the head and tail-end part of the basin and sea water intrusion in the tail-end area.

Land and water resources in the coastal area have also been affected due to shrimp farming activities. The release of pollutants and sea water from shrimp farms to lagoons, natural water courses and paddy lands has serious negative impacts on land and water resources in the area. In the process of developing shrimp farms, natural vegetation like mangroves has been destroyed, causing environmental damage.

Institutional issues

As mentioned above, there are several sectoral organizations responsible for managing water for specific activities and no integrated approach for water resource management can be observed in the basin. There is no system of water allocation among different uses (agricultural, domestic, industrial, etc.). No Institutions or practices and procedures exist to oversee the manner of water use and the management of each sector comprehensively. This would create serious problems over water allocation and distribution, and the control of water pollution. With the increase of demand for water by different sectors like industries etc., a mechanism for water allocation among contending parties will be much needed. Also, there will be competition and conflicts within water user sectors such as farmers diverting water for different schemes along the Deduru Oya and the domestic water users depending on water from the same source. With the urbanization, industrial development and population increase, water resources are likely to get polluted as reported from the Kurunegala municipal area. An integrated approach for water resource management in a basin context is required to address all these problems.

Socio-economic issues

The main socio-economic issue in the basin is the high incidence of poverty. Out of the total families in the basin, more than 61 percent receive assistance under the government poverty alleviation program indicating widespread poverty in the basin. Poverty is as high as 80 percent in DS divisions in urban areas close to the Kurunegala city and in the DS divisions in the dry zone areas.

Unemployment is the other major problem in the basin. The average rate of unemployment in the basin was around 40 percent in 1999. In some DS divisions, rate of unemployment is over 50 percent. The rate of unemployment was comparatively high in urban areas. The study further reveals that the rate of unemployment is on the increase (30%) over the last 10 years in the basin sample DS divisions.

Poverty and unemployment have a negative impact on natural resource base in the basin as the unemployed people tend to exploit natural resources for their livelihood. Activities like brick making and sand mining can not be curtailed due to this reason.

Action Proposed to Arrest Problems

The major problems and issues that emerged in this study include resource related-problems, socio-economic problems and institutional problems. The resource-related problems include mainly, (1) low productivity of land and water resources and (2) problems related to long term sustainability of land and water resources. When closely examined, both these are more or less the result of institutional problems. Socio-economic problems in the basin too result mainly from the low productivity of land and water resources resulting from institutional weaknesses. Therefore, socio-economic problems as well as resource-related problems can be fully solved only through the institutional reforms that have been proposed by the Interim Water Resources Authority. Following steps are proposed to be implemented along with the institutional reforms to find solutions to the problems discussed in the previous section.

Low productivity of land and water resources

One main problem in the basin is low cropping intensity and low productivity in minor irrigation schemes and agro-wells. Comparatively, a high performance is observed in lift irrigation systems (pump irrigation systems along the river and its tributaries), but they have potential for further improvement too. Temporal and spatial variations in performance related to yields and productivity are reported from major and medium irrigation schemes. As there are well-established formal institutional mechanisms in the major irrigation schemes to address performance-related problems, no interventions are proposed in this study to improve the management of these schemes in the short run. However, there are many valid reasons for proposing interventions for performance improvements in small tanks, agro-wells and lift irrigation systems. First, their magnitude in terms of geographical spread and the number is very high. Therefore, improved performance of agriculture in them would definitely contribute to increase overall agricultural production in the basin. It is noteworthy that these three categories of irrigation schemes provide irrigation to small command areas ranging from 10 – 80 acres in most of the cases. The beneficiaries under these systems are mostly economically disadvantaged poor small-holding peasants. Since there are about 2500 small tanks and 2000-2500 agro-wells and lift irrigation schemes in the basin, the number of families depending on them is remarkably high.

Both water and non-water factors contribute to the low productivity in these systems. In small tank systems, cropping intensity is around 90 percentage even in *maha* (wet) season due to water shortage. However, it was revealed that productivity in the small tank systems could be increased through the introduction of new technologies and the efficient management of scarce water resources. In most cases the agro-wells are under-utilized. This is mainly due to reasons such as marketing problems and the problems associated with cropping systems adopted by farmers. Some lift irrigation sachems in the basin perform extremely well while in some, the performance is very low. Non-water factors significantly contribute to the low cropping intensity and low yields in agro-wells and lift irrigation schemes. It was understood through stakeholder consultations that cropping intensity and the yield could be remarkably increased in agro-well schemes and lift irrigation schemes through appropriate institutional and technological innovations.

Constraints in interventions under action phase

The interventions need a favorable and positive environment for their implementation. The existing organizations need reorientation in their roles and functions for improved performance. The ADB-

assisted project on the development of water resource-related policies intends to establish favorable institutional environment in the basin areas and in the country for implementing activities that would lead to sustainable management of water resources. It is understood with the recent decisions of the government to refrain from producing the re-drafted water resources policy before parliament, that the process of introduction of changes in Sri Lanka would be slow. This would be a serious constraint on the implementation of institutional changes in the country. However, this paper highlights the possible actions that would lead to efficient and sustainable water resources management in the basin in the short and long run.

Strategy Proposed for Productivity Improvement in Three Types of Irrigation Schemes

A program to increase the agricultural production in small tank systems, agro-wells and lift irrigation systems is proposed to address the problem of low productivity in these systems. This program needs to be pilot-tested in a selected sample through participatory action research. The parties that should involve themselves in this action research include the Department of Agriculture (DOA), the Department of Agrarian Services (DAS) and the Farmer Organizations (FOs) in the case of small tank systems. The Agricultural Development Authority (ADA), DOA and individual farmers are required to participate in the agro-well program. The individual farmers and DOA would be the main actors with regard to the lift irrigation schemes.

The lessons learned through this pilot project can be replicated in the other schemes in the long run. However, IWMI cannot decide the mode of implementation in both short and long runs. It has to be decided collaboratively by all the parties that would be involved in this action–research program. However, the chronological steps that may be possible for implementation of the proposed action, in the short run, are highlighted in tables 57, 58 and 59.

