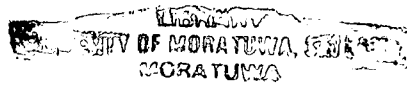


**STRATEGIES FOR THE IMPROVED MANAGEMENT OF
COASTAL ZONE OF SRI LANKA**

By Miss. U.A.P.K. Dissanayake



**A Dissertation submitted in partial fulfillment of the requirement for
the Master of Science Degree in Environmental Management**



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

624"05"
504(043)

Research Work supervised
By
Prof.S.S.L.Hettiarachchi and Dr.S.P.Samarawickrama

Department of Civil Engineering
University of Moratuwa
Moratuwa
Sri Lanka



University of Moratuwa

July 2005



84388

84388

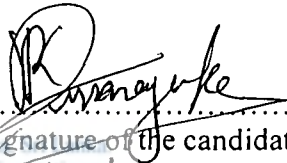
84388

Declaration

I certify that this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any university and to the best my knowledge and belief it does not contain any material previously published or written or orally communicated by another person except where due reference is made in the text.

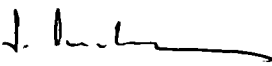


University of Moratuwa
Electronic Theses & Dissertations
www.lib.mrt.ac.lk


.....
Signature of the candidate

To the best of my knowledge the above particulars are correct


.....
Prof.S.S.L.Hettiarachchi


.....
Dr.S.P.Samarawickrama



Acknowledgement

My first and foremost thanks go to Prof.Mrs.N.Ratnayake and Dr.Kodikara, Department of Civil Engineering for granting me permission and creating this opportunity to follow the Master of Environmental Management course in University of Moratuwa.

I would like to pay my heartfelt gratitude to Prof.S.S.L.Hettiarachchi without whose supervision and guidance, this endeavor would have not been a reality. I would like to pay my special gratitude to Dr.S.P.Samarawickrema for the guidance extended to me. My special thanks go to Dr.R.Samaranayake of Coast Conservation Department for providing me the Draft Coastal Zone Management Plan.

I wish to extend my gratitude to Mr.S.Pathinather, Dr (Mrs.) P.Hettiarachchi and Dr.S.S.Wickremasooriya, Prof.A.K.W.Jayawardena, and Ms.Buddika Gunawardena for the encouragement and support given to me to make this research a success.

I am thankful to full time Research Students; Ms.Manori Fernando, Ms.Thushari Thilekeratne, Mr.Thisara Welhena, Mr.Gayan Wijesekera, Mrs.Rekha Mallawarachchi and all the part time post graduate students who followed the Post Graduate Diploma in Environmental Engineering and Management with me.

My special thanks go to staffs of Lanka Hydraulic Institute, Coast Conservation Department and the library of University of Moratuwa for providing me with necessary data and documents required for the research.

Abstract

Sri Lanka has a fully operative Coastal Zone Management Plan (CZMP), which is periodically updated. The 2003 Coastal Zone Management Plan has followed and built upon the 1997 Coastal Zone Management Plan with additional components introduced to address the current requirements. However, some areas have not been addressed in great detail even in CZMP 2003. The Coastal Erosion Management Plan does not include green engineering measures and the Conservation Plan does not include the Estuary and Lagoon management in depth. It has been emphasized that a national recommendation regarding policy design is inappropriate and site specific policy design is required. Fisheries concerns, which were not addressed earlier, are included in CZMP 2003. Extending the SAM process to all areas requiring site specific and integrated sustainable resource management are key objectives in the CZMP 2003.

Sea level rise is one of the more certain responses to global warming and presents a major challenge to human kind. The average global sea level rise estimated by IPCC is at 31cm to 110cm by the year 2100 with a best estimate of 66cm. The land loss estimated using the simple drowning concept on the southwest coast is 6.0 to 11.5 km² when the low and high scenarios of sea level rise are concerned respectively. In assessing the vulnerability to sea level rise the new techniques such as GIS, Remote Sensing and Aerial Video Tape assisted analysis should be used. Brunn Rule is another very widely used technique to assess the land loss. It has been estimated that the Coastline of Sri Lanka will recede by as much as 50 to 500m within the next century purely due to rise in sea level. Therefore, it is extremely important to pay attention to sea level rise in the future in the design, planning and implementation stages of coastal development, coastal protection and coastal management activities.

