

Integrated Coastal Area and River Basin Management in South Asia

Pilot Survey

Attanagalu Oya - Sri Lanka

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Chapter 1

1. Introduction

1.1 Background

The Attanagalu Oya basin, located between Kelani River and Maha Oya river basins, has a catchment area of 736 km² and is approximately 45 km long and 35 km wide (figure 1.1). The river originates from the lower peneplains of Kegalle District, and flows westwards throughout its course until it meets the ancient depositional plain around Kotugoda where the river is deflected northwards before turning south to become the Dandugam Oya. Two other smaller streams, the Mapalana Oya and the Kimbulapitiya Oya drain the north-western portion of the basin and join the main Attanagalu Oya around Madawala. The Attanagalu-Dandugam Oya finally discharges into a wetland, which is at the junction of the Negombo lagoon and Muthurajawela marsh.

The upper catchment of the river is approximately 250 km², consisting of rubber and coconut estates and the highest elevation is 300 M.S.L. at Galapitamada. The lower catchment is predominantly cultivated with paddy. There is slightly over 4,000 ha of paddy cultivation irrigated under the Attanagalu Oya Irrigation Scheme (AOIS), the largest irrigation project in the basin. The AOIS consists of ten major diversion schemes for irrigation with 34 minor diversion weirs in the lower reaches.

The Muthurajawela coastal marsh, 6232 ha in extent, is located at the western end of the basin. Freshwater from catchments of 727 km² drains into the system via Dandugam Oya and Ja-ela at the point where the Negombo estuary and marsh meet. The marsh estuary complex in its present form is estimated to have originated about 5000 years ago.

This wetland ecosystem is a typical barrier-built estuary, where the marsh and the lagoon are partially separated from the sea by a sand barrier. The sand barrier is developed as a result of the interaction between wave action and coastal currents of the sea with the sand and sediments that are discharged by the Attanagalu Oya and the Kelani River. The lagoon and the marsh is one of the 41 wetland sites identified in the Asian Wetland Directory and has been studied under the Wetland Conservation project implemented by the Central Environmental Authority. The GOSL declared the northern section of the marsh (area of 1,777 ha) as a sanctuary in July 1996 under the Fauna and Flora Protection Ordinance.

The basin provide a home for about 5 percent of Sri Lanka's total population and has a population density of 1,280 persons per sq. km compared with the national average of 296 persons per sq. km. GRDP of the Attanagalu Oya basin accounts for about 10 percent of the nations GDP in 1994 and the basins economy is likely to experience high growth in the coming years due to high level of industrial activity in the basin. Gampaha district, which is largely within the river basin, is already the most industrialized district in Sri Lanka. Ekala, Ja Ela, Minuwangoda and Katunayake are some of the existing industrial estates.

The important water uses in the Attanagalu Oya are for the supply of drinking water (especially to the Raddoluwa Housing Scheme) and the maintenance of the Negombo lagoon and the Muthurajawela marsh. The available water quality data from the river basin indicates high pollution levels, especially in the lower reaches. The pollution arises from the concentration of industry in the Ja-Ela and Katunayake AGA divisions, including the Katunayake EPZ and the Ekala Industrial Estate. Algal blooms are observed more frequently in the lagoon as result of phosphate and nitrate inputs from the industries and agricultural runoffs, especially from the paddy cultivations. The decrease in lagoon area and the narrowing of the entrance channels at the lagoon mouth, which are a result of sedimentation and land reclamation, have decreased the tidal flushing of the lagoon. A study by Madduma Bandara et al. (1989) concluded that the lagoon had lost 25 percent of its surface area during 1956 to 1981. The ground and surface water is also affected by the seepage and direct discharge of septic tanks effluents and solid waste.

Flooding is another major concern in the basin. The causes of flooding are heavy rainfall and the limited conveyance capacity of the main waterways discharging into the Negombo lagoon. Reclamation of low-lying areas for development, which are mainly illegal, is the major reason for flooding. Flood damage mainly affects the paddy areas and a few roads while the damage is mostly caused by the long time taken for the flood to recede from inundated areas.

Table 1.1 summarizes the major problems and issues in the basin, as identified under the ADB funded Western River Basin Sector Projec

Table 1.1

Issue	Causes	Effects
Water quantity Stressed surface water resources during the dry season	Relatively small catchment area; High demand for water and uncontrolled abstractions	Reduced river flows for around 6-8 weeks of the year; Reduced dilution of pollutants; Growing competition among different users; Environmental degradation

Issue	Causes	Effects
▪ Flooding in the wet season	Inadequate drainage	Inundation of agricultural lands in the lower catchment
Deterioration of water quality ▪ River water (during dry season) ▪ Lagoon water ▪ Ground water	Input of solid wastes; Uncontrolled shanty and slum dwellings; Increased abstractions; Sand mining Excessive use of pesticides and fertilizers in agriculture; Reduced outlet from lagoon to sea Input of industrial, domestic and agricultural pollutants; Over pumping of coastal aquifers	Public health risks Reduce fish catch, ecological and aesthetic values Saline intrusion in to wells and boreholes; Contamination of aquifers; Public health risks
Land use	Deforestation and inappropriate land use	Reduce infiltration and groundwater recharge; Drying up of springs
Inadequate knowledge of resources availability	Sparse coverage of hydrometric stations and infrequent monitoring; No collaboration between the different institutions dealing with various aspects of the basin.	Unreliable data base for water allocation and infrastructure development

Other several projects and programmes have been carried out in the river basin. The Integrated Resource Management Programme (IRMP) initiated in 1998, selected the Negombo-Muthurajawela wetland to demonstrate a replicable model in ecosystem based natural resource management of the country. The Conservation Management Plan for the area was prepared under the Wetland Conservation Project (1992-1997) and the essential elements in this Plan were the basic consideration that the local people should not be victimized by either development or conservation. The IRMP project has identified that threats to the ecosystem of the Negombo Lagoon originate for a large part from the sources of pollution in the upstream industrial areas and part of the Attanagalla catchment area. It has recommended an integrated coastal area and river basin management effort for the conservation of this important wetland.

Location Map of Study Area

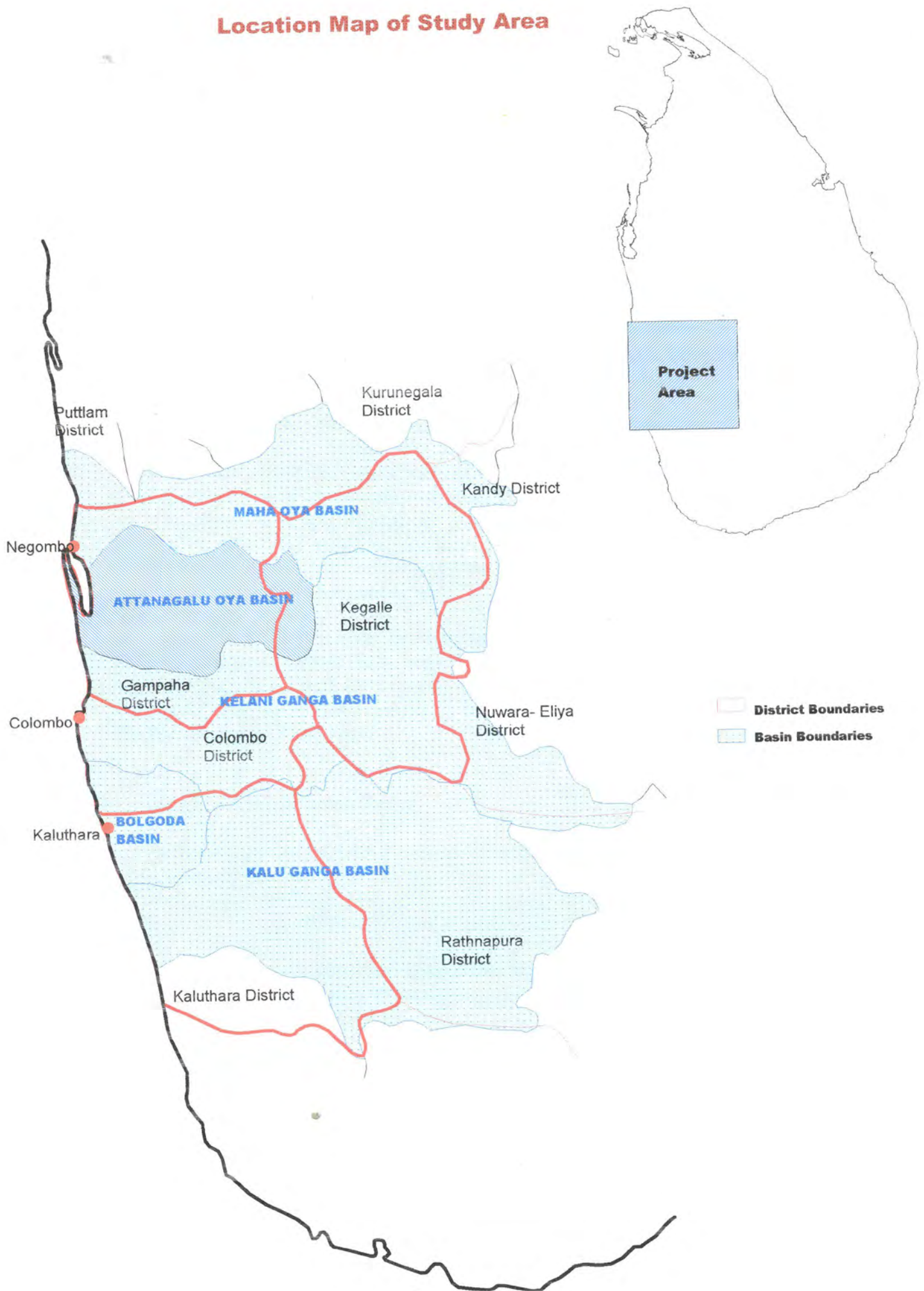


Figure 1.1

1.2 The Concept of Integrated Coastal Area and River Basin Management

The United Nations Environment Programme (UNEP) has been advocating an approach to manage both river basins and coastal areas in an integrated manner, on the basis not only of their hydrological and geochemical relationships but also of needs for a more effective socio-economic development of the two management units, which were conventionally managed separately. River basins were traditionally viewed from the perspective of management of a single important resource, water resources, while the coastal areas were planned for economic development, taking into consideration environmental aspects. In this understanding, UNEP and Priority Actions Programme Activity Centre of the Mediterranean Action Plan have jointly prepared the Conceptual Framework and Planning Guidelines for Integrated Coastal Area and River Basin Management (ICARM).

In the 2002 World Summit on Sustainable Development in Johannesburg, a new partnership initiative was launched by the UCC-Water in collaboration with UNEP/GPA on linking Integrated Water Resources Management (IWRM) and Integrated Coastal Zone Management (ICZM). This Type 11 partnership proposal titled FreshCo promotes more efficient methods for management of fresh, coastal and marine water resources, including protection of the productivity and biodiversity of aquatic ecosystems. It focuses on providing management options for solving problems originating from the inter-relation between human activities in the river basins and those in the coastal zone.

To promote the ICARM concept in South Asia, a workshop was held on 7-10 April 2003 at the National Institute of Ocean Technology (NIOT) Campus in Chennai, India. The workshop was organized by SACEP with the financial support from UNEP Regional Seas Programme. The Attanagalu Oya River Basin project is being financed by the UNEP-RS to pilot test the ICARM concept in South Asia.

1.3 Goal and Purpose of the Study

The overall goal of the pilot project is to demonstrate the usefulness and applicability of the approaches and tools that are introduced as the whole or part of the Integrated Coastal Areas and River Basin Management (ICARM), that supports environmental conservation and management, which is of equal importance to economic efficiency and social equity.

There is a need for integrated coastal area and river basin management of the Attanagalu Oya River Basin and the Muthurajawela Marsh / Negombo Lagoon coastal area due to the following reasons:

- As identified by the IRMP, the river basin is having significant and severe impacts on the coastal system.
- There are many different government, industry and community stakeholder groups in both the river basin and coastal areas. Currently there is no integrated management framework for the river basin and coastal systems with responsibility for various components spread between a range of government departments/agencies.

- The pressures on the river and coastal systems are likely to become increasingly severe and therefore timely and coordinated management responses are required to prevent substantial and irreversible degradation/damage of the river and coastal systems.

1.4 Objective of the Study:

- The Main Objectives of the Study are to Examine and assess the main environmental and socio-economic issues of the river basin and the coastal area and their linkages to society and the economy, using secondary data and field observations.
- Identify major management issues in the Attanagalu Oya River basin and Muthurajawela - Negombo coastal wetland ecosystem and their interactions and linkages.
- Identify constraints as well as opportunities for Integrated Management of the river basin and the coastal area.
- Publication and distribution of an Environment Profile and a Management Plan.

1.5 Methodology

The following methodologies were adopted in the collection of data and information for the purpose of preparing this report.

- Collection of data and information from secondary sources such as published and unpublished reports, maps, and aerial photographs
- Focused group discussions with key stakeholders such as local residents and community based organizations
- Questionnaire based surveys
- Participatory Rapid Appraisal (PRA) technique
- Direct observations and enumeration technique
- Field tours with stakeholders

Secondary information on Attanagalu river basin area were obtained from sources such as Divisional Secretariats of Gampaha District, District Planning Secretariats, Gampaha Western River Basins Sector Project, Water Resources Secretariat (WRS), National Aquatic Resources Agency (NARA), Coastal Resources Management Project (CRMP), Central Environmental Authority (CEA), Coast Conservation Department (CCD), University of Sri Lanka and the Irrigation Department. These included various research papers, reports, survey maps, field reports of fishery data, environmental information and demographic information.

group discussion were utilized to fill some of the vital information gaps on past ecological status of the Negombo lagoon, Muthurajawela marsh area and Attanagalu river basin area, existing issues and management initiatives. Focused group discussions were used to clarify certain issues in relation to management structure, and their effectiveness in the basin area. These discussions were very useful to observe the existing management initiatives and their effectiveness.

Field tours and visits were made with relevant stake-holder participation to identify the issues and their impacts to the environment and people of the area. These trips were included to boats trips to the Negombo lagoon and along the Attanagalu River up to 18 kilometers. In addition to the boats trips, several field visits were made to observe the gravity of solid waste problems, liquid waste disposal sites and land use disputes.

Impacts due to pollution and other undesirable activities were studied through direct observations and enumeration by the study team. Beside these activities questionnaire based surveys also conducted in several place to collect present information in the area. These information made were helpful for extracting first hand information on present ecological status resource utilization problem, and socio economic status in the basin area.

The core portion of the pilot project was the establishment of an integrated management framework by undertaking the following activities

- Review the mandate and activities of existing management bodies and structures within the river basin and coastal areas.
- Based on the outcomes of the review, a suitable model for ICARM will be developed in consultation with key stakeholders. This integrated management framework would be presented to the Sri Lanka government authorities for their consideration and approval.
- An integrated management committee will be established to oversee the ICARM. The terms of reference of this committee will be documented. As part of the pilot project, the integrated management committee will develop an Action Plan for the establishment of ICARM.
- A stakeholders meeting will be held to present the integrated management framework to the stakeholder group to obtain their input and feedback. The Action Plan developed by the Integrated Management Committee would also be reviewed and finalized

1.6 Outputs

The expected deliverable products of this pilot project are:

- A case study report,
- A set of land use maps in the river basin area and a set of maps indicating foold buffer zone to prevent new settlement
- An integrated management framework.

Chapter 2

Physical Setting Land Use and Land Cover

2.1 Physical Setting

During the mid and late Holocene epoch, the sea level rose about 3.0m above the present level and headland – bay beaches developed in the south-west and Southern coast of Sri Lanka. (Katupotha 1988a and 1988b).

The major rock types of the basin include hornblende biotitic gneiss, charnockites, magmatites, granitic, gneisses, garnetiferous sillimanite gneiss, quartzite and undifferentiated metasediments. Of these rock types secondary porosity is mainly provided by quartzites, due to intense fracture patterns and joints, which result in excellent ground water transmissivity in addition to storage.

The coastal plain of the basin shows an NW –SE rock structural trend of major antiforms and synforms (figure 2.1) which will be significant basement aquifers. In addition both in coastal plain and the low relief terrain NNW-SSE shear zones are significant when they intersect the river trace (Figure 2.1). The shear zones are inter-basinal, whereby inter-basinal transmissivity is a possibility.

Major geological faults intersecting shear zones run across the basin in the upper catchments (Figure 2.1). In this area are also folded quartzite discontinuation and the river tributaries. Therefore this area, identified as the low relief terrain (Figure 2.2) should be excellent for both groundwater transmissivity and storage.

The topography and surface geology of the basin are related to its aquifer characteristics. The basin is divisible into three regions based on geomorphological features. As analysis made from available maps is given below to show the correlation of each geomorphological unit to principal aquifer types. The above geomorphological limits are shown in figure 2.2.

Unconfined aquifers of the basin include alluvial, colluvial, and residual laterite aquifers. Of these the alluvial aquifers, and the coastal sands are of importance.

In the coastal plain the coastal sand belt from excellent aquifers in addition to river alluvium. Such sand beds are mainly observed in areas of Ja-ela, Ekala, Katunayake and Kimbulpitiya. These sand deposits are porous and permeable to sustain productive groundwater.

River alluvium is thick in the coastal terrain (Figure 2.2) where areas bordering the rivers have coarse to fine sand profiles offering good groundwater storage. The paddy sectors of the coastal plain have profiles of sandy clays and clay beds with poor aquifer capacity, as seen in the Attnagalla area. The productivity can be expressed as and it ranges from 664 m³/day to 295 m³/day from west to east of the basin zones (Kodipilli, 1998).

In the area bordering the Negombo lagoon and Muthurajawela Marsh, beds of peat and peaty organic clays up to 7 meters are found. The large quantity of water found in these aquifers is mainly importable.





Figure

Attanagalu River Basin



- Legend
- Dense To Vesicular Laterite
 - Quartzites
 - Marsh
 - Aquifer formed by Shear Zone
 - Thrust of Shear
 - Catchment Boundaries
 - Synform
 - Towns



Figure 2.1

2.2 Agro Ecological Regions (AERs)

The Attanagalu Oya basin, 73,600 ha in extent, is approximately 45 km long and 35 km wide, and it differs in form and shape from most other elongated river basins of the island. Two major streams of Diyella Oya from the north and Uruwal Oya from the south join the Attanagalu Oya which discharges into the Negombo lagoon as the Dandugam Oya, and also a part through Ja-Ela (Figure 2.3). The Digella Oya has its confluence with the Attanagalu Oya at Gampaha, and it forms a moderately broad inland flood plain around this area. Two other smaller streams, the Mapalana Oya and the Kimbulapitiya Oya drain the north western portion of the basin and join the main Attanagalu Oya around Madawala.

The main Attanagalu Oya cuts through the residual lower peneplain and flows westward throughout its course without any impedance until it meets the ancient depositional plain around Kotugoda where the river gets deflected northwards before turning southward to become the Dandugam Oya. This ancient (Pleistocene) depositional plain is 5 to 6 km wide and has a very high permeability as compared with the residual peneplain that covers the rest of the basin. Hence the abrupt change in the drainage pattern and direction that take place within this depositional plain.

The Attanagalu-Dandugam Oya finally discharges into a wetland which is at the junction of the Negombo lagoon and Muthurajawela marsh. This marsh-lagoon complex in its present form is estimated to have originated about 5000 years BP. This marsh-lagoon wetland is made up of 3,000 ha of Muthurajawela marsh extending southward from the lagoon (Figure 2.4) and 3,165 ha of Negombo lagoon which is connected with the sea by a single narrow opening called the Negombo channel segment. This delicately balanced marsh-lagoon wetland system depends on its interaction between both the terrestrial watershed flows of the Dandugam Oya and the tidal flows of the sea for the continuity of its ecosystem structure and functioning. This has important implications for the management of the main watershed of the Attanagalu Oya and its subsequent inflow to the marsh-lagoon wetland.

A major proportion of the basin (64 percent) is situated at an elevation of less than 35m, while 30 percent is situated between 35m and 165m, and only 6 percent lies above the 165m, the latter being mainly confined to the uppermost south eastern sub watershed beyond Attanagalla town. Around 85 percent of the basin is situated within the residual lateritic mantled plan which has a high drainage density that enables a ready disposal of high intensity rainfall. Short duration surface flooding is experienced in the lower portion of the main Attanagalla Oya below Gampaha town where it enters a moderately broad inland flood plain. The surface drainage of the river system is impeded beyond Kotagoda where it enters the old depositional plain.