Table 57. Activities proposed for short run small tank systems.

Activities	Responsible actors	Time required
• Awareness raising session on the need of interventions	• DAS through its committee meetings. Commissioner of DAS should provide strategic and institutional support for the program of awareness creation that will take place at Agrarian Service Committees.	• Two weeks for implementation in the selected sample agrarian service centers
• Selection of six agrarian service divisions in which small tanks are located (representative divisions)	• Deputy commissioner of DAS in basin area in NWP, DSs in the basin area	• Two weeks
• Identification of problems that need solutions	• Divisional Officers of DAS with farmer leaders. Officials of DOA will provide technical assistance.	• One month
• Development of strategies to address the problems	• Divisional Officers of DAS with farmer leaders. Technical assistance will be provided by officials of DOA.	• One month
• Implementation of feasible strategies in small tank schemes	• Farmers and FOs, DAS and DOA. A party with experience on documenting the lessons should document the planning and implementation process of the interventions for identification of the feasible interventions for replication in the rest of the agrarian service divisions in the basin and elsewhere in the country.	• One year (two typical cultivation seasons, maha and yala)

Note: DAS = Department of Agrarian Services DSs = Divisional secretaries NWP = North Western Province
DOA = Department of Agriculture FOs = Farmers Organizations

Table 58. Possible interventions for agro-wells.

Activities	Responsibilities	Time frame
• Classification of agro-wells in the selected sample agrarian services divisions based on their performance (poor, moderate and well performing in terms of cropping intensity and yields)	• DAS, DOA, farmers	• Two weeks (parallel to work in small tank systems)
• Identification of reasons for performance variations	• DAS, DOA, farmers	• Two weeks (parallel to work in small tank systems)
• Implementation of feasible strategies to improve cropping intensity and yields and also to identify new changes in management of agriculture with agro-wells including farmer behavior	• DOA, DAS, ADA and farmers. A suitable party to document the process of implementation of the activities should be employed to learn the lessons that can be replicated in other areas of the basin and elsewhere.	• One year, two cultivation seasons (parallel to activities under small tank systems)

Note: DAS = Department of Agrarian Services DOA = Department of Agriculture
ADA - Agricultural Development Authority

Table 59. Possible interventions for river lift irrigation schemes.

Activities	Responsibility	Time frame
• Preparation of inventory of river lift irrigation schemes and mapping the locations	• Divisional officers of DAS. Individual farmers/ farmer groups and DOA	• Two weeks
• Classification of river lift irrigation schemes in terms of cropping intensity, cropping patterns and yield etc.	• -do-	• Three weeks (parallel to first activity
• Organize mutual learning program from well performing lift irrigation farmers	• DAS, DOA and well performing farmers and poorly performing farmers. The lessons for replications in other basins should be properly documented.	• One year, two agriculture season

*Note:*DAS = Department of Agrarian Services DOA = Department of Agriculture

Problems Regarding Long Term Sustainability of Land and Water Resources

Several problems that have endangered the long-term sustainability of land and water resources in the basin were identified in this study. They include:

- Excessive sand mining in the Deduru Oya river and its tributaries.
- Brick making on the river reservations.
- Other developments in the river reservations.

- Pollution of water in the river and its tributaries.
- Unplanned groundwater extraction.
- Undesirable development activities and interventions including deforestation in the catchment areas of small tank systems.

In the short run, a program can be initiated to make people aware of these problems and to draw up plans to address them. The action for long-term solutions should be initiated through the existing institutional mechanisms in the basin area. The relevant reforms in laws, regulations and other institutional changes can be attempted while implementing pilot project activities intended to be implemented by the Interim National Water Resources Authority (INWRA) under the ADB assisted water management project in future.

The possible short-term interventions to initiate actions in this regard are as follows:

Excessive sand mining in the river bed

Joint awareness sessions should be held with the participation of DSs, pradesheeya sabha chairmen, and representatives of the Geological Survey and Mines Bureau. These meetings can be used to develop methods for doing sand mining in a way that would not create problems for the river and the related eco-systems. These strategies should include changes on the permit system, identification of critical locations that have to be avoided when mining, the monitoring system required, the responsibilities of each party etc. These proposed meetings should be held in six sample DS division areas in which excessive sand mining is done.

Brick making on river reservations

A series of strategic planning sessions should be held with the pradeshiya sabha staff and the staff of agencies at DS level, to analyze the impact of brick making on the river banks and come out with solutions acceptable to both parties; the agencies responsible for protecting river banks and the brick makers. The participation of the public health inspectors attached to pradeshiya sabhas should also be sought at these meetings. These sessions should be held in the six DS divisions selected for the other interventions referred to above. The result expected from these sessions include better understanding of the implications of unplanned brick making on the stability of the river banks and the contribution of brick making to the mosquito problem etc. The possibilities for brick making without serious harmful impacts on environment, too can be explored at these meetings.

Other developments in river reservations

Clearing of the forest cover and cultivation activities in riverbank areas prevail in the basin. This problem can be discussed at the DS level Agricultural Committee (DSAC) meetings held in each DS division. At present, the problems related to river reservations are not discussed at DSACs. DSACs can workout programs to study the magnitude of this problem in their jurisdiction, and discuss with the encroachers and propose suitable solutions for the long-term sustainability of river reservations.

Pollution of water in the river and tributaries

The major cause for water pollution in the river and its tributaries is the unplanned urbanization process. For example, one main tributary of the Deduru Oya (Maguru Oya) in the Kurunegala town area has been polluted due to the discharge of sewage and wastewater into the tributary. This type of problems are observed in other townships too. At present, a project for the improvement of storm water drainage is being implemented in Kurunegala with ADB financial assistance. It is not known whether this project would address the problems related to wastewater and solid waste management. Once the River Basin Committee is established as planned by INWRA, this matter should be discussed with the implementers of the storm water management project in the Kurunegala town. The possibility of including a program to manage the wastewater and solid waste should be explored in these discussions. The National Water Supplies and Drainage Board (NWS&DB) may be contacted to explore the possibilities of testing the water quality in Maguru Oya. The zone manager of NWS&DB will be the key person for this action. Similarly a program should be drawn up with sample pradesheeya sabhas, and Town and Urban Councils in the basin to arrest surface water pollution due to sewage, waste water and garbage disposal.