The estuary management plans should be consistent with the tenets of total catchment management and ecologically sustainable development. It is important to realize that basic methods to understand the distribution of pollutants in estuaries can be a management tool and an aid in decision-making but nothing more. The recommended ratios of nutrients in estuaries are given by Redfield Ratios, however, a review of the literature indicates that optimum N: P ratio can vary between seven and eighty-seven. The greatest uncertainty with estuary nitrogen budgets concerns the contribution of atmospheric deposition. The principal management objective identified for Sri Lanka is conserving lagoons and estuaries to sustain and enhance environmental functions of and promote socio-economic activities connected with them.

Three budgets were created for Negombo estuarine system using CABARET. The one layer 1 box budget indicates that the system is net heterotrophic and denitrification is dominant. The 2 box 1 layer budget indicates that the estuary is net heterotrophic in the wet season. In the dry season the system box 1 is net autotrophic while system box 2 is net heterotrophic. In 2 box 1 layer system too denitrification is dominant in the estuary both in wet and dry seasons. In the 3 box 1 layer model there are some regions in the estuary, which are autotrophic while rest of the regions, are heterotrophic. And in some region nitrogen fixation is the dominant process. Therefore, it is more suitable to use a

multiple box model to understand the nutrient pollution problems and biogeochemical processes in the estuary.

From the types of management programmes, which have been adopted globally, the use of an effective Integrated Coastal Zone Management Framework is most relevant to the management of Coastal zone of Sri Lanka. When compared to applications of management frameworks from different countries, legal, institutional and organizational requirements are not a serious problem in Sri Lanka. Community based approach which is already in use should be extended and management tools such as GIS and Vulnerability Assessments should be incorporated into the ICMF.



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Table of Contents

Acknowledgement	IV
Abstract	VI
Table of contents	XII
List of Figures	XV
List of Tables	XVII
List of Annexes	XVIII
Abbreviations	
Chapter 1 Introduction	1
Chapter 2 Review of Coastal Zone Management in Sri Lanka	
2.1 Status of Coastal Zone Management (CZM) Programs	2
2.2 The 2003 Coastal Zone Management Plan (CZMP)	5
2.3 Managing Coastal Erosion	6
2.4 Conservation of Coastal Habitats	9
2.5 Controlling Coastal Water Pollution	10
2.6 Integrating Coastal Fisheries and Aquaculture	12
2.7 Special Area Management	16
Chapter 3 Sea Level Rise	
3.1. Sea Level Rise - Global Context	18
3.2. Significance of the Coastal Zone of Sri Lanka	20
3.3. Analysing the Impacts of Sea Level Rise	22
3.4. Impacts on the Coastal Zone	25
3.4.1 Inundation	25
3.4.1.1 Coastal Settlements	26
3.4.1.2 Coastal Wetlands	28
3.4.2 Coastal Erosion	29
3.4.3 Flooding and Storm Damage	32

3.4.4 Quality of Surface and Groundwater	33
3.4.4.1 Low lying Agriculture	34
3.4.4.2 Fresh Water	35
3.4.5 Fishery Industry	36
3.4.6 Marine Ecosystems and Coral Reefs	36
3.4.7 Sea Defense Structures and Breakwaters	37
3.4.8 Near shore Infrastructure	38
3.4.8.1 Near shore Land Based Infrastructure	38
3.4.8.2 Near shore Land Reclamation	38
3.4.9 Tourist Industry	39
3.5 Coastal Impact Assessment -Vulnerability to the Accelerated Sea Level Rise	40
3.5.1 Studies Recommended by the Coastal Zone Management Subgroup to Assess the Vulnerability to the Accelerated Sea Level Rise	40
3.5.2 The Vulnerability Analysis Carried Out for UNCSP by Weerakkody	41
3.5.3 GIS and Remote Sensing in Vulnerability Analysis	42
3.5.4 Aerial Video-Tape Assisted Vulnerability Analysis	43
3.5.5 Shoreline Retreat Distance Estimated from Brunn's Rule	44
3.6 Adaptive Responses	47
3.6.1 Categories of Adaptive Responses	47
3.6.1.1 Retreat	47
3.6.1.2 Accommodation	47
3.6.1.3 Protection	48
3.6.2 Adaptive Responses Used in Sri Lanka	49
Chapter 4 Estuary and Lagoon Management	
4.1 Importance of Estuaries and Lagoons	50
4.2 Physico-Chemical Processes in Estuaries and Lagoons	52
4.2.1. Conservative Pollutants	53