Schematic Diagram of Attanagalu Oya Network

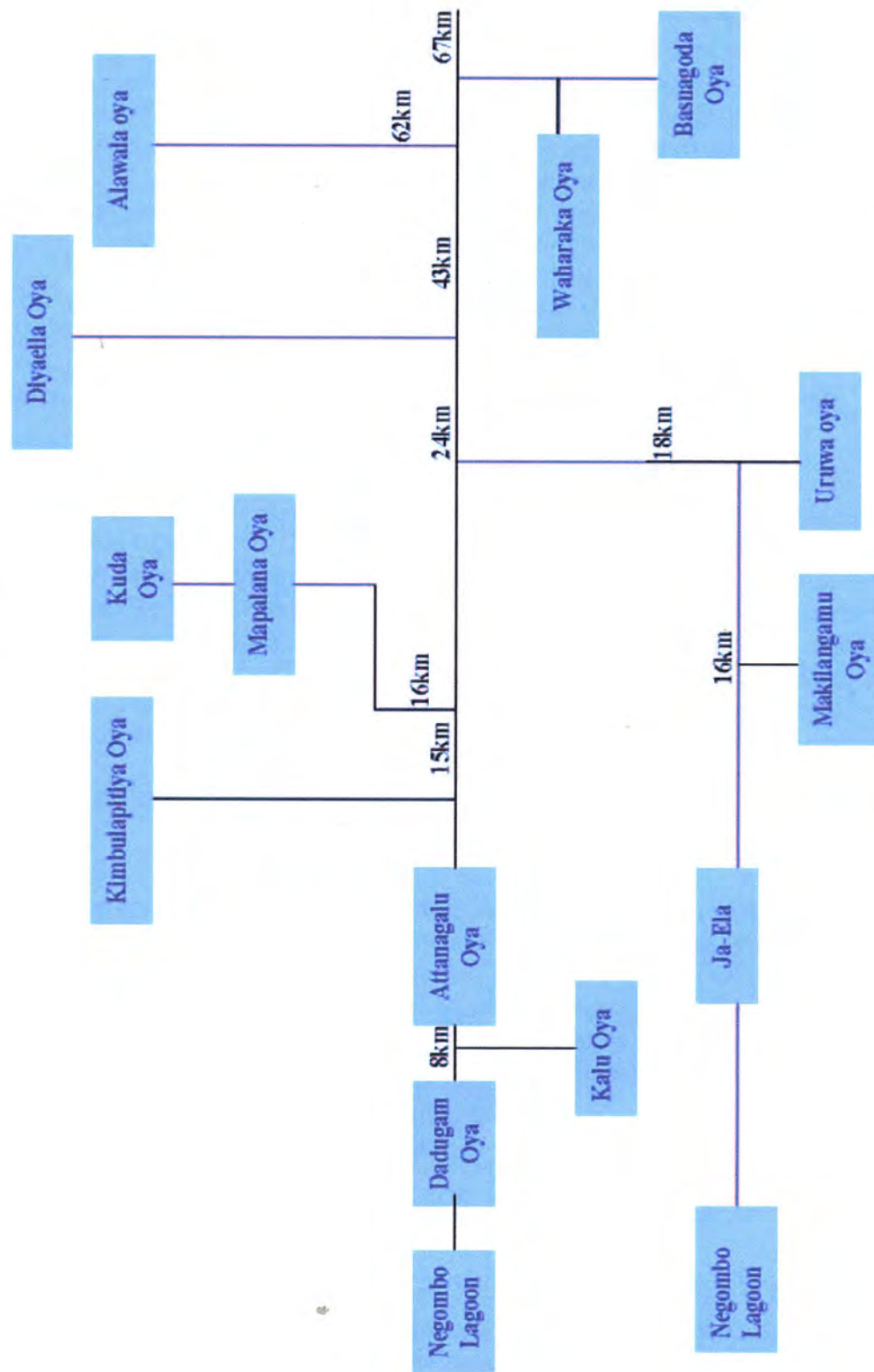


Figure 2.3

The two thirds of the western basin has one of the best rainfall regimes of the low country wet zone which permits the cultivation of a very wide range of rainfed perennial crops. One third of the eastern basin has a higher rainfall which is better suited for rubber and forest plantations.

In respect of landform, soil and climate, there are little or no constraints to agriculture and settlement within this basin. This is supported by the fact that approximately 75 percent of the basin is under homestead gardens and tree crop cover and another 16 percent is made up of paddy land. Thus 90 percent of the basin is being utilized for agriculture and settlement purposes which itself is a very high figure for any river basin in the country.

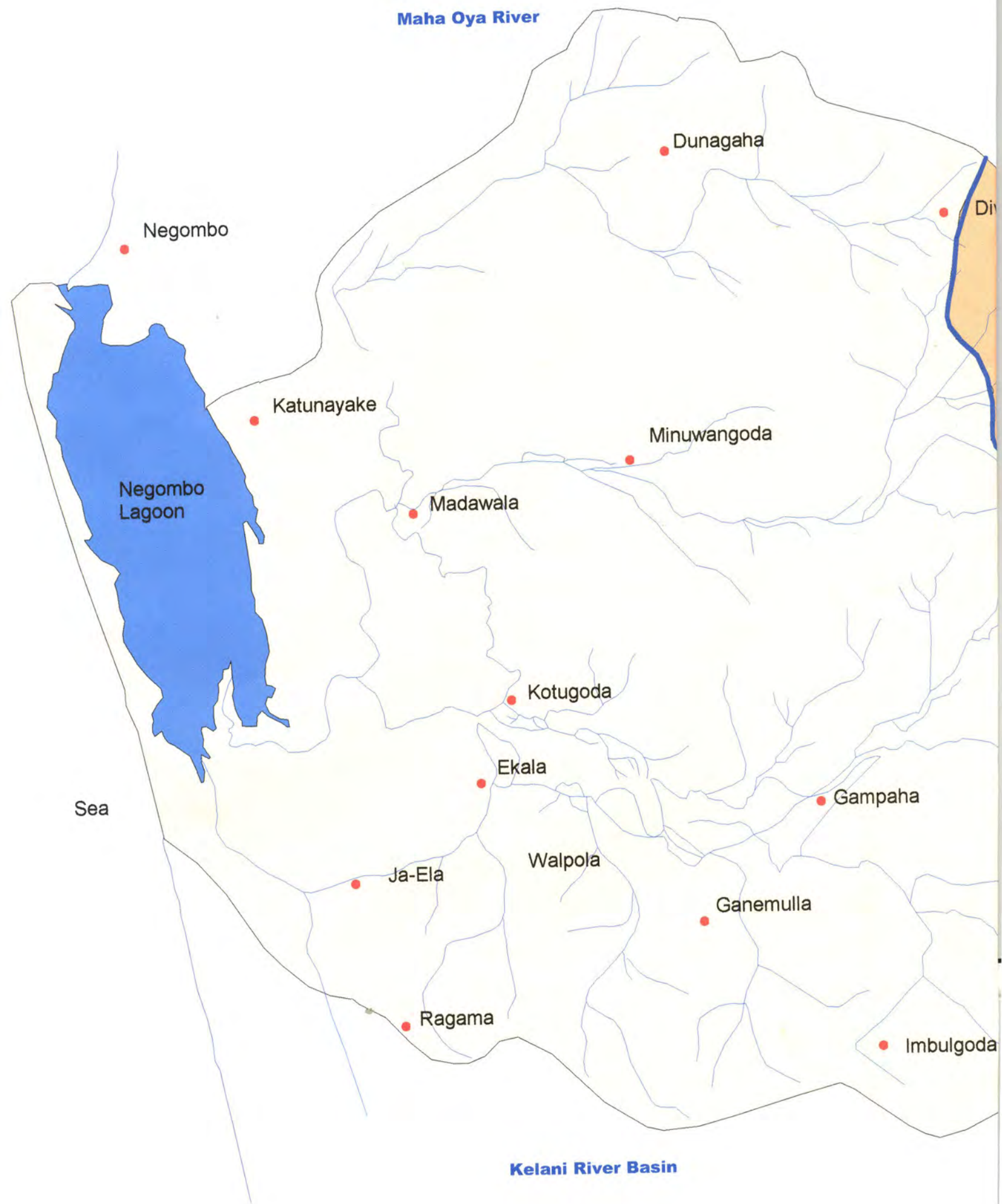
For logical reasons it would be convenient to discuss the basin composition of the Attanagalu Oya under three sub divisions all in starting with the up-country and ending with low country as shown figure 2.5.

The basin is dominated by (Wet zone) WL3 and WL2 areas. Small areas of WL4 and WL1 are also present. WL3 covers 75 percent of the area of the whole basin and almost all of it is situated at an elevation of less than 35 m, within the middle and lower watershed areas of the basin. This has one of the best rainfall distribution patterns for the low country wet zone. Its mean annual rainfall of between 2,000 to 2,500 mm is well distributed from April to December, and is followed by a distinct dry period from mid January to late March. Peak rainfall occurs during October to November, and again in May to June while considerable runoff is experienced. The 75 percent probability of annual rainfall almost balances the mean annual evaporation of around 1,500 mm and this makes agriculture very productive in this AER. Accordingly, a wide range of perennial tree crops, annual cash and food crops, and beverage crops are grown, and intercropping of pineapple with coconut finds its best expression here.

The areas of WL2 and WL1 which occur in the eastern portion and make up 25 percent of the area of this basin have a higher mean annual rainfall, with WL2 having a mean annual rainfall of more than 2,500 mm, and WL1 more than 3,000 mm. These AERs are therefore more suited for woody perennials and timber species. A small extent of steeply dissected and hilly terrain is found in the uppermost watershed around Gonagaldeniya and Galapitamada. The highest elevation point here is 450 m.

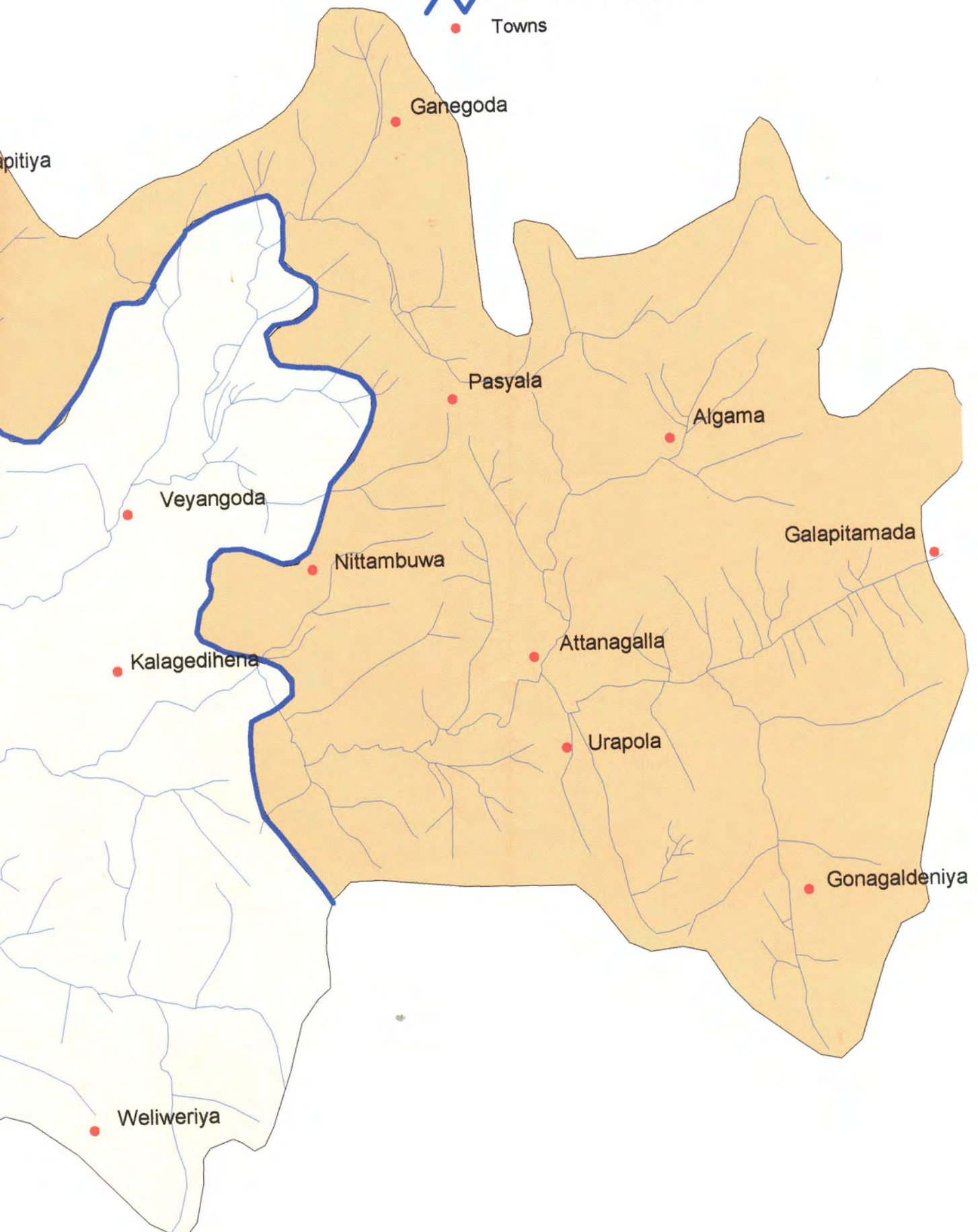
The Negombo Lagoon – Muthurajawela swamp ecosystem has its own distinctive hydromorphic environment, and it should, therefore, be considered separately from the above three AERs. This area lies in the WL4 AER.

For convenience of presentation and discussion of land use characteristic, the basin is considered under two broad divisions of lower basin and upper basin, with the AERs of



River Basin

- Coastal Plain
- Low Relief Terrain
- Catchment Boundaries
- Hydrological Boundaries
- Towns



2.3 Land Use

The present land use and land cover is given in figure 2.6. According to the figure most of the lands are use for homestead. For presentation convenience of land use, the basin is considered under two major divisions as lower basin and upper basin.

2.3.1 Lower Basin

The lower basin covers an extent of 62,350 ha whild equals or 75 percent of the total land area of the basin. The extents under the main land use categories are shown in table 2.3.2.

Table 2.3.2

Land use/cover	Extent ha	Percent
Built up land	1400	2.3
Paddy	11375	18.4
Sparse crops	180	0.3
Coconut	9505	16.00
Rubber	1210	2.0
Homesteads	34300	56.0
Mixed plantation	404	0.7
Forest	-	-
Marsh	2075	3.4
Mangrove	665	1.0

According to the above table, 56 percent of the lower basin area is under homestead gardens. This is typical of the intense settlement pattern in this part of the basin. A high percentage of the homestead gardens is made up of a variety of crops such as coconut, pineapple, mangoes etc. Intercropping pineapple in coconut plantation is common within area. The soil erosion problem has minimized due to the presence of very good crop cover through out the year. Because of the very good crop cover that is present throughout the year, the soil erosion hazard is minimized.

Built up land accounts for around 2.5 percent of the area of lower basin which is quit characteristic for the type of human settlements found in this region. The wetland area (mangrove and marsh) cover 4.5 percent of the basin.

2.3.2 Muthurajawela Marsh

The Muthurajawela marsh area does not have much resources to use by people since most of the area comes under the wild life sanctuary. The significant agricultural activities are the cultivation of coconut and leafy vegetation. Paddy is cultivated only as a marginal activity. Coconut cultivation in the marsh is very labour intensive and the annual production is about 30,000 nuts/ha.

Small plots of raised beds are used for the cultivation of a variety of crops but marsh inhabitants make use of various natural products of the marsh. E.g. Reeds and sedges for making mats, baskets, hats etc. Tree branches are used for brush pile fishing and wood for every house building and boat making. Various plant species presently growing in the

marsh are interest to the people. Small scale livestock rearing is practiced at the edges of the marsh, the main species being pigs, cattle and poultry. Small scale poultry farming is widely practiced even by squatter families. Bee keeping is also practiced in some areas.

Aquaculture is practiced in the estuary edges only at a very small scale and according to the Fisheries Department sources 13 farms are operating in this area and most of them area illegal.

Peat mining is done at a very small scale. Peat is a resource that is available in abundance but its applicable uses are very limited. Hence not much income can be generated from peat at present.

Since the early 1970s encroachment increased into the marsh because of poverty and the inability to purchase land at location that are more conducive to secure house construction. These settlements have developed with little regard for the consequences of the obstruction of the hydrology of the wetland system.

At present some locations of the marsh are used as solid waste dumping grounds. This is an usual practice in most of the urban areas of the country. The wetlands are considered wastelands by most of the local authorities around the wetland and most of them arte state owned. In addition to this, untreated industrial effluent has also been discharged to the wetland through the towns of Ja-ela and Dadugam Oya. Here, the wetland system function as a sink for waste water.

Unfortunately some areas of the marsh also use for illicit liquor distillation. The primary requirements for the use of the marsh for illicit liquor distillation are seclusion and difficult access. A secondary requirement is the availability of water for cooling the copper coil through which rapour travels

A small section of the marsh also used for ecotourism.

2.3.3. Negombo Estuary

Basically Negombo estuary is used for fishing and fishery related activities. However the cannal segment of the estuary is used for housing development. Mangrove forest area is also used for various activities including brush piles. Some areas of the estuary is also used for waste dumping locations.

2.3.3.1 Fishing and Fishery Related Activities

At present 19 fishing methods are practically and around the estuary and nearly 5000 fishermen are engaged fishing in the estuary. Majority of them (1300) use the Discovered Tramal and also push net (1200).

There are around 40 traditional landing sites located in the estuary and over 60 jetties have been constructed in the recent past. Most of those jetties are built

without any approvals. Nearly 3000 one day boats are also anchored along estuary bank.

2.3.3.2 Housing Development in the Cannel Segment

Shoal formation at outlets of estuaries is a natural phenomenon. The canals at the outlet of Negombo estuary formed because of the natural process of delta formation. In 1956 only 11 Islands existed; at present 13 islands and several sand shoals can be distinguished.

Only two islands in the channel segment, Munnakkare and Siriwardene Place were already inhabited in 1955. By 1993 the number of inhabited islands increased to four including Pitipana Islands 1 and 2. Total houses in 1955 were 380 and in 1993 it were increased up to 1788. The land extent utilized for housing was 16.95 ha in 1956, and 20.55 ha in 1993.

2.3.3.3. Mangrove Forest

Five mangrove islands have been gazetted as forest reserves by the Forest Department and now being used for conservation purposes. Nearly 10 ha of mangrove area is used for educational and research in the Kadokele by the NARA.

Branches and twigs of the mangroves are used by the fisherman for the brush-pile fishery and nearly 450 brush-piles are in operation in the estuary. In addition to brush-piles, stake net fisherman is also used nine to ten mangrove poles for each stake net.

2.3.3.4 Waste Dumping Locations

It has been revealed that the local authorities dump solid waste is several location of the estuary. In addition to solid waste, municipal waste, and therefore surface water discharge canals also diverted into the estuary.

2.3.3.5 Other Uses of the Estuary

Many students are being used the estuary for research and education activities. In addition to the research, very few tourists also used the estuary for tourism and water sports. But many fishermen are do not agree with the tourism in the estuary.

2.3.3.6 High land Area of the Estuary

The high level area of the estuary is utilized for three activities. They are :

- a) Residential
- b) Agriculture
- c) Service infrastructures

Most of the built up area are used for housing and industries. The west portion of the estuary, high land has been cultivated coconut and homestead garden. Service infrastructure including roads, power and water supply telecommunication facilities are occupied nearly 500 ha.

2.3.4 Problems in relation to Land use in the lower basin area

One of the main planning problem in the marsh and estuary area is the encroachment for housing. This has created a severe impact on the ecological functioning of the lower basin area and caused the destruction of the habitat. These encroachments also generated lots of feecal pollution and visual pollution. In addition to pollution, encroachment also created sedimentation to the estuary and canal system that preventing the normal tidal behaviour.

According to the survey conducted in 1998 (Mahanama, 1998), the total housing units in the Marsh area in 1950 was 28 and it increased to 631 in 1998. All of these housing units were unauthorized and were encroachers. The housing expansion from 1950 to 1998 in the marsh area is in shown Table 2.3.3. According to the Table 2.3.3. housing growth in the area has increased rapidly after 1996. In 1955 the total population of the marsh area was 52 and it increased to 2454 in 1998. The Table 2.3.4 indicates the population growth in the marsh area during the period of 1950 to 1998.