Unplanned groundwater extraction

The necessity of a methodology for deciding the number of agro-wells in a given sub-watershed should be discussed with authorities in each DS division. This may lead to enhance their knowledge on the requirement of a proper plan for groundwater extraction.

The methodology developed by IWMI with the technical assistance from the University of Peradeniya for the North Central province (Senaratne 1997) may be discussed with the authorities concerned to enlighten them on this aspect. This will help them to develop a database on the groundwater potential and make appropriate decisions on groundwater extraction.

Undesirable development activities and interventions including deforestation in catchment areas of small tank systems

Deforestation and encroachment of small tank catchments for settlement and cultivation purposes has endangered their long-term sustainability. Cultivation in foreshore areas is also a major problem in many of these tank systems. Tanks have been silted up due to these development activities in the catchment. Therefore, it is required to draw up a program for the protection of tank eco-systems in small tanks with the involvement of the DAS and DSs. DSAC can be used for planning and implementing this program with the participation of NGOs and Community Based Organizations.

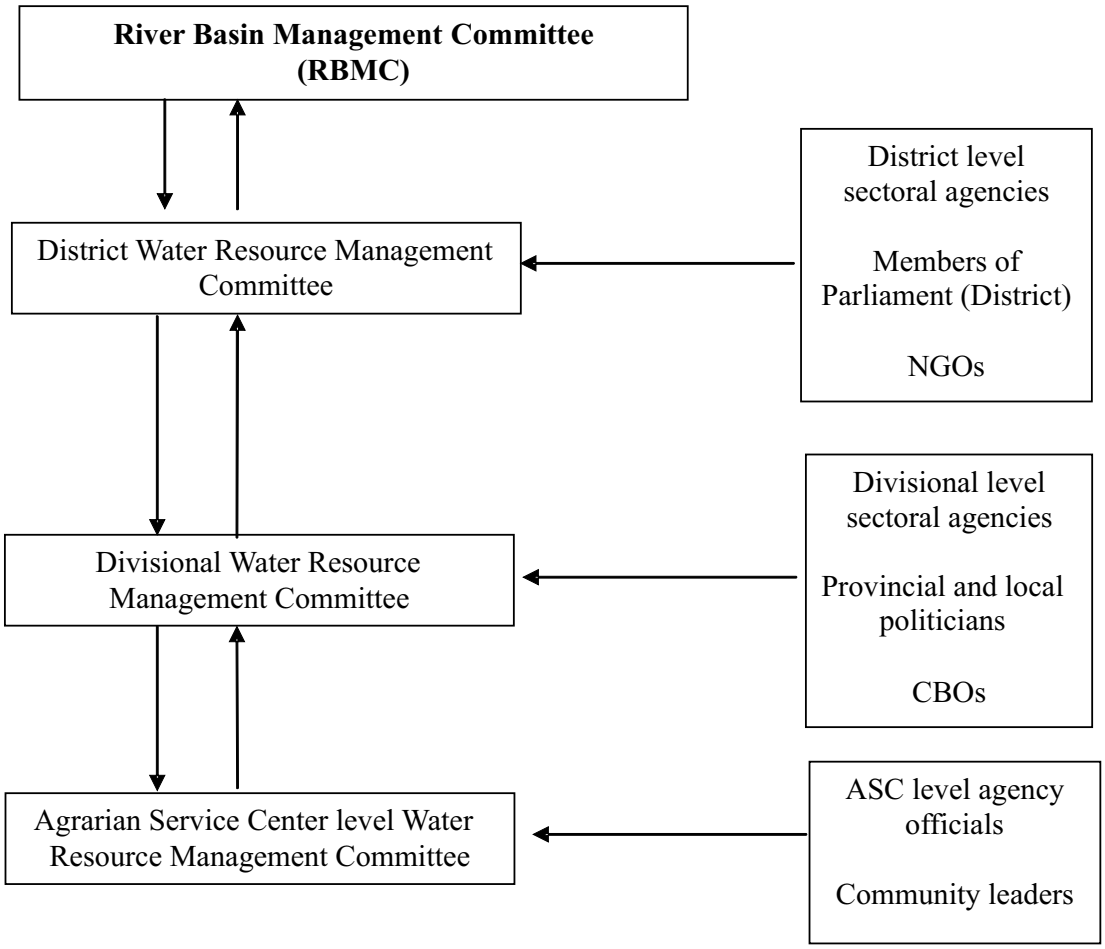
Interventions for Institutional Change

To carry out the short-term and long-term activities related to the management of land and water resources effectively in the basin, certain changes on the institutions at macro-level and basin level are required. The Water Resources Secretariat (ADB financed water management project) has proposed institutional changes required at national level for sustainable management of water resources in a river basin context. These changes include establishment of an apex body comprising three new institutions with new mandates. These three institutions include the National Water

Resources Authority, Water Resources Council and the Water Resources Tribunal. Further, the new institutional changes suggested by the water resources secretariat include the establishment of river basin organizations for a single basin or several basins in the country, depending on the specific requirements.

Need for building linkages among different agencies working at DS, District, Provincial and Central Government levels was intensively discussed during stakeholder consultations in phase 1 of the study. Most of the key stakeholder agencies recommended linking existing coordination committees in the basin to the river basin organization. The only structural change they recommended was to establish a River basin organization. The other changes recommended included functional changes of the existing coordination committees. The coordination mechanism suggested by the stakeholders is given in figure 13 below:

Figure 13. Suggested new organizational structure for the Deduru Oya basin.



The proposed institutional changes in figure 1 should be discussed with the members of the different committees mentioned therein. The awareness creation on new functions to be incorporated into the existing coordination committees, should be the responsibility at different coordination committee meetings. The functional changes that may be discussed are as follows:

- Exploring the possibilities of including natural resource management as one of the mandatory functions of the coordination committees.
- Attempting to encourage line agencies to collect and provide relevant information to the committees to make decisions.
- Identification of the level or the capacity of the coordination committees to carry out functions related to integrated water resource management (skills, power and authority etc).
- Attempting to develop mechanisms for improving communication among different levels of the committees concerned.
- Attempting to develop a monitoring and evaluation system (M&E system) to measure the effectiveness of different water resources management agencies.