4.2.2. Non-conservative Pollutants	53
4.2.3. Coupled Non-conservative Pollutants	55
4.3 Role of Nutrients in Estuaries	56
4.3.1 Nutrient Status	56
4.3.1.1. Nutrients That are Limiting Factors for Estuarine Phytoplankton	57
4.3.1.2 Regeneration of Nutrients (Cycling)	59
a) Nitrogen Cycle in an Estuary	59
b) Phosphorous Cycle in an Estuary	60
c) Gradients of Nutrients and Estuary Mixing	60
d) Effects of Nutrient Over-Enrichment (Eutrophication)	61
4.3.1.3. Chl a as an integrated, surrogate measure of nutrient status	61
4.3.1.4. Importance of DO and Water Clarity	62
4.3.2 Sources of Nutrient Inputs to Estuaries and Coastal waters	64
4.3.2.1 Wastewater and Non point Source Inputs	65
4.3.2.2. Disturbance, Non point Nutrient Fluxes, and Baselines for nutrient exports from pristine systems	65
4.3.2.3 Agriculture and Non point Source Nutrient Pollution	66
(a) Export of phosphorous from Agricultural Systems	66
(b) Export of Nitrogen from Agricultural Systems	66
4.3.2.4 Fate of nitrogen in Atmospheric Deposition	66
4.3.2.5 Processing of Nitrogen and Phosphorous in Wetlands, Streams and Rivers	66
4.3.3 Nutrient Fluxes to the Coast	67
4.3.3.1 Nutrient Budgets for Specific Estuaries and Coastal Waters	67
4.3.3.2 Oceanic Waters as a Nutrient Source to Estuaries	68
4.4 Estuary & Lagoon Management in Sri Lanka	69
4.4.1 Human Related Causes	69
4.4.2 Natural Causes	70
4.5 Specific Objectives of an Estuary Management Plan	71
4.5.1 General Objectives	71
4.5.2 The Estuary Management Process	72
4.6 Management Objectives	73
4.6.1 Policies and Planning	73

4.6.2 Future Targets of the Catchment Management Plan	74
4.6.2.1 Implications for Achieving Source Reductions	74
4.6.2.2 Source Reduction and Control	75
4.6.2.3 Implementing Remedial Measures	75
4.6.2.4 Urban sources	76
4.6.2.5 Other Mitigation Options	78
4.6.3 Conservation	79
4.6.4 Research and Development	80
4.6.5 Trade and Industry	81
4.6.6 Environmental Quality	81
4.6.7 Water Quality Goals	82
4.6.7.1 Establishing Criteria and Standards	82
4.6.7.2 Current Criteria and Standards	83
4.6.7.3 TDML Approach	83
4.6.7.4 The Flushing Time	84
4.7 Management Objectives, Policies and Actions Identified for Sri Lanka	85
Chapter 5 Estuarine Water Quality Models	
5.1 The Need For Estuarine Water Quality Models	88
5.2 Land Ocean Interaction In The Coastal Zone (LOICZ) Project	88
5.3 LOICZ Biogeochemical Budgeting Procedure	90
5.3.1 Water and Salt Budget	91
5.3.2 Nutrient Budgets	92
5.4 Computer Assisted Budget Analysis for Research, Education, and Training	94
5.5 Stoichiometric Analysis" of the Fluxes	95
5.5.1 Organic Metabolism and "Net Ecosystem Metabolism"	95
5.5.2 Phosphorous Carbon Stoichiometry	96
5.5.3 Nonconservative Phosphorus Flux and Net Ecosystem Metabolism	97
5.5.4 Nitrogen Metabolism and Net Nitrogen Fixation Minus Denitrification	99