Table 2.3.3 : Housing Expansion from 1950 to 1998 - Muthurajawela Conservation Zone

Period	Number of Housing Units	Cumulative Number of Housing Units
1950	28	28
1951 - 1955	13	41
1956 - 1960	21	62
1961 - 1965	34	96
1966 - 1970	33	129
1971 - 1975	48	177
1976 - 1980	102	228
1981 - 1985	74	353
1986 - 1990	84	436
1991 - 1995	85	520
1996 - 1998	109	631

Table 2.3.4 : Population Expansion form 1950 to 1998 - Muthurajawela Conservation Zone

Period	Migrated	Cumulative	Births	Cumulative	Total Population	total
1950	12	12	20	20	32	32
1951 - 1955	4	16	16	36	20	52
1956 - 1960	11	27	43	79	54	106
1961 - 1965	22	49	55	134	77	183
1966 - 1970	26	75	38	172	64	247
1971 - 1975	72	147	68	240	140	387
1976 - 1980	210	357	88	328	298	685
1981 - 1985	212	569	135	463	347	1032
1986 - 1990	270	839	186	649	456	1488
1991 - 1995	257	1096	185	834	442	1930
1996 - 1998	397	1493	127	961	524	2454

Source : Baseline Socio – economic survey 1998 – Muthurajawela IRMP

2.3.4.1 Housing Expansion in the Channel Segment of the Negombo Lagoon

Of the 13 island in Negombo lagoon Munnakkare is the largest island and density populated area in the channel segment. The total housing stock in the island of the channel segment was 1072 in 1980 and this increase to 1788 units in 1993. The encroachment of islands viz. Munnakkare 300 years ago, Siriwardene Pedesa began since 1950s followed by Pitipana island 1 and 2 since 1975 and Regina road settlement since 1970. Housing growth in the every islands has increased rapidly after 1980.

With the increasing of housing units, the extent of the land area has also been expanded corresponding to that rate. The land area covered by housing in 1956 including Munnakkare was 16.95 ha and it has expanded up to 20.55 ha in 1993 at a rate of 38 percent per annum. Most of the houses were constructed after 1976 by expanding the island area specially the fringe areas. This expansion created lots of imparts to minimize the tidal water exchange.

According to the survey conducted by Mahanama in 1993, the population of the channel segment area was 2160 in 1955 and it has increased to 10090 in 1993 at a rate of 4.9%. This is relatively higher than the Negombo Town growth rate of 9.7% during the same period. Population growth in the study area by locations reflects the rapid increase during the period of 1955 – 1993. Population of Siriwardene Pedesa has increased from 60 persons in 1955 ti 2680 persons in 1993.

The population in the channel segment has been increased by net influx of migrants from various locations. Out of the total families of Munnakkare 58.2% have

immigrated into the present location from the same area from the parental residence. 54% families in the Siriwardena Pedesa have migrated to the present place from the same area and 34.4% from Munnakkare area. It seems that these islands have been occupied from the people who have migrated from the same area and the adjoining areas. Families in the Pitipana islands 1 and 2 have migrated from the adjoining area of Pitipana Vilage and Duwa, 65% of families in the Regina road have migrated to the present location from the other side of the same road.

Migration of families from the previous residence to the present location have been influenced by various "push" factors. The inter-area migration occurred due to the extended family formation and the prevailing marriage system in the area. Most of the marriages have been arranged with "binna" marriage system.

Of the total, 46.3% families who became independent from the parental household at marriage have migrated into the present location. Among other reasons lack of adequate space with the parents house and unable to pay housing rent have been attributed for leaving the previous residence. Few families have migrated from north of the country due to civil disturbances. Immigration of people into the present location was further increased by some of the "pull" factors operating in the area such as employment in the fishing industry, free land, no restriction on encroachment and political and church patronage.

2.3.4.2 Main Reasons for the Expansion of housing in the Muthurajawela and Negombo Estuary

- **Implication of National Housing Development Policy :** The government committed for the provision of housing for low-income communities in the country under the "Hundred Thousand Houses Programme (HTHP)" initiated by National Housing Development Authority in 1978 and the "One Million Houses Programme" (OMHP) which followed in 1984. Some of the squatter housing settlements in channel segment were also regularized and developed under above programmes. The Sirikurasapura which is an already completed project and ongoing project of Devanathpura in Siriwardene Pedesa are examples to this statements..
- **Involvement of Non-Governmental Organisations (NGOs) :**

The islands of the channel segment are having three NGOs viz Negombo United People Organization (NUPO), SANASA and Mary Mitra Padanama. These NGOs actively engage in housing development. These organizations have directly contributed to increase the housing stock in the channel segment during last 38 years.
- **Involvement of Community Based Organization ((CBOs) :** There are CBOs who have actively engaged in the development of housing in the channel segment of the Negombo lagoon since 1980s. Some of them are the Sirikurusa Samithiya, the Deva Matha Samithiya, the Santha Peduru Samithiya, the St. Anthoniys Samithiya and the Sadasarana Samithiya.
- **Political Motivations :** It is observed that, most of the squatter settlements on state lands have been regularized and upgraded by the government with the

assistant of local authorities and politicians. Political involvement in re-settlement programmes is very significant. Authorities who are engaged in housing development taken into account the perception of the politicians with regards to low income housing development.

- **Availability of Bare State Land Free :** Most of the land in the channel segment of the Negombo lagoon belong to the state and the St. Mary's Church at Grand Street, Negombo. It was found that during last 38 years about 800 families have encroached to the 25 ha of state lands without any permissions..
- **Lack of Enforcement to Prevent Encroachment :** Three main legislation's available in relation to promote and control of development activities in the Negombo area are viz. the Coast Conservation Act, No. 57 of 1981, the Municipal Council Ordinance No. 29 of 1947 and the Housing and Town Improvement Ordinance No. 15 of 1915. But the effective enforcement cannot be done due to their limitations and the inability's of the relevant institutions.
- **Provision of Physical got the Facilities within the Area by Authorities :** It is observed that Decentralize budget (DCB) the squatters occupied in the area Western Provincial Council (WPC) basic services to the community. For instance Rs. 595,000.00 from the WPC vote and Rs. 675,000.00 from DCB vote have been spent by the DS for the development of infrastructure facilities in the Channel Segment such as road improvement, construction of road side drains etc. The provision of infrastructure facilities for the needy areas is a duty of the DS and it can be considered as an appreciable activity. But the provision of such services in an unplanned and ad hoc manner may motivate more encroachers penetrating into the Channel Segment and thereby settled them on state owned lands.
- **Land Regulation Programme Initiated by the divisional Secretariat :** This factor also contributed to some extent to increase the encroachment in the Channel Segment. It was found that, some of the squatters have got a plot of land from the Divisional Secretariat on temporary permit basis on which they built their houses. About 3.61 ha (10.3 ac) of state lands in the Channel Segment was distributed among 148 families by 6-8 perches five plot on the basis temporary permit. These permits were issued under the Section 19(2) of the Land Development Ordinance 1937 as amended by 10.
- **Employment Activities :** More than 70 percent of the labour force are engaged in fishing activities as their livelihood. It is widely accepted that, the fishermen should be resided very close proximity to the fishing areas, in the case of Negombo either Lagoon or sea. This is important to increase the productivity of the fishermen by saving time and energy .
- **Early Marriages :** This community is composed with relatively young population. It was found that, the marriage takes place alt early ages of the life of both male and female. Of the total population in the channel segment 1.66 percent were married at the age less than 20 years old. Of this the majority are female. This factor directly relates to the demand for housing in the channel segment.
- **Present Dowry System :** It was found that, most of the parents who have daughters, give a plot of land at the peripheries of the islands close to their houses

either filled, or not, as a dowry. This factor has influenced the numbers of males attracted to the region who intend to marry.

- **Lack of co-ordination** : There are various institutions that functioned at divisional level in the process of development. All these institutions carry out their duties independently as 'water tight compartments' without co-coordinating each other. This may create a situation encourage for encroachment rather than stopping.

Most of these houses have been constructed without any basic facilities such as drinking water, electricity and roads net work. In addition to the above, people also live without proper toilets facilities in this area. According to the recent survey done by the "Sevenatha" showed that nearly 5000 people are living without toilets in this area.

All the households depend upon pipe-borne water supplied by the Negombo Municipal Council (NMC). Twenty percent of the houses are connected to the NMC water pipeline, while 80 percent are served by public stand pipes. These stand pipes are used for all purposes, including bathing and washing. Their condition is unsatisfactory and the stagnating drain water associated with these have contributed directly to environmental degradation.

Forty eight percent of the houses use electricity for illumination, while a slight majority use kerosene oil. But the "SANASA," a thrift society, provides loans for obtaining electricity connections, particularly at Munnakkare and Siriwardena Pedesa. The vast majority of households (88%) use fuel wood for cooking, mainly rubber wood purchased from the nearby shops. Mangroves wood are used as fuel wood in case of emergency.. A small number of houses use gas and kerosene oil for cooking.

Almost half the number of houses in the channel segment (48 percent) do not have latrines and their inhabitants defecate directly into the lagoon. Thirty four point of houses have pit latrines or septic tanks. Since the pit latrines cannot function properly because of tidal influence, they generally open into the lagoon. Where septic tanks are installed at ground level, reverse flushing occurs during high tides. During these periods they are unusable. All these problems aggravate during the rainy seasons. It is estimated that about 250 kg/day of raw faeces are discharged from the channel segment into Negombo estuary, resulting in an annual total load exceeding 90 metric tons. Two important factors that contribute to this unsanitary situation are :

- high cost of construction of an elevated latrine (about Rs. 25,000/=); and
- ignorance of relationships between health and faecal contamination.

The health status of the residents of the channel segment (e.g. in comparison to that in the whole of Negombo) cannot be adequately assessed. During 1992, malaria (6 cases), hepatitis (4 cases), tuberculosis (2 cases), typhoid fever (7 cases) and dysentery (5 cases) were reported to the Negombo Medical Officer of Health from the channel segment.

2.3.4.3

Social factors

Almost 75 percent of the population are below the age of 34 years, while 55.1 percent of the females are in the childbearing age (15 to 49). The most obvious prediction that may be made is that this population will grow without emigration, and that with it the land demand just inevitably increase. Moreover, 35.4 percent of the females below 15 years of age will enter childbearing age by the end of this decade; when they marry and seek to set up new households a further increase of the potential demand for land will result.

The rate of population increase is influenced both by fertility and the age at marriage. In the channel segment females marry at 15 to 19 years while males marry when they are between 20 to 24 years old. Factors that generally stimulate early marriage include regular income, access to housing, and acquired training for employment. In the channel segment, however, these factors are less valid, since the lagoon provides immediate income and the inter tidal areas provide land for a house at "no cost" (ecological costs are not understood). Use of estuarine water for various fishing activities also created several problems.

2.3.4.4.

Jetty Constructions

There are 47 jetties constructed at channels segment of the estuary and most of these jetties are unauthorized construction of individual jetties. The jetties have created user conflicts among other fishermen. Since these jetties are observation of navigational paths of the many fishing boats. These jetties are used mainly by the multi days boats and they simply discharge burnt oil into the estuary. This has become a threat to the habitats of the estuary.

2.3.4.5

Brush Pile Fishing

There are about 450 brush piles in the estuary, which use ban fishing nets. These ban fishing methods have destroyed lots of habitats in the estuary. These practices also created lots of disputes among fishermen. The recent study done by NARA revealed that new harmful fishing practices carried out by the fishermen in the marsh area and these methods will destroy the most of shrimps resources in the estuary.

2.3.4.6

Fish Processing for Dry Fish Industry

Dry fish production is practical in several places (specially Pitipana and Duwa area) and the wastage of fish processing are dumping into the estuary. These fish waste are one of the estuary polluting sources and need proper management mechanism to reduce the environmental damage.. These places also dump lots of polythene into the estuary.

2.3.4.7 Landing/Anchoring of Single Day Boats

There are more than 3000 single day boats are landing in the estuary banks and near to the estuary mouth. These boats also discharges a significant volume of oil into the estuary and other pollution veterans such polythine and fish wastes. In addition to the pollution, these fishermen are consume 8000 to 10000 gallons of drinking water per day. (these boats are not from the area but form out the Negombo area). The drinking water is an acute problem in the Negombo site area and therefore outside boats landing in the Negombo estuary is also one of the main problem to the residence of the Negombo as well as habitats of the estuary.

2.4 Aquaculture

There are 15 aquaculture forms operating in the Negombo estuary but many of them have been abandoned due to the low yield and death of fish. At present few farmers are operating shrimp farms near Muthurajawela area and are under the estuary fishermen's objections. The use of land for aquaculture in the Negombo estuary is becoming several institutional environmental socio-economic and political problems.

According to the fishermen, they are not agree to use the estuary for any type of tourism. They believe that water sports and high speed boats destroy their traditional fishing areas. Therefore, even ecotourism in the Negombo estuary will create lots of social unrest unless fisherman made well aware of the benefits of the ecotourism.

Uses of built land for industries in the Negombo area also created heavy pollution to the estuary as well as to the marsh.

Land Cover in the Attanagalu



Figure 2.4

- ★ Lakes, Village Tanks
- ▲ Marshes
- Lagoons
- ∕ Catchment Boundaries
- Towns





Figure



2.5 Land Cover

There are three main type of land covers in the basin area. They are :

- 1) Negombo estuary (Lagoon)
Muthurajawela Marsh
- 2) Fresh water marshes
- 3) Forests

2.5.1 Negombo Estuary and Muthurajawela Marsh

The Attanagalla Oya (known as Dadugam Oya in its lowest reaches) discharges at the junction of Negombo estuary and Muthurajawela marsh. The Muthurajawela marsh and Negombo estuary form a marsh lagoon complex comprising a set of continuously inter-linked ecosystems which interact with both the terrestrial watershed and the sea. Therefore these two areas are explained together. Muthurajawela marsh and Negombo estuary is one of the 41 wetland sites identified in the Asian Wetland Directory.

The extent of the Negombo estuary area is 3164 ha and the Muthurajawela marsh cover 3068 ha.

2.5.2 Fresh Water Marshes

There are several fresh water marshes in the basin area and of them opatha marsh Kimbulapitiya marsh and Epambula marsh are the prominent ones. (Figure 2.5.4). The opatha marsh consists of grasses and sedges. Some areas of the marsh have been filled for construction of houses and has housing facilities. A tannery and a tyre factory are also situated near the marsh. The tannery, which is a high polluting industry dumps its solid waste, such as off-cuts of hides of tanned leather pieces, sludge from the effluent treatment plant and discharges its effluents containing chromium salts and sulphides into the opatha marsh. The opatha marsh area is declining rapidly. The ecosystem would be directed to an ecological succession to a drier land due to sediments being transported from upstream areas and to highly polluting effluents.

Kimbulapitiya marsh and Epambula marshes are covered with grasses and sedges with scattered water pools. The marshes are close to the Negombo town at this leads to pollution by way of domestic wastewater, garbage disposal etc. Some textile finishing industries are also located close to the marshes. These marshes ecosystems are under environmental pressure.

2.5.3 Forests

The total forest cover barely reaches a value of 1.0 percent of the total area of the basin, and that even this limited extent is located in the uppermost sub-watershed of the basin. There is no forest cover in the other part of the basin. There is a considerable merit in establishing a sustainable forest cover in the uppermost watershed area of the basin which is at present having only a partial forest and rubber plantation cover. Since the primary source of the Attanagalu Oya is located within this area, every attempt should be needed to stabilize the hydrological regime of this upper watershed area. This will have many beneficial effects for the middle and lower course of the basin. Reforestation of this uppermost watershed will help to stabilize the dry weather flow in the upper portion of the Attanagalu Oya which will benefit the ground water resources of this upper portion during the dry season of February to March when the demand for ground water is much high.

LAND USE IN DANDUGAM OYA & ATTANAGALU OYA

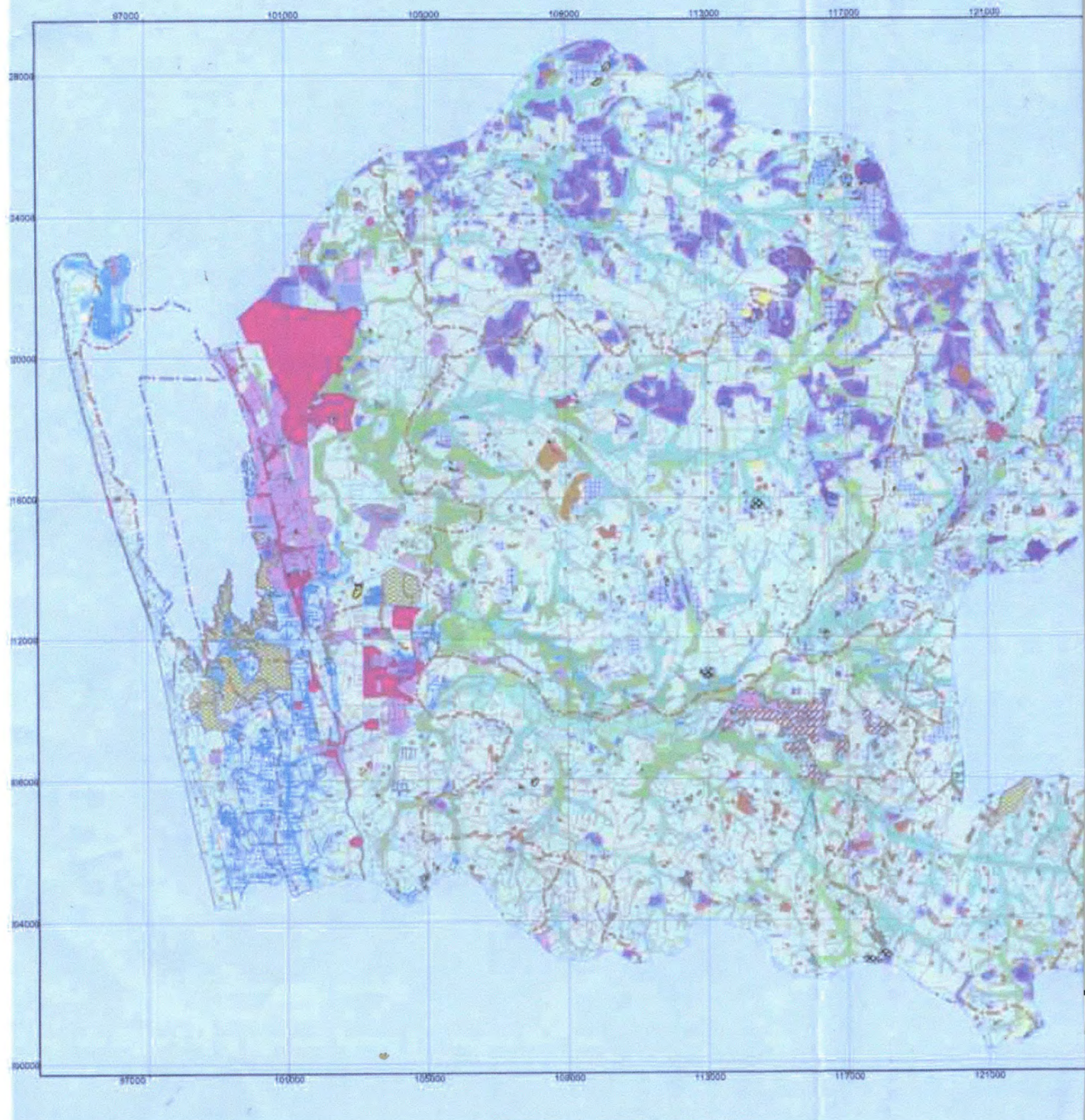


Figure 2.6

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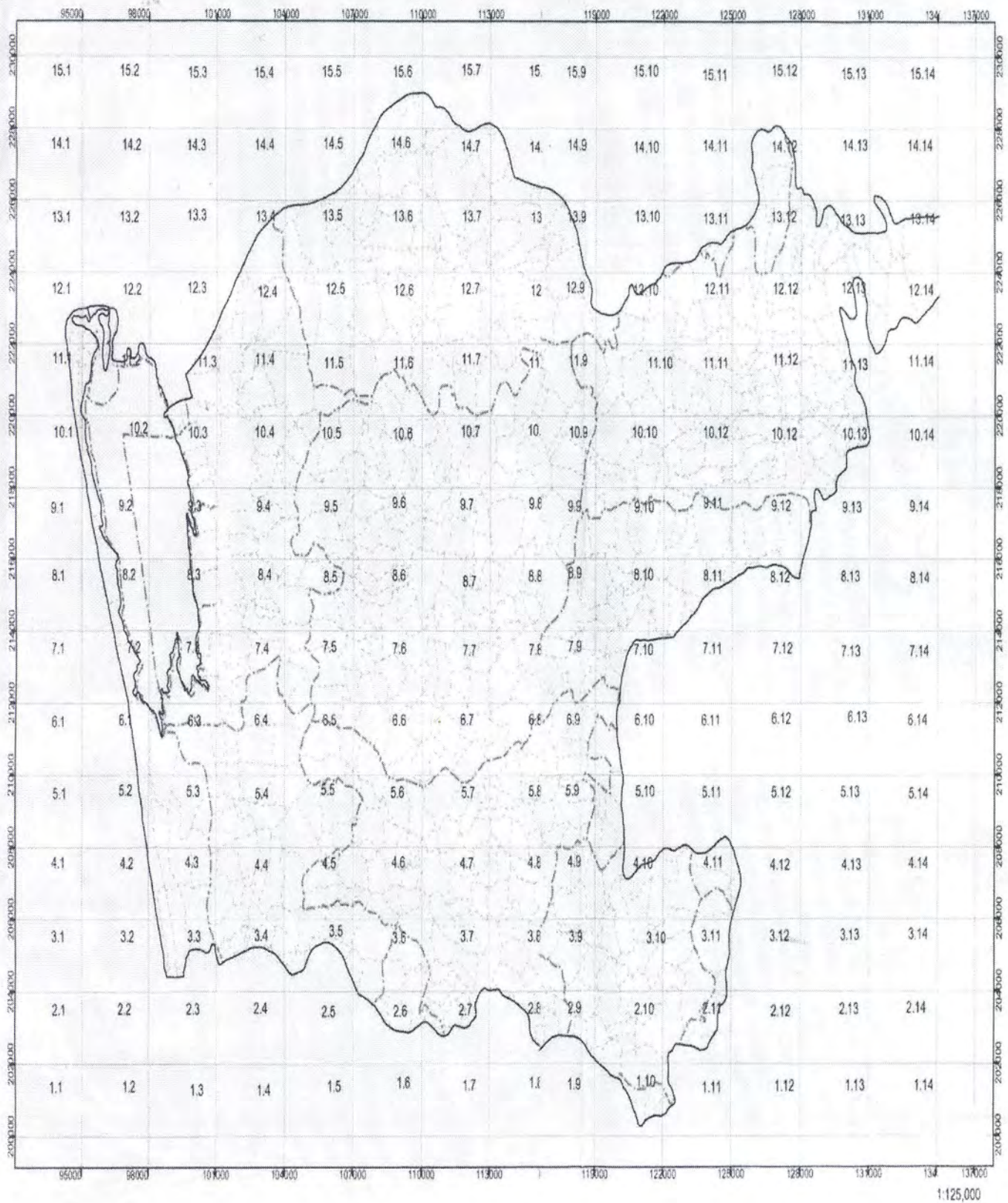


Legend

- | | |
|---|-----------------------------|
| D.S. Boundary | Mango |
| Paddy Irrigated | Citronella |
| Paddy Rainfed | Banana |
| Paddy (Abandoned) | Pineapple |
| Paddy + Other crop in one season | Other |
| Home Garden | Dense Forest |
| Market Garden | Forest Plantation |
| Rubber (monocrop) Well Managed | Scrub |
| Rubber (monocrop) Moderately Managed | Chena |
| Rubber (monocrop) Poorly Managed | Grass Land |
| Rubber (inter crop) Well Managed | Agroecological Reservations |
| Rubber (inter crop) Moderately Managed | Park Playground / Cemetary |
| Rubber Abandoned | Marshland |
| Coconut (mono crop) Well Managed | Water Bodies |
| Coconut (mono crop) Moderately Managed | Rock |
| Coconut (mono crop) Poorly Managed | Distorted Surfaces |
| Coconut (inter crop) Well Managed | Barren Lands |
| Coconut (inter crop) Moderately Managed | Settlements |
| Coconut (inter crop) Poorly Managed | Buildup Lands |
| Coconut with Livestock | Solid Waste Disposal Sites |
| Cinnamon | Reclaimed Lands |
| Coca | Sand |
| Cashew nut | Vacant Land |
| Lemon | Mangroves |

Scale 1:125,000

INDEX MAP -LAND USE DANDUGAM OYA ATTANAGALU OYA CATCHMENT



Chapter 3

3. Issues in the Attanagalu River Basin Area

According to the participatory Rapid Assessment of the basin area, community groups in this issues were grouped into three areas. They are :

- environmental
- institutional and
- socio-economic areas

3.1 Environmental Issues

The following environmental issues were identified in the study area. They are :

- sedimentation of the estuary
- water pollution
- salinity variation in the estuary
- degradation of habitats

3.1.1 Sedimentation of the Estuary

Sediment accumulating in the estuary is one of the major environmental problem, in the Negombo estuary. Accumulating of the sediment in a estuary is derived from a variety of local sources. These sediments are mainly derived from external and internal sources.

External sources includes,

- erosion of river banks
- erosion of upland watershed, delivered by streams and rivers
- sediment from upland slopes delivered by sheet flooding and surface runoff.
- Sediment from the shelf and near shore bottom delivered by long shore currents and tidal currents through the islets.

Internal sources include :

- sediment from production of organisms in the form of shells, tests, grass, debris etc.
- sediment derived from erosion of estuary banks and shares

- sediment derived from man made wastes and fillings. (anthropogenic activities)

As a result of the siltation the delta at the mouth of Attanagalu Oya (Dadugam Oya) has increased from 44.1 ha in 1956 to 92.25 ha in 1981.

The sediment transport relationships suggest entrapment of 50,000 m² within the lagoon every year (Conservation Management Plan, 1994).

As a result of excessive sedimentation of the estuary, following changes have been taken place.

- shallowing the estuary, channel segment in the estuary
- movement of sand shoals
- formation of island
- illegal filling and housing expansion
- movement of the land tip of the eastern tip of the mouth

3.1.2 Water Pollution

There are five different types of water pollution that are taking place in the basin area. They are :

- a) Faecal pollution
- b) Visual pollution
- c) Enrichment with nutrients such as nitrogen and phosphorus
- d) Organic (non-toxic and toxic) and heavy metal pollution
- e) Oil pollution

Table 3.1.1 describes the types of pollution, key sources of pollution and their main adverse impacts respectively. The proposed classification of uses for coastal waters in Sri Lanka are also described in Table 3.1.2.

Table 3.1.1 : Types of pollution, sources and main adverse impacts of water pollution in general in the Attanagalu River Basin Area

Types of pollution	Key sources	Adverse impacts
Faecal pollution	○ Municipal sewage ○ Industries ○ Tourist Sector ○ Aquaculture ○ Squatter settlements	○ Water related diseases ○ Affects the growth of marine Flora and fauna ○ Foul odors, impairs visual aspects ○ May lead to anaerobic environments
Visual pollution	○ Industries ○ Tourist sector ○ Agriculture and aquaculture ○ Squatter settlements ○ Municipal and domestic solid waste	○ Impairs visual aspects ○ Affects habitats and ○ Breeding grounds of fauna ○ Affects the growth of marine vegetation such as sea grass by reducing light penetration.
Enrichment with nutrients such as nitrogen and phosphorus	○ Municipal sewage ○ Industries ○ Tourist sector ○ Agriculture and aquaculture ○ Squatter settlements ○ Municipal and domestic solid waste	○ Stimulates algal growth ○ Causes change or decline biodiversity ○ Change water quality
Organic (non-toxic and toxic) and heavy metal pollution	○ Industries ○ Tourist sector ○ Agriculture and aquaculture ○ Squatter settlements ○ Municipal and domestic waste	○ Bio-accumulation of substance that are carcinogenic or causes health hazards in marine fauna ○ Decline of biodiversity ○ Persistence in the marine or coastal environment for long periods ○ Affects growth and reproduction of marine fauna
Oil pollution	○ Industries ○ Boats, ships oil spills and service stations	○ Impairs visual aspects ○ Destroy marine fauna and flora ○ Affects benthic fauna with the formation of oil slicks and tar balls ○ Affects migration patterns of fauna

For all these types of pollution past water quality reports, physical observations have been made and the technical judgment arrived at are used in order to perceive the degree of pollution. It is therefore imperative to check water quality parameters with the proposed ambient water quality standards for coastal waters are given in Table 3.1.2.

The different user classes given in Table 3.1.2. are assigned for various beneficial uses and are given in Table 3.1.3.

Table 3.1.3 : Proposed Classification of use of Coastal Waters for different activities in Sri Lanka

Class	Description	Use
1	Nature conservation	Ecosystem conservation Science and education Aesthetic enjoyment
2	Fishery shellfish	Fishery of shellfish (mollusc) Aquaculture of shellfish (mollusc) Saltpans Water contact recreations Ornamental production
3	Fishery/finfish	Fishery of finfish Aquaculture of finfish Fishery of non-mollusc invertebrates
4	Non-consumption use (water not used for production of any consumption goods)	Non-water contact recreations Navigation Harbour Waste disposal Sand mining Coral reef mining

With respect of the proposed classification, Negombo estuary is in accordance with current uses and subject to the following beneficial uses:

Table 3.1.3 Various beneficial water uses

Ecosystem conservation	(class 1)
Science and education	(class 1)
Aesthetic enjoyments	(class 1)
Fishery of shellfish	(class 2)
Aquaculture of shellfish	(class 2)
Water contact recreations	(class 2)
Fishery of finfish	(class 3)
Non water contact recreations	(class 3)

Faecal Pollution

Faecal pollution is said to be the most pronounced one in the recent past due to the main sources such as low-income settlements in the close proximity to the mouth of the estuary industrial development in the catchment area, and tourist sector development particularly in the shoreline and municipal sewage brought by riverine flow from Dandugam Oya and Ja-ela etc. The faecal pollution in the estuary and its neighbourhood would undoubtedly lead to water related diseases to be widespread causing health hazards. In addition, high levels of faecal coliforms, which have been used as an indicator for faecal pollution, would adversely affect the edible flora and fauna and hence human beings. The very high levels of faecal coliforms indicate that the raw sewage is in contact with estuary waters and the conditions might be anaerobic resulting in even foul odors. Table 3.1.2.1 depicts the total and faecal coliforms in the Attanagalu water basin and its connecting watercourses.

Table : 3.1.2.1 total and Faecal Coliforms in the Attanagalu River Basin Area

Location	Parameters			
	Total coliforms per 100ml		Faecal coliforms per 100ml	
	1991	2003	1991	2003
Dandugam Oya	-	2200	-	140-170
Ja-ela	-	5000-16,000	-	140-220
Hamilton canal	23,000	340-500	70-3000	70-79
Middle of the lagoon (close to Pitipana)	3200	17	750-1200	2-4
Mouth of the lagoon (in the main channel)	8010	270-9000	50-3500	70-110
Mouth of the lagoon (towards Duwa)	5200	300-500	73-150	70-80
Mouth of the lagoon (towards Kadolkele)	11200	500-16,000	Nil-2500	140-170

Sources : 1-GCEC (1991) : 2-University of Moratuwa (2003)

From the above table it is clear that the microbiological quality was worse in 1991 but has been improved remarkably in 2003. The present total coliform levels in Dandugam Oya and Ja-ela indicated very high levels (greater than 1000 per 100ml) as stipulated in proposed standards for all the classes and it indicates that the riverine flow brings in municipal sewage into the lagoon. However, once the faecal matter-rich waters meet the lagoon water, high dilution occurs making the water suitable for all types of classes from 1 to 4. Similarly, in the mouth of the estuary total coliform levels once again high mainly due to the sewage contamination from both low-income settlements and fisher folk. Hence water in the mouth area is not suitable for any beneficial use. In summary, it should be inferred that both confluences where the fresh water meets estuary and the seawater meets the

estuary are faecally polluted in such a way that no beneficial use described above could be practiced without a risk of being adversely affected. Nevertheless, in all the parts of the estuary, faecal coliform levels were within the permissible levels for all classes indicating that the dilution could reduce the degree of faecal pollution. The scenario suggests that the degree or intensity of faecal pollution could be dramatically reduced the degree of faecal pollution. This scenario suggests that the degree or intensity of faecal pollution could be dramatically reduced with the enhancement of tidal flow within the estuary.

Visual Pollution

Visual pollution in the basin area is mainly due to the floating matters thrown in the form of solid wastes. When the water level rises in the high tide the solid waste dumped at the backyards of residence is inundated as a result some of these materials are carried away with the tidal flow and deposited particularly in the mangrove islands located in the close to mouth of Negombo estuary. In addition, dumpsites at the shoreline could also be frequently seen particularly in and around the mouth. Development activities at the shoreline too sometime give rise to visual pollution in the estuary. Sedimentation of estuary particularly in and around the mouth would lead to the formation of shoals in the different parts of the estuary. These are hindrances for many multiple uses and be good sites for solid wastes reception causing visual pollution.

Most of these solid wastes become breeding and nursing grounds for mosquitoes and hence water related diseases. Management of solid waste in the area seems to be very poor and a proper management system is of paramount importance in order to lessen the visual pollution in the estuarine waters.

It was observed that the most of the residents and several industries dumped their solid waste into the Attanagaly Oya or Negombo Lagoon. According to the “Sevenatha” (an NGO) estimated nearly 15-20 tons of solid waste daily dumped into the river and estuary.

Enrichment with nutrients such as Nitrogen and Phosphorus (Eutrophication)

Eutrophication is a process by which the primary production is highly elevated with the influent of excess levels of nitrogen and phosphorous in the water body. Municipal sewage, fertilizer runoff and industrial waste waters carried by riverine flow contain usually high levels of nitrogen and phosphorus that can stimulate eutrophication. In addition, the tourist sector development and squatter settlements in the shoreline too contribute to the nutrient budget significantly. Sometimes, there could be instance where anoxic conditions prevail for a long period during which in-lake production of phosphorus through the regeneration process may occur contributing to phosphorus budget.

Eutrophication could adversely affect the health of the estuary ecosystem in many ways. Stimulation of algal growth, decline in biodiversity and subsequent changes of water quality are some of the consequences of eutrophication process that could impair the functions of the lagoon.

In the estuary invasive algal species have appeared devastating the sea grass, which could be breeding and nursing grounds for many migratory fish.

The recent data on nutrients in the estuary and streams monitored by the University of Moratuwa in 2003 are described Table 3.1.2.2 and depicts the average nutrient levels in different reaches of the estuary.

Table 3.1.2.2

Parameters	Year and Place								
	1988			1991			2003		
	Upper reach	Middle reach	Lower reach	Upper reach	Middle reach	Lower reach	Upper reach	Middle reach	Lower reach
Nitrates (mg/l)	0.10	-	0.18	-	0.10	0.11	0.35	0.18	0.18
Nitrites (mg/l)	0.002	-	0.003	-	0.002	0.003	-	-	-
Ammonia (mg/r)	-	-	-	-	<1.0	<1.0	0.00	0.00	0.31
Total nitrogen (mg/l)	-	-	-	-	-	-	1.14	0.24	0.35
Phosphates (mg/l)	0.04	-	0.05	-	0.25	0.25	0.12	0.18	0.18
Total phosphorus (mg/l)	-	-	-	-	-	-	0.15	0.28	0.15

Sources: 1-NARA (1998) : 2-GCEC (1991):3-UoM (2003)

Note : Monthly variations measured in 1988 were averaged from consistency. However only a rough measure must be obtained from these results as they were measured in different tidal cycle.

From the above table it is evident that the nitrate level in the upper reach has gone up indicating that there has been a considerable input from streams in the form of nitrate nitrogen. This could have been mainly from the municipal sewage and fertilizer runoff, which connects to the lagoon through Dandugam Oya. Nitrite levels over the past seemed to be of the same order once again indicating that there could be a recent pollution in the form of sewage or industrial waste waters. Ammonia levels were comparatively low. Nevertheless, total nitrogen in the upper reach was extremely high disclosing that there is no or very mild flushing taken place in the upper reach was extremely high disclosing that there is storage of nitrogen in the form of particulate matter. It further indicates that there

is no or very mild flushing taken place in the upper reach and the organic and refractory matters are therefore deposited in the bottom. Field observations justified this scenario and no remedial measure has been taken to curtail such depositions.

Similarly, in all reaches the phosphate levels have gone up high manifesting that the overall input into the lagoon is on the rise. High levels of phosphorus seem to be not from streams but from the activities associated with the lagoon particularly from the lower reach. This could be the main reason for algal appearance in the lower reach than upper reach.

The proposed ambient water quality standard does not stipulate any permissible levels in relation to nutrient levels but an upper bound of 0.7 mg/l for phosphate content is recommended to control eutrophication and excessive weed growth (CEA, 1992). An analysis has been done on the nutrient loads from agriculture sector by Lanka Hydraulics Institute in 1999 and given in Table 3.1.2.3.

Table 3.1.2.3 : Annual use of nitrogen and phosphate fertilizer in the Attanagala Oya Basin (LHI, 1999)

Crop/land use	Area (ha)	N Applied (Kg/ha)	PO ₄ , applied (Kg/ha)	Total N (MT)	Total PO ₄ (MT)
Paddy	10740	98	18	1053	193
Coconut	12195	8	6	98	73
Rubber	5115	10	12	51	61
Homesteads	43280	-	-	-	-
Sparsely used cropland	2100	-	-	-	-
Total				1201	328

Note : A cropping intensity of 80 percent has been assumed for the actual area under paddy and fertilizer use in homesteads has been neglected in the analysis

The table shows that the paddy accounts for about 85 percent of the nitrogen and two-thirds of the phosphate fertilizer used for the main crops. It has been estimated that the average load of Nitrate –Nitrogen is 91 g/s or approximately 2900 MT/year at Raddolugama. The estimated annual fertilizer input would be about 1000 MT and hence there is a significant contribution even from the industrial sector. The nitrogen input from Ja-ela/Ekala industrial area was estimated to be about 27 MT/year. This clearly indicates that the industrial sector would be totally responsible in bringing in high loads. Hence, high loads are anticipated from the over fertilization, which has been observed since 1997 with the introduction of subsidy scheme for fertilizer. The statistics given above does not account for over-fertilization and hence the actual loads seem to be more than given in the table.

When considering the phosphate loads, annual load was found to be 52 MT/year. The quantity applied in the catchment was about 160 MT/year and hence it could be presumed that the fertilizer runoff accounts for the actual phosphate load at Raddolugama, it was estimated that the total nitrogen and phosphate loads into the lagoon are approximately 6000 MT/year and 100 MT/year respectively (LHI 1999). Out of these, total industrial

loads were approximated to be 27 MT/year of nitrogen and 50 MT/year of phosphate. These figures suggest that the nutrient loads are predominantly from the fertilizer run-off and being carried into the lagoon by the Dandugam Oya.

Organic (toxic and non-toxic) and Heavy Metal Pollution

The general parameters of organic and pollution are the BOD and COD levels. However the toxic components consisting of pesticides, weedicides and insecticides also cause pollution covering health hazard through bioaccumulation, bioconcentration or biomagnification processes. Heavy metals too contribute to health hazards if found in high concentration in the lagoon waters. Organic pollution is generally due to municipal waste, industrial and domestic wastewaters. Toxic components are mainly from industries and fertilizer run-off. Table 3.1.2.4 shows the BOD and the COD levels of different regions of the lagoon.

Table 3.1.2.4 : Organic pollution in different parts of Negombo Estuary

Area	Year and Parameters			
	1991		2003	
	BOD	COD	BOD	COD
Lower reach	21	-	28	31
Middle reach	20	-	12	31
Upper reach	-	-	19	23
Dadugam Oya	16	-	17	25
Ja-Ela	25	-	12	21
Hamilton Canal	19	-	11	19

Sources : 1-GCEC, 1991; 2-UoM, 2003

Note : Average values are used here for comparison and only a rough measures could be obtained as the measurements were taken in different times of the tidal cycle.

The results manifested that over the years, there have been no drastic changes in BOD levels and there seems to be a trend of high BOD at the lower reaches than upper reaches. The proposed standards suggest that the BOD level must be less than 10 mg/l for class 4 and be less than 5 mg/l for classes 2 and 3 respectively. BOD values of different areas suggest that there is an organic pollution and hence not recommended for all beneficial uses. Lesser flushing rates in the lagoon may be the main reason for high BOD levels in the almost all parts of the lagoon.

The pollutant transport from the streams showed that the overall transport is dominated by small number of high flow events. In other words, it is apparent that there is very high load of organic matters entering the lagoon during the first flood after a long dry spell. It has been estimated that during the low flows (non-monsoonal periods) the COD load is approximately 850 kg/day while BOD load is about 280 kg/day respectively (LHI, 1999).

The COD to BOD ratio suggests that the major portion of organic matter is biodegradable and hence lesser toxicity effects. These loads seem to be made up of urban or/and industrial run-off. However, organic loading for the entire year was estimated to be 2500 MT/year of BOD and 5500 MT/year of COD respectively. Of these, about 500 MT/year of BOD and 2000 MT/year of COD were estimated to be from industrial flows. However, the dry season is concerned, more than 50 percent of the load is from industrial flows.

The toxic components of organic pollution due to pesticides and other persistent compounds from industries have not been measured or estimated so far. Hence no conclusive remarks could be made but the physical observations suggest that this type of pollution is on the rise.

In 1991, GCEC reported that cadmium and mercury levels in the lagoon waters, were very much less than the proposed ambient standard levels for all classes. However, recent data were not available for the evaluation of background levels. Despite the low levels in the water column, it is anticipated that higher heavy metal loads are adsorbed into the organic layer present at the bottom, particularly at the upper reach. The analysis of the industrial effluent suggests that the heavy metal loading into the lagoon was approximately 20 kg/year for mercury and chromium and 10 kg/year for lead, copper and cobalt (LHI, 1999).

In summary, it could be inferred that organic pollution is very high so that the beneficial uses indicated in all classes cannot be operated or maintained without problems while other toxic pollutions could not be estimated due to the lack of data. However, the physical observations in and around the lagoon suggest that the lagoon may be subject to toxic pollution too.

Oil Pollution

Oil pollution is mainly taking place in the lagoon primarily due to the anchorage of fishing boats in and around the mouth. Oil pollution in the lagoon generally impairs the visual quality and oxygen depletion could also occur due to the restrictions in recreation with atmosphere. This scenario could then adversely affect the flora, fauna and water quality of the lagoon. Physical observations in the areas of the mouth clearly indicate that there exists oil pollution once again due to the calmness in the area (due to the lack of tidal flows). Waste oil from fishing boats are disposed of in the lagoon, as no reception facilities are available in the area. In addition, loading and emptying of fuel within the lagoon are found to contribute to the oil pollution. Transport of fuel into the boats too contributes significantly to this type of pollution.

3.1.2.2 Sources of Water Pollution

Industrial Sources of Water Pollution

The industrial development of the Attanagalu Oya basin is concentrated in the lower end of the catchments. There are a few large industries in the upper and mid catchments, including the Veytex textile factory and some coconut based industries in the Attanagalla area. However, the textile factory is not operating and close down soon. A large number of industries are also situated in the Ekala area, around Ja-ela, in the Katgunayake EPZ, and along the Kimbulpitiya Oya to the north and east of Katunayake.

Information about the industrial water use and wastewater discharges in the Ekala, Ja-ela and Katunayake areas are available in Greater Colombo Wastewater and Sanitation Master Plan (Engineering Science, 1993), the Feasibility Study for the Joint Wastewater Treatment Plant at Ekala/Ja-ela (Soil and Water 1994) and Edirisinghe (1995). However, the first document has information only on the total water use and the presence or absence of a treatment plant. Furthermore, the information contained in this report was updated Soil and Water (1994).

A detailed survey of the effluent of industries in the Ekala area was carried out for the feasibility study. However, only the overall discharges for the area were presented in Soil and Water (1994) as the detailed data were considered confidential.

Soil and Water (1994) identified 143 industries in the Ja-ela AGA division, of which 135 were in operation at the time of the survey, 80 of these industries use water in their production process and 66 generate industrial effluent. The details of water use and effluent discharge according to the type of industry is given in Table 3.1.2.1.

TABLE 3.1.2.1 ATTNAGALU OYA BASIN-DETAILS

Type of Industry	Number of Units	Domestic water consumption (m ³ /day)	Industrial water consumption (m ³ /day)	Industrial effluent discharge (M ³ /day)
Textile and leather – wet processing	18	285	908	878
Food	14	169	617	210
Chemical	26	203	271	134
Total-three categories	58	657	1796	1222
Total – all operating units	135	1365	2340	1412

Table 3.1.2.1 shows that the effluent discharge is dominated by three categories of industry, practically all of which are in and around Ekala. Only 25 industries have an industrial water consumption of greater than 5 m³/day.

Only 13 treatments industries have any kind of wastewater treatment. However, most of these are limited to primary sedimentation, and none of the treatment plants were capable of producing effluent that compliance with the discharge regulations. All industrial wastewater is discharged into surface drains.

The 39 industries within the Ekala Industrial Estate discharge domestic sewage to a collection network that feeds a central treatment plant. However, this plant is not in operation and the essentially untreated effluent is discharged through a pipeline into the Ja-ela. The other industries discharge the domestic sewage to septic tank/soakage pit systems./ Non-sewage domestic wastewater, factory washing etc. are also discharged to surface drains.

Sludge produced in the existing treatment plants is either used for landfill within the premises or handed over to “disposal contractors” – who generally dump the material into marshy lands. Solid waste is either burnt within the premises or handed over to the same parties for disposal.

Soil and Water (1994) carried out a detailed analysis of the effluent from 40 industries in and around the Ekala Industrial Estate. These industries accounted for over 90% of the industrial effluent. The total pollutant loads before and after the existing treatment facilities are shown in Table 3.1.2.2 The table shows that the existing treatment is able to remove about half the COD, nitrogen and phosphorous loads. However, as the treatment is mainly, much of this material will remain in the sludge. As the sludge is mostly disposed of to low-lying land that is often flooded, it is still possible for the constituents of the sludge to be mobilized into the surface water.

TABLE 3.1.2.2 ATTANAGALU OYA BASIN – POLLUTANT LOADS FROM INDUSTRIES BEFORE AND AFTER EXISTING TREATMENT

	Pollutant Load (kg/day)				
	BOD	COD	Total N	Total P	Total suspended solid
Babere existing treatment	620	3370	50	40	580
After existing treatment	681	1615	26	20	133

The details of the heavy metals in the effluents are given in Table 3.1.2.3. The table shows that mercury is the most significant heavy metal. The mercury is present in the effluent of a battery manufacturing from as well as some textile factories

Table 3.1.2.3

**ATTANAGALU OYA BASIN HEAVY METAL LOADS
FROM 40 INDUSTRIES**

Heavy metal load (g/day)							
Hg	Cr	Pb	Cu	Co	Zn	Ni	Cd
60	30	30	20	30	10	0	0.02

Soil and Water (1994) has carried out a very comprehensive assessment of the pollutant loads from the industries in the Ekala area table 3.1.2.3). However, there are several major industries to the north of the area, outside the Ja-ela AGA division, that contribute to the pollution of the Dandugam Oya and the lagoon. Chief among these are the Katunayake Export Processing Zone (KEPZ), the distillery at Seeduwa and another tannery. This tannery discharges effluent into a marsh, which drains into the Dandugam Oya above the Raddoluwa intake.

The KEPZ has 76 industries located within its area and all of which discharge effluent. The effluent is treated at a common wastewater treatment plant and this discharge into the Dadugam Oya. At present the KEPZ discharges about 10,000 m³/day of treated effluent.

Edirisinghe (1995) analyzed these three discharges and the pollutant loads and details are given in table 3.1.2.4. In addition, Edirisinghe (1995) identified 5 large industries in the Ekala area whose effluent was discharged to a stream that joined the Dadugam Oya upstream of the intake.

Table 3.1.3.4 shows that the distillery and the KEPZ contribute a significant organic loading. The table also indicates that the river above the intake is also pollute4d, by organic load as well as by chromium and mercury.

**TABLE 3.1.3.4 ATTANAGALU OYA BASIN-POLLUTANT LOADS
FROM INDUSTRIES SURVEYED BY EDIRISINGHE (1995)**

	Pollutant loads (kg/day)					Pollutant loads (g/day)	
	BOD	COD	NH3	PO4	NO3	Cr	Hg
KEPZ*	340	490	43	6.2	17.5	0	0
Distillery	200	236	0.13	0	0	0	0
Tannery	43.6	73.9	5.5	0.077	0.041	18.5	0
Four industries above intake	64.4	144	6.2	0.4	0.2	24	1.12

- a discharge volume of 10,000 m³/day has been assumed.

Finally, the information in Table 3.1.2.2, Table 3.1.2.3 and Table 3.1.2.4 can be combined to estimate the total pollutant load into the lagoon from these industrial sources. The calculation yields loads of about 1,200 kg/day of BOD, 2,350 kg/day of COD, 75 kg/day of nitrogen and 45 kg/day of phosphorous. In addition heavy metal loads include 60 g/day of mercury and 50 g/day of chromium.

As there are other industries in the area, especially in the catchment of the Kimbulapitiya Oya, the actual load into the lagoon will be larger than these amounts. The presence of the Katunayake International Airport in the area should also be noted.

Urban Sources of Water Pollution

The important urban centre of Gampaha is located on the Attanagalu Oya in mid-catchment. There are also several small to medium urban centers located on the tributaries such as Veyangoda, Mirigama, Divulapitiya, Nittambuwa and Yakkala. Finally, there is an urbanized strip on both sides of the Colombo-Negombo road that includes Katunayake, Ekala, Ja-ela, Seeduwa etc. There is no information on the organic load that reaches the river from such urban areas.

3.1.2.3 Comparison of Pollution Loading and Transport

The only location for which pollutant transports can be computed is the water supply intake at Raddoluwa. There is a significant proportion of the catchment that does not drain to this point, including the sub catchments of the Uruwal Oya, the Kimbulapitiya Oya and the Mapala Oya – which together constitute about half the catchment. This fact has to be kept in mind when estimating the fertilizer run-off that passes the intake.

The analysis of pollutant transport showed that the overall transport was dominated by a small number of high flow events. Considering the organic load, i.e. as given by BOD and COD, the observations support the idea of the organic load being the greatest during the first flood after a long dry spell, when a lot of material accumulated on the surface is washed into the river. Much of this material is of natural rather than anthropogenic organic and it is obviously neither possible nor productive to account for this flood load.

On the other hand, the loads during periods of low flow will be made up of urban and industrial run-off, quantities for which estimates can be made. Table 4.7 shows that the average COD load during low flows which as defined here occur about 20 percent of the time – is 9.8 g/s or about 850 kg/day, while the BOD load is about 280 kg/day. The data in Edirisinghe (1995), shown in Figure 4.3, indicate that about half of the organic load arises from the area around Ekala, and the loads from four of these industries, as given in Table 4.11, are found to be 145 kg/day of COD and 65 kg/day of BOD. Therefore these four industries can account for about one-third the COD load and about half the BOD load.

Table 4.7 gives the average load of Nitrate - Nitrogen is given as 91 g/s, or approximately 2,900 MT/year. The estimated annual application of nitrogen through fertilizer, for the portion of the catchment draining to Raddoluwa would be 1,000 MT at the most. This

difference indicates that there must be other significant sources of nitrogen to the river. The total nitrogen load from the industries in the Ekala/Katunayake area is only about 27MT/year, which rules out industry as a significant contributor to the nitrogen load.

When considering phosphates however, the annual load is found to be about 53MT/year. This quantity applied to the catchment of the intake would be around 160 MT/year. Therefore, fertilizer run-off could account for the phosphorous load. The proportion of fertilizer run-off is less than that estimated for the Maha Oya. This difference could be due to the smaller slopes of the Attangalu Oya catchment and the extensive floodplains. These features would decrease the sediment transport, and therefore the transport of phosphorous that is mostly bound to the sediment transport of phosphorous that is mostly bound to the sediment.

The total nutrient load into the lagoon can be calculated by assuming that the load at Raddoluwa is only half the total load. This yields loads of about 6,000 MT/year of nitrogen and about 100 MT/year of phosphates. In comparison, the total industrial loads are estimated to be about 27 MT/year of nitrogen and about 50 MT/year of phosphorus. This comparison shows that while the industrial contribution of nitrogen is insignificant, the contribution of phosphates is on the same order as the expected contribution from fertilizer run-off. As most of the industrial load enters the river below Raddoluwa, the total load into the lagoon should be taken as 150 MT/year.

3.1.2.4 Impact of Water Pollution

The impact of water pollution depends of the water in the basin. The principal uses of stream water from the main of the river are abstraction for drinking water, irrigation, ground water recharge, socio cultural uses and for aquatic eco-systems. There are no impacts of water quality on irrigation. The Negombo Lagoon will be discussed separately in the next section due to its importance.

Abstraction for Drinking Water

There are three water supply intakes along the river – at Veyangoda, Gampaha and at Raddoluwa. While there is no water quality data for the two upper intakes, the pattern of development suggests that there should not be any pollution related problems at these two intakes. On the other hand the data show that the water quality at the Raddoluwa intake is severely affected by pollution from industries including a tannery, textile factories and a battery factory. The pollutants include organic material, chromium and mercury.

However, the actual impact, if any, of the lowered water quality on this particular use is more difficult to determine. The water quality is generally within the proposed standards for this use. While the concentrations of the heavy metals have not been measured, the data on the effluents presented in Editisinghe (1995), together with the flow data, show that sufficient dilution is available to bring the concentration below the proposed standard for drinking water with conventional treatment.

As discussed above one of the main concerns arises from the high COD value, a parameter that is not in the standards. The difficulty arises because of the non-specific nature of the parameter. The COD value includes all types of oxidizable organic components. Even when the important industries are identified, in this case as the textile industry, the COD could be due to harmless materials such as fine particles of cotton or potentially hazardous materials such as dyes and solvents.

The impact of any organic substance that is not removed by the conventional water treatment processes used – coagulation/sedimentation and rapid filtration – can arise in two ways. Firstly, the substances can be directly harmful and secondly, harmful substance can be formed when the treated water is chlorinated. The magnitude of these impacts cannot be evaluated in the present case due to the lack of a detailed analysis of the industrial effluents. However, the high value for the Colour at Raddoluwa indicates that dyes are among the substances present in the water.

Therefore it can be concluded that a more detailed further study of the impact of the industrial effluents on the treated water should be carried out as soon as possible.

Groundwater Recharge and Groundwater Pollution

The Attanagalu Oya flows in a relatively narrow and shallow channel, with a broad floodplain in the lower reaches. Therefore there is likely to be some exchange of water between the river and the shallow groundwater. If the river is polluted, there may be some impact on the drinking water wells near the river banks. This is an important issue because many households in the Ekala and Ja-ela areas obtain their drinking water from shallow wells.

However, in view of the methods used to dispose of wastewater, sludge from primary settling and solid waste, direct contamination from the disposal sites is likely to be the means of the severe groundwater contamination observed. Here too there are no standards for ambient groundwater. However, the water quality in the wells is often worse than what is specified in the standards for potable water.

Socio- Cultural Use

This category includes direct use for drinking (possibly with simple treatment), bathing, washing of clothes etc. as well as river related activities such as sand mining. As most of these activities take place above the industrial zone, the pollution from industry would not have had a significant impact on these activities as yet. However, they could be affected locally by isolated discharges upstream.

Ecosystems

Other than the Negombo estuary the principal aquatic ecosystems are the marshes and the river itself. The rivers below the industrial zone have been affected by pollution, with occasional fish kills reported. The marshes in the lower catchment are used as a dumping ground for solid waste and sludge. The impact of these activities have not been studied in detail.

Negombo Estuary

The impacts of the pollution on the Negombo estuary are discussed separately in view of the importance for the lagoon and the complexity of the processes involved. As described above, the lagoon shows signs of oxygen depletion and the blooms of filamentous algae are observed to be more frequent and to last longer. The algal blooms are observed to be triggered by heavy rains. These factors have an adverse impact on the ecology and the fishery.

The estuary is also affected by sedimentation from two sources – the catchment and the sea. The coarse sediment transported by the river settles at the southern end of the estuary, with the resultant growth of the delta. The fine sediment is redistributed over the entire lagoon by waves and currents, and some of it moves out to sea through the estuary mouth at the northern end while some is deposited. The overall rate of deposition in the lagoon has been estimated at 1.5 mm/year. Coarse sediment from the coastal region is moved into the lagoon by tidal flow, and some of it is deposited at the northern end of the estuary, forming.

A study by Madduma Bandara et al. (1989) concluded that the estuary had lost 25 percent surface area between 1956 and 1981. Other studies and observations showed that the ocean entrance channels had been narrowed over this same period by the reclamation of land in the flood delta islands for housing and by continued deposition of open sediment.

Both the reduction in area and the constriction of the lagoon mouth would reduce the tidal flushing of the lagoon. Therefore the above studies gave rise to the notion that the principal cause of the observed changes in the water quality of the estuary is a reduction in tidal flushing. Based on this idea, the Wetlands Conservation Project has concentrated on dredging of the entrance channels and also to increase the lagoon area – as a possible solution to the problem..

However, a recent re-evaluation of the changes in the lagoon indicates that the changes in the estuary area appear to have been over-estimated. The change from 1956 to 1994 seems to be between 5 percent and 10 percent rather than over 25 percent. Therefore the reduction in tidal flushing would also be less than thought previously.

Another possible cause of the algal blooms and the degradation in the water quality is the change in the catchment, particularly in the application of fertilizers. Large scale use of fertilizers began only after the introduction of newly developed, quick growing strains of rice. These were introduced in the 1960's and 1970s. The industrialization of the Ekala

area began in the 1960s. Therefore, the nutrient load into the lagoon would have increased by at least an order of magnitude over the last four decades. The data show that the nutrient load is strongly correlated with the flow. In fact it may be the sudden inflow of nutrients that trigger the algal blooms, rather than the inflow of fresh water.

Therefore it appears that the run-off from the catchment, which has not been considered up to the present, must also be addressed as part of any solution of the problems of the lagoon.

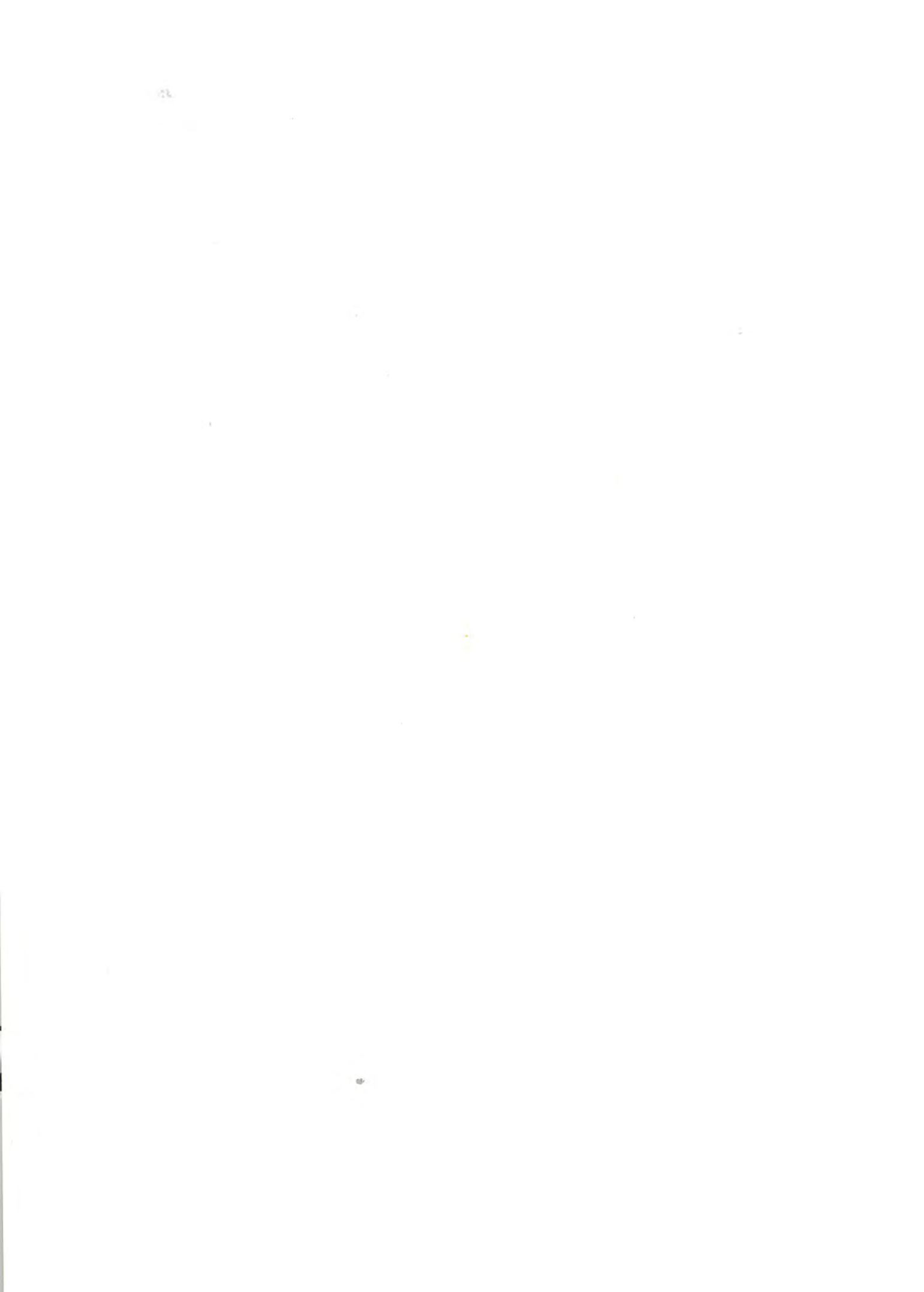
3.1.3 Salinity Variation

The salinity variation of the lagoon is primarily influenced by the tidal hydraulics of the ocean and its associated impact on the lagoon. The exchange of water between the lagoon and the sea would be the main mechanism by which the salinity levels are changed in the estuary. The tidal regime off the west coast of Sri Lanka could be categorized as mixed semi-diurnal in which the 12 hrs. and 24 hrs of tidal periods are imperative to be considered.

The water level in the estuary generally fluctuates corresponding to that of sea. Sea water flows into the estuary in the spring tide when the water level of the estuary is comparatively lower than that of sea. The vice versa is also true particularly at the trough of the cycle. However, the narrow entrance associated with complex geography at the mouth restricts the tidal flow resulting in a lesser tidal variation in the estuary than that in the sea. In other words, there exists a difference in levels both at sea and estuary. As the variation of sea is not symmetrical, the tidal flow over the mouth of the estuary may not be the same for all tidal cycles. Further, this phenomenon would be more complex with the introduction of significant flow of freshwaters into the estuary.

Salinity variation of the estuary is therefore a result of very complex phenomena attributed by both tidal exchange through the mouth and riverine flow from the inlets into estuary.

Salinity variation at 20 different locations have been measured by NARA from March 1989 to February 1990 covering complete one year. From those data it is apparent that high salinity levels were observed in the month of February 1989 in the estuary indicating that the tidal exchange was strong enough to bring in saline water rather than the freshwater by riverine flow. However, in the months of April and May 1989, rainfall intensity became high indicating that higher reception of riverine flow. This has flushed out the saline waters from the estuary and the estuary was dominated with freshwaters. With the disappearance of South-west monsoons dry season prevailed during which tidal action once again predominated giving rise to higher saline conditions in the estuary. Nevertheless, with the onset of North-east monsoon, which seemed to bring in more rainfall into Negombo area, salinity levels became less than 5 ppt in almost all areas indicating that the estuary was filled with freshwaters. These conditions were once again changed in the month of January and February with more saline water being brought to the estuary, resulting in sharp salinity gradients from mouth to inlets.



In comparing the salinity levels over the past two decades, it is apparent that there has been a reduction in saline intrusion into the upper part of the estuary. This could be due to many reasons of which sedimentation, changes in morphological features, and changes in riverine flow patterns are prominent observations.

These type of salinity changes can change the fish and shrimp production of the lagoon. In fact the lagoon fisherman indicated that their daily income drop out from Rs. 1000/= to Rs. 50/= per day as a result of delineation of shrimp harvest.

3.1.4 Degradation of Habitats

The habitats in the basin area can be divided into three main areas such as :

- Coastal
- Marsh and
- Basin

3.1.4.1 Coastal Habitats

Mangroves sea grass and the main habitats in the coastal area. At present scientific data is not available for level of mangrove destruction and their impacts. However the observations, available literature and PRA findings revealed that the mangroves in the Negombo estuary area are rapidly deteriorating. The causes for the degradation of mangroves are manifold but the following take precedence :

- removal of mangroves for various development activities
- illegal reclamation of lagoon
- illegal fishing methods
- lagoon water pollution

Mangrove habitats are very important habitat in the Negombo basin area wildlife, nursery for fish and nutrient trap and to enable extraction at a sustainable level.

According to the available information about 80 ha of mangrove land have been converted to the other development activities in the area. The trend is still continuing. Fishermen are mainly harvest the species *excoecaria aggalocha* (Thela) for fishing crafts and to use as pillars to demarcate the fishing area "Kattudal". These activities are not more destructive than large scale destruction for industries.

3.1.4.2 Sea grass

Sea grass beds are abundant in the Negombo estuary area although their locations and extent have not been precisely mapped and estimated recently. Sea grass perform a number of natural functions. They provide relief on an otherwise featureless substratum,

allowing epiphytic organisms to obtain sites for attachment and providing nesting habitat for numerous species of fish. Sea grass beds supply food to a wide variety of fish directly consume the leaves, while others, particularly juvenile fish, feed upon epiphytes, and a still others including some penacid shrimp species feed upon grass detritus.

Certain human activities including fisheries have been contributed to the destructions of sea grass beds. The impacts of fisheries activities on the sea grass bed was studied in 1993, in order to be able to incorporate in the possible management plan appropriate measures to ensure non-destructive use of these critical nursery areas. The findings of the study (Amarasinghe et al, 1993) are presented below.

The abundance and diversity of species associated with the sea grass bed at three locations, Kadolkele, Kurana, and Katunayake reflects the importance of this vegetation as nursery area.

The magnitude of stress imposed upon the sea grass bed in the Negombo lagoon could be measured in terms of the quantity of vegetation destroyed by two gear types, the push nets and the trawls, both bridging the bottom during operation.

The destruction of the operation that are most stressful to the sea grass bed is shown in figure 3.2. In term of destruction of sea grasses, the impacts from push nets and trawls are of comparable magnitude. Polychaete extraction and operation of trawls are confined to a limited area. While the operation of trawls is widespread as it is one of the highly efficient fishing method. This has resulted more widespread destruction of the sea grass beds.

3.1.4.3 Marsh

The marsh segment of the basin is poorly drained with a peaty substrate saturated for almost the whole year. The marsh plant community is unstable and represents one of the final stages of succession towards a dry land formation. The gradual build up of the marsh results from progressive accumulation of plant debris. Dominant plant species include grasses and reeds belonging to the family Poaceae, sedges belonging to the family cyperaceal and cattails belonging to the family Typhacear considerable extents of the marsh have been already colonized by the invasive, exotic plant, *Annona glabra*.

The aquatic plants in the marsh segment consists of those growing in the canals and abandoned paddy fields.

3.2 Institutional Issues

According to the participatory Rapid Assessments and other meetings in the River basin area, the communities highlighted several institutional problems and they are :

- a. lack of inter-agency coordination,
- b. lack of proper land ownership system,
- c. poor implementation of the existing laws and regulation, and the
- d. lack of a single agency responsible for entire river basin management

3.2.1 Lack of inter-agency coordination

It was observed that many institutions and agencies accepted in principle to implement an integrated resource management approach for river basin and coastal resources management. However in, practice most of these institution implement sectoral development plans based on their annual work plans. This sectoral plans always create problems to the other agencies.

A classic example to this is the use of fertilizer for agriculture purposes in the basin area . Nutrient enrichment is one of the major problem to the Negombo estuary. As explain early this is due to the over use of inorganic fertilizer in the upper and lower catchment area of Attanagalu Oya. At the some time many local authorities are dumping of solid waste to the estuary and marsh area. Those a large quantity of solid wastes are biodegradable and can be used to produce compost fertilizer which can be used as an organic fertilizer. Without considering this local authorities discharging and dumping nutrients and waste into the estuary marsh area. There are several similar kind of cases which can be identified as incompatible institutional activities in the basin area.

3.2.2 Lack of proper land ownership system.

In Sri Lanka, the major categories of land in Sri Lanka.

- the private,
- the land on which titles are unsettled, and
- the crown land

The crown land could be divided into three categories as

- lands belonging to state agencies (Forest, Wildlife, Irrigation etc.)
- alienated land (land under development projects)
- unalienated land

In the lower basin area most of the lands are either titles are unsettled or unalienated lands. Therefore many landless people are encroached into the these lands and settled without proper basic needs such as toilets facilities, drinking water and access roads. Most of the environmental problems are created by those settlers but very difficult to take action to remove these people due to uncertainty of the ownership.

No comprehensive land use act exists for these state lands. Although several laws affect land use planning and regulation on state land or private land they have limited scope or effect.

The UNDP/FAO project in 1988 described the above situation. “there is hardly any linkage between departments and other agencies as to the need or the priority in the appropriation of land resources. There is hardly any organization either at the village level, district level, or even the national level where programmes of various organizations, whether private or public are discussed and decisions made as to the land use priorities.”

3.2.3 Poor implementation of the existing laws and regulations.

There is a criticism that Sri Lanka is the only country which have enough and more laws and regulations on environment but none of these are effectively enforced. Once it is studied following deficiencies can be seen in environmental laws and regulations. They are :

- Some of these laws were enacted during colonial period. The scope and nature of these laws were not specifically directed to the natural resources management and conservation.
- Some of the laws remain fragmented and scattered among several Ministries, Departments and such other agencies. Therefore non of agencies are implementing the laws. Normally these agencies are attempting to redefine their boundaries, territorial limits, and safeguard their rights privileges without getting down to the job in the national interest.
- There are serious shortcomings in law enforcement. The implementing agencies have their roots in lack of finances, transport, staff etc.
- Sometime law enforcement is given low priority due to poverty or political reasons.
- Quite often the penalties are inadequate.
- Certain laws suffer from lack of authority to operate in all affected areas or specific areas.

Due to all or some of above reasons enforcement of existing laws in Sri Lanka either impossible or inadequate.

3.2.4 Lack of single agency responsible for entire river basin management.

As indicated early, there are 64 governmental and non-governmental organizations are responsible for Attanagalu Oya river basin management. However, non of these agencies are responsible for entire river basin management. Therefore when an activity implemented by an agency that may create a problem to the other agency.

3.3 Social Issues

Out of all other issues, social issues were highlighted as the most important. According to the field observations, PRA workshops and the literature survey, following social issues were ranked as main issues.

- insufficient lands and ambiguous land ownership.
- lack of proper houses
- low education and high school dropout rate
- excess use of liquor and the use of illegal liquor
- lack of proper drinking water
- constant outbreak of waterborne disease
- lack of basic need such as toilets, access room etc.

Table 3.3 Total population land area and Number of houses in the Attanagalu River Basin Area

Name of the Divisional Secretariat	Total Population	No. of Houses	Total Land area (acres)	Population Density
Attanagalla	154358	39727	16045	9.6
Biyagama	161236	36069	6040	26
Divulapitiya	127898	35322	19395	6.5
Dompe	130195	34894	10682	12
Gampaha	170289	44542	8707	19.5
Ja-ela	185562	44303	5813	31.9
Katana	223050	52662	11774	10302 19
Kelaniya	134588	29859	2371	56.7
Mahara	176817	44825	9221	19
Minuwangoda	152164	39858	13292	11.4
Mirigama	143744	38697	21027	6.8
Negombo	144551	32979	5218	46 3141 25
Wattala	161694	38668	5724	28
Total	2066096	512405		

3.3.1 Insufficient lands and ambiguous land ownership

The land ownership in Sri Lanka is generally unclear. As indicated before most of the land titles are unsettled or unalienated. In the Negombo Divisional Secretariat area most of lands are claimed by the churches without deeds.. However people live in these lands

are temporary buildings. During the PRA, most of the participants indicated that since ownership is unclear they are not prepared to build permanent houses or toilets. This is one of the major problems in the Negombo estuary area and the Muthurajawela marsh area.

Insufficient land scarcity also one of the major problem in the lower reaches area of the basin. The total population, land area and number of houses are given in the Table 3.3.

According to the above table, the population density in Ja-ela, Negombo and Wattala are slightly higher than that of upper catchment area such as Attanagalla, Mirigama and Divulapitiya area.

The available land area for future settlements is very low in the Negombo, Wattala, Katana and Ja-ela D.S. area. Therefore there is a tendency to encroach land such as marshes and lagoon water body area where the only land available for settlement. Available land settlements has shown Table 2.3 and the land use pattern in Gampaha District.

3.3.2. Lack of Proper Houses

Since there are lots of encroaches settle in the marsh areas and other state land areas their houses are basically semi-permanent or shanties. The unclear land ownership in the main reason for not to build the permanent houses reside. According to the field observations most of these people have been in these land over 20 years. The general condition of those houses are very poor and during the monsoon, most of houses inundated. The houses which are very close to the Negombo estuary also faced similar conditions and most of these houses are inundated partially or completely.

3.3.3 Low education and high school dropout rate

People live in the lower basin area of the Attanagalu River basin area are relatively poor and belong to the low income groups. A majority of these people are unemployed or under employed. Some of these people are engaged in lagoon fishing but income out of fishing also very low and not sufficient to meet their daily expenses. All of these have affected their children education. Therefore many of the children in these families do not attend schools regularly and resulted high school dropout rates.

3.3.4 Excess use of liquor and use of illegal liquor

The Excess Consumption of liquor is one of the most common problem of the people who reside in the estuary area and marsh area. Due to lack of any other recreational facilities they spend their leisure time inside the house. Drinking liquor is the way of spending free time. This is aggravated monthly by readily available coconut toddy and illegally brewed liquor. The excess use of liquor consumed much of their earnings and have resulted low/no level of savings. This in turn affected their children's education and stability.

3.3.5 Lack of proper drinking water

At present there are only sewer water supply schemes in the basin area serves for the urban population of 63,000 (year 1997). This indicates that only 13 percent of the urban population of the basin has access to pipe-borne water. As only 3 out of 7 schemes provide a 24-hour water supply, most of the above population has restricted supply hours. The other 87 percent of the urban population depend mainly on ground water supply. According to a survey carried out by UNICEF in 1993 showed that 6.9 percent of the rural population has access to pipe-borne water. The remaining 93.1 percent of the rural population depends on their traditional supplies, mainly ground water, for their water requirement.

The several surveys indicated that the ground water in the lower basin area is higher saline or contaminated and not safe for drinking purposes. As a result many of women are spending their time for water to bring them for away from their residence.

3.3.6 Constant outbreak of water borne diseases

In general, lower basin is subject to periodic flooding. This situation is aggravated by haphazard reclamations and estuary encroachment. Therefore water stagnation is common and as a result of this mosquito breeding grounds are everywhere thus outbreaks vector borne diseases.

3.3.7 Lack of basic needs such as toilets

According to the field survey and other information, it was observed that nearly 4000 families in the estuary area live without toilets. In addition to the above over 2000 toilets directly discharge the raw sewage into the Negombo estuary. This situation has aggravated the water born diseases and other health problems.

Chapter 4

4. The Existing Legal Framework for Integrated Coastal and River Basin Area Management (ICRAM)

4.1 Existing Legal Framework

One of the important factors of IC & RAM is the number of government institutions that are, in one way or the other, vested with certain powers and functions in relation to the IC & RAM. The several studies revealed that 64 government institutions and NGOs are directly involved in coastal resources management and river basin management (Premaratne, A 1989, Perera, E.W.M, 1989). Some of the most important act and ordinance in relation to the ICRAM are discussed in this chapter.

4.1.1 Fisheries and Aquatic Resources Act

Fisheries ordinance No. 24 of 1940 which came into operation in 1st June 1941, was repealed and replaced by the Fisheries and Aquatic Resources Act No. 2 of 1996. The Act provides for the

- Appointment of officers
- Establishment of a Fisheries and Aquatic Resources Advisory Council
- Preparation of a plan for management regulation, conservation and development of fisheries and aquatic resources
- Licensing of fishing operations
- Conservation
- Offenses and penalties

This Act prohibits any person from engaging in any prescribed fishing operation without license issued by the Director, from the provisions of the Act and the above regulations, it appears that granting of a license is not subject to any test of requirement although the Director has the power to refuse to grant a license. A license is subject to the prescribed terms and conditions with regards to fishing operations. However, for the renewal of a license, among other things, the Director should be satisfied that such renewal will not affect or threaten the sustainability of fisheries and aquatic resources.

Section 36 of the Act provides that the Minister, in consultation with the Minister in charge of the subject of conservation of wildlife, may declare any area of Sri Lanka waters or any land adjacent thereto, or both waters and land to be a fisheries reserve. Prior to such declaration, the Minister must be satisfied that special measures are

necessary to : (i) afford special protection to the aquatic resources in danger of extinction in such waters or land and to protect and preserve the natural breeding grounds and habitat of fish and aquatic resources with particular regard to coral growth and aquatic ecosystems, (ii) promote regeneration of aquatic life in areas where such life has been depleted (iii) promote the aquatic medium, and (iv) promote scientific study and research in respect of such area or to preserve and enhance the natural beauty of the area.

The management of all aquatic resources in Sri Lanka are comes under the Fisheries and Aquatic Resources Development Department under the Fisheries and Aquatic Resource Act.

4.1.2 National Environmental Act (NEA)

The NEA was introduced by Act No. 47 of 1980 and was amended by Act No. 56 of 1988. The salient features (re: power, functions, and duties of the Authority³²) of this Act, with reference to the present ICRAM are given below:

- (i) Recommend to the Minister, national environmental policy and criteria for the protection of any portion of the environment with respect to the use and values, whether tangible or intangible, to be protected, the quality to be maintained, the extent to which the discharge of wastes may be permitted without detriment to the quality of environment, and long-range development uses and planning, and any other factors relating to the protection and management of the environment.
- (ii) Undertake surveys and investigations as to the causes, nature, extent, and prevention of pollution, and assist and cooperate with other persons or bodies carrying out similar surveys or investigations.
- (iii) Conduct, promote, and coordinate research in relation to any aspect of environmental degradation or the prevention thereof, and to develop criteria for the protection and improvement of the environment.
- (iv) Specify standards, norms, and criteria for the protection of beneficial uses and for maintaining the quality of the environment.
- (v) Regulate, maintain and control the volume, types, constituents, and effects of waste, discharge, emissions, deposits, or other sources and sub-sources of pollution, which are a danger to the quality or environment of any segment of the environment;
- (vi) Require any local authority to comply with and give effect to any recommendations relating to environmental protection within the limits of the jurisdiction of such local authority and, in particular, recommendations relating to any or any of the following aspects of environmental pollution :

Only those provisions in Section 10 relating to the ICRAM are given here. Section 10 has 18 subparagraphs.

- (a) prohibition of unauthorized discharge, emissions, or deposit of litter, waste, garbage, and sewage;
- (b) prevention of discharge of untreated sewage or substandard industrial effluent or toxic chemicals into soil, canals, or waterways;
- (c) prevention of the defacement of scenic places and public property.
- (vii) Undertake investigations and inspections to ensure compliance with the provisions of the Act and investigate complaints relating to non-compliance with any of the provisions.
- (viii) Promote, encourage, coordinate, and carry out long-range planning in environmental protection and management.

The Authority also has the power to give directions to local authorities to do, or cause to be done, any act or thing which the Authority deems necessary to safeguard and protection protect the environment within the local limits of such local authority. A local authority must necessarily comply with these directions (Section 12).

The Authority, in consultation with the Council, shall with the assistance of the Ministry of Fisheries, recommend to the Minister, a system of rational exploitation of fisheries and aquatic resources within the territorial waters of Sri Lanka, or within its EEZ, or within its inland waters, and shall encourage citizen participation therein to maintain and enhance the optimum and continuous productivity of such waters (Section 18)³³. Measures for rational exploitation of fisheries and other aquatic resources may include the regulation of the marketing of the threatened species of fish or other aquatic life (Section 19). Similar provisions are found for wildlife conservation (Section 20) and forestry (Section 21).

With regard to soil conservation, Section 22 states that the Authority, in consultation with the Council and with the assistance of the Ministry in charge of the subject of Soil Conservation, recommend soil conservation programs including the identification and protection of critical watershed areas, encouragement of scientific farming techniques, physical and biological means of soil conservation, and short-term and long-term research and technology for effective soil conservation. Section 23 provides for the determination of priority areas for environmental research. Environmental protection is dealt with in part IV-A of the Act. No person, unless authorized by a license on that behalf and in accordance with the standards and criteria that may be prescribed, shall discharge, deposit, or emit waste into the environment which will cause pollution [(Section 23 (a))]. The Authority may submit an application received for this purpose to the appropriate government department or agency for a report therein.

Subject to the provisions contained in Section 23(a), no person shall deposit or emit waste into the inland waters of Sri Lanka except with the standards and criteria that may be prescribed [Section 23 (g)]. Section 23(h) further sets out that no person shall pollute the

inland waters of cause, or permit to cause, pollution of such waters, so that the physical, chemical, or biological condition of the waters is so changed as to make, or be reasonably expected to make, those waters unclean, noxious, poisonous, impure, detrimental to the health, welfare, safety, or property of human beings, poisonous or harmful to animals, birds, wildlife, fish, plants, or other forms of life, or detrimental to any beneficial use made of those waters. Without limiting this general provision, a person is deemed to have contravened this requirement if : (i) he places in or on any waters or in a place where it may gain access to any waters, any prohibited matter, whether solid, liquids or gaseous; (ii) he places any waste, whether solid, liquid, or gaseous where it falls, descends, drains, evaporates, is washed, blown, or percolates into any waters or on the bed of any river, stream, or other waterway when dry; and (iv) he causes the temperature of inland, coastal, or offshore waters to be raised or lowered by more than the prescribed limits.

Discharging or depositing waste into the soil, except with the standards prescribed, is prohibited in terms of Section 23 (m). Polluting any soil or the surface of any land so the physical, chemical, or biological condition of the soil or surface is changed is also prohibited in terms of Section 23(n). Discharging or spilling any oil or mixture containing oil in the inland waters is also prohibited [Section 23(v)].

4.1.3 Forest Ordinance

The Forest Ordinance was first introduced by Ordinance No. 16 of 1907. The Ordinance was periodically amended, and significant amendments were introduced in the last amendment, Act No. 23 of 1995. The Ordinance which was “to consolidate and amend the law relating to forests and the felling and transport of trees” was expanded by the last amendment to be an “Ordinance to consolidate and Amend the Law Relating to the Conservation, Protection and Management of Forest and Forest Resources; for the Control of Felling and Transport of Timber and Forest Produce”. Forest produce includes surface soil, rocks and minerals, limestone, coral, and all products of mines and quarries. The Minister may declare any area of State land or any part of a forest which has unique ecosystems, genetic resources, or is the habitat or rare and endemic species of flora, fauna, and microorganisms and of threatened species, or which needs to be preserved in order to achieve an ecological balance in the area to prevent salinization or drying up of rivers etc., as a reserved forest, and certain acts cannot be done in such an area.

4.1.4 Act Establishing the National Aquatic Resources Research and Development Agency (NARA)

Act No. 54 of 1981, which established NARA, was amended by Act No. 32 of 1996. NARA is the principal national institution charged with the responsibility of carrying out and coordinating research, development, and management activities on the subject of aquatic resources. “Aquatic resources” means all living and non-living resources contained in or beneath the medium of water. This Act is complementary to both the CCA and the Fisheries Act. Some of the objectives and functions of NARA are : to promote and conduct research activities directed towards the identification, assessment, management, and development of aquatic resources, among others, in the following : (i) social and economic aspects of the fishing industry, including the welfare of fishermen and their dependents; (ii) processing; preservation, and marketing of fish and aquatic products; (iii)

and to undertake work in the field of irrigation, sea reclamation, and coastal development". This power is subject to obtaining prior approval of the UDA if such area has been declared as a development area under Section 3 of the UDA Act.

4.1.7 Urban Development Law

The UDA law, though certified by the Speaker on 1 October 1978, was deemed to have come into operation on 6 September 1978. This was due to the amending provisions in Section 10 of the UDA (Special Provision) Act No. 44 of 1984. Apart from this amendment, the UDA Law was amended by Act Nos. 4 of 1982, 49 of 1987, and 41 of 1988.

The Minister, if he is of the opinion that any area is suitable for development, may declare that area as a development area, and the UDA created under the Law shall develop the development area for better physical and economic utilization. The area that may be declared, in the absence of any reference to the exclusion of the coastal zone, may include the coastal zone. The Minister also has the power to declare that, in an area declared to be a development area, any planning scheme or project under the Town and country Planning Ordinance or any other law, which is in conflict with the development plan or development project, will cease to operate in that area. Further, while such an order is in force, the responsibility of physical planning of the area will lie with the UDA.

4.1.8 Coast Conservation Act

The CCA defined the coastal zone as "the area lying within a limit of three hundred meters landward of the mean high water line and a limit of two kilometres seaward of the mean low water line and in the case of rivers, streams, lagoon or any other body of water connected to the sea permanently or periodically, the landward boundary shall extend to a limit of two kilometers measured perpendicular to the straight baseline drawn between the natural entrance points thereof and shall include the water of the such river, stream and lagoon or any other body of water so connected to the sea.

Within the coastal zone all Development Activities required to obtain a permit from the Director, Coast Conservation under the coastal zone definition, up to Bassiyawatte area comes to the coastal zone in the Negombo estuary.

4.1.9 Agrarian Development Act

Under the Agrarian Development Act No. 46 there are several important sections for the integrated coastal and river basin management.

Section 101 of the act explain the general terms and they are given below.

Agriculture :

- the growing of rice, field crops, spices, industrial crops, vegetables, fruits, flowers and pasture.
- Dairy farming, livestock rearing and breeding
- Plant and fruit nurseries
- Bee keeping and inland fisheries

Agricultural Activity

- Any activity involving agriculture
- Supply of agricultural inputs
- Use of machinery and equipment
- Any activity involving minor irrigation

Irrigation work

- An irrigation work serving up to two hundred acres of agricultural land (minor tank)

Irrigation work includes

- Any tank, bund, anicut, ela, channel, distributary/field channel, water course, or sluice gate comprised to the irrigation work.

Minor Tank (village tank)

- bund
- sluice
- spill
- tank bed
- spill tail canal
- catchment area
- command area
- irrigation canals
- drainage canal

The part v of the act explain the institutional structure of farmers' organization. This organization is a community base management system which is very useful section for involvement of community in resource management.

- Section 43 establishment of farmers' organization (FO)

Every person whose livelihood is agriculture shall eligible for membership.

- Section 46

Farmers' organization (FO) to encourage small group of farmers to organize themselves for agricultural activities.

- Section 47

FO to appoint a member to the Agrarian Development council (ADC) a council which take all decision on agricultural matters.

- Section 48

FO to assist the ADC to

- Formulate annual programmes
- Collect data regarding agricultural machinery, agricultural animals and fisheries
- Encourage soil conservation efficient water use, by recommending agriculture crops, livestock and inland fisheries
- Ensure that such crops, animals and inland fisheries are free from diseases and pests

Part VII of the act describe the irrigation work and management of irrigation water.

Under the section 81, all supervision and administration of irrigation works should be done under the FO.

- Section 81

Under the section 81, all supervision and administration of irrigation works should be done under the FO.

- Section 82

Any construction projects and any development activity in the minor tank are should be done under the FO supervision and those activities have to be informed to the FO.

- Section 83

Under this section, any person can not obstruct, block, encroach or waste of water in any irrigation work (minor tank area)

This section is explain the procedure of the meeting up the owner cultivators (Kanna Meeting).

In this meeting farmers can discussed and decided to

- encourage cultivation
- enforce the established customs
- ensure proper timing of agricultural operations
- efficient management of water
- soil conservation and control of pests/diseases
- make rules relating to the development of land and agricultural activities.
- Section 87

In this section mainly describe the actions to be taken for violator of the decisions of Kanna meeting (Customer rules) relating to the field of agriculture.

4.2 Shortcoming of the Existing legal Framework

4.2.1 Department of Fisheries and Aquatic Resources (DFAR)

The Section 6 of the Fisheries Act prohibits any person from engaging in any prescribed fishing operation without a license. However fishermen are engage fishing activities without license from the DFAR in the Negombo estuary. There are five fishing methods ban in the estuary but still they are operating in the estuary.

An Authorized Officer is permitted, under Section 46(4), to seize any boat, engine, fishing net or other fishing gear or equipment or any vehicle or item believed to have been used in connection with the commission of an offense. The Authorized Officer is required to produce such seized articles before Court, and the Magistrate is empowered to issue an order relating to the detention or custody of such article until the conclusion of the proceedings [Section 46(5). The term “custody” is not defined in the Act, and it is also not clear to whose custody such article could be released. Nevertheless, Section 53(1) provides that the owner or the person from whom the articles were seized may apply to the Magistrate to have such articles released upon a bond or other security. On such an application, the Magistrate may order the release of the articles on a bond or other security, the value of which should not be less than the aggregate value of the articles seized, including, if the article is a boat, cargo, fish and other aquatic resources. However, there is no provision to deal with the situation where articles once seized and released, are used to commit another offense either by the same person or by another.

In the terms of Section 32(1) a the Minister can declared the fisheries management areas and under section 32(2) function pf the fisheries management committee set out. These committee can form a Fisheries Management Authority. The Negombo estuary area gazzated as fisheries management area in 199 , and the Negombo Lagoon Management Authority (NLMA) established. However since then the formal procedures of the Authority functions were not monitored and any facilities for the Authority also not have been provided. In addition to the above Authority also not given any recognition by the Minister or the officials of the Fisheries Ministry and so far not consulted the Authority by any Minister since it established.

The Negombo Lagoon Management sub committee was established by the Secretary, Ministry of Housing and Construction to carry out management solution of the conservation zone identified the Master Plan for the Muthurajawela and Negombo lagoon. The wide representation of the NLMA also was included into this sub committee and several meetings of the sub committee also convened by the Authorities but actual progress of Negombo lagoon was not seen

The reason for this may be without a proper implementation mechanism, lagoon management area was gazzated. Therefore higher NLMA nor officials of the DFAR was not able to manage the area and deterioration of the estuary is still continuing.

4.2.2 National Environmental Act and CEA

The Section 72.2 explained the list of duties under the NEA to be implemented by the CEA. Under those function and duties the CEA can take vigorous action against those who are discharging pollution the Negombo estuary and marsh area. They also can direct local Authority to implement a proper waste management programs in their respective Local Authority areas.

In practice none of those action and duties of carrying out by the CEA. There are several large scale industries are directly discharge the pollution into Dadugam Oya and Ja-ela. These were informed by the communities as well as government institutions to the CEA and found out that the CEA also not capable to control or manage these activities due to various reasons. One of the most important reason is that the CEA have not proper monitoring program. The other is that the industries do not have any other alternative that discharging those polluted waters into the Dadugam Oya and Ja-ela.

The CEA also responsible to monitor the degradation of habitat and pollution levels of the waters. The CEA has developed the National standard for coastal water quality but still not developed a proper monitoring program. Therefore most of the estuaries and rivers are getting polluted.

Under the Section 18 of the NEA it can recommend to the Fisheries Minister, a system of rational exploitation of fisheries and Aquatic resources in the coastal area or inland waters and can encourage citizen participation to maintain and enhance the optimum and continuous productivity of such water. However communities in the area of ICRAM were opinion that they have informed to the CEA during last three years it was noted that the CEA has not properly attend to the complaints and regarding many polluters but unable to implement the said section of the NEA.

4.2.3 Forest Department and Forest Ordinance

Under the forest Ordinance the Minister in-charge of Forest can declare any state land or any part of a forest which has unique ecosystems or which need to be preserved in order to achieve an ecological balance in the area as a reserved area. In this aspect the mangrove forest can be declared as a reserved area. To do this it is necessary to survey the area and then can gazzeted as forest reserve. In the Attanagalu ICRAM area five islands were gazzeted as forest reserves but most of the mangrove around the estuary not comes under the Forest Department since those areas were not gazzated as forest reserve. Therefore Forest Department can not take any action in regards to removal or clearance of any mangroves in those areas. In the Attnagalu ICRAM area most of mangroves are belonging to the private owners. However, mangroves in the private land can removed without any approval of Forest Department. In many cases ownership of mangroves are not clear and therefore many individuals are claiming mangrove, as their properties. Therefore control

of destruction of mangroves under the Forest ordinance is very difficult in the Attanagalu ICRAM area.

4.2.4 National Aquatic Resources Research and Development Agency

NARA is mainly responsible to provide advice on technological and legal matters relating to the exploitation, management, conservation and development of aquatic resources.

However in the Attanagalu ICRAM area and Negombo estuary are they have not establish such a programme continuously but has done several studies. It is essential NARA to monitor water quality of the Negombo estuary to monitor changes of salinity, pollution level etc. due to important of many people livelihoods. However due to financial difficulties and many other reasons such a monitoring programme is not conducting by the NARA. Therefore effectiveness of rehabilitation activities in the area can not be quantified due to lack of proper water quality monitoring programme by any responsible agency.

4.2.5 Department of Wildlife Conservation and Fauna and Flora Protection Ordinance

Under the Fauna and flora protection Ordinance there are two specific sections are relevant to the Negombo SAM area. (Section 2 (1) They are ;

- a) empower the Minister to declare any specific area of state land to be a sanctuary or national reserve
- b) no person or organization, whether private or state, shall within one mile of the boundary of any national reserve, carry out any development activity of any land without the written approval of the Director (Section 9 (A)).

Under the Section 2(1) of the ordinance 2000 ha of the Muthurajawela marsh has been declared as a sanctuary. However this area also included some private lands and many families were residing in the sanctuary area. As a result of these settlements in the sanctuary objectives of a sanctuary were not obtained.

The other setback of the Flora and Flora protective ordinance is that only state land can declare as sanctuary but if there are any private land within the sanctuary those lands can be acquired after paying compensations.

However most funds cases are not available under the DWLC to acquire lands and this can be seen in the Muthurajawela marsh area. In addition to the above drawbacks, there are no cadres available to employ in the Muthurajawela sanctuary area and therefore the sanctuary is managing by the DWLC from the Gampaha office which is 15 km away from the sanctuary. Since it gazzated as sanctuary the boundary of the sanctuary was not properly demarcated and public is not aware that there is a sanctuary. As a result many of the municipal wastes are dumping in the sanctuary area and also several scoters of the sanctuary have been encroached by the unauthorized settlers.

4.2.6 Sri Lanka Land Reclamation and Development Corporation (SLRDC)

Under the Act No. 52 of 1982, the SLRDC can declare any low lying area as for the reclamation and development areas. When the conservation management plan for Muthurajawela marsh and Negombo Lagoon was prepared the implementation power of the plan was granted to the SLRDC. Therefore without SLRDC approval any reclamation or filling in the marsh area of the Attangalu lower basin area is illegal but still large scale filling is continuing by the various peoples and organizations.

However SLRDC is not in a position to control those reclamations. Therefore zoning scheme suggested by the conservation management plan is not a implementable plan due to poor institutional co-ordinations.

4.2.7 Urban Development Authority (UDA) and the Urban Development Act

Under the section 3 of the Urban Development Authority law, No. 42 of 1978, the Negombo estuary area was gazatted as an Urban Development Area in November 1998.

Under this declaration all construction, filling and any other development activities are required to obtain an approval from the UDA. After the declaration of Negombo as an Urban Development area, the UDA also prepared a zoning plan for Negombo including estuary. However there are many illegal development activities (construction of houses and filling of areas for industries) are continuing in the area but UDA is unable to control of these activities. However most of those illegal activities have been regularized due to political and various influences. Therefore zoning scheme of the UDA, may be another plan which is not implementing.

4.2.8 Coast Conservation Department (CCD) and the Coast Conservation Act

Under the CCA only two km area of the Negombo estuary comes under the CCD jurisdiction. Even in this two kilometers, only the water areas that are inundated periodically is come under the coastal zone. Where a water surface or a periodically inundated area is removed from that status (e.g. by filling without detection of reporting). Even destruction of mangroves in the two km land area, the CCD cannot take any action. In many cases, the resident, filling the water areas. When the inspect the filling sites by the CCD, produced the residents are deeds for the area. There is no proper survey plan available in the estuary area to clearly identify the estuary water area and the private lands. Therefore it is very difficult the CCD to take action regarding illegal filling even in the 2 km area.

- Since the CCD can take action only in the 2 km area, many residents are filling estuary beyond the 2 km area. In this area there is no any institution to control filling. Even though UDA, Divisional Secretary and SLRDC have some legal provision to control these activities, they are not very active in this area.

4.2.9 Agrarian Development Act

Most of the paddy cultivation area of the Attanagalu river basin area are comes under the minor tank definition. Therefore most of the activities in this area van be control under the Act.

However in practice, most of the illegal activities are taking place in the area without any problem from the Agrarian Services Department.

Under the section 43, 46, 47 and 48 properly explain the institutional mechanism for irrigation area management. However due to various reasons in the Attanagalu river basin area, most of these Farmers' Organizations are not functioning properly.

4.2.10 The Housing and Town Improvement Ordinance (HTIO)

According to the HTIO the all local authorities can take action against structures that have come up without the approval of the authorities. Almost all the squatter houses temporary and semi permanent, that have come up in the channel segments of the ICARM area do not have such approval. Evan the large scale landfill undertaken by many individual for construction houses and industries do not have the approvals. In many cases, the local authorities are not in a position to exercise their powers.

Moreover, the HTIO has shown to be inadequate for achieving compromises among conflicting demands. The HTIO was developed at an early stage, when even Colombo was a semi-urban centre and ICARM area was little more than a service centre settlement. The short comings of the HTIO that straddle the local authorities are absence of :

- Provisions for housing density control
- Standards for soundness of structures and building materials
- Standard specifications regarding building and site plans
- Minimum specifications for plot size in relation to height of buildings.

The multifarious problems that beset a;; unplanned and un integrated urban development are evident in the area, including land fragmentation, unauthorized occupation, flooding, clogged drains, over-crowding, and pollution.

4.2.11 Divisional Secretaries

In 1993 by way of the Divisional Secretaries Act, major changes occurred in the direction of making the role of the Divisional Secretary autonomous in administration and development of the Division. The existing administrative structure, while providing enhanced power to the Divisional Secretary, also exposes him to intense political pressure.

Most of the development activities that are actually carried out by the Divisional Secretariat often are the projects approved by the DCC. Generally the projects that are approved by the DCC are those that are promoted by pressure groups through politicians and therefore do not fall within a coherent spatial strategy. Most of them are infrastructure projects and they are implemented within each DS' divisions. This form of project implementation may provide short-term relief, but in the long term it will inevitably aggravate existing problems.

4.2.12 The Other Institutions

The churches in the area have been committed to serve the poor for many decades in the coastal area. The major service provided by the churches includes provision of land and houses for the land less communities. The church obtains funds for implementation of these projects from various sources. While this development work by the church is highly praiseworthy, a noteworthy feature is that it is again an uncoordinated, unplanned activities. For instance, the newly established Monaco village, is situated on about 1 ha of water area of the Negombo lagoon, filled with transported laterite. The church, evidently made no effort to understand that the benefits provided to the squatters in the channel segment could simultaneously undermine the entire lagoon fishery. The real costs of such development would be borne by another segment of poor people or the government to rehabilitate the lagoon.

In an approach parallel to that of the church various NGOs and CBOs also involved in various activities in the ICARM area. These NGOs and CBOs appear to have four priority objectives as to :

- Planting of mangroves to maintain mangrove forest
- Overcome insecurity of land tenure by group action.
- Construct improved types toilets and houses in the lagoon segment encroachers.
- Resist any attempts to enforce the law pertaining to unauthorized occupation of state land.
- Environment conservation
- Community institutional building
- Community infrastructure improvement
- Habitat and biodiversity improvement
- Environment education and awareness

The cumulative effect of all such small development activities on the hydrological system and habitats of the ICARM area, however is substantial and now already very evident demonstrating the “tyranny of small decisions”.

4.2.13 Political Authorities/elected members can be categorized as there sections :

- Local authority level
- Provincial level
- National level

Attitude and involvement of the political authority for the in the ICARM area are not very positive. A chain of local to national level politicians in many cases have provided patronage in acquiring regularization for squatters and most of the encroachers on state land within their own electorate to ensure those squatters votes. They also allocate government funds to provide electricity, water and roads for these squatters encouraging others also to encroach the estuary, marsh and other state own reservations in the area

4.3 Existing Institutional framework for Integrated coastal area and River Basin Management (ICARM).

Institutional framework for ICARM in the Attanagalu River Basin area can be divided in to three main areas. They are :

- Community base management
- Community and state sector management
- State sector management

4.3.1 Community Based Management

Under the section 31(1) of the Fisheries and Aquatic Resource Act, No. 02 of 1996 the Minister in-charge of Fisheries can gazette designated water and land areas as fisheries management areas. Under the section 32 of the Act, it also can be formed fisheries committees in the management area. These designated fisheries committee can established Fisheries Management Authority in any fisheries management area.

The Negombo estuary (lagoon) gazetted as fisheries a fisheries management area and established a Fisheries Management Authority as Negombo Lagoon Management Authority (NLMA). The function of the authorities included :

- formulating a fisheries programme for its area and implementing that programme
- assisting its members to obtain boats, gear and equipment to be used in fishing operations;
- carrying out social infrastructure and welfare activities with a view to improving the living standards of the fishing community of that area
- engaging in other activities for beneficial to the fishing community of the area.

This institutional set up is basically community base management systems and given an opportunity to management their resources by themselves relevant government institutions were not given any kind of support to the community base NLMA to carry out its functions. Even though the NLMA members are very keen to manage their resources no one is prepared to accept them as a management body. The Act only refers to the appointing the Authority but not the powers of the authority. Therefore this authority is a community base authority without any legal power.

4.3.2 Community and State Sector Management System

Under the directive of the President of the Democratic Republic of Sri Lanka, a Master Plan for Muthurajawela and Negombo Lagoon was prepared and this plan was approved by the Cabinet of Ministers in 1991.

Implementation of the Master Plan for the Muthurajawela and Negombo lagoon was done through the Muthurajawela Executive Committee (MEC). However actual management was done by the several government agencies. These government agencies and the NGOs in the area were represented to the management committee called Muthurajawela coordinating committee. The committee chaired by the Government Agent (GA) Gampaha who is the highest Government Officer in the District.

Main function of the coordinating committee was to direct required intervention to the relevant authorities to solve the management issues. This committee meetings open the gate to discuss the problems face by the communities⁶ with the relevant authorities. However two years experience of the coordinating committee it was found that other than discussing problems, any significant achievement was not received by the communities for their problems.

To overcome the above difficulties community and state sector management system introduced by the Coast Conservation Department (CCD) with lots of discussions and involvements of various institutions. The system called Special Area management (SAM). The SAM planning process is based on the recognition that existing planning, legislation and institutional implementation mechanisms are along insufficient. It also accepts and implementation effort, thereby making them the custodian of the resources being managed.

The basis premise for the SAM process is that it is possible to organize local communities to manage their natural resources and that they will continue to do so if they perceive that they derive tangible and perceivable benefits from better management. The planning agency or the organizational group play only a catalytic role in organizing the local community. They can provide technical and financial support for the management effort which is formulated and implemented as a local community effort. Hence the planning agency takes on the role of facilitator rather than that of a superior authority. Also the mediatory role is important where competing demands are balanced in a manner that ensure the sustainability of resource use.

The objective is to allow the local community to accept the role of custodian of the resource with a sense of ownership rather than to view the local community as a rapacious exploiter of a common heritage..

The SAM process is to mediate amongst the competing user and to build a consensus on what use or uses can be harmonious and sustainable. It will incorporate the consensus achieved into a strategy that will lay out the steps for achieving such harmonious and sustainable use and put in place the institutional mechanisms for ensuring compliance and to implement the strategy. This in turn requires a sound understanding of the social and political structure of the community, the special interest groups and stakeholders, and an identification of unbiased local leaders who can play a stewardship role.

This system requires lots of commitment by all stakeholders. Therefore there are some disadvantages of the system. They include :

- the process takes too long
- some time omit key group representatives
- selection of consultant or lead agency that is not natural
- allow lead agency to dictate task force direction
- changing group or agency representatives
- changing agency policy on SAM

However this system is very useful to develop the resource management in the river basin area.

4.3.3 State Sector Management

State sector management system is basically involved in sectoral management approach where single agency implements their activities without considering the other agency activities. However certain agencies have developed management systems with public participation. The farmers organizations under the Agrarian Services Department, Fisheries Management committees under the Fisheries and Aquatic Resources Department and community coordinating committees under the Coast Conservation Department are some of them.

Still these management systems are basically focused on limited identified resource management rather than entire river basin and coastal area resources management. The other problem with these state sector management systems is some of these agencies are development oriented and others are conservation oriented. Therefore these agencies are always biased to their basic objective and as a result many conflicts among the agencies can be seen.

Chapter 5

5. Possible Management Objectives, Policies, and Intervention Activities for Integrated Coastal and River Basin Management in the Attanagalu River Basin Area.

The management strategies policies and possible intervention in the study area will be discussed under 3 main sub sections. They are :

- a) the Environment
- b) the Institutional and
- c) the Socio-economic aspects

Under the Environment sub section, water pollution, salinity variation and the habitat rehabilitation will be discussed. Under the institutional sub section, legal, inter agency collaboration, land use and the land cover, and the proposed institutional mechanism for integrated river basin management will be evaluated. In the socio-economic sub section land allocation and ownership, alternative livelihood, infrastructures, sanitation, land ownership and education will be discussed.

5.1 Environment Sector Management Objective, Policies and Proposed Actions

The type of environmental issues and their impacts have been discussed in the Chapter 3. Therefore this section will be discuss the management objectives, policies and possible intervention.

Objective 5.1.1.

Preserve and maintained the natural land scape and land cover in the river basin area.

Policy 1

Control of development activities where there is a reasonable probability that significant degradation will occur in the natural flow pattern of the Attanagalu Oya.

Proposed Actions

1. Mapping the land use pattern in the river basin area and monitor the development activities.
2. Demarcation of high soil erosion area and initiate a reforestation program in the high soil erosion area.

Objective 5.1.2

Maintain the forest cover of the upper catchment area.

Policy 1

Ban the blocking out of land for auctions of the upper catchment area .

Proposed Actions

1. Suitable land for human settlement will be marked in the land use plan.
2. Replanting of suitable reforestations suitable trees will be done in the bare land area of the upper catchment area.

Objective 5.1.3

River bank of the Attanagalu Oya will be protected.

Policy 1

Clay mining for brick making will not be permitted between 100m from the river bank.

Proposed Action

River sand mining will be permitted only after selecting of most suitable sites.

Policy 2

River bank area and the reservation area will be maintained as forest reserve.

Proposed Actions

A program will be initiated to plant bamboo trees along the selected areas of the river banks.

Objective 5.1.4

Maintain the sediment transport load that do not have an adverse impact on Negombo estuary habitat.

Policy 1

Ensure that impacts due to encroachment, land fillings and solid waste pollution are minimized in considering proposed development within and adjacent to Negombo estuary and Attanagalu Oya.

Proposed Actions

1. Formulate and implant a monitoring plan for sediment transport along the river will be started.
2. The sediment trap will be stabilized within the appropriate distance to reduce excessive sediment discharge into the lagoon.

Objective 5.1.5

Maintain water quality and fishery habitat of the estuary.

Policy 1

Ensure the water exchange of the estuary by preventing shoal formation in the estuary.

Proposed Actions

1. Start a study on salinity variation pattern in the estuary to monitor the salinity level in the entire estuary.
2. Remove or dredge the areas where excessive siltation taken place.

5.2 Water Pollution : Sector Management Objectives, Policies and Proposed Actions

Although water pollution is a key issue to be addressed in the river basin area a single agency cannot tackle the problem alone. Taking into account of the large number of institutions and agencies that play a role in pollution control, there is a need for integrated river basin and coastal zone management through public participation. This will require a considerable (leve)l a strengthening of Local Authorities to play an important role in monitoring coastal and riverine water bodies within their jurisdiction.

Laws and regulations should be strengthened to regulate major sources of pollution thereby reducing pollution loads entering into the coastal waters. More stringent enforcement mechanism should be in place of reducing the frequency and magnitude of major pollution incidences in the river basin areas and coastal water bodies.

Objective 5.2.1

Acceptable coastal and river basin water quality is maintained by minimizing the discharge of untreated or partially treated effluents from industries effluents of toilets toilets and other development activities in the Attanagalu River Basin area.

Policy 1

All existing development activities in the coastal and river basin area will be required to comply with the Central Environmental Authority (CEA) standards on disposal of effluents.

Proposed Actions

1. Initiate a water quality monitoring programme to check ambient water quality in the coastal waters to capture the high incidence of pollution and to identify polluting industries in the area.
2. Identify low and high polluting development activities in the river basin area and prepare a data base in collaboration with the CEA.
3. Formulating of effluent standards for those development activities which do not have disposal standards in collaboration with the relevant authorities.

Policy .2

Assistance will be provided to relocate high polluting industries, toilets, and other activities, that significantly degrade the ambient water quality of river basin area water bodies to promote the use of pollution abatement technologies.

Proposed Actions

1. Coordinate with relevant authorities and stakeholders for relocation of high polluting industries, toilets outlets etc.
2. Facilitate access to information on technology providers for pollution abatement and on cleaner production technologies among industries affecting the river basin area.
3. Assist or facilitate to community to construct toilets to reduce fecal pollution to the water bodies.

Objective 5.2.2

Water quality of the basin area and coastal area is enhanced by management of pollution sources and types other than effluents.

Policy 1

Solide waste management within the river basin will be promoted to minimize water pollution in the basin area.

Proposed Actions

1. A proper solide waste management program will be prepared and implemented to reduce adverse impacts on water pollution.
2. Identify urban centers, industries and other sources, emitting solid waste for which solid waste plans are urgently needed.
3. Assisting local Authorities to identify alternate dumpsites in environmentally less vulnerable locations for relocation of unsuitable dumpsites.
4. Encouraging and assisting relevant Local Authorities to implement environmentally sound ways of waste minimization through projects for composting, biogas generation etc.

Policy 2

Faecal pollution of river basin and estuarine waters will be reduced by collaborative action with relevant authorities and individuals.

Proposed Actions

1. Study and identify areas where faecal pollution exceeds specified threshold levels for designated uses.
2. Assist to provide toilet facilities for communities whom use open areas for excretion.
3. Organize and implement programs with relevant local authorities to reduce faecal contamination in the water.

Policy 3

The adverse impacts of oil pollution on the Negombo Lagoon waters will be reduced.

Proposed Actions

1. Cooperate with Negombo Lagoon Management Authority (NLMA) to identify oil discharge points into the lagoon and arrange oil collection system in each landing site
2. Organize and conduct awareness programme for fishermen on impacts on oil pollution of coastal waters.

Policy 4

Measures will be taken to reduce nitrate pollution and salinisation of ground waters.

Proposed Actions

1. Study and identify the major sources of nitrate pollution and causes of high salinisation and implement collaborative remedial actions.
2. Introduce a program to use compost as a fertilizer in place of inorganic fertilizers.
3. Monitor sites that affected and collaborate with relevant agencies to reduce the nitrate level.

Objective 5.2.3

Pollutant loads entering coastal waters are estimated and minimized through regular monitoring and research.

Policy 1

Collaborative measures will be taken to estimate the loads of pollutants entering to coastal waters from major surface water bodies.

Proposed Actions

1. Study pollution loads in major surface waters entering the lagoon and estimate the pollution loads during dry and wet weather flows.
2. Assist Local Authorities to take necessary steps to reduce high pollutant loads by providing necessary information.

3. Collaborate with other competent agencies for possible research on water quality improvements in the river basin area.

Policy 2

Collaborative activities will be carried out to reduce pollution of coastal and basin area ground water.

Proposed Action

1. Assist relevant authorities to abate incidences of pollution.

Policy 4

Coastal pollution is minimized through education, dissemination and sharing of information using strategic communication.

Proposed Action

1. Carry out a needs assessment to gauge the target groups and specific issues and needs that need to be addressed.

5.3 Salinity Variation : Management Objectives, Policies and Proposed Actions

Salinity reduction in the Negombo estuary has been observed over the past two decades. This could be due to many reasons of which sedimentation, changes in morphological features, and changes in riverine flow patterns are prominent observations. These changes can reduce the fish and shrimp production potential of the lagoon. Therefore following objectives, policies and actions are recommended to minimize the impacts on salinity variation.

Objective 5.3.1

Estuary Water quality is enhanced by management of sand bar at the mouth.

Policy 1

Coastal development activities that degraded the sand spit of the estuary mouth will be regulated.

Proposed Actions

1. Declare the sand spit of the estuary mouth as critical zone and prohibits or control all activities that are detrimental to the spit natural behaviour.

2. Conduct a proper study to monitor the behaviour of the estuary mouth.
3. Implement a proper dredging program to allow the water circulation in the estuary.

Objective 5.3.2

Negombo estuary is conserved to sustain and enhance its salinity level and ecological functions.

Policy 1

The degradation of Negombo estuary salinity level due to development activities within and outside the estuary area will be minimized.

Proposed Actions

1. Carry out periodic sampling of water quality in the estuary to observe the changes of salinity level.
2. Initiate and implement a program with relevant agencies to control illegal filling and encroachment of the estuary.
3. Initiate and implement a program to remove the obstacles which are trapping the sediments in the estuary.

Policy 2

Minimize reduction of functional area of the Negombo estuary due to encroachment, reclamation.

Proposed Actions

1. Initiate and implement a program to identify an institute to handover the entire responsibility of the management of estuary.
2. Establish appropriate reservation around the Negombo estuary to prevent illegal encroachments.
3. Implement a program to remove illegal reclamation and encroachment which are adversely effect to the water circulation of the estuary



5.4 Degradation of habitats : Management Objectives, Policies and Proposed Actions

Extensive damage to the naturally fragmented mangrove swamps has been caused by the transformation of large mangrove areas to the other uses in the Negombo estuary. Similarly, the valuable sea grass beds in the estuary also damaged or destroy due to destructive fish harvesting techniques. The marsh areas in the river basin area also serve very vital ecological functions and have been reduced mainly by their conversion to other development activities. To conserve and sustainability of these habitats following policies and action will be implemented.

Objectives 5.4.1

Coastal habitats are conserved to maintain biodiversity, sustain ecosystem services and socio-economic activities connected with them.

Policy 1

Further degradation of coastal habitat due to unplanned development activities will be minimized.

Proposed Actions

1. Identify sensitive sea grass beds, mangrove swamps and marsh areas where management urgently needed.
2. Support for the implementation of management plans prepared by the Coast Conservation Department, Forest Department and Central Environmental Authority.
3. Formulate guidelines for rehabilitation of degraded mangrove areas, sea grass beds and marsh areas.
4. Introduce monitoring mechanism to identify the adverse impacts of present and further development activities within the habitats and formulate suitable mitigatory measures.

Policy 2

Sustainable use of coastal habitats connected with economic activities will be supported.

Proposed Actions

1. Promote community to establish ecotourism projects in suitable areas.
2. Formulate and implement awareness and education program for key target groups to promote understanding about the value of habitats.
3. Develop alternative livelihoods for current habitats users to wean them away from destructive practices.
4. Establish a suitable mechanism to ensure inter-agency coordination and participation to promote sustainable use of habitats.

5.5 Institutional Issues

As explained in the Chapter 3, there are 4 difference types of institutional issues. They are :

- a) lack of Interagency coordination
- b) lack of proper land ownership system
- c) poor implementation of existing laws and regulations
- d) lack of a single agency that responsible for entire river basin management

The management objectives, policies and actions for each of the above issues will be discussed in this section.

5.5.1 Lack of Inter-agency Coordination : Management Objectives, Policies And Proposed Actions

Inter agency coordination is a key factor for successful implementation of the Integrated coastal and River Basin Management Program. However due to various reasons this aspect is still not properly implementing in the study area. Therefore following policies and actions are recommended to overcome the above issue.

Objective 5.5.1

Integrated coastal and River Basin Management is enhanced by extending interagency coordination among all relevant institutions and agencies.

Policy 1

Integrated Coastal and River Basin Management Action Plan will be implemented with the collaboration and effective participation of all stake holders.

Proposed Actions

1. Prepare an action plan that indicate all intervention activities to be implemented by various institutions and agencies.
2. Prepare a time frame and financial estimates for each activities implemented by the relevant agencies.
3. Establish a proper monitoring and evaluation system to evaluate the progress of the inter agency cooperate management system.

5.5.2 Lack of Proper Land Ownership System : Management Objectives, Policies And Proposed Actions

One of the major problems in Sri Lanka is a lack of Comprehensive Land Use Act for state lands. Even though there are several laws on land use planning and regulations on state lands they have very limited scope. Therefore it is very difficult to formulate management policies and action on this aspect without introducing a proper legal framework. However still there are some action can be implemented to minimize the problem.

Objective 5.5.2

Uses of lands in the River Basin area will be managed through proper land ownership pattern.

Policy 1

Government Agencies will be encouraged to prepare and implement a zoning plan.

Proposed Actions

1. A proper land use map will be prepared in river basin area.
2. A survey will be carried out the areas where land title are unsettled.
3. All available state land will be surveyed and demarcate with an appropriate system.
4. Reservation will be demarcate along the river Negombo estuary and Muthurajawela marsh area to prevent further encroachments.

5.5.3 Poor Implementation of Existing Laws and Regulations : Management Objectives, Policies and Proposed Actions

Implementation of laws for poor resource abusers is one of the difficult tasks in most of the developing countries. However non implementation of the laws also create tendency to increase illegal activities. In addition to the above these law and regulations have to be

implemented by the government institution under the prevailing political, social and economical conditions. Therefore management objectives, policies and actions have to be decided on taking into account of above factors.

Objective 5.5.3

River basin management will be enhanced by proper legal procedures.

Policy 1

Existing laws and regulations for river basin management and coastal zone management will be implemented impartially.

Proposed Actions

1. A Study will be conducted to identify the difficulties to implement the existing laws and regulations and make recommendation to improve the laws and regulations.
2. Conduct a proper awareness program to make aware of resource users and of the stakeholders on existing laws and regulations.

5.5.4 Lack of Single Agency that Responsible for Entire River Basin Management : Management Objectives, Policies and Proposed Actions

According to the existing institutional and legal system it is very difficult to introduce a single agency with overall responsibility on river basin management. However some kind of institutional mechanism can be suggested to manage the river basin area.

Objective 5.6.1

Initiatives for River basin management will be done by main responsible agency in consultation with other line agencies.

Policy

Development activities in the River basin area have to be discussed with the District Development Council and all concerned agencies and need to be agreed.

Proposed Actions

1. The most responsible institute for river basin management have to be decided and this agency has to prepare an action plan for river basin management.

2. Other relevant agencies have to release funds to the responsible agency for implementing actions on behalf of them.

5.6 Social Issues

Issues and problems to the communities in the river basin area are different from upper catchment area to the lower coastal area. However there are common issues which prevail all over the catchment area. Some of the common issues are :

- ambiguous land ownership
- lack of proper houses
- low education and high school dropout rate
- lack of proper drinking water
- outbreak of waterborne diseases
- lack of proper toilets facilities

5.6.1 Management objectives, policies and proposed actions to mitigate the social issues

Objective 5.6.1

Social status of the communities of the basin area will be promoted through proper land ownership to the each families.

Policy 1

All land disputes will be solved through proper intervention of the government agencies.

Proposed Actions

1. All land plots will be surveyed and assign a number under the each owners.
2. Land Kachchari will be organized to alienate the state land.
3. A program will be implemented to resettle the communities living in hazards prone area.

Objective 5.6.2

Quality of life of the poor communities in the basin area will be improved through providing houses.

Policy 1

Saving of the communities will be promoted through many programs

Proposed Actions

1. Low cost housing construction methods will be introduced to the poor communities in the basin area.
2. Low interest loan scheme will be arranged with rural bank to improve houses of the low income group.
3. Awareness and educational programs will be organized to reduce unnecessary expenditure of the rural communities.

Objective 5.6.3

Educational level of the all communities in the basin area will be enhanced by providing facilities to all schools in the basin area.

Policy 1

More facilities will be provided to the rural schools.

Proposed Actions

1. Basic needs such as drinking water and toilets will be provided to the rural area schools
2. Facilities such as children parks including swings and other similar facility will be provided to the schools for children's attraction.
3. Awareness programs will be conducted to the parents to encourage them for sending their children to the schools.

Objective 5.6.4

Health aspect of the communities could be promoted through providing proper drinking water for poor communities.

Policy 1

Discharge of pollute water to the river that degrade the water quality of river will be controlled.

Policy 2

Adverse impacts on ground water quality due to over extraction of water will be managed.

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