The staff of INWRA can attend coordinating committee meetings to gear the agencies concerned to draw up plans and implement integrated water resource management activities in an action research mode.

Concluding Remarks

The study conducted and the nature of actions proposed have created significant opportunity for INWRA to carry out a long term program for testing the innovations for the establishment of an appropriate institutional environment in the basin. It may take quite some time to establish macro-level institutions including the National Water Resources Authority, Water Resources Council, Water Tribunal and the related legal frame work to make the proposed institutional structure function and manage water resources. Action need not be delayed until these organizations and legal framework are formally established, but the ADB-assisted INWRA can continue the implementation of the actions proposed in this report, in the Deduru Oya basin, for learning necessary lessons for the institutional reforms for the country's water resource management.

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Annex 1

Table 1. Population density and growth in the Deduru Oya basin.

DS division	Population 1999	Area (km^2)	Population density	Population 1989	Population 1993	Population 1999	Growth
Ridigama	89,848	132	681	77,509	-	89,848	1.6
Mawathagama	57,464	68	845	51,416	-	57,464	1.2
Polpitigama	78,720	234	336	66,378	-	78,720	1.9
Ibbagamuwa	84,486	194	435	Re-demarcated	-	-	-
Mallawapitiya	43,835	47.5	923	New division	-	43,835	-
Kurunegala	87,645	107	819	Re-demarcated	-	-	-
Weerambugedara	30,922	59.6	519	27,135	-	30,922	1.4
Ganewatta	38,010	191.2	199	New division	-	-	-
Maspotha	40,551	45.5	891	New division	-	-	-
Maho	52,934	247.5	214	Re-demarcated	-	-	-
Wariyapola	57,298	195.4	293	Re-demarcated	-	-	-
Katupotha	28,389	99.4	286	New division	-	-	-
Kotawehera	20,310	119.4	170	Re-demarcated	-	-	-
Nikaweratiya	38,815	181	214	Re-demarcated	-	-	-
Kobeigane	33,549	125.6	267	30,428	64,775	33,549	1.0
Hettipola	71,120	202.3	352	Re-demarcated	-	71,120	1.6
Rasnayakapura	21,646	132	164	New division	-	-	-
Bingiriya	70,101	185.9	377	52,755	-	70,101	3.3

Table 2. Gender composition and growth in the Deduru Oya basin.

DS division	Population in 1999	Male	%	Female	%	Population in 1990	Males	%	Females	%	Growth rate: male 1999	Growth rate: female 1999
Ridigama	89,848	44,160	49.15	45,688	50.85	77,509	38,886	50.17	38,623	49.83	1.36	1.83
Mawathagama	57,464	28,700	49.94	28,764	50.06	51,416	25,785	50.15	25,631	49.85	1.13	1.22
Polpitigama	78,720	39,362	50	39,358	50	66,378	34,114	51.39	32,264	48.61	1.54	2.20
Ibbagamuwa	84,486	42,665	50.5	41,821	49.5	101,498*	50,412	49.67	51,086	50.33	-	-
Mallawapitiya	43,835	22,054	50.31	21,781	49.69	-	-	-	-	-	-	-
Kurunegala	87,645	42,915	48.96	44,730	51.04	119,558*	58,198	48.68	61,360	51.32	-	-
Weerambugedara	30,922	14,786	47.82	16,136	52.18	27,135	13,606	50.14	13,529	49.86	0.87	1.93
Ganewatta	38,010	18,529	48.75	19,481	51.25	-	-	-	-	-	-	-
Maspotha	40,551	19,961	49.22	20,590	50.78	-	-	-	-	-	-	-
Maho	52,934	26,706	50.45	26,228	49.55	NA*	-	-	-	-	-	-
Wariyapola	57,298	28,095	49.03	29,203	50.97	NA*	-	-	-	-	-	-
Katupotha	28,389	14,057	49.52	14,332	50.48	-	-	-	-	-	-	-
Kotawehera	20,310	10,269	50.56	10,041	49.44	43,758*	22,998	52.56	20,760	47.44	-	-
Nikaweratiya	38,815	19,001	48.95	19,814	51.05	36,659*	18,511	50,,	-	-	-	-
Bingiriya	70,101	38,012	54.22	32,089	45.78	NA*	-	-	-	-	-	-
Chilaw	60,055	29,331	48.84	30,724	51.16	81,508*	40,716	49.95	40,792	50.05	-	-
Arachchikattuwa	38,860	19,373	49.85	19,487	50.15	40,261*	19,978	49.62	20,283	50.38	-	-
Total	1,044,558	520,470	49.83	524,,088	50.17	-	-	-	-	-	-	-

* Data prior to re-demarcation.
Source: DS office.

Table 3. Attendance at educational institutions in the Deduru Oya basin.