5.5.5 Net Sulfate Reduction, Net CaCO ₃ Precipitation, and CO ₂ Gas Flux	100
5.6 Budget for Negombo Estuarine System	103
5.6.1 River Discharge, Precipitation and Evaporation Data	108
5.6.2 Salinity, DIP and DIN	108
5.6.2.1 Salt concentrations for One Box Scenario	109
5.6.2.2 DIN and DIP for One Box Scenario	110
5.6.2.3 Salt concentrations for Two Box Scenario	111
5.6.2.4 DIN and DIP for Two Box Scenario	112
5.6.2.5 Salt concentrations for Three Box Scenario	113
5.6.2.6 DIN and DIP for Three Box Scenario	115
5.6.3 Budgets For Negombo Lagoon Using Cabaret	117
5.6.3.1 Budget Analysis 1-1 BOX 1 LAYER	117
(a) Water and Salt Balances	117
(i) Salt & Water Budget for Dry Season	117
(ii) Salt & Water Budget for Wet Season	119
(b) Nonconservative Dissolved Inorganic P and N Fluxes	121
5.6.3.2 Budget Analysis 2-2 BOX 1 LAYER	127
(a) Water and Salt Balances	127
(i) Salt & Water Budget for Dry Season	127
(ii) Salt & Water Budget for Wet Season	128
(b) Nonconservative Dissolved Inorganic P and N Fluxes	131
5.6.3.3 Budget Analysis 3-3 BOX 1 LAYER	137
(a) Water and Salt Balances	137
(ii) Salt & Water Budget for Dry Season	137
(ii) Salt & Water Budget for Wet Season	138
(b) Nonconservative Dissolved Inorganic P and N Fluxes	140
5.6.3.4 Conclusion	146
Chapter 6 Integrated Coastal Zone Management Framework	
6.1 The Need for Management Framework	147
6.2 Types of Management Frameworks	148
6.3 Integrated Coastal Zone Management Framework and its Application to Sri Lanka	153
6.4 Applications of Management Frameworks from Different Countries	157
6.4.1 Coastal Management in Nile Delta of Egypt	157
6.4.2 Coastal Management in Poland	158
6.4.3 Coastal Management in Vietnam	159
6.4.3.1 Application of Management Frameworks to Vietnam	

Coastal zone	159
6.4.3.2 ICZM Case Study - Thua Thien Hue	161
6.4.4 Coastal Zone Management in Mozambique	162
6.4.5 Coastal Management in Pacific Islands	164
6.5 Concluding Remarks on the applications of ICZM Framework	166
Chapter 7 Conclusions and Recommendations	168
References	172



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

List of Figures

- Figure 2.1 Vetiver Grass Systems Used in Sri Lanka to Prevent Soil Erosion in Tea Estates
- Figure 2.2 Vetiver Grass Products in Royal Development Projects Board (Thailand)
- Figure 3.1 Global Sea Level Rise, 1985 to 2100 (IPCC 1990)
- Figure 3.2 The Maritime Zones
- Figure 3.3 Coastal Zone Definition , Coast Conservation Act
- Figure 3.4 Devolution of Marsh as Sea Rises.
- Figure 3.5 Increasing Salinity Due to Sea Level Rise
- Figure 3.6 Impact of Sea Level Rise on Island Water Table.
- Figure 3.7 The Brunn Rule
- Figure 3.8 Overwash: Natural Response of Undeveloped Barrier Islands to Sea Level Rise
- Figure 4.1 Behavior of Conservative and Non-Conservative Pollutants
- Figure 4.2 Behavior of a Coupled Non-Conservative Pollutant
- Figure 4.3 Nitrogen Cycle in an Estuary
- Figure 4.4 Conceptual Model Illustrating Oxygen Depletion and Nutrient Regeneration in Bottom Waters (and Sediments) in the Stratified Portion of an Estuary *e.g.* Where Saline Water Underlies Riverine Water.
- Figure 5.1 Budget for Any Material
- Figure 5.2 Water Budget
- Figure 5.3 Salt Budget
- Figure 5.4 Generalized Budget for Any Material, Y, Within a Coastal Marine System.
- Figure 5.5 Budget for Nutrients

- Figure 5.6 Generalized Diagram Illustrating C, N, and P Cycling Through the Organic Metabolic Pathways.
- Figure 5.7 Diagram Illustrating How the Dissolved Inorganic Content and the Total Alkalinity of Seawater are Each Altered.
- Figure 5.8 Muthurajawela Marsh – Negombo Estuary
- Figure 5.9 Distribution of Locations of Water Quality Sampling for the One Box Scenario
- Figure 5.10 Distribution of Locations of Water Quality Sampling for the Two Box Scenario
- Figure 5.11 Distribution of Locations of Water Quality Sampling for the Three Box Scenario
- Figure 5.12 Water and Salt Balances for Dry Season 1 Box 1 Layer Scenario
- Figure 5.13 Water and Salt Balances for Wet Season 1 Box 1 Layer Scenario
- Figure 5.14 Nitrogen Balance for Dry Season 1 Box 1 Layer Scenario
- Figure 5.15 Nitrogen Balance for Wet Season 1 Box 1 Layer Scenario
- Figure 5.16 Phosphorous Balance for Dry Season 1 Box 1 Layer Scenario
- Figure 5.17 Phosphorous Balance for Wet Season 1 Box 1 Layer Scenario
- Figure 5.18 Water and Salt Balances for Dry Season 2 Box 1 Layer Scenario
- Figure 5.19 Water and Salt Balances for Wet Season 2 Box 1 Layer Scenario
- Figure 5.20 Nitrogen Balance for Dry Season 2 Box 1 Layer Scenario
- Figure 5.21 Nitrogen Balance for Wet Season 2 Box 1 Layer Scenario
- Figure 5.22 Phosphorous Balance for Dry Season 2 Box 1 Layer Scenario
- Figure 5.23 Phosphorous Balance for Wet Season 2 Box 1 Layer Scenario
- Figure 5.24 Water and Salt Balances for Dry Season 3 Box 1 Layer Scenario
- Figure 5.25 Water and Salt Balances for Wet Season 3 Box 1 Layer Scenario
- Figure 5.26 Nitrogen Balance for Dry Season 3 Box 1 Layer Scenario