DS division	Passed level								
	Preschool %	Yr. 1 -5 %	Yr.5-10 %	GCE (OL) %	Yr.12 %	GCE (AL) %	University educ. %	Degree %	No schooling %
Ridigama	2.0	33.8	42.2	8.3	2.7	2.7	0.1	0.6	7.6
Mawathagama	2	26.4	42.8	9.8	3.7	3.3	0.3	1.4	10.3
Polpitigama	3.8	31.8	49.1	6.3	1.2	2.3	0.2	0.1	5.2
Ibbagamuwa	2.3	29.5	44.8	10.6	1.5	4.7	0	0.5	6.1
Mallawapitiya	3.5	23.9	41.6	14.4	3.3	7	0.3	1.6	4.4
Kurunegala	1.9	25.4	40.8	13.2	4.8	7.2	0.3	1.3	5.1
Weerambugedara	1.9	24.3	45.8	13.9	2.9	5	0	1.1	5.1
Ganewatta	2.1	30.3	44.1	11.7	2.5	2.2	0.1	0.8	6.2
Maspotha	2.5	27.1	40.4	13.1	3.4	7.5	0.2	0.7	5.1
Maho	2.3	31.6	42.8	10.4	2.7	4.4	0.2	0.8	4.8
Wariyapola	1.9	32.5	41.3	10.9	1.5	4.3	0.5	1	6.1
Katupotha	2.3	25.4	50.3	7.8	2.5	4.9	1	0.8	5.0
Kotawehera	4.9	36.5	38.1	7.4	1.6	4.2	0.2	0.6	6.5
Nikaweratiya	2.5	28.5	46.0	8.7	1.8	3.8	0.2	0.3	8.2
Kobeigane	2.5	34.7	42.9	7.8	1.6	4.1	0	1	5.4
Hettipola	2.2	27.8	48.9	9.5	2.2	4.9	0.2	0.3	4.0
Rasnayakapura	4.3	37.2	40.7	6.9	1.8	2	0.4	0.1	6.6
Bingiriya	2.7	33.7	46.1	8.3	2.2	3.1	0.2	0.6	3.1
Chilaw	2.9	24.6	47.4	14.7	2.2	4.9	0.2	0.5	2.6
Arachchikattuwa	2	30.9	49.3	9.1	1	2.4	0.2	0.3	4.8
Kurunegala district	2.7	28.7	44.2	10.5	2.5	4.7	0.3	0.9	5.5
Puttalam district	2.9	31.2	44.4	10.9	1.9	3.8	0.2	0.7	4.0

Source: Department of Census and Statistics, Demographic Survey 1994.

Table 4. Distribution of paddy and coconut lands in the Deduru Oya basin.

DS divisions	Total land area (ha)	Coconut lands	%	Paddy lands	%
Ridigama	19,430	9,559	49	2,911	15
Mawathagama	8,710	5,085	58	1,626	19
Polpitigama	23,936	4,509	19	7,431	31
Ibbagamuwa	21,362	9,563	45	3,950	18
Mallawapitiya	12,526	4,305	34	3,082	25
Kurunegala	9,486	5,393	57	2,015	21
Weerambugedara	6,750	2,657	39	1,717	25
Ganewatta	19,198	9,402	49	2,444	13
Maspotha	NA	7,444			
Maho	NA	NA			
Wariyapola	19,620	10,919	56	2,703	14
Katupotha	9,940	5,218	52	1,714	17
Kotawehera	11,941	1,078	9	3,899	33
Nikaweratiya	13,480	NA		4,828	36
Kobeigane	10,939	6,059	55	1,784	16
Hettipola	NA	NA			
Rasnayakapura	8,472	NA		1,705	20
Bingiriya	14,082	8,947	64	2,447	17
Chilaw	NA	4,437			
Arachchikattuwa	16,868	7,270	43	2,286	14

Source: DS offices and Coconut Cultivation Board.

Table. 5. Distribution of coconut lands.

DS division	< 2 Acres		2 to 5 acres		6 to 20 acres		20 to 50 acres		Above 50 acres	
	No.	%	No.	%	No.	%	No.	%	No.	%
Ridigama	6,234	81.93	1,117	14.68	211	2.77	32	0.42	15	0.20
Mawathagama	10,890	88.41	989	8.03	377	3.06	46	0.37	15	0.12
Polpitigama	1,406	52.04	1,164	43.08	94	3.48	26	0.96	12	0.44
Ibbagamuwa	8,944	92.78	541	5.61	97	1.01	40	0.41	18	0.19
Mallawapitiya	4,113	87.27	204	4.33	321	6.81	74	1.57	1	0.02
Kurunegala	5,263	85.93	476	7.77	304	4.96	73	1.19	9	0.15
Weerambugedara	3,893	72.23	1,082	20.07	337	6.25	62	1.15	16	0.30
Ganewatta	1,049	49.00	-	0.00	967	45.17	97	4.53	28	1.31
Maspotha	7,039	73.98	-	0.00	2,399	25.21	64	0.67	13	0.14
Maho	-	-	-	-	-	-	-	-	-	-
Wariyapola	7,005	60.99	3,838	33.42	533	4.64	102	0.89	7	0.06
Katupotha	5,200	62.55	2,900	34.89	147	1.77	40	0.48	26	0.31
Kotawehera	-	-	-	-	-	-	-	-	-	-
Nikaweratiya	-	-	-	-	-	-	-	-	-	-
Kobeigane	4,000	50.35	3,180	40.03	613	7.72	131	1.65	21	0.26
Arachchikattuwa	2,200	46.14	2,361	49.52	114	2.39	83	1.74	10	0.21
	< 1 acre	%	1 to 5 acres	%	6 to 10 acres	%	11 to 50 acres	%	Above 50acres	%
Bingiriya		0.00	79	20.26	115	29.49	171	43.85	25	6.41
Chilaw	6,745	81.27	1,265	15.24	240	2.89	44	0.53	6	0.07

Source: Coconut Cultivation Board and DS offices.

Table 6. Irrigated and rain-fed paddy cultivation.

DS division	Total no. of (Paddy lands)	Irrigated		Rain-fed	
		No.	%	No.	%
Ridigama	2,911	1,164	40	1,747	60
Mawathagama	1,626	261	16	1,365	84
Polpitigama	7,439	5,843	79	1,595	21
Ibbagamuwa	3,950	2,596	66	1,354	34
Kurunegala	2,015	612	30	1,403	70
Weerambugedara	1,717	245	14	1,472	86
Ganewatta	2,444	1,924	79	520	21
Wariyapola	2,703	1,822	67	881	33
Kotawehera	3,899	2,550	65	1,349	35
Nikaweratiya	4,828	3,033	63	1,795	37
Kobeigane	1,784	1,420	80	364	20
Rasnayakapura	1,705	1,291	76	414	24
Bingiriya	2,447	2,088	85	359	15
Chilaw	1,090	802	74	288	26
Arachchikattuwa	2,286	1,885	82	401	18
Total	42,844	27,537	64	15,307	36

Source: DS offices.

Table 7. Minor irrigation schemes (amunas and small tanks) in selected DS divisions.

DS division	Agrarian service center	Total No.	Command area (ha)	Families	
				No.	% of the total
Ridigama	Dodamgaslanda	35	123	1,409	-
	Karadagolla	18	319	1,315	-
	Ranbadagolla	49	341	2,995	26
Ibbagamuwa	Ibbagamuwa	83	1,364	1,903	-
	Melsiripura	102	542	1,880	20
Ganewatta	Ganewatta	40	332	973	-
	Kumbukgete	53	311	944	21
Wariyapola	Auleagama	192	1,236	3,830	-
	Wariyapola	193	1,595	3,571	42
Nikaweratiya	Nikaweratiya	124	74	3,231	-
	Divullagoda	105	583	2,332	57
Bingiriya	Bingiriya	150	1,143	3,318	-
	Tharana	95	627	2,194	41
Chilaw	Chilaw	17	486	534	10
Arachchikatuwa	Arachchikatuwa	36	-	1,013	10

Source: Agrarian Services Centers, Department of Agrarian Services.

Table 8. Monthly income level of families.

DS division	No. of families	Below Rs. 1,000	%	Rs. 1,001-Rs. 2,000	%	Rs. 2,001-Rs. 4,000	%	Rs. 4,000-Rs. 6,000	%	Above Rs. 6,000	%
Ridigama	21,783	13,625	63	1,748	8	1,630	7	2,400	11	2,380	11
Ibbagamuwa	19,187	11,301	59	3,591	19	1,940	10	1,450	8	905	5
Ganewatta	9,140	5,531	61	2,038	22	1,000	11	500	5	71	1
Hettipola	17,736	9,498	54	4,750	26	3,488	20	780*	4		
Bingiriya	13,548	5,847	43	2,213	16	2,160	16	1,928	14	1,400	10

*Total above Rs4,000.
Source: DS offices.

Table 9. Number of poverty alleviation beneficiary families.

DS division	No. of families	No. of Samurdhi beneficiaries											
		Rs.1,000	%	Rs. 500	%	Rs.250	%	Rs.200	%	Rs 100	%	Total	%
Rideegama	21,783	101	0.46	9,310	42.74	3	0.01	2,625	12.05	1,687	7.74	13,726	63.01
Mawathagama	12,402	50	0.40	6,904	55.67	1	0.01	1,747	14.09	998	8.05	9,700	78.21
Polpitigama	15,313	109	0.71	3,446	22.50	7,148	46.68	1,406	9.18	926	6.05	13,035	85.12
Ibbagamuwa	19,187	127	0.66	8,664	45.16	2	0.01	1,675	8.73	960	5.00	11,428	59.56
Mallawapitiya	8,939	15	0.17	4,786	53.54	2	0.02	1,719	19.23	909	10.17	7,431	83.13
Kurunegala	19,755	0	0.00	7,380	37.36	0	0.00	1,664	8.42	1,220	6.18	10,264	51.96
Weerambugedara	8,473	76	0.90	2,851	33.65	94	1.11	662	7.81	499	5.89	4,182	49.36
Ganewatta	9,140	38	0.42	4,314	47.20	18	0.20	742	8.12	457	5.00	5,569	60.93
Maspotha	9,957	0	0.00	5,122	51.44	0	0.00	1,316	13.22	639	6.42	7,077	71.08
Maho	14,657	24	0.16	2,069	14.12	3,792	25.87	1,018	6.95	1,004	6.85	7,907	53.95
Wariyapola	17,442	27	0.15	2,925	16.77	3	0.02	5,719	32.79	1,621	9.29	10,295	59.02
Katupotha	6,526	14	0.21	1,445	22.14	1,788	27.40	838	12.84	0	0.00	4,085	62.60
Kotawehera	5,584	154	2.76	860	15.40	2,505	44.86	488	8.74	475	8.51	4,482	80.27
Nikaweratiya	9,733	121	1.24	1,424	14.63	3,107	31.92	682	7.01	589	6.05	5,923	60.85
Kobeigane	8,273	27	0.33	1,846	22.31	2,915	35.24	445	5.38	377	4.56	5,610	67.81
Hettipola	17,736	60	0.34	6,873	38.75	3	0.02	1,621	9.14	1,001	5.64	9,558	53.89
Rasnayakapura	5,374	68	1.27	406	7.55	2,180	40.57	657	12.23	477	8.88	3,788	70.49
Bingiriya	13,548	100	0.74	865	6.38	3,584	26.45	621	4.58	777	5.74	5,947	43.90
Chilaw	13,865	1	0.01	4,449	32.09	1	0.01	1,175	8.47	680	4.90	6,306	45.48
Arachchikattuwa	9,860	0	0.00	4,742	48.09	0	0.00	867	8.79	199	2.02	5,808	58.90
Total	247,547	1,112	0.45	80,681	32.59	27,146	10.97	27,687	11.18	15,495	6.26	152,121	61.45

Source: DS offices.

Table 10. Rate of unemployment, 1999, in the Deduru Oya basin.

DS divisions	Employed	%	Unemployed	%	Total
Ridigama	26,617	50.12	26,485	49.88	53,102
Mawathagama	13,850	60.85	8,910	39.15	22,760
Polpitigama	15,691	66.27	7,988	33.73	23,679
Ibbagamuwa	25,229	84.05	4,789	15.95	30,018
Mallawapitiya	7,678	39.40	11,808	60.60	19,486
Kurunegala	29,747	58.01	21,532	41.99	51,279
Wariyapola	22,038	67.22	10,749	32.78	32,787
Katupotha	10,355	69.29	4,589	30.71	14,944
Kotawehera	9,050	77.54	2,621	22.46	11,671
Nikaweratiya	8,597	52.95	7,640	47.05	16,237
Rasnayakapura	5,087	44.74	6,283	55.26	11,370
Chilaw	15,941	45.24	19,296	54.76	35,237
Arachchikattuwa	9,715	51.02	9,325	48.98	19,040
Total	197,595	57.84	144,015	41.57	341,610

Source: DS offices.

Table 11. Rate of unemployment, 1990, in the Deduru Oya basin.