Figure 5.27 Nitrogen Balance for Wet Season 3 Box 1 Layer Scenario

Figure 5.28 Phosphorous Balance for Dry Season 3 Box 1 Layer Scenario

Figure 5.29 Phosphorous Balance for Wet Season 3 Box 1 Layer Scenario



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk



List of Tables

Table 3.1	Scenarios of the Accelerated Sea Level Rise for Sri Lanka
Table 3.2	Land Loss of the Southwest Coast of Sri Lanka
Table 3.3	Estimated Areas of Inundation Around the Lowlands Adjacent to Marshlands, Lagoons and Estuaries of the Southwest Coast of Sri Lanka
Table 3.4	The Major Categories and Types of Land Use of the Southwest Coast of Sri Lanka (km encountered under each type of land use)
Table 3.5	Erosion Rates Resulting from an Increase of Sea Level Based on 'Brunn Rule'
Table 5.1	Average Discharge, Precipitation and Evaporation for both Dry & Wet seasons
Table 5.2	Outer Box (Sea) Salt Concentrations – One Box Scenario
Table 5.3	System Box Salt Concentrations – One Box Scenario
Table 5.4	Freshwater (River) Salt Concentrations – One Box Scenario
Table 5.5	DIN and DIP Outside the System (Sea) at Location 1 – One Box Scenario
Table 5.6	DIN and DIP Inside the System Box (considering locations 1A, 2, 2A, 2B, 3, 4,5,6,6A, 7) – One Box Scenario
Table 5.7	DIN and DIP in Freshwater Discharge (Considering Locations 8,8A, 9, 9A, 10, 10A) – One Box Scenario
Table 5.8	Salt Concentrations in the Outer Box (Sea) - Two Box Scenario
Table 5.9	Salt Concentration Inside the System Box 2 (locations 1A, 2, 2A, 3, 4) - Two Box Scenario
Table 5.10	Salt Concentration Inside the System Box 1 (considering locations 5, 6,6A, 7) - Two Box Scenario
Table 5.11	Salt Concentrations in the Fresh Water Discharge (Considering locations 8, 8A, 9, 9A, 10, 10A) - Two Box Scenario
Table 5.12	DIN and DIP Outside the System (sea) at Location 1 - Two Box Scenario

Table 5.13	DIN and DIP Inside the System Box 2 (Considering locations 1A, 2, 2A, 3, 4) - Two Box Scenario
Table 5.14	DIN & DIP Inside the System Box 1 (Considering locations 5, 6, 6A & 7) - Two Box Scenario
Table 5.15	DIN and DIP in the Freshwater Discharge (Considering locations 8, 8A, 9, 9A, 10, 10A) - Two Box Scenario
Table 5.16	Salt Concentration in the Outer Box (Ocean)
Table 5.17	Salt Concentration in System Box 3 (Considering Locations 1A, 2, 2A, 3, 4)
Table 5.18	Salt Concentration in System Box 2 (Considering Locations 5 & 6)
Table 5.19	Salt Concentration in System Box 1 (Considering Locations 6A & 7)
Table 5.20	Salt Concentration in the Freshwater Discharge (Considering points 8, 8A, 9, 9A, 10, 10A)
Table 5.21	DIN and DIP Outside the System (Ocean) at Location 1
Table 5.22	DIN and DIP in System Box 3 (Considering Locations 1A, 2, 2A, 3, 4)
Table 5.23	DIN and DIP Inside the System Box 2, (Considering Locations 5 and 6)
Table 5.24	DIN & DIP Inside the System Box 1 (considering Locations 6A and 7)
Table 5.25	DIN and DIP in Freshwater Discharge (Considering Locations 8, 8A, 9, 9A, 10, 10A)
Table 4.26	Nonconservative Dissolved Inorganic P and N Fluxes in Negombo Lagoon Considering as a 1 Box 1 Layer System.
Table 5.27	Non conservative Dissolved Inorganic P and N Fluxes in Negombo Lagoon Considering as a 2 Box 1 Layer System.
Table 5.28	Nonconservative Dissolved Inorganic P and N Fluxes in Negombo Lagoon Considering as a Three Box 1 Layer system
Table 6.1	Significance of Main Variables (Coastal Issues and Parameters)