DS divisions	Employed	%	Unemployed	%	Total
Ridigama	17,884	70.10	7,628	29.90	25,512
Mawathagama	13,450	64.99	7,244	35.01	20,694
Ibbagamuwa	23,939	62.66	14,263	37.34	38,202
Polpithigama	14,216	56.21	11,076	43.79	25,292
Kurunegala	30,058	66.24	15,319	33.76	45,377
Kotawehera	7,052	65.78	3,668	34.22	10,720
Nikaweratiya	10,200	51.78	9,500	48.22	19,700
Chilaw	16,420	53.38	14,338	46.62	30,758
Arachchikattuwa	9,405	57.56	6,935	42.44	16,340

Source: DS offices.

Chilaw	60,055	80	751	Re-demarcated	-	-	-
Arachchikattuwa	38,860	115.2	337	Re-demarcated	-	-	-
Total	1,044,558	2,762.5	378	-	-	-	-

Table 1. Runoff (MCM) measured at the Deduru Oya runoff measuring station, Chilaw (drainage area 2610.0 km^2).

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1990/91	262.80	589.30	147.90	210.60	200.40	253.60	250.40	213.90	343.10	218.80	227.50	219.70
1991/92	273.20	399.30	209.10	154.20	137.50	215.80	202.50	228.40	180.90	190.90	190.60	192.70
1992/93	365.60	412.40	209.30	215.80	191.70	213.80	212.20	243.20	220.70	209.50	189.90	214.70
1993/94	315.19	513.04	588.99	323.91	270.21	128.91	178.59	175.13	163.73	166.06	165.71	162.86
1994/95	245.29	272.25	166.66	153.19	145.67	163.12	188.61	458.87	160.40	161.57	151.37	158.02
1995/96	176.08	487.94	142.65	160.62	154.65	168.74	203.82	178.50	176.34	179.45	179.02	187.49
1996/97	363.48	224.12	87.43	173.31	147.74	166.40	166.58	248.61	164.72	172.71	163.03	176.25
1997/98	312.85	593.74	342.79	149.04	125.49	156.73	157.16	230.26	159.75	182.65	179.19	184.63

Source: Hydrological Annuals, Hydrology Division, Irrigation Department.

Table 2. Runoff coefficients available in Irrigation Department publications.

Year	Rainfall (mm)	Runoff (mm)	Ratio %
1992/93	1,344	1,111	83
1993/94	2,360	1,208	51
1994/95	1,537	928	60
1995/96	1,525	918	60
1996/97	1,603	864	54
1997/98	2,111	1,061	50

Table 3. Seasonal runoff ratios calculated from data in tables 1 and 2.

Season	Gross inflow (MCM)	Outflow (MCM)	Runoff ratio %
1994 yala	1,890.7	1,012.08	53.5%
1994/95 maha	2,093.0	1,146.18	54.8%
1995 yala	2,902.3	1,278.84	44.1%
1995/96 maha	2,247.8	1,290.68	57.4%
1996 yala	1,733.7	1,104.62	63.7%
1996/97 maha	1,443.7	1,162.48	80.5%
1997 yala	2,740.8	1,091.90	39.8%
1997/98 maha	3,313.7	1,680.64	50.7%
1998 yala	2,209.0	1,093.64	49.5%

Source: DS offices.

Table 4. Water accounting for 1994 yala season.

Climatic condition of the season–Dry
Climatic condition of the previous season (1993/94 maha)–Wet

Component	Component value (MCM)	Total (MCM)
Gross inflow		1,202.11
Rainfall	1,202.11	
Storage changers		258.77
Surface storage	102.69	
Soil storage	156.08	
Net inflow		1,460.88
Process depletion		614.86
ET paddy	140.73	
ET OFC	0.14	
ET chena	0.75	
ET plantation	469.18	
Domestic use	2.61	
Animal use	0.03	
Industrial use	1.42	
Non-process depletion (beneficial)		245.40
ET forest	39.64	
ET scrub/grassland	23.64	
ET homestead	182.12	
Non-process depletion (non-beneficial)		243.06
Evapo. uncultivated	137.35	
Evapo. water surface	105.71	
Uncommitted outflow		357.58
Calculated value	357.58	

Notes: ET = Evapotranspiration OFC = Other field crops
Evapo = Evaporation

Table 5. Water accounting for 1994/95 maha season.

Climatic condition of the season–Average

Climatic condition of the previous season–Dry (1994 yala season)

Component	Component value (MCM)	Total (MCM)
Gross inflow		2,070.78
Rainfall	2,070.78	
Storage changers		-179.43
Surface storage	-51.35	
Soil storage	-128.08	
Net inflow		1,891.35
Process depletion		984.53
ET Paddy	315.38	
ET OFC	84.81	
ET Chena	26.87	
ET Plantation	551.15	
Domestic use	4.85	
Animal use	0.05	
Industrial use	1.42	
Non-process depletion (beneficial)		304.88
ET forest	56.10	
ET scrub/grassland	23.67	
ET homestead	225.11	
Non-process depletion (non-beneficial)		195.57
Evapo. uncultivated	77.89	
Evapo. water surface	177.68	
Uncommitted outflow		406.37
Calculated value	406.37	

Notes: ET = Evapotranspiration OFC = Other field crops
Evapo = Evaporation

Table 6. Water accounting for 1995 yala season.

Climatic condition of the season–Wet

Climatic condition of the previous season –Average (1994 /95 maha season)

Component	Component value (MCM)	Total (MCM)
Gross inflow		2,004.56
Rainfall	2,004.56	
Storage changers		71.00
Surface storage	0.00	
Soil storage	71.00	
Net inflow		2,075.56
Process depletion		1,018.58
ET paddy	248.63	
ET OFC	69.30	
ET chena	23.02	
ET plantation	673.58	
Domestic use	2.61	
Animal use	0.03	
Industrial use	1.42	
Non-process depletion (beneficial)		386.20
ET forest	68.56	
ET scrub/grassland	28.93	
ET homestead	288.72	
Non-process depletion (non-beneficial)		254.90
Evapo. uncultivated	110.97	
Evapo. water surface	143.93	
Uncommitted outflow		415.87
Calculated value	415.87	

Notes: ET = Evapotranspiration OFC = Other field crops
Evapo = Evaporation

Table 7. Water accounting for 1995/96 maha season.

Climatic condition of the season–Dry

Climatic condition of the previous season–Wet (1995 yala season)

Component	Component value (MCM)	Total (MCM)
Gross inflow		1,577.77
Rainfall	1,577.77	
Storage changers		9.14
Surface storage	51.35	
Soil storage	-42.21	
Net inflow		1,586.91
Process depletion		841.78
ET paddy	328.09	
ET OFC	85.65	
ET chena	30.74	
ET plantation	390.98	
Domestic use	4.85	
Animal use	0.05	
Industrial use	1.42	
Non-process depletion (beneficial)		204.50
ET forest	33.03	
ET scrub/grassland	19.70	
ET homestead	151.76	
Non-process depletion (non-beneficial)		192.01
Evapo. uncultivated	103.92	
Evapo. water surface	88.09	
Uncommitted outflow		348.62
Calculated value	348.62	

Notes: ET = Evapotranspiration OFC = Other field crops
Evapo = Evaporation

Table 8. Water accounting for 1996 yala season.

Climatic condition of the season–Average

Climatic condition of the previous season–Dry (1995/ 96 maha season)

Component	Component value (MCM)	Total (MCM)
Gross inflow		1,744.64
Rainfall	1,744.64	
Storage changers		39.88
Surface storage	-17.12	
Soil storage	57.00	
Net inflow		1,784.52
Process depletion		840.35
ET paddy	179.71	
ET OFC	20.70	
ET chena	23.23	
ET plantation	612.66	
Domestic use	2.61	
Animal use	0.03	
Industrial use	1.42	
Non-process depletion (beneficial)		401.16
ET forest	71.22	
ET scrub/grassland	30.06	
ET homestead	299.88	
Non-process depletion (non-beneficial)		485.20
Evapo. uncultivated	292.93	
Evapo. water surface	165.27	
Uncommitted outflow		84.81
Calculated value	84.81	

Notes: ET = Evapotranspiration OFC = Other field crops
Evapo = Evaporation

Table 9. Water accounting for 1996/97 maha season.

Climatic condition of the season–Dry

Climatic condition of the previous season–Average (1996 yala season)

Component	Component value (MCM)	Total (MCM)
Gross inflow		1,557.96
Rainfall	1,557.96	
Storage changers		-39.88
Surface storage	17.12	
Soil storage	-57.00	
Net inflow		1,518.08
Process depletion		967.93
ET paddy	512.36	
ET OFC	44.42	
ET chena	13.85	
ET plantation	390.98	
Domestic use	4.85	
Animal use	0.05	
Industrial use	1.42	
Non-process depletion (beneficial)		204.50
ET forest	33.03	
ET scrub/grassland	19.70	
ET homestead	151.76	
Non-process depletion (non-beneficial)		115.70
Evapo. uncultivated	27.61	
Evapo. water surface	88.09	
Uncommitted outflow		229.95
Calculated value	229.95	

Notes: ET = Evapotranspiration OFC = Other field crops
Evapo = Evaporation

Table 10. Water accounting for 1997 yala season.

Climatic condition of the season–Wet

Climatic condition of the previous season–Dry (1996 /97 maha season)

Component	Component value (MCM)	Total (MCM)
Gross inflow		2,172.40
Rainfall	2,172.40	
Storage changers		-9.35
Surface storage	-51.35	
Soil storage	42.00	
Net inflow		2,163.05
Process depletion		966.94
ET paddy	236.20	
ET OFC	23.70	
ET chena	29.40	
ET plantation	673.58	
Domestic use	2.61	
Animal use	0.03	
Industrial use	1.42	
Non-process depletion (beneficial)		392.46
ET forest	68.56	
ET scrub/grassland	28.93	
ET homestead	294.98	
Non-process depletion (non-beneficial)		349.84
Evapo. uncultivated	205.92	
Evapo. water surface	143.93	
Uncommitted outflow		453.81
Calculated value	453.81	

Notes: ET = Evapotranspiration OFC = Other field crops
Evapo = Evaporation

Table 11. Water accounting for 1997/98 maha season.

Climatic condition of the season–Wet

Climatic condition of the previous season–Wet (1997 yala season)

Component	Component value (MCM)	Total (MCM)
Gross inflow		3,030.58
Rainfall	3,030.58	
Storage changers		-150.34
Surface storage	-51.34	
Soil storage	-99.00	
Net inflow		2,880.24
Process depletion		1,108.57
ET paddy	499.02	
ET OFC	30.02	
ET chena	11.74	
ET plantation	561.47	
Domestic use	4.85	
Animal use	0.05	
Industrial use	1.42	
Non-process depletion (beneficial)		319.08
ET forest	56.66	
ET scrub/grassland	23.92	
ET homestead	238.50	
Non-process depletion (non-beneficial)		134.64
Evapo.uncultivated	15.74	
Evapo. water surface	118.90	
Uncommitted outflow		1,317.95
Calculated value	1,317.95	

Notes: ET = Evapotranspiration OFC = Other field crops
Evapo = Evaporation

Table 12. Water accounting for 1998 yala season.

Climatic condition of the season–Wet

Climatic condition of the previous season–Wet (1997 / 98 maha season)

Component	Component value (MCM)	Total (MCM)
Gross inflow		2,009.53
Rainfall	2,009.53	
Storage changers		150.34
Surface storage	51.34	
Soil storage	99.00	
Net inflow		2159.87
Process depletion		968.52
ET paddy	231.35	
ET OFC	11.34	
ET chena	48.19	
ET plantation	673.58	
Domestic use	2.61	
Animal use	0.03	
Industrial use	1.42	
Non-process depletion (beneficial)		392.46
ET forest	68.56	
ET scrub/grassland	28.93	
ET homestead	294.98	
Non-process depletion (non-beneficial)		298.97
Evapo. uncultivated	155.05	
Evapo. water surface	143.93	
Uncommitted outflow		499.91
Calculated value	499.91	

Notes: ET = Evapotranspiration OFC = Other field crops
Evapo = Evaporation

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