List of Annexes

- Annex A1 Proposed Ambient Water Quality Standards for Inland Waters
- Annex A2 Coastal Water Quality Standards
- Annex A3 Water Quality of Negombo Lagoon Study 1
- Annex A4 Water Quality of Negombo Lagoon Study 2



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Abbreviations

ADB	- Asian Development Bank ADB
ANZECC	- Australian and New Zealand Environment and Conservation Council
APC	- Area of Particular Concern
AVA	- Aerial Video-tape Assisted vulnerability analysis
BAU	- Business as Usual
BMP	- Best Management Practices
BOD	- Biochemical Oxygen Demand
CABARET	- Computer Assisted Budget Analysis for Research, Education, and Training
CCA	- Coast Conservation Act
CCAC	- Coast Conservation Advisory Council
CCD	- Coast Conservation Department
CEA	- Central Environmental Authority
Chl a	- Chlorophyll a
COD	- Chemical Oxygen Demand
CRM	- Coastal Resources Management
CRMP	- Coastal Resources Management Project
CZM	- Coastal Zone Management
CZMP	- Coastal Zone Management Plan
CZMS	- Coastal Zone Management Strategy
DFAR	- Department of Fisheries and Aquatic Resources
DIC	- Dissolved Inorganic Carbon

DIN	- Dissolved Inorganic Nitrogen
DIP	- Dissolved Inorganic Phosphorous
DO	- Dissolved Oxygen
DON	-Dissolved Organic Nitrogen
DOP	-Dissolved Organic Phosphorous
DRP	-Dissolved Reactive Phosphorous
EEZ	- Exclusive Economic Zone
EIA	- Environmental Impact Assessment
EPA	- Environmental Protection Agency
ESID	- Ecologically Sustainable Industrial Development
FAO	- Food and Agricultural Organization
GIS	- Geographic Information System
ICZM	- Integrated Coastal Zone Management
ICZMF	- Integrated Coastal Zone Management Framework
IGBP	- International Geosphere- Biosphere Program
IPCC	- Intergovernmental Panel on Climate Change
IRMP	- Integrated Resource Management Project
IUCN	- International Union for Conservation of Nature
LHI	- Lanka Hydraulic Institute
LOICZ	- Land Ocean Interaction in the Coastal Zone
MFARD	- Ministry of Fisheries and Aquatic Resources Development
MHWS	- Mean High Water Spring Tide level
MICOA	-Ministry for the Coordination of Environmental Affairs

NARA	- National Aquatic Research Agency
NAQDA	-National Aquaculture Development Agency
NEA	- National Environmental Act
NEM	- Net Ecosystem Metabolism
NEP	- Net Ecosystem Productivity
NGO	- Non Governmental Organization
NORAD	- Norwegian Agency for Development Cooperation
PAR	- Photosynthetically Active Radiation
PP	- Particulate Phosphorous
SAM	- Special Area Management
SAMP	- Special Area Management Plan
SCOPE	- Scientific Committee on Problems of the Environment
SIDS	- Small Island Developing States
SLR	- Sea Level Rise
SSSI	- Sites of Special Scientific Interests
SW	-South West
TA	-Total Alkalinity
TMDL	- Total Maximum Daily Load
TN	- Total Nitrogen
TP	- Total Phosphorous
TOR	- Terms of Reference
UDA	- Urban Development Authority
UN	- United Nations
UNCED	- United Nations Conference on Environment and Development
UNCSP	- United Nations Committee to Stabilize the Population



- UNFCC - United Nations Framework Convention on Climate Change
- UNEP - United Nations Environmental Program
- US - United States
- WMO - World Meteorological Organization



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk