ANNUAL REPORT & ACCOUNTS
2023

National Aquatic Resources Research and Development Agency
Crow Island, Colombo 15
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Ministry of Fisheries, Aquatic and Ocean Resources

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NATIONAL AQUATIC RESOURCES RESEARCH & DEVELOPMENT AGENCY

1. CORPORATE INFORMATION

The National Aquatic Resources Research and Development Agency (NARA) is the principal national institution charged with the responsibility of carrying out and co-coordinating research development and management activities on the subject of aquatic resources in Sri Lanka. NARA was established in the year 1981 by restructuring the Research Division of the Department of Fisheries. In the restructuring process Research Division was amalgamated with the institute of Fish Technology which existed in the present premises of NARA at Crow Island, Mattakkuliya, Colombo15 to establish a fully fledged research agency, under an Act of Parliament, National Aquatic Resources Agency Act No. 54 of 1981 and amended subsequently by National Aquatic Resources Research and Development Agency Act No. 32 of 1996. The following Vision, Mission, Goals/Objectives as the highlights of the NARA functions as a statutory body under the Ministry of Fisheries and Aquatic Resources Development are as follows.

Our Vision

To be the premier institution for scientific research in conservation, management and development of aquatic resources in the region.

Our Mission

To provide innovative solutions for national development issues in the aquatic resources sector utilizing scientific and technological knowledge & resource base.

The main objectives and functions of the Agency:

- To ensure application and utilization of Scientific and Technological expertise for the implementation of national development programs.
- To promote and conduct research activities directed at identification, assessment, management and development of living and non-living aquatic resources.
- To co-ordinate and provide advisory and consultancy services on matters relating to exploitation, management and development of aquatic resources.
- To undertake collection, dissemination and publication of scientific research information on aquatic resources & related subjects.
- To provide training related to fisheries and aquatic resources fields.

Governing Board

The Governing Board consists of Eight (08) Appointed Members and Eight (08) Ex officio members in accordance with the Section 6 of the National Aquatic Resources Research & Development Agency Act No 54 of 1981 as amended by Act No 32 of 1996. The following members served as the members of the Governing Board during the year 2023 and twelve (12) Board Meetings were held during the year.

The Governing Board Members of NARA 2023

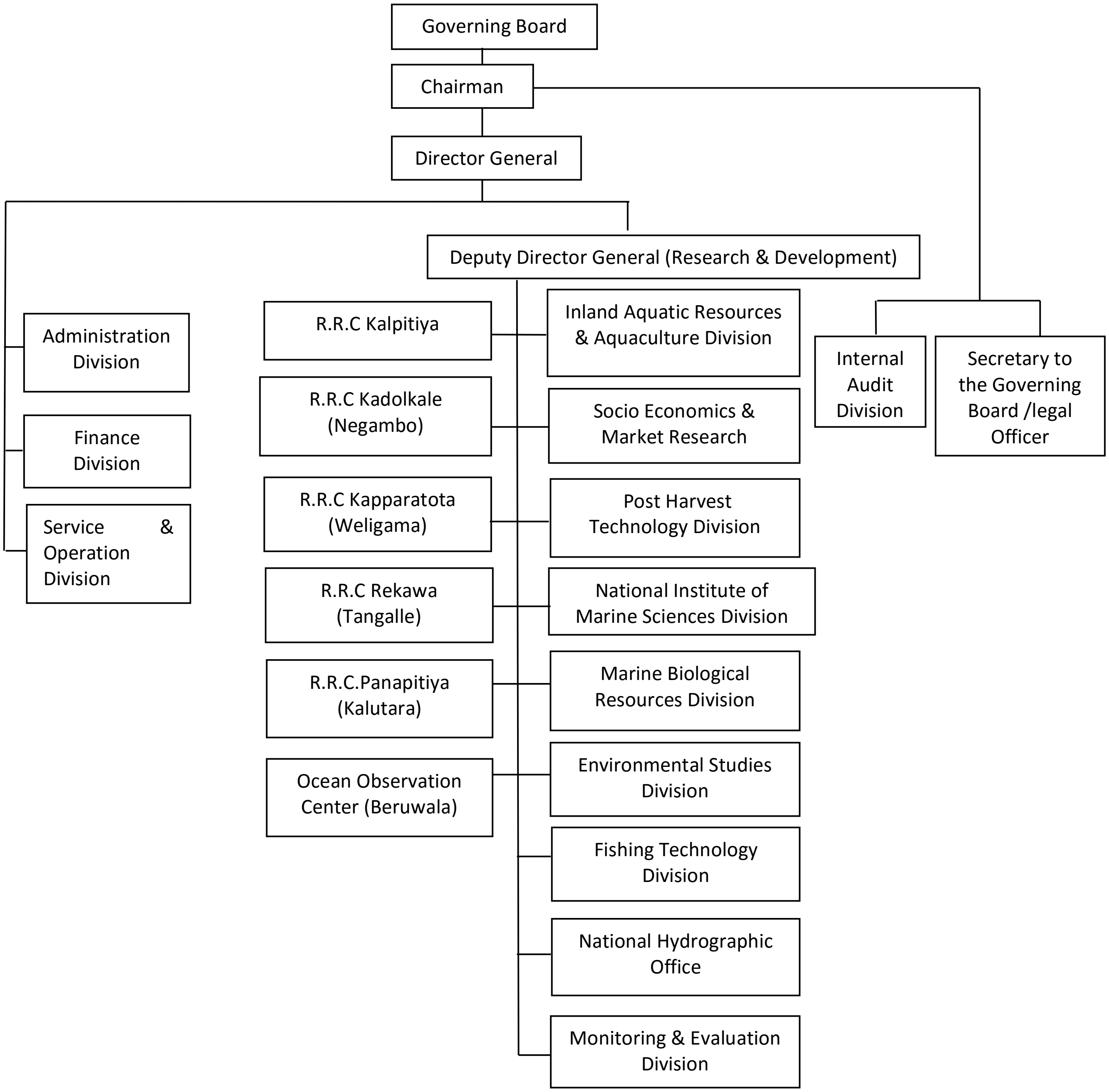
Members who appointed by the Minister

The Name and Address	Designation	Date of Appointment
Senior Prof. M. J. S. Wijeyaratne, Chairman, National Aquatic Resources Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	The Chairman The Governing Board Member	10th February 2022
Mr. Selvendran Salivan de Marian No. 17/2, Uyarappulam, Anaikoddai, Jaffna.	The Governing Board Member	10th February 2022
Mr. Gizal Chinthan de Silva No. 273, Stanley Road, Jaffna No 3/9, Railway station Road, Colombo 04.	The Governing Board Member	From 10th February 2022 to 08th June 2023
Prof. P. Vinobaba, 6/1, Vetharanium Square, Batticaloa	The Governing Board Member	08th June 2023
Mr. N. M. P. Chaminda Fernando, Secretary, Sri Lanka Aquaculture Development Alliance, 53B, Singhapura Road, Chilaw, 61000	The Governing Board Member	10th February 2022
Emeritus Prof. Upali S. Amarasinghe, Department of Zoology & Environmental Management University of Kelaniya Kelaniya	The Governing Board Member	10th February 2022
Dr. (Ms.) J. M. Asoka, Director General, National Aquaculture Development Authority of Sri Lanka, No. 41/1, New Parliament Rd, Pelawatte, Battaramulla	The Governing Board Member	10th February 2022
Prof. Alagaiah Navaratnarajah 6, 3/2 Indra Lane, Colombo 04	The Governing Board Member	04th April 2023

Ex-Officio members who appointed by official		
The Name and Address	**Designation**	**Date of Appointment**
Dr.Kamal Tennakoon Director General, National Aquatic Resources Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	The Director General The Governing Board Member	18th November 2022
Mr. T. A. C. N. Thalangama Additional Secretary, Ministry of Ornamental Fish, Inland Fish and Prawn Farming, Fishery Harbour Development, Multiday Fishing Activities and Fish Exports, New Secretariat, Maligawatta, Colombo 10	The Governing Board Member	10th October 2021
Mr. A.P Kurumbalapitiya, Director General, Department of Management Audit, Ministry of Finance, The Secretariat, Colombo 01.	The Governing Board Member	18th March 2022
Ms. K.N. Kumari Somaratne Additional Secretary (Development), Ministry of Ports & Shipping, No. 19, Chaithya Road, Colombo 01.	The Governing Board Member	12th February 2020
Mr. S.J. Kahawatta Director General Department of Fisheries & Aquatic Resources Development, Maligawatta Sec, Colombo 10	The Governing Board Member	12th February 2020
M.M.G.K. Meegahakotuwa Director General (Planning)/ Ministry of Education, Isurupaya, Battaramulla	The Governing Board Member	25th September 2020
Rear Admiral K.A.P.S.K. Kariyapperuma, Naval Assistant to the Commander & Chief Hydrographer of the NAVY	The Governing Board Member	20th September 2022

Mr. S. Sivanandarajah, Surveyor General, Survey Department of Sri Lanka, 150, Kirula Road, Narahenpita, Colombo 05	The Governing Board Member	From 01st January 2023 to 30th August 2023
Mr. W.S.L.C Perera, Surveyor General, Survey Department of Sri Lanka, 150, Kirula Road, Narahenpita, Colombo 05	The Governing Board Member	14th September 2023

Organizational Structure



Organization

Prof. M. J. S. Wijeyaratne, functioned as the chairman and Dr T.K.D.Tennakoon functioned as the Director General and Dr. G.J.Ganegama Arachchi functioned as the Actg. Deputy Director General(Research & Development)during the year under review. In order to perform the mandated functions of the Agency the organization had been designed to constitute nine Research and Technical/Services Divisions, Environmental Studies, Fishing Technology, Hydrographic Office, Inland Aquatic Resources & Aquaculture, Monitoring & Evaluation, Marine Biological Resources, National Institute of Oceanography & Marine Sciences, Socio-Economic and Market Research, Institute of Post Harvest Technology divisions. Supported divisions were, Administration, Services & Operations and Finance Divisions.

Following officials officiated as Heads of Divisions during the year 2023.

Research Divisions

	Name	Division
1	Ms.K.A.W.S.Weerasekara	Environmental Studies Division
2	Dr.W.N.C.Priyadarshanie(Actg.)	Fishing Technology Division
3	Mr.S.R.C.Ranaweera	Hydrographic Division
4	Dr.Prajani Hennatigala	Inland Aquatic Resources & Aquaculture Division
5	Dr.R.P.P.K.Jayasinghe	Marine Biological Resources Division
6	Dr.K.Arulananthan	National Institute of Oceanography & Marine Sciences
7	Dr.K.W.S.Ariyawansa	Institute of Post Harvest Technology
8	Mr. K. H. M. L.Amaralal	Socio Economics & Market Research Division
9	Mr. A. B. A .K. Gunaratne (01.01.2023 – 23.05.2023) Mr.P.A.D.Ajith Kumara(Actg.) (01.06.2023 – 31.12.2023)	Monitoring & Evaluation Division

SUPPORT SERVICES DIVISIONS

Mr.R.D.P.P.Ranasinghe	Administration Division
Mr.N.S.Hewagama	Finance Division
Mr.S.K.S.Liyanaarachchi	Services & Operation Division
Ms. Thushari pradeepika	Internal Audit Division

2. RESEARCH HIGHLIGHTS-2023

Ornamental Industry:

By considering the export demand for local ornamental species, NARA has attempted to develop fancy verities of fishes by hybridizing the endemic *Dawkinsia* spp. and *Pethia* spp. Results shows that offspring with very attractive and noticeable characters.

Mariculture Development:

NARA has further identified more than 1600 acres extent for sea cucumber farming in Mannar, Killinochchi and Jaffna districts this year. This include 1250 hec area which is demarcated to gazette as a "Special Sea Cucumber Aquaculture Development Zone" in Palavi, Killinochchi district

Aquatic Plant and Aquascaping Industry:

Aquatic plant tissue culture laboratory has conducted research work to develop micro-propagation techniques for high-demand high-valued aquatic plants. They were able to develop five micro-propagation techniques and are willing to start commercial culture production in the year 2024 as per the stakeholder's request.

Aquascaping Industry is the art of arranging aquatic plants, rocks, stones, cave work or driftwood, in an aesthetically pleasure manner within an aquarium and it appears to have begun to be a popular hobby worldwide. There are many different types of substrates commercially available that will assist the plants growth. Aqua-soil or aquarium soil is popular among the aquarium keepers as it releases nutrient slowly that minimizes the algae growth and turbidity of the tank. Although many commercially available substrates available in the market, there is no proper standardized protocol to produce it. It is essential to develop low cost and effective aquarium substrate as it is highly demanded in the industry. Thus, in NARA attempts were taken to develop protocol for aquarium soil which standardized the granular size and the composition. Thus, in NARA attempts were taken to develop protocol for aquarium soil which standardized the granular size and the composition.

Tune Advisory Services:

NARA generates and issues two separate advisories on Yellow fin tuna and skipjack tuna three days per week. Advisories are disseminated to multiday fishing groups (vessel owners and skippers) and DFAR officers through WhatsApp group members (> 700 numbers); 380 email subscribers (including ~350 vessel owners); 1700 Facebook followers for FIS NARA page (2000+ reach per each post) https://www.facebook.com/tuna.forecast; Dialog "Sayuru" network (TV screens at 5 harbours; 25,000 Facebook followers) and conducted awareness programs; and display banners and distribute leaflets (Sinhala/Tamil) in all active fisheries harbours.

Ecosystem monitoring of Fish Aggregating Devices (FADs) deployment sites to enhance the fish production and eco-tourism in coastal waters

32 No's Fish Aggregating Devices deployed by NARA since 2018 and Obsolete vehicle (24 buses and 14 boats) deployed by Department in Trincomalee in 2021 were monitored. It was observed that "Hingura fish", *Dipterygonotus balteatus* (Mottled fusilier) was found as dominant fish species among 27 fish species in Sinnapadu. Twenty-nine fish species were identified at Trincomalee, while edible snapper species were highly prominent.

National Charting Programme:

i. 60% of the near shore areas covered by the surveys which are navigationally significant, around the Sri Lankan Coastal belt and can undertake bathymetric surveys where the data coverage is not available.

ii. During, 2023 ENC charts of Puttalam Harbour and Approaches to Puttalam Harbour were prepared and sent to UKHO for validation process while Colombo to Weligama chart is in progress with using NARA owned data.

Development of Coastal Water Quality Index (WQI) for Southern beaches: a road to the Blue Flag Certification Prevailing water quality conditions at the southern beaches, specifically Unawatuna, Mirissa, and Polhena using Water Quality Index (WQI) towards acquiring the "Blue Flag Certification" for the selected beaches with the purpose of further elevating the desirability of these beaches for international tourism purposes.

Reduce Post-harvest Losses:
Aiming to minimize the high percentage of post-harvest losses in multi-day fisheries, NARA, in collaboration with the Ministry of Fisheries, National Engineering Research and Development Centre (NERDC) and DFAR, under the financial assistance of FAO, a multi-day fishing boat has been upgraded by installing a refrigerated system and compartmentalized the fish hold in order to for reduce ice melting rates in fish hold of boat.

Institutional Collaboration with Foreign Countries:
1. NARA has built up institutional collaboration with Indian Center for Agricultural Research (ICAR) and Center for Marine Fisheries Research India (CMFRI) to develop mariculture and coastal aquaculture sector. Accordingly, Indian scientists visited Sri Lanka and carried out pipe line study.

2. Under the Norway-Sri Lanka bilateral project, in the especial focus on in the Northern province

3. There are several Technical Cooperation Projects (TCP) with FAO are going on to reduce post-harvest losses, multi-vessel modification, sea cucumber breeding technology, marine ranching programmes and shrimp bio security and big data handling.

4. China Academy of Science (CAS) has collaborated with NARA to conduct ocean research and financially assisted to World Ocean day event as well as this session too.

5. University of Western Australia (UWA) collaborated with NARA to monitoring of ocean process in Indian Ocean.

6. University of Sydney, Primary Industries of Australia, UWA and Australian Aidprogramme (DFAT, KLIE) jointly collaborative with NARA to conduct Scope study on mariculture development in the country.

7. Korea Institute of Ocean Science and Technology team will assist to initiate Marine and Ocean Data Center for NARA.

Private Public Partnership (PPP) for Research & Development:
NARA has made Private Public Partnership (PPP) marking new era in research collaboration with private sector for Aqua Feed Production. Accordingly, KMN Aqua PVT Ltd has started their fish feed production under the technical guidance of NARA with view to produce high quality fish feeds at affordable prices to the farmers.

Extension Works:
1. An International workshop was organized in parallel to World Ocean's Day on the theme of 'Towards a National Ocean Policy' on 08th June 2023 at the NARA auditorium in collaboration with China Sri Lanka Joint Center for Education and Research (CSL-CER). A number of

stakeholders in the oceanic and maritime sector and NARA officials were participated to this event. It served as an initial discussion platform with all the experts in the oceanic and maritime sector to open the first step of a long-term process of formulation a "National Ocean Policy" for sustainable ocean economic development.

2. Over 100 post graduate & under graduate students, researchers, vocational training students were undertaken to supervise theirs final year research projects, industrial and internships trainings.

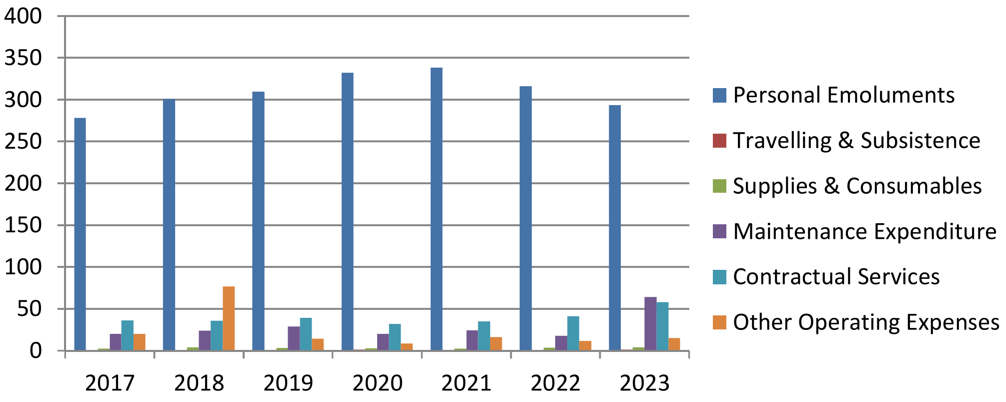
3. Awareness and *in situ* filed training programmes were conducted for naval officers, public health Inspectors, post-graduate & under graduate students, school children and NGO's via public lectures, field lectures, online lectures and exhibitions. Over 800 persons were benefitted.

4. Residential and onsite training programmes were conducted in the aspects of mariculture, aquatic plant industry, product development and minimizing post-harvest losses.

3. FINANCIAL HIGHLIGHTS - 2023

RECURRENT EXPENDITURE

Rs. Million							
Description	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Personal Emoluments	278.110	300.533	309.714	331.910	338.14	316.26	293.26
Travelling & Subsistence	0.298	0.406	0.747	1.179	0.74	0.166	1.31
Supplies & Consumables	2.366	3.760	3.025	2.665	2.3	3.485	3.89
Maintenance Expenditure	20.133	24.059	28.535	20.114	24.3	17.39	63.9
Contractual Services	36.211	35.635	39.310	32.047	34.7	41.083	58.0
Other Operating Expenses	20.091	76.583	14.222	8.396	16.23	11.659	15.12
Total Rs. Million	**357.209**	**440.976**	**395.55**	**396.311**	**416.41**	**390.043**	435.48



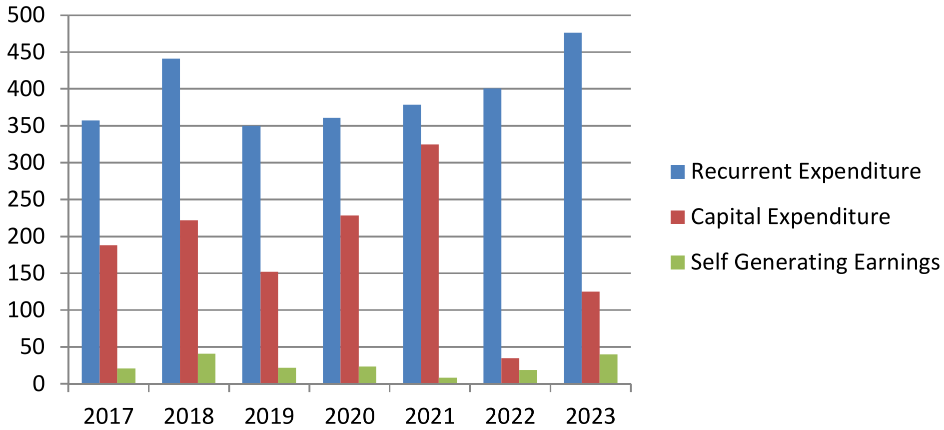
In the year 2023, the personal emolumentshas decreased compared to the years 2021 and 2022. In the year 2023, travel and subsistence expenses, expenses incurred for supplies and consumables, expenses incurred for maintenance activities, expenses incurred for Contractual Services and expenses incurred for other operational activities have increased compared to the years 2021 and 2022.

TREASURY ALLOCATION & SELF EARNINGS

Rs. Million

Description	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	2023
Recurrent Expenditure	357.209	440.970	350.000	360.905	378.6	400.5	476
Capital Expenditure	188.000	222.000	152.000	228.600	325.0	35.0	125
Self Generating Earnings	20.810	40.814	21.678	23.900	8.2	19.00	40.0
Total Rs. Million	**566.019**	**703.784**	**523.67**	**613.405**	**711.8**	**454.5**	515.2

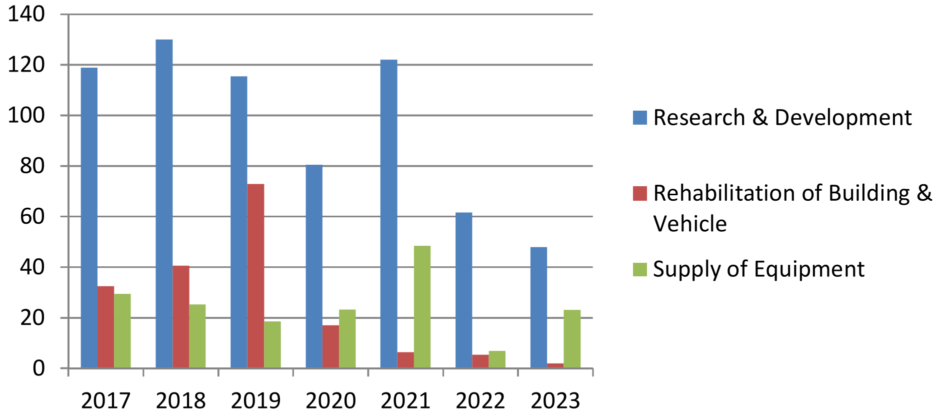
In the year 2023, the General Treasury allocation for recurrent expenses has increased compared to the years 2021 and 2022. The General Treasury allocation for capital expenditure has increased in the year 2023 compared to the year 2022. Self-generated earnings have increased in 2023 compared to 2021 and 2022.



CAPITAL EXPENDITURE

Rs. Million

Description	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	2023
Research & Development	118.829	130.047	115.538	80.482	122.02	61.524	48.03
Rehabilitation of Bldg., Vehicle & Material	32.456	40.590	72.94	16.923	6.30	5.367	1.9
Supply of Equipment	29.530	25.173	18.477	23.346	48.5	6.914	23.1
Total Rs. Million	**180.815**	**195.810**	**206.95**	**120.751**	**176.82**	**73.805**	**73.03**



Compared to the years 2022 and 2021, the amount spent on research and development expenses, building and vehicle rehabilitation in the year 2023 was reduced.

4. HUMAN RESOURCES INFORMATION

Recruitments (As a internal promotion)

No	Name & Division	Previously held Position	Current Position	Date of Promotion
1	Mr. S.R.T.P.Sinhabahu National Hydrographic Division	Cartographer JM - 1-2 - Grade I	Senior Cartographer MM - 1-2- Grade II	01.07.2023

Departures

Resignations

No	E.P.F. No	Name, Designation and Division	Permanent / Contract / Causal	Date of First Appointment	Date of Resigned
01	232	Mr. W. D. M. De Mel Research Assistant/ SED	Permanent	04/01/1993	02/02/2023
02	990	Mr. H. P. K. E. Gunarathne Research Assistant/ IPHT	Contract	01/06/2021	28/03/2023
03	926	Ms. K. L. C. Perera Lab Attendant/ IARAD	Permanent	16/09/2019	04/05/2023
04	541	Dr. A. A. D. Amarathunga Senior Scientist / ESD	Permanent	03/10/2005	12/05/2023
05	582	Ms. W. A. P. P. Wijesundara Hydrographic Surveyor/ NHO	Permanent	15/02/2008	22/06/2023
06	725	Ms. P. A. M. J. Wijepala Scientist/ IPHT	Permanent	10/02/2014	17/08/2023
07	945	Ms. N. P. H. Deepa Kumari Scientist/ IARAD	Permanent	20/08/2020	03/09/2023
08	940	Ms. K. M. B. P. P. Kalaotuwawe Scientist/ ESD	Permanent	20/08/2020	25/09/2023
09	935	Mr. P. V. D.Tharanga Hydrographic Surveyor/ NHO	Permanent	01/10/2019	30/09/2023
10	955	Ms. N. G. L. Nadee Uthpala Scientist/ NIOMS	Permanent	20/08/2020	05/10/2023
11	961	Ms. W. A. A. M. Bandara Scientist/ SED	Permanent	20/08/2020	26/10/2023
12	986	Ms. S. G. Thilini Piumali Research Assistant/ ESD	Permanent	29/03/2021	2023/10/10
13	709	Ms. P. Nishamani Dharmarathne Personal Assistant to the Director General/ Director General Office	Permanent	15/07/2013	31/12/2023
14	497	Ms. I. A. Nanayakkara Assistant Information Technology Officer/ Information Technology Unit	Permanent	01/10/2003	31/12/2023
15	976	Ms. Dushyanthi Rajakumar Research Assistant/ ESD	Permanent	22/03/2021	31/12/2023

Retirements

No	EPF No	Name , Designation and Division	Permanent / Contract / Causal	Date of First Appointment	Date of Retirement
01	280	Mr. G. D. L. Bonifus Survey Helper/ NHO	Permanent	02/05/1994	01/01/2023
02	80273	Mr. Nimal Jayawardena Driver / S&O	Permanent	16/12/1988	30/01/2023

03	397	Mr. W.K. Winsont Driver/ S&O	Permanent	11/11/1988	01/02/2023
04	326	Mr. L. Karunarathne Helper/ NHO	Permanent	01/12/1994	26/02/2023
05	249	Ms. B. H. B. Jayamalee Cartographer / Data Analyst)ENC)/ NHO	Permanent	02/08/1993	24/04/2023
06	80088	Mr. U. A. D. Sunil Gamini Driver/ S&O	Permanent	01/01/1984	27/04/2023
07	242	Mr. A. B. A. K. Gunarathne Director /(Monitoring & Evaluation) / M&E	Permanent	16/08/1993	23/05/2023
08	80240	Mr. D. M. N. Disanayaka Skilled Labourer/ S&O	Permanent	02/02/1988	31/05/2023
09	80137	Ms. K. G. Siriyalatha Lab Attendant/ IPHT	Permanent	01/09/1985	12/06/2023
10	197	Mr. D. A. Athukorala Principal Scientist / RRC Panapitiya	Permanent	15/09/1992	30/06/2023
11	209	Mr. B. L. J. Perera Driver/ S&O	Permanent	06/11/1992	15/07/2023
12	134	Mr. R. Madawala Account Clerk /	Permanent	04/04/1983	20/08/2023
13	80232	Mr. S. P. Jayasooriya Research Assistant RRC Kapparatota	Permanent	04/08/1993	02/10/2023
13	235	Ms. A. S. L. E. Corea Scientist/ IARAD	Permanent	03/05/1993	26/10/2023
14	671	Mr. T. M. S. Nandasiri Driver/ S&O S&O	Permanent	28/05/2012	24/11/2023
15	80272	Mr. Kapila Jayasena/ IPHT	Permanent	01/10/1991	31/12/2023

Foreign trainings/seminars/workshops.

No	Name and Designation	Country	Purpose	Period
01	Dr. S.S.K. Haputhantri Principal Scientist (Marine Biology)	Thailand	FAO Regional workshop for a network of practitioners on fishery stock assessment and FAO SOFIA Analysis meeting for southeast Asia Area 57 (Transparent Assessment Framework)	22.01.2023 – 28.01.2023
02	Dr. A.A.S.H. Athukorala Senior Scientist	Belgium	Blue Economy Seminar in Belgium	21.01.2023 – 05.02.2023
03	Professor M.J.S. Wijeyaratne Chairman/ NARA	India	International Symposium on Innovations in Fishing Technologies for a Sustainable and Resilient Fisheries	12.02.2023 – 18.02.2023

04	Ms. G.W.N. Pavithra Assistant Director (Finance)	India	ITEC : Training Slots under the Indian Technical & Economics Cooperation (ITEC) Scholarship Scheme of the Ministry of External Affairs, Government of India for the year 2022 – 2023	05.03.2023 – 13.03.2023
05	Dr. T.D.K.D. Tennakoon Director General (Actg.) Mr. H.A.S.D. Perera Scientist	Indonesia	The Fourteen Intergovernmental Session of the IOC Sub – Commission for the Western Pacific (WESTPAC – XIV)	03.04.2023 – 08.04.2023
06	Mr. S.S. Gunasekara Scientist	Norway	Marine research survey in Norway	23.04.2023 – 08.05.2023
07	Mr. S.R.C. Ranaweera Chief Hydrographer / Head of the Division (National Hydrographic Office)	Monaco	3rd Session Of The International Hydrographic Organization Assembly (A – 3)	03.05.2023 – 07.05.2023
08	Mr. K.R. Dalpathadu Scientist	Seychelles	13th IOTC Working Party on Neritic Tunas (WPNT13)	02.07.2023 – 09.07.2023
09	Dr. K. Arulananthan Principal Scientist (Oceanography)/ Head of the Division (National Institute of Marine Science)	United Kingdom	Establishment of a New TSS – MEPC Session 80	02.07.2023 – 09.07.2023
10	Mr. R.M.R.M. Jayathilaka Scientist	China	Training Course on Subsurface Mooring Design, Recovery & Deployment	15.07.2023 – 23.07.2023
11	Ms. Y.M.R.N. Kumari Deputy Hydrgrapher Mr. R.M.D.I. Rathnayake Hydrographic Surveyor	Japan	GEBCO Alumni Conference 2023	30.07.2023 – 04.08.2023
12	Ms. D.W.L.U.De Silva Scientist	Norway	For PhD Studies	06.08.2023 – 31.10.2023
13	Dr. R.P.P.K. Jayasinghe Principal Scientist/Head of the Division (Marine Biological Resource Division) / Head (Kalpitiya Regional Research Centre)	France	21st Working Party on Billfish and 19th Working Party on Ecosystems and Bycatch	05.09.2023 – 11.09.2023
14	Dr. K. Arulananthan Principal Scientist (Oceanography)/ Head of the	China	Invitation to China Forum on International	23.08.2023 – 26.08.2023

	Division (National Institute of Marine Science)		Ecological Competitiveness 2023	
15	Mr. S.S. Gunasekara Scientist	India	Invitation to attend the ITCOocean Training Course & HackWeek on : Machine Learning based Species Distribution Modelling	10.09.2023-23.09.2023
16	Mr. H.A.S.D. Perera Scientist	China	Invitation to Attend the 1st China – ASEAN Countries Forum on Blue Economy	17.09.2023 – 20.09.2023
17	Dr. (Ms) N.D. Hettige Senior Scientist Ms. K.H.K. Bandaranayake Senior Scientist	U.S.A.	INVITATION FOR OIL SPILL RESPONSE WORKSHOP	17.09.2023 – 25.09.2023
18	Mr. J.S. Jayanatha Senior Scientist	China	International Workshop on Blue Carbon Actions in the Western Pacific	18.10.2023 – 25.10.2023
19	Mr. S. Thanusanth Scientist	India	FAO Workshop on Mainstreaming Climate Change in to International Fisheries Governance and Strengthening of Fisheries Management Measures in the Indo – Pacific Region	16.10.2023 – 19.10.2023
20	Professor M.J.S. Wijeyaratne Chairman/ NARA Mr. K.W. Indika Scientist	China	Third Belt and Road Forum for International Co-operation	16.10.2023 – 21.10.2023
21	W.N.C. Priyadarshani Principal Scientist (Fishing Technology)/ Head of the Division (Fishing Technology Division) Mr. R.M.R.M. Jayathilaka Scientist	China	Post Cruise data and sample analysis of JAMES cruise 2020	21.10.2023 – 18.11.2023
22	Ms. K.H.K. Bandaranayake Senior Scientist	Spain	14th Working party on Methods Meeting (WPM 14)	25.10.2023 – 31.10.2023

23	Dr. S.S.K. Haputhantri Principal Scientist (Marine Biology)	Spain	25th Working party on Tropical Tunas Meeting (WPTT25)	29.10.2023 – 06.11.2023
24	Dr. A.A.S.H. Athukorala Senior Scientist	Australia	AFRAN Forum on Combatting IUU Fishing in the Indian Ocean Region	24.10.2023 – 28.10.2023
25	Dr. R.P.P.K. Jayasinghe Principal Scientist/Head of the Division (Marine Biological Resource Division) / Head (Kalpitiya Regional Research Centre)	Mozambique	EAF Nansen programme Mini – Symposium and Forum	28.10.2023 – 04.11.2023
26	Mr. W.A.K. Prabath Scientist Mr. K.P.G.L. Sandaruwan Scientist	China	Seminar on Marine Spatial Planning and Blue Economic Development for Developing Countries	30.10.2023 – 15.11.2023
27	Ms. S.R.C.N.K. Narangoada Scientist Ms. J.K.P.C. Jayawardena Scientist	China	WESTPAC – ECNU International Workshop on Stem the tide of Asia's riverine plastic emission into the ocean	18.11.2023 - 24.11.2023
28	Dr. R.P.P.K. Jayasinghe Principal Scientist/Head of the Division (Marine Biological Resource Division) / Head (Kalpitiya Regional Research Centre)	India	26th Session of the IOTC Scientific Committee	03.12.2023 - 09.12.2023
29	Mr. S. Thanusanth Scientist	Thailand	Regional workshop on fisheries - related other effective area – based conservation measures in the Bay of Bengal and Southeast Asia	05.12.2023 - 09.12.2023
30	Dr. T.D.K.D. Tennakoon Director General W.N.C. Priyadarshani Principal Scientist (Fishing Technology)/ Head of the Division (Fishing Technology Division)	චීනය	China- Indian Ocean Region Forum on Development Co-operation	06.12.2023 - 11.12.2023

Courses and Programs - Online

No	Name and Designation	Country Visited/Organizing body	Matter	Period
01	Dr. K.H.M.L. Amaralala Principal Scientist (Socio Economics & Marketing) Dr. M. Gammanpila Principal Scientist Ms. W.K. Suwandhahennadi Scientist Mr. J.S. Jayanatha Senior Scientist Ms. S.R.C.N.K. Narangoda Scientist Ms. K.M.B.P.P. Kalaotuwawa Scientist Ms. S. Thirukeshwaran Scientist	The Secretariat of the Indian Ocean Rim Association (IORA)	Webinar on "Promoting the Manual of Blue carbon standard methods to be used for standardized baseline data sets (Online Program)	23.01.2023
02	Dr. S.S.K. Haputhantri Principal Scientist (Marine Biology)	Bay of Bengal Programme Inter - Governmental Organisation (BOBP)	FAO Regional Workshop for a Network of Practitioners Fishery Stock Assessment (BOB – SAN)'	07. 06.2023
03	Ms. A.M.A.N. Adikari/Scientist Dr. G.S.C. Perera/Scientist Ms. S.H.U. Chathurani Scientist/ Officer Incharge (Kadolkele Regional Research Centre) Mr. S.P. Jayasuriya Research Assistant	Thailand International Cooperation Agency (TICA)	Annual International Training Course (AITC) Programme (online)	20.03.2023 – 31.03.2023
04	Dr. A.A.S.H. Athukorala Senior Scientist Ms. H.M.U. Ayesha Scientist Mr. S. Thanusanth Scientist	Secretariat of the Convention on Biological Diversity	Sustainable Ocean Initiative Workshop (Virtual)	24.04.2023 – 28.04.2023
05	Dr. A.D.W.R. Rajapaksha Senior Scientist	Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asia and Pacific Region	INFOFISH Workshop on Technology and Innovation to Enhance Productivity and Reduce Costs in Shrimp Farming	10.05.2023

06	Ms. S. Thirukeshwaran Scientist	The Secretariat of the Indian Ocean Rim Association (IORA)	International Seabed Authority's (ISA) Deep Dive e – learning Programme for candidates from the ISA developing Member States	23.10.2023to 15.12.2023
07	Dr. S.S.K. Haputhantri Principal Scientist (Marine Biology) Ms. G.K.A.W.Fernando Scientist W.N.C. Priyadarshani Principal Scientist (Fishing Technology)/ Head of the Division (Fishing Technology Division) Dr. K.H.M.L. Amaralala Principal Scientist (Socio Economics & Marketing) Mr. K.P.G.L. Sandaruwan Scientist Mr. H.A.S.D. Perera Scientist Ms. N.G.L.Nadee Uthpala Scientist	The Secretariat of the Indian Ocean Rim Association (IORA)	Third Working Group on Blue Economy (Virtual)	21.08.2023
08	Mr. D.S. Ariyarathna Senior Scientist Dr. P.S. Jayasinghe Senior Scientist Mr. J.S. Jayanatha Senior Scientist Dr. K.K.T.Nuwansi Senior Scientist Ms. D.M.S. Sugeeshwari Scientist Mr. M.R. Perera Research Assistant Mr. B.K.G. Pahan Pabasara Research Assistant	Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asia and Pacific Region	Virtual Training Workshop on Seaweed Processing for Value Added Products	24.08.2023

09	Ms. K.H.K. Lakmali Piyasiri Scientist	India	Online International Training Program on "Agri – business through cooperative Business Model at Vaikunth Mehta National Institute of Co – operative Management (VAMNICOM)	03.10.2023 – 06.10. 2023
10	Dr. G.J. Ganegama arachchi Deputy Director General / R &D (Actg.) Ms. S.H.U. Chathurani Scientist/ Officer Incharge (Kadolkele Regional Research Centre) Ms. M.D.S.R. Maddumage Scientist	Republic of Korea	The 4th Republic of Korea (ROK) – Indian Ocean rim Association (IORA) partnership Seminar,	14.12.2023

Promotions

No	Name	Previously held Position	Current Position	Date of Promotion
1	Mr.D.L.P.Hewage National Hydrographic Division	Hydrographic Surveyor AR-1- Grade II	Hydrographic Surveyor AR-1- Grade I	09.02.2020 (The evaluation test was conducted on 03.08.2023)
2	Mr.Chamal Abeywickrama National Hydrographic Division	Survey Recorder MA 1-2 - Grade II	Survey Recorder MA 1-2 - Grade I	02.01.2023
3	Mr.W.A.C.Perera Finance Division / Purehasing unit	Management Assistan MA 1-2 - Grade III	Management Assistant MA 1-2 - Grade II	20.08.2022 (The evaluation test was conducted on 13.02.2023)
4	Mr.L.S.C.Siriwardena National Hydrographic Office	Hydrographic Surveyor AR - 1 - Grade II	Hydrographic Surveyor AR - 1 - Grade I	06.07.2022 (The evaluation test was conducted on 08.08.2023)
5	Ms. G.W.N.Pavithra Finance Division	Assistant Director MM 1-2 - Grade II	Assistant Director MM 1-2 - Grade I	15.07.2023
6	Ms.V.K.G.Jayasena Administrative Division	Administrative Officer (Administrative) JM - 1-2 - Grade II	Administrative Officer (Administrative) JM - 1-2 - Grade I	08.07.2023
7	Ms.P.N.Dharmarathne Director General Office	Personal Assistant to the Director General JM - 1-2 - Grade II	Personal Assistant to the Director General JM - 1-2 - Grade I	15.07.2023

8	Mr.A.K.Wickramaratme	Helper PL - 1- Grade II	Helper PL - 1- Grade I	30.06.2017 (The evaluation test was conducted on 08.08.2023)

Unfilled vacancies - 2023

No	Designation	Salary Code	Vacant
1	Deputy Director General (R & D)	HM 2-1	1
2	Director (Monitoring & Evaluation)	HM 1-3	1
3	Principal Scientist	HM 1-3	1
4	Senior Scientist	AR-2	5
5	Senior Hydrographic Surveyor	AR-2	2
6	Scientist	AR-1	38
7	Sociologist	AR-1	1
8	Economist	AR-1	1
9	Hydrographic Surveyor	AR-1	3
10	Senior Land Surveyor	MM 1-2	1
11	Senior System Analyst /Programmer	MM 1-2	1
12	Data Analyst	MM 1-2	1
13	Asst. Director (Service & Operation)	MM 1-2	1
14	Asst. Director (Admin)	MM 1-2	1
15	Asst. Director (Information Technology)	MM 1-2	1
16	Senior Librarian	MM 1-2	1
17	Senior Extension Officer	MM 1-2	1
18	Assistant Director (Vessel Operation & Maintenance)	MM 1-2	1
19	Personal Assistant to Chairman	JM 1 -2	1
20	Assistant Information Technology Officer	JM1-2	1
21	Librarian	JM1-2	1
22	Technical Officer (Mechanical)	JM1-2	1
23	Cartographer Data Analyst (Nautical)	JM1-2	1
24	Cartographer Data Analyst (GIS)	JM1-2	1
25	Cartographer Data Analyst (ENC)	JM1-2	1
26	System Analyst /Programmer	JM1-2	1
27	Skipper	JM1-2	1

28	Land Surveyor	JM1-2	1
29	Cartographer	JM1-2	1
30	Diving Officer	JM1-2	1
31	Translator	MA 4	1
32	Development Officer (Project)	MA 3	12
33	Fabricator	MA 2-2	1
34	Technical Assistant (Electronic)	MA 2-2	1
35	Assistant Network Administrator	MA 2-2	1
36	Field Research Assistant	MA 2-2	5
37	Research Assistant	MA 2-2	38
38	Cartographic Droughman	MA 2-2	2
39	Coxwain	MA 2-2	2
40	Head Driver/Marine	MA 2-2	1
41	Engine - room Artificer	MA 2-2	1
42	Multi Media Designer	MA 2-2	1
43	Diver	MA 2-2	3
44	Diver Assistant	MA 2-2	1
45	Technical Assistant (Civil)	MA 2-2	1
46	Technical Assistant (Electrical)	MA 2-2	1
47	Management Asst. (Library)	MA 2-2	1
48	Ocean Observation Technician	MA 2-2	1
49	Assistant Skipper	MA 2-2	1
50	Geological Information System Technician	MA 2-2	1
51	Radio Officer	MA 2-2	1
52	Management Assistant	MA1-2	9
53	Hydrographic Assistant	MA1-2	1
54	Boatswain	MA1-2	1
55	Book-Binder	PL-3	1
56	Plumber	PL-3	1
57	Electrician	PL-3	1
58	Mason	PL-3	2
59	Motor Mechanic	PL-3	2
60	Driver	PL-3	14

61	Boat Operator	PL-3	1
62	Deck Hand	PL-3	1
63	Marine Mechanic	PL-3.	1
64	Video Editor	PL-3	1
65	Lab Attendant	PL-2	4
66	Caretaker/Cook	PL-2	3
67	Helper	PL-1	23
68	Survey Helper	PL-1	2

Court Cases

I. Cases Filed Against the Agency in the Labour Tribunal

No	The Case Number	The Applicant	The Respondent	Labour Tribunal	The Last Date the Case was Heard	Present Status
01	Case No. LT/M/26/48/2019	Warnakulasuriya Gordiyage Jayaratne	National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	Matara Labour Tribunal	28.04.2023	Issued the judgement

II. Cases Filed Against the Agency in the Sri Lanka - Human Rights Commission

No	The Case Number	The Complainant	The Respondent	The Last Date the Case was Called	Present Status
01	HRC/MT/127/17/5	Mr.J.B.Alahahapperuma No-08, Mudalindha Piriwena Road, Heennatiya, Matara.	Chairman, National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	18/04/2017	The inquiry has completed. Recommendations have not yet been received from Sri Lanka Human Rights Commission.
02	HRC/3222/16	Mr.A.A.Suresh Mr.R.C.C.Perera	Director General, National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	27/04/2017	The recommendation of the Sri Lanka Human Rights Commission has not been received
03	HRC/3573/17	Mr.D.D.P.L.Dahanayake No- 120, Palliya Road, Brandiyamulla, Gampaha	Chairman, National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	02/10/2020	The Cases has postponed due to the COVID- 19 pandemic until further Notice.

			Director General, National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15		
04	HRC/3432/19	Ms. P.S Jayasinghe 26/2 B, Henawatta, Meegoda	Chairman National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	21.09.2019	The Cases has postponed due to the COVID- 19 pandemic until further Notice.
05	HRC/3562/19	Mr. P.A.D. Ajith Kumara 104B, Hapugahagama Road, Barawavila, Diulapitiya.	Chairman National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	03.02.2020	The Cases has postponed due to the COVID- 19 pandemic until further Notice.
06	HRC/3561/19	Mr. N.B.P Punyadewa 447/1 B, Walgama, Kottawa Road, Aturugiriya	Chairman National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	28.02.2019	The Cases has postponed due to the COVID- 19 pandemic until further Notice.
07	HRC/3713/19	Ms. A.A.S.H Athukorala, No.410/F, Jayamawatha, PolpitiMookalana, Kadana.	Chairman National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	28.02.2019	The Cases has postponed due to the COVID- 19 pandemic until further Notice.
08	HRC/910/2021	Ms. W.A. T Pradeepika No 672, IDH Road, Nagoda, Kaluthara	1.Chairman 2.Director General 3.Director Administration & Human Resources National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	The case is not called to hear yet.	The Sri Lanka Human Right Commission has informed the institute that case has been filed however the notice has not been received for the inquiry by HRC.

III. Cases filed by the National Aquatic Resources Research and Development Agency (NARA) in the District Court Colombo

No	The Case Number	The Plaintiff	The Dependent	District Court	The Last Date the Case was Called	Present Status
01	Case No-DMR/3930/2010	National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	Dr. N.H Dassanayeka	Colombo District Court	15.03.2019	The first defendant of the case has entered into a settlement with NARA to pay bond value of Rs. 5.932.721/= within five years. As per the above settlement the first defended has been paying the instalments.

IV. Cases has filed against the National Aquatic Resources Research and Development Agency (NARA) in the Supreme Court, Colombo

No	Case Number	The Plaintiff	The Dependent	Supreme Court/ Court of Appeal	The Last Date the Case was Called	Present Status
01	CA (Writ) Application: No. 383	Withange Don Hemantha Ranjith Sisra Kumara, Wijethunga Appuhamige Herman Kumara, Patharagoda Centre of Environmental Justices (Guarantee) Limited	Dr. H. M. P. Kithsiri Director General of National Aquatic Resources Research and Development Agency. 07th Respondent	Court of Appeal	26th September 2022	For argument
02	SCLA Application No. 25/2023 (CA (Writ) Application No.463 / 2020)	Environmental Foundation (Guarantee) Limited	Prof. A. Navaratnarajah Chairman National Aquatic Resources Research and Development Agency. 05th Respondent	Supreme Court	25th May 2023	To be mentioned
03	S.C. (F.R) Application No. 277/2021	Most Venerable the Archbishop of Colombo, Most Venerable Cardinal Malcolm Ranjith	National Aquatic Resources Research and Development Agency. 19th Respondent	Supreme Court	24th May 2023	For Argument
04	SC (F.R) Application No.159 A / 2021	Environmental Justice (Guarantee) Limited, Withanage Don Hemantha Ranjith Sisira Kumara, Anuradha Nirosha Ponnamperuma, Morawakkoralage Don	National Aquatic Resources Research and Development Agency. 04th Respondent	Supreme Court	12th May 2023	To be mentioned

		Mahesh Piyawardana				
05	SCFR-176/2021	Fr.Benedict Sarath Iddamalgoda , Mr. Weeramulage Gamini Fernando, and Mr. Warnakulasuririya Kristofer Sarth Fernando	National Aquatic Resources Research and Development Agency 7th Respondent	Supreme Court	24th May 2023	For Argument
06	CA/LTA/13/2023 (Action in Personam No. 12/2022)	The West of England Ship Owners Mutual Insurance Association (Luxembourg)	National Aquatic Resources Research and Development Agency Plaintiff Respondent	Court of Appeal	12th September 2023	For Support
07	CA (Writ) Application 271/2023	Podjana Progressive Employee Union and other	National Aquatic Resources Research and Development Agency 01st Respondent & others	Court of Appeal	27th January 2024	For support
08	SCFR Application No. 207/2023	W.N.F. Livera, President, Kalpitiya Ekdina, Bahudina, Torling Yathra Himiyange Samupakara Samithiya & other	Prof. A. Navarathnarajah, Chairman, National Aquatic Resources Research and Development Agency 5th Respondent & others	Supreme Court	04th September 2023	To be mentioned

V. Cases has filed against the National Aquatic Resources Research and Development Agency (NARA) in the High Court of Matara

No	The Case Number	The Applicant Appellant	The Respondent Respondent	High Court	The Last Date the Case was Called	Present Status
01	HC 84/2023 (LT/M/26/48/2019)	Warnakulasuriya Gordiyage Jayaratne	National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	High Court of Matara	27.11.2023	Mentioned

Welfare Activities

- Sinhala and Hindu New year festival and Christmas day celebrated.
- In addition to that transport facilities provide to the NARA staff to make easy.

5. RESEARCH DIVISIONS

5.1 ENVIRONMENTAL STUDIES DIVISION

Head of the Division: Dr. K.A.W. S. Weerasekara

Overview of the Division

Environmental Studies Division (ESD) strives to serve as the cornerstone of the aquatic environment-related research and development sector of the NARA with the vision to simulate science-based solutions through interdisciplinary research that ensures the sustainability and pristineness of the inland, coastal, and marine environment of Sri Lanka. The competent research teams of ESD in coordination with relevant government agencies, private sector institutions, international research organizations, academic institutions, and the industrial sector on science, innovation, technology, education, law, and policy to solve the most challenging environmental issues of Sri Lanka, with marine litter, excess nutrients, untreated wastewater, and maritime disasters continuing to be the focus areas in 2023. Researchers of ESD are frequently tapped for their knowledge and expertise in multiple aspects of the aquatic environment such as inland, coastal, and marine water quality, eco-toxicology, limnology, water pollution, aquatic ecology, modeling of ecosystem dynamics and policy, chemical and physical dynamics in aquatic ecosystems, hydrology, and environmental policy and legislations.

Moreover, the division provides a comprehensive range of environmental monitoring and consultancy services to help industries, developers, businesses, and government authorities fulfill their legal obligations in terms of Environmental Impact Assessments (EIA), Initial Environmental Examination (IEE), and feasibility studies and to comply with environmental regulations. The expert research team of ESD provides island-wide research coverage and services including site investigation, sampling and analysis, stakeholder discussions, monitoring and evaluation, and consultancy. In addition, water and wastewater quality testing services are provided. ESD has extraordinary capabilities to measure and monitor water quality, and therefore it is recognized as one of the leading research arms of the country for water and wastewater quality testing. In addition, ESD plays an important role in a number of national advisory councils, national technical committees, environmental monitoring programs, and expert committees on environmental emergencies through the provision of technical expertise, science-based knowledge sharing, consultancy provision, and being part of the policy and legislator framework.

The Environmental Studies Division comprises a team of 18 members, which includes a Principal Scientist, two Senior Scientists, and eight Scientists who actively engage in research activities and contribute to other significant research and development projects. However, towards the end of the year, the division experienced the departure of one Senior Scientist, one Scientist, and two Research Assistants, who resigned and migrated to other opportunities.

In the financial year 2023, ESD has completed two significant research projects, two consultancy projects, and two externally funded projects, in addition to public awareness campaigns focused on environmental management, development, and the preservation of fish and aquatic resources.

Summary of the Project Details

Table 1: Summary of the project details for 2023

Project		Budget	Responsible officers	Period	
No	Title	Rs.Mn		From	To
5.1	Development of Coastal Water Quality Index (WQI) for Southern Beaches: A road to the Blue Flag Certification	2.6	Dr. K.A.W.S Weerasekara Mr. N.K.R.N Jayawardane Ms. S. Thirukeswaran Ms. K.M.B.P.P Kalaotuwawe Mr. S.K Pemaratne Dr. A.A.D Amaratunga Dr. N.D. Hettige Ms. M.D.S.R Maddumage Ms. J.K.P.C Jayawardhane Ms. S.R.C.N.K Narangoda	Jan 2023	Dec 2023
5.2	Investigation of causes for environmental emergencies (e.g. mass fish kills, oil and chemical spills, algal blooms)	2.0	Dr. K.A.W.S Weerasekara Dr. A.A.D Amaratunga Dr. N.D. Hettige Ms. M.D.S.R Maddumage Ms. J.K.P.C Jayawardhane Ms. S.R.C.N.K Narangoda Ms. K.M.B.P.P Kalaotuwawe Mr. N.K.R.N Jayawardane Ms.S. Thirukeswaran Mr. S.K Pemaratne	Jan 2023	Dec 2023

PROJECT NO : 5.1

DEVELOPMENT OF COASTAL WATER QUALITY INDEX FOR SOUTHERN BEACHES: A ROAD TO THE BLUE FLAG CERTIFICATION.

The coast is a distinct environment in which land, water, and atmosphere interact and interplay, influencing a narrow strip of area. Sri Lanka's coastline serves as a focal point for the social, environmental, and economic growth of the country for centuries. Currently, a majority of Sri Lanka’s population lives within the coastal zone and primarily relies on the coastal zone’s ecological resources, and recreational value for their livelihood in terms of fisheries and Ecotourism. There is a considerable risk of coastal zones becoming polluted due to the increasing use of resources. Degradation of coastal resources severely affects the coastal areas and end up with coastal pollution. Therefore, this study focused on the water quality in coastal waters and its impacts on the recreational values of beaches. This was also aimed at identifying the initial stage for the attainment of the Blue Flag Certification.

Therefore, the development of a water quality index is very important to identify the current status of water quality in Unawatuna, Polhena, and Mirissa beaches and also to identify the pollution sources (if any) to prevent the beaches from the pollution and serve them as the focal points for the social, cultural, environmental and economic development of the country for sustainable utilization of coastal water resources. This water quality index development will lead to the attainment of globally recognized “Blue Flag Certification” for the stated beaches which will indirectly increase the foreign exchange to Sri Lanka. Therefore, the objectives of the project were;

- To rank the current status of water quality of the southern beaches (Unawatuna, Mirissa, and Polhena) using the Water Quality Index (WQI) to facilitate economic development of the country through tourism attraction.
- To study the feasibility of obtaining “Blue Flag Certification” for the selected beaches.
- To identify the water pollution sources in selected beach areas.

- To facilitate both local and international tourists to safe recreational facilities.
- To provide recommendations for sustainable utilization of selected beaches to serve the social, cultural, environmental, and economic development of the country.

To achieve the objectives, the water quality of the selected beaches was measured to identify the current status. Although it was planned to collect samples from the study location every month between January 2023 and December 2023, due to the unavailability of funds and transportation facility, sample collection was not carried out in January, February, and April 2023. Later, water samples were collected from Unawatuna, Mirissa, and Polhenabeaches representing two monsoon seasons (March to December) in 2023 following the National Field Manual for the collection of water quality data (USGS). The pH, DO, EC, Salinity, TDS, TSS, Nutrients, BOD, COD, and Chlorophyll-a, were measured by the Environmental Studies Division, and the microbiological parameters (E-coli levels and Intestinal Enterococci levels) were analyzed by the Institute of Post Harvest Technology. Table 2 shows the mean values of in-situ data and Table 3 shows the laboratory analysis data.

Photographs taken during the field surveys

Results

Table 2: In-situ data of the study sites

	pH	EC (mS/cm)	Salinity (ppt)	TDS (ppm)	DO(mg/L)	WT (^{0}C)	Turbidity (NTU)
Polhena	8.1 ± 0.3	46.5 ±6.2	38.3 ± 5.4	36.0 ±6.5	7.7 ± 0.2	29.5 ±0.5	7.7 ± 4.6
Mirissa	8.2 ± 0.2	48.1 ±4.3	39.7 ± 6.0	37.5 ±5.5	7.4 ± 1.4	29.3 ±1.5	4.2 ± 2.4
Unawatuna	8.2 ± 0.3	45.4 ±5.4	36.8 ± 4.6	34.4 ±4.3	7.7 ± 0.6	29.6 ±1.3	7.1 ± 4.6

Table 3: Results of the Laboratory Analysis

Location	Phosphates (mg/L)	Nitrates (mg/L)	Nitrites (mg/L)	Ammonia (mg/L)	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	Chl-a (mg/L)
Polhena	0.0283± 0.0109	0.0182 ±0.0104	0.0219 ±0.0223	0.0412± 0.0037	3.6±2.1	81± 60	33.1± 6.8	2.3083 ±0.6371
Mirissa	0.0252± 0.0131	0.0154 ±0.0080	0.0059 ±0.0023	0.0251± 0.0038	3.3±2.4	95± 50	26.9± 11.1	2.0333 ±0.6644
Unawatuna	0.0304± 0.0176	0.0137 ±0.0062	0.0212 ±0.0231	0.0280± 0.0012	3.7±1.9	62± 15	30.3± 12.3	1.9678 ±0.9225

However, Sri Lanka does not have any criteria or guidelines for marine water quality standards, the data cannot be compared and concluded on the water quality. According to the ASEAN guidelines, 100 fecal coliform 100 mL-1, and 35 enterococci 100 mL-1 would be the maximum count coastal water should have. Nevertheless, the majority of the samples have exceeded the threshold limit indicating the mixing of wastewater with the coastal water. Further, it was planned to analyze the concentrations of Hg, Fe, B, Mo, Al, Cr, Cu, Zn, Pb, Se, Mn, As, Cd, Sb, U, Cyanide, and Total Phenol in collected waters. The quotations were called from three institutions including Industrial Technology Institute, SGS Lanka (Pvt.) Ltd; and Joint Research Center for Water Technology since NARA does not have facilities for the mentioned analysis. After a long official procedure (TEC and Tender Board), the lowest quoted Joint Research Center for Water Technology has been selected to analyze the above-mentioned parameters. Even though the JRDC has put forward a quotation they have neglected our award after all procedures were in place.

Two abstracts have been published in conference proceedings based on this study; National Aquatic Resources Research and Development Agency Scientific Session 2023 and 28th International Forestry and Environment Symposium (USJ) highlighting the impacts and the outcomes of the project. Further, two full papers incorporating heavy metal analysis done in 2021, water quality analysis done in 2023 and policy aspects of the coastal based tourism are currently in progress. Findings suggest, that Blue Flag Certification (BFC) draws tourists who care about the environment, lowers operating costs, and guarantees the long-term health of the marine ecosystem, the value of BFC is a potent tactic for striking an equilibrium between preserving the environment and generating revenue from tourism, it has also been identified that Unawatuna beach has achieve majority of the criteria for BFC compared to Mirissa and Polhena. However, the microbial water quality of the Unawatuna was found to be unsafe for bathing, and enhanced cleanliness and aesthetic values of beaches were observed where the environmental management criteria were prioritized especially in Mirissa.

Furthermore, the research team involved in this project has taken part in four technical meetings with key stakeholders, such as the Sri Lanka Tourism Development Authority (SLTDA),Marine Environment Protection Authority (MEPA), Foundation for Environmental Education (FEE- Blue Flag Officials), Sri Lanka Coast Guard, Coast Conservation and Coastal Resource Management Department (CC & CRMD), Department of Wildlife Conservation (DWC), Ministry of Foreign Affairs and Local Council;

- Shared the major study findings and advisories on improving sustainable coastal-based tourism potential.
- Provided information regarding safe recreational facilities and details on pollution sources in Unawatuna, Mirissa, and Polhena Beaches.
- Discusses the potential to incorporate environmentally friendly approaches in mitigating pollution and improving the bathing water environment.
- Provided valuable insights and holistic approach for policymakers, local councils, and tourism development stakeholders to implement the necessary strategies to fulfill all the BFC's criteria.
- Recommended a steady and efficient incorporation of all the criteria by relevant authorities to promote sustainable tourism.

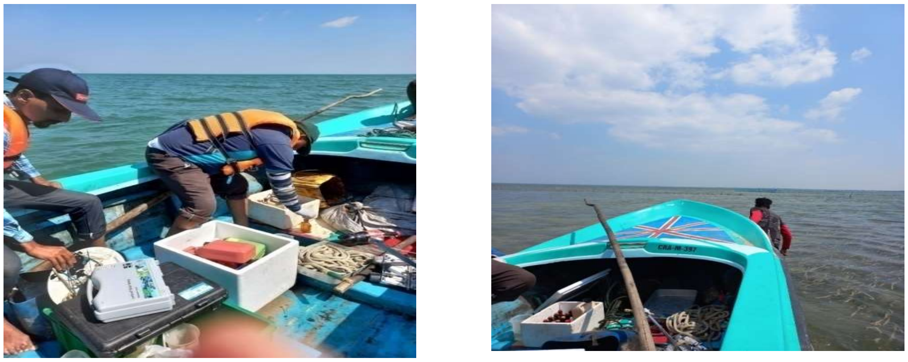
PROJECT 5.2

TITLE:INVESTIGATION OF CAUSES FOR EMERGENCY INCIDENTS SUCH AS OIL SPILLS, ALGAL BLOOMS AND FISH KILLS (EMERGENCY STUDY PROJECT).

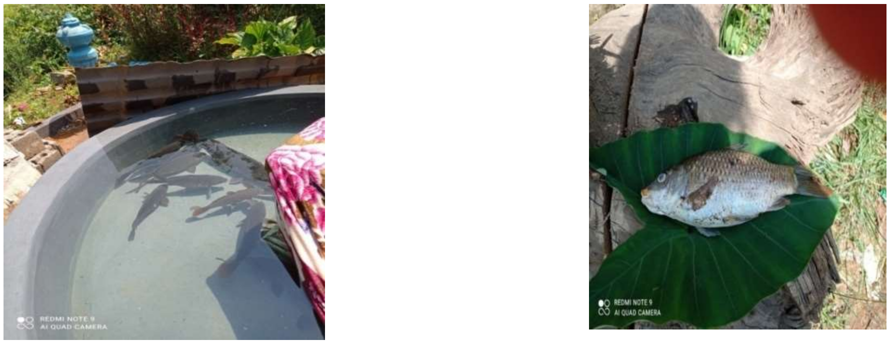
An environmental emergency can be defined as a sudden-onset disaster or accident resulting from natural, technological or human-induced factors, or a combination of these, that causes or threatens to cause severe environmental damage as well as loss of human lives and property. The aquatic environment is highly sensitive and susceptible to catastrophic incidents, and the majority of them could cause emergency situations such as mass fish kills, oil spills, and pollution of water bodies with highly toxic chemicals, sudden algal blooms, and water quality deterioration. Since these incidents result in severe impacts on environmental health and human well-being, they need to be addressed immediately with relevant recommendations. As a leading national research agency, NARA is responsible for assessing these incidents from a scientific perspective to determine the magnitude of the problem, current and potential impacts, and mitigation measures. Many government organizations, including MEPA, CCD & CRM, CEA, the Environmental Division of SL Police, local authorities, the MOH Department, and many other institutions, coordinate with NARA to provide information regarding emergency environmental incidents/situations requesting scientific investigations. In addition, NARA takes immediate action to respond to the requests from the general public regarding environmental emergencies and take the necessary actions to manage them.

Therefore, the objective of this project was to assess and investigate the causes for emergency situations in terms of water pollution, oil spills, ship fire, fish kill incidents and algal blooms etc. and finally provide recommendations to overcome the situation.

This project was coordinated by the Environmental Studies Division and all the technical divisions of NARA (ESD, FTD, MBRD, SED, NHO, and IARAD) are contributing to the emergency investigations depending on the expertise required to handle the situation. The main tasks involved in conducting an emergency project are field investigations (field sampling, in-situ measurements, making important observations, discussions with relevant people), required sample collection (Water, Sediment, Plankton, Fish), laboratory analysis of samples, technical report compilation and data analysis, technical meetings, and coordination with other government institutions. Some of the photographs taken during field investigations of relevant emergency cases in 2023;



Sea Cucumber farm Palavi Study



Kotmale Fish Kill Incident

Jelly fish Stranding Incident (Collected samples of Porpitaporpita Species)

Sea Turtle Stranding- Galle Face

MundalLagoon Fish Kill Incident and Vidathalthivu case study

Total of sixteen (16) emergency case studies were carried out in 2023, Reports and recommendations on mitigation of pollution and preventive measures for similar incident in future were delivered depending on the request. We were able to ensure that aquatic environments are kept clean and healthy by providing recommendations to the relevant stakeholders. In return, we were also able to increase our understanding on environment friendly sustainable exploitation of aquatic resources.

Summary of the emergency case studies conducted were tabled below;

Table 4: Emergency Incidents investigated in the year, 2023

No	Date of Investigation	Incident	Causes of the Emergency Situation	Output
1	February - March 2023	Water quality and benthos Study for Sea cucumber farms in Palavi, Kilinochchi.	Water quality analysis and benthos study were done in sampling locations of demarcated areas for sea cucumber farms. The quality of water and benthos was found to be suitable for sea cucumber culture.	Field investigation was done and the report was submitted to the Ministry of Fisheries.
2	03 April 2023	Study regarding	A dispute had arisen due to the use of	A stakeholder meeting was

		fishing gear dispute in Chilaw area.	certain fishing gear in the Chilaw area and a team of FTD conducted an investigation and stakeholder meeting at Chilaw.	conducted and agreed to conduct further study.
3	17th April 2023	Contamination of the Trincomalee beach area due to tar ball pollution incident.	Tar ball like substances was floated in the waters around the Trincomalee sea.	Field investigation was done andreport was submitted to the Marine Environmental Protection Authority.
4	18th April 2023	Fish kill incident in KotmaleOya.	Dissolved oxygen in the water samples was found to be significantly low and it was considered the direct reason for the fish kill and waste dumping was found to be the major reason for this incident.	A field investigation was done and the report was submitted to the relevant authority.
5	06th May, 2023	Oil spill in ChilawLagoon.	Water quality analysis was done in sampling locations.	A field investigation was done and the report was submitted to the relevant authority.
6	17thMay 2023	Inspection of accidental boat with fuel.	The IMUL fishing boat departure from Dikovita fisheries harbor was an accident in the coastal area off Ambalangoda-Balapitiya. Fishermen revealed that the front part of the boat with the fuel tank was floated in the Ambalangoda area and expected an oil spill.	Investigations were done after finding the boat off Seenigama and instructed the owner to recover safely.
7	5th June 2023	Meeting on Chilaw Lagoon pollution.	Chilaw Lagoon stakeholders requested the Hon. Minister of Fisheries to restore the lagoon from persistent water pollution and associated fish kill and excessive algal growth, during an inspection visit by the Hon. Minister on May 27, 2023. The Hon. minister was advised to conduct a meeting with all stakeholders related to the Chilaw Lagoon. Through this project, a team of scientists participated in that meeting on 5th June 2023 at the DS office of Chillaw. After the meeting, a field inspection was conducted to observe pollution sources. A preliminary report including the field observations and the results of water quality study was submitted to Hon. Minister of Fisheries.	Participated in the meeting and a report based on secondary data was submitted to the Fisheries Ministry.
8	4th July 2023	Jelly fish Stranding in Mount Lavinia Beach.	Due to the unusual environmental conditions including, current pattern and wind speed, the swarming event of the *Porpitaporpita* Towards the seashore occurred.	After the field investigation, a report was submitted to the Ministry of Fisheries.
9	9th July 2023	Investigation of the Fishkill incident at Depa-Ela, Mulleriyawa.	Water pollution of the canal due to discharge of chemical substances into the canal water.	Investigation report with relevant recommendations was submitted to the Officer Incharge, Police

				Station, Mulleriyawa and Assistant Divisional Secretary, Kolonnawa.
10	22nd August 2023	Sea turtle Stranding in Gall face Beach.	The direct reason for the turtle carcass stranding was not found as it could have happened somewhere else in the ocean. However, it was suggested to be dynamite fishing or deep sea upwelling considering the physical injuries identified from carcasses.	A field investigation was done and the media speech was provided by NARA to the relevant authority.
11	22ndAugust 2023	Investigation of arrested fishing gear in Batticoloa.	An illegal fishing gear had been arrested by fisheries officers of Batticoloa. Hon. Magistrate ordered to provide a specialist report regarding arrested nets. (Case numbers: MS/1296/F/23,B/30/FI/23)	The investigation was done and two reports (Case numbers: MS/1296/F/23, B/30/FI/23) were submitted to the Hon. Magistrate Courts Kalawanchikudi.
12	25thAugust 2023	Fishkill at Nayaru, Vidathalathive	A shrimp farm has discharged wastewater to Nayaru, Vidathalathive.	Field investigation was done and the report was submitted to the Ministry of Fisheries.
13	04th / 05thSeptember 2023	Investigate the unnecessary aquatic weeds observed in the tank, and understand the prevailing conditions that may have contributed to this incident in the area.	The observed species in the reservoir, *Najas marina*, is known to thrive in nutrient-rich water. Fisher folk report that issues began after the construction of the "Yan Oya Dam," suggesting that the diversion of water may have spread seeds of this plant. This assumption is supported by the high density of algal bloom observed in all four sampling locations. It is possible that the altered water flow facilitated the spread of *Najas marina seeds*, leading to its proliferation in the reservoir.	A comprehensive field investigation was conducted in collaboration with IARAD. Verbal instructions were given to the officers (Department of Irrigation of Jayanthiya) and a report has been prepared detailing the findings.
14	16th to 17th October,2023	Pre-feasibility study for the bathymetric survey in the Chalai Lagoon and the canal connecting Chalai Lagoon and the Nandikadal Lagoon on an urgent basis	The Ministry of Fisheries has an urgent requirement to do the study in the Chalai Lagoon.	A field investigation has been completed and, the pre-feasibility report has been submitted to the Ministry of Fisheries.
15	27th October 2023	Mass Fish Kill Incident in Mundal Lagoon.	The direct cause of the incident was a significant drop in dissolved oxygen and the sudden onset of heavy eutrophication.	A field investigation was done and the report was submitted to the Environment Police, Mundal, and District Fisheries Office, Puttalam.
16	25th November 2023	Investigation of arrested fishing gear	An illegal fishing gear had been arrested by fisheries officers of Trincomalee and Muthur. Hon. Magistrate of Muthur and Trincomalee ordered to provide a specialist report	Investigation was done and seven reports were submitted to the Hon. Magistrates of Muthur and Trincomalee courts. (Case

			regarding arrested nets.	Nos: BR/749/23, BR/653/23, BR/654/23, BR/681/23, BR/682/23, BR/1369/01/FS/23, BR/KIN/365/FS/23)

Consultancy Projects Environmental Studies Division – 2023

CONSULTANCY PROJECT NO : 5147 V
STUDY ON PHYSICAL CHEMICAL AND BIOLOGICAL PARAMETERS IN PUTTALAM ESTUARY

Project Proponent : Lakvijaya Power Plant, Ceylon Electricity Board
Budget : LKR 08 Mn
Duration : March 2022 – January 2023
Project Coordinator : Dr.K.A.W.S. Weerasekara
Activity Coordinator : J.K.P.C Jayawardhane

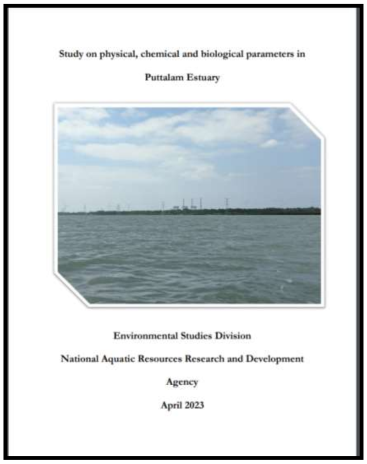
Puttalam is the second largest estuary in the country, located in the North Western Province, of Sri Lanka. It is one of the most productive basin estuaries, being important for its finfish and shellfish fisheries. This study was conducted at the request of the Lakvijaya Power Plant of the Ceylon Electricity Board (CEB) to assess the environmental impacts of the Lakvijaya Power Plant on the Puttalam estuary. Selected physical, chemical, and biological properties of the estuary were analyzed four times a year, according to rainfall seasons as mentioned below;

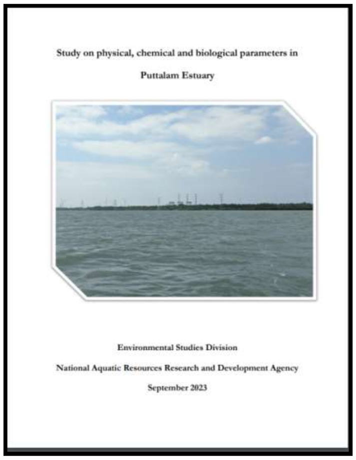
- Middle of the southwest monsoon (May to September)
- Second Inter monsoon (October-November)
- Middle of the Northeast Monsoon (December to February)
- First Inter monsoon (March-April)

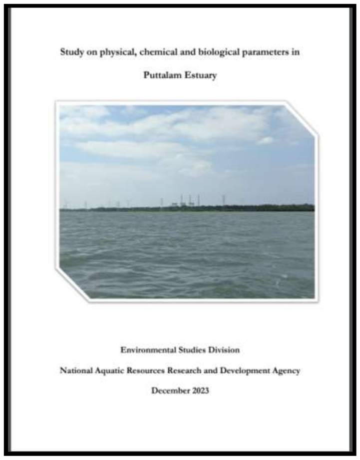
Conducting Research work at the Puttalam Estuary

The study aimed to assess physical, chemical, and biological parameters in the Puttalam estuary with special reference to toxic trace metal levels in fish, sediment, and water in the vicinity of the Lakvijaya Coal Power Plant. The results of the study will provide the level of contamination of fish, sediment, and water in the estuary.

Water, sediment, and fish samples were collected from 10 sampling locations, representing above mentioned rainfall seasons as mentioned in the given TOR by CEB. Analysis of In-situ and laboratory parameters of water, macroinvertebrates, phytoplankton, zooplankton, and analysis of heavy metals in water, sediment, and fish were completed. Three (03) interim reports carrying the results of the first, second, and third sampling events were submitted to CEB during 2023 and writing of the final report is in progress.


Study on physical, chemical and biological parameters in
Puttalam Estuary
Environmental Studies Division
National Aquatic Resources Research and Development
Agency
April 2023


Study on physical, chemical and biological parameters in
Puttalam Estuary
Environmental Studies Division
National Aquatic Resources Research and Development Agency
September 2023


Study on physical, chemical and biological parameters in
Puttalam Estuary
Environmental Studies Division
National Aquatic Resources Research and Development Agency
December 2023

First Interim Report-April, 2023

Second Interim Report-September, 2023

Third Interim Report – December, 2023

CONSULTANCY PROJECT NO: 5149 V

STUDY ON THE ENVIRONMENTAL IMPACTS TO MARINE RESOURCES DUE TO LAKVIJAYA POWER PLANT

Project Proponent : Lakvijaya Power Plant, Ceylon Electricity Board
Budget : LKR Rs. 33,318,380.56
Duration : May 2022 – July 2023
Project Coordinator : Dr.K.A.W.S. Weerasekara
Activity Coordinator : N.K.R.N Jayawardena

The largest thermal power facility in Sri Lanka, known as the Lakvijaya Power Plant or Norochcholai Power Plant, is located in Norochcholai, Puttalam, situated at the southern tip of the Kalpitiya peninsula within the Northwestern province of the country. China Machinery Engineering Corporation (CMEC) was responsible for the construction of the Lakvijaya Power Plant, which was carried out in three stages, with the final phase concluding in 2014. The initial 300 MW phase became operational in 2011, followed by the second and third phases in 2014. In total, this power plant can generate 900 Megawatts of electricity, and the overall project was estimated to cost USD 1.35 billion.

This study was conducted on the request of the Lakvijaya Power Plant of the Ceylon Electricity Board (CEB) with aim to assess the environmental impacts of the Lakvijaya Power Plant on the Marine Resources.Within the scope of the project, various assessments and analyses were conducted, including a marine biological survey, water quality evaluation, toxicological assessment, and numerical modeling of thermal effluent.As part of the marine biological survey, analyses were performed on plankton and benthic organisms. Additionally, fishery-independent and fishery-dependent surveys, along with underwater inspections, were carried out.The toxicological assessment encompassed rigorous testing of water quality, including the evaluation of heavy metal concentrations in water, sediment, and fish specimens.Selected physical, chemical, and biological properties of the estuary were analyzed four times a year, according to rainfall seasons as mentioned below;

- Middle of the southwest monsoon (May to September)
- Second Inter monsoon (October-November)
- Middle of the Northeast Monsoon (December to February)
- First Inter monsoon (March-April)

The main objective of the study was to assess the environmental impacts to marine resources through marine biological survey, water quality and toxicological assessment and temperature modelling.Benthos analysis, plankton analysis, fishery dependent survey, fishery independent survey and underwater survey were carried out under the marine biological survey.

Conducting Field Assessments

Writing of the three (03) interim reports are in progress and will be able to submit during the January, 2024.

External Funded Project Progress 2023, ESD

1. ADB project: Development and implementation of a training program for the National Aquatic Resources Research and Development Agency

The National Aquatic Resources Research and Development Agency (NARA) is thegovernment institute in Sri Lanka responsible for carrying out research in monitoring andassessing the environmental damage caused by MV X-Press Pearl.Following this devastating maritime disaster, NARA has recognized the need to enhance its capabilities in investigating such incidents in the future. This includes bolstering the expertise of NARA scientists and strengthening the equipment capacities. Consequently, NARA has submitted a project proposal to the Asian Development Bank (ADB) to seek assistance in capacity building for its scientists.

NARA received approval for this project proposal from ADB on October 3, 2022. The duration of the project is initially for 12 months period starting from itsinception date in 2022 (11th October 2022), with the Regents of the University of California,San Diego as consultants responsible for the implementation of activities as elaboratedwithin this document.

The overarching goal includes three key activities: strengthening infrastructure through the acquisition of monitoring equipment, providing feedback on ongoing X-Press Pearl disaster monitoring, and conducting training sessions on equipment use and the development of a coastal monitoring framework. These efforts are designed to empower NARA in responding to potential impacts on coastal water quality, the base of the food web, and coastal fisheries.

The "Development and Implementation of a Training Program for the National Aquatic Resources Research and Development Agency (NARA), Sri Lanka," project was initiated through an in-person capacity building workshop held from June 19-23, 2023 both at NARA Premises and the Pegasus Reef ,Wattala after several discussions at NARA and through online meetings. The workshop was mainly focused on addressing pollution and environmental damage caused by the MV X-Press Pearl wreck; the project aims to enhance NARA's preparedness for managing maritime disasters in future.

Table 5: ADB/UCSD/NARA Capacity Building Project(Training Schedule June 19-23, 2023).
Total Participants: 160 ;Non NARA:28

Date	Session	Trainer/s	No: of Participants
19-Jun	Training Session 1(Afternoon). Data Collection Principles.	Prof. Uwe Send and Mathias Lankhorst	23
20-Jun	Training Session-2(Morning). Water column ecosystem monitoring. Needs: Internet access, all participants individually on zoom.	Prof.M. Ohman Prof. L. Aluwihare	32
	Training Session-3 (Afternoon): Assessing the status and trends of coral reefs.	Dr. S. Sandin	19
21-Jun	Training Session-4(Morning). Plastics and oil monitoring and disaster response.	C. Reddy Prof.L. Aluwihare	30
	Training Session-5(Afternoon). Plastics laboratory sessions.	Prof. L. Aluwihare	30
	Training Session-6(Afternoon parellel Session).NetCDF Training on Models and Validation.	Dr. Mathias Lankhorst and Prof. Uwe Send	9
22-Jun	Training Session-7(Morning).Round-table: Modeling considerations, model data validation NARA staff involved in modeling and data validation efforts.	M. Lankhorst, U. Send, S. Diggs	22
	Training Session-8 (Afternoon).Data Management(Principles of Data Management, Documentation and meta data, Datapreservation, Data accessibility, public dissemination, Hardware and platforms,Software,Interactive practice session with provided Chrome book).	S. Diggs, U. Send, S. Sandin	22
23-Jun	Visiting NARA Technical Divisions to get an idea about Database Management at NARA.	S. Diggs	
05-July	Environmental Valuationof Adverse Maritime Pollution Impacts Workshop.	Prof. Richard Carson	NP:25 NNP:28

NARA Participants (NP); Non NARA Participants (NNP) (from University of Sri Jayawardenapura, University of Uwa Wellassa, IUCN, University of Colombo).

Workshop Highlights

Although some requested equipment has been received, others are still pending, marking critical progress toward effective implementation of the monitoring plan. The success of this project is anticipated to significantly bolster NARA's immediate response capabilities and contribute to the resilience of Sri Lanka's coastal ecosystems.

Equipment received up to 31.12.2023;
Microplastic Manta Net
Turner design Fluorometer
ThermoScientific^{TM} GENESYS^{TM} 40/50 UV-Vis Spectrophotometer

Pending Equipment;
OSIL, 2m Mini Vibrocorer
YSI sensors – two EXO1 with all sensors, and one EXO1without pH and no pressure

Collaborative project with NARA and Cefas
The Centre for Environment, Fisheries and Aquaculture Science (Cefas), operating as an executive agency of the United Kingdom government's Department for Environment, Food and Rural Affairs, stands as a pivotal institution conducting an array of research, advisory, consultancy, monitoring, and training activities on a global scale. In a collaborative effort with the National Aquatic Resources Research and Development Agency (NARA), Cefas actively engages in multifaceted initiatives.Notably, Cefas provides crucial funding for collaborative research endeavors with the University of Kelaniya, supporting the academic pursuits of four MSc andMPhil students. This collaborative approach underscores a commitment to advancing knowledge and expertise in environmental and aquatic sciences. Furthermore, Cefas has played a significant role for essential research efforts directed at addressing plastic pollution in the Kelani River. Through the provision of a litter boom, Cefas contributes materially to the ongoing scientific endeavors aimed at mitigating the impact of plastic pollution on aquatic ecosystems.In November 2023,Cefas undertook their inaugural field survey in Sri Lanka, focusing on construction along the Kelani River banks near the Kohilawaththa area. While the cement works were finished, the deployment of the boom was hindered by adverse weather conditions and logistical challenges.

Installation efforts of the litter boom across the Kelani River

Despite setbacks, Cefas is optimistic about commencing the second phase of deployment in March 2024, which will include launching litter categorization efforts.In a testament to their dedication to knowledge dissemination and collaborative problem-solving, Cefas conducted a workshop titled “Working toward proactive preparedness: Showcasing science and strengthening collaboration in marine pollution environmental response” from November 27-30, 2023. This workshop, conducted in collaboration with NARA and other pertinent institutions, reflects Cefas's commitment to proactive measures, scientific advancements, and fostering collaboration in the realm of marine pollution environmental response. This collective effort underscores the importance of international cooperation in addressing complex environmental challenges.Another opportunity for in-person training on the use of "QGIS" software is forthcoming. This session will offer participants a comprehensive and hands-on learning experience, allowing them to explore deeply into the functionalities and capabilities of QGIS. Attendees can expect to gain valuable insights into spatial data analysis, mapping, and visualization techniques using this powerful open-source GIS platform.

Test Services

ESD provides water quality testing services for a range of customer base including government institutions, private companies and industries, and individual clients by measuring the important water quality parameters and comparing them against the stipulated standards by the Central Environmental Authority. Parameters that are being tested in the ESD laboratory include water pH, water temperature, electrical conductivity (EC), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Turbidity, Salinity, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), alkalinity and hardness, nutrient levels (Ammonia-N, Nitrate-N, Nitrite-N and DissolvedPhosphate), and Chlorophyll-a. Total number of 18 test services hasbeen conducted in 2023 and clients include industries, private sector institutions, small and medium scale businesses, and individual clients. Concerning these 18 test services and total cost earned through the provision of test services is Rs 469,400.00 for the year 2023.

Public Awareness Programmes

Negombo Lagoon Management Programme

Negombo Lagoon is one of the most productive lagoons and its associated wetlands, including other important habitats associated with the lagoon such as mangrove and sea grass beds provide an array of ecosystem services to the communities living around the lagoon. However, Negombo Lagoon is subjected to pollution due to anthropogenic activities and the development of urban centers on both sides of the lagoon. This has affected the hydraulic regime of the lagoon causing the problem of increased sedimentation. The establishment of an industrial city in Ekala and a Free Trade Zone in Katunayake may have also had a direct and indirect impact on the water quality of the Negombo lagoon. In addition, large quantities of solid and liquid waste are being dumped at various locations in the lagoon resulting in pollution problems. As a result, the water quality of the Negombo lagoon has deteriorated over the last few decades. Therefore, the Environmental Studies Division and Kodolkele Regional Research Centre of NARA have jointly initiated to carry out the Negombo Lagoon Management Programme to minimize the impacts of anthropogenic activities.

Accordingly, the first discussion of Negombo Lagoon management was organized by NARA with some fishing communities around Negombo Lagoon on 24.08.2023. They have requested to organize discussions with fishing communities and government officers. Hence, NARA organized the second meeting by inviting both parties. It was successfully implemented on 26.09.2023 at the Negombo National Fisheries Cooperation Center to make the Negombo Lagoon a garbage-free ecosystem. For this meeting, government agencies (Coastal Conservation Department, Marine Environment Protection Authority, Negombo Sulu Fishermen Federation, Central Environment Authority, Negombo Police, Hotel Association Negombo, Municipal Council Negombo, Sri Lanka Land Reclamation and Development Institute, Regional Secretariat Negombo, Fisheries Department, Aquaculture Development Authority, Regional Education Office Negombo, Wildlife Conservation Department, Negombo Youth Catholic Association Public and private sectors as well as members of fishing organizations also participated. The main cause of Negombo Lagoon pollution (plastic pollution, water pollution from dry fish and fish farming activities, recreational activities, tourist hotels, etc) identified during the meeting based on the knowledge and experience of the participants. After that, NARA was planning to organize several programs to succeed in this event. Based on the ideas of the officers who were involved in the second meeting, NARA organized the 3rd meeting by also identifying the additional stakeholders on 25.10.203 the Negombo National Fisheries Cooperation Center. The presentation on “Dumping garbage in Negombo Lagoon” was conducted by one of the officers from the Department of Fisheries, Negombo Regional Office. The second presentation was “Identifying government bodies responsible for Negombo lagoon and coming up with a method to involve all of them in the cleaning process by dividing tasks among them. Finally, the 3rd presentation was done by the Senior Scientist of the Environmental Studies Division of NARA on .26.11.2023. The presentation was mainly focused on wastewater treatment techniques suitable for Negombo Lagoon which included implementation methods for the cleanup project. The presentation included treating lagoon litter using the biochar method, prevention using a wastewater treatment plant, water treatment using bioremediation, and collecting surface solid waste using litter boom. Many of the stakeholders proposed to give the main responsibility to the divisional secretariat, Negombo during the discussion.



Some photographs of the workshop activities

Workshop Organizing team:

- Dr.N.D.Hettige/Senior Scientist-Environmental Studies Division
- Mrs. U. Chathurani/Scienstist-Kadolkale Regional Research Centre

Annual scientific sessions

- A total of nine (09) abstracts (As an Author/s: 5 abstracts; As a Co-Author/s: 4 abstracts were published by the ESD at NSS 2023.
- Additionally, two officers actively participated in the organizing committee for organizing the event compering, video editing, and e-certificate designing.
- Ms.ChandimaNarangoda /Scientist/Environmental Studies Division/NARA – Organizing committee member.
- Mr. RamodhJayawardena/Scientist/Environmental Studies Division/NARA – Organizing committee member, compering, video editing, e-certificate designing.

Meetings attended and committees represented

ESD officials are representing number of nationally important committees including technical evaluation committees; EIA & IEE report evaluation committees, national steering committees, advisory committees, consultancy groups, expert committees, international environmental monitoring committees, and etc. Meetings and information sessions related to these committee representations are for the year 2023 is listed below;

Date	Meeting	Venue
2023.01.05	Establishing a Management Committee for the Bolgoda Environmental Protection Area	Central Environmental Authority
2023.01.18	Round Table Discussion on " Marine Environment Protection in Sri Lanka: A Lesson Learnt from Recent Marine Accident.	Zoom Meeting
2023.01.23	Webinar on Promoting the manual of blue carbon standard methods to be used for standardized baseline date sets	Online
2023.01.24	Second policy Roundtable on Marine Litter prevention (Sri Lanka) under EU-SWITCH ASIA Project on ''Prevention of Marine Litter in the Lakshadweep Sea (Promise)	GaladariHotel,Colombo.
2023.02.01	Discussion on "Preparation of Report on The Current Status of Preparedness for Disaster Response in Sri Lanka"	Conference Hall of the Disaster Management Center
2023.02.03	Joint Site Inspection for proposed Tourism Investment Projects	Sri Lanka Tourism development Authority
2023.02.14	Coast Conservation & Coastal Resource Management Advisory Council meeting	Ministry of Urban Development and Housing

2023.02.20	Management Committee meeting for the Bolgoda Environmental Protection Area	Central Environmental Authority
2023.02.21	Technical Evaluation Committee Meeting for the Initial Environmental Examination (IEE)Procedure on Proposed 100MW Wind Power Project (Phase 1) At Pooneryn in Kilinochchi district- Sri Lanka Sustainable Energy Authority.	Department Of Coast Conservation & Coastal Resource Management, Maligawaththa, Colombo-10.
2023.02.21	Validation of the report on "The Current Status of Preparedness for Disaster Response in Sri Lanka	Disaster Management Center
2023.02.23	Scoping committee meeting on The Proposed Project for Eramathivu West Island, Kalpitiya The Proposed Project for Underwater Sculpture Gallery at Ambalangoda organized by Investor Relations Unit (IRU)-of Sri Lanka Tourism Development Authority (SLTDA)	TajSamudra Hotel – Colombo
2023.02.22 to 24.02.2023	Final Site Survey(Fss) of INDO -PACIFIC Environmental Security forum (1PESF) 2023.	Light House Galley
2023.02.24	The Proposed Project on offshore sand extraction from SLPA sand borrow area at Kerawalapitiya for reclamation of east container terminal phase II (ECT phase II) and west container terminal phase II (WCT phase II) in the port of Colombo	Central Environmental Authority
2023.03.08	Environmental committee meeting – Colombo District	District Secretariat-Colombo
2023.03.14-2023.03.15	International Forum '' Sustainable Ocean management in Sri Lanka and Indian Ocean'' Colombo, Sri Lanka	Hilton Colombo Residence, Colombo-02
2023.03.15	Technical Evaluation Committee Meeting for the Initial Environmental Examination (IEE) Procedure on Proposed Modern Shrimp Farm Project - Aralithurai,Velanai, Jaffna- Annai and Sons (Pvt.) Ltd, No 257, 259, Beach Road, Navanthurai North, Jaffna	Department of Coast Conservation and Coastal Resource Management
2023.03.20	Intergovernmental Dialog - Joint Facilitation for Tourism Investments organized by Tourist board	Sapphire Courtyard by Marriot Colombo
2023.03.20	Re- modelling the Draft National Fisheries Policy	Ministry of Fisheries
2023.03.21	Invitation to the stakeholder meeting: braking the Plastic Spell: Apolicy Dialogue for effective and Sustainable Plastic Waste Management.	Central Environmental Authority
2023.03.21	Stakeholder Consultation for preparation of Activity plan for the Project on ''Natural capital values of Costal and Marine Ecosystem in Sri Lanka. Integrated into Sustainable Development Planning''	Ministry of Environment
2023.03.22	Stakeholder Consultation on a Roadmap to a Marine Spatial Plan	Hilton, Colombo
2023.03.28	Workshop on Identification of Environment Sensitive Areas (FSAs) in Nationwide	Ministry of Environment.
2023.03.30	Technical Evaluation Committee meeting for EIA procedure on proposed Colombo North Port Development Project-Sri Lanka Port Authority	Conference room, Ministry of Fisheries
2023.03.31	Meeting on Implementation of Budget Proposals 2023-Promotion of Marine Tourism	Ministry of Tourism and Lands
2023.04.20	Coast Conservation & Coastal Resource Management Advisory Council meeting	Ministry of Urban Development and Housing
2023.04.25	Meeting on reviewing further matters related to compensation related to the maritime disaster Express Pear ship accident	Parliament of Sri Lanka
2023.04.28	Coast Conservation & Coastal Resource Management Advisory Council meeting	Ministry of Urban Development & Housing

2023.05.19	Meeting on Implementation of Budget Proposals 2023-Promotion of Marine Tourism	Ministry Tourism, 698/4, Maradanard, colombo-10
2023.06.02	Meeting on 50MW Kalu Ganga Reservoir Floating Solar Project	Central Environmental Authority, Online
2023.06.05	Incident Management Team Meeting -Discussion on Marine Disaster Preparedness	Marine Environment Protection Authority
2023.06.05	Third Policy Roundtable meeting	Galadari Hotel, Colombo
2023.06.07	Meeting on Dredging And Cleaning Arugambay Lagoon	Ministry of Fisheries
2023.06.12	Meeting on UCPM Advisory Mission to Sri Lanka and Upgrading the NOSCOP Responsibilities of Stakeholder Agencies	Presidential Secretariat
2023.07.07-09	The Law of the sea programme by Australian Center for Ocean Resources & security (AncORS), university of Wolongong, from 7-9 July 2023, Colombo.	Hotel Hilton,Colombo
2023.07.17	Organizational Result Framework	Department of Budget, Ministry of Finance
2023.07.18	Promotion of Marine Tourism Blue Flag Certification for Sri Lanka's Coastal beaches - meeting	Ministry of Tourism and Lands,696/4, Maradana Rd, Colombo-10
2023.07.27	Reference to the Odour Emitting From Beira Lake Due to Addition of Waste Water	Presidential Secratriat
2023.07.27	Select Committee of Parliament to investigate into and to make suitable recommendations relating to the disasters caused by New Diamond and X press Pearl Vessels in the Maritime Zone of Sri Lanka	in Committee Room No,04, of the Parliament
2023.07.28	Tentative Agenda: Consultation Workshop on Revision of National Coastal Zone And Costal Resource Management Plan.	Nelum Room, Waters edge, Battaramulla.
2023.08.10	Reference to the Odour Emitting From Beira Lake Due to Addition of Waste Water	President Secretariat
2023.08.11	Promotion of Marine Tourisms Blue Flag Certification for Sri Lanka's Coastal Beaches	Ministry of Tourism and Lands,
2023.08.22-23	Invitation to 2 Day NOSCO workshop 2023 updating Maritime Plans for SriLanka	Winchester Ballroom at Kingsbury, Colombo
2023.09.01	Commemorating the International Coastal Cleanup day and ''National Marine Recourses Conservation week'' 16th -23rd September, 2023	Marine Environment Protection Authority (MEPA)
2023.09.04-2023.09.15	Union Civil Protection (UCPM) advisory Mission to Sri Lanka	The Kingsbury Hotel,
2023.09.07	Sensitization Workshop on the National Disaster Management plan (NDMP) 2023-2030	Gale Face Hotel
2023.09.08	Selected Committee of Parliament to Investigate into and to make suitable recommendation relating to the disasters caused by new diamond and X-Press Pearl Vessels in the maritime zone of Sri Lanka	Parliament of Sri Lanka
2023.09.11	Progress review of Chilaw lagoon conservation and development programme	Ministry of fisheries
2023.09.11	Submission of expert committee report according to the decision given for Cabinet Memorandum No. 22/1315/606/001-0 regarding Kirinda Fishery Harbour.	Office of the Cabinet of Ministers
2023.09.22	World Rivers Day Celebration-2023	Department of Irrigation
2023.09.22	Colombo District Environment Committee Meeting-	District Secretariat, AlvitigalaMawatha
2023.10.05	Development and Conservation of Lagoon -Cleaning of Nayaru and Nandikadal Lagoon	Board room, Ministry of fisheries
2023.10.05	Sectoral Oversight Committee on National Security	Parliament of Sri Lanka

2023.10.09	Meeting on feasibility to continue operation of Kirinda fishery habour	Temple tress house
2023.10.10	Disaster Risk Management and Japan's Role in the Indian Ocean Rim Association (IORA)	Gen Sir Johan Kotelawala Defense University
2023.10.10	LKI- Japan Seminar on '' Disaster Risk Management and Japan's Role in the Indian Ocean Rim Association	LakshmanKadirgamar Institute
2023.11.03	Meeting on Proposed 1 MW floating solar power Project on ChandrikaWewa at Embilipitiya, Rathnapuara District	Central Environmental Authority
2023.11.03	Meeting on Proposed 1 MW floating solar power Project on KiriibbanWewa at Sewanagala, Monaragala District	Central Environmental Authority
2023.10.04	Indian Ocean Tsunami Exercise	Disaster Management Center
2023.11.16	Awareness raising and policy rollout related to the National Policy on Environmentally Sensitive Areas in Sri Lanka.	Ministry of Environment
2023.11.16	Colombo District Environment Committee Meeting	District Secretariat - Colombo
2023.11.09	Formation of special sub-committees of Colombo District Coordinating Committee	Auditorium,7th Floor, District Secretariat
2023.11.13	Invitation for the 1st National Advisory committee meeting on Abandoned Lost and Discarded Fishing Gear (ALDFG) management	Ministry of Environment
2023-11-27 to 2023.11.30	Ocean Country Partnership programme : Workshop Delegate Pack	Cinnamon Grand Hotel
2023.12.05	Proposed 10 MW floating solar power project proposed to setup on Negombo Lagoon (meeting and site visit)	Central Environment Authority
2023.12.11	Validation Workshop for the National Policy on E-waste management.	Ministry of Environment.
2023.12.21	BRSM NCC meeting	Ministry of Environment, “SobadamPiyasa”

Trainings and Workshops Participated

Training/Workshop	Duration
Workshop on “Sustainable Ocean Management in Sri Lanka and the Indian Ocean” at Hilton Residences Colombo (Union Place), Sri Lanka organized by Oceanography Division, NARA.(Dr. K.A.W.S Weerasekara, Dr.N.DHettige, S. R. C. N. K. Narangoda).	14th and 15th March 2023
Training on Marine Pollution Response organized by Marine Environment Protection Authority with the collaboration of UK Maritime Coastguard Agency.(Dr.N.DHettige).	17th March 2023
Marine Environmental Protection and Maritime Disaster Preparedness. Panel 03. International Conference on Ocean Governance and Maritime Security conducted by the LakshmanKadirgamar Institute in coordination with the European Union.((Dr. K.A.W.S Weerasekara, J.K.P.C. Jayawardhane, N.K.R.N Jayawardane).	08 May 2023
Quantitative skills for Ecologists, jointly offered by Oceanswell, University of Plymouth, University of St Andrews and Bertarelli Foundation, Colombo Sri Lanka (S.Thirukeswaran)	8th -16th May 2023
ADB workshop on capacity building of NARA Scientist Coordinated with National Coordinator and Resource persons, SCRIPS, USA (All scientists).	19-23 June 2023
International Zoom Webinar Session-2nd Part-Plastic Marine Pollution Organized By: HSBC, Sri Lanka. (Dr. K.A.W.S Weerasekara).	05 July, 2023

'Stakeholder Consultation Meeting for the ongoing Nuclear Power Planning Programme'' (S.K.S. Pemarathne)	20 July 2023
Ocean governance training program, jointly offered by International Ocean Institute (IOI) and NARA (S.Thirukeswaran)	17 August- 04 September 2023
Workshop on updating oil spill contingency plan Response organized by Marine Environment Protection Authority (Dr. K.A.W.S Weerasekara, Dr.N.DHettige, J.K.P.C. Jayawardhane)	22nd to 23rd August 2023
International workshop on Union Civil Protection Mechanism(UCPM), advisory mission to Sri Lanka, conducted by the Marine Environmental Protection Authority (MEPA) (Dr. K.A.W.S Weerasekara, Dr.N.DHettige)	04-15 September 2023
Working Together to Adapt to Climate Change: A Workshop on the Adaptation Fund Concept “Strengthening resilience of vulnerable communities in coastal districts of Sri Lanka to increased impacts of climate change” (Dr. K.A.W.S Weerasekara).	11 October 2023
Training Programme on Digital Technologies for Disaster Risk Management organized by SLIDA, Sri Lanka. (Dr. N.D. Hettige)	11th to 13rd October 2023
Deep-Dive E-learning program on UNCLOS and the governance of the Area, jointly offered by International Seabed Authority(ISA) and Marawa Research and Exploration ltd (S.Thirukeswaran)	23 October to 15 December 2023
Workshop on the Study on the Implementation of UNCLOS in Sri Lanka.(Dr. K.A.W.S Weerasekara).	6-8 November 2023
Workshop on Working Towards Proactive Preparedness: Showcasing Science and Strengthening Collaboration in Marine Pollution Environmental Response organized by jointly organized by Marine Environment Protection Authority (MEPA) in collaboration with the Ocean Country Partnership Programme (OCPP), a UK-Government led project delivered under the Blue Planet Fund (Dr. K. A. W. S. Weerasekara, S. R. C. N. K. Narangoda, M. D. S. R. Maddumage, ShynugaThirukeshwaran, RuchiraJayathilaka, Achini Fernando).	27-30 November, 2023
Validation workshop on National Policy on Electrical and Electronic Waste Management in Sri Lanka at Ministry of Environment,“SobadamPiyasa” (Dr. K. A. W. S. Weerasekara).	December 11th, 2023
FAO Workshop on Fisheries Data Interoperability organized by Ministry of Fisheries(.(Dr. K.A.W.S Weerasekara).	December 21st, 2023
Foreign Training	
Oil spill response workshop in Hawaii, USA from 18th to 22nd September 2023 organized by Embassy of United State. (Dr. N.D. Hettige)	18th to 22nd September 2023
WESTPAC-ECNUInternationalworkshop“Stem the tide of Asia’s riverine plastic emission intothe ocean”, Sanya, Hainan, China. (J.K.P.C. Jayawardhane, S.R.C.N.K. Narangoda)	20-22 November 2023

Presentations & Awareness Programs

Presentation Title/ Awareness Programs	Date
Invited Presentation on “Controlling and Eliminating marine pollution in Sri Lanka”. International Ocean Policy Workshop conducted by National Aquatic Resources	14.03.2023

Research and Development Agency **(Dr. K.A.W.S.Weerasekara).**	
Invited Presentation on “Environment Maritime Protection and Disaster Preparedness”. Conference on Ocean Governance and Maritime Security conducted by the LaxmanKadiragamar Institute in coordination with the European Union **(Dr. K. A. W. S. Weerasekara).**	08.05.2023
Presentation on “Selection of suitable freshwater bioindicatory fish species for assessing water quality of Kelani River basin, Sri Lanka, University of Colombo (S. R. C. N. K. Narangoda).	03.06.2023
Presentation on “National Aquatic Resources, Research and Development Agency (NARA)’s Status and Needs on Disaster Preparedness”. International Capacity Building Workshop on ADB TA-9911 Sub Project: Development and Implementation of a Training Program for the National Aquatic Resources Research and Development Agency (NARA), Sri Lanka (53068-002) **(Dr. K. A. W. S. Weerasekara).**	19.06.2023
Invited Presentation on “Unmasking Plastic Pollution- A Pathway to Environmental Resilience”, Zoom Webinar Session-2nd Part-Plastic Marine Pollution Organized By: HSBC, Sri Lanka. (Dr. K. A. W. S. Weerasekara).	05.07.2023
Invited Presentation on “Role of NARA for the Environmental Damage Assessment of X-Press Pearl Ship fire incident”, International workshop on Union Civil Protection Mechanism (UCPM), an advisory mission to Sri Lanka, conducted by the Marine Environmental Protection Authority (MEPA) **(Dr. K. A. W. S. Weerasekara).**	06.09.2023
Invited Presentation on “Environmental Damage Assessment and Lessons Learnt from recent Maritime Disasters in Sri Lanka”, International workshop on Union Civil Protection Mechanism(UCPM), advisory mission to Sri Lanka, conducted by the Marine Environmental Protection Authority (MEPA) **(Dr. K. A. W. S. Weerasekara).**	09.09.2023
Presentation on “Enhancement of Eco-toxicology Testing Facilities of National Aquatic Resources Research and Development Agency (NARA)”, presented to Centre for Environment, Fisheries and Aquaculture Science (CEFAS), UK representatives of the Ocean Country Partnership Programme**. (Dr. K. A. W. S. Weerasekara).**	20.09.2023
Invited Presentation on ‘Current status of plastic pollution in Sri Lanka andway forward to remediation with special reference tomarine and riverine plastic’, representing the country status at WESTPAC-ECNU International Workshop “Stem the tide of Asia’s riverine plastic emission into the ocean”20-22 November 2023, Sanya, Hainan, China. (J.K.P.C. Jayawardhane)	21.11.2023
Invited Presentation on ‘Selection of pilot river for microplastic analysis in Sri Lanka’, representing the country status at WESTPAC-ECNU International Workshop “Stem the tide of Asia’s riverine plastic emission into the ocean”20-22 November 2023, Sanya, Hainan, China. (S. R. C. N. K. Narangoda)	22.11.2023
Presentation on “Wastewater treatment technique suitable for Negambo Lagoon” Presented during theNegambo Lagoon Conservation progarmme for government officers organized by the NARA (Dr.N.D. Hettige).	26.11.2023
Invited Presentation on “Post spill monitoring and lessonslearnt in Sri Lanka”, presented to workshop on Working Towards Proactive Preparedness: ShowcasingScience and Strengthening Collaboration in Marine PollutionEnvironmental Response organized by jointly organized by Marine Environment ProtectionAuthority (MEPA) in collaboration with the Ocean Country Partnership Programme(OCPP), a UK-Government led project delivered under the Blue Planet Fund**. (Dr. K. A. W. S. Weerasekara).**	28.11.2023
Invited Workshop on Working Towards Proactive Preparedness: Showcasing Science and Strengthening Collaboration in Marine Pollution Environmental Response organized by jointly organized by Marine Environment Protection Authority (MEPA) in collaboration with the Ocean Country Partnership Programme (OCPP), a UK-Government led project delivered under the Blue Planet Fund. (M. D. S. R. Maddumage).	28.11.2023

Presentation On Blue Flag Certification for the Sri Lanka Tourist Development Board(SLTDA).(RamodhJayawardena)	June ,2023

Supervision of undergraduate students for industrial training

A total of 31 undergraduate students specializing in Water Resource Technology & Management, Environmental Management, and Bio-Science Fields were provided with supervision for their industrial training. Additionally, 6 students, consisting of both undergraduate and MPhil students, received supervision for their research component. The training aimed to improve their skills in research planning, literature review, scientific data collection, sample collection and preservation, laboratory analysis, basic laboratory procedures, quality control and assurance, data interpretation, and scientific writing.

Publications

International journal Publications (04)

1. Narangoda, S. R. C. N. K., Dangalle, C. D., Amarathunga, A. A. D. (2023). “Evaluation of water quality in the upper and lower catchments of KelaniRiverBasin Sri Lanka”. Journal of Water Practice & Technology. Vol 00 No 01.
2. Hettige, N.D., Hashim, R. B., Kutty, A. B. A., Ash'aari, Z. H. B. A. (2023). New Model for Organic Contamination Assessments using Benthic Macroinvertebrates as Biological Indicators, Turkish Journal of Fisheries and Aquatic Sciences, *23*(7), 1-15.
3. Athukorala,A., Amarathunga,A.A.D., De Silva,D.S.M., Bakir, A.,McGoran, A., Sivyer,D. and De Silva, R.C.L.2023. Microplastics in lagoon ecosystems: A review on occurrence and methods for microplastic detection. Biology and Environment:Proceedings of the Royal Irish Academy 123B (3) .
4. Jayawardena, N.K.R.N, Thirukeswaran, S., Kalaotuwawe K.M.B.P.P, Pemarathne, S.K.S, Weerasekara, K.A.W.S. (2023). Surface water quality status of the Nayaru Lagoon in Sri Lanka and its impacts on Aquatic Organism. *International Journal of Innovative Research in Science Engineering and Technology.* Vol 8 (6): 2063-2070.

Local Journal publications (01)

1. Jayawardhane J.K.P.C., Weerasekara K.A.W.S.,Pathmalal M.M. “Spatial and temporal variation of physicochemical parameters of coastal waters in the southwestern region of Sri Lanka”, *Sri Lanka Journal of Aquatic Science.* 28(1) (2023): 01 – 09.

Abstracts (09)

1. Jayawardhane,J.K.P.C., and Hettige, N.D., (2023). Rapid assessment of phytoplankton assemblages in Mundel Lagoon, Sri Lanka,*Proceedings of the 79th Annual Sessions,* Association for the Advancement of Science (SLASS), Colombo, Sri Lanka.
2. S.R.C.N.K. Narangoda, K.A.W.S. Weerasekara, A.A.D. Amarathunga, N.D. Hettige, (2023). A Review of Marine Litter Pollution in Coastal Waters of Sri Lanka. "Sustainable Fisheries for Economic Prosperity and Food Security" - NARA Scientific Session Colombo-15, Sri Lanka, p. 79.
3. J.K.P.C. Jayawardhane, A.A.D. Amarathunga, K.A.W.S. Weerasekara, (2023). Assessment of physicochemical and biological characteristics of surface water in Galle Fishery Harbour, Sri Lanka. "Sustainable Fisheries for Economic Prosperity and Food Security" - NARA Scientific Session Colombo-15, Sri Lanka, p. 81.
4. R. Dushyanthi , R.C.L. De Silva , A.A.D Amarathunga, (2023). Study on Distribution and Accumulation Patterns of Marine Litter and MicroplasticsOn Beaches in The West Coast of Sri Lanka. "Sustainable Fisheries for Economic Prosperity and Food Security" - NARA Scientific Session Colombo-15, Sri Lanka, p. 82.

5. N.K.R.N. Jayawardena, S. Thirukeswaran, K.A.W.S. Weerasekara, (2023). Blue Flag Certification; Developing Sustainable Tourism and Economic Growth through Environmental Conservation. "Sustainable Fisheries for Economic Prosperity and Food Security" - NARA Scientific Session Colombo-15, Sri Lanka, p. 83.
6. A.I. Madhumali,A. A. D. Amarathunga, M. A. P. C. Piyathilaka,M. D. S. R. Maddumage, K. Dalpathadu, (2023). Microplastic contamination in beach seine fishery in southern and western coastal waters in Sri Lanka. "Sustainable Fisheries for Economic Prosperity and Food Security" - NARA Scientific Session Colombo-15, Sri Lanka, p. 72.
7. A Kodippili , A. A. D. Amarathunga, M. A. P. C. Piyathilaka , M. D. S. R. Maddumage , S. R. C. N. K. Narangoda, H.N.L. Jayasekara , M.G.C.R. Wijesinghe , P.H. Ginigaddarage , K.A.W.S. Weerasekara, (2023). Assessment of surface water quality in the Mirissa and Beruwala fishery harbors with reference to anthropogenic activities. "Sustainable Fisheries for Economic Prosperity and Food Security" - NARA Scientific Session Colombo-15, Sri Lanka, p. 73.
8. H.N.L. Jayasekara, A.A.D. Amarathunga, S.M. Young1, S.R.C.N.K. Narangoda, M. D.S.R. Maddumage, A.A. Kodippili, M.G.C.R. Wijesinghe, P.H. Ginigaddarage, M.A.S. P Dissanayake, K.A.W.S. Weerasekara, (2023). Assessment of the impact of harbor operations using sediment of the Beruwala and Mirissa fishery harbors in Sri Lanka. "Sustainable Fisheries for Economic Prosperity and Food Security" - NARA Scientific Session Colombo-15, Sri Lanka, p. 75.
9. J.M.D.N.P. Jayamanne, H.B. Jayasiri , A.A.D. Amarathunga , H.P.S. Jayapala, (2023) Abundance and Characterization of Microplastics in a Commercial Salt Manufacturing Process in Southern Sri Lanka. "Sustainable Fisheries for Economic Prosperity and Food Security" - NARA Scientific Session Colombo-15, Sri Lanka, p. 76.

Book Chapters (02)

1. Vithanage, M., Priyal de Alwis, A., &Botheju, D. (Eds.). (2023). Maritime Accidents and environmental Pollution - The X-Press Pearl Disaster: Causes, Consequences, and Lessons Learned (1st ed.). CRC Press. https://doi.org/10.1201/9781003314301Chapter 7:MadushikaSewwandi, KalaniImalkaPerera,Christopher M. Reddy, Bryan D. James, A.A.D. Amarathunga, IndikaHema Kumara Wijerathna, and MeththikaVithanage (2023). Plastics, Nurdles, and Pyrogenic Microplastics in the Coastal Marine Environment:Implications of the X-Press Pearl Maritime Disaster.
2. Vithanage, M., Priyal de Alwis, A., &Botheju, D. (Eds.). (2023). Maritime Accidents and environmental Pollution - The X-Press Pearl Disaster: Causes, Consequences, and Lessons Learned (1st ed.). CRC Press. https://doi.org/10.1201/9781003314301Chapter 11: P.R.T. Cumaranatunga, K.R. Dalpathadu, H.M.U. Ayeshya, K.A.W.S. Weerasekera, S.S.K. Haputhantri, W.N.C. Priyadarshani, G.K.A.W. Fernando, L.D. Gayathry, H.B.U.G.M. Wimalasiri .Impact of MV X-Press Pearl Disaster on Coastal and Marine Fish & Fisheries.

Newspaper and Magazine articles(02)

1. Narangoda, S. R. C. N. K.,Dangalle, C. D, Amarathunga, A. A. D. and Weerasekara, K. A. W. S. (2023). The usage of bioindicators for assessing health of aquatic ecosystems. Mulla Magazine by Turtle Conservation Project.
2. J.K.P.C Jayawardhane.Submitted an article on Blue carbon conservation to Vidusara newspaper and accepted to publish (December 2023).

Reports, concept papers(15)

1. Report on investigation of fish kill incident in Kotmale River.(Ambewela to Talawakelle) .(S. Thirukeswaran, Dr. W. Rajapakse).
2. Report on investigation of Jellyfish stranding in MountLavinia Beach.(S.Thirukeswaran, L.D Gayathri).
3. Report on Assessment of on-going sea cucumber farming practices and their implications on fisheries livelihood at Kiranchi and Parititivu(February 2023). (Dr. N.D.Hettige and S. Thirukeswaran).

4. Report on Economic and Social Feasibility Regarding the Further Development and Maintenance of Kirinda Fishery Harbor- Marine Environmental Conditions and Possible Damages (April 2023) (Dr. N.D.Hettige).
5. Rapid assessment on water pollution status in Chilaw Lagoon, Sri Lanka (May 2023). (J.K.P.C.Jayawardhane and Dr. N.D.Hettige).
6. Feasibility study on Sea cucumber farming site in Palavi coastal area, Sri Lanka: A Rapid assessment study (February 2023). (Dr.N.D.Hettige and S. Thirukeswaran).
7. Fitting Sustainable Solutions for the Challenges of Chilaw lagoon (June 2023).(Dr. N.D Hettige. J.K.P.C Jayawardhane).
8. Report on investigation of fish kill incident in Mundal Lagoon. (S. Thirukeswaran, S.K.S.Pemarathne,S.Thanushanth).
9. Report on investigation of fish kill incident at Nayaru, Vidathalathive.) .(Ramani Shirantha,RamodhJayawardena) .
10. Report on investigation of fish kill incident at Depa-Ela,Mulleriyawa.). (RamodhJayewardene,S.K.S.Pemarathne) .
11. Three (03) interim reports on Physical chemical and biological parameters of Puttalam Lagoon carrying the results of the first, second, and third sampling events were submitted to CEB (First Interim Report-April, 2023, Second Interim Report-September, 2023, Third Interim Report-December, 2023).(All scientists)
12. Concept note on Blue Economy in Sri Lanka submitted to the Director General/NARA. (S.Thirukeswaran).
13. Concept note on establishing free trade zone exclusively for fisheries industry in Mullaithivu District, submitted to the Director General/NARA. (S.Thirukeswaran).
14. Concept note on water quality analysis and benthos study for feasibility study on sea cucumber and sea weed culture in Sri Lanka.(Dr. N.D Hettige, S.Thirukeswaran).

5.2 FISHING TECHNOLOGY DIVISION

Head of the Division: Dr. Nilanthi Priyadarshani

PROGRESS SUMMARY OF "ECOSYSTEM MONITORING OF FISH AGGREGATING DEVICES (FADS) DEPLOYMENT SITES TO ENHANCE THE FISH PRODUCTION AND ECO-TOURISM IN COASTAL WATERS"

Background

Fishing gear technology division is conducting research and development on Fishing gears used in Sri Lanka waters. Sri Lanka coastal water and coastal fisheries consist with multispecies and multi gears. Therefore, fishing technology division is conducting research to introduction of new, ecofriendly fishing gears, modify existing fishing gears to sustainable utilization of coastal and marine fisheries. Same as FTD is conducting research on deployment and monitoring of Fish aggregating devices to enhance the coastal fisheries sector of Sri Lanka. Division consist, one Principle scientist, two scientists, one research assistant and one helper.

Ecosystem monitoring of Fish Aggregating Devices (FADs) deployment sites to enhance the fish production and eco-tourism in coastal waters" was treasury funded project carried out by Fishing Technology division, NARA in 2023. Here, underwater observations were also carried out in 2023 using Underwater camera, purchased under "Establishment of in near shore areas in order to increase space of protective breeding ground for coastal fishery resources (FTD)" funded by Department of Fishery in 2021.Here,water quality monitoring, fish stock assessment and under water monitoring was carried so as to examine the viability of FADs and obsolete vehicle deployment forresource enhancement,as a food security buffer against socioeconomic and climate shocks, Safety at sea with improved through defined fishing zones around FADs and increase the resilience of coral reef ecosystems etc.

Methodology

Site selection

Under this project, two sites were selected Sinnapaduwa, Kalpitiya with artificial FADs (Figure1) and Trincomalee (Figure 2) with obsolete vehicle deployments. Four sampling points were selected from Sinnapaduwa FADs site, and five sampling points were selected from Trincomalee obsolete vehicle deployment site. Different surveys were conducted to evaluate the condition of FADs site in both area.

Under water SCUBA diving

Underwater SCUBA divers were employed to determine the status of the deployed structures (buses and boats) and to identify aggregated fish species around the FADs in both Sinnapaduwa and Trincomalee area and degraded vehicles.

Collection of oceanographic parameters

Chemical and Biological parameters including nutrients (nitrate, Nitrite, phosphate and Silicate), TSS, Sechii depth, Chlorophyll a, temperature and salinity, were carried out using both instrumental methods, and laboratory analytical methods. Four monitoring events for four major monsoon seasons were carried out in March, August, October and December, 2023 in Trincomalee.

Collection of Plankton samples

Zooplankton, Phytoplankton, and Icthyoplankton were collected, observed, and analyzed. Each type of sample was collected using relevant sampling nets. Few samples are yet to be analyzed.

Acoustic Survey

A standard survey design for abundance estimation of a population, with zig zag transects and one stratum was made. This design was not optimal as the aim of the estimation was not to calculate the biomass of a defined population, but rather the fish density and distribution relative to the FAD (Figure 3 and Figure 4).The total length of the survey line was 29 nautical miles.

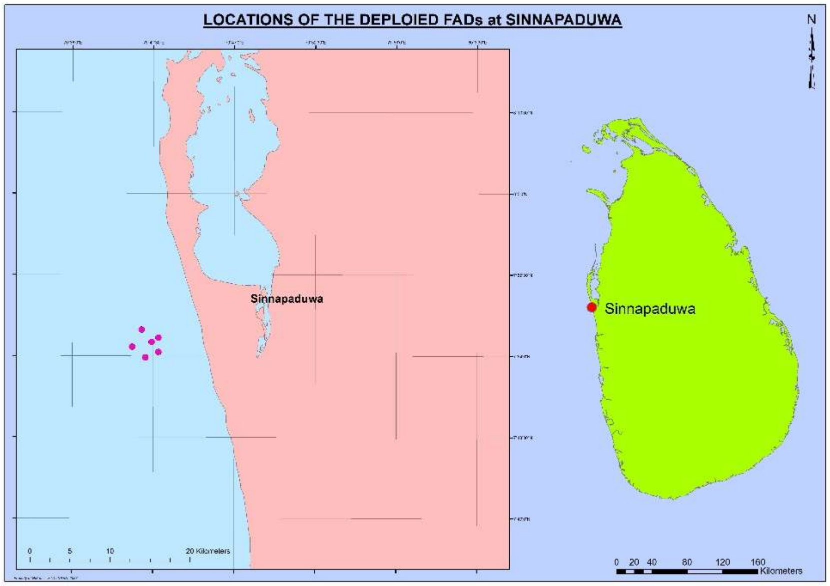


Figure 1. FADs locations at Sinnapadu, Kalpitiya

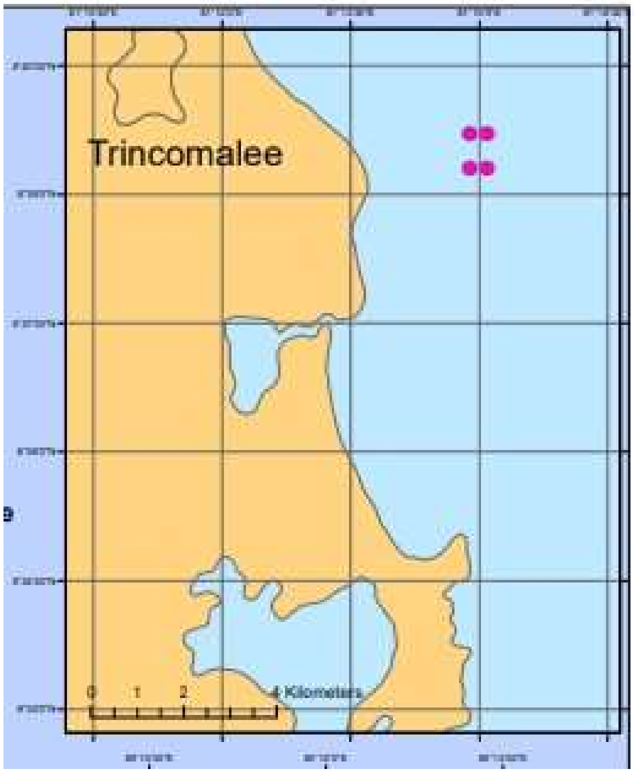


Figure 2. Obsolete vehicle deployment sites at Trincomalee

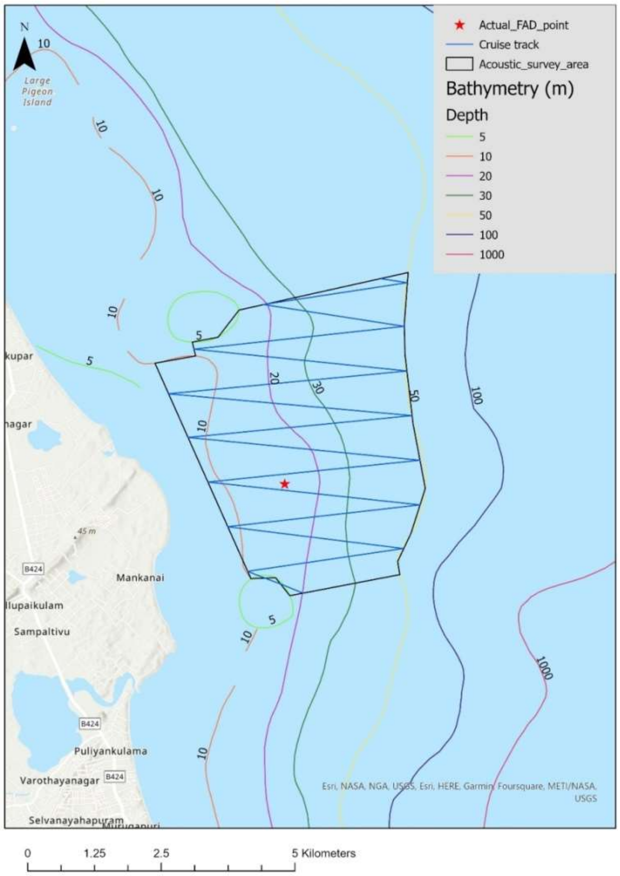


Figure 03. Acoustic survey area map at obsolete vehicle deployment site in Trincomalee coastal area.A red star indicates the location of the FAD (08° 39.3740'N, 081° 14.7060' E).

Figure 4. Acoustic survey with Bar reef sanctuary boat

Observations and Results

Underwater Survey

32 submerged FEDs (Fish enhancing devices) made up with iron bars and covered with nylon nets deployed at Sinnapaadu in 2018 were completely damaged or washed off from its original site after five years (Figure 5). Several vehicles out of 24 buses and 14 boats were totally damaged and became a debris due to unaccepted fishing practices such as dynamite fishing and Laila fishing method at Trincomalee area (Figure 6). According to under water survey analysis, fish population of both areas were high. Twenty families with 27 species were identified at Sinnapaadu while small fish like,

Dipterygonotusbalteatus (hingura- mottled fusilier) which is used as live bait fish for Pole and Line Tuna fishery, were dominant in Sinnapaadu study site.

According to the underwater survey done at Trincomalee obsolete vehicle deployment area, plenty of fish schools was observed, Based on the underwater videos and pictures, 29 fish species belonged to nine fish families were identified and edible snappers were prominent at Trincomaee area. The highest number of fish species (7 species) was belonged to Chaetodontidae (Butterfly fish, banner fish and other coral fish) family. However, the highest density of fish population was found in family Lutjanidae which include edible Common Snappers (Ranna species).

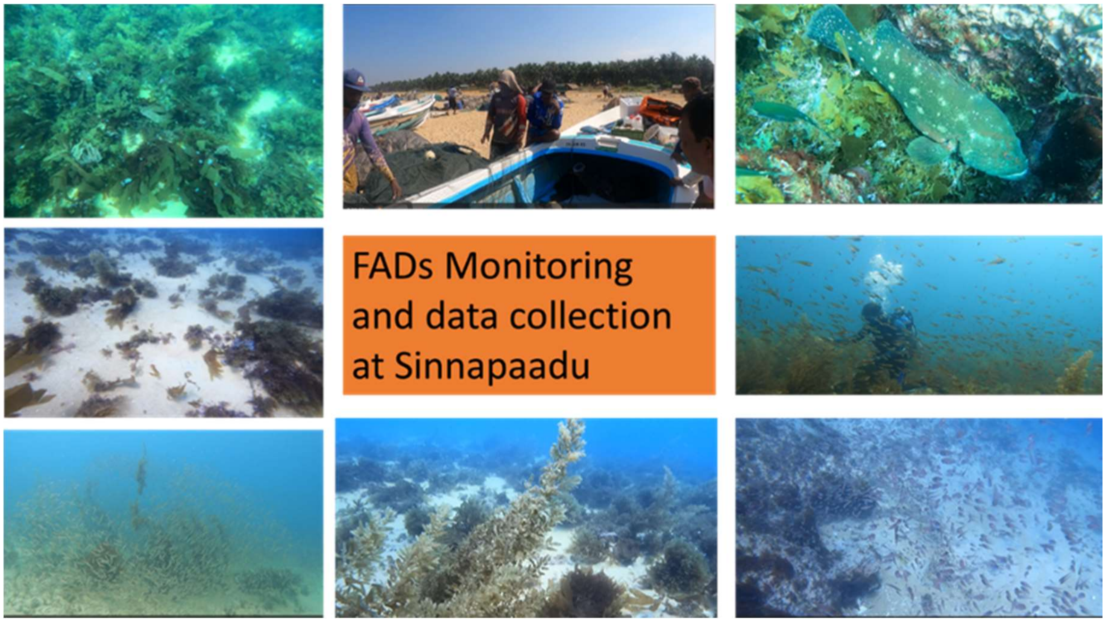


Figure 05. Bottom Condition of FAD Deployment sites at Sinnapadu during February 2023.

Figure 06.Bottom Condition of Obsolete Vehicle Deployment sites at Trincomalee during March-April 2023.

Acoustic survey

Majority of the fish species were marine ornamental fish species. However, detailed study at same site based on acoustic survey was carried out in August, 2023 and covered 20km^{2}of the area at the vicinity of vehicle deployment area.

The decision to conduct an acoustic FAD survey came up rather abruptly. There was therefore limited time to develop an appropriate survey design to estimate the aggregating effect of the artificial FAD. A standard survey design for abundance estimation of a population, with zig zag transects and one stratum was made. This design was not optimal as the aim of the estimation was not to calculate the biomass of a defined population, but rather the fish density and distribution relative to the FAD. The 2023 acoustic survey did not reveal a clear indication that the fish densities increased closerto the fish aggregating artificial reef. Schooling herring type of fish (PEL1) was distributedthroughout the survey area without an obvious association to the FAD. A few schoolsof mackerel type (PEL2) were found at different locations (. Single fish echoes close to theseabed were assigned to bottom/semi demersal fish (BOT) during the LSSS interpretation.Plankton analysis using acoustic survey has given in Figure 7.

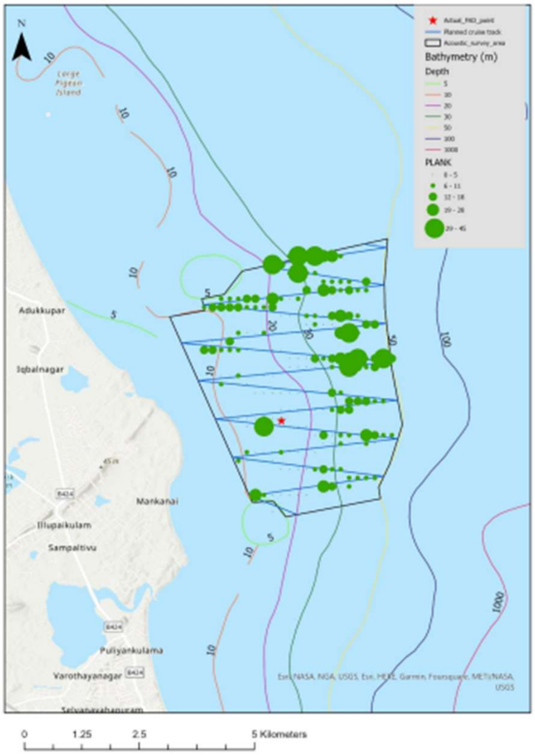


Figure 7. Nautical area backscattering coefficient (NASC) distribution of plankton

A few schoolsof mackerel type (PEL2) were found at different locations. Single fish echoes close to theseabed were assigned to bottom/semi demersal fish (BOT) during the LSSS interpretation.

The total biomass of PEL 1, PEL 2 and BOT was estimated to 2248.20, 8.50 and 32.50 tons, with asampling variance expressed as Coefficient of Variance (CV) of 0.21, 0.42 and 0.20 respectively(Table 2). The CV of PEL 2 (0.42) is high and the patchy distribution lead to a high CV.

Nutrients status

Nitrite, Nitrate, Phosphate and Silicate concentrations collected from Trincomalee is given in table No 01.

Site	Nitrite(µg/L)	Nitrate(µg/L)	Phosphates(µg/L)	Silicates(µg/L)
1	0.89	0.251	0.568	5.308
2	0.18	0.217	0.568	5.813
3	0.135	0.091	0.119	5.308
4	0.248	0.163	0.568	5.319
5	0.112	0.168	0.119	3.962

Plankton abundance

Zooplankton, phytoplankton and ichthyoplankton analysis is in progress.

Conclusion.

It is obvious that fish aggregation is remarkable near the FADs/ obsolete vehicle deployment sites and eco-tourism could promote associated with this location due to the diversity of fish resources. If illegal fishing methods such as Liala and dynamite fishing practices will continue further associated with FADs/Obsolete vehicle deployment sites, the damage to the marine environment/ sensitive habitats and the faunal resources will be highly affected. Meantime, potential chemicals could be releasing from those degraded vehicles have to be measured since ocean could pollute with a wide variety of marine debris, ranging from tiny micro plastics, smaller than 5 mm, to derelict fishing gear and abandoned vessels.

Fish stock estimation using acoustic survey cannot correlated exactly to the results of FADs or deployed vehicles since coral reef ecosystem also exhibit nearby. However, further studies on biological sampling of fish, the biomass and abundance estimationsshould be carried out and consider as indicators of the abundance of herring-like small pelagic fish species ratherthan exact estimations in future. Fish and plankton were abundant in the 30-50 m depth stratum and morefishing activity was also observed there. The FAD site does not show a high abundance of fish.

Publications

1. Wenqi Ye, Xiao Ma, Chenggang Liu, Ruijie Ye, Nilanthi Priyadarshani, Ruchi Jayathilaka, Ashoka Weerakoon, UdeshikaWimalasiri, Kushlani Dissanayake, Gayan Pathiranage, Anu Gamage, Yuanli Zhu, Zhongqiao Li, Bin Wang, Lu Shou, Lihua Ran, Feng Zhou, Jianfang Chen, Ping Du (2023). Vertical Variation of Bacterial Production and Potential Role in Oxygen Loss in the Southern Bay of Bengal. Frontier of Microbiology, (14).
2. Ruijie Ye, Feng Zhou, Xiao Ma, Lu Shou, Qicheng Meng, Dingyong Zeng, Chenggang Liu, Di Tian, Beifeng Zhou, Feilong Lin, Mingquan Xu, Zhentao Hu, W. N. C. Priyadarshani, Jiaying Zhang, R. M. R. M. Jayathilake, Gayan Pathirana, and R. G. A. Iroshanie (2023). An Energetic Mesoscale Anticyclonic Eddy in the Southern Bay of Bengal in June 2020: A Case Study. Journal of Geophysical Research: Oceans, 128 (8).
3. Madhushankha, H.M.T.C., Prabatha, W.A.K., Priyadarshani, W.N.C., 2023. Seasonal and spatial variations of Indian Scads harvesting from ring net fishery in Sri Lanka. Proceeding of NARA annual scientific session

Trainings and workshop

Dr. W.N.C.Priyadarshani

1. The forum on “Blue sustainable development for maritime Community with a shared Future” in Kumming, China during 07-08 December 2023.

2. The Port Cruise data Analysis on Joint Marine research Cruise (Honag Xiang 6) sampling was carried out in second institute of Oceanography, Hangzhou, China during 22nd October- 17th November, 2023.
3. ADB/UCSD/NARA- Capacity Building Project TRAINING WORKSHOP from 19-23 of June 2023

H.M.T.C.Madhushankha

1. "Responsible Use of Fisheries and Aquaculture Resources for Sustainable Development" organized by The Food and Agriculture Organisation of the United Nations with the Ministry of Fisheries and Aquatic resources development on 31/03/2023
2. ADB/UCSD/NARA- Capacity Building Project TRAINING WORKSHOP from 19-23 of June 2023.
3. Workshop on Illegal Unregulated unreported fishing gear at Movenpick hotel, organized by Center for poverty analysis.

W.A.K.Prabath

1. ADB/UCSD/NARA- Capacity Building Project TRAINING WORKSHOP from 19-23 of June 2023.
2. Seminar of marine spatial planning and blue economic development for developing countries. 1-14/November/2023

Committee

- H.M.T.C.Madhushankha was a technical committee member of FAD deployment project conducted by Department of fisheries and Aquatic Resources.

External activities

1. Involvement in court case reports (Case Numbers MC/2256/FS/23, MS/1296/F/23, BR/23/749, BR/23/653, BR/23/654, BR/23/681, BR/23/682, BR/KIN/365/FS/23, BR/1369/01/FS/23)
2. Xpress Pearl shipwreck monitoring

5.3 NATIONAL HYDROGRAPHIC OFFICE

Head of the Division : Mr. S.R.C. Ranaweera

Overview of the Year

The prime objective of National Hydrographic Office (NHO) is undertaking to arrange for the collection and compilation of hydrographic data and the publication, dissemination and keeping up to date of all nautical information necessary for safe navigation in Sri Lankan waters. There are couple of International Obligations to Provide Hydrographic Services.

- International Convention on the Safety of Life at Sea
- United Nations Convention on the Law of the Sea 1982

Regulation 9 of SOLAS Chapter V specifies very clearly the hydrographic services which have to be provided by Contracting Governments. The provision of these hydrographic services is, in effect, an obligation for the Contracting Governments under an International Treaty Law.

This is a mandatory requirement of full filling the obligation of the International Convention for the Safety of Life at Sea (SOLAS). Accordingly charting areas are selected to ensure that hydrographic surveys are being carried out, as far as possible, adequate to the requirements of safe navigation where stakeholders and also being to prioritized. The other principal services are the provision of up dated and accurate bathymetric and topographic data for coastal zone management, environmental protection and maritime delimitation. Investment in a national Hydrographic Service improves safety at sea, increases the protection of the marine environment and advances national development. This means more efficient and safe maritime transport, leading to improved international and coastal trade.

It has been realized that hydrographic data is underpinning the blue economy activities, accordingly NHO has carried out new surveys for Nandikadal lagoon under Lagoon development program to develop a master plan. Here the hydrographic information perform a vital and valuable part of calculating carrying capacity to quantify the optimal economic and commercial benefit of each lagoon. Following surveys and activities were conducted for the year 2023,

3.1 National Charting Program
    3.1.1. Bathymetric data acquisition for Nautical Chart from Colombo to Negombo
    3.1.2. Bathymetric data acquisition for Coastal Nautical Chart of Colombo to Weligama
    3.1.3. Upgrading existing charts
3.2. Establishment of database and online data processing Unit for crowd sourced bathymetry parallel with the Seabed 2030 global mapping project of the General Bathymetric Chart of the Oceans (GEBCO)

This project is continuation project since the year 2020 and establishment of database and online data processing Unit has been completed. During the year 2023 it was possible to gather crowd sourced bathymetry from various research vessels which has visited Sri Lankan waters earlier .Those bathymetric data has been incorporated to the bathymetric database to create a definitive bathymetric model of EEZ of Sri Lanka. The abstract was submitted to NARA Scientific Sessions 2023 by using these data. In addition volunteer contribution has been given to GEBCO Seabed 2030 mapping project by processing world crowd sourced bathymetry online.

3. 3 Surveys conducted for special requests

Activities Undertaken

Table 1:1 Activities undertaken by NHO for year 2022

Program/Projects	No.	Activities	Officer Responsible	Period
1.0 National Charting Programme	1.1 1.2 1.3 1.4	Data acquisition and compilation of Coastal Chart from "Colombo to Negombo" Data acquisition and compilation of Coastal Chart "Colombo to Weligama" Upgrading Existing Nautical Charts Data processing and Cartographic works	S.R.C. Ranaweera Y.M.R.N. Kumari R.K.A. Ariyarathne W.A.A.P. Wijesundara K.A. Ranasinghe D.L.P. Hewage L.S.C. Siriwardane R.M.D.I. Rathnayake S.R.T.P. Singhababu B.H.B. Jayamalie N. Malarathne	Jan- Dec
2.0 Establishment of Database and online data processing unit for crowd sourced bathymetry parallel with the "Sea Bed 2030" global mapping project of General Bathymetric Chart of the Oceans (GEBCO)/ Nippon foundation	2.1 2.2 2.3 2.4	Gathering Crowd Sourced Bathymetry from Non survey Vessels Gathering Systematic Survey Data Processing Data uploading, Database managing	Y.M.R.N. Kumari R.K.A. Ariyarathna R.M.D.I. Rathnayake	Jan-Dec
3.0 Surveys Conducted for Special Requests from Government and other Institutions	3.1 3.2 3.3 3.4	Demarcating and mapping of areas in the sea for Sea cucumber export village in Mannar, Killinocchchi and Jaffna districts for Ministry of Fisheries/NAQDA. Preparation of Navigation Chart to first international Cruise from Chennai to Sri Lanka for Vessel "Cordelia" by Clarion Shipping, Hayleys Group. Bathymetric survey at off Negombo sand borrowing site by the request of Sri Lanka Land Development Corporation (SLLDC). Calculation of water capacity of Maussakale and Castlreigh Reservoirs to Ceylon Electricity Board (CEB).	S.R.C. Ranaweera Y.M.R.N. Kumari R.K.A Ariyarathne W.A.A.P. Wijesundara K.A. Ranasinghe D.L.P. Hewage L.S.C. Siriwardane R.M.D.I. Rathnayake S.R.T.P. Singahababu B.H.B. Jayamalie M.Malarathne	Jan- Dec

Project No : 1.1

Data Acquisition for Nautical Chart from "Colombo to Negombo".

Being an island nation located in a central position of the Indian Ocean, adopting a Blue Economy strategy is a mandatory for Sri Lanka. As the National Hydrographic Office, NARA of Sri Lanka improves safety at sea, increases the protection of the marine environment and advances national development leading for more efficient and safe maritime transport. The availability of the nautical charts have been promoting safety and security in navigation and peaceful and sustainable harness of ocean resources.

Further, the coastal stretch from East to West of Sri Lanka including Jaffna peninsula is covered with two British Admiralty charts named “Colombo to Cape Comorin” – BA 1587 and “Trincomalee to Point Calimere” BA-1584. Both of these charts are produced around 1970s with the scale of 1:300,000 and most of the sea areas are available as unsurvey area. The country aspires to become a maritime hub in the region, taking the advantage of its, the National Hydrographic Office of Sri Lanka is planned to produce a Nautical Chart from “Colombo to Negombo” with the Scale of 1: 100,000 based on the BA chart of 1587. The location of the chart is decided by considering the Colombo Harbour and the access route to Puttalam Harbour from Colombo Harbour. In addition to that the selected area is high attraction for tourism and recreation industries.

NHO planned to conduct the bathymetric surveys to produce a nautical chart from Colombo to Negombo within this year. Compilation of the existing data has been completed within the period. 60% of the chart area has been covered with the data.

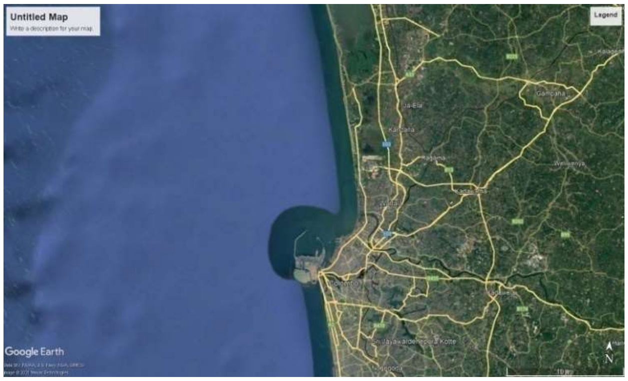


Figure 1:1
Area of the nautical chart from Colombo to Negombo in 2023

PROJECT NO : 1.2
DATA ACQUISITION FOR COASTAL CHART “COLOMBO TO WELIGAMA”.

With the limited budgetary allocation NHO has been completed topographic data collection for preparing Electronic Navigation Chart (ENC) of “Colombo to Weligama” and 90% of the bathymetric data collection for Nautical chart “Colombo to Weligama” has been completed.

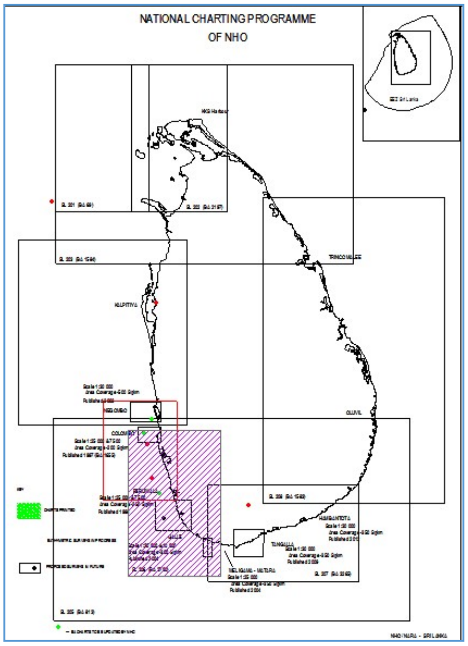


Figure 1:2 Area covered by nautical chart “Colombo to Weligama”

Figure 1.3: Topographic data collection using newly purchased RTK survey system for the nautical chart “Colombo to Weligama”

PROJECT NO : 1.4

UPGRADING THE PUBLISHED NAUTICAL CHARTS

As a normal routing, necessary communications have been maintained with the relevant authorities, Harbor Master of Sri Lanka Port Authority and Director General of Merchant Shipping Secretariat. Accordingly necessary topographic details of newly constructed tall structures (buildings and telecommunication towers which can be used as an aid to navigation) were collected. Sri Lanka Telecom provided the locations of telecommunication towers.

PROJECT NO : 1.5

DATA PROCESSING AND CARTOGRAPHIC WORKS

- Data processing, mapping and cartographic work completed for producing the nautical chart of “Approaches to Puttalam Harbour” (paper chart).
- Completed the Electronic Navigational Chart (ENC) of Puttalam Harbour and sent to the United Kingdom Hydrographic Office which is one of the validation authority of the worldwide ENCs’ as per the standards of International Hydrographic Office (IHO). The final version has submitted to UKHO after the completion as per the validation instructions of UKHO (Authorized ENC distributer).

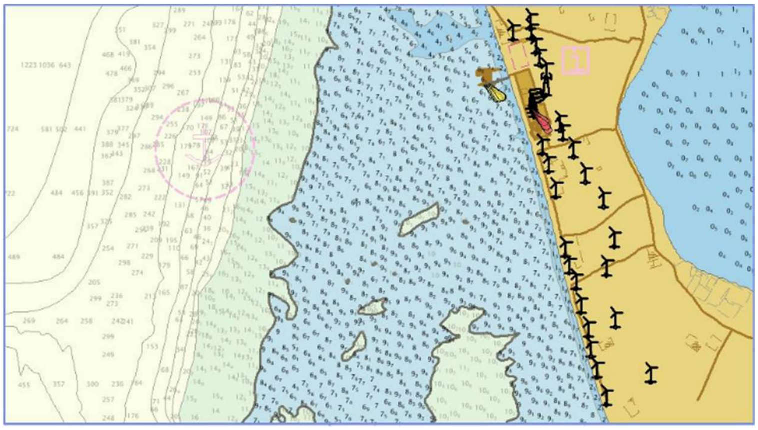


Figure 1:4 ENC at Puttalam Harbour

Other than ensuring safe navigation, there are lot more important applications with the bathymetric data; marine exploration and research, resource exploration, environmental management, coastal zone management, maritime security, infrastructure development, tourism and recreation etc.

Project No : 2.0

Establishment of Database and online data processing unit for crowd sourced bathymetry parallel with the “Sea Bed 2030” global mapping project of General Bathymetric Chart of the Oceans (GEBCO)/ Nippon foundation.

Bathymetric coverage of the sea around our country is very little and need to be done vast area and it needs years and years to fulfil this with the systematic bathymetric surveys. The world contest is very similar and hence the GEBCO Nippon Foundation has started a project called Seabed 2030 and member states of International Hydrographic Organization been invited to collaborate this project covering their own seas from the bathymetry.

The objective of this project is to map the EEZ of Sri Lanka associate with the crowd sources bathymetry apart from the systematic survey data and maintain and updating the data base and disseminate data for marine management, spatial planning and research in marine geology, ecology and oceanography. This will be a continuation project until 2030.

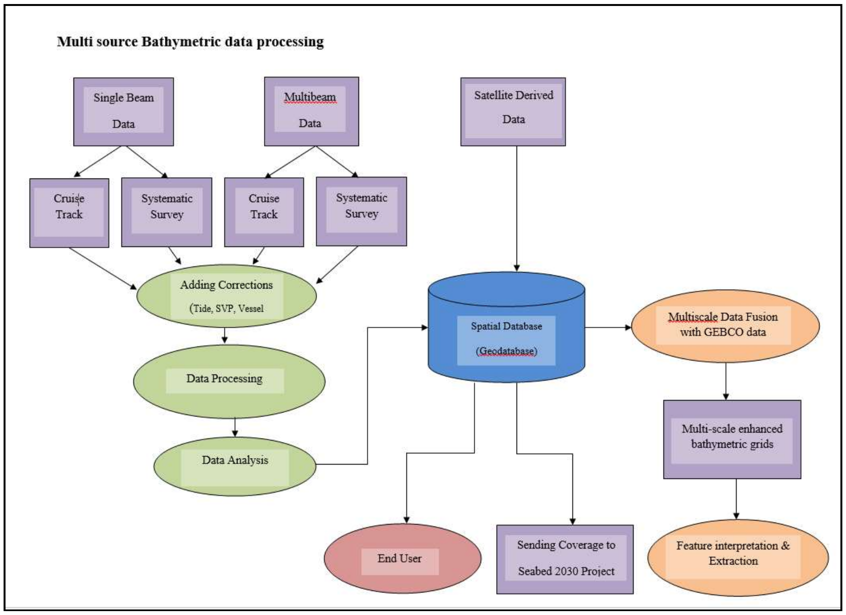


Figure 2.1: Working procedure of multi-source data processing

This project is continuation project since the year 2020 and establishment of database and online data processing Unit has been completed. During the year 2023 it was possible to gather crowd sourced bathymetry from various research vessels which has visited Sri Lankan waters earlier .Those bathymetric data has been incorporated to the bathymetric database to create a definitive bathymetric model of EEZ of Sri Lanka. The abstract was submitted to NARA Scientific Sessions 2023 by using these data. In addition volunteer contribution has been given to GEBCO Seabed 2030 mapping project by processing world crowd sourced bathymetry online.

With the budgetary restrictions the planned instruments were not purchased but database has been updated with the crowd sources bathymetry especially with the “Fridtjof Nansen” Survey data and the RV “Samuddrika” cruise track data. The overall progress of the project of year 2023 is 60%. Furthermore, the database was updated by bathymetric data from cable laying ship MV ”Responder”, (SEA ME WE 6 Submarine cable project).

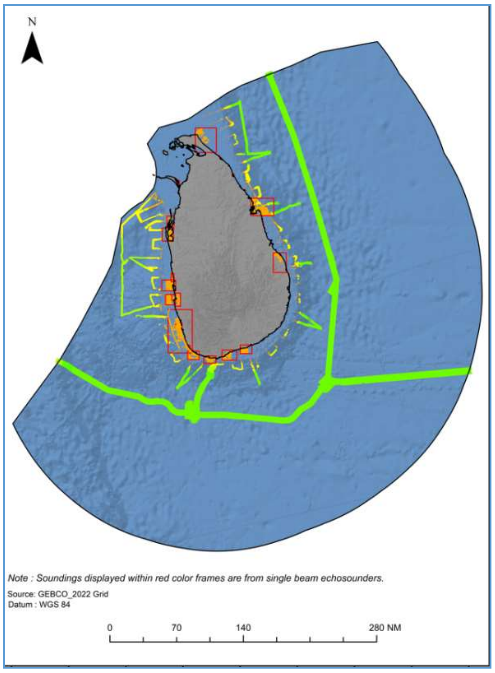


Figure 2.2: Track line of RV "Fridtjof Nansen" and cable laying ship MV "Responder"

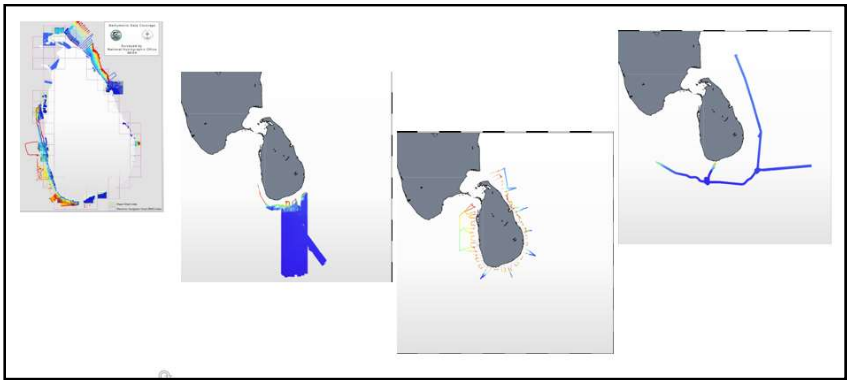


Figure 2.3: Track line of RV "Fridtjof Nansen" and cable laying ship MV "Responder"

Project No : 3.0

Surveys Conducted for Special Requests from Government and Other Institutions

Project 3.1: Demarcating and mapping of areas in the sea for Sea cucumber export village in Mannar, Killinocchchi and Jaffna districts for Ministry of Fisheries.

NHO carried out demarcation of blocks in the sea for Sea Cucumber farming in Kilinochchi and Jaffna districts. The demarcation of blocks in the sea is a part of export oriented project implemented by the Ministry of Fisheries with NAQDA and NARA.

Figure 3.1: Field work demarcation of sea cucumber blocks in Killinochi and Jaffana districts

PROJECT NO : 3.2

PREPARATION OF NAVIGATION CHART TO FIRST INTERNATIONAL CRUISE FROM CHENNAI TO SRI LANKA FOR VESSEL CORDELIA BY CLARION SHIPPING, HAYLEYS GROUP.

NHO prepared custom made nautical chart to cover the passage from Trincomalee to KKS Harbour. This is for the first international cruise from Chennai to Sri Lankan ports in East and North coasts.

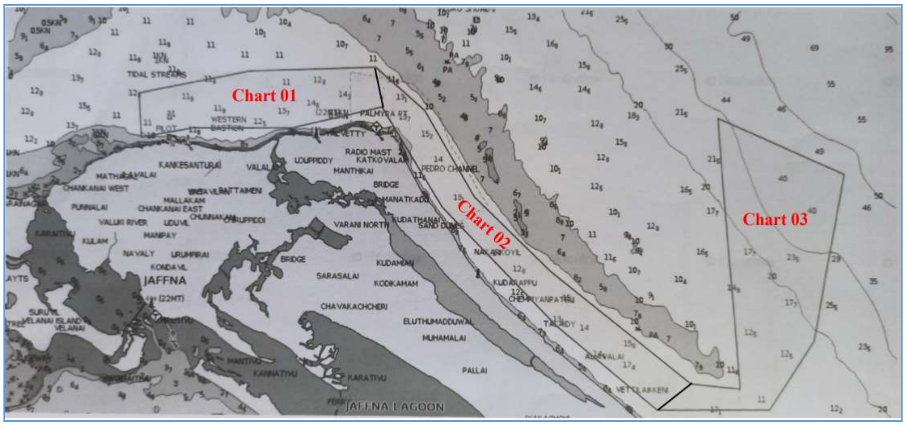


Figure 3.2: Proposed chart area for the cruise liner

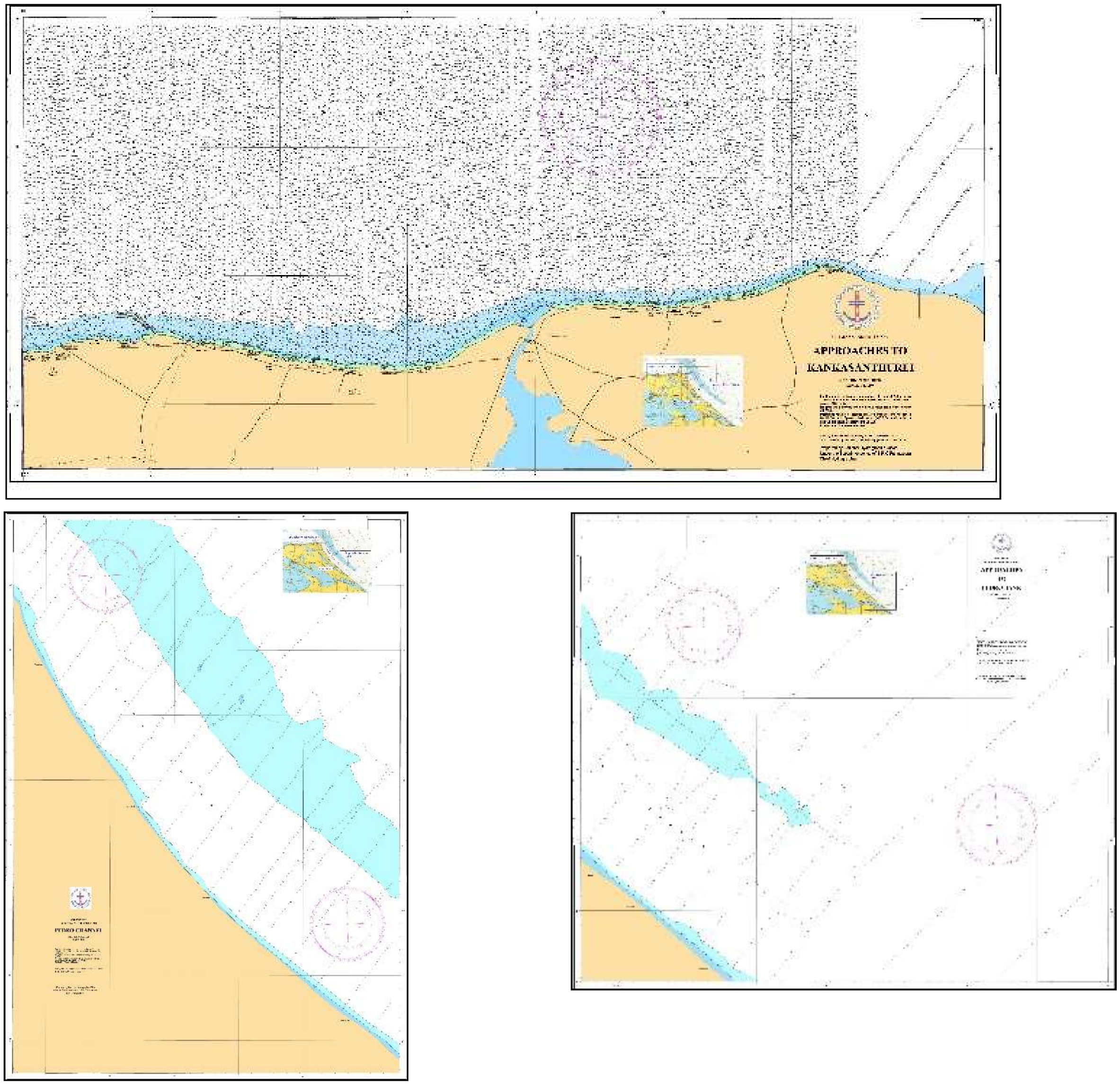


Figure 3.3: Produced nautical charts for the cruise liner

Project No : 3.3

Bathymetric survey at off Negombo sand borrowing site by the request of Sri Lanka Land Development Corporation

The proposed survey area of off Negombo sand borrow area located within 10 km to 22 km off Negombo has two adjacent blocks which have areas of 47 sq.km and 71 sq. km. At first stage of the survey 47 sq.km block has been completed.

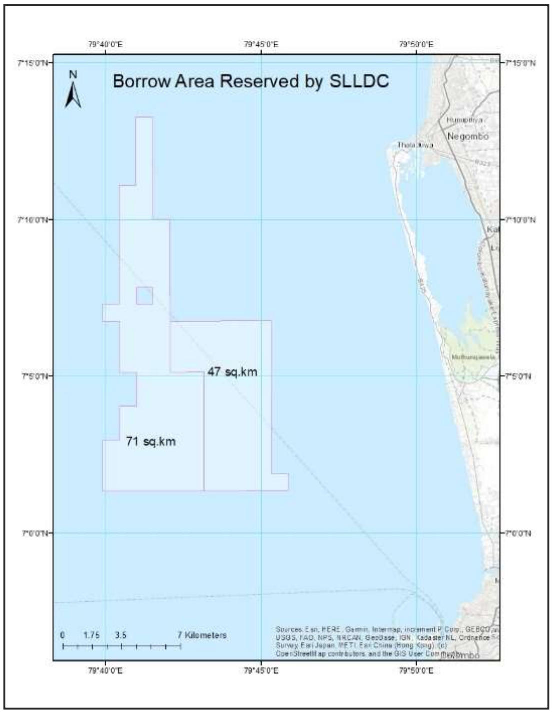
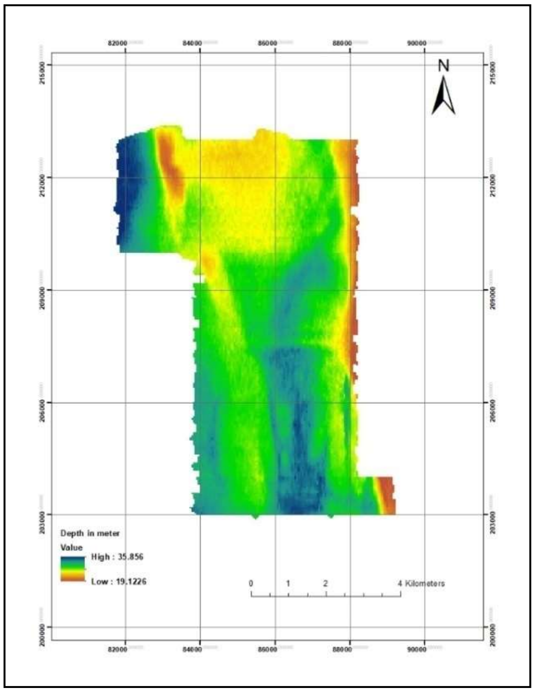
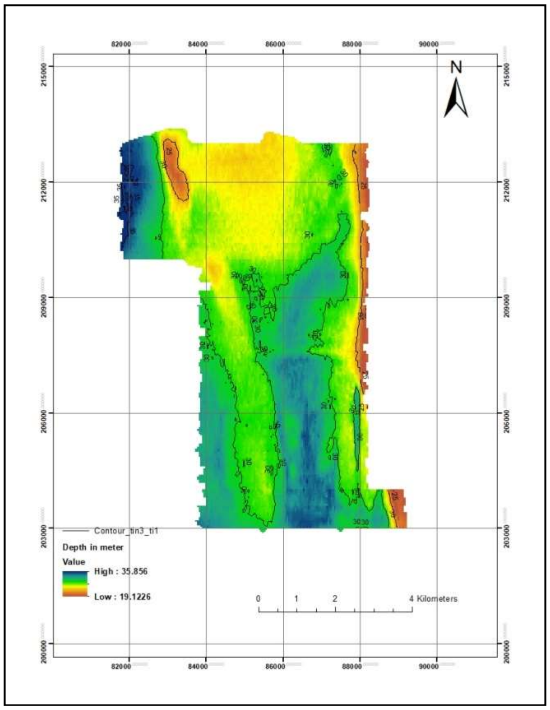


Figure 3.4: Sand barrow site off Negombo.





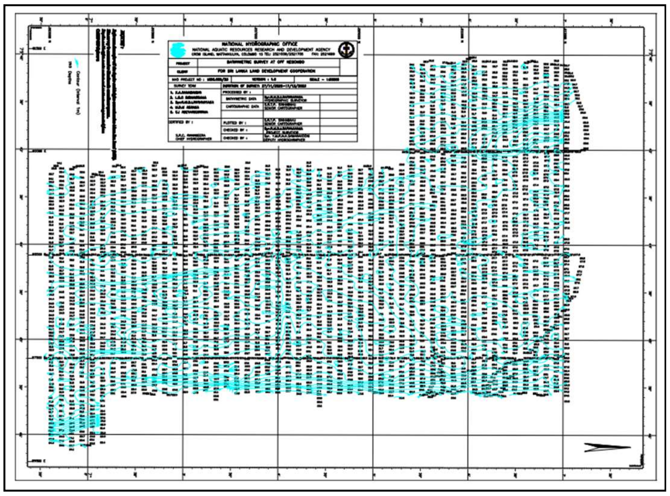


Figure 3.5: Produced charts and data visualization

Project No : 3.4
Calculation of water capacity of Maussakale and Castlreigh Reservoirs to Ceylon Electricity Board.

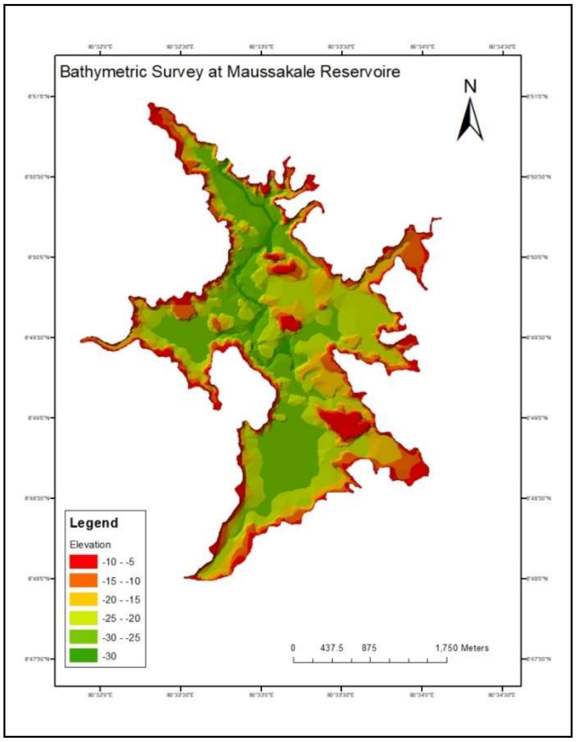


Figure 3.6: Produced charts for volumetric calculations – Maussakale Reservoir

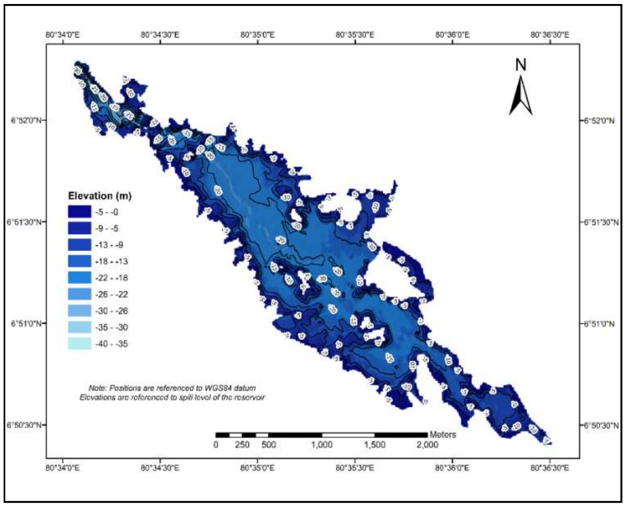
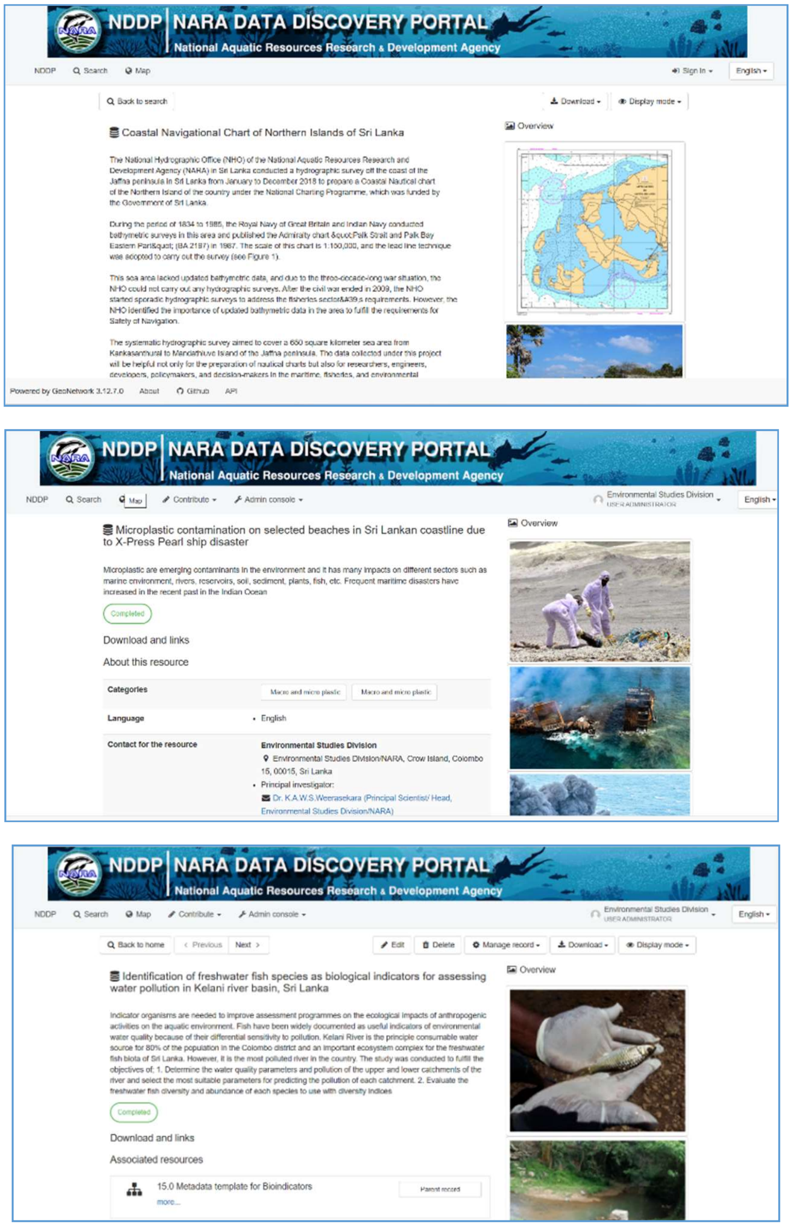


Figure 3.7: Produced charts for volumetric calculations – Castlereagh Reservoir

PROJECT NO : 4.0

ESTABLISHMENT OF DATA CENTRE FOR NARA

Establishment of data center for NARA has been initiated collaborate with all the other research divisions of NARA for data management, storage and visualization and to sharing data and information with the outsiders. Updating of Marine Spatial Data Infrastructure (MSDI) was done collaboration with Faculty of Geomatics, Sabaragamuwa University.



Coastal Navigational Chart of Northern Islands of Sri Lanka

The National Hydrographic Office (NHO) of the National Aquatic Resources Research and Development Agency (NARA) in Sri Lanka conducted a hydrographic survey off the coast of the Jaffna peninsula in Sri Lanka from January to December 2018 to prepare a Coastal Nautical chart of the Northern Island of the country under the National Charting Programme, which was funded by the Government of Sri Lanka.

During the period of 1834 to 1985, the Royal Navy of Great Britain and Indian Navy conducted bathymetric surveys in this area and published the Admiralty chart "Palk Strait and Palk Bay Eastern Part" (BA 2187) in 1987. The scale of this chart is 1:150,000, and the lead line technique was adopted to carry out the survey (see Figure 1).

This sea area lacked updated bathymetric data, and due to the three-decade-long war situation, the NHO could not carry out any hydrographic surveys. After the civil war ended in 2009, the NHO started sporadic hydrographic surveys to address the fisheries sector's requirements. However, the NHO identified the importance of updated bathymetric data in the area to fulfil the requirements for Safety of Navigation.

The systematic hydrographic survey aimed to cover a 650 square kilometer sea area from Kankasanthurai to Mandathivu Island of the Jaffna peninsula. The data collected under this project will be helpful not only for the preparation of nautical charts but also for researchers, engineers, developers, policymakers, and decision-makers in the maritime, fisheries, and environmental

Microplastic contamination on selected beaches in Sri Lankan coastline due to X-Press Pearl ship disaster

Microplastic are emerging contaminants in the environment and it has many impacts on different sectors such as marine environment, rivers, reservoirs, soil, sediment, plants, fish, etc. Frequent maritime disasters have increased in the recent past in the Indian Ocean

Completed

Download and links

About this resource

Categories	Macro and micro plastic Macro and micro plastic
Language	English
Contact for the resource	Environmental Studies Division Environmental Studies Division/NARA, Crow Island, Colombo 15, 00015, Sri Lanka Principal investigator: Dr. K.A.W.S.Weerasekara (Principal Scientist/ Head, Environmental Studies Division/NARA)

Identification of freshwater fish species as biological indicators for assessing water pollution in Kelani river basin, Sri Lanka

Indicator organisms are needed to improve assessment programmes on the ecological impacts of anthropogenic activities on the aquatic environment. Fish have been widely documented as useful indicators of environmental water quality because of their differential sensitivity to pollution. Kelani River is the principle consumable water source for 80% of the population in the Colombo district and an important ecosystem complex for the freshwater fish biota of Sri Lanka. However, it is the most polluted river in the country. The study was conducted to fulfill the objectives of; 1. Determine the water quality parameters and pollution of the upper and lower catchments of the river and select the most suitable parameters for predicting the pollution of each catchment. 2. Evaluate the freshwater fish diversity and abundance of each species to use with diversity indices

Completed

Download and links

Associated resources

15.0 Metadata template for Bioindicators
Parent record
more...

Figure 3.8: Marine Spatial Data Infrastructure; NARA data discovery portal

Publications / Maps

Publications

Electronic Navigational Chart of Puttalam Harbour
Paper chart for "Approaches to Puttalam Harbour"

Training / Awareness Programs conducted:

1. Routine Awareness Program in Hydrographic Surveying and Chart Production for the undergraduates, Naval Maritime Academy of Sri Lanka Navy and school children
   Industrial training programmes for the;
2. Faculty of Geomatics, Sabaragamuwa University of Sri Lanka for fulfil the requirement of FIG/IHO/ICA Category B (Hydrography)
   Faculty of Built Environment, Southern Campus, Sir John Kothalawala Defense University

Foreign / Local Training and International Commitments

1. FIG/IHO/ICA Cat A Course at University of New Hampshire under the Nippon Foundation/ GEBCO Training programme
2. North Indian Ocean Hydrographic Commission (NIOHC) - Hybrid, 2023, Bali, Indonesia.
3. International Hydrographic Organization III Assembly – Monaco, May, 2023

Figure 3.9: International Hydrographic Organization (IHO) 3rd Assembly in Monaco

4. The Nippon Foundation- GEBCO Alumni Conference in Japan: From 31 July – 03 August 2023.

Figure 3.10: All the participants of the Nippon Foundation- GEBCO Alumni Conference

5. Safety and maritime & Seamanship courses for Hydrographers in NHO at Mahapola Training Institute, Sri Lanka Port Authority of Sri Lanka.
    - Personal survival Techniques
    - Fire Fighting
    - First aid
    - Personal safety and social responsibilities

Consultancy Surveys Conducted for Special Requests

Project	Contract Amount (Rs)
Preparation of Navigation Chart to first international Cruise from Chennai to Sri Lanka for Vessel Cordelia by Clarion Shipping, Hayleys Group	Rs.13,364,650.00
Bathymetric survey at off Negombo sand borrowing site by the request of Sri Lanka Land Development Corporation	Rs.8,060,175.00
Total	Rs.21,424,825.00

5.4 INLAND AQUATIC RESOURCES AND AQUCULTURE DIVISION

Head of the Division : Dr. P.P.M Heenatigala

No.	Project title	Allocation requested LKR Mn	Responsible officers
1	Enhancement of export oriented aquatic ornamental industry through technology development for intensive culture/*in vitro* propagation.	1	Ramani Shirantha Jayanthi Mallawaarachchi Tharaka Nuwans Amitha Adikari Sumangala Sugeeshwaree Harshani Deepakumari
2	Evaluate the Optimum Culture Conditions for Grow-out Farming of Sea Cucumber; *Holothuria scabra* in Northern Province of Sri Lanka	1	Pradeep C. Kumara R. Weerasingha J.S. Jayanatha P. A. D. Ajith Kumara
3	Disease monitoring and health management in shrimp aquaculture industry in Sri Lanka	2	A. D. W. R. Rajapakshe A.S.L.E.Corea Amitha Adikari P. Mythyli Harshani Deepakumari P.P.M.Heenatigala
Total		4	

Summary

The IARAD division undertook three (03) research projects in 2024, with focused on the development and monitoring of inland aquatic resources. Project number 01 comprised of four distinct activities. The utilization of Recirculation Aquaculture System (RAS) in the extensive production of guppy (*Poecilia reticulate*) fish has revealed that the ideal stocking density within the RAS system is 2 fish/L. Consequently, the yield per unit area in the RAS system was discovered to be at least tenfold higher compared to that of the traditional culture system. The successful development of new ornamental fish varieties was achieved by hybridizing the female of the endangered fish species *Dawkinsia srilankensis* with the male of the native fish species *D. filamentota*. Nevertheless, further research is necessary to investigate the possibilities of reverse hybridization.

The successful aqua soil production was achieved by combining compost and top clay soil in a 1:1 ratio and its efficacy was confirmed by the satisfactory growth and the production of high-quality plants *Bacopa monnieri* 'Lunuwila'. Further, the most suitable size of the aqua soil ball was identified as 5mm.
The impact of brooder maturity on ornamental shrimp *L. amboinensis* was found to be significant when a combination of commercial feed and Polycheat flesh was provided for the *L. amboinensis* adult as their diet.

The investigation carried out to examine the existing environmental conditions for sea cucumber and seaweed cultivation in various locations within the Northern Province unveiled that the discovery of suitable farming sites and the development of effective feeding methods play a significant role in enhancing the economic and social viability of sea cucumber mariculture in the region. But immediate actions needed to be taken to increase the seed production capacity by increasing the number of hatcheries and increasing the production capacity of the existing hatcheries to fulfill the growing demand for seeds.

The monitoring of shrimp diseases in the North Western province (NWP) has revealed that the EHP disease is a prevalent disease condition frequently observed in the *L. vannamei* culture system in Sri Lanka. Among the five shrimp culture zones in NWP, it has been consistently reported that zone number 3 is particularly affected by the EHP disease.

PROJECT 1.1 ENHANCE THE EXPORT ORIENTED AQUATIC ORNAMENTAL INDUSTRY THROUGH TECHNOLOGY DEVELOPMENT FOR HIGH DENSITY CULTURE AND *IN VITRO* PROPAGATION.

Officer/s responsible	:	Ms. Ramani ShiranthaMrs. Jayanthi Mallawaarachchi, Dr. Tharaka Nuwansi, Mrs. Amitha Adikari, Mrs. Sumangala Sugeeshwaree, Mrs. Harshani Deepakumari.
Total Allocation	:	1.0 million (LKR)
Duration	:	One year (January to December 2023)
Beneficiaries	:	Ornamental plant & fish exporters, NAQDA, DFAR
Locations	:	NARA Head Office, Matale & Kegalle districts
Source of funds	:	NARA

Introduction

Increase of foreign exchange earnings is timely requirement as the country currently undergoes a severe economic crisis in particular after the COVID pandemic hit. Thus, it is extremely essential to earn foreign exchange through different industries for which the export oriented aquatic ornamental industry can play a significant role. Despite of the great threat of corona virus pandemic to many industries in worldwide,30% of the ornamental fish and aquatic plant exporters of the country are still receiving unexpected increased number of export orders and the country has earned nearly 15 million USD in 2019(Nanayakkara *et al.*, 2021).Thus, the industry is identified as a thriving income generator for the country. Development of suitable mass production technologies at least for selected high demand fish and aquatic plant species as well as navel fancy varieties development through hybridization and increased contribution of marine ornamental species can help to booster the industry. There is a great request from different stakeholders in particular NAQDA to develop a water re-circulation/reuse system (RAS) or no or little water exchange culture system which, can minimize culture duration as well as the water budget. In order to invent such, trailing out of research-based culture techniques is essential. Moreover, water recirculation and aqua-soil development are not adequately developed in the country. It is also extremely necessary to focus on captive breeding technology development for marine ornamental fish species which, is in an infant stage and their export is highly depends up on the exploitation of natural stocks.

Specific Objectives: Enhance technology application capacity in different stakeholders of export oriented aquatic ornament industry.

Objectives

- To develop Recirculation System as a culture technique for mass production of ornamental fish
- To develop fancy verities through hybridization of the endemic ornamental fish.
- To develop protocols for *in vitro* propagation of aquatic plant species and aqua-soil
- To develop captive breeding technology for selected marine ornamental invertebrate
- To develop microalgae feed for arteamia.

Scope of the project

- Develop bettertechnologies for ornamental fish/aquatic plant culture and adopt them to enhance export earnings.

Progress: Financial 100% Physical 91%

Activity 1: Development of intensive culture techniques for (*Poecilia reticulate*) guppy fish

Officer/s responsible **:** Amitha Adikari , Dr. Prajani Heenatigala

Introduction:

Sri Lanka is one of the leading ornamental fish exporters to the world. Sri Lanka exports marine, freshwater, brackish water fish species and marine invertebrates. Freshwater aquarium fish comprise the more colorful and striking species of guppies, which account about 60-70% of export. Sri Lankan guppies highly recognized in international markets due to the strength and diversity of the particular fish species when compared to other exporting nations (EDB, 2022). Ornamental fish nowadays is a very prospective business with a great opportunity for development. Therefore production can increase through the intensive culture system (Ahmad et al., 2017). Intensive culture system requires high stocking density. Therefore production volume, as a function of growth rate and stocking density which determines the success of fish culture (Andrade et al 2015). Stocking density affects fish growth, survival rate, feed efficiency, reproduction performance, and productivity. On the other side, high stocking density is a stress inducer that will influence physiology, behavior, and growth of cultured fish (Luoet al 2013).Therefore, this study is aimed to increase the productivity of guppy by evaluation of stocking density, growth rate, survival, water quality management and role of bacteria in nutrient cycling and biological filtration under intensive culture system.

Objectives:

Study stocking density, growth rate, survival rate, water quality and role of bacteria in nutrient cycling and biological filtration under intensive culture system.

Methodology:

The experiment was conducted inAquaculture Research Center (ARC) of the National Aquatic Resources Research and Development Agency (NARA).

Experiment 01: Determination of optimum stocking density of *Poecilia reticulate* using closed Recirculated Aquaculture System (RAS) (existing facility of ARC).

Before start the experiment several modifications were made to overcome the identified problem in existing facility of RAS of ARC (Figure: 1). Rectangular fiberglass tank with a 2.88 m3 production unit and 0.72 m^3 filter unit (40% of the total system volume) were used for the first experiment. The production section had 0.72 m^3 04 fiberglass tanks and 0.72 m^3 filter basin. The filter basin had four separate compartments. The first compartment served as mechanical filters, second compartment and third compartment served as biological filters. The second and third compartments consisted of bio balls and ceramic rings respectively. The fourth compartment of the filter basin was connected to the UV filter (Figure: 2) Given an average water flow of ….., the water volume in the filter was exchanged twice every hour.

Figure 1: Existing facility before modification

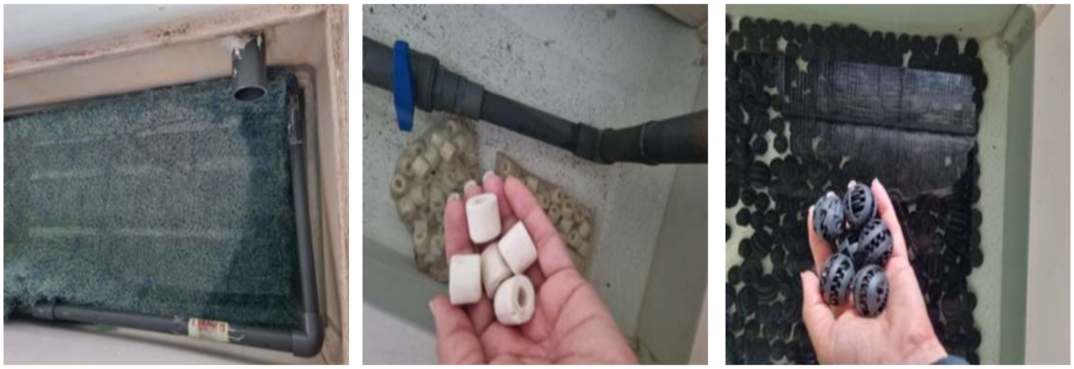


Figure 2: filter system compartments

Three-week-old guppy fish with a total length of 2.2 cm and 0.12g body weight were used for the experiment. Prior to the experiment, the fish had been subjected to quarantine for two weeks. At the start of the experiment fish were size-sorted, and randomly assigned to duplicate culture tanks at stocking densities of 1 fish/liter and 3 fish/liter. Four weeks trials were conducted. The fish were fed a commercially available fish feed with 42% crude protein twice per day at the rate of 2.5% of the body weight of the fish.

Random samples of 100 fish were taken from each tank at two-week intervals to measure the weight and length of the fish. Temperature, pH, and dissolved oxygen values were measured every second day before fish feeding. Once a week, ammonia-N and nitrite values were measured every 3h for a 12h period in all tanks.

Samples were collected from UV tank, bio balls, sand tank, and treatment tanks at weekly intervals to determine the total bacteria count in the RAS system. Serial dilution for the purpose of diluting the bacteria load of water sample taken from the relevant tanks is prepared and autoclaved using 0.85% saline solution. Tryptic Soy Agar (TSA) was selected as the appropriate culture media for bacterial enumeration, considering the diversity of bacteria in RAS. In rate of 40g/1lit from TSA was used for the preparation of culture media. Perform a plate count by pouring prepared nutrient agar medium was added to the pates along with 1ml from each dilution factor to separate plates. Then incubate the plates under $37^{o}C$ for 24 hours.Counted bacterial colonies that form and calculate total bacteria count, expressed as colony- forming units per millilitre (CFU/ml).

Figure 3: Microbial analysis

Results:

After the modification, the turnover rate of the RAS was adjusted to a sufficient level to run the RAS according to the capacity of the production unit (Figure: 4).

Figure 4: After modification

Table 1: shows NH_3 variation of the production tank of the RAS for different densities within the 12 h period.

Table 01: Ammonia level variation of production tanks

	TNA mg/l			
Time interval	**2 fish/l**	**2 fish/l**	**3fish/l**	**3 fish/l**
9.00a.m	1.32±0.01	1.37±0.1	0.08±0.01	0.01±0.1
12 noon	2.67±0.02	2.10±0.2	2.11±0.1	2.08±0.6
3.00 p.m.	2.34±0.1	0.01±0.05	0.01±0.02	3.04±0.04
6.00 p.m.	2.99±0.03	2.68±0.1	2.41±0.5	2.75±0.02
9p.m	2.67±0.1	2.72±0.4	2.56±0.2	2.76±0.28

Water temperature, pH, and dissolved oxygen concentration of water were varied 26 to 28.5 ^{0}C, 6.5-8.9 and 7-8.5 mg/l respectively. The mean TNA mg/l level of the production system varied between 0.01-2.99 mg/l and 0.01-3.04 mg/l in 2fish/l and 3 fish/l respectively.

According to previous research toxic TNA level for fish is more than 1.0 mg/l, TNA ma/l level of the RAS system is higher, and high molarity was observed during the experimental period.(figure: 4). And also in remaining fish abnormalities(figure: 5). were observed According to the literature high level of ammonia and nitrite condition can make deformed fish.

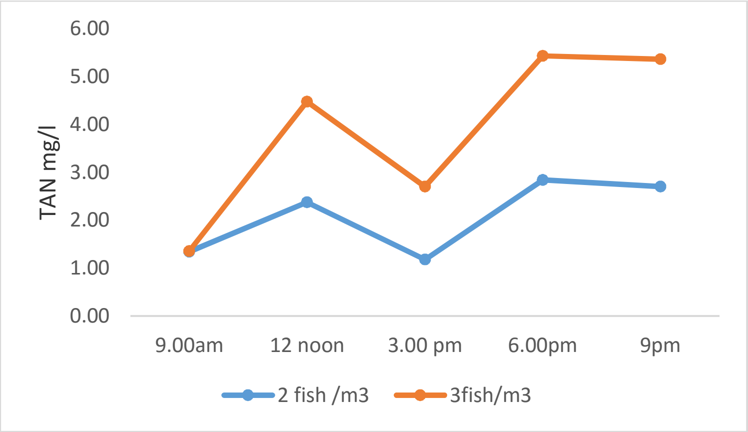


Figure 4: Total Ammonical Nitrogen (TAN) mg/l variation

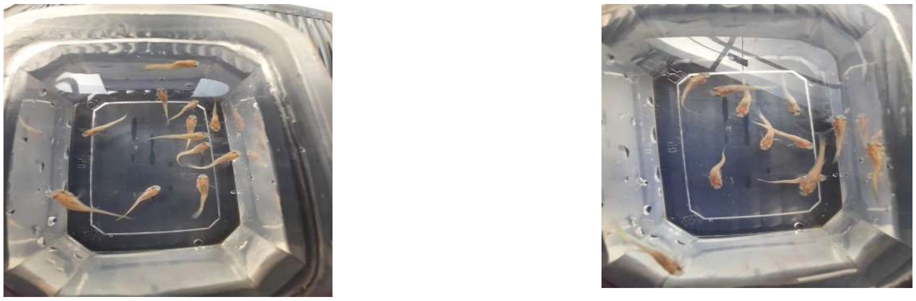


Figure5: Deformed fish

Experiment 02:
To overcome the observed issues in first experiment second experiment was conducted.
Title: Determination of optimum stocking density of *Poecilia reticulate* using closed Recirculated Aquaculture System (RAS) (new facility of ARC).

This new facility consists of fifteen plastic tanks (55 cm x 35 cm) and a separate filter unit. Rectangular fiberglass tank with a 0.432 m3 production unit and 0.32 m^3 filter unit (69% of the total system volume) were used for the first experiment. The production section had 0.03 m^3 15 fiberglass tanks and 0.32 m^3 filter basins. The filter basin had four separate compartments. The first compartment served as mechanical filters, second compartment and third compartment served as biological filters. The second and third compartments consisted of bio balls and ceramic rings respectively. The fourth compartment of the filter basin was connected to the UV filter (Figure: 2) given an average water flow of 2.5 liter/h the water volume in the filter was exchanged twice every hour

Figure 6: Newly designed RAS system

Figure 7: Newly designed filter unit of RAS system

One month old guppy fish with a total length of 2.0 cm and 0.09g body weight were used for the experiment. Prior to the experiment, the fish had been subjected to quarantine for two weeks. At the start of the experiment fish were size-sorted, and randomly assigned to duplicate culture tanks at stocking densities of 2 fish/liter, and 3 fish/liter.4 fish/liter,5 fish/liter and 6 fish/liter. Four weeks of trials were conducted. The fish were fed a commercially available fish feed with 42% crude protein twice per day at the rate of 2.5% of the body weight of the fish. Once every two weeks, 50 % of the total stocked fish were randomly selected to measure the weight and length. Temperature, pH, and dissolved oxygen, values were measured every second day before fish feeding. Once a week, ammonia-N and nitrite, Biological oxygen demand (BOD). Chemical oxygen demand (COD) and Total suspended solid (TSS) values were measured every 3h for a 12h period in all tanks.

Microbial analysis was carried out as mentioned in experiment 01.

Figure 8: Sample collection for microbial analysis

Results:

Guppies with an initial size of 0.2cm and 0.09 g reached a size of 0.14g-2.3cm, 0.13g-2.2cm, 0.13g-2.2cm, 0.13g-2.2cm and 0.13g-2.2cm for T1, T2, T3, T4 and T5 respectively (Figure:8) . However, final weight, length and length and weight gain of guppies in different stocking densities did not show significant difference ($p>0.05$). Figure 8 shows Specific Growth Rate (SGR) values for different stocking densities. All experiment group shows more than 65% survival rate under the RAS system. Two fish/l shows significantly higher survival rate (91%) than all the stocking densities ($p<0.05$). However, the significantly low survival percentage was recorded for 4 fish/l stocking density ($p<0.05$) (Figure: 9).

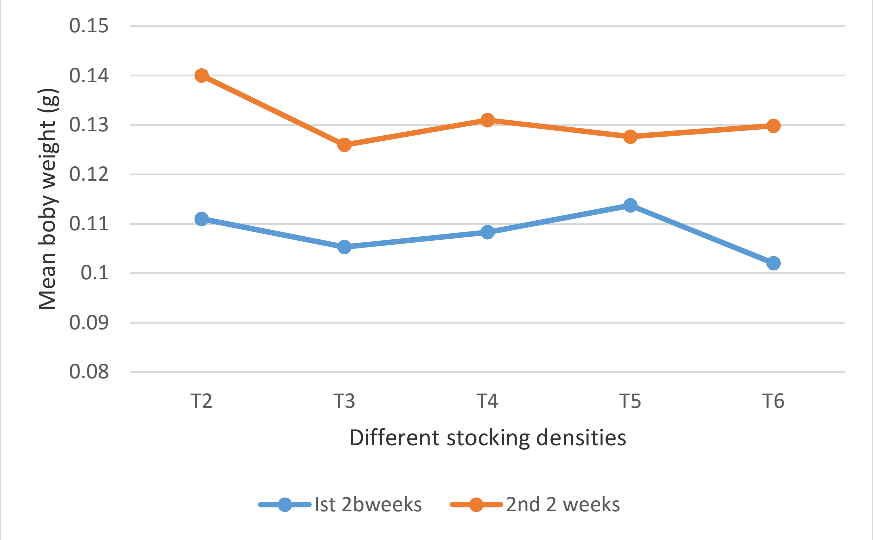


Figure 2: Mean body weight variation among different stocking densities

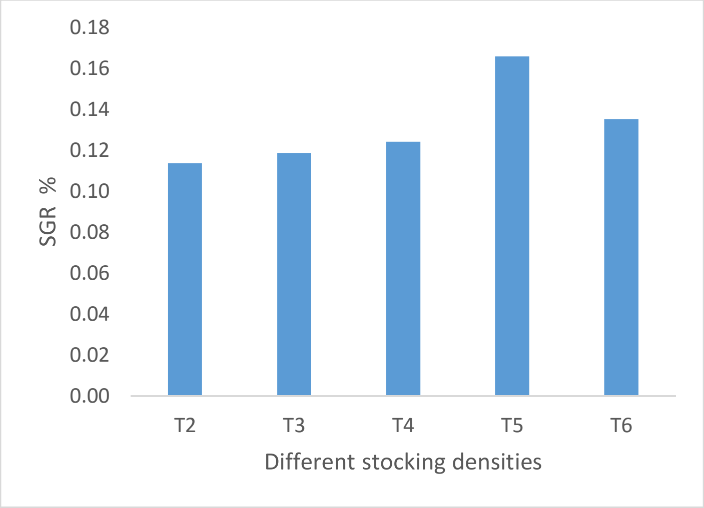


Figure 3: SGR for different stocking densities

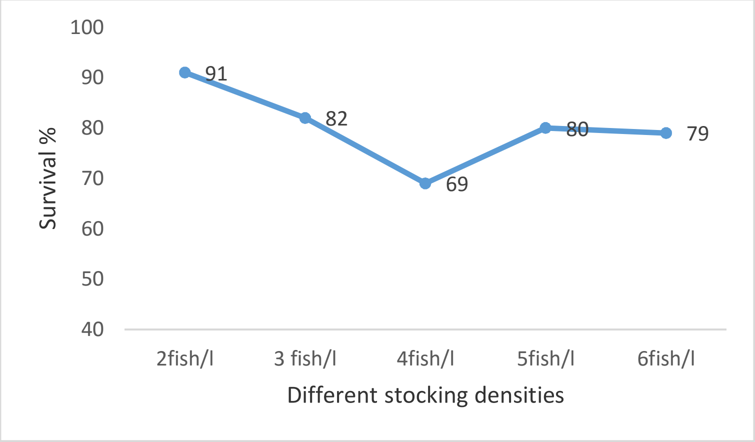


Figure 4: Survival % of guppies in different stocking densities

Temperature, pH and DO of the RAS system varied 26 to 28.5 ^{0}C, 6.5-8.9 and 7-8.5 mg/l respectively. These parameters are in the acceptable level for guppies. According to the figure 4 at the beginning of experiment the NO_2 level of the RAS system much higher than the acceptable level for fish growth. Normally acceptable range of NO^2 for fish is less than 0.5 mg/l. But at the end of the experiment period the NO^2 level of the system drastically reduced up to the level beyond the 1 mg/l. proper filter function may be the reason for drastically reduction of the NO^2 in the RAS system. However, still the NO_2level of the system higher than the acceptable level of NO_2 for fish. This higher of toxic level NO_2 may be the reason for low level of survival of some stocking density (T4, T5 and T6).

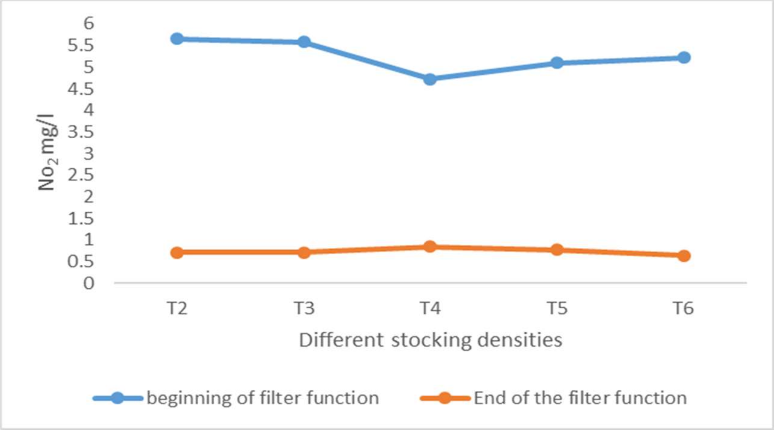


Figure 4: Nitrite variation in RAS

NO_3 level of the RAS system varied within the 10-19 mg/l level throughout the experiment period and it was vary within the acceptable level for fish growth.

Total ammoniac Nitrogen level of the newly designed RAS system varied in acceptable level to the fish. (Fig:5)

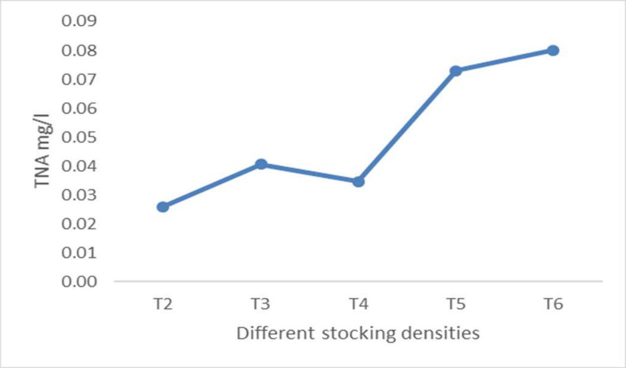


Figure 5: TNA variation in RAS

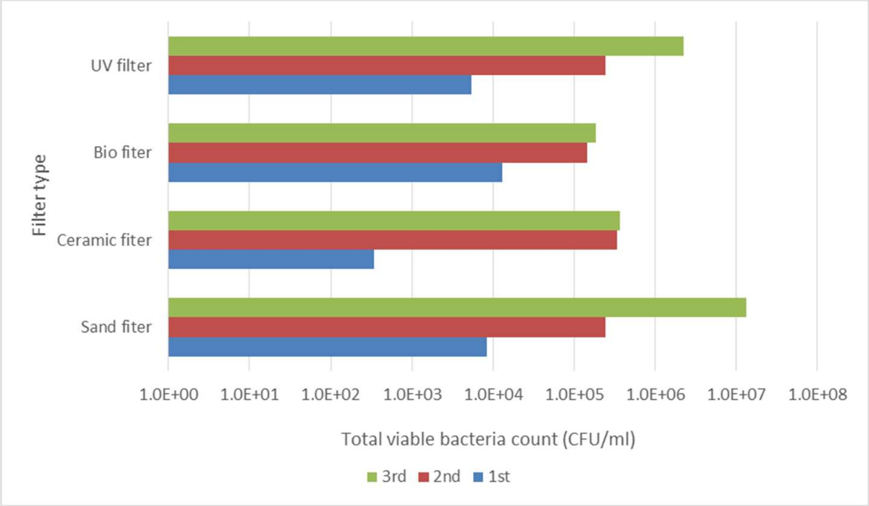


Figure 6: Total bacteria count of the RAS system

Total Bacteria Count in RAS Application of the developed method to assess total bacteria count in the RAS over a specific period. Interpretation of results in relation to system performance, water quality, and potential impacts on aquatic organisms.Bacterial community members identified in samples of sand filter, representing greater than ceramic filter, bio filter and UV filters of the total reads are shown in and Fig.3.1. Nitrifying bacteria of the *Nitrospirae* phylum accounted for 187272 CFU/ml in the bio filter (bio balls) at end and both nitrifying and denitrifying bacteria were carried in ceramic filter.(Fig: 6)

Conclusion:

According to results of preliminary study optimum stocking density of guppy in RAS system is 2 fish/l. Therefore based on the current results, yield obtained per unit area in RAS is at least ten times higher than the conventional culture system. The efficiency of the filter system need to be further incase to reduce the NO_2 level of the production system to increase the survival percentage. Therefore further studies need to be carried out.

Progress: Financial :100% Physical : 90%

Activity 2: Development of fancy verities by hybridizing the endemic *Dawkinsia spp.*

Officer/s responsible : Ramani Shirantha

The project component was focused to develop fancy hybrid varieties as direct exportation of pure endemic species is restricted due to many reasons. *Dawkinsia srilankensis* is a legally protected beautiful fish species endemic to the knuckles mountain range. If hybrid variety developed the country can earn money through their export market. Thus, present research was carried out to develop hybridized by crossing the threatened endemic fish species *Dawkinsia srilankensis* with the common indigenous species *D. filamentosa.*

Initially brooders were collected from the wild, were acclimatized to tank condition and reared over three months period. Wild caught brooders of the selected two species were separated into male &female, and reared in cement tanks until they attained sexual maturity. Afterwards were transferred to 06'×06' fish breeding cement tank and fed with ox-heart, the feeding rational was 5-6g/body weight twice a day. Once they matured their cross breeding was trailed-out (four pairs) following the open-pond cross-breeding method i.e. introduction more than one breeding pairs to a same breeding tank. The selected line was male *D. filamentosa* × female *D. srilankensis* brooders (TL ranged from 6.5-7.2 cmand from 5.2 cm to 6.4 cm) in 2:1 female to male ratio were introduced to 02 separate 4'×8' cement tanks with 1/3 submerged aquatic plants cover. Some water quality parameters i.e. water temperature (°C), pH, Dissolved Oxygen content (mg/l), alkalinity & hardness ($CaCO_3$ mg/l), nitrate, nitrite, phosphate (mg/l), turbidity and total suspended solids (TSS) in the experimental water were recorded weekly in particularly breeding and larval rearing period. Once breeding was success the length and weight of offspring and their exhibited external characters were recorded. Evaluation of the offspring for attractive features was done. The same breeding line was repeated twice in October and November but was not success.

Another two hybridization lines were trailed-out i.e. male *Pethia cumingii* (3-3.5 cm TL) × female *P. nigrofasciata* (4-5 cm TL) and male *Pethia cumingii* (3.5-43.8 TL) × female *P. reval* (2.9-3.2 TL) in 1.5' × 2' glass tanks with 1/3 submerged aquatic plant cover from September to December 2023 but were not successful.

Breeding of other endemic fish species for which species captive breeding technology has been developed during the past years were continued.

15 different species of rare endemic fishes were being reared at the indoor aquarium.

Results and Discussion

A total of four cross breeding trails were carried out in 2023 but only two were success for crossing breeding of *Dawkinsia* spp. Most successful line was male *D. filamentata* and female *D. srilankensis.* The length gained with two months period was varied from 2.42 to 1.06 cm with 1.73 cm average total length. Their growth performance variation is shown in figure 1 and several length classes in the graph indicate that the brooders have laid eggs in several times as serial spawners.

Present hybrid variety exhibitsa notable growth performance achieving an average length of 17.29 mm within two months period. This average value has surpassedpreviously reported value for fingerlings of the parent species*D. srilankensis × D. Filamnetosa*at similar ages (De Silva et al., 2014). The maximum recorded length was 24.22 mm, exceeding even the average size of juveniles reported by Gunasinghe et al. (2022) after 5 months in tanks (23.4 mm). Notably, the minimum length observed (10.68 mm) suggests potential variability in growth rates within the hybrid population. This hybrid also recorded relatively high survival rate (figure 2). However, further research is necessary to determine if this superior growth translates to sustained size advantages throughout the hybrid's lifespan..

Figure 1: growth performance of the hybrid individuals against the time period.

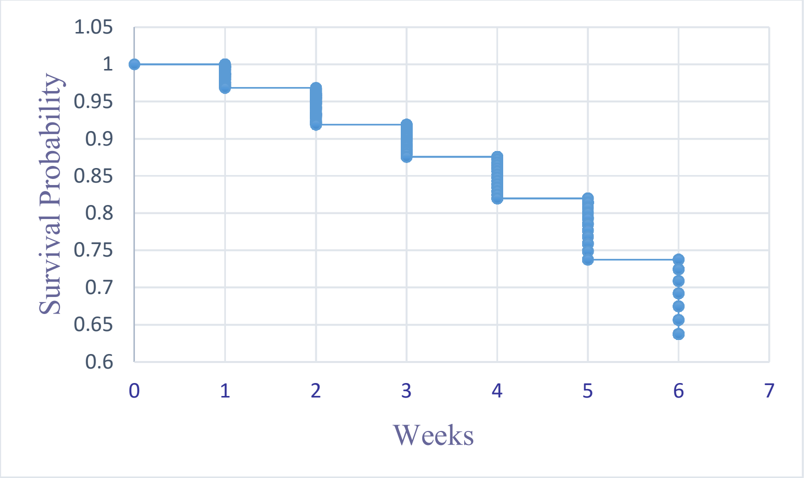


Figure 2: variation of the survival probability of the hybrid individuals.

The evaluation of fancy characters of the offspring is still awaiting as they all offspring yet exhibit more less similar features of the juveniles of *D. filamentosa*.

Major Findings and outputs

Male *D.filamentosa* and female *D.srilankensis*is a successful hybrid line which, can develop a good hybrid variety but further researches need with the inverse hybridization line as majority offspring looks like *D. filamentota.*

Three months aged a total of 65 hybrid individuals.

Recommendations

Further research is needed on this cross breeding experiment.

Progress: Financial 100% Physical 90%

Constraints:

Lack of sufficient enough fish stocking tanks.

Activity 3 Development of protocols for in vitro propagation of selected *Bucephalandra* spp. and to develop aqua-soil for hardening or propagation of aquatic plants

Responsible Officer **:** D. M. S. Sugeeshwari, K.K.T.Nuwansi

Introduction

Plant tissue culture or micro-propagation is a very important technology which is used for mass production of high valued, demanded, quality plants to boost the production. Micro-propagation allows rapid production of high quality, disease free and uniform plants irrespective of the season and weather. The technique has certain demerits like high production cost which have limited the use and therefore it is very much important to protect the produced plants with minimum loss.*Bucephalandra* spp. are exotic aquatic plants which have high demand in the Aquaculture industry. These plants are having high value in the local and foreign markets.

Substantial numbers of micro-propagated plants do not survive transfer from in vitro conditions to field environments because of the lower relative humidity, higher light levels, and septic environments presence in the field environment that are stressful to micro-propagated plants. Most species grown in vitro require an acclimatization process in order to insure that sufficient numbers of plants survive and grow vigorously when transferred to soil. Hence need to develop proper techniques to harden or acclimatized these micro-propagated plants to ensure best survival.In order to increase growth and reduce mortality in plantlets at the acclimatization stage, research has been focused on the control of the environmental conditions (both physical and chemical) and to acclimatize the plants to compete with soil micro-flora.

Thus, it is very much important to develop aquarium substrate or aqua-soil to obtain maximum survival and considerable growth in the acclimatization process of micro-propagated aquatic plants. Aqua-soil enables the slow releasing of the nutrients to the plants to obtain proper growth which minimizes the algae growth in the aquarium.

Specific Objective

To develop protocols for in vitro propagation *Bucephalandra* spp. and to develop aqua-soil for hardening or propagation aquatic plants

Materials and methods:

This research was conducted in the Inland Aquatic Resources and Aquaculture Division of the National Aquatic Resources Research and Development Agency, Crow Island, Colombo 15.

The experiments were conducted to develop a proper sterilization method for the explant of *Bucephalandra* spp. In this step use 4%,8%, and 10% sodium hyperchloride solutions as disinfectants. Maximum survival rate has been shown by using 8% and 10 % NaOCl solutions. Survival rate was 80%. The second step was to reduce the brown form of the explants due to phenol. Hence, modified the murashige and skoog medium with different concentrations of citric acid and Ascorbic acids. According to the results, the minimum number of brown ex plants has shown in 100mg/L Citric: Ascorbic acid combination in MS medium. The survival percentage was 70% in this medium. This research work is continuing for the next year as there was a huge barrier to initiating the shoot or callus due to the phenol effect. Research work is continuously performed.

Production of *Cryptocorynewendii*has been done and around 1000 plants were sent to the plant house for hardening. Developed duckweed monoculture in the laboratory for duckweed identification as well as for the identification of photo effect and carbon source for the growth performance of the plants. Experiments are continuing for next year.

Development of a new laboratory complex in the NARA for Aquatic plant Production.

The experiment conducted as two stages and in the first stage standardized the particle size using Lunuwila plant. As the second stage same experiments done with tissue cultured *Cryptocoryne*plants.

In the first experiment the effects of different particle sizes of pre-prepared soil on the growth performance of*Bacopamonnieri* (Lunuwila) were examined. Four different particle sizes: soil dust, 2-3mm, 5mm, 6-7mm of aqua soil were tested in triplicates.

Preparation of Aqua soil

Compost and Top clay soil from NARA premises were used to prepare aqua soil medium. Only the mixture of two sieved soil samples was used as the control. The compost and the top soil were sieved separately using a 500µm sieve. The sieved soil samples were mixed in a 1:1 ratio. Then 50mL of water was added to the 500g of soil mixture and make in to a dough. For the other three treatments, aqua – soil balls were prepared manually to obtain different sizes such as 2-3mm, 5mm, 6-7mm. In this aqua-soil balls sizes were separated by using ruler. Then aqua-soil balls and the soil mixture for control were put in an oven (YCO-010) at 180 °C for 2 hours. After two hours the aqua-soil balls were allowed to cool into room temperature and stored air tied bottles until use.

Sizes of the substrate particles of the each treatment.

Treatment	Sizes of the substrate particles(mm)
C	dust
T1	2-3
T2	5
T3	6-7

Fig:1 Aqua soil balls

Results & Discussion

Table 1: Mean ± (SD) of Total height, Root length, % of root length and the number of adventitious roots of the plants in different treatments.

Parameter		Treatment			
	Day	C	T1	T2	T3
Total height (cm)	Initial	10.00±0.00^{a}	10.00±0.00^{a}	10.00±0.00^{a}	10.00±0.00^{a}
	Final	12.18±0.84^{a}	12.09±1.24^{a}	14.08±1.07^{b}	13.22±1.19^{b}
Root length (cm)	Final	3.22±0.30^{a}	3.12±0.65^{a}	2.98±0.54^{a}	3.02±0.51^{a}
% of root length	Final	26.57±3.34^{b}	26.13±6.26^{b}	21.36±4.22^{a}	23.00±4.12^{a}
Plant wet weight (g)	Initial	0.78±0.13^{a}	0.79±0.18^{a}	0.76±0.21^{a}	0.78±0.14^{a}
	Final	0.97±0.16^{a}	1.01±0.16^{a}	1.09±0.19^{a}	1.07±0.26^{a}
Plant dry weight (g)	Initial	0.047±0.013^{a}	0.046±0.006^{a}	0.045±0.006^{a}	0.046±0.006^{a}
	Final	0.05±0.009^{a}	0.06±0.009^{a}	0.06±0.012^{b}	0.05±0.005^{a}
% of wet weight gain	Final	28.87±13.84^{a}	29.51±14.81^{ab}	44.85±27.28^{b}	38.77±22.12^{ab}
% of dry weight gain	Final	12.70±25.20^{a}	23.46±23.35^{a}	46.33±24.37^{b}	19.00±13.83^{a}

^{a,b} values in columns with different superscripts differ significantly at $p<0.05$

Table 2: Mean ± SD of leaf length, leaf width, number of leaves, and number of buds, chlorophyll concentration, and leaf surface area in different treatments.

Parameter		Treatment			
	Day	C	T1	T2	T3
Leaf length (cm)	Initial	1.59 ± 0.11^{a}	1.54 ± 0.10^{a}	1.51 ± 0.11^{a}	1.49 ± 0.10^{a}
	Final	2.02 ± 0.22^{a}	1.99 ± 0.25^{a}	1.87 ± 0.22^{a}	2.09 ± 0.25^{a}
Leaf width (cm)	Initial	0.67 ± 0.17^{a}	0.61 ± 0.16^{a}	0.75 ± 0.16^{a}	0.72 ± 0.19^{a}
	Final	0.98 ± 0.20^{b}	0.93 ± 0.16^{b}	0.91 ± 0.14^{a}	0.74 ± 0.15^{a}
Number of leaves	Initial	14.00 ± 0.00^{a}	14.00 ± 0.00^{a}	14.00 ± 0.00^{a}	14.00 ± 0.00^{a}
	Final	20.13 ± 5.68^{a}	20.53 ± 4.91^{ab}	24.00 ± 4.75^{b}	22.87 ± 4.94^{ab}
Number of buds	Final	7.07 ± 3.77^{b}	5.80 ± 3.05^{ab}	3.87 ± 1.50^{a}	4.00 ± 2.90^{a}
Number of adventitious roots	Final	0.73 ± 1.44^{a}	0.93 ± 1.30^{a}	1.53 ± 1.25^{a}	1.53 ± 1.41^{a}
Chlorophyll content (µg/g)	Initial	7.92 ± 0.58^{a}	7.54 ± 0.65^{a}	8.05 ± 0.43^{a}	7.96 ± 0.62^{a}
	Final	12.92 ± 0.77^{a}	15.59 ± 1.74^{b}	16.01 ± 0.82^{b}	14.96 ± 1.13^{ab}
Leaf surface area (cm^2)	Initial	0.70 ± 0.13^{a}	0.73 ± 0.07^{a}	0.74 ± 0.06^{a}	0.71 ± 0.04^{a}
	Final	0.77 ± 0.16^{a}	0.79 ± 0.07^{a}	0.80 ± 0.05^{a}	0.76 ± 0.04^{a}

^{a,b} values in columns with different superscripts differ significantly at $p<0.05$

Table 3 : Mean ± SD of environmental parameters during the experimental period .

Parameter		Treatment			
	Day	C	T1	T2	T3
Water temperature (°C)	Initial	27.5 ± 0.10^{a}	27.5 ± 0.15^{a}	27.3 ± 0.31^{a}	27.6 ± 0.10^{a}
	Final	26.5 ± 0.15^{b}	26.1 ± 0.25^{ab}	26.2 ± 0.35^{ab}	26.0 ± 0.31^{a}
pH	Initial	7.51 ± 0.051^{a}	7.48 ± 0.042^{a}	7.48 ± 0.061^{a}	7.50 ± 0.068^{a}
	Final	6.79 ± 0.031^{a}	6.77 ± 0.05^{a}	6.77 ± 0.05^{a}	6.76 ± 0.05^{a}
Conductivity	Initial	59.5 ± 0.00^{a}	59.5 ± 0.00^{a}	59.5 ± 0.00^{a}	59.5 ± 0.00^{a}
	Final	88.70 ± 7.34^{a}	85.63 ± 10.03^{a}	81.8 ± 1.49^{a}	81.7 ± 3.15^{a}
DO (mg/L)	Initial	7.17 ± 0.06^{a}	6.77 ± 0.06^{a}	6.93 ± 0.23^{a}	7.07 ± 0.23^{a}
	Final	7.55 ± 0.03^{a}	7.54 ± 0.11^{a}	7.61 ± 0.06^{a}	7.59 ± 0.05^{a}
TDS (mg/L)	Initial	26.10 ± 0.00^{a}	26.10 ± 0.00^{a}	26.10 ± 0.00^{a}	26.10 ± 0.00^{a}
	Final	38.70 ± 2.99^{a}	36.37 ± 4.17^{a}	35.13 ± 0.31^{a}	35.20 ± 1.57^{a}
TSS (mg/L)	Initial	4.70 ± 0.00^{a}	4.70 ± 0.00^{a}	4.70 ± 0.00^{a}	4.70 ± 0.00^{a}
	Final	4.43 ± 0.40^{a}	4.67 ± 0.61^{a}	6.20 ± 0.46^{b}	3.77 ± 0.93^{a}

^{a,b} values in columns with different superscripts differ significantly at $p<0.05$

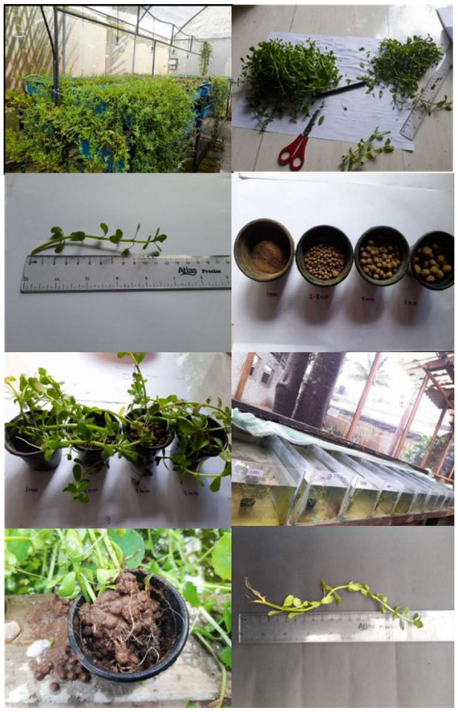


Figure 2: Steps of the experiment (a-*Bacopamonnieri* mother culture section, b-Healthy, fleshy stem cuttings, c-Measured the initial length of the stems, d-Aqua-soil balls in the pots, e-Experimental design, f-Final output of the plants and g-Measured final total plant height.)

In this study, plant were cultured using four different treatments, and all plants were survived until the end of the experiment without showing any nutrient imbalances or deficiency symptoms. Deformities or pathological changes were also not observed in plants during the experimental period. The growth performances of the plants was significantly affected by particle sizes of substrate compositions. The characteristics of soil play a big part in the plant's ability to uptake water and nutrients in terrestrial plants as well as aquatic plants.

Conclusions

For the *Bucephalandra*spp sterilization could suggest using 10% and 8% Clorox solutions for the explant sterilization and then culture in MS medium with 100mg/L Citric and Ascorbic Acid medium.

In the present study, 5mm illustrated better growth performances and good quality plants in freshwater ornamental aquatic plant *Bacopamonnieri*'Lunuwila'. Compost is easily available and they can be bought in local markets at a cheaper price even. These type of aqua-soil can be used in aquarium decorations. It helps to reduce the waste the manure in the culture conditions. Growth of aquarium plants can be increased in short time period. As aqua-soil balls prepared with naturally available substances it do not contain any harmful or toxic substances, so that fish or aquatic animals won't affect. Also aqua-soil is a baked item it may not responsible for create high water turbidity and maintained the clear aquatic environment which is very much suitable for the display aquariums. Also it is responsible for the slow releasing of ions to the water column algae growth can be minimized or control. These type of aqua-soil balls can be kept nearly 6 months without dissolve in the water. These findings will be useful for the commercial culture of aquatic ornamental plant.

Project outputs & outcomes

Outcomes

- Developed Sterilization protocol for *Bucephalandra*spp
- Production of *Cryptocorynewendii* plants
- Monoculture of duckweed species.
- Developed protocol for aqua-soil for aquatic plants
- Protocol for proper hardening of tissue cultured aquatic plants

Outputs

Economic development of the country through better and efficient aquaculture practices.

Constrains:

- No sufficient laboratory or equipment facilities to smooth running of the experiments.
- *Bucephalandra*spp plants are very expensive and have to spend huge amounts of money to maintain the mother stock for the experiments.

Progress: Financial :90% Physical : 90%

Activity 4 : Development of captive breeding and culture techniques for a selected marine ornamental invertebrate species Fire Cleaner shrimp*Lysmata amboinensis*

Responsible Officer **:** M.A.J.C. MallawaArachchci

Introduction

The export of Scarlet Cleaner Shrimp (*Lysmatadebelius*) from the seas around Sri Lanka has raised concerns about the species' potential extinction due to overreliance on wild collection. In response to this threat, a research project was initiated with the objective of establishing a sustainable breeding and culture program for a closely related species, Cleaner Shrimp (*Lysmataamboinensis*).

L.amboinensis, commonly known as the peppermint shrimp, is a popular marine ornamental species. The primary aim was to support both conservation efforts and the commercial culture of this species in the local region.

Objective:

The primary objective of this research project is to establish a sustainable breeding and culture program for the Cleaner Shrimp (*L.amboinensis*) with the dual purpose of supporting conservation efforts and meeting the demands of the commercial market in the local region. The project aims to address the threat of extinction faced by this indigenous species, driven by the dependence on wild collection for export and the challenges in the commercial production of *L. amboinensis* due to poor larval survival and lengthy larval life. Specifically, the project seeks to develop a captive breeding protocol and larviculture technology to overcome these challenges and promote the sustainable management of the species.

Brooder maturity is crucial for successful breeding in captivity, and dietary factors play a significant role in influencing reproductive capabilities. In the initial phase of this research project, the primary objective was to explore how various feeding programs influence the brooder maturity of *L. amboinensis* adults.

Specific Objectives :

- To assess brooder maturity
  Evaluate the maturity of *L. amboinensis* adults maintained at an indoor marine hatchery in Colombo, NARA, by analyzing the reproductive capabilities of the adults under captive conditions.
- To evaluate the Influence of different feed
  Investigate the impact of different feeds on brooder maturity.
- To develop a brooder feeding protocol
- To develop larvae culture protocol
- Based on the feed selected for adult maturation conduct breeding trial and develop larvae culture protocol

Materials and methods:

The research project aimed to assess brooder maturity in *L. amboinensis* adults maintained at a marine hatchery in Colombo, NARA. The study focused on the influence of different feeds on the reproductive capabilities of adults under captive conditions.Nine pairs of*L. amboinensis* adults were collected from established aquariums and accommodated innine glass tanks with 12 liters of water volume in each tank.Each pair consisted ofa berried female. Three feeding dietary programs were tested against the brooder maturity.Three feed types were as

- commercial feed (C)
- polychaete flesh feed (P)
- mix of commercial and polychaete flesh feed (C+P).

All three treatments were triplicated. Each female in tanks was allowed to hatch their eggs. To assess the impact of these feeds on brooder maturity each aquarium was daily observed for the presence of exuviate or eggs on shrimp pleopods.

The number of days was monitored until appear eggs within female pleopods.

Results & Discussion :

Preliminary results indicate a significant influence of the feed on brooder maturity in *L. amboinensis* adults.

Table 1: Impact of different feeds on brooder rest period in *Lysmataamboinensis*

Treatment	Days taken to eggs appear on pleopods (mean ± SD)
Commercial	10.0 ± 2.00^{b}
Polychaete flesh	6.3 ± 1.53^{ab}
Commercial +Polychaete flesh	3.3 ± 0.57^{a}

*Means with the same letter are not significantly different at $p > 0.05$ using LSD

Figure 1: Brooder pairs housed in glass tanks for reproductive assessment

Statistical analysis indicated that the C+P feed significantly ($p < 0.05$) reduced the rest period after egg hatching (3.3 ± 0.57) compared to commercial feed. However, it was not significantly different from the sole polychaete flesh feed.

The mix of commercial and polychaete flesh feed (C+P) demonstrated the most promising impact on brooder maturity. Further experimentation and implementation of this feed in broodstock maturation in captivity will be pursued, and the breeding and larvae culture protocol development will continue in year 2024.

Conclusions

The research project has made significant steps in developing a sustainable breeding and culture program for Cleaner Shrimp (*L. amboinensis*) in Sri Lanka. In conclusion, the choice of feed significantly influences brooder maturity in *L. amboinensis* adults. The C+P feeding program showed the most promising results, reducing the time taken for eggs to appear on pleopods and minimizing the rest period after egg hatching. This feed will be further investigated for its potential to enhancebroodstock maturation in captivity.

Future research will focus on fine-tuning the feeding protocol, optimizing the C+P feed composition, and exploring additional parameters affecting brooder maturity. Continuous monitoring and experimentation will contribute to the development of effective breeding and culture protocols for *L. amboinensis* in marine hatchery settings.

Project outputs & outcomes

Project Output

Development of feeding protocol for brooder maturation of*L. amboinensis*. Successful maturation of *L. amboinensis*broodstock in captivity is a crucial step toward sustainable breeding and culture of marine ornamental shrimp species

Constraints

Less and seasonal availability of brooders effected the project initiation.

Progress: Financial :95% Physical : 65%

PROJECT 1.2: EVALUATE THE OPTIMUM CULTURE CONDITIONS FOR GROW-OUT FARMING OF SEA CUCUMBER; *HOLOTHURIA SCABRA* AND CURRENT METHODS AND REGULATION FOR WILD SEAWEEDS (MARINE ALGAE) HARVESTING IN NORTHERN PROVINCE OF SRI LANKA.

Officer/s responsible **:**P. A. D. Ajith Kumara, R. Weerasingha, J.S. Jayanatha, Pradeep C. Kumara

Total Allocation : 1.0 million **(LKR)**

Introduction

Sea cucumber farming is a luxurious business in coastal areas of the North Sea of Sri Lanka. Due to the low supply of larval sea cucumber, farmers always try to catch the required stock from the wild or buy from sea cucumber collectors. This practice shows a huge pressure on the wild population. The export data of processed sea cucumber and information of previous studies warn the future imbalances in this resource.

Demand for seaweeds like Sargassum spp. is currently increasing due to the nutrient richness in it. Recently sea cucumber farmers started to feed Sargassum spp for farming sea cucumber. The wild collection of Gracilariasalicornia has also increased in past years due to the availability of chemical compounds. Nevertheless, this wild harvesting shows a significant impact on natural stocks.

Therefore, the project aimed to evaluate causes that affect the expansion of sea cucumber farming in the Northern waters of Sri Lanka and the status of wild seaweed stocks in the Northern Province of Sri Lanka.

Fig .1 sea weed culture Area

Objective/s

- Investigate the present culture conditions of sea cucumber and seaweed in different places of Northern Province to screen unsuitable farming practices
- Identify positive and negative impacts of present sea cucumber farming in North coast.
- Collect fundamental data for establishing an Ecosystem-Based Management (EBM) for future seaweed sustainment.
- Formulate recommendations for possible changes which has to be necessarily done for the sustainability of sea cucumber farming.
- Prepare practical diets that can feed for growing sea cucumbers.
- Evaluate current harvesting strategies and assess future risks to the ecosystem.

Methodology

The project utilized a multi-faceted approach, including monitoring commercial sea cucumber farms and hatcheries, gathering information from farmers and hatchery owners to formulate sea cucumber feeds, analyzing water quality parameters, and collecting ecological data through suitable methods like Underwater Visual Census (UVC). The project team collaborated with the National Aquaculture Development Authority (NAQDA) and relevant stakeholders in collecting information.

Results

Sea cucumber

- There are many positive and negative impacts in the present sea cucumber farming of the North Coast.

Positive impacts

- It is proved through discussions conducted with sea cucumber farmers in studied areas that the income of people who engage in the sea cucumber aquaculture sector has increased.
- The exporters of processed sea cucumber in the Northern area buy cultured sea cucumber, process and export; therefore they could bring foreign currency to the country. Ex: According to the export price of Suganth International (Pvt.) Limited, one acre farm produces 4050 USD (Please see section 5.10.5)
- Several job opportunities have created in the area through expanding sea cucumber farming.
- An opportunity has been created to transfer from stake net and fyke net fishery to sea cucumber farming in some areas. For instance, Eluvaitivu fishery community is willing to transfer to sea cucumber farming from the artesian fishery. Almost all fishermen in Mandativu and Punkudutivu have transferred to sea cucumber farming from stake and/ or fyke net fishery while the majority of fishermen engaged in stake or fyke net fishery (around 80%) has transferred in Gurunagar and Pasaiyoor areas. However, no evidence that transformed farmers has established their removed cage in another place.

Negative impacts

- Most sea cucumber farms in Parititivu area are practiced by enterprises employing persons from outside the fishing community in the area. Therefore, it has not created alternative livelihoods for low-income fishermen in this area.
- After culturing, the farming groups have left all farming materials (plastic nets and PVC pipes) in the sea where it was practised leading to reduced circulation of water and thereby to increased pollution in Parititivu, Mandativu and several other locations. They may have thought to restart the culture next time. However, it is not suitable to keep fencing nets longer in the sea after a harvest and remain empty. After a culture cycle, removing the fencing nets until the next cycle start is recommended. However, farmers need to take it to a landing site for cleaning before the next culture cycle.
- Lowered water flow rate due to poor cleaning of fencing nets has resulted in increased sedimentation in those areas.
- Increasing conflicts between sea cucumber farmers and small-scale fishers. For instance, fishermen in the Parititivu area complain about solar lights established in sea cucumber farms because their catch hasdropped after establishing sea cucumber pens. They assume that the light effect at night control fish movements. Similarly, Bassi et al. (2021) state that artificial light at night is a potential cause for changing fish fitness, behaviour and physiology.
- Reducing the wild sea cucumber stocks when using wild juvenile sea cucumbers for farming because export data of sea cucumber in the Ministry of Fisheries shows a decline yearly. Collectors of juvenile and adult sea cucumbers also state that there is a decreasing trend in the wild catch.
- Some farming areas which earlier were recommended by NARA through previous studies as not suitable areas are widely used for sea cucumber farming. However, deliberately constructed sea cucumber farms in those areas have resulted in a lowered growth in growing sea cucumbers. Ex: Sea cucumber farms at Gurunagar.

Two practical feeds were formulated.

- Sea cucumber juveniles are collected from April to May from Pallikuda, Iranativu, Alaippiddi area which is around 80% of the sea cucumber farming requirement. Some juveniles are kept in pits of the shallow sea until starting the farming season.
  - Bad management practices like overstocking of sea cucumber in very shallow waters, poorly cleaned boundary nets, and narrow and unacceptable free spaces in between two fences are extensively reported in Valeipadu and Kiranchi area.
  - Active monitoring of six commercial farms and addressing two identified issues.
  - Frequent socio-economic studies and water quality analyses were conducted to measure present farming conditions.
  - Present Sargasum spp. stocks around Delft Island was monitored with UVS.
  - The present status of all sea cucumber hatcheries was monitored. Issues for further expansion of juvenile production were recorded from their aspects.

Seaweeds:

Density of Gracilariasalicornia

Total sampled area from Kiranchi (Kakkaduwa) to Eramathive island= 15m^2

(60 random plots in six transects along the dense collecting areas).

- To get a more realistic picture,
- Density=n/A
- n= total number of individuals of the sp
- A= total area sampled

Total samples *G.salicornia* bush= 212

Total number of other specie=415

Average density of G.salicornia =212 individuals/15 m2 =14.13

- Cover=a/A
- This is proportion of the ground or substratum occupied by the individuals of the species
- A= total area covered by species
- A=total area sampled

Coverage of *G.salicornia* in wild collected area in Kakaduwa=$(44*0.25m^2)/(15m^2)$

Percentage cover from the *G.salicornia* =74%

Standing crop biomass in selected species

- It is the weight of existing species in the given area at any one time.
- B=(D)(TW/n)
- D= density
- Tw= sum of the weight of individual species in a sample.
- n=number of individuals in the sample

Standing crop biomass in G.salicornia = (Density) (sum of the weight of individual Species in a sample/ number of individuals in the sample). =8.84kgm^{-2}

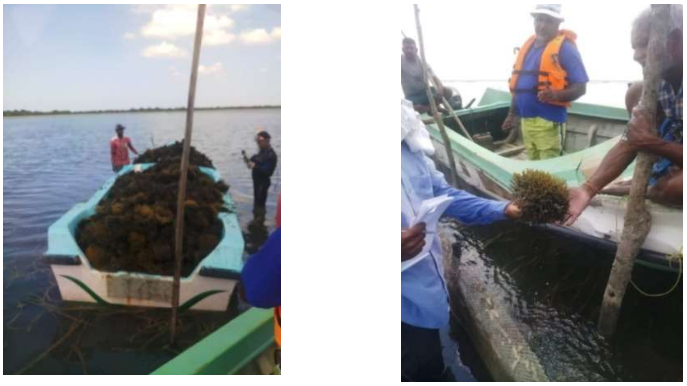


Fig 2 .sea weed sample collection

Fig 3: conducting awareness programme

Output

- A list of positive and negative impacts of present sea cucumber farming
- Developed feed formulae.
- Identified suitable and unsuitable farming sites
- Socio-economic issues in sea cucumber farming
- Issues related to the expansion of hatchery production
- A list of new recommendations
- A place (Palaitive Island) that has to be declared as a marine protected area.

Outcome

The project outcomes include the establishment of viable sea cucumber farming practices, informed by scientific research and community engagement. The identification of new farming sites and the formulation of practical feeds contribute to the economic and social sustainability of sea cucumber mariculture in the Northern Province.

Progress

The project achieved an overall physical progress of 93%, meeting and exceeding the set milestones.

Financial 100% **Physical** **93**%

Conclusion

Mostly, sea cucumber farmers depend on sea cucumber juveniles collected from the wild. Thus, the period after the two monsoons is recommended as the suitable season for surveying to determine the availability of juvenile sea cucumber in the wild. Sea cucumber farms are closely located with very narrow buffer zones (less than 30 m). Establishing a 30 m buffer zone is recommended for sustainable sea cucumber farming in this area. In some crowded farming areas, water velocity is less than the acceptable range. Therefore, regular cleaning of the fencing material of each farm is recommended to maintain the optimum culture conditions in farms as for the well-being of other marine fauna. Immediate actions should be taken to increase the seed production capacity by increasing the number of hatcheries and increasing the production capacity of the existing hatcheries.

PROJECT 1.3: DISEASE MONITORING, PREVENTION AND HEALTH MANAGEMENT IN COSTAL SHRIMP AQUACULTURE.

Responsible Officer **:** A.D.W.R.Rajapakshe, A.S.L.E.Corea, P.P.M.Heenatigala

Total Allocation : 2.0 million (LKR)

Introduction

Shrimp farming is a multi-billion dollar industry contributing a major income to several countries in Asia and South America. The rapid growth of shrimp farming led to an economic boom but, unfortunately, the outbreak of viral diseases has increased the economic risks and slowed the industry development (Flegel, 2006). The most important diseases of cultured penaeid shrimp, in terms of economic impact, in Asia, the Indo-Pacific, and the Americas have infectious etiologies. Among the infectious diseases of cultured shrimp, certain virus-caused diseases stand out as the most significant. The pandemics due to the penaeid viruses WSSV (White spot) and TSV (Taura Syndrome), and to a lesser extent to IHHNV(Infectious Hypodermal and Hematopoietic Necrosisvirus) and YHV (Yellow Head), have cost the penaeid shrimp industry billions of dollars in lost crops, jobs and export revenue. The social and economic impacts of the pandemics caused by these pathogens have been profound in countries in which shrimp farming constitutes a significant industry. In the present study some of the common diseases in *L.vannamei* will be assessed in detail in puttlam district.

Objective

- Determination of the disease conditions of *L.vannamei* farming.
- Identify the disease mitigating factors and remedial measures.
- Increase the shrimp production and income from the export

Materials and methods

Randomly selected farms from 5 zones (1,2,3,4,5) in Puttlam District. Quarterly visited each zones and 3 farms from each zones were monitored. Collected water samples, shrimp samples from each farm for the analysis. Water quality parameters such as DO, pH, Tem and salinity were recorded and taken Water samples aseptically for Vibrio bacteria isolation. Shrimp samples were collected for histopathology and DNA extraction for diagnose shrimp viral and parasitic disease. Fecal matter tested with wet mount and stain with Gimsa for EHP gross identification. Target viral pathogens are WSSV,IHHNV,AHPND, YHV,TSV and NHPB. EHP was highly targeted as it is emerging pathogen in Sri Lankan waters. Histopathological investigation have been carried out in Vet faculty, University of Peradeniya and IARAD Histopathology lab.

Fig . Shrimps ample collection

Results & Discussion

40 farms were visited throughout the sampling period.3 shrimps from each farm were collected for DNA extraction and histopathological analysis. Fig.1 shows the water quality variation in farms of different zones .Salinity varied between 0-28 in zone 3 also 3-21 in zone 5 due to fresh water inputs near to that area. WSSV,IHHNV,AHPND,YHV,TSV and NHPB were not recorded in each farms throughout the sampling period.In zone 3, EHP positive in 6 farms (according to the PCR analysis and histopathological findings are in progress) during the period of October to November 2023.Bacteria not grown in samples due to usage of probiotics in farms. Therefore samples are negative for Vibrio.

Zone	No.of Farms visited	Water quality				Viral Pathogens(-ve/+ve)	EHP (-ve/+ ve)	Vibrio (-ve/+ve)
		Salinity(ppt)	TC°	PH	DO (mg/l			
1	5	19-26	29-34	6.5-8.5	2.4-7.2	-ve	-ve	-ve
2	4	18-28	31-33	7.1-7.5	2.4-7.2	-ve	-ve	-ve
3	14	0-28	28-31	5.7-8.5	0.9-9.7	-ve	6 farms +ve	-ve
4	5	6-20	30-32.5	6.75-7.92	0.3-8	-ve	-ve	
5	7	3-21	30.9-31.5	6.62-8.79	6-?	-ve	-ve	

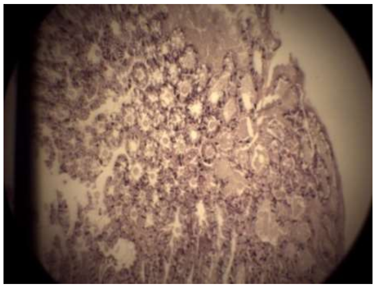


Fig.1: Section of EHP positive heapatopancrious (10x 40 H&E)

Conclusions

Our shrimp industry invade by EHP disease mainy distribute in zone 3

Project outputs & outcomes

Farmers were aware of the disease condition, water quality & farm situation

Constrains

Lack of Finance and Transport difficulties

Progress: Financial : 90% Physical : 92%

Publications

Full papers

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2. **Weerasingha, R.,**Kamarudin, M.S., Karim, M.M.A. and Ismail M. F. S. (2023). Detection of sub-lethal concentration (LC50) of *Aeromonashydrophila*against hybrid lemon fin barb (*Hypsibarbuswetmorei*♂ × *Barbonymusgonionotus*♀) early fry. *Sri Lanka Journal of Aquatic Sciences,* 28 (2), 75-82.

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3. M. Namithra, A.D.W.R. Rajapakshe, E.T.S. Madhubhashini. and G.R.H. Rupika,Effects of the dietary supplementation of coriander seed (Coriandrum sativum), Heen Bovitiya leaf (*Osbeckia octandra*) and Hathawaria leaf (Asparagus racemosus) against Aeromonas hydrophilla infection in Koi Carp, Cyprinus carpio (L) , National Aquatic Resources Research and Development Agency, Scientific Sessions 2023
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8. W .M.N. Tharushi, M.A.J.C.MallawaArachchi, Varthani Susruthan. Influence of different microalgae species on the growth, survival and fecundity of brine shrimp Artemia. l Scientific Sessions of NARA 2023, Colombo
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10. M. P. P. Gunawardana*, M. G. I. S. Parakrama, A. D. W. R. Rajapakshe and **R. Weerasinghe** (2023) Effect of almond-based diet, on the growth performance and selected hematological parameters of

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11. R.M.T.D. perera, A.M.A.N.Adikari, S.B.K. Dunusinghe,K.L.W.T. Maduka, K.K.Asanka Sanjeewa, P.P.M. Heenatigala, Development of a Bioencapsulated oral vaccine against *Aeromonas hydrophila* infections in Koi carp (*Cyprinus carpio*) (2023), ICIET/Biotechnology, Bioengineering, and Industrial Bioprocessing, University of Sri Jayawardhanapura.
12. A.M.A.N. Adikari, H.A.C.C. Perera, U.S.Amarasinghe, C. Jones and M.D.S.T. Cross Evaluation of the impact of stocking on the performance of culture-based fisheries in perennial irrigation reservoirs of Sri Lanka (2023),Proceedings of twenty-ninth Scientific sessions of the Sri Lanka association for fisheries and Aquatic resources,10th November 2023, faculty of Science, university of Kalaniya, Sri Lanka
13. G. C. Nethmini*, M. G. I. S. Parakrama1, A. D. W. R. Rajapakshe and **R. Weerasinghe**(2023). Effect of dietary supplementation of probiotics and ascorbic acid on the growth, survival and haematological parameters, and enhancement of resistance to bacterial infections in Nile Tilapia (*Oreochromisniloticus*): *In:* B. Jayawardana (Ed.), International Conference on Applied and Pure Sciences, 2023.Faculty of Science, University of Kelaniya, Sri Lanka, 13th October 2023, **Pp 47.** Colombo: ICAPS.
14. **Weerasingha**, **R.,** Kamarudin, M. S. B.*, Abd Karim, M. M. B. and Ismail, M. F. S. (2023). The optimum dietary phospholipids requirement for hybrid lemon fin barb (*Hypsibarbuswetmorei♂×Barbonymusgonionotus♀*) larvae: their survival, growth and disease resistance against *Aeromonashydrophila In:* Arulananthen, A. (Ed.) Proceedings of the International Scientific sessions of National Aquatic Resources Research and Development Agency (NARA) 2023, 13th December 2023. **pp. 25**. Colombo:NARA.
15. Lekamage, A.L.I.N., **Weerasingha, R.***, Zoysa, M.C.L. and Deepakumari, N. P. H. (2023). Optimum dietary replacement level of local fish meal with Azolla sp. on growth performances and colour development in fingerling koi carp (*Cyprinuscarpio*). *In:* Arulananthen, A. (Ed.) Proceedings of the International Scientific sessions of National Aquatic Resources Research and Development Agency (NARA) 2023. 13th December 2023. **pp. 12.**Colombo:NARA.
16. **Weerasingha, R.,** Kamarudin, M. S. B.*, Abd Karim, M. M. B. and Ismail, M. F. S. (2023). Optimal dietary lipid requirement of hybrid lemon fin barb *(Hypsibarbuswetmorei ♂ × Barbonymusgonionotus ♀)* larvae. *In:* S. D. Hajimirrahimi (Ed.). 7th International Congress on Fisheries and Aquatic Research (ICFAR), 24-25th December 2023. **Pp 48**. Karaj: ICFAR.
17. K.G.M. Prabhani, K.K.T. Nuwansi, W.A.A.M. Bandara, Growth performances of micro-propagated aquatic plant, *Aponogeton natans*in different culture conditions, National Aquatic Resources Research and DevelopmentAgency,Annual Scientific Sessions – 2023,“Sustainable Fisheries for Economic Prosperity and Food Security”,13th December 2023
18. M.H.R. Subhanu, K.K.T. Nuwansi, S.S.Herath, Effects of liquid extract of fish waste on growth performance of micro-propagated Water Trumpet (*Cryptocoryne wendtii),* International Symposium on Agriculture and Environment 2023,University of Ruhuna, Sri Lanka
19. N.D.A. Sewwandi, K. Radampola,K.K.T. Nuwansi, An assessment of phytoremediation potential of *Ipomoea aquatica* (Kangkong) in carp rearing water, International Symposium on Agriculture and Environment 2023,University of Ruhuna, Sri Lanka
20. Upul S.P.K. Liyanage, J.S. Jayanatha, W.A.L. Wickramasinghe, S.P. Jayasuriya, J. F. Nizreena Life History Traits and Stock Assessment of the Scalloped Spiny Lobster (Panulirus homarus) in Hambanthota District-Sri Lanka , National Aquatic Resources Research and Development Agency, Scientific Sessions 2023
21. J.S. Jayanatha,, H.N. Ilanperuma,, I.G.H. Manujaya, W.A.L. Wickramasingha and U.S.P.K. Liyanage Wild harvest of Seaweed (Grasilaria salicornia) can be sustain in the near future? , National Aquatic Resources Research and Development Agency, Scientific Sessions 2023

Conference poster

1. **Weerasingha**, R.*, Kumara, P. A. D. A., Maheepala, A., Jayatissa A. J. and Fahim, M.S.M. (2023) Use of Palm olein to replace fish oil in juvenile Asian sea bass (*Latescalcarifer*) diets used in floating cages of lagoon waters of Sri Lanka. *Proceedings of the International Scientific sessions of National Aquatic Resources Research and Development Agency (NARA) 2023*. 13th December 2023**. Pp 28**. Colombo**:** NARA.
2. K.G.M. Prabhani, K.K.T. Nuwansi, W.A.A.M. Bandara, Current status of Indian scad (*Decapterusrusselli*) catch from Ring-net landings in Galle Fishery Harbour - Sri Lanka,National Aquatic Resources Research and DevelopmentAgency,Annual Scientific Sessions – 2023,“Sustainable Fisheries for Economic Prosperity and Food Security”,13th December 2023

Awards

1. President’s award for scientific research for 2020 for the research titled “Expression of Lam B vaccine antigen in *Wolffia globosa* (Duckweed) against fish vibriosis”.

Training/ workshops conducted:

1. Training for the agricultural officers of the deputy Director of Agriculture (SAB) Ratnapura– About aquatic ornamental plants, propagation methods and maintaining.
2. Initiate a knowledge disseminating program at Kaluthara District by gathering the famers of aquatic ornamental plants and identify their problems and discussion to minimize the problems of them.
3. Second step of the knowledge disseminating program conducted with the help of NAQDA, EDB. Giving lecturers and worked as resource persons.
4. Participated for a workshop conducted by Sri Lanka Export Development Board (EDB) in collaboration with INFOFISH, on “Seaweed Processing and Value Addition” which will be held on 24th August 2023.
5. Online workshop on Techniques in Freshwater Fish stock assessment conducted by Bay of Bengal program.

Training (virtual) / Workshops /Meetings participated:

1. Member of the Ad hoc Committee on biotechnology , National Science Foundation (NSF), 2023
2. Member of the joint review meeting for development of National strategic plan on antibiotic resistant (AMR)(2023 – 2028)
3. Member of the expert cluster on “Inland fisheries and Aquaculture” to prepare comprehensive national food security and nutrition starter for Sri Lanka conducted by Ministry of health.
4. Member of the committee for Finalization of National policy on bio safety and bio security Sri Lanka, conducted by Ministry of health.
5. Member of the special advisory committee on “export oriented ornamental fish”, Ministry of fisheries, Sri Lanka.
6. Management committee-Export ornamental fish industry, 08 January & 16 Feb. 2023. Ministry of Fisheries, Colombo 10.
7. Prepared permissible checklist of tropical ornamental fishes for export and re-export.
8. NARA-NAQDA collaborative work plan, 13 Feb. 2023, Battaramulla.
9. Participated to the Blue Economy Workshop, 15 March 2023, Cinamon Lake, Colombo 01.
10. Mapping of wetland for restoration measure in Kaduwela Municipal Council area, 31 March, 2023, UDA, Battaramulla.
11. ADB training program on marine disaster management, 07-09 March, Pegasus Reef Hotel, Uswetakeiyawa.
12. Zoom meeting-TC meeting for project proposal evaluation mangrove re-plantation, 14 June 203, Ministry of Environment, Battaramulla.
13. Indian Ocean Marine Protected Area Assessment, DWC and Ocean Partnership, 01-03 August 2023, Colombo.

14. IAS National Species Specialist Group, 12 September, 2023, BDS, Ministry of Environment, Battaramulla.
15. Scope meeting, Wee Oya reservoir on Wee Oya, 17 Oct. 2023, CEA, Battaramulla.
16. Resource Person, Wildlanka Symposium 2023, 19-20 Oct. 2023, Water's Edge, Battaramulla.
17. Bolgoda Lake Development Plan, UDA.
18. SEA policy document launch, 16 Nov. 2023, BDS, Battaramulla.
19. Role of the National Quarantine Service for trade facilitation of plant and plant products of Sri Lanka, 27 Nov. 2023, PQSC, Katunayake.
20. IAS awareness program, 5 Dec. 2023, BDS, Battaramulla.
21. National Biodiversity Strategic Action Plan 2023-2030, 15 Dec. 2023, MOE, Battaramulla.
22. Online workshop on Techniques in Freshwater Fish stock assessment conducted by Bay of Bengal program.

Participated as Resource Persons/Interview Panelist/Lecture Delivered

1. Participated as Co-Chair of Aquaculture category of the NARA Scientific Session
2. Participated as member as FAO Technical committee
3. Participated as resource persons for the work shop conducted by the Central Environment Authority at Dehiwala Soba Ketha Center. Effective utilization of "Japan Jabara" for the livelihood development of the people living near Bolgoda Lake.
4. Participated as resource persons for the work shop conducted by the Lion's club at Piliyandala central college for livelihood development of the participants through ornamental plants and fish culture.
5. Participated as resource persons Weerasingha, R. (2023) How to make your own feed at the farm? (A lecture). In: Training program on fish feed formulation organized by SLASS. 16th September 2023. University of Kelaniya: SLASS.

As a reviewer

1. Potential of thermo-stable enzyme complex to improve growth performance, digestibility of multiple nutrients and sustainability of Nile tilapia production. *Turkey Journal of Fisheries and Aquatic Sciences* (29.03.2023) **IF 1.423**
2. Probiotic supplement enhances the hematological parameters and immune response of Common carp against fish pathogen *Aeromonashydrophila*. *Uttar Pradesh Journal of Zoology* (04.01.2024).
3. Effects of Detergent on Biochemical Profile of Common Carp *CyprinusCarpio*(Linnaeus, 1758). *Uttar Pradesh Journal of Zoology* (20.12.2023).
4. Zootechnical performance of *Cyprinuscarpio*fry in unfertilized ponds fed a local feed formulated with *Muscadomestica*larvae flour. *Asian Journal of Fisheries and Aquatic Research* (16.01.2024).

Technical support rendered:

1. X-press Pearl Ship Fire Incident – bio monitoring on the coastal and estuarine ecosystems from Chilaw to Kerawalapitiya

- Ramsar COP 15, 07 Dec. 2023, DWC, Battaramulla.
- TC meeting, Kitulgala MHP, 21 Dec. 2023, CEA, Battaramulla.
- Research Committee, DWC, Battaramulla.
- Wetland committee, CEA, Battaramulla.
- NBSAP updating meeting, BDS, Battaramulla.
- Zoom meetings to finalize the sensitive area assessment of freshwater fishes of Sri Lanka.
- Zoom meetings –data interpretation and report writing
- Organizing committee of NSS 2023 of NARA

Other technical work attended, reports & recommendations prepared/Submitted:

1. Essential highlights for sea bass farming in sea cages at Mutur, Trincomalee, requested by Global Ceylon Seafood (Pvt.) Limited. Submitted to the Ministry of Fisheries on 24.01.2023.
2. A Rapid Assessment of the Impacts of Sea Cucumber Farming on Capture Fisheries and Fishery-Based Livelihoods in Jaffna District, from 22nd to 25th of November, 2022 and from 16th to 20th January 2023, requested by Ministry of Fisheries. Summited to the Ministry of Fisheries on May 2023.
3. Rapid assessment of the feasibility of sea cucumber farming in Palaitivu Island in Kilinochchi district, Northern Province, from 17th to 20th March 2023, requested by the Ministry of Fisheries. Summited to the Ministry of Fisheries on April 2023.
4. Rapid assessment of the feasibility of sea cucumber farming in Valaipadu and Kawutharimunai in Kilinochchi district, Northern Province, from 17th to 20th March 2023, requested by the Ministry of Fisheries. Summited to the Ministry of Fisheries on May 2023.
5. Rapid site observation along the South, Northwest, North, Northeast and East coastal areas for sea cage farming, hatchery establishment, seaweed and oyster farming, feed mill installation, from 23.09.2023 to 02.10.2023 and from 20.11.2023 to 26.11.2023, requested by the Ministry of Fisheries. Summited to the Ministry of Fisheries on December 2023.
6. A feasibility report on sea cucumber farming in the adjacent shallow sea of Punkuduthivu (North) in the Jaffna district, from 30th October to 2nd November 2023, requested by the Ministry of Fisheries. Summited to the Ministry of Fisheries on December 2023.
7. Issued seaweed reports as per the requests of stakeholders.

Other Extension work participated:

1. Active member of NARA Media Hub.
2. Active member of NARA data center Project.
3. Information and instructions were provided to the ornamental fish farmers who engaged with natural and induced breeding and high density culture on their request.

Student supervision

Guide B. Sc undergraduates for their researches and industrial training under the following topics.

1. A.L.I.N. Lekamage (2023). Optimum dietary replacement level of local fish meal with *Azolla* sp. on growth performances and colour development in koi carp (*Cyprinuscarpio* var. koi) fingerlings [*Undergraduate thesis*]. Ocean University of Sri Lanka.
2. G.P.H.N. Pathirana (2023). Nutrient bioremediation efficiency of a plant-based biofilter (*Azolla* sp.) in a recirculating koi carp (*Cyprinuscarpio*var. koi) culture system [*Undergraduate thesis*]. University of Colombo of Sri Lank
3. J. H. Meepearachch (2023). investigation the effect of the duck weeds on the growth performance of the Guppy- [*Undergraduate thesis*].University of Colombo
4. H. D. Tharushi, Development of Bio- encapsulated oral vaccine using Daphnia, Moina and Micro worms against *Aeromonas hydrophila* infections in koi carp [*Undergraduate thesis*]. - University of Sri Jayawardenapura
5. Five student from ocean university for industrial training
6. Five student from university of Ruhuna for industrial training
7. Three student from university of kelaniya for industrial training
8. One student from university of wayamba for industrial training
9. Two student from university of Colombo for industrial training
10. One student from university of Jaffna for industrial training
11. One student from Eastern university for industrial training

5.5 MARINE BIOLOGICAL RESOURCES DIVISION

Head of the Division : Dr. R.P.P.K. Jayasinghe

Research Staff: The Marine Biological Resources Division (MBRD) consists of 12 Scientists, 1 Development Officer, 5 Research Assistants, 5 Field Research Assistants, 1 Management Assistant, 1 Lab Attendant and 1 Helper.

The MBRD is the major division carrying out research towards the management, development and conservation of marine living resources. The research programme carried out by MBRD includes,

- Management-oriented research projects on small and large pelagic fishery resources.
- Development-oriented research projects assessing the viability of under-exploited and unexploited marine resources.
- Conservation of coral reefs and threatened marine fauna.
- Species identification and population studies using molecular methods.

Two major treasury-funded research projects were carried out by MBRD in 2023. Apart from treasury funded projects, MBRD carried out several externally funded/consultancy projects. MBRD attended to several activities in advisory and consultative capacities. More importantly, MBRD responded to several requests made by the Ministry of Fisheries (MoF) and the Department of Fisheries and Aquatic Resources (DFAR) by providing recommendations to resolve problems related to the exploitation of marine fishery resources.

On court orders, several fish samples were analysed by MBRD to determine whether the fish samples submitted had been killed using explosives or not. The MBRD staff also appeared at several Magistrates' Courts, in order to provide expert evidence regarding dynamite cases handled by the Sri Lanka Police and DFAR.

In 2023, a large number of marine samples including fish and other aquatic organisms were received from various stakeholders, notably Magistrates' Courts, DFAR, Department of Wildlife Conservation (DWLC), Department of National Zoological Gardens and the fishing industry for identification. In addition, MBRD issued 278 reports on the identification of shark fin/skin samples in the year 2023. The identification of shark fin/skin samples was mostly based on morphological characters. When morphological identification failed, organisms were identified using molecular methods.

The staff of the division was very interactive with the fishing community throughout the island and also supported the private sector by attending to requests made by them. The division provided facilities and guidance to university students in undertaking industrial training and final year research projects/postgraduate projects and to school students to carry out their research projects. In addition, the division conducted lectures and awareness programmes, especially for Sri Lanka Coast Guards, Sri Lanka Navy, and the fishing community.

The research staff of MBRD was actively engaged in updating the large pelagic and small pelagic fishery databases, analysing the fish landing statistics, providing national statistics on large pelagic fish production and preparing research papers on trends and prospects of marine fisheries in Sri Lanka. Several reports were also prepared and submitted to the DFAR for settling fishing disputes, advising on resource utilization and fisheries management.

Treasury funded projects carried out by MBRD in 2023:

No	Project Title	Budget (Rs. Millions)	Ongoing	New
2.1	Monitoring and assessment of coastal fishery resources	1.5	Ongoing	
2.2	Monitoring and assessment of large pelagic fishery resources	1.5	Ongoing	
2.3	2.3.1 Strengthening marine fisheries data collection in Sri Lanka	0.7	Ongoing	
	2.3.2 Independent Survey on shrimp trawl fishery, Kalpitiya coastal area	0.6		New

PROJECT NO : 2.1

MONITORING AND ASSESSMENT OF COASTAL FISHERY RESOURCES

Coastal fisheries in Sri Lanka predominantly target small pelagic species, encompassing a diverse array of over seventy marine species within Sri Lankan waters. Key species groups within this fishery include sardines, herrings, anchovies, and mackerels, despite incidental targeting of other species, including large pelagic and demersal fish. Unsustainable fishing practices exist in the coastal fishery such as effort increase, night fishing during spawning season(s), and extensive catching of immature fish.

Small pelagic fish, comprising a substantial proportion of Sri Lankans' animal protein intake, contribute significantly, constituting approximately 30% of the country's marine fish production. Artisanal fishermen, operating on a small scale with gears such as small-meshed gillnets and outboard engine Fiber Reinforced Plastic (OFRP) boats, primarily target these small pelagic species. Some regions also employ surrounding nets, while the traditional beach seine, operating seasonally, captures a noteworthy quantity of small pelagic fish.

However, at present, the fishery remains uncertain in the potentiality of coping with the unprecedented challenge of rapidly growing food demands under unsustainable fishing practices and deteriorating environmental conditions while experiencing resource depletion.

The Marine Biological Resources Division (MBRD) of the National Aquatic Resources Research and Development Agency (NARA) has been responsible for monitoring small pelagic fish landings over several years. The primary objective is to assess the status of the fishery and resources, with a key focus on ensuring the long-term sustainability of these vital resources. In 2023, MBRD continued its port sampling data collection program at major and minor coastal fish landing sites in Sri Lanka. Additionally, enumerators from the Department of Fisheries and Aquatic Resources (DFAR) were actively engaged in the same data collection program, further contributing to a comprehensive understanding of the dynamics of small pelagic fishery despite the prevailing challenges.

The small pelagic fishery data collection was carried out at major and minor fish landing sites of the island according to a new sampling scheme developed under the Sri Lanka- Norway bilateral project. Sampling employs a stratified random method at fish landing sites. The data collection included reporting fish landings by species, details on fishing operations: fishing time (true fishing time and total fishing time), gear operated depth, number of fishing devices used and their sizes (for example, number of net pieces used in the gillnet fishery and their mesh sizes). In addition, biological data (length-frequency data) collection of key species was carried out. The data collected by tablet software is stored in a database maintained by the DFAR. Apart from that, small pelagic data are manually entered into the small pelagic Access database available at MBRD.

Our comprehensive studies have mainly been focused on the west coast as the western coastal waters give the highest contribution to the small pelagic fisheries in Sri Lanka. The following results are based on the data collected from 2000 -2021 on the west coast in the small pelagic fishery in Sri Lanka:

Three types of coastal fishing crafts are involved in the small pelagic fishery: Non-motorized traditional boats (NTRB), motorized traditional boats (MTRB), and outboard engine Fiber Reinforced Plastic (OFRP) crafts. Their percentage contributions during the last two decades to the total fish production are 4%, 5%, and 91%, respectively (Figure 1) where the current dominance in the fishery has been taken by the OFRP boats. The catch rates by each boat category reveal that both OFRP and MTRB have more or less similar catch rates while the NTRB has a considerably low catch rate (Figure 2).

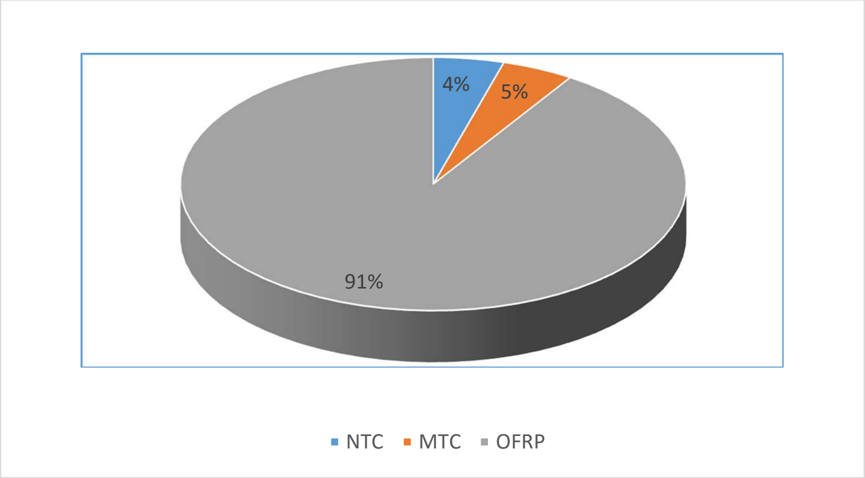


Figure 1. The relative contribution of non-motorized traditional crafts (NTC), motorized traditional crafts (MTC) and outboard engine Fiber Reinforced Plastic (OFRP) crafts in the small pelagic fish production on the west coast of Sri Lanka during 2000 – 2021

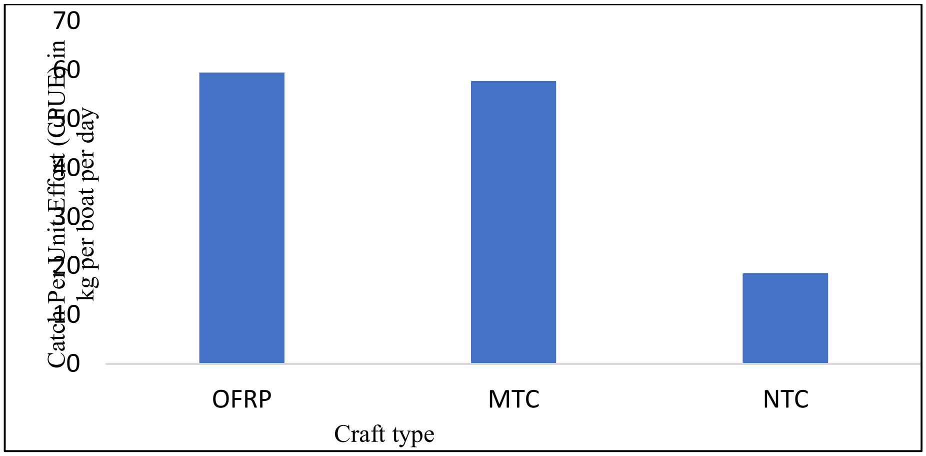


Figure 2. The catch per unit effort (CPUE) in kg per boat per day for Non-motorized traditional crafts (NTC), motorized traditional crafts (MTC), and outboard engine Fiber Reinforced Plastic (OFRP) crafts: 2000-2021

A greater inter-annual variation could be seen over the past two decades with an extraordinary increase in Catch per Unit Effort (CPUE) for OFRP boats observed in 2017 probably resulting in extremely favourable oceanographic conditions, however, the following years showed a remarkable decline. Further, it would be interesting to note that higher catch rates were mostly observed after a one-year time lag after reporting Chlorophyll peaks (Figure 3).

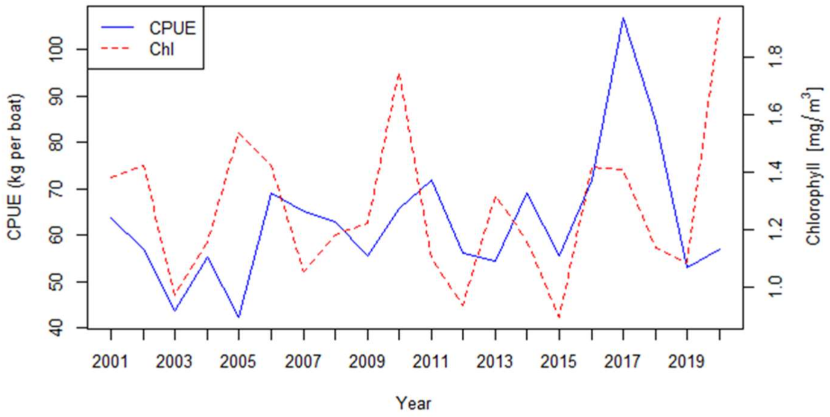


Figure 3. Annual average Catch per Unit Effort (CPUE) by outboard engine fiber reinforced plastic boats (OFRP) operated with small mesh gillnets and average Chlorophyll concentration on the West Coast, Sri Lanka

Small pelagic gillnet fish catch is dominated by Clupeids which include Spotted sardinella (*Amblygaster sirm)*, Goldstripe sardinella (*Sardinella gibbosa*), Indian oil sardine (*Sardinella longiceps*) and White sardinella (*Sardinella albella*). The other species mainly include Scads (*Decapterus russelli* and *Selar crumenophthalmus*), queen fish (*Scomberoides commersonianus*), travellies (*Caranx* sp) and Sprats (*Stoleophorus* sp and *Thryssa* sp*)* (Figure 4).

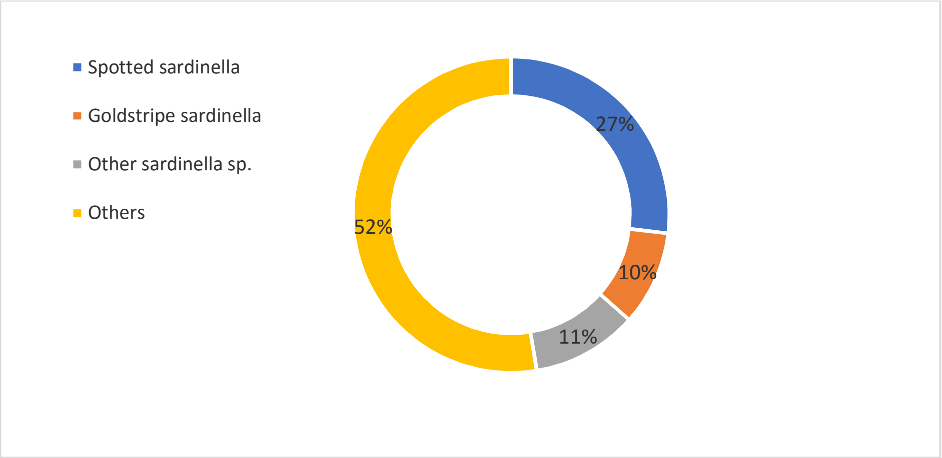


Figure 4. The relative contribution in the total small pelagic fish production on the west coast of Sri Lanka by key species/ species groups: 2000-2021

A remarkable decline in the relative contribution of spotted sardinella in the small meshed gillnet fishery was observed over the past two decades (Figure 4). The average contribution has dropped dramatically from 47% in 2001-2005; 51% from 2006-2010; to 37% in 2011-2015 and 34% in 2015-2020 (Figure 5). Moreover, it was observed that the average CPUE of the spotted sardinella showed a decreasing trend over the past two decades (Figure 6) with a 25% drop in recent five years (2016-2020) with respect to 2000s.

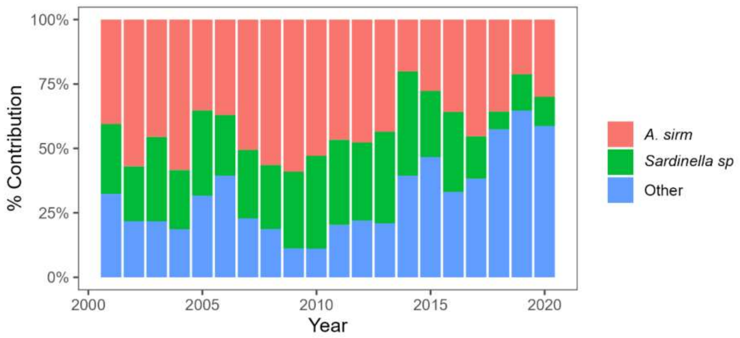


Figure 5. Species composition of key small pelagic fish landings; *Amblygaster sirm*; *Sardinella* species and others in small meshed gillnet fishery in the west coast of Sri Lanka: 2001 – 2020.

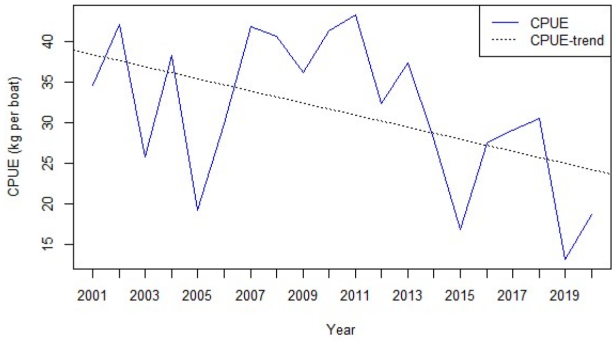


Figure 6. Annual variation in mean CPUE of spotted sardinella target fishery in the west coast, Sri Lanka: 2001- 2020

The changes in the marine food web of coastal waters in Sri Lanka were assessed based on the coastal landing profile of the exploited 65 marine fish species recorded during 2001–2020. A declining trend in the Mean Trophic Level (MTL) of the coastal fish landings on the west coast could be observed over the past twenty years. Moreover, the forecast from 2022 to 2026 is given in Figure 7 in a blue line, with the 80% prediction interval as a purple-shaded area, and the 95% prediction interval as a grey-shaded area. The model forecasts an MTL value of 3.38 for the above period.

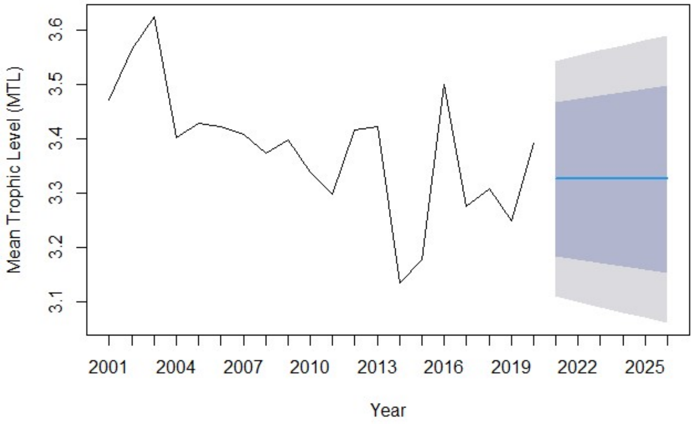


Figure 7. Trend of Mean Tropic Level (MTL) over the past 20-year period (2001-2020) in the coastal fishery, on the west coast of Sri Lanka with Forecasted Mean Trophic Level (MTL) for 2022 to 2026 (Summary results for the fitted ARIMA model ma1 = -0.6673, SE = 0.1614). The forecast is presented in a blue line, with the 80% prediction interval as a purple-shaded area, and the 95% prediction interval as a grey-shaded area.

The small pelagic Fishery in the west coast of Sri Lanka is in danger and has already shown several alarming signals such as declining CPUE and MTL and increasing non-target species over the past twenty years. One of the main reasons for this is the overfishing of targeted commercial species coupled with climatic impacts. However, a management plan has been proposed to be in place to sustainably manage the small pelagic fisheries on the west coast of Sri Lanka.

Stock assessments based on ASPIC surplus production models will be carried out for selected coastal resources; spotted sardinella, kawakawa and Indian mackerel.

As an initiation to the above, a Stock assessment training program was conducted in September and October 2023 by Dr. Tom Nishida, representing the menu-driven fish stock assessment and management decision software development team in Japan. Nine scientists from NARA were trained to Catch Per Unit Effort (CPUE) standardization, ASPIC surplus production models, and the application of Kobe I and II management decision tools, alongside in-depth discussions on risk assessments.

PROJECT No : 2.2
MONITORING AND ASSESSMENT OF LARGE PELAGIC FISHERY RESOURCES

The offshore and high sea fisheries in Sri Lanka are conducted targeting highly migratory large pelagic species such as tuna and tuna-like fish. Some vessels operating in the coastal fishery also target large pelagic species. Sri Lanka is historically a tuna-catching nation. The records indicate that tuna fishing has played a vital role in the tradition and culture of Sri Lanka. The major group in the tuna fishery in Sri Lanka is tropical tuna which mainly comprises three species: yellowfin tuna (*Thunnus albacares*)*,* bigeye tuna (*Thunnus obesus*) and skipjack tuna (*Katsuwonus pelamis*)*. Auxis thazard* (frigate tuna), *Auxis rochei* (bullet tuna) and *Euthynnis affinis* (kawakawa) are the major neritic tuna species found in Sri Lankan waters, while *Scomberomorus commerson* (Narrow- barred Spanish mackerel) is dominating the species associated with neritic tuna. The other important group of fish reported in large pelagic fish production in Sri Lanka is the billfish which includes 3 species of marlins (Indo-Pacific Blue Marlin (*Makaira mazara*), Black Marlin (*Makaira indica*) and Striped Marlin (*Tetrapturus audax*), one species of sailfish (Indo-Pacific Sailfish, *Istiophorus platypterus*) and a single species of swordfish (*Xiphias gladius*). In addition, several shark species are recorded as a bycatch in the tuna fishery.

Large Pelagic Port sampling is a collaborative fisheries data collection programme implemented by the Marine Biological Resources Division (MBRD) of NARA, Department of Fisheries and Aquatic Resources (DFAR) and the Statistics Unit of Ministry of Fisheries (MoF) for obtaining large pelagic fish landing data. Large pelagic resources mainly comprise tuna and tuna-like species. The large pelagic port sampling survey in Sri Lanka was started in the 1990's by NARA and the project is conducted continuously to obtain catch and effort data and biological data on large pelagic fish, in particular on tuna and tuna-like fish. It is a mandatory requirement to submit large pelagic fisheries data to the Indian Ocean Tuna Commission (IOTC). The data collected annually via the port sampling programme needs to be analyzed and then submitted to the IOTC before 30th June each year. This is a collaborative attempt of the

Statistics Unit of MoF, DFAR and the MBRD of NARA. We were able to submit the production estimations of 2022 as per the required formats adhering to the deadline. The total production of tuna and tuna like species of Sri Lanka in year 2022 was 81973t with more than 80% contributions from the EEZ (Fig.1).

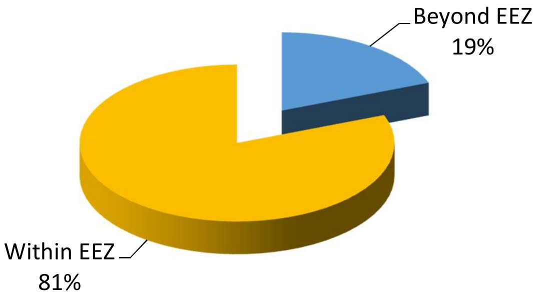


Figure 1. Large pelagic fish production (Tuna and Tuna like including bill fish, seer fish, sharks and skates) Sri Lanka in 2023

Species-wise catch records in 2022 is shown in Fig 2 where skip jack followed by yellow fin has provided the highest contribution while frigate tuna and sword fish also have a significant contribution to the large production.

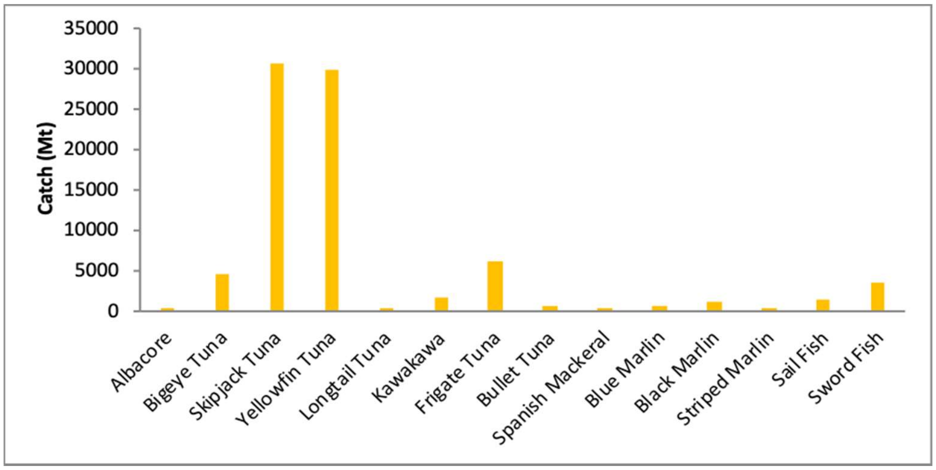


Figure 2. Large pelagic catch by major species in 2022

In the data submission to the IOTC, catch and effort data, length-frequency data, information on discards and vessel information were provided in detail as per the requirements of the resolutions. As a result of complying with the resolutions relating to data submission (Resolution 15/02), Sri Lanka was able to achieve an 83% compliance rate in 2022.

Among the range of gear operated, the highest proportion of catch was harvested by long line in high seas (Fig. 3) while gill net in within EEZ (Fig.4).

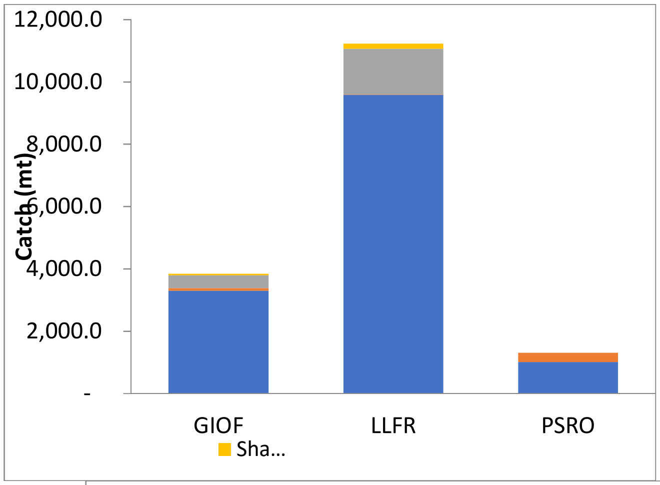


Figure 3. Large pelagic production in Sri Lanka in high seas in 2022 (LL- Long Line, GN –Gill net, RN- Ring net)

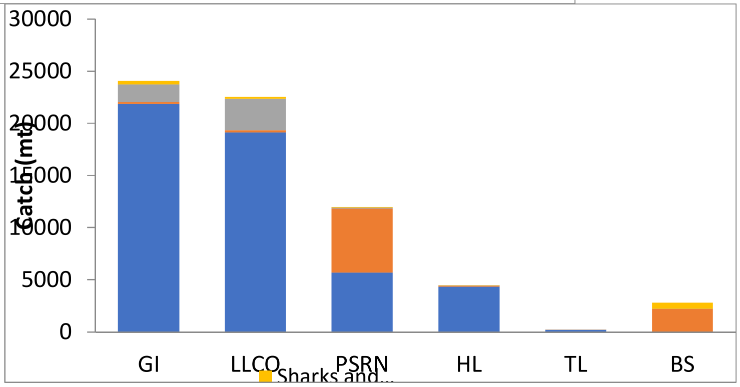
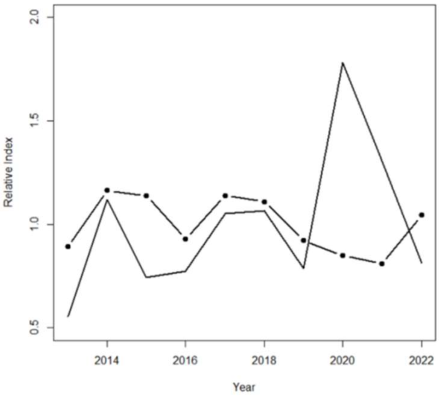


Figure 4. Large Pelagic Production within the EEZ of Sri Lanka in 2022 (GI – Gill net, LL- long line, RN- Ring net, HL- Hand line, TL- Troll line, BS-Beach seine)

Based on the stock assessments conducted by the IOTC, it is apparent that the potentialities in the expansion of the large pelagic fishery are limited. However, the expansion potentialities could still be pragmatic for skip jack tuna and swordfish fisheries. The below findings and recommendations were based on the focused research conducted using the available data and presented at the IOTC conference proceedings.

Accounting for spatial, temporal and operational effects in the Catch Per Unit Effort standardization of Skipjack tuna in tuna drift gillnet fishery in Sri Lanka

Large meshed drift gillnets are widely used in the tuna fishery in Sri Lanka and the key target species for this gear is Skipjack tuna. The fishery conducted by this gear is characterized by the inboard engine fishing vessels, relatively longer fishing trips, use of supplementary fishing gear with gillnets, and harbor-based landings of multispecies catches. The present study was undertaken to standardize the catch per unit effort (CPUE) of skipjack tuna in the tuna drift gillnet fishery in Sri Lanka. Ten years of port sampling data (2013- 2022) were used for the CPUE standardization. A delta-lognormal model comprising a Gaussian-based Generalized Linear Model (GLM) for positive catch rates and a Bernoulli-based GLM for binary data of skipjack tuna was used for the CPUE standardization (Fig. 5). The explanatory variables considered for the study include year, month, vessel category, gear used, number of net panels used, trip duration, gear setting time, and fishing area. All variables except the “fishing area” in Gaussian-based GLM were significant at 0.01 level. The abundance index of skipjack tuna is largely influenced by the “vessel category”, “gear” and “year” variability. A remarkable variation in the annual abundance index was observed during the studied period (Fig. 6). A similar standardized CPUE series obtained for an extended period could perhaps be beneficial in the future when stock assessments of skipjack tuna in the Indian Ocean are conducted.



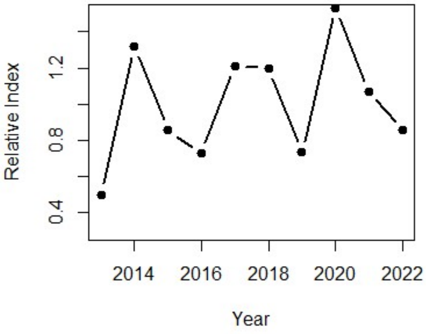


Figure 5. Standardized relative indices of skipjack tuna in the tuna drift gillnet fishery, Sri Lanka using Bernoulli-based and Gaussian-based GLM models

Figure 6. Standardized catch per unit effort (CPUE) indices of skipjack tuna in the tuna drift gillnet fishery, Sri Lanka using the delta-lognormal method. Values were scaled by dividing their means.

Population dynamics of kawakawa (*Euthynnus affinis* (Cantor, 1849)) in Sri Lankan waters

The estimated growth parameters were L∞ = 62.98 cm (FL); K = 0.70 yr-1; Ø = 3.44. The estimated values of total mortality (Z), natural mortality (M) and fishing mortality (F) were 1.60 yr-1, 0.81 yr-1 and 0.79 yr-1 respectively. The Exploitation ratio (E) was estimated at 0.50. The fishing mortality that led to the maximum yield per recruit (Fmax) was estimated at 1.22 yr-1. The estimated target reference points of F0.1 and F0.5 were 0.63 yr-1 and 0.45 yr-1 respectively, which were lower than the current F. Based on the findings it was fair to conclude that the current exploitation level of kawakawa in Sri Lanka is sustainable. However, there is a risk of growth overfishing of the kawakawa stock in Sri Lankan waters. The estimated values for the above mentioned parameters could be made used when stock assessments are conducted (Fig. 7).

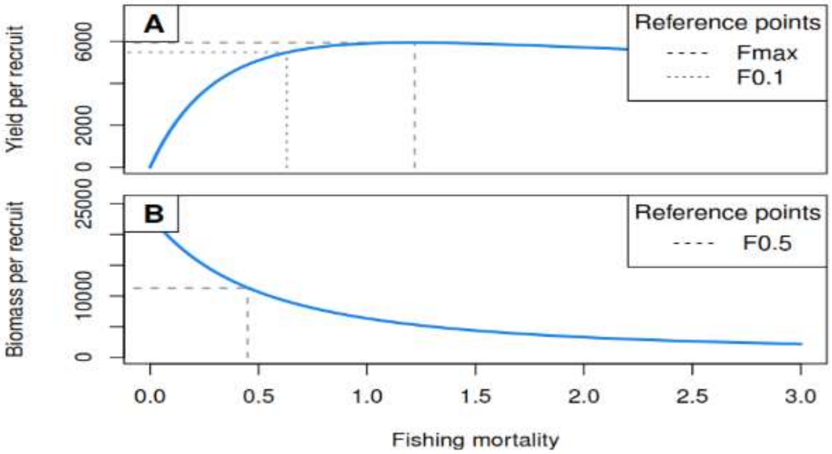
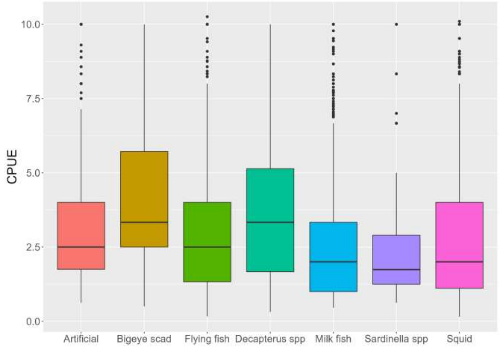


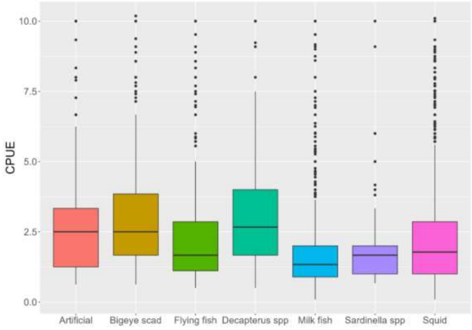
Figure 7. Yield per recruit (A) and biomass per recruit (B) of kawakawa in Sri Lankan waters for a range of fishing mortality rates (x-axis). Grey segments indicate various reference points.

Effect of Bait Types on Catchability of Billfish in Tuna Longline Fishery in Sri Lanka

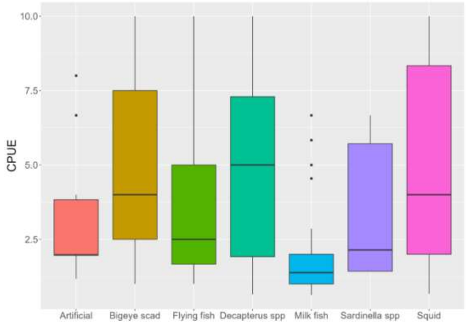
Among the seven popular bait types; squids, bigeye scad (*Selar crumenophthalmus*), flying fish (family Exocoetidae), milkfish (*Chanos chanos*), Indian scad (*Decapterus* spp.), Sardine (*Sardinella* spp.) and artificial baits, longlines with Indian scad as a bait were reported with the highest average catch rate in terms of the number of fish per 1000 hooks: (4.0 ±2.6) followed by big eye scad (3.7 ±2.3) while lowest was recorded with milk fish (2.6 ±2.1). The results further showed that the highest catch rates of swordfish, blue marlin and striped marlin were recorded for Indian scads while sailfish and black marlin for bigeye scad. This study highlights the importance of bait types in catchability of billfish and the findings could be used to manage tuna long line fisheries (Fig. 8).



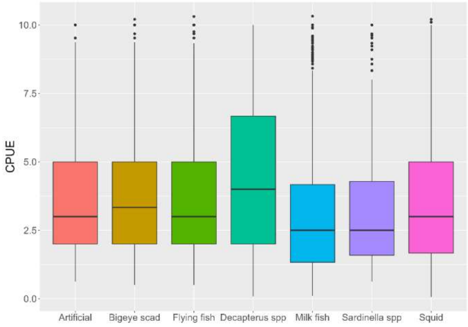
Black Marlin



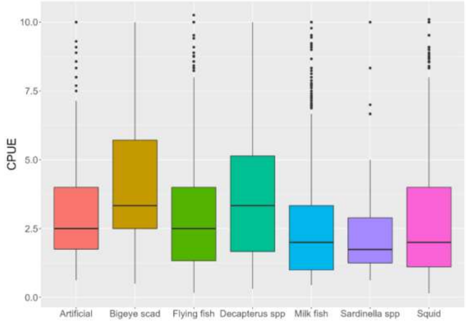
Blue Marlins



Striped marlin



Sword fish



Sail fish

Figure 8. Catch rates of bill fish species by different bait types

Application of DPSIR framework in tuna fisheries management in the Indian Ocean with special reference to Sri Lanka

The Driver-Pressure-State-Impact-Response (DPSIR) framework for Tuna Fisheries in Sri Lanka was developed. "Driving forces" such as high dependency for fish, economies of the stakeholders, climate change, urbanization and industrialization through the "pressures"; increased fishing effort, overexploitation, use of destructive gears, Illegal, Unreported and Unregulated fishing practices, changing oceanographic conditions to "state" of, depleted fish stocks and low fish production deviation of fish distribution and fishing grounds, and more warm pools and 'impacts' on declining catch, loss of early life stages, marine environment degradation and eventually leading to 'responses' of fisheries and environmental laws and regulations as well as novel technological applications (Fig. 9).

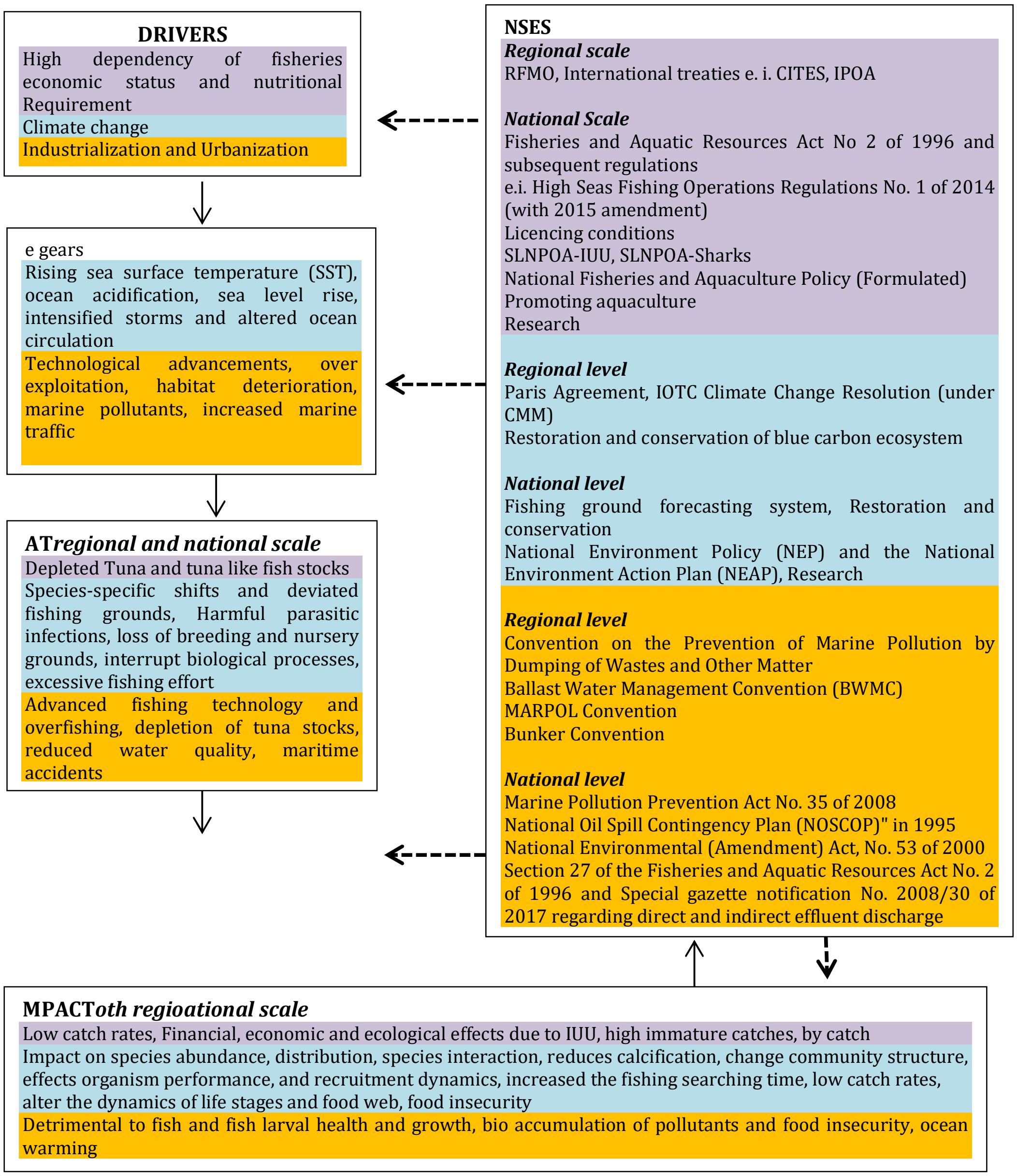


Figure 9 Schematic Diagram of DPSIR Frame work for Tuna Fisheries Management

Project 2.3: Sri Lanka - Norway bilateral project

Prompt

2.3.1: STRENGTHENING MARINE FISHERIES DATA COLLECTION IN SRI LANKA

Among the key industries in Sri Lanka, the fisheries industry has a vital place as the major livelihood of the coastal people, and foreign revenue is generated via exporting fish and fish products. The fisheries data is also an important tool to manipulate the industry according to the correct decisions. Further, the data is used for various purposes to understand the current status and to make future predictions. Hence, there is a necessity to collect fisheries data correctly and precisely. The project was initiated in 2016 with the collaboration of the Norwegian government.

Phase I of the project ended in 2019 by laying the foundation for strengthening the fisheries dependent data collection system of the marine fishery of Sri Lanka. The data collection system in the marine fishery is complex since the fishery is multi-species, multi-gear and multivessel. On the other hand, landing sites of smaller to larger sizes are scattered over the island. Phase I of the project completed a baseline survey to classify all landing sites and harbours concerning vessel composition, gears, target species, seasonality, etc. Also, during phase I, the project staff created a new standardized set of data collection sheets with a manual to be used in the fisheries data collection. Further, tabulated software was developed for data collection, data entry, validation, and use of a standardized set of codes to ensure that high-quality data are readily available, which was part of a separate data infrastructure project within the Department of Fisheries and Aquatic Resources (DFAR). Hence, landing data collected by DFAR and NARA enumerators are stored in the same system by DFAR with other related data like fisher's registry, vessel registry, and logbook data of the multiday fishing fleet.

Data collection under the new plan was started in October 2020 at the major fishery harbours by the enumerators of NARA and DFAR. They were encouraged to enter the data using the software on the provided tablets. The Norway experts provided the technical support to improve the fish landing data collection system of small pelagic and large pelagic and demersal fisheries in Sri Lanka. Further, the project activities were widened in 2022 by continuing the data collection via the app, conducting training for the enumerators and data analyzers, and introducing new methods for collecting biological data. In addition, data collection using tablet software was continued, workshops for the enumerators and data analysers were held, photo-based method for the length data collections was tested in different parts of the country in 2023.

Port sampling

The project's main goal is to collect the coastal fisheries data at the landing sites classified as high, medium, and low according to the registered number of boats and boat types at the landing sites. The sampling was conducted according to a strategic sampling plan. At the beginning of the year, a review of the fish landing site registry was conducted to eliminate the registry's non-operating sites and obtain the current number of active boats. This file was used to prepare the annual sampling plan as an input file along with vessel registry. The randomized stratified sampling technique was used to prepare the yearly sampling plan, and the sampling frequency was determined according to the strata of the landing site. This means the most important landing sites and fisheries are allocated more sampling effort than less important sites. Accordingly, two sampling programmes were prepared for sampling fishery harbours and coastal landing sites.

The monthly sampling plans for each fisheries district were generated using the prepared annual sampling plan. The sampling schedules were provided for the DFAR and NARA enumerators attached to the FI divisions or fisheries districts. They visited a particular site on a particular date and entered the data through tabulated software. Consequently, the data was stored at the data server in the data unit of the DFAR. Apart from that, NARA enumerators were advised to enter the data into the data forms, which were entered into the PELAGOS database and small pelagic databases located at Marine Biological Resource Division, NARA.

Data analysis workshop

Several online and physical data analysis workshops were carried out by the Norwegian team members from the Institute of Marine Research (IMR) and the Directorate of fisheries. The first and second phases of the workshop were completed in 2021 and 2022. In 2023 the first workshop was conducted on the 29th and 31st of March 2023 via the Microsoft Teams online platform. Scientists of the Marine Biological Resources Division of NARA, officials of the DFAR and the Statistics Unit of the Ministry of fisheries participated in the workshop. The second online session was conducted on 3rd May 2023. The following matters were taken into consideration in the above sessions.

Exploration and analysis of recently collected scientific data from landing sites in Sri Lanka using R statistical Software.

- Reading and exploring files, technical issues
- Sampling compliancy
- Upscaling from sampled vessels to total fleet (population)

The third workshop was conducted physically from 21st to 24th August 2023 at Citrus Hotel, Hikkaduwa. The following topics were included in the workshop:

- Repetition
- Sampling plan 2024
- Developing reports for “Data quality monitoring team”
- From sample to population – Catch estimation and upscaling

The workshop was conducted by Norwegian team members from the Institute of Marine Research (IMR) and the Directorate of fisheries. The 15 officers from the Department of Fisheries and Aquatic Resources, the Statistical unit of the Ministry of Fisheries, and Scientists attached to the Marine Biological Resources Division of NARA actively participated in the workshop.

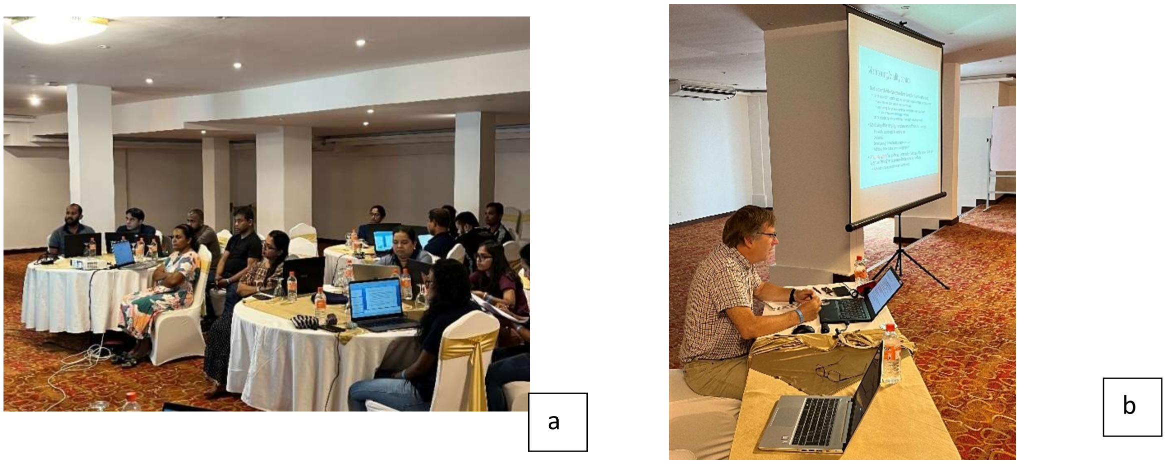


Fig.1 a & b: Conducting the data analysis workshop for the Sri Lankan team

Due to the technical issues of the current tablet software application, a new web-based application was created and the demonstration was held during the workshop.

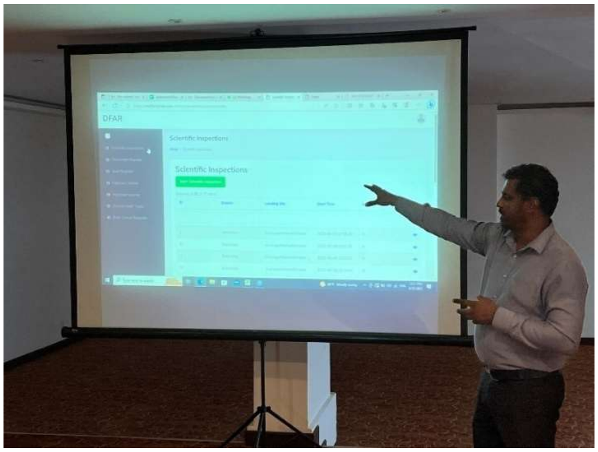


Figure 2: Demonstration of new data collection application

The new web-based application is introduced to Kaluthara Fishery district in 2023 and it was planned to use the new application in all the other fisheries districts in 2024.

I. Introducing measuring boards for obtaining reliable fish length data

The Norwegian team introduced a photo-based system for obtaining fish length data at the sampling sites to enhance the efficiency and reliability of the fish length data in 2022. Ten measuring boards were provided by Norway to be used for taking the length measurements. In December 2022, the inventor of the method, the Norway project coordinator visited Sri Lanka to demonstrate and test the method. Several field visits were made to identify the potential issues in data collection in landing sites and testing the practicality of the photo method using a measuring board to get length measurements.

II. Field visit to down south and Kalpitiya

Measuring boards were tested in several landing sites with different fishing methods and development of the sampling protocol was initiated during the periods of 15th July 2023 to 16th July 2023 and 13th to 15th of November 2023 in Down south and Kalpitiya respectively.

III. Field visit to East coast

A field visit was conducted in Ampara and Batticaloa districts with Dr. Tore (Coordinator – Norway-Sri Lankan bilateral project) with the aim of understanding the nature and activities in different fish landing sites which are necessary for the formulation of the data collecting protocol. The field visit was conducted from 07/11/2023 to 10/11/2023. Fish landing centers in Ampara district such as landing center near Oluvil light house, Addalaichenai, Karaitivu and Sainthamaruthu as well as fish landing centers in Batticaloa district such as Pasikuda, Punnakuda and Valaichchenai were visited during the field visit. In addition, the District Fisheries office in Batticaloa was also visited to gather some background information. During the site visits, the time of boat arrival, average catch of the boats, species composition, different fishing gears and how the system works was observed.

Figure 2 a & b: Fish landing sites in eastern coastal region

IV. Field visit to Chilaw

Field visit was conducted on 20th July 2023 to examine the possibility of using the measuring board with photo method to get the length measurements during the night fishing time. Team with NARA scientist, RA and Norwegian scientist visited a landing site in Chilaw and took the measurements of several small pelagic fish species and recorded species composition and number of active boats.

Several other field visits were made by NARA scientists and enumerators (DFAR and NARA) to check the practically of the photo method using measuring board in landing sites belonging to Negombo and Beruwala fisheries districts. All the photos were sent by the enumerators to a separate google drive storage maintained by NARA.

PROJECT NO : 2.3.2

NORWAY SRI LANKA BILATERAL PROJECT - WORK PACKAGE 2 (WP2) INDEPENDENT SURVEY ON SHRIMP TRAWL FISHERY, KALPITIYA COASTAL AREA

(This research was collaboration of Kalpitiya RRC and NIOMS)

Fisheries independent shrimp trawl survey and biomass estimates in the Kalpitiya trawling ground in 2023.

In total 89 species were recorded within the defined trawling ground, including shrimps, finfish, shellfish, and echinoderms. All together 2491 individual shrimp and fish were sampled for one or more individual parameters such as length, weight, maturity, sex and carapace length. The total biomass of all species combined was estimated to be 221.173 ± 53.20 tons within the defined 4.3 nm^2 trawling ground and the density of all recorded species within the area was calculated as 51.43 $tons/nm^2$ (14.99 $tons/km^2$). The biomass consisted of 0.551 tons of shrimps, 187 tons of pony fishes (Karalla) and 33.622 tons of other by-catch species (Fig 1).

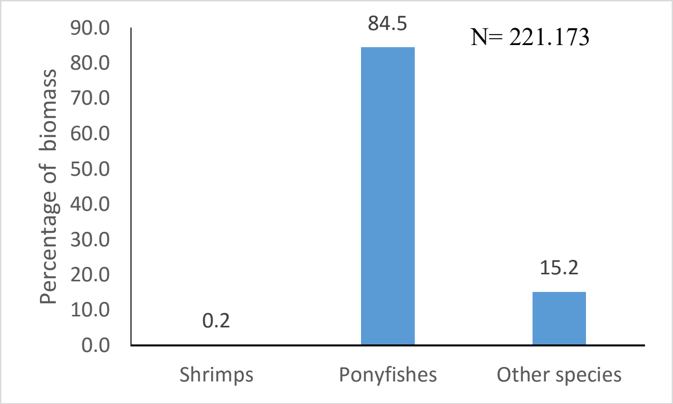


Figure 1. Biomass (%) distribution in the defined trawl ground/survey area (N= Total Biomass)

Biomass and abundance of shrimp species

With regards to shrimp, a total of five species (*Penaeus semisulcatus, P. merguiensis, Metapenaeus affinis, M. moyebi* and *M. dobsoni*) were recorded during the survey. The total shrimp biomass was 0.551 tons within the defined 4.3 nm^2 survey area, and the total shrimp density was derived as 0.128 $tons/nm^2$. Each shrimp species with their respective biomass and abundance value is tabulated below (Table 1). The estimated total shrimp biomass was smaller compared with the 2021 survey which had 1.66 tons.

Table 1: Biomass and abundance estimates of shrimp species

SN	Shrimp species	Total biomass (kg)	Total Abundance (No of individuals)	Density (No of individuals /sq nm)	Density (kg/sq nm)
1	*Penaeus semisulcatus*	237	10136	2357.21	55.12
2	*Penaeus merguiensis*	304	8878	2064.65	70.70
3	*Metapenaeus affinis*	7.5	366	85.12	1.74
4	*Metapenaeus moyebi*	1.6	386	89.77	0.37
5	*Metapenaeus dobsoni*	1.0	99	23.02	0.23
Total		**551.1**	**19865**	**4619.77**	**128.16**

P. semisulcatus is the most abundant shrimp species representing around 51 % of total shrimp abundance (Fig 2), while *P. merguiensis* is the second most abundant (45 % of total abundance). Furthermore, *M. affinis, M. moyebi* and *M. dobsoni* were rarely recorded during the survey. Although, *P. semisulcatus* showed the highest abundance, *P. merguiensis* contributed mainly to the biomass of shrimps. Meantime, *P. semisulcatus* had the second highest biomass and other shrimp biomass was also insignificant.

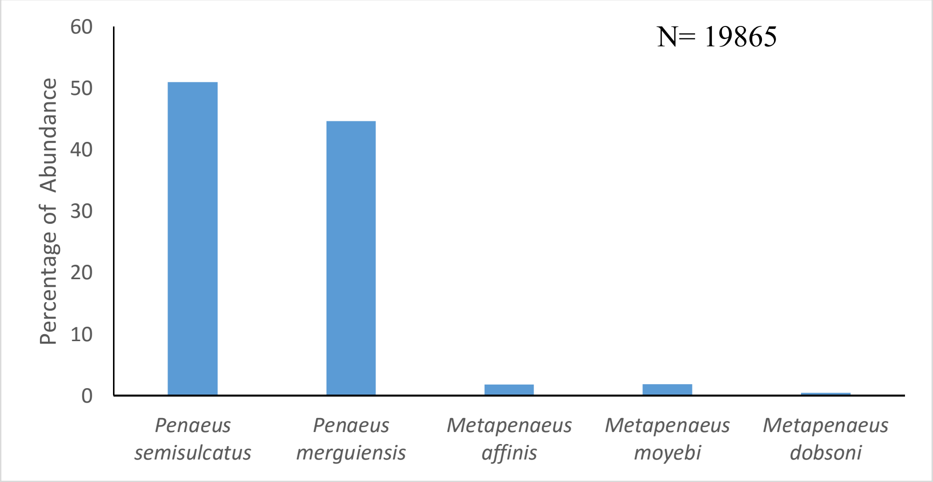


Figure 2. Abundance (%) variation among recorded shrimp species in Kalpitiya trawl ground

A bootstrap method with the replacement of the trawl stations was applied to get measures of the sampling variance. A high CV will indicate that the true abundance might be found within a vast range on either side of the mean estimate. This scenario is very unfortunate and may jeopardize the possibility of seeing trends in a survey time series, and thereby the development of the stock over time. In our case, however, the CV for the main target species *P. semisulcatus* was very low, at 0.18. This indicates that the sampling design and effort was good and provides a good estimate of the abundance within the survey area.

Length and weight distribution of shrimp species

For the most prominently caught shrimp species, *P. semisulcatus* and *P. merguiensis*, length distributions are given in Figures 3 and 4 respectively.

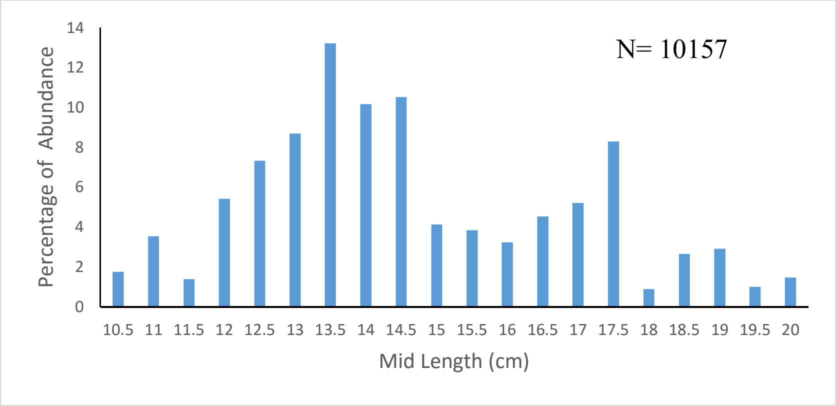


Figure 3. Length class distribution pattern of *Penaeus semisulcatus*

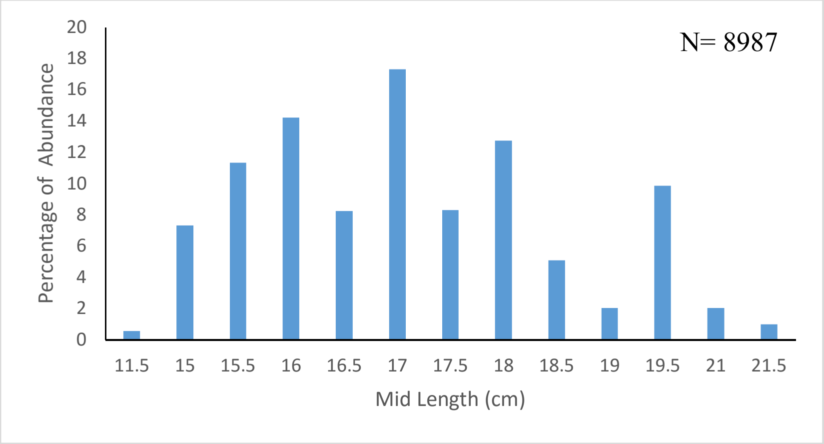


Figure 4. Length class distribution pattern of *Penaeus merguiensis*

Table 2 shows the mean values of individual total length and individual weight of different shrimp species that represent defined trawl grounds.

Table 2: Mean individual length and weight distribution patterns of different shrimp species

Species	Individual Length (cm)			Individual Weight (g)		
	Min	Mean	max	Min	Mean	max
Metapenaeus affinis	13.5	14.4	15.5	17.0	20.6	25.5
Metapenaeus dobsoni	1.0	6.8	12.5	8.0	10.0	12.0
Metapenaeus moyebi	7.0	8.6	10.5	2.0	4.3	7.0
Penaeus merguiensis	11.5	17.1	21.5	14.3	34.3	72.6
Penaeus semisulcatus	10.5	14.7	20.0	5.7	23.5	61.0

Shrimp populations and individual mean sizes (length, weight) are considered as valuable parameters to provide information on sustainable fishing activity, especially with time series data. For instance, any reduction of size in one year compared to previous years, may indicate overfishing and it can help to resurge the sustainability. Similar to the present survey, *P. semisulcatus* was the prominent shrimp species in the 2021 survey followed by *P. merguiensis*. The shrimp species, *P. indicus*, *P. monodon*, *P. vannamei* and *P. canaliculatus* which were recorded in the previous survey (2021) were absent in the present survey. Furthermore, *M. affinis* and *M. dobsoni* were newly recorded in present survey. The mean length of *Penaeus semisulcatus* (14.7 cm) was reduced compared to the 2021 survey (15.5 cm). On the other hand, *Penaeus merguiensis* mean length has increased from 15 cm to 17.1 cm.

In the analyses of abundance related to the maturation stage of shrimp species, the *P. semisulcatus* immature stage represents around 80% of the total population. The immature population of *P. indicus* slightly overrules the matured ones. However, matured individuals (about 85%) of *P. merguiensis* recorded in the 2021 survey has been reduced about 45 % in the present survey. Overall results among the whole shrimp communities in defined trawl ground, the most abundant shrimp *P. semisulcatus* where dominated by females and no adult males were recorded. The second most abundant shrimp *P. merguiensis* also dominated by females.

Even though the trawl fishing activity is carried out by a bottom trawl net, pelagic fish species were also caught in large quantities by the net. This may be explained by the shallow depth of the water column, trawl net design and swimming behaviour of fish. From the survey, the depth range within the survey area was between 6 - 9 m. During the trawl operations, highly migratory fast-swimming species could escape and slow movable species such as pony fish could easily get caught.

DNA barcoding

The identity of eleven samples from a trawl survey done in Kalpitiya in February 2023 were confirmed by DNA barcoding. The species identified are tabulated in Table 3.

Table 3 Identified species by DNA barcoding and their common names.

	Molecular identification	Common name
1	*Zebrias quagga*	Fringefin zebra sole
2	*Inimicus sinensis*	Spotted ghoul
3	*Ostorhinchus pleuron*	Rib-bar cardinalfish
4	*Mugil cephalus*	Flathead grey mullet
5	*Grammoplites scaber*	Rough flathead
6	*Thryssa hamiltonii*	Hamilton's thryssa
7	*Lagocephalus spadiceus*	Half-smooth golden pufferfish
8	*Thryssa vitrirostris*	Orangemouth anchovy
9	*Pomadasys maculatus*	Saddle grunt
10	*Equulites oblongus*	Oblong ponyfish
11	*Takifugu oblongus*	Lattice blaasop

Recommendations

The survey, when conducted over the years, will provide data that can be utilized to identify trends in stock development. The 23 trawlers previously operated 6 days a week in the small 4.3 square nautical mile trawling ground. Each week 100% of the seabed in the area was trawled, but still, catches are reasonable. This shows that there is a constant refilling of shrimps and fish from the surrounding areas into the trawling ground. It is likely to assume that overfishing and decline of the stock would be reflected in the declining refilling rate and consequently in future abundance estimates.

Declining trends may also be reflected in the average and maximum individual length and weight. Continued monitoring and establishment of time series surveying is therefore important. In combination with landing statistics, fisheries survey time series could give a good basis for the sustainable management of these resources.

In general, survey time series must be conducted in a consistent way from year to year so that the estimates are not influenced by a change in survey method or sampling gear. Due to the sudden trawl ban of 2022, the entire ecosystem seems to have undergone a complete shift between the two surveys. Consequently, any changes in abundance, species composition etc., cannot directly be attributed to fishing pressure or natural environmental changes, but rather to a human induced change of the ecosystem.

The time-series data directly contributes to the implementation of sustainable management strategies for the fish stock by considering the biomass and abundance estimates changes over years. This will reveal the degree of exploitation of the fishery resources and will help to resurge the sustainability of resources once overexploited. Sustainability can be achieved through the implementation of fishing restrictions, closed seasons, gear modifications, etc. So, this particular independence survey should be continuously carried out at a regular interval (one year or two years) for the better sustainability of shrimp resources in Dutch Bay.

Outputs

- Biomass and abundance time series data on penaeid shrimps and other bycatch species in Kalpitiya trawl fishing ground
- Abundance pattern of penaeid shrimps related to the length, weight, sex and maturity categorizations in Kalpitiya trawl fishing ground
- Comparison of the fishery resource existence in trawl fishing ground between previous and present survey
- Recommendations and future concerns for the sustainable fishery resource management on Kalpitiya trawl fisheries
- Scientific reports

EXTERNALLY FUNDED PROJECTS/ CONSULTANCY PROJECTS CARRIED OUT IN 2023

Continuous monitoring of the study which is carried out to assess the environmental impacts to marine resources due to Lakvijaya power plant 2022-2023.

Study on the Environmental Impacts on Marine Resources due to Lakvijaya Power Plant- That was a one-year project and project activities were conducted from September 2022 to September 2023. Marine Biological Resources Division was responsible for investigating the impacts on marine biota including zooplankton, Ichthiyoplankton, and benthic macro-invertebrates. Fishery-independent surveys and dependent surveys were carried out to investigate the possible impacts on commercially important fish species. In addition, underwater surveys were conducted in the sea adjacent to the power plant and nearby coral reef habitats to assess the possible impacts.

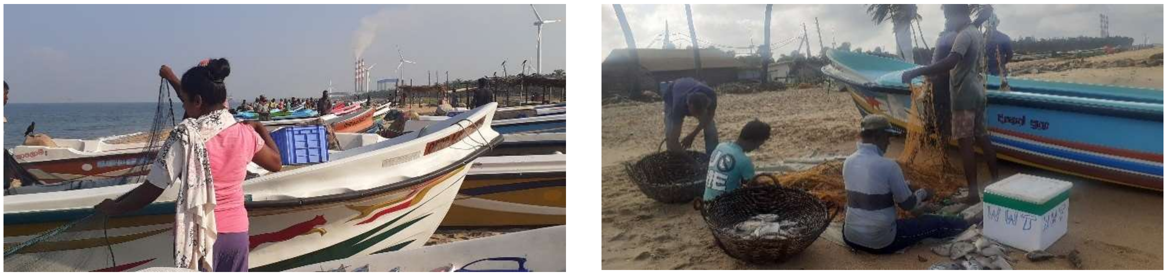


Figure 1: View of the Mampuri fish landing site.

OTHER ACTIVITIES UNDERTAKEN BY MBRD

1. MBRD Staff conducted lectures and awareness programs for SL NAVY and School students.
2. MBRD provided facilities to the 33 undergraduates (Universities: Kelaniya, Sri Jayawadenapura, Colombo, Ruhuna, Wayamba and Ocean University)
3. Dr. A.A.S.H. Athukoorala conducted lectures for the students following BSc (Hons) in Oceanography, BSc (Hons) in Coastal Resource Management, BSc (Hons) in Development of Aquaculture and Seafood Technology, Ocean University of Sri Lanka.
4. Dr. A.A.S.H. Athukoorala conducted NARA Annual Scientific Sessions 2023.

5. MBRD Staff conducted the initial Assessment of the Dead Sea shell bed at Kinniya Lagoon, Trincomalee.
6. MBRD Staff conducted the Sea cucumber stock assessment in Mullaithive coast and provided recommendations to the Department of Fisheries and Aquatic Resources
7. Dr. D.R. Herath Served as TEC chairman for 11 Procurement committees for the purchase of chemicals and consumables of IARAD (3), IPHT (5) and ESD (3) divisions.
8. Dr. D.R. Herath provided Industrial Training on Biotechnology for 5 students of the University of Ruhuna and 5 students from the Ocean University, 1 student from Wayamba University of Sri Lanka.
9. Dr. D.R. Herath served as the External Examiner for the thesis evaluation of 2 students following the MSc in Aquaculture and Fisheries Management of the University of Kelaniya (Ms. G.P. Chamali Kanchanamala and Ms. Anitha Ganeshwaranathan).
10. Dr. R.P.P.K. Jayasinghe served as an External Examiner for the thesis evaluation of M.Phil in Marine Sciences of the Uwa-Wellassa University (Mr. E.P.D.N. Thilakarathne)
11. Dr. R.P.P.K. Jayasinghe served as a Resource Person for the Online workshop on "The Ocean Governance Training Programme" conducted by the International Ocean Institute (IOI) & NARA from 17th August to 10th September 2023
12. Dr. R.P.P.K. Jayasinghe served as the external supervisor for Ph.D. Student P.G.J.B. Gamage, Department of Chemistry, University of Colombo.
13. Dr. R.P.P.K. Jayasinghe served as the external supervisor for M.Phil.Student Supun Bandara Pallemulla, Department of Fisheries, University of Jaffna.
14. Dr. S.S.K. Haputhantri successfully coordinated the Stock Assessment Training Programme and collaborative work on stock and risk assessment conducted at NARA from 25th September to 5th October 2023 by Dr. Tom Nishida, a representative of the menu-driven fish stock assessment and management decision software developing team in Japan.
15. Dr. S.S.K. Haputhantri successfully coordinated the seminar on menu-driven fish stock assessment and management decision-making software held at NARA on 12th June 2023.
16. Dr. Y.C. Aluwihare served as the external supervisor for Ms. Dharani Rathnayaka, B.Sc. (Hons.) in Agriculture (Undergraduate), Department of Biotechnology, Faculty of Agriculture & Plantation Management, Wayamba University of Sri Lanka.
17. Identified 2 morphologically unidentifiable fish samples collected from Kalpitiya in May 2023 to species level by molecular techniques: *Inimicus sinensis* (Spotted ghoul) and *Zebrias quagga* (Fringefin zebra sole).
18. Identified 4 stranded whales (4 short-finned pilot whales of the mass stranding that occurred in Kalpitiya on 11.02.2023) and 1 stranded dolphin (Bridled dolphin) to species level using molecular methods.
19. Identified stomach content of demersal fish and identified a crab species that is the 1st record in Sri Lanka: *Monomia gladiator / Portunus gladiator*.
20. MBRD research staff actively engaged in the environmental impact assessment of the X-Press Pearl ship disaster. Accordingly, MBRD conducted studies/ surveys aiming to investigate the effect of the incidence on demersal fish populations and chemical contaminations for the marine biological resources and marine environment.

WORKSHOPS/MEETINGS ATTENDED

1. FAO regional workshop for a network of practitioners on fishery stock assessment and FAO SOFIA Analysis meeting for Southeast Asia held from January 23.-27, 2023 at the Novotel Bangkok Ploenchit Sukhumvit, Bangkok, Thailand.
2. Exchange of expertise on Blue economy from 23rd January to 03rd February 2023 in Brussels, Belgium.
3. Sri Lanka Sharks and Ray identification workshop conducted by Blue Resources Trust on 22nd -23rd February 2023 at Jetwing Blue, Negombo.

4. New Paradigms in Fish Stock Assessment (CMFRI, India and BOBP) [Colombo , Sri Lanka, 25/05/2023 – 01/06/2023]
5. International forum on "Sustainable Ocean Management in Sri Lanka and the Indian Ocean" held on 14th and 15th March 2023 at Hilton Colombo Residences, Colombo, Sri Lanka.
6. Management Development Programme (MDP) on New Paradigms in Fish Stock Assessment – BOBP, CMFRI, NARA, MFAR, 25 May 2023 - 01 June 2023, Colombo, Sri Lanka
7. IOTC training on CPUE Standardisation, Eden Island, Seychelles, 03 –07 July, 2023
8. The Indian Ocean Tuna Commission (IOTC) 13th Working Party on Neritic Tunas, Eden Island, Seychelles, 03 –07 July, 2023.
9. Inaugural Session of the Bay of Bengal Stock Assessment Network (A virtual network of practitioners from the region) held on 17th August 2023
10. Training on Exploration of data quality, sampling and analysis of landing data from coastal fisheries in Sri Lanka, Using R statistical Software under the Norway Sri Lanka Bi lateral Project, 20-24th August, 2023, Hikkaduwa, Sri Lanka
11. September 2023: 19th IOTC working party on Ecosystems and By-catch (Virtual)
12. Indian Ocean Tuna Commission (IOTC) organized the 21st Working Party on Billfish (WPB21) 06-09 September 2023, La Reunion
13. Developing research connections for the Indian Ocean and a panel on IUU fishing in the Indian Ocean from 25th October to 27th October in Perth, Australia
14. Indian Ocean Tuna Commission (IOTC) 25th Working Party on Tropical Tuna held in San Sebastian, Spain from 29th October – 6th November 2023.
15. Represented Sri Lanka in Indian Ocean Tuna Commission (IOTC) Working Party Meetings *Indian Ocean Tuna Commission (IOTC) fourteenth working party on Methods, San Sebastian, Spain, 26-28 October 2023.*
16. Stock Assessment Training Programme and collaborative work on stock and risk assessment conducted at NARA from 25th September to 5th October 2023 by Dr. Tom Nishida, a representative of the menu-driven fish stock assessment and management decision software developing team in Japan.
17. Mini-Symposium and Forum of the EAF-Nansen Programme (FAO) in Maputo, Mozambique, 30 October-2 November 2023.
18. 26th Scientific Committee Meeting (SC26) of Indian Ocean Tuna Commission (IOTC), 4-8 December 2023, Mumbai, India
19. Fish Acoustic Survey by Mr. Totland Atle, Institute of Marine Research, Norway in November 2023.
20. Workshop on working towards Proactive Preparedness for oil spill event in Sri Lanka conducted by OCPP, CEFAS from 27th -30th November 2023 in Colombo, Sri Lanka.
21. Dr. R.P.P.K. Jayasinghe Panelist: Panel discussion on "Biodiversity Beyond National Jurisdiction Agreement". Organized by the Laksman Kadiraganmar Institute and the European Union. 24 November 2023.
22. Dr. R.P.P.K. Jayasinghe Keynote Speaker: China-Sri Lanka Joint Symposium of Coral Reef Ecology. Speech on "Knowing the unknown: the way forward in coral taxonomy". Organized by the University of Ruhuna and the South China Sea Institute of Oceanology, Chinese Academy of Sciences (CAS).
23. Dr. S.S.K. Haputhantri, at the FAO regional workshop for a network of practitioners on fishery stock assessment held in Bangkok, Thailand in January 2023, delivered the country presentation on "review of fishery stock assessment in Sri Lanka – current assessment approach and status of fisheries"

24. Dr. S.S.K. Haputhantri at the international forum on “Sustainable Ocean Management in Sri Lanka and the Indian Ocean” held on 14th and 15th March 2023, delivered the presentation on “Transboundary ocean and fishery resource management in Sri Lanka and adjacent Indian Ocean”.
25. Dr. S.S.K. Haputhantri, at the inaugural Session of the Bay of Bengal Stock Assessment Network on 17th August 2023, delivered the country presentation on “Stock Assessment Methods & Opportunities for Knowledge Sharing”.
26. Dr. S.S.K. Haputhantri at the 25th session of IOTC Working Party on Tropical Tuna held in San Sebastian, Spain from 29th October – 6th November 2023, presented the paper “Accounting for spatial, temporal and operational effects in the Catch Per Unit Effort Standardization of Skipjack tuna in tuna gillnet fishery in Sri Lanka”.

PUBLICATIONS

Full papers

1. K.H.K. Bandaranayake, S.S. Gunasekara, R.P.P.K. Jayasinghe, D.R. Herath, V.K. Ranasinghe and S. Yatawaka. 2021. Reproductive morphology, morphometric aspects and molecular identification of *Scylla* (Mud Crab) species in Sri Lanka. *Journal of the National Aquatic Resources Research and Development Agency* **48-50**: 14-25. (Published in 2023).
2. K.H.K. Bandaranayake, S.S. Gunasekera and R.P.P.K. Jayasinghe. (2023). Effect of bait types on catchability of billfish in tuna longline fishery in Sri Lanka. IOTC Working Party on billfish. IOTC-2023-WPB21-24_Rev1
3. K.H.K. Bandaranayake, S.S. Gunasekera, R.P.P.K. Jayasinghe and R. Maldeniya. (2023). Present Status and Future Developmental Perspectives of Pole and Line Fishery in Sri Lanka. *Sri Lanka Journal of Aquatic Sciences* **28**(2): 55-64.
4. M.P. Hendawitharana, R.P.P.K. Jayasinghe, M.M.C. Karunarathne and S.S.K. Haputhantri. (2021). The present status of the shallow reef patches at the Bar Reef Marine Sanctuary, Sri Lanka. *Journal of the National Aquatic Resources Research and Development Agency* **48-50**: 74-80. (Published in 2023)
5. P.R.T. Cumaranatunga, K.R. Dalpathadu, H.M.U. Ayeshya, K.A.W.S. Weerasekera, S.S.K. Haputhantri, W.N.C. Priyadarshani, G.K.A.W. Fernando, L.D. Gayathry and H.B.U.G.M. Wimalasiri. (2023). Impact of MV X-Press Pearl Disaster on Coastal and Marine Fish and Fisheries. In: M. Vithanage, A. P. de Alwis, D. Botheju (Eds). Maritime Accidents and Environmental Pollution - The X-Press Pearl Disaster: Causes, Consequences, and Lessons Learned, CRC Press, Boca Raton. Chapter 11. https://doi.org/10.1201/9781003314301
6. W.K.A.M.T.S. Aththanayaka, H.M.U. Ayeshya, S. Thanusanth, S.C.V.U. Senevirathna, C.B. Madagedara and R.P.P.K. Jayasinghe. (2021). Present status of mangroves and seagrasses in the upper western border of the Puttalam Lagoon, Sri Lanka. *Journal of the National Aquatic Resources Research and Development Agency* **48-50**: 59-73. (Published in 2023).

PROCEEDINGS OF CONFERENCES

1. R.P.P.K. Jayasinghe, K.H.K. Bandaranayake and S. Thanusanth. (2023). Application of DPSIR framework in tuna fisheries management in the Indian Ocean with special reference to Sri Lanka. IOTC Working Party on Methods. IOTC-2023-WPM14-09_Rev1.
2. K.R. Dalpathadu, D.G.T.C. Balawardhana and S. S. K. Haputhantri (2023). Population dynamics of kawakawa (*Euthynnus affinis* (Cantor, 1849)) in Sri Lankan waters. In: IOTC–2023– WPNT13-18. 13th Session of the Indian Ocean Tuna Commission (IOTC) Neritic Tunas Working Party.Eden Island, Seychelles, 03 –07 July, 2023.
3. Sisira Haputhantri, Gayan Jayasinghe and Sudeera Gunasekara. (2023). Accounting for spatial, temporal and operational effects in the Catch Per Unit Effort standardization of Skipjack tuna in tuna drift gillnet fishery in Sri Lanka. 2023. IOTC–2023–WPTT25–06. Twenty-fifth Session of the Indian Ocean Tuna Commission (IOTC) Tropical Tuna Working Party.

4. A.A.S.H. Athukoorala, K.R. Dalpathadu, S.S. Gunasekara, M.P. Hendawitharana, M.M.C. Karunarathne, M.D.I.C. Kumara, J.A. C. Prasad, S.C.V.U. Senevirathna, R.P.P.K. Jayasinghe. (2023). Stock status of Sea cucumbers on the North East coast of Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023. 22 p.
5. D.G.T.C. Balawardhana, H.L.N.S. Herath, S.S.K. Haputhantri. (2023). Catch Composition and Some Biological Aspects of Silky sharks (*Carcharhinus falciformis*) landed by Surrounding Net Fishery in Sri Lanka, IOTC-2023-WPEB19-35. Nineteeth Session of the Indian Ocean Tuna Commission (IOTC) Ecosystems and By Catch Working Party
6. D.P.T.H. De Silva, W.N.N. Dabarera, S.S. Ediriweera, C.M. Nanayakkara, K.G.S.U. Ariyawansa, N.N. Wijayawardene, R.P.P.K. Jayasinghe, S.C. Karunarathna and D.Q. Dai. (2023). In vitro evaluation of the antioxidant activity of selected fungal endophytes isolated from two species of family Pandanaceae in Sri Lanka. Proceedings of the 43rd Annual Sessions of Institute of Biology, Sri Lanka. 81p
7. D.R. Herath, S. Yatawaka, M.P. Hendawitharana, R.P.P.K. Jayasinghe, G.K.A.W. Fernando and U.S.P.K. Liyanage. (2023). Genetic diversity of short-finned pilot whales stranded on the coastal beaches of Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023. 32 p.
8. H.A.D.N.N. Happitiya, C.M. Nanayakkara, K.G.S.U. Ariyawansa, S.S. Ediriweera, N.N. Wijayawardene, R.P.P.K. Jayasinghe, Don-Qin Dai, S.C. Karunarathna. (2023). Antibacterial Activities of Lichen-associated Fungi in Mangrove Ecosystems in Sri Lanka as Potent Candidates for Novel Antibiotic Agents. Proceedings of SLIIT International Conference on Advancements in Sciences and Humanities, 1-2 December, Colombo, 397-403.
9. H.M.U. Ayeshya, L.D. Gayathry, S.C.V.U. Senevirathne, S.S.K. Haputhantri and R.P.P.K. Jayasinghe. (2023). Reproductive biological aspects of Indian Mackerel (*Rastrelliger kanagurta*) in the west coast of Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023. 26 p.
10. D.R. Herath, S. Yatawaka, M.P. Hendawitharana, R.P.P.K. Jayasinghe and G.K.A.W. Fernando and U.S.P.K. Liyanage (2023). Genetic diversity of short-finned pilot whales stranded on the coastal beaches of Sri Lanka. Proceedings of the NARA Scientific Sessions 2023.
11. K.H.K. Bandaranayake, S.S.K. Haputhantri and R.P.P.K. Jayasinghe. (2023). Recolonization of macro-zoo benthos in sand dredging site located off shore Negombo, Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023. 78p.
12. M.K.D. Fernando, S.S. Ediriweera, C.M. Nanayakkara, N.N. Wijayawardene , R.P.P.K. Jayasinghe, Don-Qin Dai, S.C. Karunarathna, K.G.S.U. Ariyawansa. (2023). Diversity of fungal endophyte morphotypes of Mangrove plant *Avicennia marina* in the Puttalam Lagoon, Sri Lanka. Proceedings of the 43rd Annual Sessions of Institute of Biology, Sri Lanka. 79p.
13. M.A.S. Ranjula, P. Jayasinghe, and M.I.G. Rathnasuriya. (2023). Larval fish assemblage in Western coastal waters of Sri Lanka: Seasonal and spatial structure. Proceedings of 46th Annual Larval Fish Conference, Lisbon, Portugal. 71p.
14. M.M.C. Karunarathna, M.P. Hendawitharana and R.P.P.K. Jayasinghe. (2023). Status of two reef sites, Arippu and Silawathurai on the Northwest coast of Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023. 80 p.
15. A.I. Madhumali, A.A.D. Amarathunga,., M.A.P.C. Piyathilaka, , M.D.S.R. Maddumage and and K.R. Dalpathadu (2023). Microplastic contamination in beach seine fishery in southern and western coastal waters in Sri Lanka. In: Scientific Sessions, National Aquatic Resources Research and Development Agency, (2023), Sri Lanka.
16. P.H.H.J. Bandara, D.A. Arokkiam, S.S. Ediriweera, C.M. Nanayakkara, K.G.S.U. Ariyawansa, N.N. Wijayawardene, R.P.P.K. Jayasinghe, Don-Qin Dai and S.C. Karunarathna. (2023). Extracellular enzymatic activities of halophilic fungi in Kalpitiya area of Puttalam Lagoon, Sri Lanka. Proceedings of the 43rd Annual Sessions of Institute of Biology, Sri Lanka. 80p.

17. R.G.S. Anurangi, C.M. Nanayakkara, S.S. Ediriweera, N.N. Wijayawardene, R.P.P.K. Jayasinghe, Dong-Qin- Dai, S.C. Karunarathna, K.G.S.U. Ariyawansa. (2023). Diversity and industrial potential of endophytic fungi isolated from *Avicennia marina* in the Puttalam Lagoon, Sri Lanka. Proceedings of the 43rd Annual Sessions of Institute of Biology, Sri Lanka. 84p.
18. S. Thanusanth, R. Srikrishnan and R.P.P.K. Jayasinghe. (2023). Exploring the fisheries aspects of fyke net fishery in Puttalam Lagoon, Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023. 24 p.
19. S. Thanusanth, R. Srikrishnan, M.M.A.S. Maheepala and R.P.P.K. Jayasinghe. (2023). Preliminary study on biological, fisheries and socio-economical aspects of Gastropod fisheries in Kalpitiya area, Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023. 23 p.
20. S. Yatawaka, D.N.A. Ranmadugala, A.A.D.G. Amarakoon, U. Liyanage, R.P.P.K. Jayasinghe and D.R. Herath. (2023). Phylogeographic analysis of dugongs (*Dugong dugon*) of Sri Lanka and other warm coastal waters. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023. 31 p.
21. Y.C. Aluwihare, S. Fernando, M.S. Gunasingha, R.D.C. Ranasingha, M.A.S. Ranjula T. Weerakoon, S.S.K. Haputhantri, R.P.P.K. Jayasinghe and P.N. Psomadakis (2023) First record of rare adult Pacific squaretail, *Tetragonurus pacificus* (Teleostei:Perciformes: Stromateoidei) from Sri Lankan coastal waters.
22. Y.C. Aluwihare, R.P.P.K. Jayasinghe, S.S.K. Haputhantri1, S. Fernando 2, M.S. Gunasinghe, R.D.C. Ranasinghe, M.A.S. Ranjula, T.N. Weerakoon and P.N. Psomadakis. (2023). The first record of a very rare adult Pacific squaretail, *Tetragonurus pacificus* from the Indian Ocean. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023. 34 p.

REPORTS

1. Species identification of dried shark fins, skin, jaws, ray gills and fresh shark meat samples produced by the exporters to get the export permit.
2. U. Liyanage and D. R. Herath. Reports on the analysis of ambergris samples from Mullativu Magistrate’s Court (court case No. B/85/2023) and Matara Magistrate’s Court (court case no. මාතර ම/උ BR 3354/23).
3. Report on the identification of a dolphin sample (court case No. 46476 from Tangalle Magistrate’s court forwarded by the Department of National Zoological Gardens)
4. එස්. එස්. කේ. හපුතන්ත්‍රි, කේ. ආර්. දල්පතාදු, 2023. ත්‍රිකුණාමලය දිස්ත්‍රික්කයේ නව හැඹිලිදැල් බලපත්‍ර ලබාදීම සදහා නිර්දේශ ඇතුලත් වාර්තාව .ජාතික ජලජ සම්පත් පර්යේෂණ සහ සංවර්ධන නියෝජිතායතනය (NARA) මගින් ධීවර සහ ජලජ සම්පත් දෙපාර්තමේන්තුව නිකුත් කරන ලද වාර්තාව .

REVIEWED PAPERS / EDITORIAL BOARDS

1. Dr. S.S.K. Haputhantri reviewed a scientific paper submitted to the Sri Lanka Journal of Aquatic Sciences (SLJAS) for possible publication.
2. Dr. S.S.K. Haputhantri reviewed a scientific paper submitted to the Thalassas: An International Journal of Marine Sciences for possible publication.
3. Dr. R.P.P.K. Jayasinghe reviewed a paper submitted to the Marine Policy.
4. Dr. R.P.P.K. Jayasinghe reviewed a paper submitted to the Asian Fisheries Science
5. Dr. D.R. Herath reviewed a manuscript for consideration of publication in the Journal of Science of the University of Kelaniya.

REPRESENTATION OF MBRD SCIENTISTS AT NATIONAL COMMITTEES/ NATIONAL SERVICES

1. Dr. R.P.P.K. Jayasinghe, Principal Scientist serves as a member of the National Expert Committee on Biological Diversity (NECBD) coordinated through the Biodiversity Secretariat, Ministry of Mahaweli Development and Environment.
2. Ms. Bandaranayake, K.H.K, secretary of the Expert Committee on Promoting High Impact Fisheries appointed by the Presidential Secretariat, Sri Lanka. (Goal: Transforming Sri Lankan marine fisheries to a key contributor to the national economic growth, ensuring sustainability in line with principles of Blue Economy).
3. Dr. D.R. Herath, Senior Scientist of MBRD acts as a member of the National Committee on Fisheries and Aquatic Resources Sector (NCFARS) of the Sri Lanka Council for Agricultural Research Policy (SLCARP).
4. Drs. R.P.P.K. Jayasinghe and A.A.S.H. Athukoorala have been appointed as the President and the Joint Secretary respectively for Sri Lanka Association for Fisheries and Aquatic Resources (SLAFAR) 2023/2024.
5. Dr. A.A.S. H. Athukoorala serves as one of the Sri Lankan experts in the Regional expert committee in the BOBLEM programme.
6. Dr. S.S.K. Haputhantri, Principal Scientist of MBRD acts as NARA focal point of the AFD fisheries harbour development project.
7. Dr. S.S.K. Haputhantri, Principal Scientist of MBRD acts as a NARA representative of the World Bank-related activities.
8. Dr. S.S.K. Haputhantri, Principal Scientist of MBRD acts as a member of the committee formed by the Ministry of Fisheries to develop the local canned fish industry in Sri Lanka.
9. Dr. S.S.K. Haputhantri, Principal Scientist of MBRD acts as the Country Representative of the FAO Fish Stock Assessment Network.
10. Dr. S.S.K. Haputhantri, Principal Scientist of MBRD acts as the Country representative of the Bay of Bengal Stock Assessment Network (BOBSAN).
11. Dr. S.S.K. Haputhantri, Principal Scientist of MBRD acts as NARA DG's representative at the Executive Committee on High-Impact Fisheries formed by the Presidential Secretariat.
12. Dr. S.S.K. Haputhantri, Principal Scientist of MBRD acts as a Member of the Marine Fisheries Subcommittee to develop a Policy Framework to modernize the Marine Fisheries Sector.
13. Dr. S.S.K. Haputhantri, Principal Scientist of MBRD acts as NARA focal point of the Korean government's ODA (Official Development Assistance) project on the Establishment of the National Oceans and Fisheries Data Center at NARA.
14. Ms. G.K.A.W. Fernando, Scientist of MBRD act as a member of the Blue Carbon Ecosystems Task Force appointed by the Secretary, Ministry of Environment, Sri Lanka since 2022.

5.6 NATIONAL INSTITUTE OF OCEANOGRAPHY AND MARINE SCIENCES

Head of the Division : Dr. K. Arulananthan

Oceanography Division is responsible for planning and conducting coastal and offshore oceanographic studies around Sri Lanka. In this regard oceanographic and marine geological scientists conduct research in the fields of physical, chemical, biological oceanography. The Division has been conducting research on coastal and deep ocean research having long term archival of oceanographic datasets such as tides, currents and waves. The division provides its scientific and technological services to a wider range of applications such as coastal constructions, living and non-living resource exploitation, and energy harnessing including environmental impact assessments (EIA).

Progress of Research Projects

Oceanography Division has conducted fourmajor projects and several consultancy services during the year 2023. Following are the major projects conducted by the division during 2023.

	Projects	Responsible Officer/s
6.1	Potential fishing ground forecasting (Tuna Fishing Ground Advisory and Fisheries Information Service)	Sudheera Gunasekara
6.2	Prospecting and quantification of Garnet bearing sand deposit in South-Eastern coast of Sri Lanka as a tool to enhance the foreign exchange	Ruchira Jayathilake Dileka Samaranayaka Damith Perera
6.3	Restoring Lagoon dynamics and ecology under ecosystem based approach: A case study of Lankapatuna Lagoon in Eastern coast of Sri Lanka	H.A.S.D. Perera Ruchira Jayathilaka T.B.D.T. Samaranayake N.G.L.Nadee Uthpala Dr. K. Arulananthan
6.4	Maintenance of sea-level monitoring network around Sri Lanka	K.W.Indika

PROJECT NO 6.1:
POTENTIAL FISHING GROUND FORECASTING (TUNA FISHING GROUND ADVISORY AND FISHERIES INFORMATION SERVICE)

Officer/s responsible : S.S. Gunasekara
Financial Allocation : (Rs) 1.3 million

Introduction

The fishery has a long tradition in Sri Lanka and contributed 1.0 % of GDP in 2022 (CBSL., 2022). The marine fishery is the dominant fisheries sector in Sri Lanka, contributing 71% to the country's total fish production (Ministry of Fisheries., 2022). Offshore tuna fishery has a significant contribution to the economy as tuna contributes 49.5% of total fish exports of 299 million US$ in 2019 (Ministry of Fisheries., 2020).

Expansion of coastal fisheries has limited prospects as coastal resources are heavily utilized presently. A comparison of Dr Fridtjof Nansen's surveys (1978-1980) with the survey results in 2018 shows that the decline in total catch rates was oblivious in all the coastal regions, incredibly profound along the West coast (Krakstad et al. 2018). Sustainable development of the fisheries sector needs to be focused on the offshore fisheries sector. It can be expanded fishing area and can be improved by incorporating technology to minimize post-harvesting losses. Offshore fishing was introduced several decades ago. Fishers use their traditional knowledge and information from other fishing vessels to find fishing grounds. Satellite remote sensing is a proven tool for finding potential fishing areas and significantly reducing the search time. The National Fisheries and Aquaculture policy section emphasizes "Strengthen the fisheries forecasting system for fishers to obtain information on locations for productive fishing" Section 4.1.17 (Ministry of Fisheries, 2018).

At present, fishers use traditional knowledge and information from other vessels to reach the fishing grounds. Nevertheless, fishing masters used to rely on word-of-mouth from other fishing vessels to locate fishing grounds. Since the fishery role is opportunistic, a non-random distribution of fishing vessels highly concentrated in an area indicates an abundance of target fish. Like skipjack tuna, fishers tend to remain in warmer waters where masters seek opportunities to cast their nets. Therefore, this kind of fishery is not economically inefficient and post-harvest loss is high.

Potential fishing areas are places in the waters where a high abundance of fish and suitable for fishing operations. Understanding the oceanographic factors that affect fish distribution is important to find out the possible fishing grounds. It is possible to use near-real-time oceanographic information from satellite remote sensing to predict potential fishing grounds.

Fishery forecasting involves understanding the oceanic processes and interactions of physical, biological, and chemical parameters. Remote sensing data can provide a significant part of the information needed to assess and improve the potential fishing grounds and assist judicious exploration, conservation and management of marine resources. Timely forecasting of potential fishing grounds information can help an optimizing the scheduling of fishing operations. Fish tend to aggregate in ocean areas that exhibit conditions favoured by specific fish species. Relevant oceanographic conditions, such as sea surface temperature, ocean colour (productivity), upwelling, thermal fronts gyres and eddies favouring the fish school, can be monitored and measured by remote sensing sensors. Several countries use potential fishing zone prediction technology to increase fishing efficiency.

Main objective

To enhance the economic and time efficiency of offshore/high seas fishery by providing information on potential tuna fishing ground advisory to multi-day fishing vessels

Specific Objective/s

To provide potential fishing zone advisories for tuna multi-day fishing vessels of Sri Lanka

Methodology

Utilizing data from satellite remote sensing, including sea surface temperature, sea surface height, and sea surface chlorophyll, along with fisheries catch information and global ocean physical models, the project aims to identify favorable areas for yellowfin tuna. Similarly, data from Copernicus global ocean physical models, focusing on sea surface temperature and sea surface salinity, is employed to produce a 5-day fishing ground forecast for skipjack tuna gillnet fishing vessels. Forecast maps are issued thrice weekly on Monday, Wednesday, and Friday and disseminated through various channels such as WhatsApp, email, telephone, SSB radio, and Facebook.

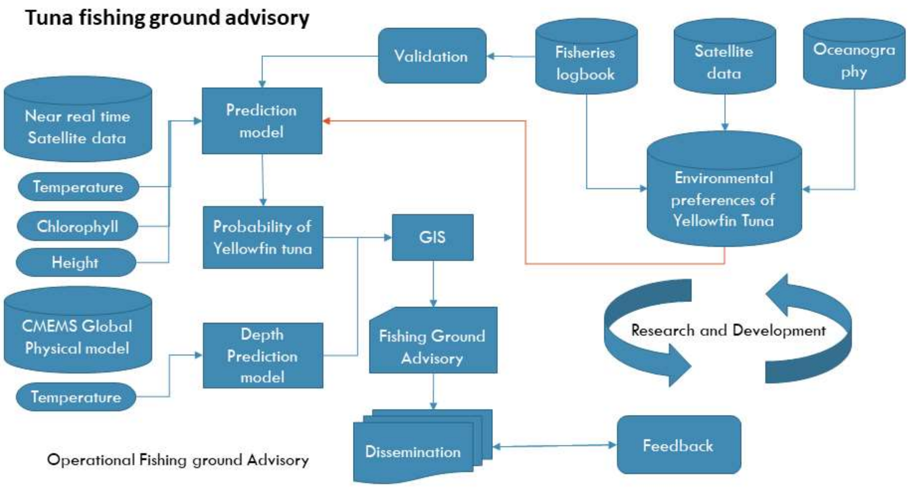


Figure.1 Flowchart of the Methodology of yellowfin tuna fishing ground advisory

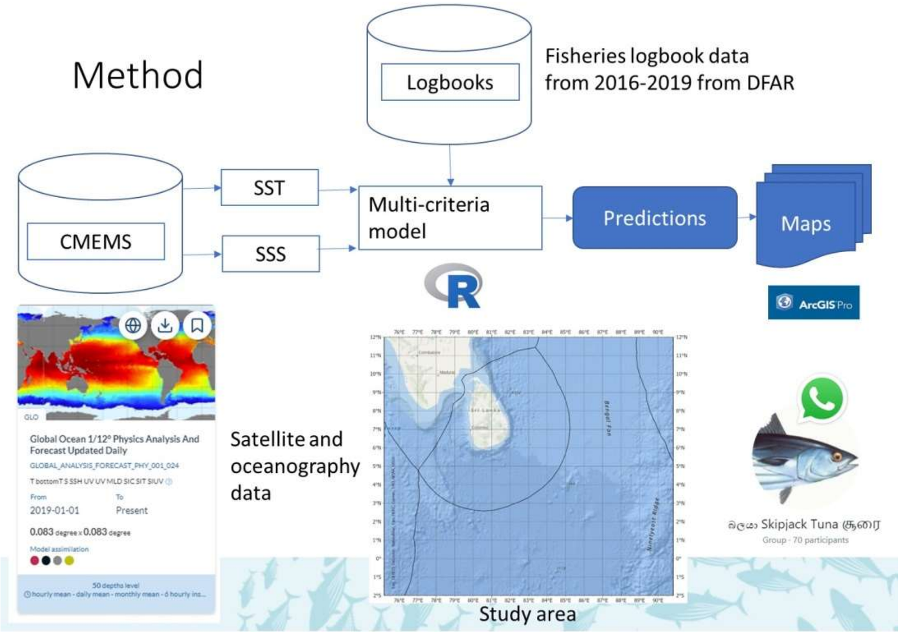


Fig 4. Flow chart of the method use for Skipjack tuna 5-day fishing ground forecast

Activities proposed to be completed during the period

- Generating fishing ground advisory maps
- Fishery data collection: VMS data fisheries data
- Model development
- Validation of results
- Disseminate information by telephone, radio, email and web to the users
- Awareness programs for fishermen, vessel owners and other stakeholders

Results:

Activities carried out:

Timely forecasting of potential fishing grounds information can help an optimizing the scheduling of fishing operations.

Despite challenges like limited research staff and technical failures, the project successfully produced and disseminated 141 yellowfin fishing ground advisories (target 143) and 139 potential fishing ground advisories (target 143) for skipjack tuna three times a week via email, telephone, and WhatsApp.

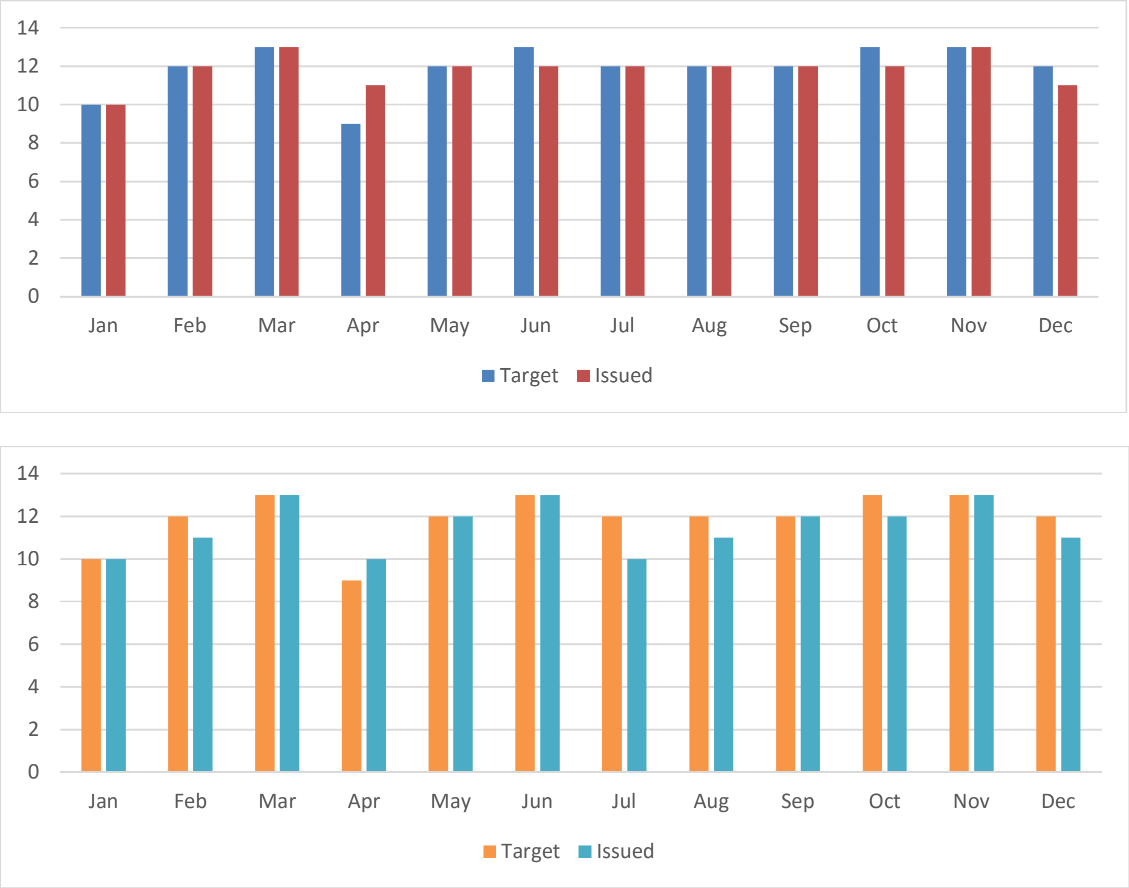


Figure 2: Comparison of Monthly Issued Fishing Ground Forecasts with Target Numbers; (Upper) Yellowfin tuna, (Lower) Skipjack tuna

Raising awareness among skippers and owners of multi-day fishing boats regarding Nara's potential fishing ground forecasts is crucial for the project's success. The project exceeded its target by conducting 37 awareness programs (target 24) and fisheries data collection in multiple locations, including Negambo, Dikowita, Beruwala, Ambalangoda, Hikkaduwa, Galle, Mirissa, Devinuwara, Suduwella, Nilwella, Kudawella, Tangalle, Hambantota, Kirinda, Valachenai, Kalmunai, Trincomalee, Chilaw, Wennapuwa, Kalpitiya, Myliddy, and Point Pedro fisheries harbors. Awareness leaflets in Sinhala and Tamil were distributed to multiday fishing boat owners and fishermen.

Fishing ground advisories were primarily disseminated via WhatsApp, reaching 750 vessel owners and DFAR officers, with email subscribers increasing to 380. The project's Facebook page (www.facebook.com/tuna.forecast) boasts 1950 followers, while the Department of Fisheries registered skippers' Facebook group (ධීවර දෙපාර්තමේන්තුවේ ලියාපදිංචි නියමු එකතුව) has 1200 followers, effectively aiding in advisory dissemination. Dialog Sayuru project also contributes to advisory dissemination through TV screens at eight fisheries harbors and their Facebook page.

To collect in-situ data, Temperature Depth Recorder (TDR) sensors were provided to fishermen using longline fishing gear. Fishermen voluntarily attached sensors at different depths of longline hooks, recording catch information to study the relationship between hook position, temperature, and catch rates, ultimately improving fishing ground advisories.

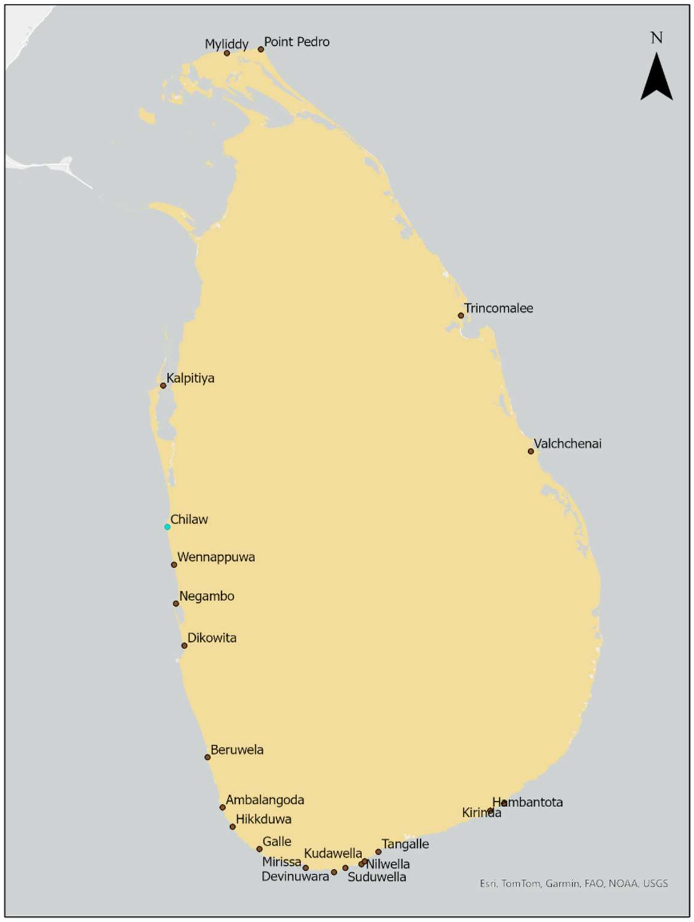


Figure 3: Map of fisheries harbours awareness programs conducted during 2023

Outputs & outcomes

The impact of the project will be the improved high sea fishery of Sri Lanka.

Outputs

- Improved the predictability of potential fishing grounds for yellowfin tuna longline fishery and skipjack tuna gillnet fishery
- The model was updated for the latest satellite and oceanographic modal data sources
- Increasing the number of recipients
- The number of email recipients was increased up to 380
- WhatsApp 750 recipients
- Facebook page 1950 followers
- Increase the awareness on the usage of fishing ground advisories
- Outcome
- Improve the efficiency of the tuna multi-day fishery of Sri Lanka. Due to the fuel crisis, fishermen are more dependent on potential fishing ground advisories.

Conclusions

Despite challenges like limited research staff and technical failures, the project successfully produced and disseminated 141 yellowfin fishing ground advisories (target 143) and 139 potential fishing ground advisories (target 143) for skipjack tuna three times a week via email, telephone, and WhatsApp.The project exceeded its target by conducting 37 awareness programs (target 24) and fisheries data collection in all fisheries harbors.

Recommendations

Potential fishing ground forecasting is a dynamic process of analyzing fisheries, satellite and oceanographic data and fine-tuning prediction models by updating data sources. There are no scientific fishing programs for tuna and tuna-like species, in-situ oceanographic data collection and adequate fisheries logbook data collection program. The validation of predictions and improvementof the tuna environmental preferences rely on the Department of Fisheries logbook data which has low accuracy and low quality. It is crucial to improve the quality of fisheries logbook data. These are essential to enhance the prediction model and provide reliable advisories.

Hardware failures of satellites and data delays caused interruption of the advisories for few days. Therefore, the development of methods to get alternative satellite data is recommended.

Constraints

As outlined in the project proposal, two new fishing ground advisories (bigeye tuna and billfishes) were slated for development in 2023. However, data analysis was hindered by a lack of research staff. The potential fishing ground forecasting capacity of Nara remains highly vulnerable, with only one scientist involved in the project and insufficient knowledge transfer to additional scientists and research assistants. Support from supporting divisions of Nara has been minimal, and monitoring and evaluation efforts have been limited. Addressing these challenges is crucial for the project's sustained success.

Unfortunately, the forecast results could not be validated with fisheries logbook data and VMS data due to erroneous logbook data and limited VMS data for the year 2023. VMS data were received only for three (3) days of year 2023. Fishermen's feedback was the only validation method, but obtaining personal fishing records proved challenging. While DFAR has agreed to provide logbook data and VMS access, improvements in eLogbook data quality and VMS access via API or SecondScreen® app of Blue tracker VMS are yet to be addressed.

Progress : Financial : the data were not provided by finance division Physical : 70%

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PROJECT NO : 6.2

PROSPECTING AND QUANTIFICATION OF GARNET BEARING SAND DEPOSIT IN SOUTH-EASTERN COAST OF SRI LANKA AS A TOOL TO ENHANCE THE FOREIGN EXCHANGE

Officer/s responsible : T.B.D.T Samaranayake , H.A.S.D Perera

Introduction

Garnets are *a group of silicate minerals that have been used as gemstones and abrasives*. It was first used for coated sandpaper in 1878. Although garnet sandpaper is still in use, the industrial technology that employs garnet has expanded to include abrasive airblasting, water filtration, abrasive powder, and waterjet cutting. Currently, Garnet is a minor export commodity in Sri Lanka and is extracted from Pulmuddai area. Current global supply of the critically important minerals may be insufficient to meet future demand unless new sources are identified. Therefore, identifying and prospecting new mineral deposit should be done to meet the demand. Further, the demand for the heavy minerals increase day by day and in 2019, the average unit value of garnet imports was $250 per ton, an increase of 19% compared with the average unit value in 2018. In the United States, most domestically produced crude garnet concentrate was priced at about $230 per ton. The project aims to identify and quantify the heavy mineral percentages in the southeastern coast, namely Dikwella, Tangalle,Hambantota, Ambalantota and Kirinda areas.

Objectives

To identify resource availability for maintaining a sustainable upstream heavy mineral industry

To identify and quantify major and trace element compositions

Methodology (Study area, Field sampling, data collection and analysis)

Sample collection

Surface sediment samples collected from beaches namely Dikwella, Tangalle, Ambalantota,Ussangoda,Hambantota and Kirinda beaches. Three samples were obtained from each location representing beach, berm and the vegetation line. Further, few core samples were collected from Hambantota and Kirinda beaches. The sample collection was done in March and October months to cover up the two monsoon periods. The sample locations are as bellows

Figure01: Sampling points

Laboratory procedure

The collected samples were washed and dried for pre-preparations. During the pre-preparation procedure the samples which are in between the sizes of 1mm and 40 um were separated. The separated samples were then treated with Hcl to remove debris such as shell and coral particles. Then they were again treated with NaOH to disaggregate sediment particles. The pre-prepared samples were then treated with bromoform liquid and separated the heavy mineral portion. Alternatively, panning method was used.

The separated heavy mineral fractions were observed through microscope and identify the heavy mineral types. Each sample was divided in to four portions using cone and quartering method and 3 portions from each sample were observed through microscope to maintain the accuracy. Mainly focused to garnet,Ilmenite,monazite and rutile minerals.

Analysis and calculation

Heavy mineral percentage for each location was calculated and tabulated

Results: Activities carried out:

Literature survey was carried out through -out the year and was completed as proposed.

Table 01 : Activities carried out

Activity	Progress	
	Pre- southwest monsoon	Post-southwest monsoon
Sample collection	Completed	Completed
Pre-preparation	Completed	Completed
Heavy mineral separation	Completed	Completed
Mineral identification	Completed	Completed
Calculations	Completed	Ongoing

Outputs & outcomes

a. Grain size characterization

The sand grains which are in between 1mm to 63um were selected for further analysis and the weight percentage of the desired range in each location is tabulated below.

location	Percentage	
	Pre-monsoon	Post-monsoon
Dikwella	90	92
Tangalle	89	87
Hambantota	85	84
Ussangoda	91	91
Ambalantota	92	90
Kirinda	89	88

b. Shell and coral percentage

Shell and coral percentage varied from 0.82-4.4% in beach samples during the post southwestern monsoon and the range of the same during the pre-monsoon period was varied from 0.72-3.5%. The highest shell and coral percentage reported in Tangalle beach while the lowest shell and coral percentage reported in Hambantota beach.

c. Heavy mineral percentage

Heavy mineral percentages of the surveyed locations before and after monsoon are as bellows.

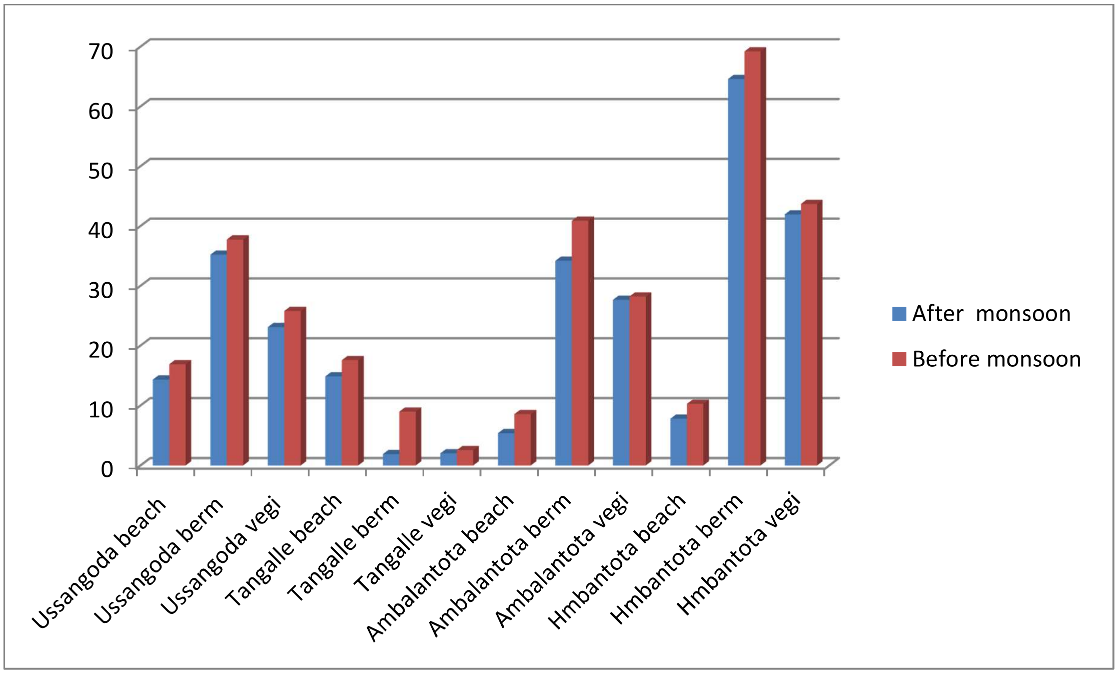


Figure 02 : Heavy mineral percentage pre- and after monsoon

The concentrated heavy minerals were examined for heavy mineral types and are as bellows.

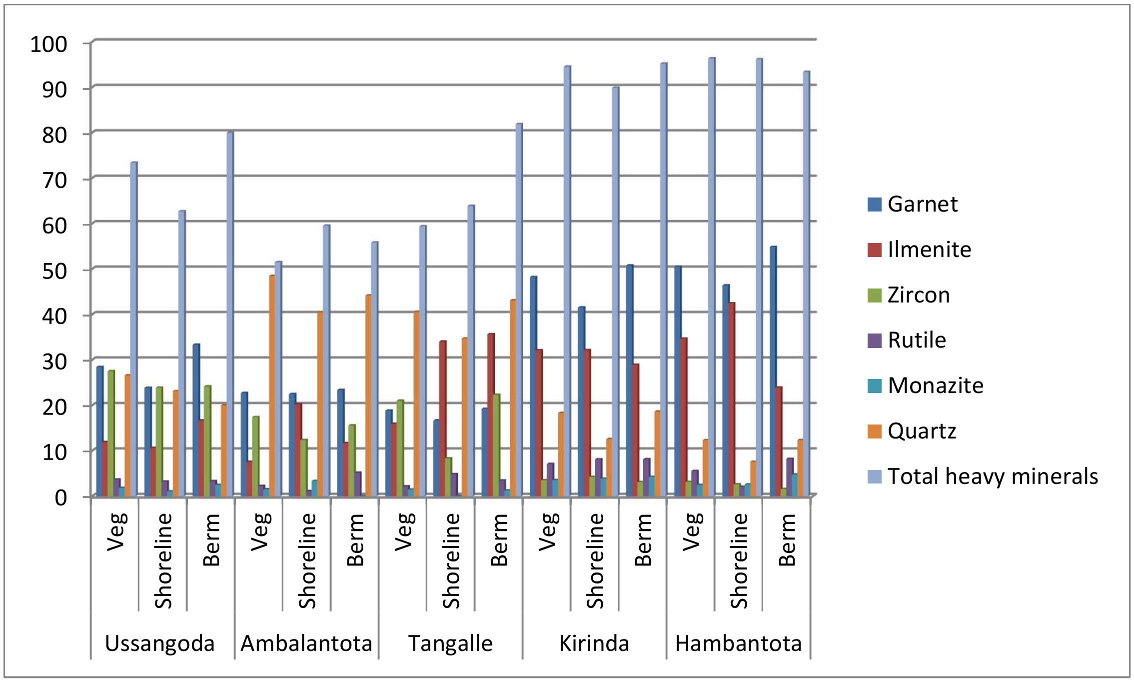


Figure 03 : Heavy mineral percentages pre_monsoon

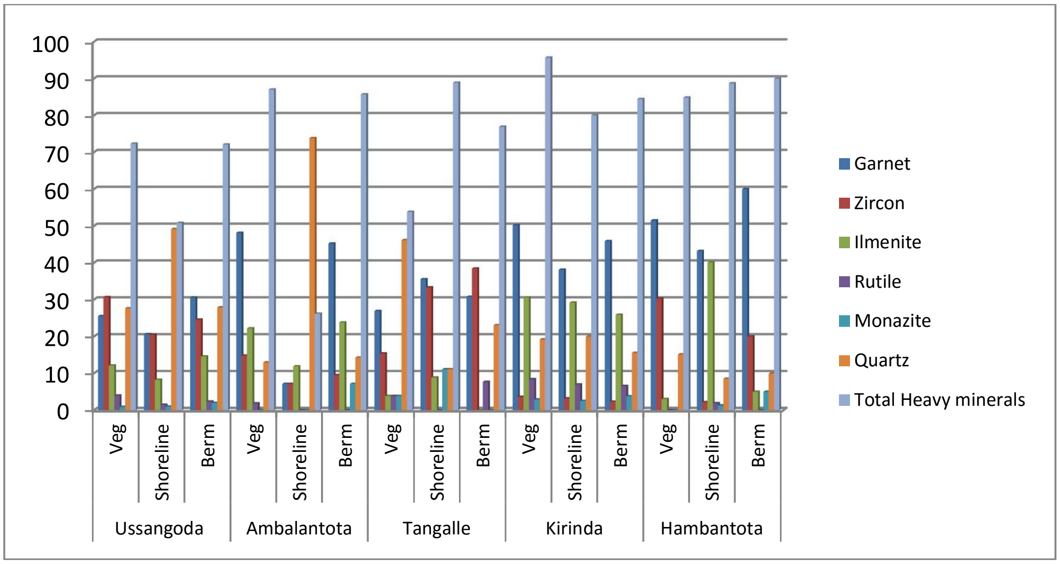


Figure 4: Heavy mineral percentages post_monsoon

Conclusions

The highest heavy mineral percentage could be observed in Hambantota area followed by Kirinda. Amongst the surveyed points highest garnet percentage was reported in Hambantota area. The heavy mineral percentage during the pre-monsoon period (southwest monsoon) is higher than the post monsoon period which lead to the assumption that these minerals get deposited with the ocean currents.

Constraints

Unfavorable weather conditions, Unexpected rise of fuel cost

Component 02 : Sediment transport patterns at Kirinda area

General Oceanographic Condition of the area

Site description

The Kirinda-Palatupana coastline stretch is a 4-kilometer sand dune that is situated close to the Yala and Bundala National Parks, between Kirinda Fisheris Harbour (KFH) and Palatupana Point as shown in the figure 1.

Figure 1: Overview of Kirinda Fishery Harbor (KFH) and adjacent area, the study area is enclosed by the polygon (red). A and B picturs show the sand dunes of Kirinda-Palatupana Beach (Image courtesy: Ruchira Jayathilaka)

It has been determined that this shoreline contains heavy minerals including ilmenite and garnet (Subasighe et al., 2021). Consequently, there is a possibility that certain places have mineral deposits that could be mined. The basic oceanographic conditions of the region, including sediment movement, wave-wind climate, and coastline stability, are covered in this section of the report.

Wind/ Wave climate

A two distinct wave types that is sea waves which is generated by local wind fields and swell waves which is generated far away from the coast by storms are identified for both southwest and northeast monsoon seasons as shown in the figure 2. According to the parameters obtained through numerical simulation, the wave climate near the harbor is made of with both swell waves and sea waves. However, the mean wave directions for both locally wind generated (sea) and swell waves belong to common directional range (i.e. between south and southwest) (Laknath 2011).

According to the wind roses diagram, wind mainly blows two directions during the year, blows between North-East (30-06 N) directions during NE monsoon season and blowing South-West (240 N - 270 N) directions during SW monsoon season.

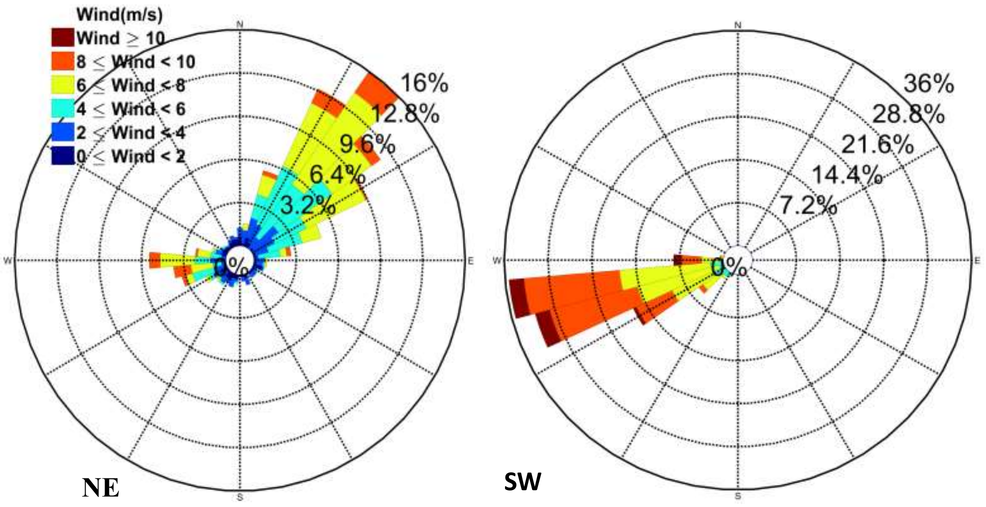
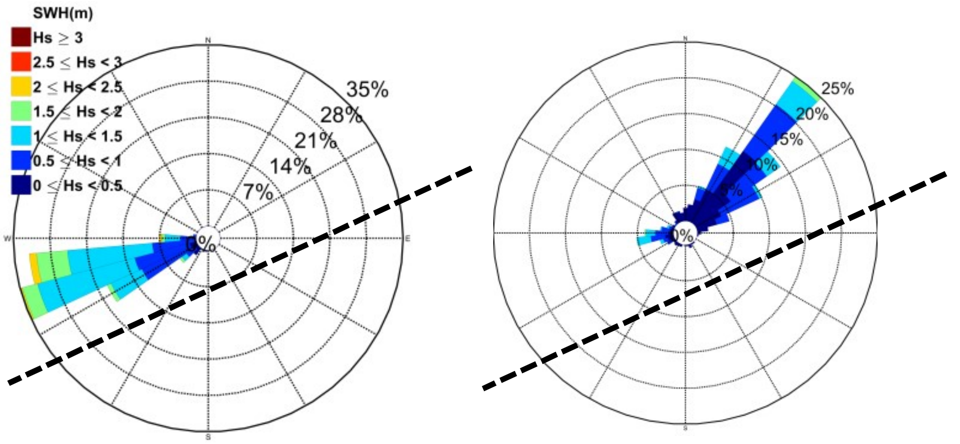
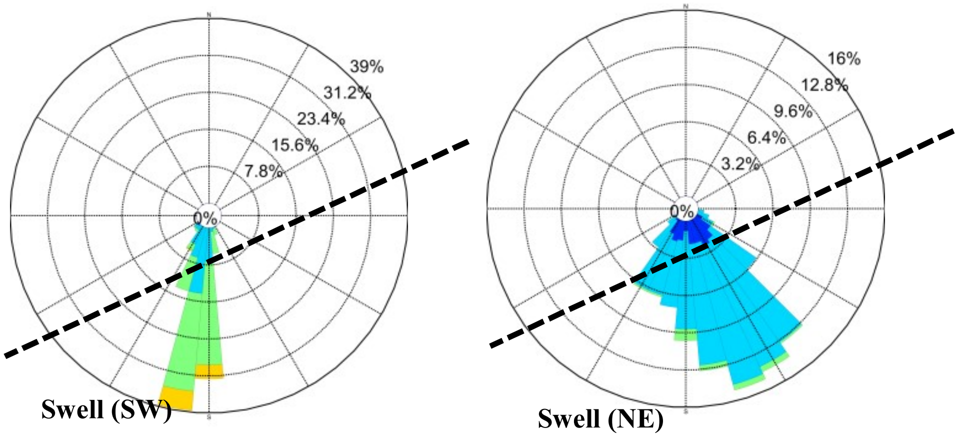


Figure 2: Monthly wind rose diagrams for southwest and northeast monsoons during 2005-2006 period at (81° E, 6° N)

Moreover, the sector is experiencing average wave heights 1.0-2.0 m and 0.5-1.0 m during SW and NE monsoon respectively. Most of the period both Swell and wind waves propagates toward North-North East direction while wind waves during NE monsoon propagate towards south- south east direction (figure 3). Since wave energy is proportional to the square of the wave heights, when compared to the southwest monsoon, the northeast monsoon consists of low wave energy, demonstrating the lower capacity of sand erosion and transport. However, the swell wave effect during northeast monsoon is identified as significant comparing to the wind generated (sea) waves.



Wind Wave (SW) **Wind Wave (NE)**



Swell (SW) **Swell (NE)**

Figure 3: Wave raised diagrams for Swell and Wind waves during the southwest and northeast monsoons at 81° E, 6° N. Black dotted line represents the angle of shore parallel coastline

Kirinda Harbor Deposition/Siltation

A significant concern in the region is the ongoing siltation problem at the KFH. At Kirinda Harbour Area, there are now around 100,000 cubic meters of dredged sand stockpiled. The following findings on the siltation issue were discovered in the technical survey undertaken in 1987 by the Japan International Cooperation Agency (JICA).

- The beach is subjected to swell from the south throughout the year and often attacked by the waves overlapped by the wind waves at the time of monsoons. During the SW monsoon season (April to October), the swell and the wind waves comes in same direction, resulting higher waves compared waves compared to the NE monsoon (December to March).

- SW monsoon waves cause the current along the coast from South to North. On the contrary NE monsoon cause the current from north.
- Because of such wave conditions, more than 100,000 m^3 of sand drift comes from the west of the Kirinda point each the year causing harbor siltation. During the NE monsoon, tens of thousands of sand assume to come into the harbor from the east opposite direction to that of SW monsoon season.
- The sand is assumed to enter the harbor not only by the harbor mouth, but also through the gaps of rubble stone in the breakwater, and over the crest of the breakwater by overtopping.

To address the aforementioned problems, JICA suggested building a 200 m groyne at Kirinda point, extending the main breakwater by 200 m, and building a new sub-breakwater of 230 m length east of the harbor. The layout of the counter measures that were constructed in 1994 is shown in the figure 4.

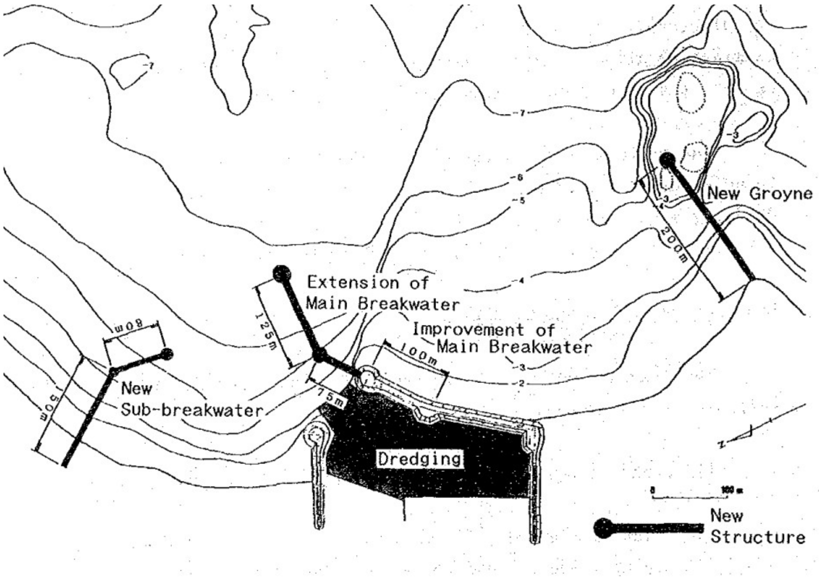
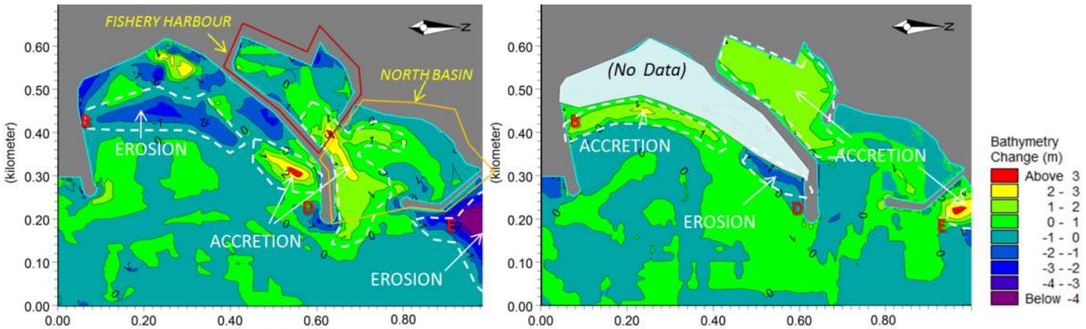


Figure 4: The measures that were taken after the study conducted by JICA in 1991

A study conducted by LHI in 2011 evaluated the sediment deposition inside the harbor basin under SW and NE monsoon using numerical modelling as given in the table 1. Sedimentation statistics show that the harbor basin and the area south of the main breakwater are filled during the NE monsoon, whereas the harbor entrance and the north basin are filled during the SW monsoon. Furthermore, we can expect that the 1994 construction of the new groyne (figure 4) at Kirinda Point will halt the majority of the silt entering from the south. As a result, it is also hypothesized that the sediments that were deposited in the area south of the main breakwater during the NE monsoon may serve as a source for sediments that are transported into the harbor entrance during the SW monsoon.

Table 1: Total sedimentation volume during the period inside the harbor basin (inside the red line on the left of figure 5) and staying on the north side of harbor (within the yellow line on the left of figure 5) during ESW and NE monsoon on the (Laknath, 2011)

Location	under the southwest monsoon amount of deposition (m^3)	under the northeast monsoon amount of deposition (m^3)
Inside the harbor basin	7,932	54,395
North Basin	38,235	10,159



SWM NEM

Figure 5: Measured sediment erosion distribution during southwest monsoon (left) and northeast monsoon (right) (Laknath, 2011)

Sediment Characteristics

Beach sediment sampling survey on either side of Kirinda Harbor was conducted by the Oceanography Division of NARA on October 26th and 27th, 2022. Sand samples were gathered at each of 14 locations between KFH and Palatupana sand dune as shown in the figure 6.

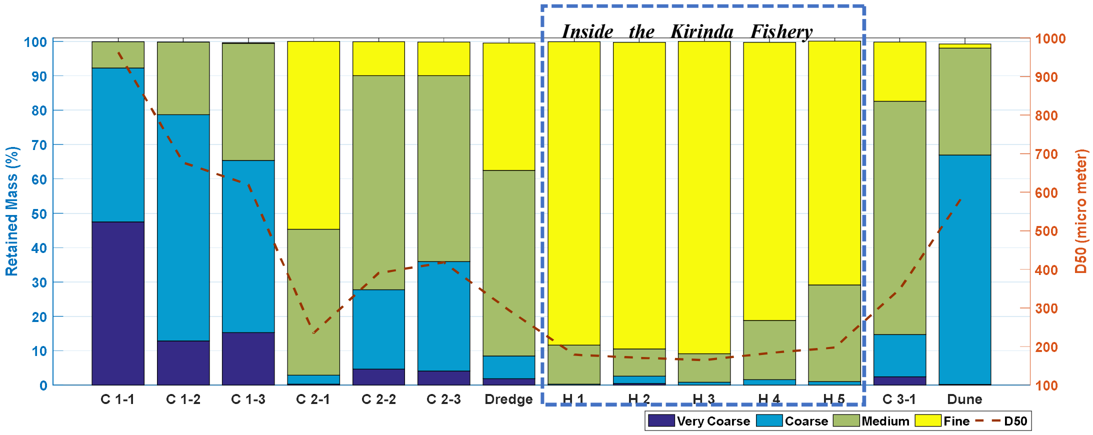


Figure 6: Retained mass (%) and medium grain size (D50) of sediment samples along the shoreline. Very Coarse (>1 mm), Coarse (1 mm-0.5 mm), Medium (0.5mm-0.25 mm) and Fine sand (< 0.25 mm)

The analysis of particle size reveals that the sediment inside Kirinda Harbor is fine sand with a D50 of about 200 microns. The grain size toward the Tangalle side is steadily growing, although the grain size distribution on the Palatupana sand dune is relatively similar to that of the sand inside the Kirinda harbor. The average grain size of a deposit of sediment serves as a good measure of the energy of the environment at the time of deposition. Fine-grained sediments denote low-energy conditions while coarse sediments represent high-energy conditions.

Coastal erosion

The Google Earth Pro software was used for analyzing coastal erosion and accretion in the study area. For investigation, Google Earth images from 2010 to 2023 were downloaded between Palatupana and Kirinda point. Further analysis was done on Google Earth images that were captured after the NE and SW monsoons.

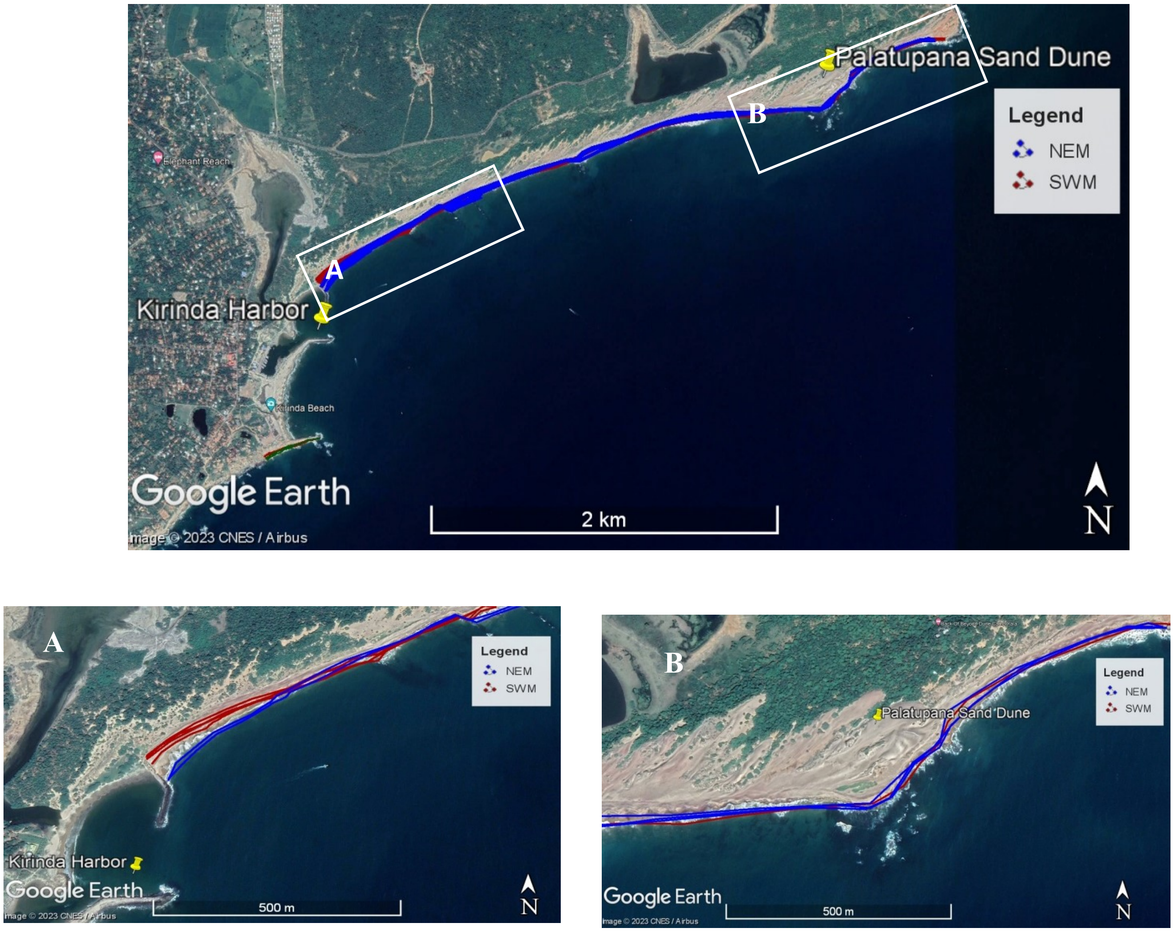


Figure 7: Available Google Earth images captured between 2010 and 2023 after the SWM (Red lines) and NEM (Blue line)

The spatial and seasonal variations in the coastline changes between Kirinda and Palatupana area is shown in Figure 7. Between the kirinda harbour breakwater and the rocky headland in Palatupana, the coastline appears to behave as a littoral coastal cell, with sediments oscillating northward and southward during the SW and NE monsoons, respectively.

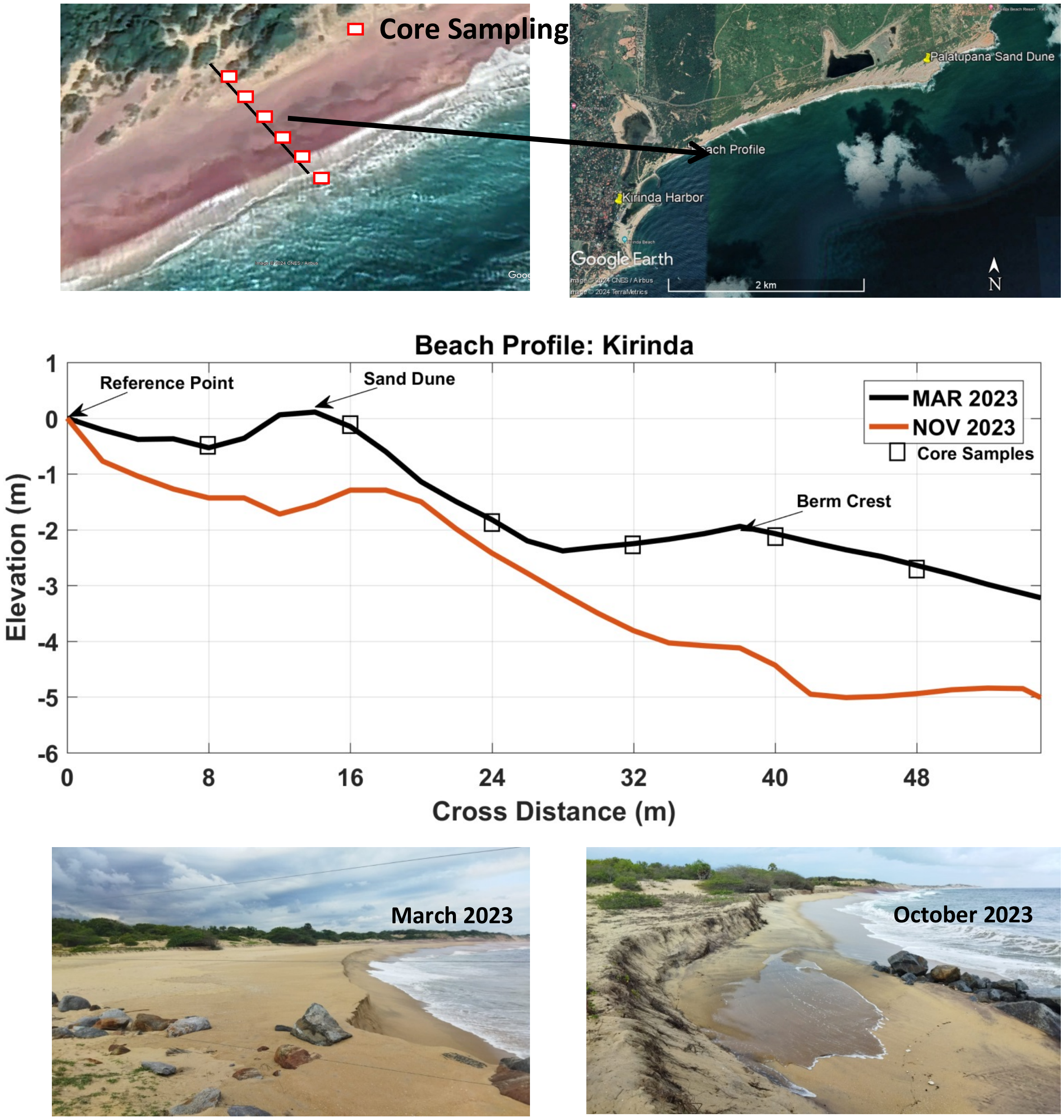


Figure 8: Comparison of beach profile evaluation at Kirinda-Palatupana Beach (Near to Kirinda harbor) in March 2023 (Pre SWM) and October 2023 (Post SWM) profiles.

Our examination of Google Earth images from 2010 to 2023 shows that there is no significant coastal retreat in the area except this seasonal fluctuation. This seasonal erosion is observed in the measured beach profile as shown in the figure 8.

Figure 9 depicts the sediment pathway that is hypothesized in this study. The sediment from Palatupana, a sand dune, travels south (toward Kirinda) during the NE monsoon and builds up against the sub-breakwater arm, this can be seen in figure 8. Once the silt reaches the breakwater's tip, it tends to move in excess into the north basin and the main breakwater region. During the upcoming SW monsoon season, this deposition of sediment will be easily moved into the Harbor basin.

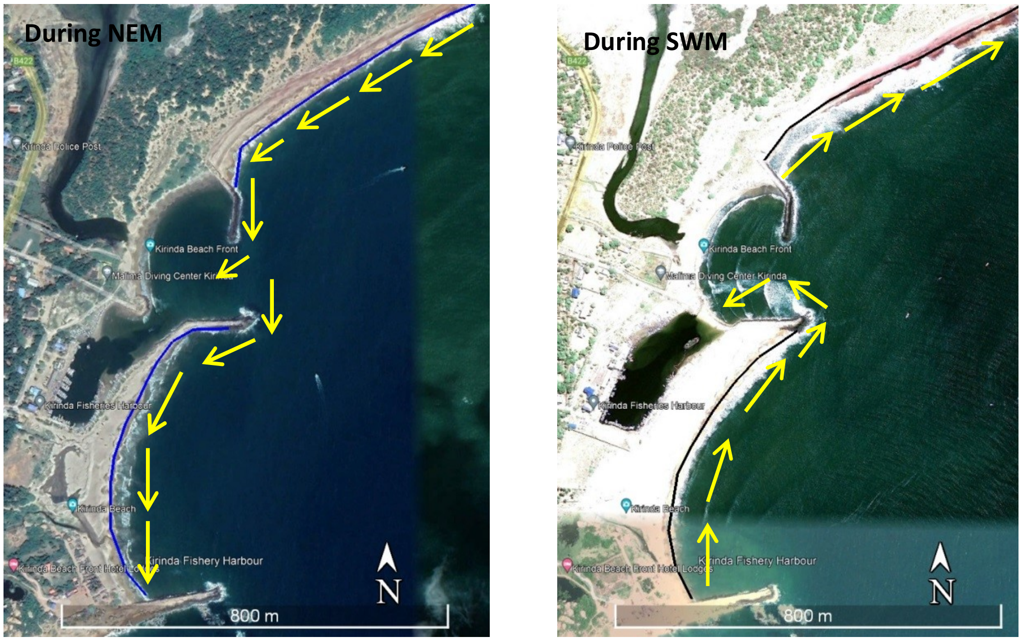


Figure 9: Google Earth images captured after the SWM and NEM either side of the Harbor area. Yellow arrows represent the most probable sediment pathways

Recommendation

- The concentration of heavy minerals and garnet in the dredged sand from the Kirinda harbor basin should be investigated since it might have originated from the Palatupana sand dune. This might be a win-win solution for both the continuous functioning of KFH and the siltation problem.
- At the moment, the Kirinda-Palatupana coastal section is not experiencing significant erosion, unless there is seasonal sediment oscillation. Continuous dredging in KFH, however, would weaken the sand dune's durability, which would eventually lead to severe erosion northward. The Kirinda-Palatupana beach stretch must therefore be nourished with the leftover sand whatever after the minerals has been harvested.
- It is highly recommended to conduct a comprehensive study on environmental impacts assessment on coastal ecosystems, coastal stability and sand budget in the study area by monitoring conditions at least for two years period.

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PROJECT NO : 6.3

RESTORING LAGOON DYNAMICS AND ECOLOGY UNDER ECOSYSTEM BASED APPROACH: A CASE STUDY OF LANKAPATUNA LAGOON IN EASTERN COAST OF SRI LANKA

Officer/s responsible : H.A.S.D. Perera, Ruchira jayathilaka, T.B.D.T. Samaranayake, N.G.L.Nadee Uthpala, Dr. K. Arulananthan

Specific Objective/s:

- Evaluate the hydrology of the lagoon, including quantity, distribution, flow pattern, and quality of the water
- Study the dynamics of biological components (phytoplankton, zooplankton, ichthyoplankton, fauna and flora) and their variability with physical and chemical parameters in lagoon.
- Study the sedimentological parameters and suitability for aquaculture practices.
- To promote optimum and sustainable utilization of lagoon systems for aquaculture activities through an integrated strategy that combines measurement and a 2D hydrodynamic model /ecological applications.

Introduction

Lagoon is a highly dynamic environment and Natural phenomena changing with human intervention is highly impact not only environment but also on livelihood activities. Coastal lagoons in Sri Lanka are resulted by of mid-Holocene marine transgression and subsequent barrier formation and spit development enclosing the water body between the land and the sea (Silva et al., 2013) enriched with fish, crustacean and as well as with molluscan fauna for feeding and breeding ground for many aquatic organisms (Colombo, 1977). Coastal lagoons play an important role not only by offering various "natural resources" for regional community but also by providing "natural infrastructure" for hazard protection and/or mitigation, which is commonly called "bio-shield (Tanaka 2009).

Lanka patuna Lagoon which called as Ullackalie Lagoon is a coastal waterbody located in Trincomalee District in the Eastern Province Main freshwater provider is Verugal Aru and Uppu Aru are two small freshwater streams. Newly bridge was built across the lagoon in 2017. The Lagoon enriched with the extensive mangroves and surrounded by evergreen forest and scrubland as well as paddy cultivations. Anthropogenic activities such as bridge and land uses are caused to prevent flushing of the lagoon by natural water flow; causing continues sedimentation in the lagoon. Lankapatuna Lagoon most enriched with most abundant shrimp species and commercially important shrimp fish species. That Lagoon is designated as wildlife sanctuary in 1970. Wetlands such as Lagoons which required the monitoring under some major variables for effective management (Devendra, 2002) described as follows.

Methodology (Study area, Field sampling, data collection and analysis)

Study Site

The Lankapatuna is located 8.416290° - 81.352138° North and 8.354051° - 81.379634° East and the area and the length of the lagoon is almost 7.5 km and maximum width is 2 km. The total lagoon area covered around 13 Km^2 (5 sq mi) and the maximum depth was recorded as 2m. The main freshwater feeders are Verugal aru and Uppu aru stimulated with rain.

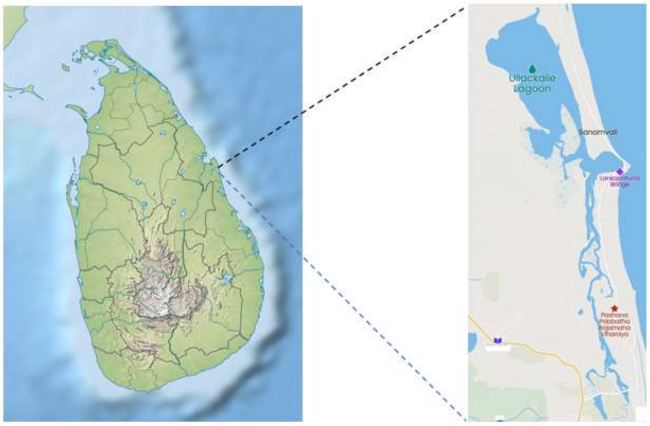


Figure 7: Lankapatuna lagoon study area

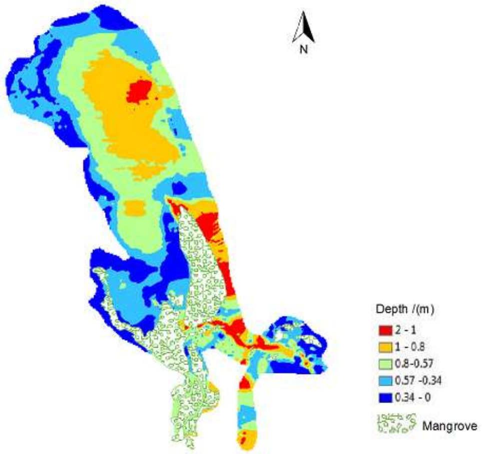


Figure 8: Bathymetry and mangrove patches in Lankapatuna lagoon

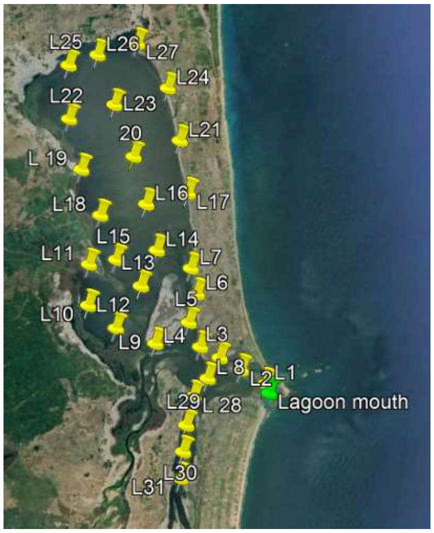


Figure 9: Sampling map of the Lanka patuna lagoon

Main activities

- Lagoon water Circulation :Hydrology and Hydrodynamic
- Chemical properties of lagoon water
- Setting up a hydrodynamic modeling of temperature, salinity and water level.

Collection of samples

- In order to study the water balance and bio-geochemical properties, major 30 stations, including outside stations and major stations were selected with close to stream outflows were selected for sampling in the lagoon (figure 3).
- Under the activity 1, to investigate the water circulation in the lagoon water level (tide pole/pressure sensors), flow rate (flow meter/RCM), salinity (SBE 19plus CTD, RBR Brevio and Autosal), evaporation and precipitation (met. department data) data was collected during the field visit under the activity 1.
- Under the activity 2, Chemical properties (Nutrients, TSS) and Geological components (Grain size) were analyzed in the field.
- Under the activity 3, The hydrological budget models which called Water balance was estimated. Therefore, the net water balance can be written as follow.
- All water samples were collected during high tide in the maximum capacity level of lagoon system according to water exchange.

Analysis of sample and Data

Samples were analyzed for both quantitative and qualitative parameters. As on site parameters Salinity and Temperature were measured by SBE 19 plus v2 CTD and Autosal. Nutrient and Sediment analysis were conducted as Laboratory analysis. Tidal prism, Residence time and phase lag were measured by using tidal variation and velocity data. In addition, the descriptive and inferential statistical techniques were employed in the study. Software packages: MATHLAB and SPSS were used to analyze data. Data was interpreted by using ARCGIS.

Table 2: Activities proposed to be completed during the period

Main activities	**Measurable parameters**	**Instruments**
Water exchange and Water residence time	Sea level, Water flow rate	Tide pole, Pressure gauge, Rotor Current meter (RCM)
Chemical properties	Salinity, nitrate, Nitrite, Phosphate, Silicate	Spectrophotometer and Autosal
Sediment properties analysis	Grain size, organic content	Sieve set
Plankton Abundance analysis identification with life cycle analysis	Density and Distribution	Plankton nets, Microscope
Setting up a hydrodynamic modeling of temperature, salinity and water level.		

Results and Discussion

Sea Level

Water exchange between lagoon and sea are controlled by the tidal force, wind and river discharge. As tidal waves propagate from the ocean through an inlet and into the Back Bay (lagoon), amplitudes decrease, and phase lags develop relative to the oceanic sea-surface elevation fluctuations. If the amplitude reduction is large, the system is considered tidally choked. Tidal choking influences the amount of flushing from the lagoon to the ocean, which is important to coastal ecology, water quality, and sedimentation. Coastal lagoons have been divided into three categories (choked, restricted, and leaky) based on the ability of the lagoon to flush water. In Lankapatuna Lagoon under study periods Semi diurnal tidal pattern (figure 4,6,8, &10) was observed during the field visit at the lagoon. Lagoon water measurements explain the significant variations among different months and explain the water exchange between the sea and lagoon. It's an indicator of how energy moves over the system. The most significant tidal variation (13 cm) was observed in April and the mouth was opened to freely exchange. Also lagoon head recorded a 6 cm tidal variation, which behaved similarly in 2022. Phase lag which induced by the different factors was 2-3 hours until the tidal wave reached to head.

Measuring sea level in lagoons is evaluating many key significant factors as follows:

- Ecosystem health
- Human activities
- Infrastructure and development planning
- Biodiversity
- Habitat Lost
- Water Quality
- Coastal erosion and flooding
- Climate change Impact

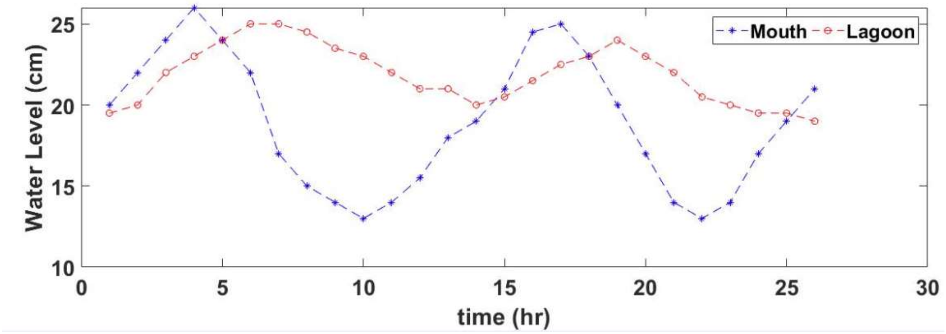


Figure 10: Sea level fluctuation on lagoon in May

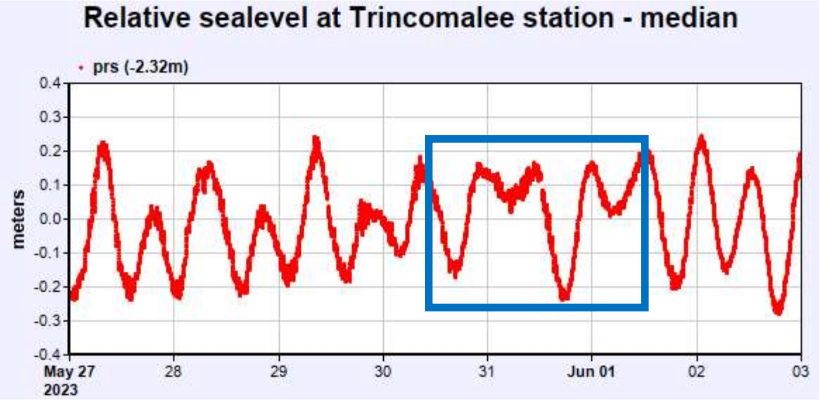


Figure 11: Sea level fluctuation in Trincomalee during the study in May

During the studies on May tidal variations on open sea was 30 cm by neap tide. When it was reached to lagoon mouth tidal range was decreased up to 13 cm and only 6 cm variation on lagoon head decreased by bottom and wind friction. Phase lag for the lagoon mouth to head was 2 hours.

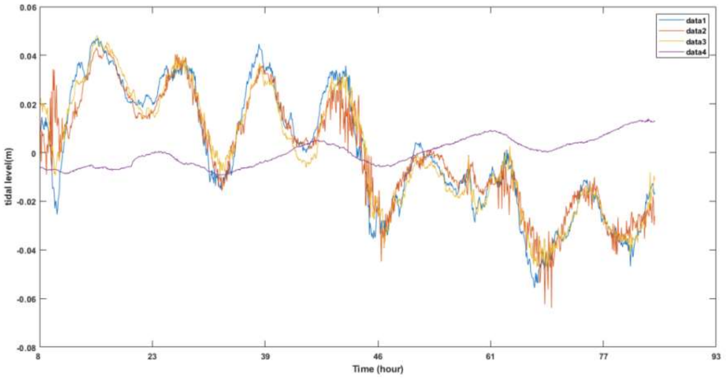


Figure 12: Tidal fluctuation on Lagoon in August

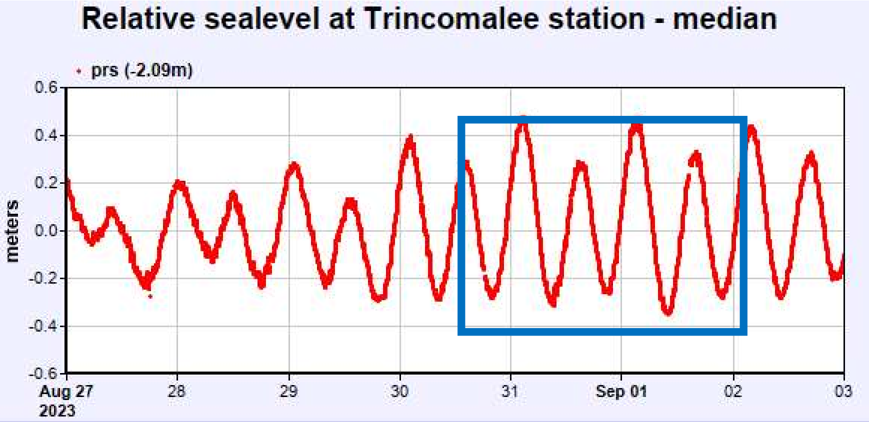


Figure 13: Tidal fluctuation in Trincomalee during the study in August

During the August lagoon mouth was partially closed and bottom friction was affected on water exchange between mouth and sea. During this period open sea tidal was 65-70 cm and it was decreased up to 6-7 cm and 1-2 cm on the lagoon head. It was revealed their phase lag was around 6 hours.

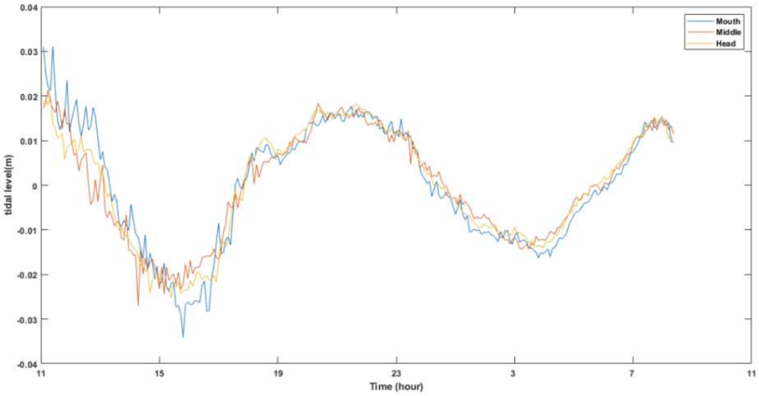


Figure 14: Sea level fluctuation on Lagoon in October

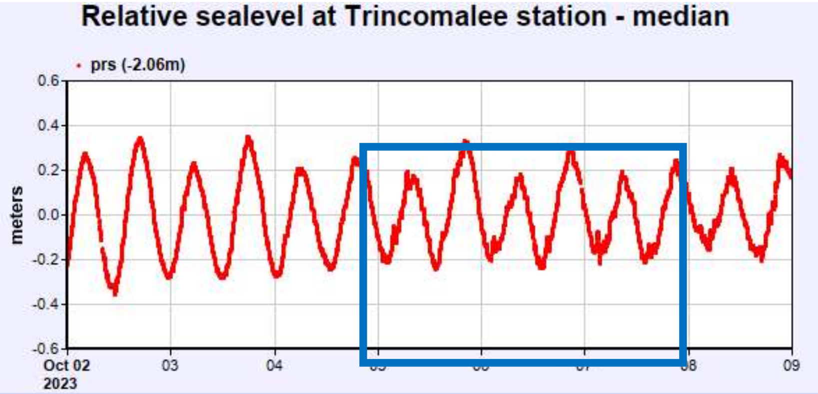


Figure 15: Sea level fluctuation in Trincomalee during the study in October

In October entire lagoon mouth was closed and river discharge was not sufficient to breach the sand bar. In the lagoon, there was no sea level exchange and fluctuation only effect by atmospheric tidal (6cm) revealed in figure(8).

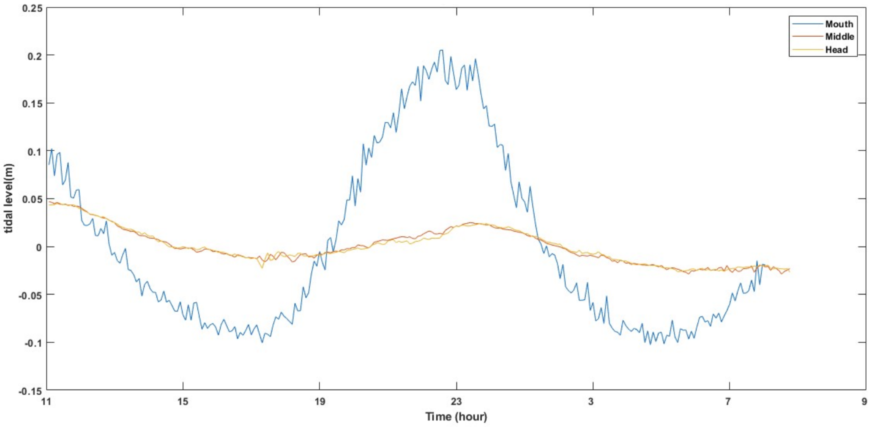


Figure 16: Tidal fluctuation of Lagoon in December

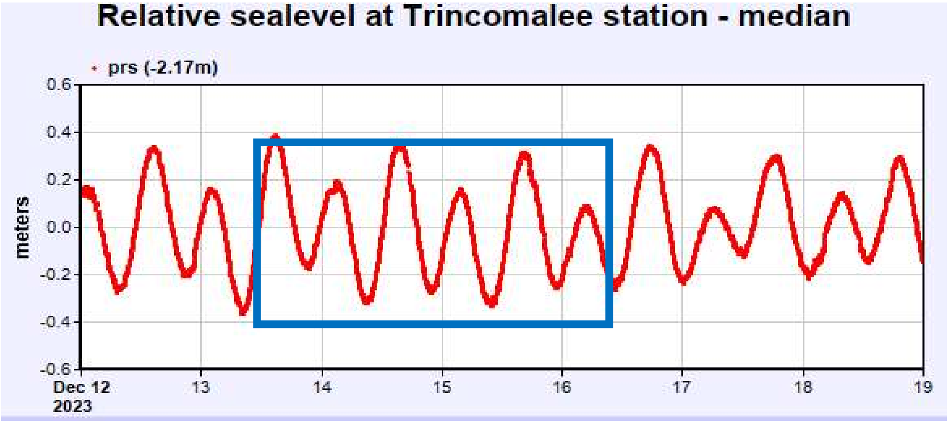


Figure 17: Sea level fluctuation in Trincomalee during the study in December

During the study period of December tidal fluctuation in the sea was 60 cm (Figure 11) and it was reduced up to 3 cm (figure 10) when it reached to lagoon mouth. However, drastically dropped in lagoon head (0.5 cm). Verugal aru river is discharging at maximum capacity (0.72m/s) with the onset of the Northeast monsoon. That energy overcome the tidal energy wasn't allowed to spread tidal surrent due to has no sufficient energy to particle distribution over the system.

Table 3: Tidal characteristicts during studies in Lankapatuna lagoon

Month	May			August			October			December		
Location	Sea	Lagoon Mouth	Head	Sea	Lagoon Mouth	Head	Sea	Lagoon Mouth	Head	Sea	Lagoon Mouth	Head
Tidal variation(cm)	30	13	6	70	7	2	50	6	6	60	3	0.5
Phase lag (hr)		2			6						1	

Tidal fluctuation in the system was weakened comparatively in 2022 and it indicated sea water distribution and spreading of energy getting lower with time. Siltation process caused to reduced water circulation in the system and partcle distribution weaken will affect on biotic abiotic factors. Significantly highest river discharge choked the seawater inflow via mouth and lowest tidal impact on the lagoon system can be observed in December. Except for October (the lagoon mouth was closed) and December flood tide gets dominant and water exchange during December is led by river discharge.

Table 4: Water exchange and hydrodynamic variations in Lankapatuna lagoon

Month	Inflow (m^3)	Outflow (m^3)	Retained amount (m^3)	Maximum velocity (m/s)	Minimum velocity (m/s)	Inflow / Cycle (m)	Outflow/ cycle (m)	Salt inflow(g)	Salt outflow(g)	retained(g)
May	417,722	121,152	296,570	0.0245	0.0007	39,120	18,843			
Aug	1,121,875	617,947	503,928	0.3204	0.004	4,102	3,125	3,039,770	1,748,018	1,291,752
Oct	Lagoon mouth was closed									
Dec	229,094	4,574,341	(-)4,345,247	0.72	0.026	8,172	14,437	58,213,941	61,371,545	(-)3,157,604

Dominant Oceanic inflow was observed during May, August and December study periods and it resulted in the maximum oceanic inflow recorded during April while river discharge got lower and highest retained amount per cycle as well.

Maximum velocity was observed in December by oceanic outflow and the highest particle moving distance was recorded at 39120m during April in December there wasn't an opportunity for particle inflow with tidal current and particle distribution was managed by river inflow. Similarly Maximum salt conservation was obssrved during august (1291752g per cycle) and no opportunity to remaining salt by tidal action in December and excess salt in lagoon system was push out toward the sea.

Highest salt inflow was observed in December while entire lagoon mouth was opened. Also maximum salt outflow in same period due to maximum river discharge.

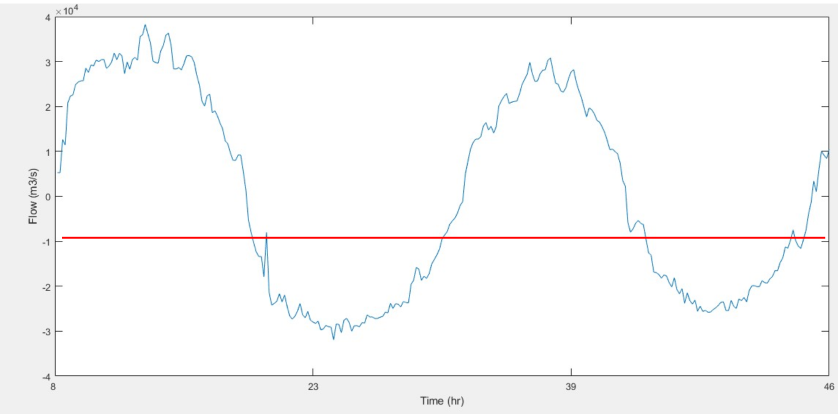


Figure 18: Water exchange rate on lagoon mouth during April

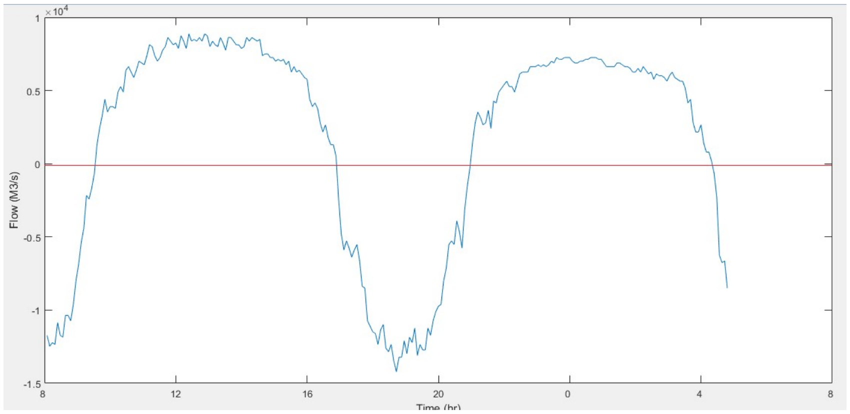


Figure 19: Water exchange rate on lagoon mouth during August

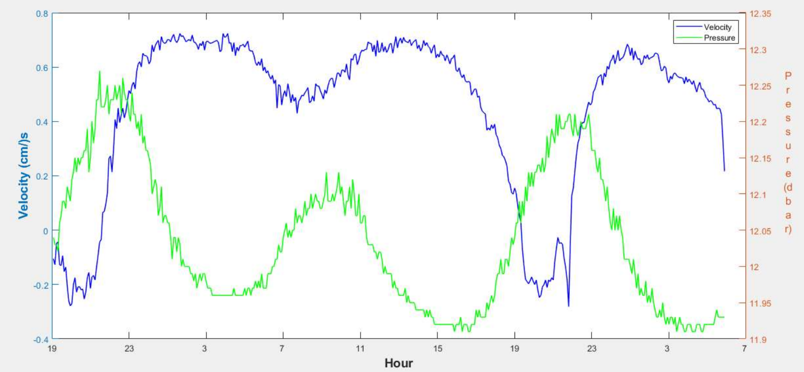


Figure 20: Water flow velocity with pressure on lagoon mouth during December

During April oceanic inflow get dominant (12187.93 m^3/s) and maximum outflow was 9414.45 m^3/s. 1st inter-monsoon period river discharge was dropped with low precipitation cause to flood tidal getting dominant during this period. However, in the August study period lagoon mouth was partially closed and it was restricted to oceanic flow dropped up-to 8924.9 m^3/s and outflow (ebb tidal) maintained the flow up-to 9393.2 m^3/s. During December it was difficult to observe the effect of oceanic inflow and outflow by the ebb and flood tidal phase. River discharge gets dominant and it shows the maximum discharge and velocity (0.72m/s) comparatively in all study periods.

Residence time

The residence time of a coastal lagoon is the time it takes for a water parcel to leave the system through its mouth to the sea (Reyes & Blumberg, 1995). In an estuary, time scales of flushing rate and residence time, which are usually used to measure the rate of water exchange between estuary and the adjacent ocean, have a major impact on the ecological processes and functions including water chemistry and sedimentation and in turn biophysical environment. The water exchange and residence time in the lagoon is mainly driven by river input (Wijeratne, 2003).

Table 5: Residence time of Lankapatuna lagoon

Study period	April	August	October	December
Residence Time (days)	22	16.75	∞	7.5

Lankapatuna lagoon is act as a pool of resources which content all nutrients, microbes and pollution factors also. That suspended and dissolved particles spend the time in system according to physical and chemical factors.

Residence time is plays as a major hydrodynamic factor indicate particle movement, pollution and chemical factors within period. During the 1st Inter-monsoon (April), it was 22 days. At this period lagoon mouth was opened well and low rivers discharged were observed and Flood tidal get dominant. However, in South west monsoon lagoon mouth was partially closed and tidal inflow was very low and only river discharging get dominant which residence time explained 16.75 days. After that in October entire lagoon mouth was closed and water exchange was not occurred. Highest rainfall during Northeast monsoon in December increased the maximum river discharge and residence time dropped up to 7.5 days.

Bio-Chemical properties

Salinity

Salinity is simply the measure of dissolved salts in the water (Sivapriya et al., 2022) which explain dissolved salts amount in g per 1kg of water.

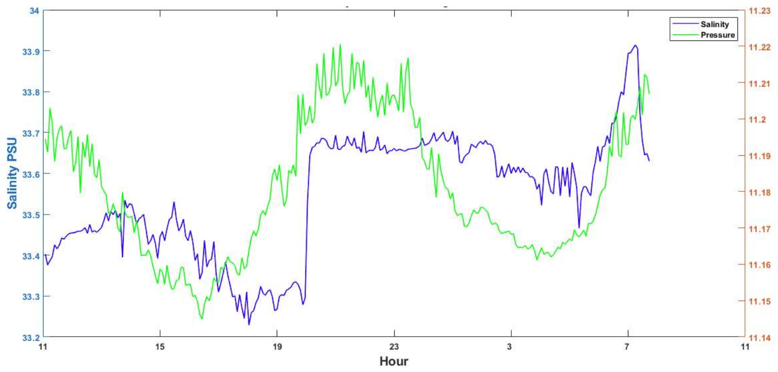


Figure 21: Lagoon mouth salinity variation with sea level changes in August

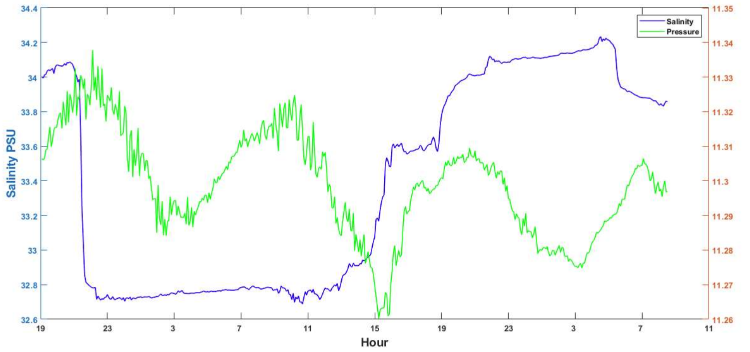


Figure 22: Lagoon mouth salinity variation with sea level changes in October

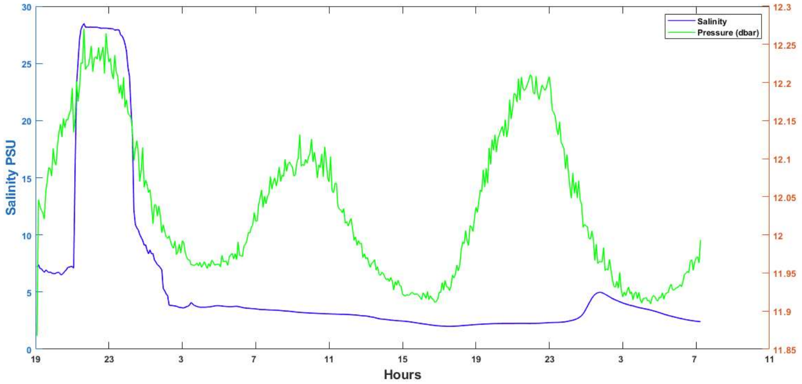


Figure 23: Lagoon mouth salinity variation with sea level changes in December

In August lagoon mouth salinity was depended on flood and ebb tidal phase while maximum in flood tide 33.9 PSU and lowest in ebb tide 33.2 PSU (figure 15) However, during October lagoon mouth was closed & salinity fluctuation depend on river discharge, evaporation and wind (figure 16). Also at night time surface layer gets cool and highly dense particles sink to the bottom causing an increase in the salinity and this process stimulated with high tide. In December lagoon was received significant precipitation and filled with freshwater resulting in the lowest salinity range observations in the mouth area. It was drastically dropped up to 4-5 PSU (figure 17) due to maximum river discharge.

Spatial and Temporal salinity is most important factor for lagoon management process. Study period sea water salinity was 35 PSU and it was fluxed via the lagoon mouth respect to tidal phase. Overall salinity level was observed between 1-38 psu during the study periods. Also, 50% of system exceeded 35 psu (figure 19) in August which resulted in flood tidal and evaporation processes. It was revealed that more than 90% of the system was exceed 35 PSU during October was due to excess evaporation while the lagoon mouth was closed and less river discharge.

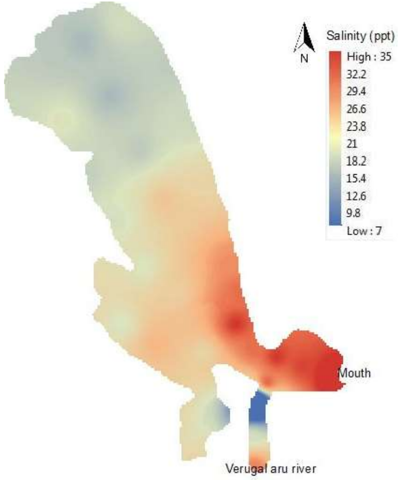


Figure 24: Spatial Salinity variation in May

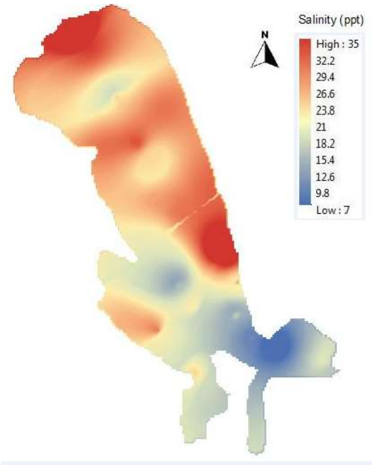


Figure 25: Spatial Salinity variation in August

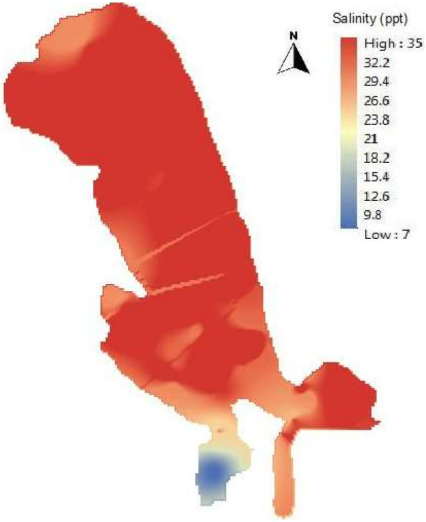


Figure 26: Spatial Salinity variation in October

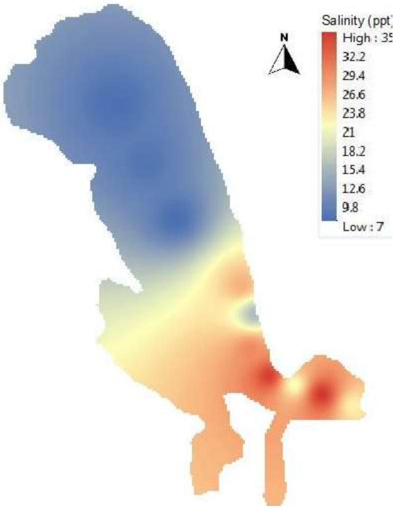


Figure 27: Spatial Salinity variation in December

Nutrients

Most of the study revealed that nutrient concentration is highest in river discharge and trends toward the lagoon head with flood tidal dominant.

Highest concentrations in all nutrient factors except Silicate were observed in August. During this period lagoon mouth was closed and sea water inflow got very less and agricultural practices was conducted in middle and lower catchment areas. Mostly lowest concentration was recorded on lagoon mouth due to efficiency exchange of water. At this period phytoplankton and zooplankton density increased with maximum nutrients and they are going to decay after this period cause to reduce nutrient concentration in October.

During the May, dominant flood tidal cause to particle movement up to lagoon head and increased the residence time. Results explained major nutrient inputs carried to the system by the river.

The western boundary of the lagoon is demarcated by the Seruwavila division and paddy cultivation is major agricultural practice in there. The application of fertilizers and other chemicals for agriculture caused to increase in the nutrient level in the lagoon system.

Table 6: Nutrient concentration in major study periods

		Parameters															
		Nitrite				**Nitrate**				**Phosphate**				**Silicate**			
		Minimum	**Location**	**Maximum**	**Location**	**Minimum**	**Location**	**Maximum**	**Location**	**Minimum**	**Location**	**Maximum**	**Location**	**Minimum**	**Location**	**Maximum**	**Location**
Study Period	**MAy**	0.372	Mouth	0.788	Head	0.289	Middle	0.788	Head	1.914	Mouth	4.605	River	20.788	Mouth	118.89	Head
	AUGUST	0.863	Mouth	2.114	Middle	0.493	Head	1.022	Middle	26.136	Head	28.829	Mouth	35.428	Mouth	114.85	Middle
	OCTOBER	0.18	Mouth	0.863	Head	0.115	Mouth	0.362	Middle	1.465	Mouth	5.053	Middle	20.78	Mouth	118.89	Head
	DECEMBER	0.42	Mouth	0.97	Middle	0.331	Mouth	0.806	Middle	0.043	Mouth	3.066	Middle to Mouth	27.01	Middle	100.72	Head

Sediment

Table 7: Sediment distribution in lagoon

	Sediment type (%)		
Location Id	**Pebble**	**Sand**	**Clay/silt**
LP -03	0.09	95.15	4.36
LP -04	0.00	87.55	12.45
LP -05	0.08	82.96	16.96
LP -07	0.00	82.93	17.07
LP -06	0.17	95.80	3.93
LP -02	0.00	92.80	7.20
LP -10	0.36	93.80	5.84
LP -09	0.15	84.94	14.91
LP -08	0.00	82.15	17.85
LP -11	0.00	94.94	5.05
LP -09	0.11	99.35	0.54

More than 90% of all samples grain size was explained most abundant sediment type is sandy sediment and it was increased some significant amount of Silt/Clay in middle of the lagoon. This condition most suitable for aquaculture practices (shrimps, crabs and Sea cucumber).

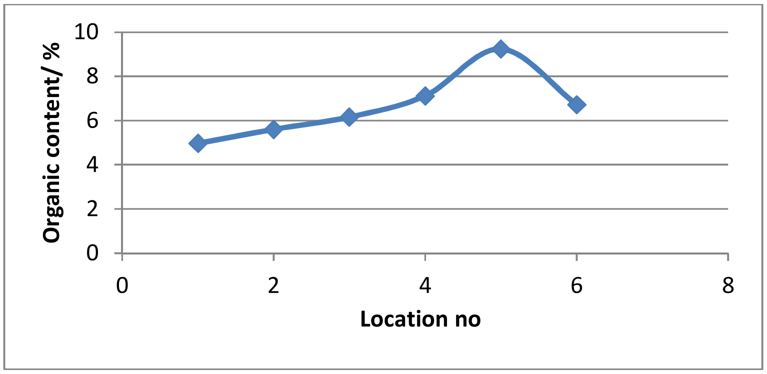


Figure 28: Horizontal Variation of average sediment organic content in Lankapatuna lagoon (Mouth to Head)

Organic content is impact major factor for benthic organisms as their food source. Highest organic content is 9.24% was recorded in between middle and head of the lagoon and lowest was on lagoon mouth is 4.97%. Aquaculture practices like sea cucumber and benthic organisms most favorable condition in middle of the lagoon with considering other impact conditions.

Zooplankton and Phytoplankton

River discharge releases both zooplankton and Phytoplankton to the system than oceanic inflow. Calanoid & Oithona species are highly abundant species that recorded the highest numbers in the river mouth.

Figure 29: Calanoid sp.

Figure 30: Oithona sp

Table 8: Zooplankton's species in Lankapatuna lagoon

Genus	Species
Appendicularia	
Acartia	
Bivalvia	
Calanoid	
Calanoid	nauplii
Decapoda	
Oncaea	
Oithona	
paracalanus	
Trochophore	larva
Veliger	larva
Sagitta	

Similarly, significant abundance of phytoplankton was recorded on river mouth and major species are Nitzschia sp, Protoperidinium, coscinodiscus.

Figure 31: Nitzschia sp

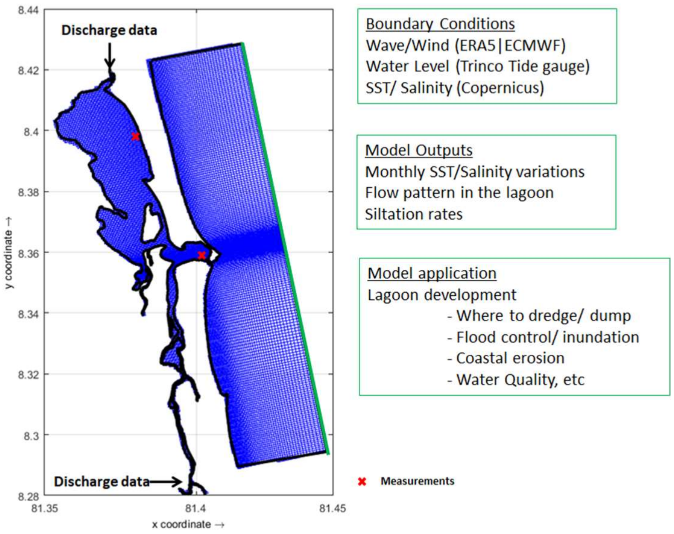
Figure 32: Protoperidinium sp

Table 9: Phytoplankton's species in Lankapatuna lagoon

Group	Genus	Species
Bassilariophyceae	*Coscinodiscus*	
	Nitzchia	
	Pleurosigma	directum
	Pleurosigma	capens
	Rhizosolenia	
	Tintinnids	
Mediophyceae	Cheatoceros	
	Ceratium	furca
Dynophyceae	Protoperidinium	
	Prorocentrum	micans

Modeling the hydrodynamics and salinity of the Lankapattna Lagoon

In recent years' time, most of the lagoon has been subjected to high anthropogenic pressures such as dredging, reclamation and restoration of the lagoon inlets which make strong consequences on the hydrology, ecology, and fisheries of the lagoon. In this study, in order to understand the local hydrodynamics in the Lankapttna Lagoon, a 2D model was setup. This will give more insight in the impact of the diversion on salinity (gradients), hydrodynamic and salinity modeling of the lagoon basin is desired. The lessons learnt from this research can be used as a foundation for future modeling initiatives of the coastal lagoons along Sri Lanka's east coast.



Boundary Conditions
Wave/Wind (ERA5|ECMWF)
Water Level (Trinco Tide gauge)
SST/ Salinity (Copernicus)

Model Outputs
Monthly SST/Salinity variations
Flow pattern in the lagoon
Siltation rates

Model application
Lagoon development
- Where to dredge/ dump
- Flood control/ inundation
- Coastal erosion
- Water Quality, etc

Figure 33: Model grid setup for Lankapattna Lagoon

At present the 2DH hydrodynamic model has been applied to simulate Lankapattna Lagoon hydrodynamics. The flow module of the model is a two dimensional (depth average) hydrodynamic (and transport) which calculates non-steady flow and transport phenomena resulting from tidal and meteorological forcing on a curvilinear, boundary fitted grid in the water. It takes into account also inflows from rivers and other point sources. The cell dimensions vary from 10 m to 150 m. The smaller cells are applied close to the lagoon mouth, where large velocity gradients are expected. The bathymetry is taken from the National Hydrographic Office of NARA (NHO). There are two small freshwater streams called Verugal Aru and Uppu Aru discharging into the model area. As we do not have measured river discharge data, the seasonally averaged discharge for dry and wet seasons are used in order to model set up. The average discharge in the wet and dry season of the year is 12 m^3/s and 7 m^3/s respectively while the salinity of the river discharges is 0 ppt. The model is forced with the amplitudes and phases of the most important tidal constituents as given in the table 1.

Table 10: Main tidal constitutes for the open sea boundary in study area.

Tidal Constitute	Amplitude (m)	Phase (Degree)
M2	0.16	74
S2	0.05	104
N2	0.03	65
K2	0.01	91
K1	0.06	245
O1	0.01	220
P1	0.02	241

Figure 2 shows the water level variation for the Lagoon's inside and outside in March 2022.

We do not have sufficient information on measured water level variation in the lagoon section for this period that would allow us to contrast the model results. However, model was calibrated with the water level measured at Trincomelee bay (IOC Lea Level data). The model simulation set the parameters of horizontal eddy viscosity E = 1 m 2 /s, and horizontal eddy diffusivity Dh = 1 m2 /s. for the bottom condition, the Manning friction formula is applied, with coefficient value equal to 0.025.

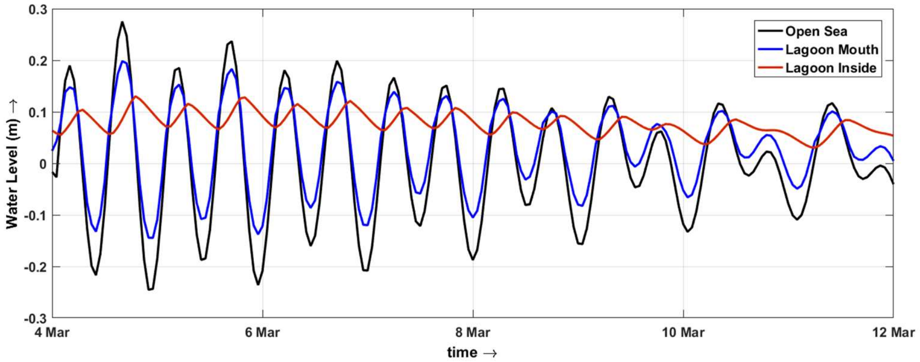


Figure 34: Water levels variations inside the Lagoon, Lagoon mouth and open sea of the Lankapuna Lagoon

A numerical model was set up to determine the Current pattern and their spatial distribution within the Lankapattna Lagoon. Numerical results of tidal Current (m/s) and their spatial distribution within the Lagoon when it is peak spring flood and ebb tides are shown in the figure 3. The maximum tidal current was recorded as 50 cm/s on a rising spring flood tide while on an ebb tide; the tidal current is little lower through the lagoon mouth. However, inner lagoon shows less than 5 cm/s flow speed. The simulations show that the tide driven currents are stronger as this region is a semi-diurnal, micro-tidal regime with a maximum spring tidal range of 0.7 m.

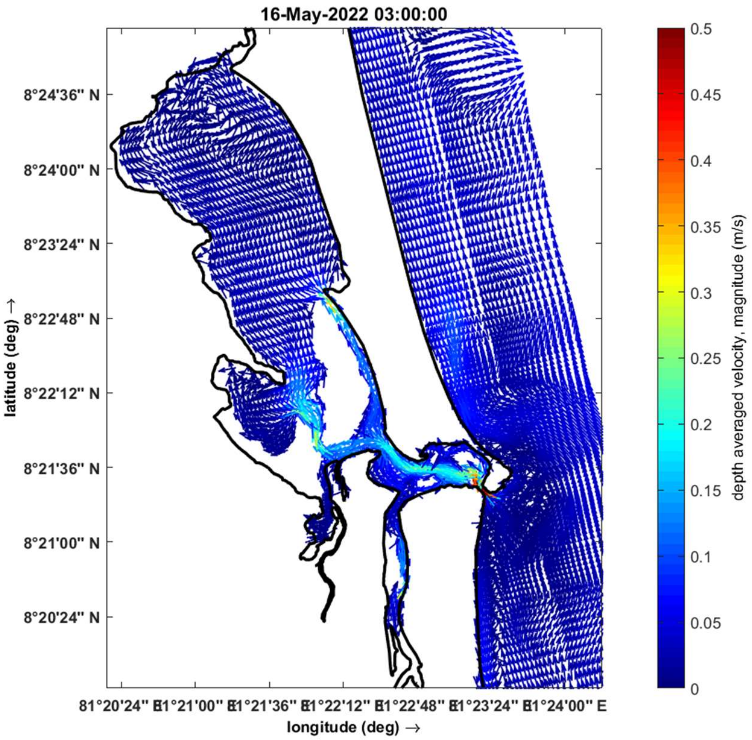


Figure 35: Model results of flow velocity in the upper layer during Flood tide in May 2022.

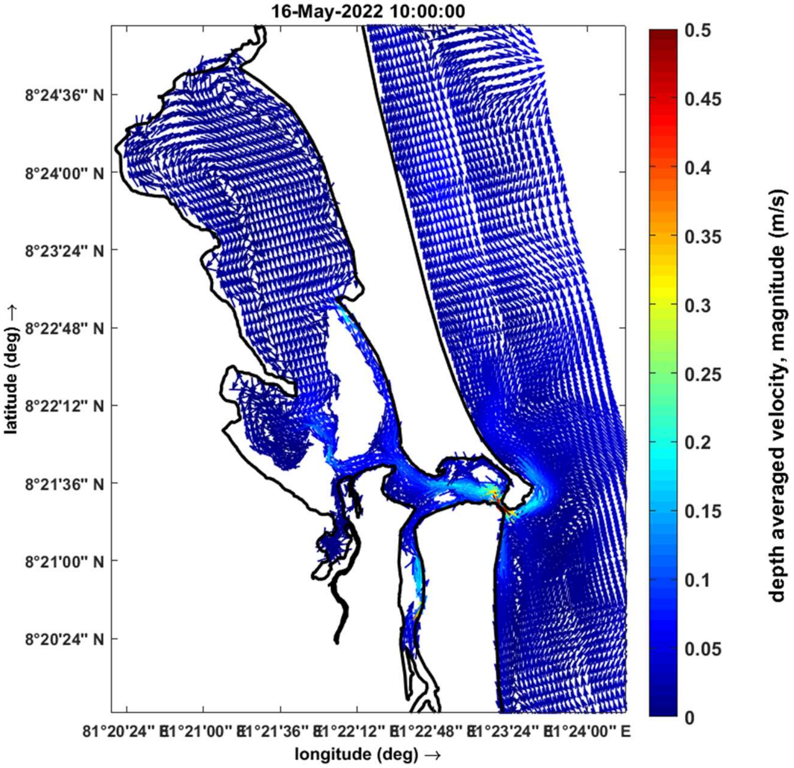


Figure 36: Model results of flow velocity in the upper layer during Ebb tide in May 2022

Numerical results of spatial variance of salinity indicate that northern section of the lagoon tend to be less vary during both flood and ebb tides due to the poor water exchange from the sea and inner lagoon (Figure 30).

However, the numerical result of salinity is in good agreement with the most of the measured salinity data.

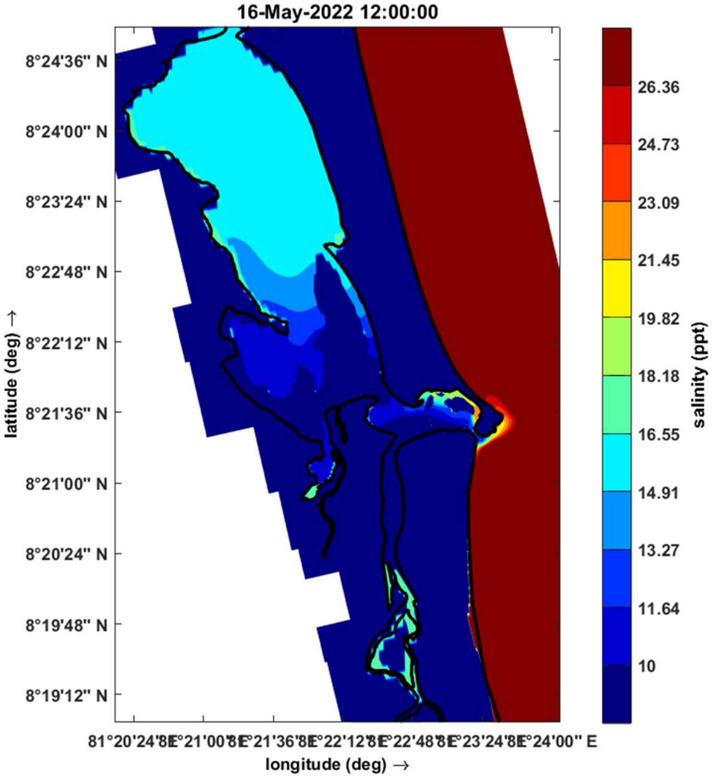


Figure 37: Model results of salinity distribution in the upper layer during ebb tide in May 2022.

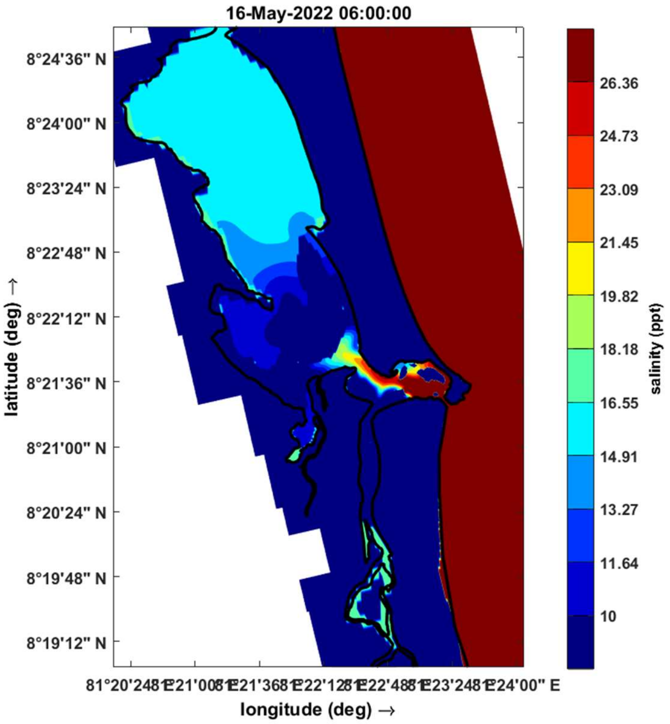


Figure 38: Model results of salinity distribution in the upper layer during Flood tide in May 2022

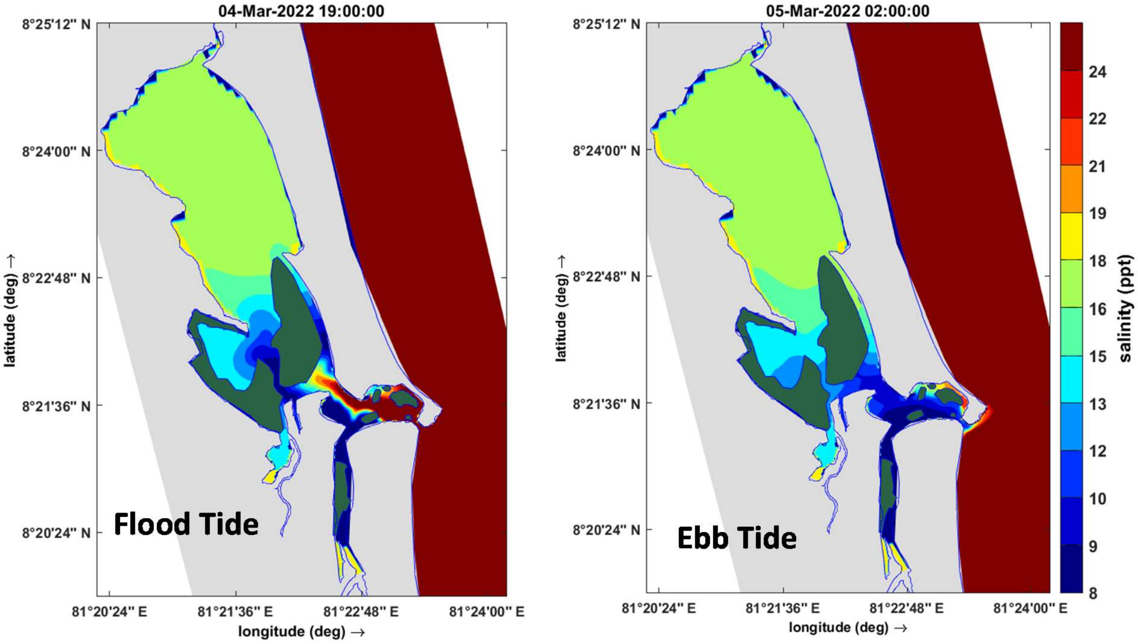


Figure 39: Model results of salinity distribution in the upper layer during Flood tide and Ebb tide in March 2022.

The Lankapattna Lagoon's water level and salinity changes for March and May 2022 are accurately simulated by the model. Due to computational capacity restrictions and a lack of measurable data, we are currently unable to model the remaining months. A reliable velocity pattern must be constructed in order to model water quality in the Lagoon system. A more accurate description of the conditions at open boundaries can lead to better results. This would enhance the explanation of the lagoon's salinity balance.

This study demonstrates that numerical models provide a suitable tool for evaluating the effects of human interventions on the sensitive environments of the coastal lagoons. Moreover, this model is capable to predict the environmental impacts due to changes of geomorphological and hydrodynamic conditions. Maintenances Dredging, deepening, reclamation and restoration of inlets can be incorporate with the model. The model can also be used to simulate the lagoon under different dredging scenarios, covering different dredging depths and extensions.

Outcomes

- Temporal and spatial usage of lagoon water and water balance, circulation, and zonation identification in the lagoon.
- Temporal and spatial variability of water balance, water renewal time, circulation, and zonation identification in the lagoon
- Seasonal variation of salinity and nutrients
- Temporal variations of Water Circulation in lagoon
- Sediment variations on lagoon bed and water for aquaculture practices.
- Setting up hydrodynamic model for lagoon salinity predictions

Outputs

- Identified spatial usage of aquaculture and effects on lagoon water.
- Ability to provide better awareness to the stakeholders about the hydrology, hydrodynamic of the lagoon in temporal and spatial scale.

- Temporal variability of water balance, circulation, and zonation identification in the lagoon
- Identification of Zooplankton and Phytoplankton species.
- Seasonal and spatial variation of salinity, TSS, water nutrients, soil organic content and grain sizes.
- Temporal variations of Water Circulation in lagoon

Conclusions

Lankapatuna lagoon is a highly dynamic and invaluable ecosystem in eastern not only monsoon wise annually it was changed. Changes in hydrodynamics seem to vary not only from monsoon to monsoon but also from year to year. It appears that the flow of tidal energy in to the lagoon system reducing with time. The sediment deposited in the lagoon is probably the reason for that.

The discharge of the verugal aru river, which is the main water source, close to lagoon mouth hinders the circulation of seawater into the lagoon. However, with proper management, the use of the lagoon's resources still operates in a manner that minimizes human impact on the natural system. So there is a potential to maximize national GDP and to achive SDG goals in future.

Recommendations

The freshwater flux in the lagoon should be properly controlled so that the particles and energy circulate in the lagoon. In this way, the users should be move towards aquaculture using the lagoon sustainably and the necessary support should be provided to properly manage the fishing activities. Also following recommendations are mentioned according to current studies.

- Further analysis to make suitable decision regarding lagoon carrying capacity enhancement.
- Implement the pilot project for Aquaculture practices.
- Control the irrigation canal discharge according to requirement.
- Improve the awareness of sustainable utilization of stakeholders.

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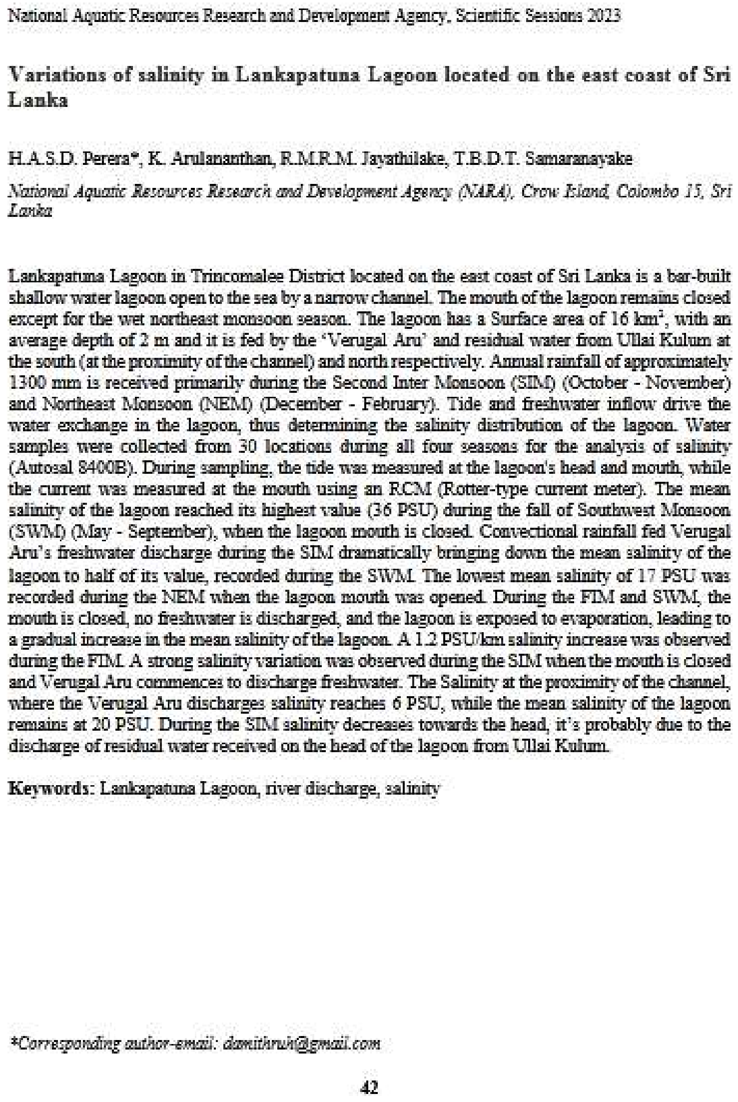

National Aquatic Resources Research and Development Agency, Scientific Sessions 2023

Variations of salinity in Lankapatuna Lagoon located on the east coast of Sri Lanka

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Lankapatuna Lagoon in Trincomalee District located on the east coast of Sri Lanka is a bar-built shallow water lagoon open to the sea by a narrow channel. The mouth of the lagoon remains closed except for the wet northeast monsoon season. The lagoon has a Surface area of 16 km^2, with an average depth of 2 m and it is fed by the 'Verugal Aru' and residual water from Ullai Kulum at the south (at the proximity of the channel) and north respectively. Annual rainfall of approximately 1300 mm is received primarily during the Second Inter Monsoon (SIM) (October - November) and Northeast Monsoon (NEM) (December - February). Tide and freshwater inflow drive the water exchange in the lagoon, thus determining the salinity distribution of the lagoon. Water samples were collected from 30 locations during all four seasons for the analysis of salinity (Autosal 8400B). During sampling, the tide was measured at the lagoon's head and mouth, while the current was measured at the mouth using an RCM (Rotter-type current meter). The mean salinity of the lagoon reached its highest value (36 PSU) during the fall of Southwest Monsoon (SWM) (May - September), when the lagoon mouth is closed. Convectional rainfall fed Verugal Aru's freshwater discharge during the SIM dramatically bringing down the mean salinity of the lagoon to half of its value, recorded during the SWM. The lowest mean salinity of 17 PSU was recorded during the NEM when the lagoon mouth was opened. During the FIM and SWM, the mouth is closed, no freshwater is discharged, and the lagoon is exposed to evaporation, leading to a gradual increase in the mean salinity of the lagoon. A 1.2 PSU/km salinity increase was observed during the FIM. A strong salinity variation was observed during the SIM when the mouth is closed and Verugal Aru commences to discharge freshwater. The Salinity at the proximity of the channel, where the Verugal Aru discharges salinity reaches 6 PSU, while the mean salinity of the lagoon remains at 20 PSU. During the SIM salinity decreases towards the head, it's probably due to the discharge of residual water received on the head of the lagoon from Ullai Kulum.

Keywords: Lankapatuna Lagoon, river discharge, salinity

**Corresponding author-email: damithruh@gmail.com*

PROJECT NO : 6.4

MAINTENANCE OF SEA-LEVEL MONITORING NETWORK AROUND SRI LANKA

Officer Responsible	**:** K.W. Indika
Total Fund Allocation	: 0.33 million LKR
Duration	: Continues Project
Locations	: Trincomalee, Colombo, Mirissa, Kirinda, Point Pedro, Dondra, Potuvill.

Introduction:

Sea level variability and change manifest as outcomes of both natural and man-made circumstances. Sea level variation serves as a unique indicator for studying the impacts of climate change. The United Nations' Sustainable Development Goal (SDG) No. 13, 'Climate Action,' highlighted the urgent need for action against climate change arising from anthropogenic activities. Based on the records from the Intergovernmental Panel on Climate Change (IPCC), the rate of Global Mean Sea Level Rising (GMSLR) was 1.5 millimeters per year (with a range of 1.3 to 1.7 mm/year) from 1901 to 1990. However, from

1993 to 2010, the rate increased to 3.2 millimeters per year (with a range of 2.8 to 3.6 mm/year). This indicates a higher rate of sea level rise since the late 19th century. As of December 2022, the Climate Change Research Centre of NASA reported that the current annual average global sea level trend is 3.4 millimeters per year. This includes a steric height increase of 1.2 millimeters per year and an ocean mass increase of 2 millimeters per year. More than 90% of the stored excess energy is linked to anthropogenic climate change, making it the primary contributor to the global thermosteric sea level rise (J. Climate, 2015).

The increase in sea levels results from the absorption of atmospheric temperature, causing the expansion of oceanic water volume. Additionally, the melting of glaciers and ice sheets contributes excess water to the oceans, coupled with a reduction in solid water storage on land. According to NASA's historical records of the Earth's surface temperature, the decade from 2010 to 2019 stands out as the warmest ever recorded. The latest report from the United Nations' IPCC presents a very sobering picture of the challenges we confront, particularly with the prospect of a 1.1-meter rise in sea levels at the end of this sanctuary. Continuous monitoring, recording, and reporting of sea levels are crucial for studying the threats posed to coastal life. This is especially significant for island nations, where the potential for ocean-based disasters is higher. Such proactive measures are essential for both understanding and mitigating the effects of climate change on coastal lands."

Main objective:

- Maintenance of existing sea level monitoring network
- Establishing additional sea level monitoring stations

Specific Objectives

- Continuous data collection.
- Quality controlling and archiving of sea level time series data
- Quantification of Sea level rise around Sri Lanka.
- Determination of monsoon's impact on sea level fluctuations around Sri Lanka.
- Development of existing “Sea Level” web page to sharing data and data product with community
- Providing monthly reports on sea level-related destructive events to the Disaster Management Centre (DMC)

Methodology (Study area, field sampling, data collection and analysis)

The methodology of the study conducted based on data acquisition from the automated sea level monitoring network around the country.

Study area

The study area is entire coastal region of the country. The existing sea level monitoring network comprises five stations located at Trincomalee, Point Pedro, Colombo, Kirinda, and Mirissa. Additionally, proposed new four stations are currently in progress at various stages of establishment.

Construction is ongoing at the Dodara station. Land clearance and drawing is completed at Hambanthota station at fisheries harbor. Land clearance is in progress at Pottuvill : Kottukhal, and Mannar :Vankalai sea level monitoring stations.

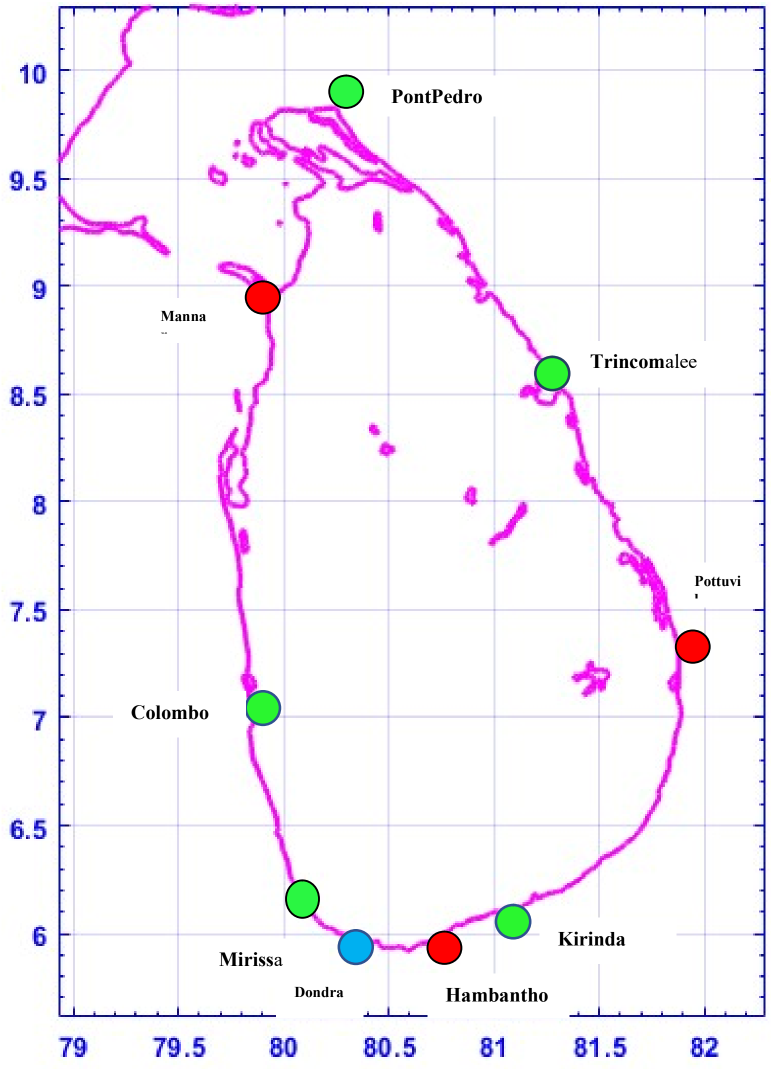


Figure 01: Sea level monitoring network around the country

The green colorindicates the present functioning sea level monitoring stations, and the red colure shows the proposed sea-level stations. Blue colure indicates ongoingconstruction.

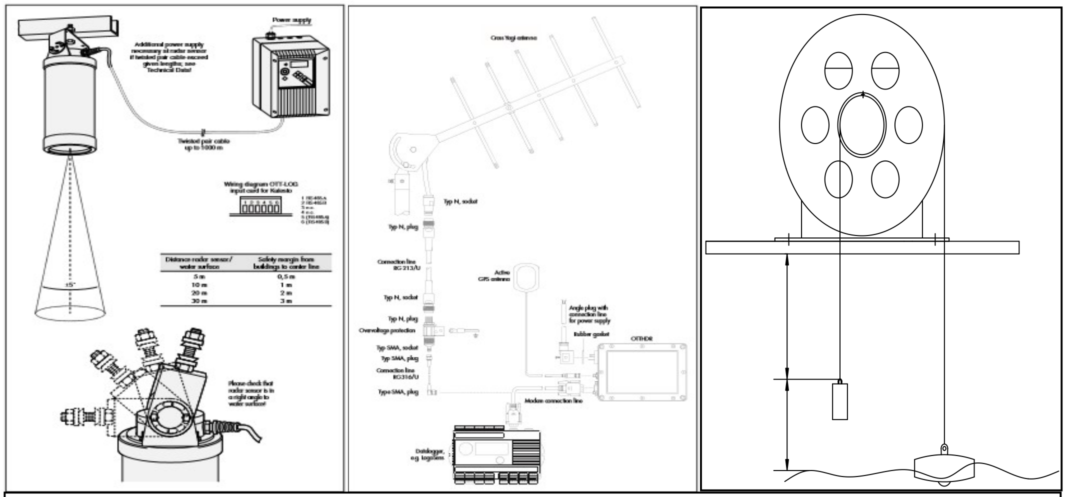
Table 01: Description of the sea level stations and data collection

	Location	**Status**	**Parameters**	**Transmission**	**Collaboration**
1	Trincomalee	Functioning	Water height : Radar and Hydrostatics pressure sensor	Satellite : communication	University of , Hawaii, IOC
2	Point Pedro	Functioning	Water height : Radar and Hydrostatics pressure sensor	General Packet Radio Service (GPRS) : local communication via Mobitel	First Institute of Oceanography (FIO), China
3	Colombo	Functioning	Water height : Radar and Hydrostatics pressure sensor	Satellite : communication	University of Hawaii, IOC

4	Mirissa	Functioning	Hydrological and meteorological :Wind, rain fall, water temperature, tide, pressure, Humidit	General Packet Radio Service (GPRS) : local communication via Mobitel	First Institute of Oceanography (FIO) , China
5	Dondra	Construction on going	Water height : Radar and Hydrostatics pressure sensor, Wave bouy	General Packet Radio Service (GPRS) : local communication	South China Institute of Oenology (SCIO) , China
6	Kirinda	functioning	Water height : Radar and Hydrostatics pressure sensor	Data Transmission USB	Hawaii University, Hawaii, IOC
7	Pottuvil	Completed Site selection and Received approval from Department of forest.	Hydrological and meteorological parameters	GPRS	FIO

Mechanism of the data collection

The methodology consisted of data acquisition, temporary saving, and transmission to the data server at the head office. The received data to the server need to be completed following the main steps in order before using the data product development, downloading, processing, quality controlling, and analyzing. The data process and analysis were conducted by using Matlab R2018a, Panoply, and Microsoft excel. The collected data was validated using satellite observation from ECMWE and AVISO. The tidal analysis conducted according to the tidal equations Understanding of Tide by NOAA (Hicks. 2006). The parameters we use to collect under the main two categories. They are meteorological parameters such as wind speed and direction, atmospheric pressure, atmospheric temperature, humidity, and precipitation, and hydrological parameters such as water temperature and sea level height. The data acquisition, temporary saving, and transition conduct automatically by pre-defined time intervals via satellite and General Packet Radio Service (GPRS). The Mirissa data transmit every minute to the NARA data server at the head office via the local communication network (Mobitel). The satellite data transmission conducts every 15 minutes via the Metosat to the server of the University of Hawaii and update on the web page of the Global sea level monitoring facility of the Intergovernmental Oceanographic Commission (IOC) with a delay of a few minutes.



A). Radar sensor B). Satellite Transmitter and data logger C). Floating tide

Figure 02: Schematic diagram of Kalisto radar sensor, Satellite antenna and floating tide gauge.

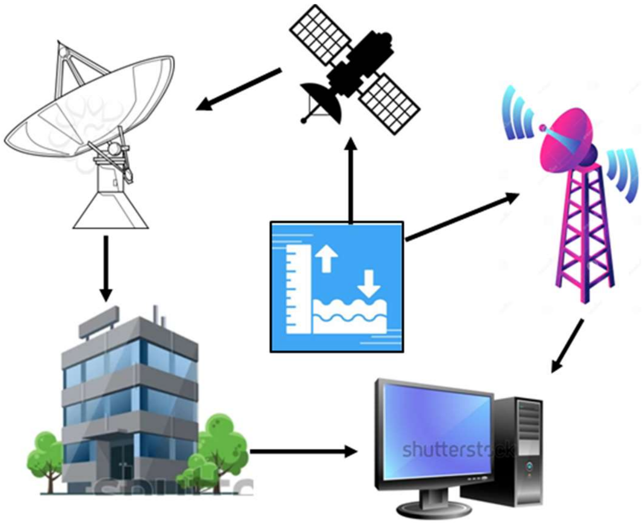


Figure 3: The mechanism from data acquisition tp transmitting to desktop.

The instruments deployed in the field collect data, temporarily storing it in a data logger. Subsequently, the data is transmitted to the ground station through satellite communication, while some stations use the General Packet Radio Service (GPRS) for data collection and transmission. The received data is stored in a server and disseminated through a webpage accessible to data providers worldwide.Trincomalee and Colombo stations are data transmit via satellite communication while Point Pedro and Mirissa stations are data transmit via the GPRS technology.

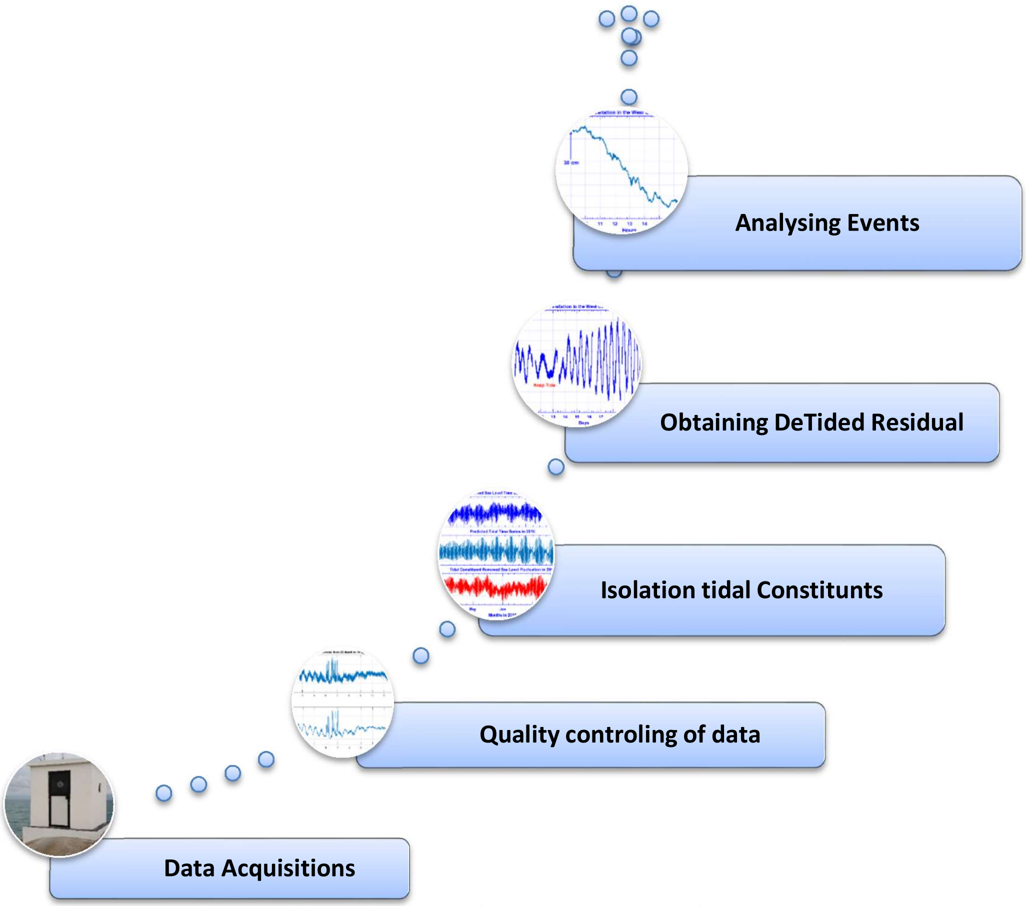


Figure 04: Flow chart shows the basic steps of the data handling from acquisition to analyzing.

The controlled data were used to obtain de-tided residual sea level signals and analyze the events such as storm surges, meteotsunami, and Tsunami. The analysis was conducted using Harmonic analyzing functions developed by Matlab software, high-frequency detection functions, and moving averages, analyzing of energy density spectrum, and filling of missing time column functions.

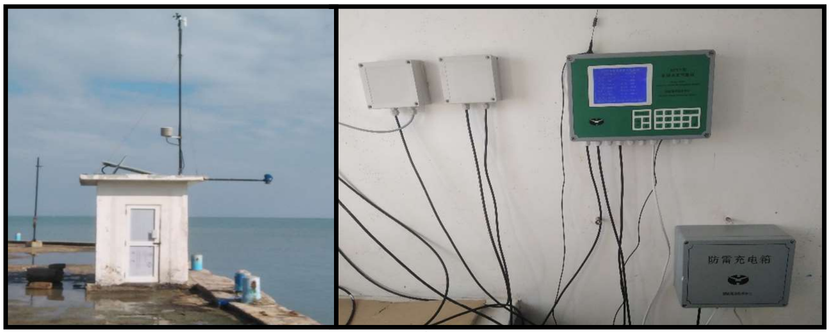


Figure 05: Sensors and transmitters of a sea level measuring station

Sea level monitoring station and data transmission modems installed at Point Pedro's new sea level Monitoring station. The instrument cost approximately more than 10 million. The instrument was obtained under the donation of the First Institute of Oceanography, China.The collated data save automatically to a data logger and transmit by pre-defined time intervals via satellite and General Packet Radio Service (GPRS).

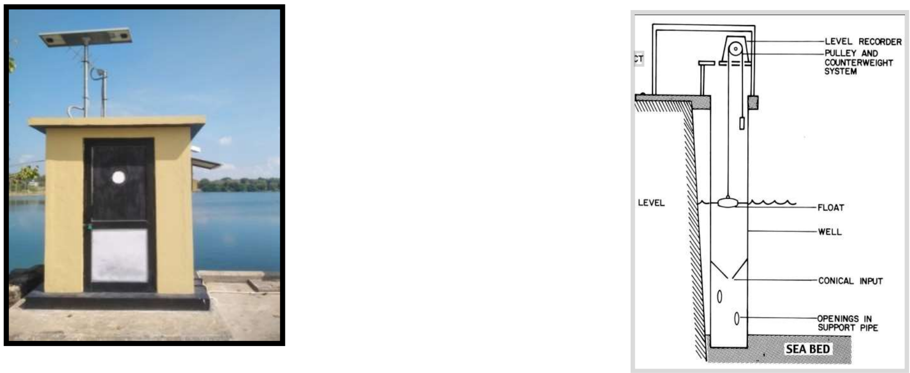


Figure 06: Sea level measuring station at Trincomalee

Its shows the tide well established along the jetty wall to direct to the bottom of the sea from the tide house. The floater was established on the water surface inside the tide well. It gives a noise-filtered environment to measure sea level signals due to the creation of an undisturbed environment inside the well.

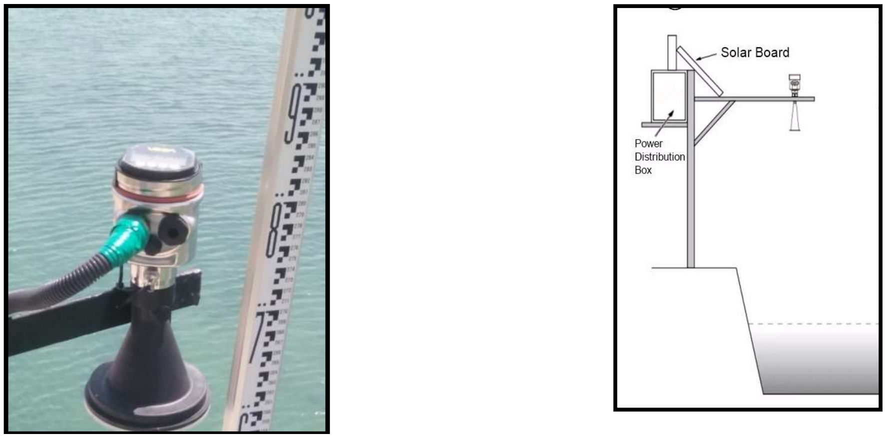


Figure 07: Acquisition of water level using radar sensor installed at Point Pedro fisheriesharbor.

The first figure shows the actual installation of the radar sensor to direct sea surface mean while the leveling process also was done, the second image is the schematic diagram of the sea level measuring using the radar sensor.When the radar antenna emits microwave pulses, it has a certainemission angle. There should be no obstructions in the area radiated from the radar cone to the medium surface and within the area of the radiated microwave beam.

Activities conducted during period of project

- Updated Quantification of Sea level rise around Sri Lanka
- Analyzed seasonal sea level signals.
- Study of extreme sea level events (Storm Surge)
- Data downloading, processing& quality controlling
- Data Product development and published on the NARA web page.
- Repaired damaged aluminum doorat Mirissa tide house at fishery Haber.
- Installed used instrument toKirinda sea level monitoring station
- Issued monthly sea level-related destructive event reports (12) to the Disaster Management Center (DMC).
- Trained 03 university students (Undergraduate)
- Published a abstract using sea-level data
- Land clearance for construction of new sea level stations at Hambanthota, Dondra , Mannar, and Potuvill

- Obtained foreign fund for construction of Potuvill and Mannar new Stations.
- Procurement for construction of Dondra new sea level and wave monitoring station

Establishment of new sea level monitoring stations

The existing sea level monitoring facilities are not sufficient to cover the whole island. Sea level monitoring facilities required around the country as an island nation surrounded by sea. Therefore we intended to establish new stations to cover southeast coast - Potuvill , Northwest coast-Mannar, Hambanthota and Southern tip-Dondra.

Proposed sea level Monitoring station at Dondra

Land clearance and drawing already completed. The procurement process also completed and awarded to a contractor by sign the agreement. Construction will be started within the first week of January 2024.

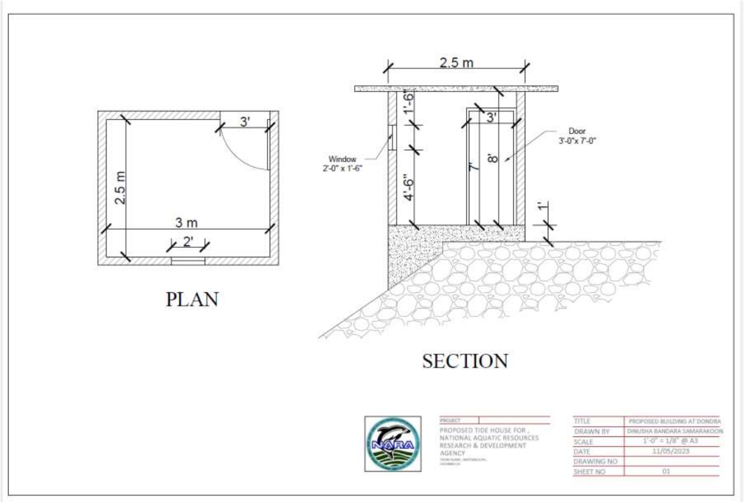


Figure 08: The drawing of proposed building and the locationmap of the proposed tide and wave monitoring station at Dondra fisheries harbor.

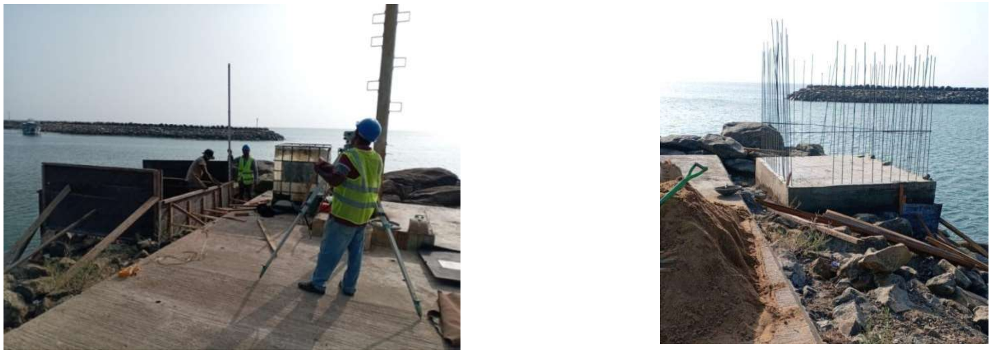


Figure 09: Ongoing Construction for new tidal and wave monitoring stations at Dondra fisheries harbor under the collaboration of South China Sea Institute of Oenology (SCSIO), China.

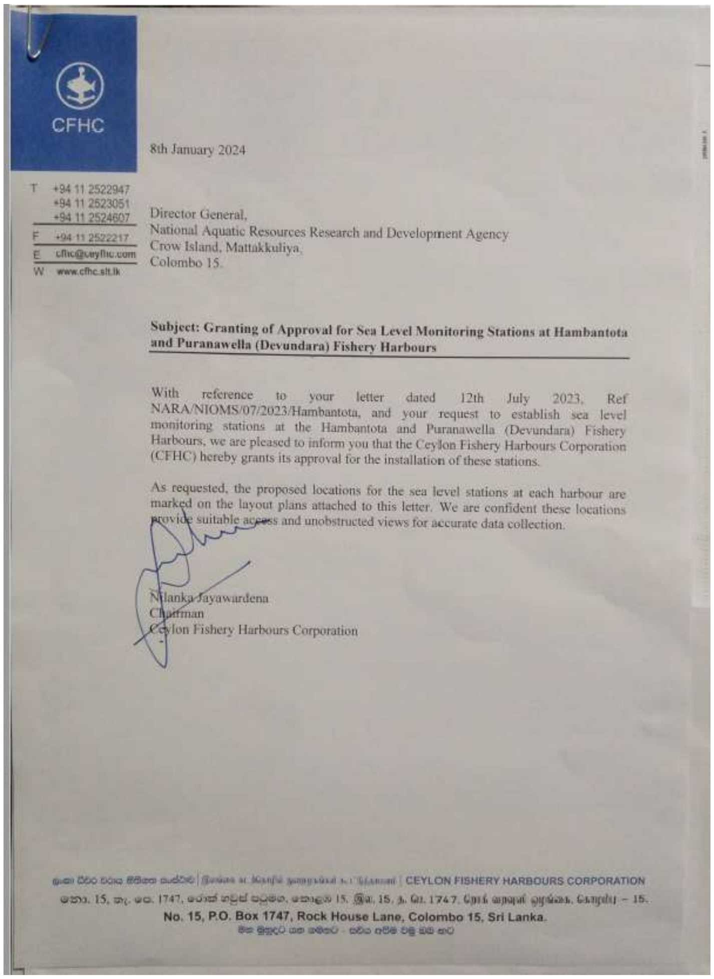
Kirinda sea level monitoring station

It was established in 2006 with radar and underwater hydrostatic sensors. The present status of this station is not properly functioning due to malfunctioning of the sensors. Spare sensor not available in NARA. Therefore we hope to purchase under the instrument budget in 2024.

Figure 10: Sea level Monitoring stations at Kirinda

Proposed sea level Monitoring station at Hambanthota

Land clearance of Cylon fisheries Haboure Corporation and drawing is completed for construction new station at Hambanthotat fisheries harbor.



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8th January 2024

Director General,
National Aquatic Resources Research and Development Agency
Crow Island, Mattakkuliya,
Colombo 15.

Subject: Granting of Approval for Sea Level Monitoring Stations at Hambantota and Puranawella (Devundara) Fishery Harbours

With reference to your letter dated 12th July 2023, Ref NARA/NIOMS/07/2023/Hambantota, and your request to establish sea level monitoring stations at the Hambantota and Puranawella (Devundara) Fishery Harbours, we are pleased to inform you that the Ceylon Fishery Harbours Corporation (CFHC) hereby grants its approval for the installation of these stations.

As requested, the proposed locations for the sea level stations at each harbour are marked on the layout plans attached to this letter. We are confident these locations provide suitable access and unobstructed views for accurate data collection.

Nilanka Jayawardena
Chairman
Ceylon Fishery Harbours Corporation

CEYLON FISHERY HARBOURS CORPORATION
No. 15, P.O. Box 1747, Rock House Lane, Colombo 15, Sri Lanka.

Table 02: The status of the proposed new sea level monitoring stations at Hambanthota, Dondra, Potuvill and Manna

	Name of the station	Status of progress	Description
01	Dondra : Fisheries Haboure	Construction on going	Tide and wave monitoring
02	Pottuvil: Kpttukal	Land clearance in progress	Tide and weather
03	Hambanthota fisheries habour	Completed land clearance , drawing	Tide and wave monitoring
04	Mannar : Vankalai	Land clearance in progress	Tide and weather

Results obtained

The sea level variation was studied around Sri Lanka using the Mirissa, Colombo, Trincomalee, Point Pedro and Kirinda tide gauge observations by the segmented time period of a solar day, fortnight, monthly, seasonal, and long-term. The tide gauge observation was compared with the satellite observations of Archiving Validation & Interpretation of Satellite Oceanography data (AVISO). The tidal-related calculation was done according to the methodology of Understanding of Tide by NOAA (Hicks. 2006).

Long-term sea level variation around the country:

Sea level changer around the country estimated using historical observations collected by tide gauge network and satellite observations during the last few decades. Understanding long-term sea level variation is crucial for coastal communities and policymakers because it directly impacts coastal erosion, flooding risks, and the sustainability of coastal infrastructure.

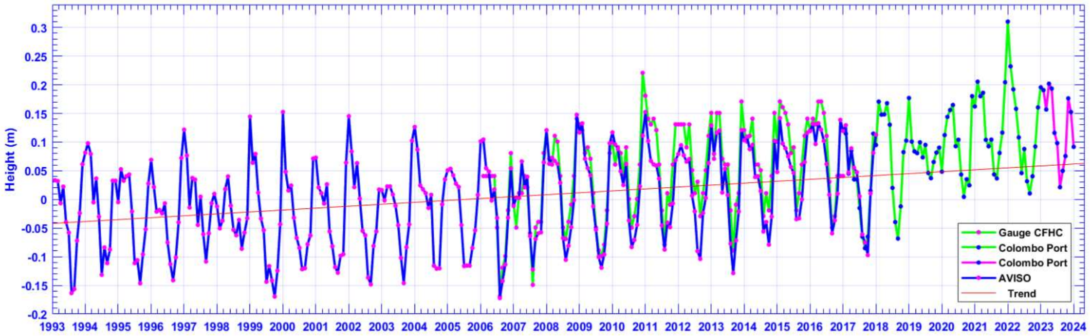


Figure 11: The figure shows the long term sea level observations of the Sri Lanka.

The blue line is the satellite observations done by Archiving Validation & Interpretation of Satellite Oceanography data from 1993 to 2018. The light green color represents the Tide gauge observations of mutual fisheries harbor from 2006 to 2022 and the pink line indicates the tidal observations of Colombo port tide gauge. The red line indicates the trend of the sea level in Sri Lanka. The sea level rising trend in the Sri Lanka is positive with the range of 2.5-3.2 mm per year.

Seasonal wind variations:

Seasonal wind variation refers to changes in wind patterns throughout the year due to factors such as the tilt of the Earth's axis and the differential heating of land and water. These variations influence wind direction, speed, and distribution across different regions of the country.Mainly northern and southern parts of the country exhibit deferent seasonal wind patterns driven by monsoons phenomena.

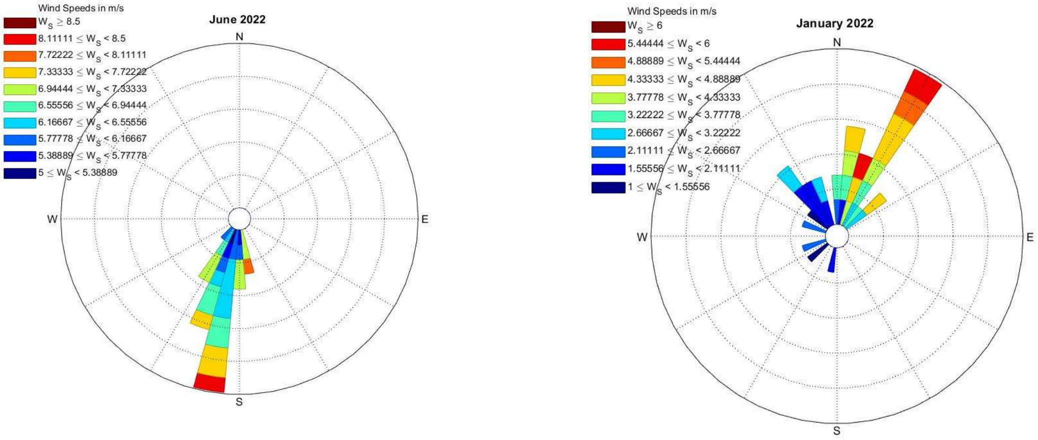


Figure 12: Wind rose diagrames during the South west monsoon and North east monsoon.

A wind rose is a graphical tool used by meteorologists and climatologists to represent the frequency and strength of winds blowing from different directions over a specific period, typically a year or a season. The firest wind rose shows the wind direction during the south west monsoon and the second wind rose indictes the wind diredction and the speed during North east monsoon. During south west monsoon wind blow from the southwest , and during the north east monsoon blow from northeast which are characterized by a reversal in wind direction between the main monsoon of the country.

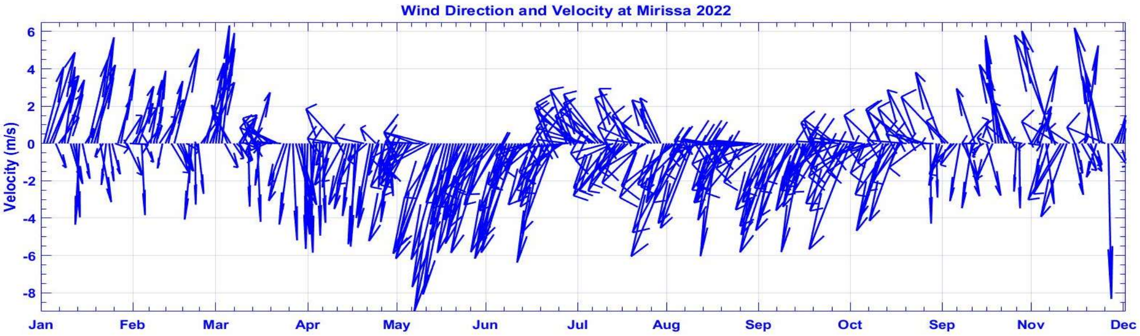


Figure 13: Time series observation of wind direction and amplitude.

A Wind Feather plotis a graphical representation used in meteorology to depict wind speed and direction at a specific location or across a region. It typically consists of lines or "feathers" pointing in the direction from which the wind is blowing, and the amplitude of the wind velocity.The blue line of the graph depicts clearly the wind direction and the strength throughout in 2023. During the south west monsoon wind point toward the south west. The monsoon onset was little early in 2023 than previous years.

Annual sea surface temperature Variation

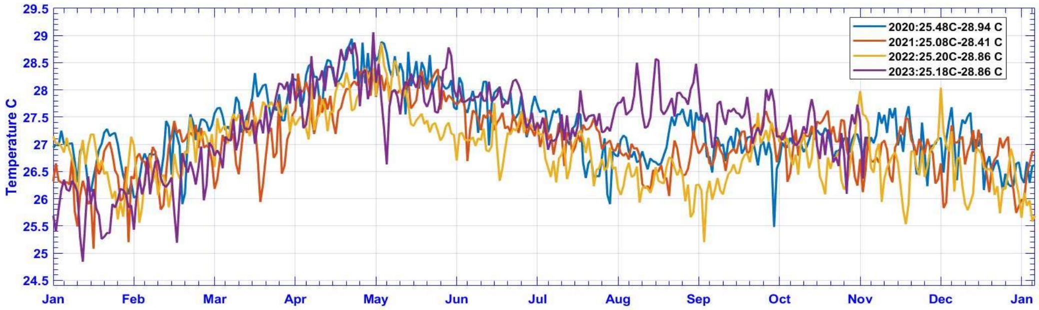


Figure 14: Temperature variation in the southern coast of Sri Lanka.

The annual temperature fluctuates between 25.0-28.94 C^0 during last four years. The brown line shows abnormal higher temperature variation end of south west monsoon by experiencing Sevier drought by effecting to the aquaculture and agriculture industry of the country.

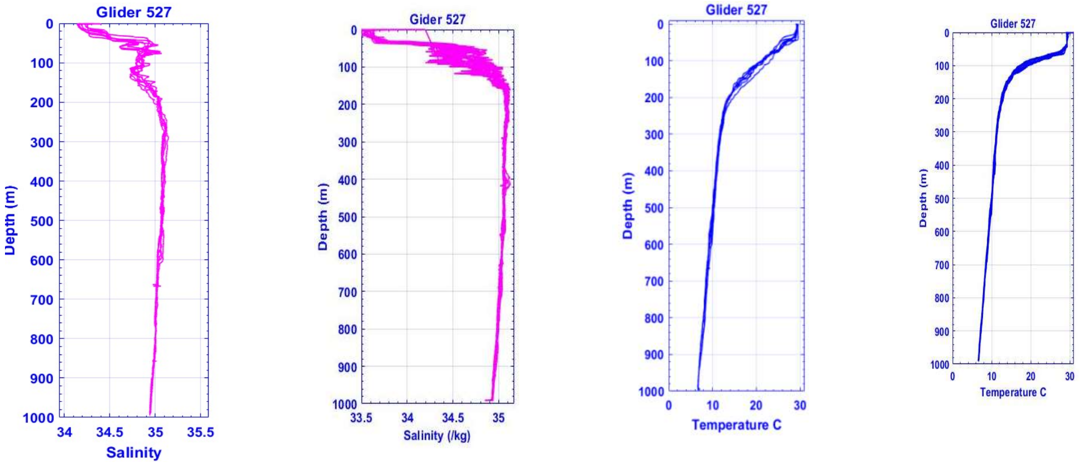


Figure 15 : Salinity and temperature variation during south west monsoon.

During the southwest monsoon, the Mix Layer Depth (MLD) and Thermocline range between 34-48 m and 205-210 m, respectively, while during the Northeast monsoon, they vary between 52-61 m and 195-200 m.Steric heights exhibit variations from 0.0126 m to 0.0251 m in the southwest monsoon and from 0.0156 m to 0.0201 m in the northeast monsoon.

Observation of Cyclones

Severe Cyclonic Storm Michaung was a moderate tropical cyclone which formed in the Bay of Bengal during the 2023 North Indian Ocean cyclone season. Michaung originated as a low-pressure area in the Gulf of Thailand which crossed into the Bay of Bengal and became a deep depression on December 2.

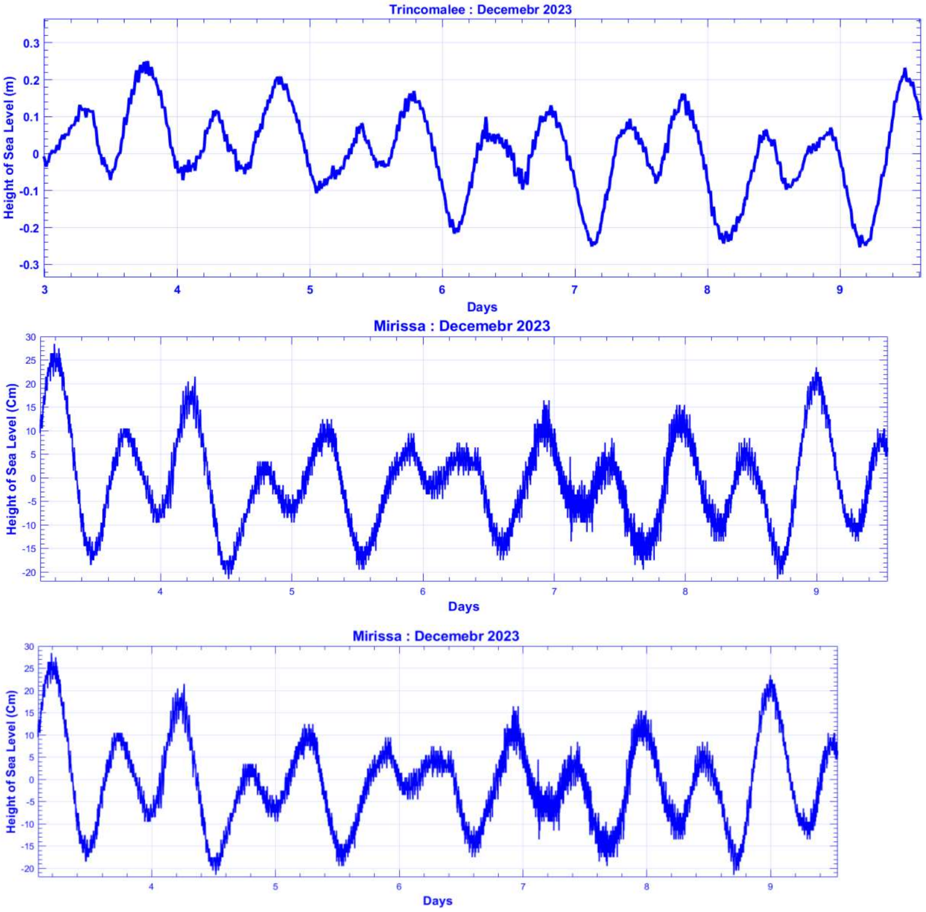


Figure 16: Sea level records at Trincomalee, Colombo and Mirissa during the Cyclonic storm Michaung

During Cyclone Michaung, Trincomalee Colombo, and Trincomalee experienced storm surge conditions with heights of less than 10 cm. The strength was not sufficient to inundate coastal areas, causing floods and destructive to the coastal community living low-lying land due to the events occur Neap tidal period.

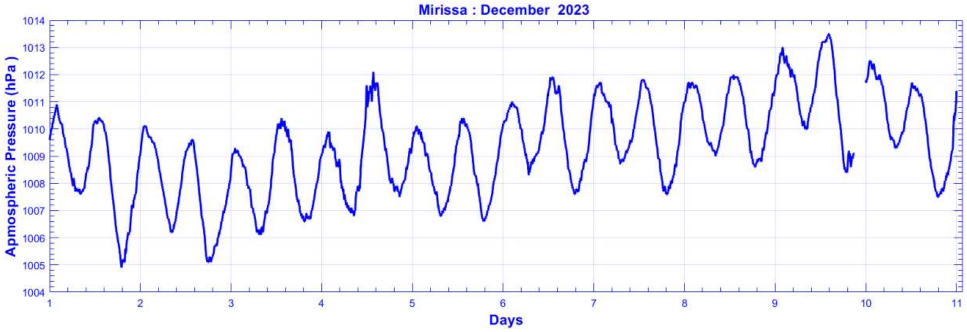


Figure 17: Atmospheric pressure variation at Mirissa during the Cyclonic storm Michaung

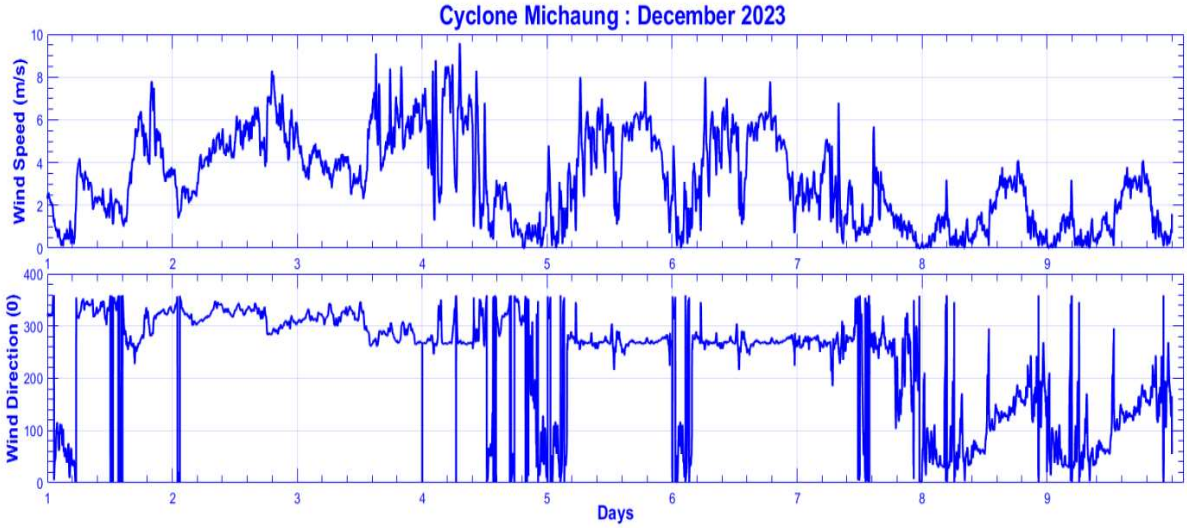


Figure 18: Wind speed and direction variation at Mirissa during the cyclone Michaung

First graph is observed wind velocity variation from 1st to 9th December 2023.Second graph is direction variation during the cyclone period. This grape indicates the wind speed at Mirissa stations fluctuate in range of 10-1 ms-1 while the wind direction fluctuates in 3600 during the period of cyclone Michaung in the Bay of Bengal.

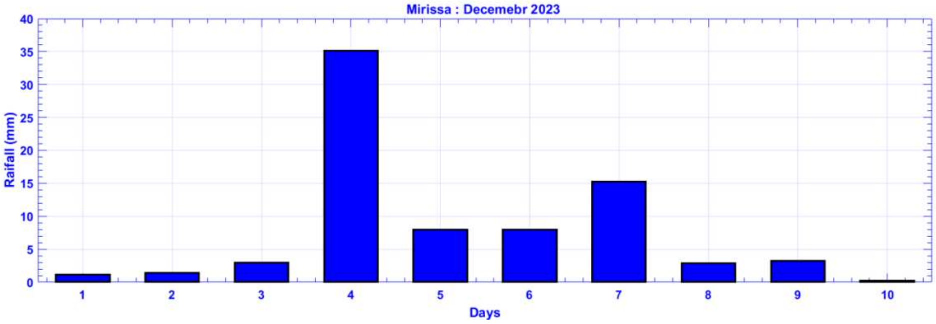


Figure 19: The rainfall at Mirissa during Michaung during the

Heavy rainfall was recorded in 35 mm per day on 4th December an gradually droppedat Mirissa during the northeast monsoon.

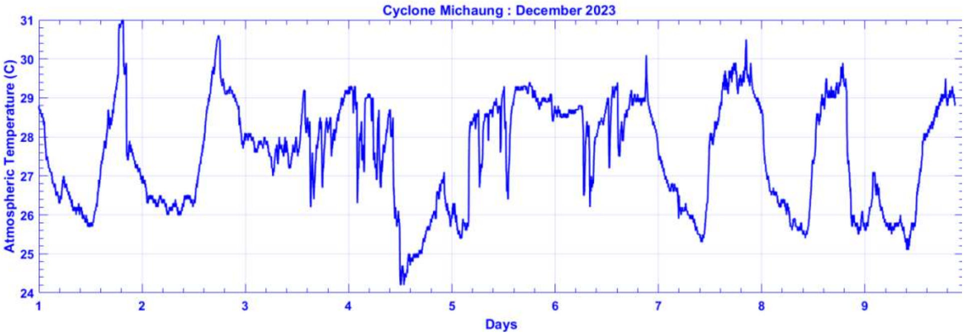


Figure 20: Atmospheric temperature fluctuation during the Cyclone Michaung

During the cyclonic period the typical wind pattern change and lower temperature was recorded from 3rd to 7th December 2023. The atmospheric temperature was dropped to $24C^0$ during the 4th with the heavy rainfall.

Figure 21: Track of cyclone Michaung

Track map of severe cyclone Michaung in Northern Indian Ocean during 3-6 December in 2023. The point shows the location of the storm at 6 hours intervals.

Source: https://en.wikipedia.org/wiki/Cyclone_Michaung#/media/File:Michaung_2023_path.png

Technical consultation for National policy planning

1. Implementation plan for the National Determined Contributions 2021:2030:

   Represent as working group member for validation and implementation of the Nationally

   - Determined Contribution (NDC) of the "Coastal & Marine Sector".
   - Establishment of the Required database with historical tidal level data as a Leading Agency
   - Measure and record present mean sea level (MSL) and assess and publish sea level rise measurements.
2. Technical report issued Sea level related destructive event :

12 reports were issued to Disaster Management Centry (DMC) based on Sea level observation around Sri Lanka; Thos observations are use for the disaster management including scientific evidence for the compensation process loss and damage coastal community.

3. Publication done during this year 2023
   - Seasonal Dynamics on the Southern Coast of Sri Lanka Revealed Through Meteorological and Oceanographic Observations. NARA annual Scientific Session 2023

Description of trained university students

Most of undergraduate and master students are select NARA to complete their internship as well as the research thesis. Following students were directed by the universities and they were completed their academic requirements using sea level and meteorological data including the mentoring.

Table 05: Trained undergraduate students

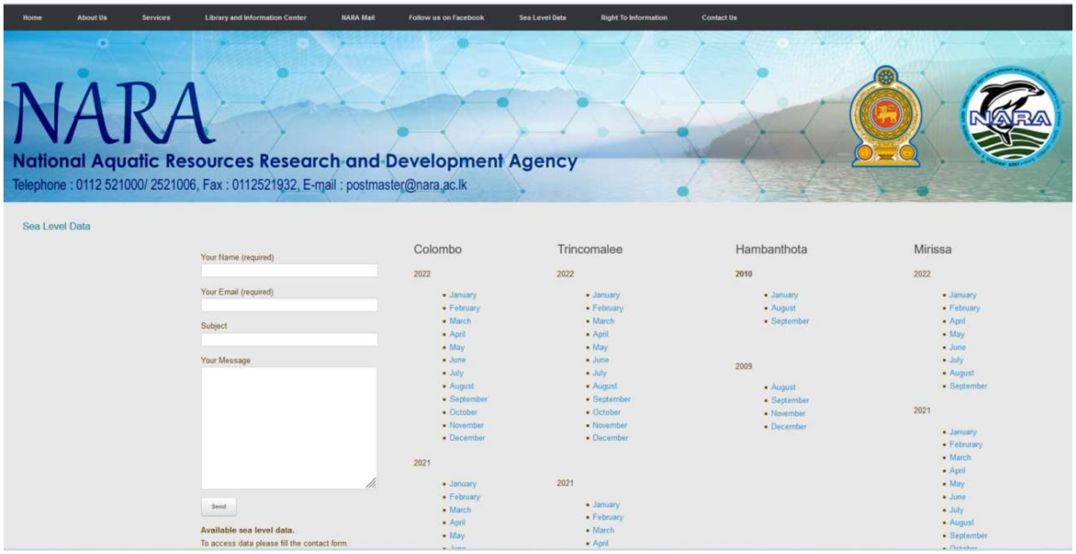
Name	University	Tropic of the research
Ms Karthiga Inthirakumaran	Department of Civil Engineering, University of Jaffna ,	Groundwater monitoring at Karainagar Island to understand the spatiotemporal variation of water level and salinity.
Ms. N. Naomi Vishvadharini Chandrasekaran,	Department of Zoology, Faculty of Natural Sciences, Open University of Sri Lanka. Registration No: 719218582	Oceanography and Ocean Resources (ZYU 6309) Short term training, 14 days
Ms. L. A. M. Hindumini Shashini Ruwandika	Department of Fisheries and Marine Sciences, Tangalle Branch, Ocean University of Sri Lanka ,Registration : FS/2019/024	Monsoon response in the southern coast of Sri Lanka

Principles Oceanography ZL 4055	Department of Zoology and Environment Science, Faculty of Science, University of Colombo	Practical component on Particles of Oceanographic instrument, Data handling, 50 Student.
Capacity Development	Sri Lanka NAVY, Naval Based, Trincomalee. J2000 Sailors	Education tour of Underwater control & Underwater weapon 11 (UC/UW11) Qualifying Course,
Capacity Development	Sri Lanka NAVY, Trincomalee .	Education Excursion of 64th Intake officers under training, Naval Based ,Trincomalee,

Dissemination data and data product

The metadata and data product have published through the NARA main web page under the "Sea Level" portal. The interest community can be requested the data according to their requirement based on the row data or as technical report. We have provided technical reports and row data for the several coastal development works such as waste water management system, harbor developments, researches, student, and bathymetric surveys.

The "Sea Level" web page consisteda contact form for a person who interest can be sent a massage with an email address via the contact form, then we can be provided relevant data or information as their requirements. Further web portal includes monthly sea level graphs generated using processed data based on availability of data in sea level stations around the country.



National Aquatic Resources Research and Development Agency

Telephone : 0112 521000/ 2521006, Fax : 0112521932, E-mail : postmaster@nara.ac.lk

Available sea level data.

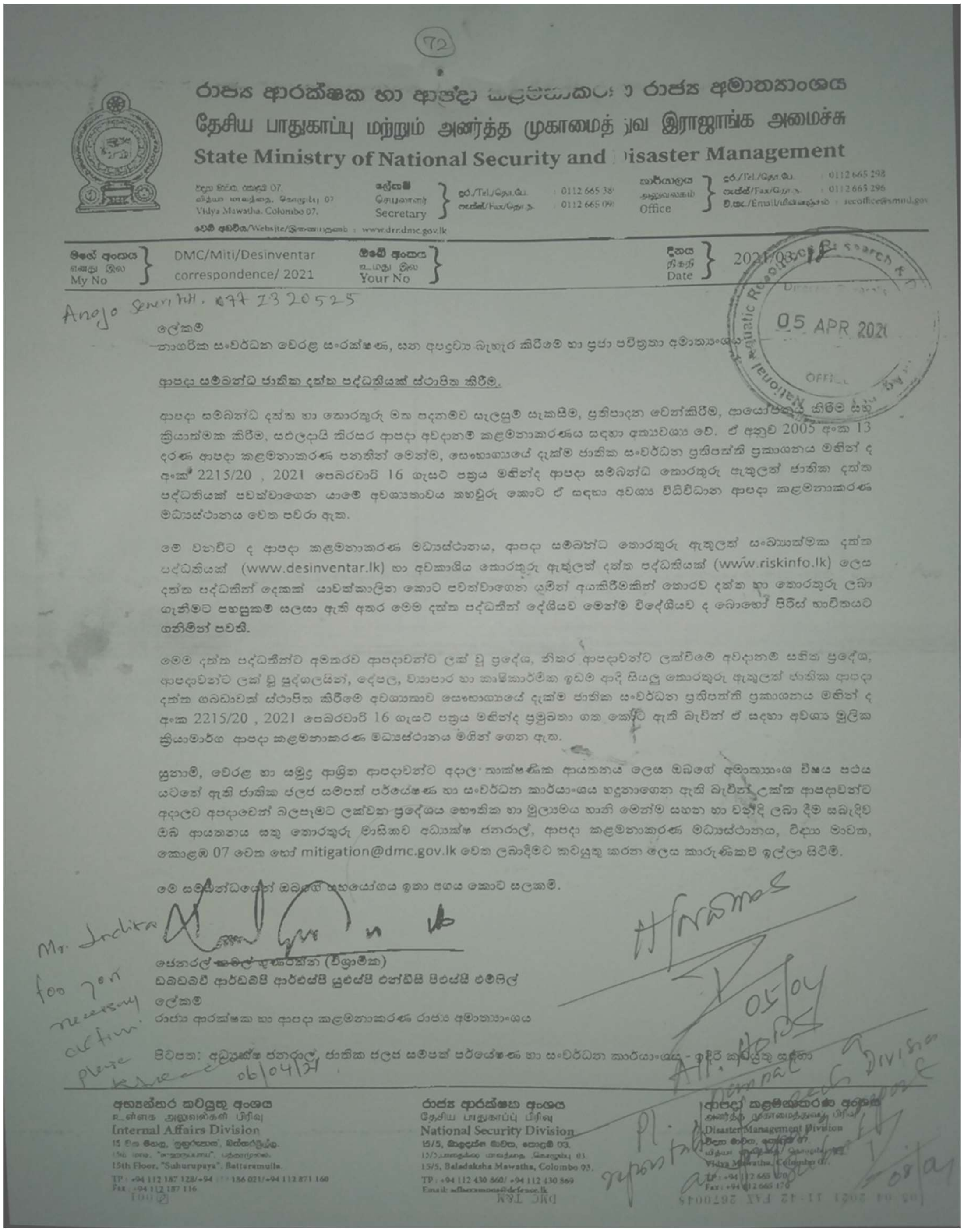
To access data please fill the contact form.

Figure 17: Sea level web portal interconnected with NARA web page

NARA has provided facilitate and directed approximately 80 users through the contact form of the web page. Total number 593 of mails received through contact form increasing the number of users of NARA webpage. The monitoring and evaluation division of the NARA contributes for the updating and developing of Sea Level web portal.

Technical report issued Sea level related destructive event

12 reports were issued using sea level records around Sri Lanka to the Disaster Management Center (DMC). The report will be used as scientific evidence for the compensation process of the coastal communities and assets affected by the ocean-based distractive event by DMC.



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தேசிய பாதுகாப்பு மற்றும் அனர்த்த முகாமைத்துவ இராஜாங்க அமைச்சு
State Ministry of National Security and Disaster Management

විද්‍යා මාවත, කොළඹ 07.
வித்யா மாவத்தை, கொழும்பு 07
Vidya Mawatha, Colombo 07.

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ෆැක්ස්/Fax/தொ.ந. : 0112 665 09

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ෆැක්ස්/Fax/தொ.ந. : 0112 665 296
වි.තැ./Email/மின்னஞ்சல் : secoffice@smnd.gov

වෙබ් අඩවිය/Website/இணையத்தளம் : www.drr.dmc.gov.lk

මගේ අංකය / எனது இல / My No: DMC/Miti/Desinventar correspondence/ 2021
ඔබේ අංකය / உமது இல / Your No:
දිනය / திகதி / Date: 2021/03/…

National Aquatic Resources Research …
OFFICE
05 APR 2021

Anojo Seneviratne. 077 2320525

ලේකම්
නාගරික සංවර්ධන වෙරළ සංරක්ෂණ, සහ අපද්‍රව්‍ය බැහැර කිරීමේ හා ප්‍රජා පවිත්‍රතා අමාත්‍යාංශය

ආපදා සම්බන්ධ ජාතික දත්ත පද්ධතියක් ස්ථාපිත කිරීම.

ආපදා සම්බන්ධ දත්ත හා තොරතුරු මත පදනම්ව සැලසුම් සැකසීම, ප්‍රතිපාදන වෙන්කිරීම, ආයෝජනය කිරීම සහ ක්‍රියාත්මක කිරීම, සඵලදායී තිරසර ආපදා අවදානම් කළමනාකරණය සඳහා අත්‍යවශ්‍ය වේ. ඒ අනුව 2005 අංක 13 දරණ ආපදා කළමනාකරණ පනතින් මෙන්ම, සෞභාග්‍යයේ දැක්ම ජාතික සංවර්ධන ප්‍රතිපත්ති ප්‍රකාශනය මඟින් ද අංක 2215/20 , 2021 පෙබරවාරි 16 ගැසට් පත්‍රය මඟින්ද ආපදා සම්බන්ධ තොරතුරු ඇතුලත් ජාතික දත්ත පද්ධතියක් පවත්වාගෙන යාමේ අවශ්‍යතාවය තහවුරු කොට ඒ සඳහා අවශ්‍ය විධිවිධාන ආපදා කළමනාකරණ මධ්‍යස්ථානය වෙත පවරා ඇත.

මේ වනවිට ද ආපදා කළමනාකරණ මධ්‍යස්ථානය, ආපදා සම්බන්ධ තොරතුරු ඇතුලත් සංඛ්‍යාත්මක දත්ත පද්ධතියක් (www.desinventar.lk) හා අවකාශීය තොරතුරු ඇතුලත් දත්ත පද්ධතියක් (www.riskinfo.lk) ලෙස දත්ත පද්ධතීන් දෙකක් යාවත්කාලීන කොට පවත්වාගෙන යමින් අයකිරීමකින් තොරව දත්ත හා තොරතුරු ලබා ගැනීමට පහසුකම් සලසා ඇති අතර මෙම දත්ත පද්ධතීන් දේශීයව මෙන්ම විදේශීයව ද බොහෝ පිරිස් භාවිතයට ගනිමින් පවතී.

මෙම දත්ත පද්ධතීන්ට අමතරව ආපදාවන්ට ලක් වූ ප්‍රදේශ, නිතර ආපදාවන්ට ලක්වීමේ අවදානම් සහිත ප්‍රදේශ, ආපදාවන්ට ලක් වූ පුද්ගලයින්, දේපල, ව්‍යාපාර හා කෘෂිකාර්මික ඉඩම් ආදි සියලු තොරතුරු ඇතුලත් ජාතික ආපදා දත්ත ගබඩාවක් ස්ථාපිත කිරීමේ අවශ්‍යතාව සෞභාග්‍යයේ දැක්ම ජාතික සංවර්ධන ප්‍රතිපත්ති ප්‍රකාශනය මඟින් ද අංක 2215/20 , 2021 පෙබරවාරි 16 ගැසට් පත්‍රය මඟින්ද ප්‍රමුඛතා ගත කොට ඇති බැවින් ඒ සඳහා අවශ්‍ය මූලික ක්‍රියාමාර්ග ආපදා කළමනාකරණ මධ්‍යස්ථානය මඟින් ගෙන ඇත.

සුනාමි, වෙරළ හා සමුද්‍ර ආශ්‍රිත ආපදාවන්ට අදාල තාක්ෂණික ආයතනය ලෙස ඔබගේ අමාත්‍යාංශ විෂය පථය යටතේ ඇති ජාතික ජලජ සම්පත් පර්යේෂණ හා සංවර්ධන කාර්යාංශය හඳුනාගෙන ඇති බැවින් උක්ත ආපදාවන්ට අදාලව අපදාවෙන් බලපෑමට ලක්වන ප්‍රදේශය භෞතික හා මූල්‍යමය හානි මෙන්ම සහන හා වන්දි ලබා දීම සබැඳිව ඔබ ආයතනය සතු තොරතුරු මාසිකව අධ්‍යක්ෂ ජනරාල්, ආපදා කළමනාකරණ මධ්‍යස්ථානය, විද්‍යා මාවත, කොළඹ 07 වෙත හෝ mitigation@dmc.gov.lk වෙත ලබාදීමට කටයුතු කරන ලෙස කාරුණිකව ඉල්ලා සිටිමි.

මෙ සම්බන්ධයෙන් ඔබගේ සහයෝගය ඉතා අගය කොට සලකමි.

Mr. Indika for your necessary action. please
06/04/21

ජෙනරල් කමල් ගුණරත්න (විශ්‍රාමික)
ඩබ්ඩබ්වී ආර්ඩබ්පී ආර්එස්පී යූඑස්පී එන්ඩීසී පීඑස්සී එම්ෆිල්
ලේකම්
රාජ්‍ය ආරක්ෂක හා ආපදා කළමනාකරණ රාජ්‍ය අමාත්‍යාංශය

05/04

පිටපත: අධ්‍යක්ෂ ජනරාල්, ජාතික ජලජ සම්පත් පර්යේෂණ හා සංවර්ධන කාර්යාංශය - අදාළ කටයුතු සඳහා

Pl.
08/04

අභ්‍යන්තර කටයුතු අංශය
உள்ளக அலுவல்கள் பிரிவு
Internal Affairs Division
15 වන මහල, 'සුහුරුපාය', බත්තරමුල්ල.
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රාජ්‍ය ආරක්ෂක අංශය
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15/5, බලදක්ෂ මාවත, කොළඹ 03.
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Disaster Management Division
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Sea Level Observations - September 2023

Prepared by:

K.W. Indika - Research Scientist
National Institute of Ocean and Marine Sciences (NIOMS)

Sea level observations including tidal and extreme events are as following during the month of September 2023.

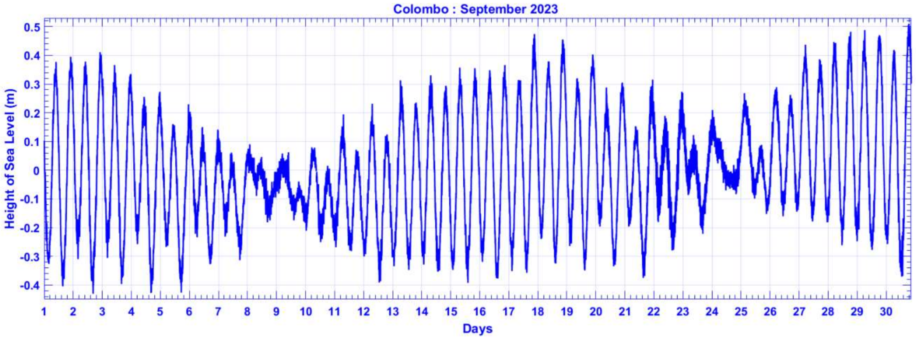


Figure 01: Sea level variation at Colombo

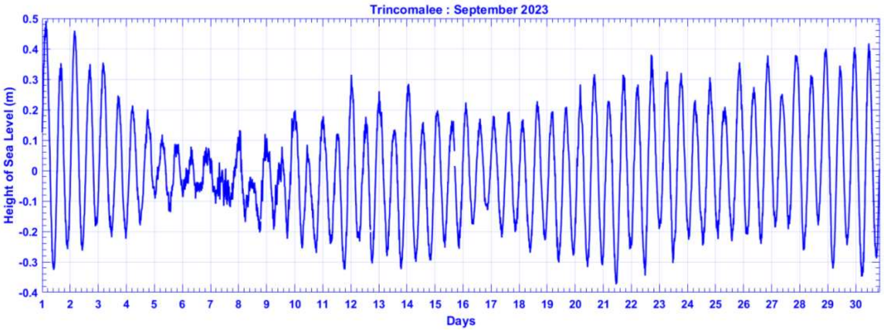


Figure 02: Sea level variation at Trincomalee

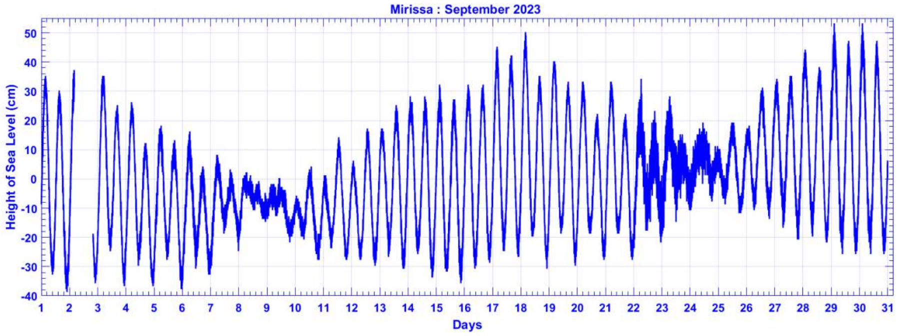


Figure 03: Sea level variation at Mirissa. No sea level records on 2nd September 2023.

According to the observations no destructive events were recorded during the month of September 2023.

Preparing meta data sheet for the development of national oceanographic data base

Title : Sea level monitoring around Sri Lanka
Project ID : TF2023/NIOMS/6.4
Funded by : Foreign and Treasury
Date (Creation/Publication/Revision) : 27/7/2023

Edition :1st Edition

Abstract:Sea Level variation is the short and long-term fluctuation of water level by the forces of astronomical, meteorological, and hydrological properties of the location. Continues recording and reporting of sea level data is vital for understanding the ocean statearound the country.

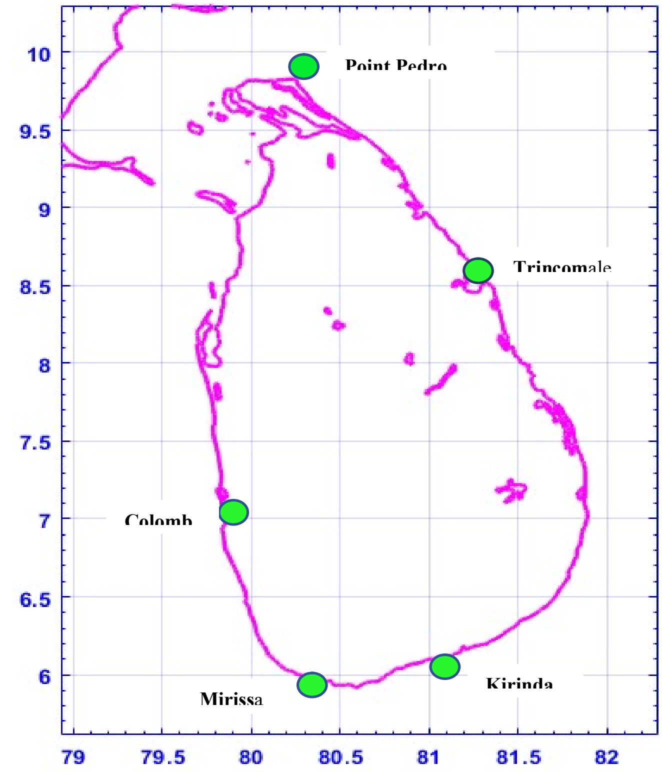


Figure 01: Sea level monitoring network around the country.

The sea level observations can be applied for the model validation, coastal construction, navigation, bathymetric survey, water sports, river mouth management, flood management, researchers, policy planers, planning of climate change adaptation, coastal low lying land management and study of Tide, Tsunami, Cyclone, El Nino, La Nino, Metotsunami, Seasonal variation, sea level rise.

1. Purpose: Establishment of ocean observation facility in real time around Sri Lanka.
2. Status : Ongoing
3. Point of Contact
   3.1. Role : Principle Investigator
   3.2. Designation :Head/NIOMS
   3.3. Organization :National Institute of Oceanography and Marine Sciences
3.4. E-mail : arul@nara.ac.lk
4. Spatial representation type : Excel, txt, Jpg
5. Spatial Resolution :Not applicable
6. Topic Category: Physical Oceanography, Sea level monitoring
7. Geographic Location :Around the countr
8. Geographic Limit : Upper Left Coordinate - 000° 00’ 00.00” N, 000° 00’ 00.00” E (DMS)
   Lower Right Coordinate - 000° 00’ 00.00” N, 000° 00’ 00.00” E (DMS)

9. Temporal Extent
13.1 Start Date: Jun/23/2006
13.2 End Date : Continues
10. Keyword : Sri Lanka, Sea level, Climate change, Seasonal Change, Thermosteric, Halosteric
11. Frequency of update: 1m and 15 Minutes
12. Resource constraints
16.1 Access constraints: Copyright
16.2 User constraints : Copyright
16.3 Other constraints :
13. Language : English
14. Supplemental Information
18.1 Thematic Area: Around Sri Lanka
18.2 Methodology: Time series, Harmonic Analysis, Power Spectral (PSD) analysis, Moving average.
18.3 Status : Analyzed , Row
18.4 Standard : ISO standard
18.5 Equipment Used :Floating tide gauge, Radar Sensors, Hydrostatics Pressure sensor, Rain gauge, Anemometer, Water and atmospheric Temperature gauge
18.6 Major Parameters: Water level height, Atmospheric Temperature, Water Temperature, Atmospheric Pressure, Humidity.
18.7 Sampling size: Not applicable
18.8 Sampling frequency: 1min to 12 hour
18.9 Sampling method: Automated instruments and transmission via Satellite and General Packet Radio Service(GPRS)
18.10 Sampling depth: 1-2m.
19.Published material available sites:

1. https://www.researchgate.net/publication/321484677_Sea_Level_Variability_in_the_East_Coast_of_Male_Maldives
2. https://www.ajol.info/index.php/wiojms/article/view/48252/34614
3. https://www.researchgate.net/publication/322244253_Sea_Level_Variability_in_the_west_coast_of_Sri_Lanka
4. https://www.researchgate.net/publication/295726235_Determination_of_Long_Term_Sea_Level_Rise_in_the_Northern_Indian_Ocean

Conclusions

- The sea level rising trend 2.5-3.2 mm per year.
- Seasonal variation is 18-22 cm per year.
- During the southwest monsoon, the Mix Layer Depth (MLD) and Thermocline range between 34-48 m and 205-210 m, respectively, while during the Northeast monsoon, they vary between 52-61 m and 195-200 m.
- Steric heights exhibit variations from 0.0126 m to 0.0251 m in the southwest monsoon and from 0.0156 m to 0.0201 m in the northeast monsoon.
- Sea level rising rate around Sri Lanka is a little lower than the global sea level trend (Global 3.4mm Ref: NASA).
- The maximum seasonal sea-level variation was recorded from November to December, while the minimum was from August to September on the east coast.
- No destructive cyclonic event was record strong enough to inundate the coast al land. The maximum storm surge height was 10-20 cm.

Output

- Establishing of Sea level and meteorological observations network around the Sri Lanka
- Long term archive of sea level data and information

- Estimation of annual sea level rise around Sri Lanka.
- Identification of extreme sea level event real time and near real time (Strom Surge, Meteotsunami, El Niña, La Niña)
- Data to re-establish Mean Sea Level (MSL).
- Strengthening the national disaster management system of the country. For ocean based disaster prevention, mitigation and management.
- Dissemination quality-controlled data and data product through the NARA web page
- Establishment of sea level data base for research and national developments.
- Conservation of historical data for the research and national development

Outcome

- Quantification of long term sea level rise around Sri Lanka
- Providing information's regarding ocean based destructive event to prevention, mitigation and management to the DMC (Monthly Report).
- Maps and graphs for highly vulnerable coastal area by the sea level rise.
- Minimizing the damages from ocean based destructive events
- Prevention and mitigation of coastal low laying land and communities in ocean based destructive events.
- Preparedness for the future climate change impact. (sea level rise)
- Recommendations for the policy planers of coastal development, land use management and disaster managers
- Commercial benefits for the construction of coastal infrastructures (Break Waters, sand bars, coastal cities, harbors, waste management, river mouth management, saltwater intrusion)

Beneficiaries

- Policy planers of national adaptation plan for Climate change impact, coastal land used planning, coastal resource management, Construction
- Disaster managers of Ocean based disaster prevent, mitigate and manage.
- Researchers and Scientists who interest Oceanic dynamic and climate change.
- General public

Recommendations

- Concern of policy planers and manages of coastal development
- Awareness of people living along the coastal belt
- Protection of highly vulnerable coastal Infrastructures (harbour, port cities, water breaks, sand bars, Jetties, railway track, road, piers)
- Protection of highly sensitive lowland coastal habitats
- Continues monitoring, recording and further studies are required

Constraints

The estimated fuel cost in 2022 was not sufficient for conducting field activities in 2023 due to inflation of economy in the country. The maintenance process of Kirinda and Point Pedro was not able as required because of the spare parts not availability in the local market. The radar sensor need to replaced for the Kirinda station. The fund allocated for purchasing a radar sensor under the instrument budget of 2024.

5.7 INSTITUTE OF POST HARVEST TECHNOLOGY

Head of the Division : Dr. S. Ariyawansa

Strategy: Development of post-harvest technologies, make improvements in aquatic resources quality, safety and value addition

A team of seven Scientists comprising one Principal Scientist, three Senior Scientists and three Scientists is attached to IPHT. IPHT has conducted two research projects under thrust areas of reduction of post-harvest losses and value addition of aquatic resources including fish and seaweeds. In addition, IPHT has provided testing services, training programs and awareness programs on fish quality and safety, processing and value addition technologies for stakeholders. The laboratory maintains accreditation status for microbiological analysis and in 2023 the lab was audited by the Sri Lanka Accreditation Board as per ISO/IEC 17025:2018. In collaboration with NERDC, IPHT has initiated, coordinated and developed a cooling system with proper storage facilities for a multiday fishing boat with the financial assistance of FAO. Following the modification IPHT organized a modified multiday boat launching ceremony, which received patronage from the Prime Minister and other distinguished officials. In assessing the effects of this enhancement, IPHT conducted studies to evaluate the impact for the fish quality and economic feasibility. The findings revealed an 8% reduction in fish quality loss as a direct outcome of the modification. In 2023, an assessment was conducted to analyze post-harvest quality loss in 23 fishery harbors, supported financially by the FAO. The findings revealed an average quality loss of 41.4% across the catches. Notably, ring net fishing exhibited the highest quality loss percentage at 55%, followed by gillnet fishing at 35%, and longline fishing at 15%. The survey data suggests that the annual estimated value of quality loss is 20,199 million LKR, with a physical value loss of 2,241 million LKR. The annual total post-harvest loss value stands at 22,439 million LKR equivalent to 70 million USD. Arrangements were made to upgrade Maldive fish industry and dried fish industry in the Southern province. Follow-up was carried out with the end users who are utilizing the recently developed set of equipment for the hygienic production of Maldive fish in the Southern region of the country. Research was undertaken to assess antibiotic resistance in cultured shrimp and seafood. The findings revealed a concerning trend, with the majority of *E.coli* isolates (38 out of 39) and all Salmonella isolates (8 out of 8) displaying multiple antibiotic resistance. There is an increase in antibiotic resistance, especially in commonly prescribed drugs like Erythromycin and Amoxicillin, crucial for human use. This trend underscores the escalating challenge of bacteria developing resistance to widely used antibiotics, posing a significant threat to public health. Another study focused on the presence of heavy metals (Arsenic, Cadmium, Lead, and Mercury) in fish collected from selected lagoons and fishery harbors. While the levels of these heavy metals in edible parts of selected fish species did not surpass the food safety limits set by international authorities such as WHO and EU/EC 1881/2006 legislations, Arsenic exceeded the specified limits. Fish protein hydrolysate was extracted from fish skin using Papain enzyme derived from papaya fruit. The study suggested that fish protein hydrolysate could serve as a nutrient enhancer for food products, improving their quality by enhancing textural properties. However the utilization of papain extracted from papaya fruit was considered impractical due to the high cost of commercially available papain. Therefore, the next phase of the project aims to simplify the extraction procedure for papain to make it more practical and cost-effective. Additionally, salted fish was prepared using Pothubari(*Canthidermis maculate*) to promote the popularization of this species in the dried fish processing industry in Sri Lanka. The analysis of storage trial samples indicated that vacuum-sealed salted fish, when stored at refrigeration temperature could be preserved for up to four weeks without compromising quality.

PROJECT NO : 4.1

STUDY ON THE STATUS OF CONTAMINATION OF HEAVY METALS, AND POLYCYCLIC AROMATIC HYDROCARBONS (PAH) IN SELECTED HARBORS AND LAGOONS IN SRI LANKA, AND A STUDY ON THE PREVALENCE OF ANTIMICROBIAL RESISTANCE ASSOCIATED WITH MARKET-AVAILABLE CULTURED SHRIMPS

Component 1: Study on the prevalence of antimicrobial resistance associated with market-available cultured shrimps

Responsible officers : K.W.S. Ariyawansa, Pavithra Ginigaddarage, Sudeepa Ranasinghe
Total budget : 1.5Million

Justification

The rise of antimicrobial resistance is a concern worldwide. It's crucial to stop antibiotic resistance from spreading through the use of antibiotics in animals raised for food. Multiple antimicrobial resistance (MAR), on the other hand, is an alarming issue; where bacteria and other microorganisms become resistant to more than one antibiotic. Since there are no emerging new antibiotic drugs, and the existing antibiotics are the only treatment options that are available to human medicine, it is always crucial to conduct routine surveillance and monitoring of the status of the existing antibiotics. Usage of antibiotics in food animals can cause easy accumulation of antibiotic residues inside human bodies, causing antimicrobial resistance in humans. This can lead to the ineffectiveness of existing antibiotics, generating a pre-antibiotic era in human medicine. Although several studies related to antibiotic resistance have been conducted in the global context to study MAR in humans and animals, similar studies in the Sri Lankan context are lacking. Most of such conducted studies are limited to bench work and large-scale industrial application is limited. Especially, studies related to antibiotic studies related to the animal-based food commodities intended for human consumption. Therefore, this study was conducted to evaluate if antibiotic resistance is present in market-available cultured shrimp from the Central Fish Market (CFM), Peliyagoda.

Objectives

- To isolate *E. coli* and *Salmonella* from commercial shrimp and fish samples
- To evaluate the presence of antibiotic resistance, and antimicrobial resistance profile related to *Escherichia coli* (*E. coli*) and *Salmonella* isolated from the CFM
- To evaluate the presence of Multiple Antibiotic Resistance (MAR)

Methodology

Thirty-six (36) shrimp samples and six (6) fish samples were collected from the CFM, Peliyagoda, and brought to the laboratory within isothermal conditions. Collected samples were used to isolate *E. coli* and *Salmonella* bacteria, if present, using ISO 7251: 2005(E) and ISO 6579: 2017(E) methods, respectively. Positive *E. coli* cultures were inoculated into Eosin Methylene Blue (EMB, Oxoid, UK) agar for morphological identification, and isolated positive cultures were grown on Nutrient agar slants for further evaluation on antibiotic sensitivity test (AST). Positive Salmonella cultures were directly transferred from Xylene Lysine Decarboxylase (XLD, HiMedia, Mumbai, India) and Brilliant Green Agar (BGA) to nutrient agar slants. Positive cultures grown on nutrient agar were then transferred to 5mL of nutrient broth, to prepare active *E. coli*and*Salmonella* cultures. Exponentially growing *E. coli* and *Salmonella* cultures bacterial concentrations were adjusted according to the turbidity level of 0.5 McFarland turbidity level, using a McFarland densitometer using sterile water and sterile saline. One milliliter (1 mL) of the positive culture on nutrient broth media was then poured into Muller Hinton Agar (MHA, HiMedia, Mumbai, India) plates and spread evenly until a uniform bacterial lawn was obtained. Six (6) types of antibiotic discs (Oxoid, UK); amoxicillin (30mcg/mL), ampicillin (30mcg/mL), erythromycin (10mcg/mL), tetracycline (30mcg/mL), oxytetracycline (30mcg/mL) and chloramphenicol

(30mcg/mL) were placed on MHA using an antibiotic disc dispenser. A sterile disc was used on each plate as a negative control. Positive cultures of *E. coli* ATCC 25922 and ATCC 14028 were used as positive controls for each test. MHA plates were incubated at 37°C for 18±2 hrs, and the diameters of the inhibition zones formed were measured using a digital vernier caliper. The average diameter for each antibiotic was taken as the diameter of the inhibition zone for the particular antibiotic, and the diameters were then compared against Clinical Laboratory Standards Institute (CLSI) guidelines, 2020. The status of the inhibition zone was assessed as resistant, sensitive or intermediate based on the CLSI guidelines for *E. coli* and *Salmonella*.

Results

Thirty-four (34/36) shrimp samples and five (5/6) fish samples were positive for *E. coli*.*Salmonella*were detected only in eight (8/36) shrimp samples. No fish samples were positive for *Salmonella*.

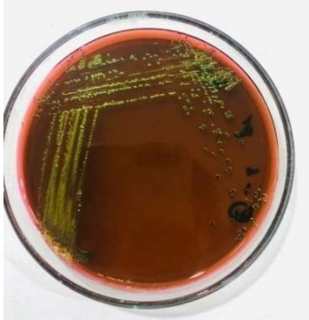


Figure 1: Positive *E. coli* colonies on EMB agar

Figure 2: Positive *Salmonella* colonies on XLD agar

Thirty-seven (37/39) *E. coli*isolates were resistant to erythromycin, showing 94.87% resistance. All eight *Salmonella* samples were resistant to erythromycin, showing 100% resistance. *E. coli* resistance was shown by amoxicillin (27/39), ampicillin (20/39), oxytetracycline (20/39), tetracycline (18/39), and chloramphenicol (5/39). *Salmonella* resistance was shown by amoxicillin (5/8), ampicillin (2/8), oxytetracycline (1/8), tetracycline (3/8), and chloramphenicol (3/8).

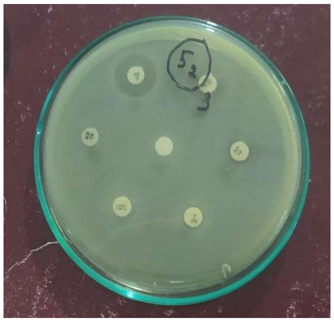


Figure 3:MAR in *E. coli* culture on MHA

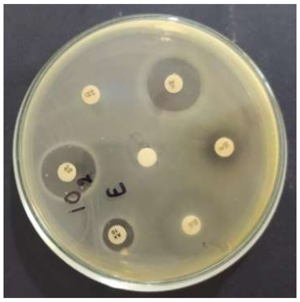


Figure 4: MAR in a *Salmonella* culture on MHA

Table 1: Resistance denoted by *E. coli*

Antibiotic	Resistant percentage
Amoxicillin	69.23%
Ampicillin	51.28%
Erythromycin	98.87%
Oxytetracycline	51.28%
Tetracycline	46.15%
Chloramphenicol	12.82%

Table 2: Resistance denoted by *Salmonella*

Antibiotic	Resistant percentage
Amoxicillin	62.50%
Ampicillin	25.00%
Erythromycin	100.00%
Oxytetracycline	12.50%
Tetracycline	37.50%
Chloramphenicol	37.50%

Table 3: MAR Index of E. coli

MAR Index	Frequency
0.16	1
0.50	33
0.67	4
0.83	1

Table 4: MAR Index of *Salmonella*

MAR Index	Frequency
0.33	5
0.67	3

Conclusions

It was evident that the majority of the *E. coli* isolates (38/39) and all (8/8) *Salmonella* isolates showed multiple antibiotic resistance, indicating an alarming risk of commercially available shrimp and seafood to human health.

An alarming surge in antibiotic resistance has been observed, particularly in commonly prescribed drugs for human use, such as Erythromycin and Amoxicillin. This concerning trend highlights the growing challenge of bacteria developing resistance to these antibiotics, which are widely utilized in medical practice. The increased resistance poses a serious threat to public health, emphasizing the need for effective strategies to address and mitigate the rising issue of antibiotic resistance to safeguard the efficacy of these crucial medications for human health.

Component II: Study on the contamination status of Heavy metalsin fish from selected harbors and lagoons in Sri Lanka

Responsible officers : K.H.S. Nirbadha, K. Piyasiri

Justification

Aquatic ecosystems are often polluted by different types of contaminants, at different levels and from diverse sources. Among them, heavy metals occupy an eminent place due to their toxicity and non-biodegradability. Lagoons are identified as one of the most sensitive and productive ecosystems in Sri Lanka. Local communities in the lagoon areas mainly depend on the ecological, economic, and social benefits from the lagoon including fishing, tourism, crab, and prawn rearing etc. In fact, a proper assessment of the distribution of toxic heavy metal contaminants in lagoons is important for pollution control in the lagoons. Hence, this study aimed at investigating the distribution of several selected heavy metals (As, Cd, Hg and Pb) in the fish samples collected from selected lagoons. In the recent years, world consumption of fish has increased simultaneously with the growing concern of their nutritional and therapeutic benefits. In addition to its important source of protein, fish typically have rich contents of essential minerals, vitamins and unsaturated fatty acids. However, fish can accumulate heavy metals and other organic substances in their tissues by absorption along the gill surfaces and kidney, liver and gut tract wall to higher levels than environmental concentration known as bio accumulation. In this context, this research was carried out to acquire baseline data on several selected Heavy metals, in fish tissue from selected lagoons in Sri Lanka.

Objectives

- To acquire baseline contaminant profile on selected heavy metals in fish tissue
- To determination of levels of contamination/accumulation of selected heavy metals in fish tissue, from selected lagoons

Methodology

Fish, were collected from the selected Lagoons (Negombo, Chilaw, Kalpitiya, Jaffna, Mulathiv and Rekawa) and fishery harbors (Negombo, Chilaw, Kalpitiya, Jaffna, Kirinda, Hambanthota , Mirissa and Dikovita) (Table 01). All the laboratory experiments were done at the Analytical Chemistry Laboratory (ACL), IPHT, NARA. Collected samples were digested using CEM/MARS XP-1500+ microwave oven for the microwave assisted digestion with 99% HNO_3 and 99% HCl (3:1). The metals such as As, Cd and Pb determine using an in-house graphite furnace atomic absorption spectroscopic (GF-AAS) method, based on AOAC 990.10 (AOAC, 2002a) with a Varian GTA 120 atomic absorption spectrometers, equipped with a computer-controlled auto sampler (Varian PSD-120, Varian Australia Ltd, Victoria, Australia). Total Hg level determine using a cold vapor system (CV-AAS), based on AOAC 971.21 (AOAC, 2002b) with a Varian VGA 77.

Table 01: Fish species availability in each location

#	locations	Fish Species								
		Carangoidesarmatus	*Chanoschanos*	*Etroplussuratensis*	*Oreochromis mossambicus*	*Oreochromis niloticus*	*Lutjanus fulviflamma*	*Mugil cephalus*	*Scylla serrata*	*Portunuspelagicus*
1	Negombo (L)	+	+	+	+	-	+	+	+	-
2	Chilaw (L)	+	+	+	-	-	-	+	+	-
3	Kalpitiya (L)	+	+	+	+	+	+	+	+	+
4	Jaffna (L & H)	+	+	+	+	+	+	+	+	+
5	Mulathivu (L)	+	+	+	+	+	+	+	+	+
6	Kirinda (H)	+	-	-	-	-	+	-	-	-
7	Rekawa (L)	+	+	+	+	+	+	+	+	-
8	Mirissa (H)	+	-	-	-	-	+	-	-	+
9	Dikovita (H)	+	+	+	-	+	+	+	+	+

L-Lagoon, H-Harbor

Results

Table 02: Heavy metals contents(mg/kg = ppm) in analyzed fish sample

		Carangoidesarmatu	*Chanoschanos*	*Etroplussuratensis*	*Oreochromis*	*Oreochromis*	*Lutjanus fulviflamma*	*Mugil cephalus*	*Scylla serrata*	*Portunuspelagicus*
Negombo (L)	As	1.06	1.02	1.52	1.61		0.98	2.13	2.48	
	Cd	ND	ND	ND	ND		ND	ND	0.61	
	Pb	0.09	0.28	0.51	0.69		0.09	0.88	1.04	
	Hg	0.91	0.87	0.66	0.51		0.48	0.98	1.07	

Chilaw (L)	As	1.11	0.96	1.78				1.94	1.86	
	Cd	ND	ND	ND				ND	0.55	
	Pb	0.07	0.19	0.48				0.92	1.07	
	Hg	0.71	0.77	0.97				0.89	0.91	
Kalpitiya (L)	As	0.54	0.93	0.85	0.95	0.95	0.83	1.24	2.17	1.05
	Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Pb	0.06	0.33	0.21	0.18	0.19	0.12	0.85	0.97	0.52
	Hg	0.60	0.47	0.57	0.39	0.29	0.51	0.97±	1.06	0.66
Jaffna (L & H)	As	0.61	1.08	1.10 ± 0.10	0.82 ± 0.04	0.78± 0.02	1.02± 0.04	2.15± 0.02	2.23± 0.04	0.84
	Cd	ND	ND	ND	ND	ND	ND	ND	0.91	ND
	Pb	0.59	0.87	0.39	0.36	0.58	0.09	0.89	0.97	0.54
	Hg	0.81	0.91	0.66	0.34	0.47	0.56	0.99	1.18	0.69
Mulathivu (L)	As	0.64 ± 0.04	0.99	0.89	0.67	0.92	0.55	1.14	2.11	0.95
	Cd	ND	ND	ND	ND	ND	ND	ND	0.71	ND
	Pb	0.64	0.91	0.41	0.46	0.65	0.10	0.89	0.99	0.54
	Hg	0.79	0.84	0.59	0.31	0.39	0.92	0.99	0.92	0.69
Kirinda (H)	As	0.58					0.71			
	Cd	ND					ND			
	Pb	0.51					0.81			
	Hg	0.58					0.83			
Rekawa (L)	As	0.64	0.99	0.89	0.67	0.92	0.55	1.14	2.11	
	Cd	ND	ND	ND	ND	ND	ND	ND	ND	
	Pb	0.64	0.91	0.41	0.46	0.65	0.10	0.75	0.86	
	Hg	ND	ND	ND	0.24	0.55	0.78	0.99	0.57	
Mirissa (H)	As	0.55 ± 0.05					0.48			0.51
	Cd	ND					ND			ND
	Pb	0.39					0.55			0.09
	Hg	0.29					0.48			0.52
Dikovita (H)	As	0.89	0.67	0.92	0.55		0.48	1.14	1.09	0.59
	Cd	ND	ND	ND	ND		ND	ND	0.52	ND
	Pb	0.41	0.46	0.65	0.19		0.21	0.89	0.87	0.51
	Hg	0.59	0.31	0.39	0.97		0.89	0.99	0.88	0.49

ND-Not Detected

Conclusions

The four heavy metal levels in selected fish species tissues (Edible parts) did not exceed the food safety limits specified by international authorities (WHO and EU/EC 1881/2006 legislations) except Arsenic. The total Arsenic (As) level represents both Inorganic and Organic Arsenic levels. Inorganic arsenic compounds are highly toxic while organic arsenic are less harmful to health. Since Sri Lanka does not possess relevant equipment to quantify Inorganic Arsenic, Total As levels are given in the results.
Due to budget constraints, we were unable to fully achieve the project objectives. Therefore, the project will be extended into the year 2024.

PROJECT NO : 4.2

INTRODUCTION OF READY TO EAT SNACK TYPE AQUATIC RESOURCE-BASED PRODUCTS AND SALTED DRIED FISH PRODUCTS

Total Budget	:	Rs 1.0 Million
Component 1	:	Introduction of ready to eat snack type aquatic resource-based product
Responsible Officers	:	D.S.Ariyarathna, M.Paththuwearachchi

This is a collaborative project between NARA and the Department of Bio-Systems Technology, Faculty of Technology, University of Sri Jayewardenepura and this project consists with two phases

Phase -1; Extraction of fish protein using Papen enzyme extracted from the papaya fruit and characterization of the extracted protein.

Justification

Currently, there has been a rise in fish consumption because of the growing demand from individuals. Nevertheless, it is important to acknowledge that fish resources are finite. Fish serves as a remarkable source of protein that can be easily digested, in addition to containing polyunsaturated fatty acids, vitamins, and minerals.

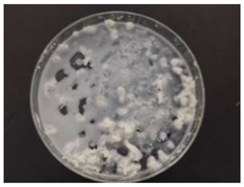
Fish protein hydrolysates (FPH) are derived from fish or fish material through the process of protein hydrolyzation, which involves breaking down the proteins found in fish tissues into smaller components such as peptides and amino acids. Consequently, FPH represents a blend of proteins. Extensive research has demonstrated that FPH exhibits a variety of enhanced characteristics in comparison to the original protein source. These include superior functional properties as well as bioactive properties like anti-oxidative or anti-hypertensive activity.

This study was designed with the intention of utilizing and enhancing the value of fish waste in order to address the increasing demand for fish and reduce the wastage of this valuable resource.
Enzyme hydrolysis is widely recognized as a prominent technique employed for protein extraction. In this study, the feasibility of utilizing papain enzyme derived from papaya fruit was also investigated as an option to the high cost associated with enzymes available in the market.

Objectives

- Extract the papain enzyme using papaya fruits
- Extract the protein hydrolysate using papain enzyme
- Estimate the yield of fish protein hydrolysates form fish waste
- Characterization of fish protein hydrolysate

Results


Papaya latex


Dried papaya latex powder


Purification of papain enzyme


Extracted enzyme


Fish waste (Fish skin)


Hydrolyzing (Fish skin + Papain enzyme)


Separation


Dried fish protein powder

Characterization of extracted protein powder

In the process of protein characterization, some assessments were conducted. These include evaluating water holding capacity, analyzing oil holding capacity, examining ash content, determining crude fat levels, and measuring moisture content. These comprehensive analyses contribute to a thorough understanding of the protein's properties and composition (refer table below).

Proximate analysis	
Parameter	%
Moisture	7.31
Protein	89.5
Ash	2.5
Fat	0.1
Other parameters of characterization	
Parameter	%
Water holding capacity	5.5 ml/g
Oil holding capacity	3.5 ml/g
Yield % of purified papain enzyme (%)	4.3
Yield of (%) Fish Protein hydrolysate powder	10.5

Conclusions

The study results indicate that fish protein hydrolysate has the potential to serve as a nutrient enhancer for food products, enhancing their quality by improving texture properties. The extraction of papain from papaya fruit holds significance due to the high cost of commercially available papain. Consequently, in the next phase of the project, we aim to simplify the extraction procedure for papain to ensure practical and cost-effective production. This innovative approach seeks to extract valuable proteins from fish byproducts, contributing not only to waste reduction but also to the generation of economically feasible products with potential applications in various industries.

Component II Introduction of heavy salting method for preparation of dried fish using Pothubari fish *(Canthidermis maculata* (Bloch, 1786)/Rough triggerfish/Muhudukukula)

Justification

The heavy salting method is an alternative technique for producing dried fish without the need for exposure to sunlight or the use of mechanical dryers. In this method, the fish is dried within a closed system, eliminating the risk of cross-contamination from flies, animals, and dust that is commonly encountered during open drying. As a result, the loss of freshness, quality, and weight of the fish is significantly reduced compared to traditional salting and sun drying methods. Consequently, dried fish products processed using this method have gained popularity in the European market.

The Pothubari fish, also known as the Rough triggerfish or Muhudukukula (*Canthidermismaculata* (Bloch, 1786)), is a plentiful fish variety commonly found in fish markets along the southern coastal line. These fish are brought to the market in a very fresh condition. However, other fish varieties such as skip jack tuna and Indian scads are only used in the dried fish processing industry after they have lost their quality. The traditional practice of sun drying negatively affects the quality of the final product and leads to economic losses, especially during unfavorable weather conditions. While Sri Lankan people are accustomed to consuming salted and sundried fish, Europeans prefer salted fish that has not been dried under sunlight. Therefore, the introduction of a salted drying method in the industry could open up new opportunities in the export market and contribute to earning foreign exchange.

Objectives

Popularization of heavy salting method in dried fish processing industry

Results

MuhuduKukula fish

Salting

Final product

Desalting

Desalted dried fish

Comparison of heavy salted fish and traditional salted dried pothubari fish

Parametere	Heavy salted fish	Traditional salted dried
Weight loss	32%	54%
Moisture content	50.07%	39.38%
Water activity	0.585	0.576
Protein content	41.48%	46.70%
Salt content	17.44%	14.66%
After desalting salt content of the product	10.47%	

Conclusions

The analysis of the storage trial samples indicated that the vacuum-sealed heavily salted fish, when stored at a refrigeration temperature of 14°C, could be preserved for duration of four weeks without any compromise in quality. This research holds significant importance in guaranteeing the presence of high-quality dried fish in the market. It aims to sustain the production of dried fish even in adverse weather conditions, thereby minimizing post-harvest losses of fish and ensuring uninterrupted livelihoods for fisherfolk. Creating a platform to utilize the good quality fish waste and under-utilized fish for value addition and popularize the fish base products in the local market and export market.

- Two awareness programs were conducted to promote the production of salted pothubari fish among 80 fisherwomen and men in the Negombo and Trincomalee

Component III: Evaluation of material losses of anchovies (*Engraulidae*) during washing and cooking

Officer responsible: P.S. Jayasinghe, G.J. Ganegama Arachchi

Introduction:

Anchovies undergo significant contamination with sand during the collection and drying processes. Drying them on sand or mats exacerbates sand contamination, while gillnet fishery contributes to impurities as anchovies, harvested from gillnets, come into contact with sand. Consequently, the drying process increases impurities, adds weight to the anchovies, and impacts market prices.

To address this issue, anchovies undergo repeated rubbing and washing during cooking or product development to eliminate sand and impurities. However, this washing process also results in the removal of anchovy residues, reducing the overall weight and nutrient content, including protein, fat, and minerals. The elevated impurity levels adversely affect both the quality and quantity of the anchovies, ultimately influencing market prices. Hence, this study aims to investigate the quantity and quality losses incurred during the washing process of dried anchovies.

Objectives:

- To determine weight losses occur during washing and cooking process
- To determine nutrition losses occur during washing and cooking process

Methodology

Eight anchovy samples were purchased from both Negombo (4), Chilaw(4) areas and 4 imported samples from Fort. Each sample was then divided into three portions, with each portion weighing approximately 300g.Subsequently, the samples were beheaded, and the head and body parts were weighed separately for all 36 portions. Following this, one portion was placed in a snail pan, and approximately 300ml of water was added. The sample was then rubbed and washed for 2-3 minutes. After washing, the sample was removed from the water, and the remaining water was filtered through a filter pan to collect anchovy residues. The remaining water was then washed in a snail pan to separate and collect sand. The resulting components organic matter, sand, and anchovy residues were transferred into glass bottles, while the washed anchovies were placed in a tray. Subsequently, the components were dried in an oven at 105°C to eliminate water content. Finally, the weights of the organic matter, sand, anchovy residues, and dried anchovies were recorded. This washing and drying process was repeated for the 2nd, 3rd, and 4th washings for all samples (Refer Figure 4).

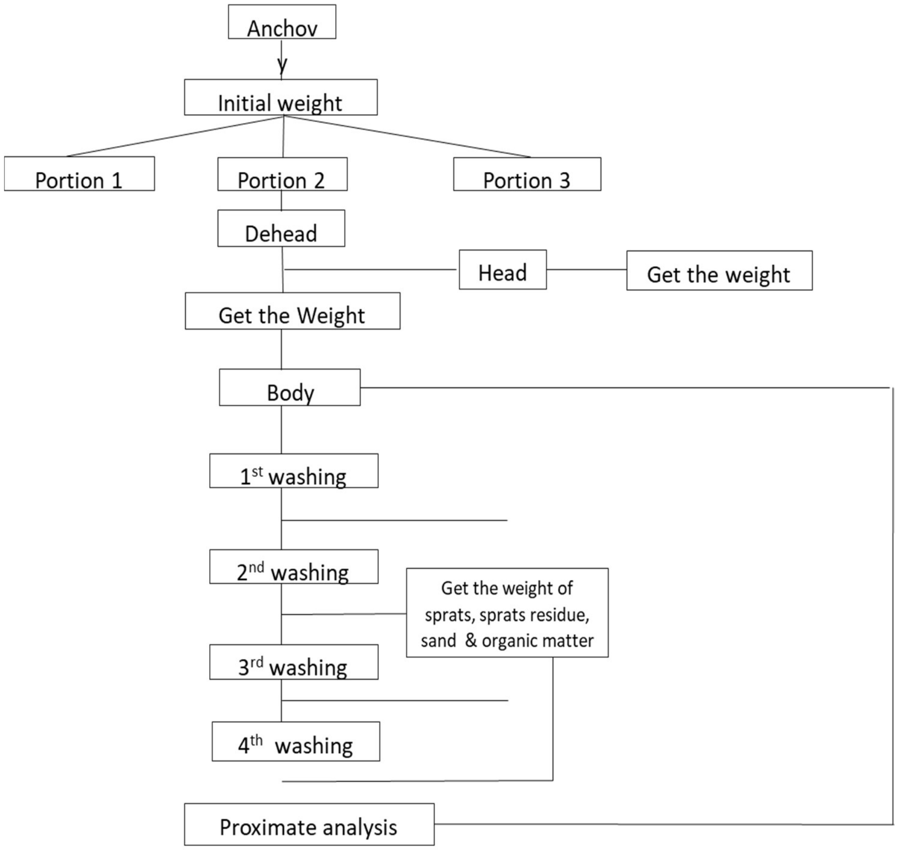


Figure 4: Flow chart of Methodology:

Results

The yield of beheaded raw dried sprat (before washing) collected from Negombo, Chilaw, and retailing were 81.23, 88.3 and 79.02%. After four washing stepsof beheaded anchovies, the total sand content of Negombo, Chilaw, and retail shop samples were 3.524±0.21, 4.447±1.52, and 3.696±2.06%, respectively. Losses of edible material of cleaned Anchovies (dry weight basis) after washing four times, in Negombo, Chilaw, and retail samples were 14.6±5.92, 9.01±3.53, and 6.81±27.49%, respectively. Yield of beheaded and cleaned edible anchovies which were from Negombo, Chilaw and retail shop, after four washings were 52.30, 61.47and 70.23 % respectively.The protein content of beheaded Anchovies after cleaning and washing Negombo, Chilaw, and retail samples were 18.92, 34.48~~,~~ and 17.76%, respectively. The reduction of fat in Anchovies after washing with four times Negombo, Chilaw, and retail samples were 1.0912, 1.083, and 1.5288%~~,~~respectively.

Conclusions

Present study indicated high level of losses in edible materials of dried anchovies during repeat washings of anchovies in order to remove sand particles in dried anchovies. Therefore, valuable nutrients in dried anchovies are also lost owing to rigorous washing process. It is recommended to adopt proper methods to prevent the high level of sand contaminations in dried anchovies during handling and drying of anchovies.

Testing Services of IPHT

The laboratory maintains accreditation status for microbiological analysis and the lab was audited by the Sri Lanka Accreditation Board as per ISO/IEC 17025:2018.A total of 560 samples were analyzed for microbiological (486) and chemical (74) quality. Relevant to these samples, 232 test reports were issued by IPHT and the total income from testing services was LKR 3,536,330.00. Forty percent (40%) of total revenue was remitted to NARA as a royalty payment.

Local trainings attended

No	Training (Local / Foreign)	Duration	Venue	Participants
01	Awareness and unlocking the standard requirements of ISO 17025:2017	25th and26th January, 2023	Hector Kobbekaduwa Agrarian Research and Training Institute	Janitha Meepearachchi
02	Preparation of the QMS documents	11th and 12thJuly 2023	CARITAS	Janitha Meepearachchi
03	Training on quality assurance as per ISO/IEC 17025:2017	28th November 2023	Hector Kobbekaduwa Agrarian Research and Training Institute	Dr.S.Ariyawansa P.Ginigaddarage K.G.S Nirbadha K.H. KaumiPiyasiri R.A.S.S. Ranasinghe Pahan Pabasara Janitha Meepearachchi

Training/Awareness programs conducted during the year 2023

Date	Name of the program	Aim	Participants	Place
20/02/2023	Awareness on the seaweeds and the production of seaweed-based products	To upgrade the knowledge	Students of the University of Peradeniya	NARA
17/06/2023 to 20/06/2023	Documentary Awareness on the production of Maldive fish using upgraded method	To upgrade the livelihood of the community	Maldive fish producers in the area	Dickwella/ Matara
13/09/2023	Technology transfer for the production of Heavy salted dry fish	To introduce the new technology	Dried fish producers of Kuttiduuwa - Negombo	Kuttiduuwa - Negombo
30/11/2023	Identification of fish, quality and safety issues related to fish	To upgrade the knowledge	40 Nos. trainee PHIs - Galle District	NARA
05/12/2023 – 08/12/2023	Post Harvest Technology and Preparation of Fish and Seaweed Products	Introducing a source for generating income	40 Nos. women	District Secretariat - Trincomalee
15/12/2023	Proper on board handling and handling after unloading	To reduce post harvest quality loss	31 Nos Multi-day boat owners, skippers and crew members	Vellamankara - Wennappuwa
20/12/2023	Identification of fish, quality and safety issues related to fish	To upgrade the knowledge	99 Nos. trainee PHIs - Kaluthara District	NARA

Exhibitions

1. Science exhibition (Sciamatics 2023) at Musaeus Collage, Colombo 09 - (10/11/2023)
2. Mahapola exhibition at Ja-Ela – (14/12/2023 – 17/12/2023)

Publications

1. H. Ginigaddarage, G.J. GanegamaArachchi, K.W.S. Ariyawansa and C.M. Nanayakkara. Prevalence, isolation and identification of histamine forming bacteria in selected nodes of the supply chain of Sri Lankan Yellowfin tuna. ***Journal of National Science Foundation Sri Lanka***. 2023.51(2): 215-223.
2. Sujeewa Ariyawansa, Kuruwitage N. Gunawardana, Muditha M. Hapudeniya , Nimal J. Manelgamage, Chinthana R. Karunarathne, Roshan P. Madalagama , Kamalika H. Ubeyratne , Darshana Wickramasinghe ,Hein M. Tun , Peng Wu , Tommy T. Y. Lam and Olivia S. K. Chan. (2023). One Health Surveillance of Antimicrobial Use and Resistance: Challenges and Successes of Implementing Surveillance Programs in Sri Lanka ***Antibiotics*** 12(3): 446.
3. Kamalika H. Ubeyratne, Roshan P. Madalagama, Xin Liu, Sujatha Pathirage, Sujeewa Ariyawansa, Matthew K.L. Wong, Hein M. Tun 2023. Phenotypic and Genotypic Characterization of Antibiotic-Resistant Salmonella Isolated from Humans, Aquaculture, and Poultry in Sri Lanka. ***Journal of Infection and Public Health***. 2023.
4. J.M.V.D.B. Jayasundara, R.M.L.S. Ramanayake, H.M.N.B. Senarath, H.M.S.L. Herath, G.M.R.I. Godaliyadda, M.P.B. Ekanayake, H.M.V.R. Herath, S. Ariyawansa. 2023. Deep learning for automated fish grading. ***Journal of Agriculture and Food Research.***14(2023).
5. P.H. Ginigaddarage, G.J. Ganegama Arachchi, K.W.S. Ariyawansa, G.P. Roshan, J.H. Meepearachchi and C.M. Nanayakkara, 2023. Effect of storage temperature on bacterial growth and histamine formation in Yellowfin tuna, National Aquatic Resources Research and Development Agency Annual Scientific Sessions – 2023, p. 55
6. K.V.D.M. Bhagya, R.A.S.S. Ranasinghe, P.H. Ginigaddarage, J. Rajeetha, G.P. Roshan, J.H. Meepearachchi and S. Ariyawansa, Isolation and identification of spoilage microorganisms from Indian Scad (*Decapterus russelli*) stored at chilled temperature and evaluation of spoilage potential, National Aquatic Resources Research and Development Agency Annual Scientific Sessions – 2023, p. 56
7. L. Rajendren, P.H. Ginigaddarage, R.A.S.S. Ranasinghe, S.L. Panoshan, G.P. Roshan, J.H. Meepearachchi, R. Pereraand S. Ariyawansa, Isolation and identification of spoilage microorganisms from Indian Scad (*Decapterus russelli*) stored at chilled temperature and evaluation of spoilage potential, National Aquatic Resources Research and Development Agency Annual Scientific Sessions – 2023, p. 57
8. Bhagya, K.V.D., Ranasinghe, R.A.S.S., Ginigaddarage, P.H., Rajeetha, J., Roshan, G.P., Meepearachchi, J.H.,Ariyawansa, K.W.S., 2023. Antimicrobial resistance profile of *Escherichia coli* and *Salmonella* isolated from shrimpin Central Fish Market, Peliyagoda Sri Lanka, in National Aquatic Resources Research and Development AgencyAnnual Scientific Sessions – 2023. p. 56.
9. P.S. Jayasinghe, Himasha, Keerthini, G. Ganegamarachchi R. Perera (2003) Evaluation of quality and quantity losses of edible (*Engraulidae*)during preparation of cooking and processing"Proceedings of Annual Scientific Session in National Aquatic Resource Research and Development Agency
10. Jayasinghe, P.S., Himasha, L. F. , Keerthini, S., Ganegama Arachchi, G. J., and Perera, R. (2023). Evaluation of quality and quantity losses of edible Anchovies (Engraulidae) during preparation of cooking and processing. Proceedings of NARA Scientific sessions, 2023.

Supervision of undergraduates

	University	Name of the student	Degree program
1	Rajarata University	Hasini Tharuka	Food Technology
2	University of Kelaniya	P.T.K.Pathirana	Microbiology
3	University of Kelaniya	J.M.K.M.Bandara	Environmental conservation & Mgt
4		R.M.S.H.Dissanayaka	
5		S.R.A.R.Fernando	
6		T.M.T.T.Gunasekara	

7		H.J.M.D.M.Jayawardhena	
8		K.A.D.K.Nimeshika	
9		N.V.S.Nimthara	
10		B.G.K.N.D.B.Samaraweera	
11		W.E.B.K. Sithumini	
12		R.M.L.T.Rathnayaka	
13	University of Jaffna	Francis Dilukshika	Food production Technology
14		Francis Dilaniruth	
15	University of Jaffna	L.H.Himasa	Fisheries Science
16	University of Jaffna	D.H.J.Madhushika	
17		G.R.R.J.N.Rathnayake	
18		R.Krishnathasan	
19		K.Puwaneshwaran	
20		S.Sivspriya	
21		VithusikaYogarajah	
22		U.M.C.P.Bandara	
23	University of Sri Jayawardhanapura	M.P.G.H.Thilakarathne	Zoology
24		N.F.Rasna	
25		E.R.G.Nayomi	
26		W.M.S.S.Wijekoon	
27	University of Sri Jayawardhanapura	OshadiMedagoda	
28	University of Kelaniya	K.S.D.Liyanage	Microbiology
29		E.A.H.B.Elpitiya	
30		W.M.S.Kamchana	
31		M.G.N.Wathsala	
32		W.G.M.P.Dissanayake	
33		K.D.L.G.Kongasdeniya	
34	Wayamba University	R.M.D.Rathnayake	Biotechnology
35	University of Kelaniya	G.J.Weerasinghe	Chemistry
36		B.L.R.S.A.Jayarathne	
37	University of Kelaniya	K.K.G.N.Yasandhika	
38		J.AkshaniSathruwani	
39	University of Jaffna	H.M.Ishara Kanchana	Food Production Technology
40	University of Jaffna	Lavanya Rajendren	
41		W.K.S.Soysa	
42	University of Jaffna	K.V.D.Madushani Bhagya	
43		U.Sanduni Nisansala	
44		H.S.Wanigasinghe	
45	University of Ruhuna	M.W.E.M.N.De Silva	Food Science & Technology
46	Eastern University	S.M.G.D.S.Sipkaduwa	Biotechnology
47	Ocean University	M.R.F.Rishadha	Aquaculture & Sea Food Technology
48	University of Sri Jayawardhanapura	W.T.D.A.Sandeepani	Zoology
49		J.D.A.U.Senarathne	

50		W.H.K.E.Senevirathne	
51		P.G.D.D. Tharuka	
52	Ocean University	R.P.D.A.N.Rajapaksha	Aquaculture & Sea Food Technology
53		K.S.Pathira	
54		L.G.G.K.Sandapeum	
55		Ms.Alanka Dharmasiri	
56	University of Kelaniya	M.M.Prabhani	Chemistry
57	Eastern University	S.M.G.D.S.Sipkaduwa	Biotechnology

Other Involvements

The officers from IPHT attended several meetings contributing to the development of the National Strategic Plan for Combating Antimicrobial Resistance in Sri Lanka for the period 2023-2028.

5.8 SOCIO-ECONOMIC AND MARKETING RESEARCH DIVISION

Head of the Division : Mr. K.H.M.L. Amaralal

The main functions of the division include social economic and marketing studies in the fishing industry, including the welfare of the fishermen and their dependents, analysis of fish marketing system and its impact on consumers.

Research projects conducted in the year 2023

Programme	Project	Responsible Officer/s	Duration
Socio-economic and Marketing Research Division	Value Chain Analysis of Skipjack Tuna Fishery in the North-west and West coasts of Sri Lanka	K.H.M.L.Amaralal K.P.G.L.Sandaruwan D.W.L.U.De.Silva A.Bandara M.T.N.Thilakarathna H.P.D.A.Lakmali	One year
	Information Service- Fisheries Information Centre (FIC) of NARA and Industry Outlook	K.H.M.L.Amaralal H.P.D.A.Lakmali	Continuous

Under the above projects, following activities were performed during the year according to the activity plan.

I. Data collection
II. Data Sorting &Analysis
III. Report Preparation/Annual Publication

PROJECT NO : 8.1

VALUE CHAIN ANALYSIS OF SKIPJACK TUNA FISHERY IN THE NORTH-WEST AND WEST COAST OF SRI LANKA

Responsible Officer/s: K.H.M.L.Amaralal, K.P.G.L.Sandaruwan, D.W.L.U.De.Silva, A.Bandara, M.T.N.Thilakarathna and H.P.D.A.Lakmali

Introduction

Marine fisheries are significantly contributed to the total annual fish production and consumption of the country. Marine species such as tuna, mackerel and seer, snapper, and reef fishesare common in the catch composition. In 2020, marine fish and fishery products export has contributednearly 2% to the country's total exports while earning 190 Million LKR, although it showed a decreased by 28% compared to 2019 due to Covid-19 pandemic (EDB, 2023).Tuna species dominated in marine fish exports of the country butseveral species of tuna including Blue-fin, Yellow-fin, Big-eyed and Skipjack tunas were high valued.Skipjack tuna (Katsuwonuspelamis) is one of widely consumed species worldwide and featured as long-distance swimmers that often usedfor canning industries. Further, Skipjack tuna is used for production of fresh and frozen products for consumption and economically valuable traded commodity in international markets (Miyake et al., 2010; Grande et al., 2014).

Although skipjack tuna is commercially important to the country,continuous deterioration of physical qualityof landed fish has been examined and voiced over the years mainly due to the improper post-harvest handling which plays a vital role in ensuring quality, food safetyand price of fish throughout the entire value chain.Therefore, the concept of value chain analysis can be used as a tool to identify need requirementsto upgrade the overall tuna value chain(Rosales et al., 2017) of the country. Even though many scholars have often focused on biological aspectsyet little attention has been paid to identify upgrading needs to reduce post-harvest lossesthrough the entire fish value chain in Sri Lanka which this study aims to enhance the efficiency of skipjack tuna value chain of the country.

Objectives of the study

- To examine the gilling and gutting practices of skipjack tuna in north-west and west coasts marine fisheries in Sri Lanka
- To identify influencing factors in onboard gilling and gutting of skipjack tuna during the fishing operations

Methodology

The value chain concept was introduced by Michael Porter in his book Competitive advantage: Creating and Sustaining Superior Performance (Porter 1985). He defines "Value Chain'' as a representation of a firm's value-adding activities, based on its pricing strategy and cost structure. Value chains encompass the full range of activities and services required to bring a products or services from its conception to sale in its final market whether local, national, international or global. This study aims fishers the starting node of the skipjack tuna value chain because the quality, quantity and price of fish in entire value chain is mostly affected with their onboard handling of fish. Beruwala and Negombo fishery harbours were selected as the study area of the research study. A questionnaire survey was conducted during the time period of January to June in 2023 for primary data. Apart from that two consultative workshops with skippers and multiday boat owners, one each, were conducted in Beruwala and Negombo for additional data. A total sample of 40 IMUL boat owners/ skippers in Negombo and Beruwala were selected using the purposive sampling technique. Collected data were summarized and analyzed using descriptive statistics.

Key findings

Study results revealed that 43% of respondents were aware of the gilling and gutting technique but never practiced it due to physical, financial and marketing barriers. Only 20% of respondents practice onboard processing where majority of them not involved in any form of onboard fish processing for Skipjack tuna. The average monthly income of boat owner was 208000 LKR while skipper was earned average monthly income of 148500 LKR. Moreover, 57% of the responded expected premium price for gilled and gutted as it incurred additional cost of 218 LKR per Kg. A set of physical, financial and market constraints hinder the practical application of gilling and gutting practices for skip jack tuna.

Barriers to adopt on-board tuna processing

Physical Barriers

- Harvest come as large quantities and it is impracticable gilling and gutting due to time consuming
- Average weight of the tuna catches in this area range from 4-5 kg where it really difficult to gill and gut
- Quality of the ice is not up to the standards. So using ice with mud and impurities lead to deteriorate the quality of gilled and gutted tuna significantly
- Majority of boats lengths range from 34-36 make it difficult to practice due to space limitation. Length of the fishing boat is a considerable factor in adopting to on board handling practices such as gilling and gutting. The fishing crafts were categorized into 3 groups according to their hull lengths. It is apparent that the majority of fishing crafts (60%) were belonged to the 33- 40 ft length category followed by 41- 60 ft (37.5%) and 28-32 (2.5%) second and third respectively.Therefore, it is clear that majority (62.5%) of the boats were below 40ft length category make it difficult to process large quantities of skip-jack tuna on board at a time.

Financial barriers

- Increase in operational cost per boat as on board processing of skip-jack tuna requires additional labor and time
- Additional cost to purchase tools and equipment required for gilling and gutting
- Lack of capital for the development of boat facilities. Fishermen reported that even if they gilled and gutted tuna with the intention of ensuring quality and safety, the existing cool store facilities

and ice quality were insufficient and not up to the standards for storing processed skip jack tuna on board safely. Yet investing on such facilities incur huge cost.

Marketing barriers

- Selling gilled and gutted tuna at a premium price is the greatest marketing barriers perceived by the fishers. This is because onboard processing of fish requires additional time, labor and tools and equipment which increase the cost of the gilled and gutted tuna. Therefore fishers need to sell those on-board processed tuna at a higher price to cover the additional cost.

Conclusion

Although fishers aware of importance of practicing gilling and gutting technique for better quality of tuna in multiday fisheries fishers reluctant to practice it due to a number of physical, financial and marketing barriers.

Recommendations

- It is recommended that government intervention to develop market linkages to sell gilled and gutted tuna at a premium price and to secure the market. Build cool room facilities, and ensure the quality of ice and water use on-board to assure the quality of on-board processed tuna.
- It is recommended to provide trainings to improve skills in on-board fish processing and value addition

PROJECT NO : 8.2
INFORMATION SERVICE- FISHERIES INFORMATION CENTRE (FIC) OF NARA AND INDUSTRY OUTLOOK

Responsible Officer/s : K.H.M.L.Amaralaland H.P.D.A.Lakmali

Introduction

Effective information sharing plays an important role in sustainable fisheries management.The real time information are also needed for fishery managers, policy makers, researchers, academics and general public for their short term and long term planning and development activities as well as day today works. In fulfilling thesegaps, National Aquatic Resources Research and Development Agency (NARA) initiated to establish a user friendly information system in 2013 which called "Information Service-Fisheries Information Centre (FIC) aiming to provide timely and accurate information to users.It provides information through a hot line (0710101010)under five categories such as academic and research, consumer and industry related services, fishermen welfare and disaster related services, trade and investment related services and general complaints and comments throughout the day.

Objectives

- To disseminate and receive real time information related to the industry
- To promote the information Centre and its activities among users and potential users of the country
- To publish Fisheries Industry Outlook of the year

Numbers of queries and the percentages

A total number of 95 queries were received from different respondents by the end of the year. All the queries were categorized based on the nature of queries. The percentages under each information criteria are as, 35% of the total calls related to academic and research, 31% are consumer and industry related services, 16% are general complaints and comments while 13% and 5% are related to fishermen welfare and disasters related services and trade and investment related services respectively. All queries received were successfully solved with the assistance of NARA scientists and officials of governmental and non governmental institutions.

To promote information centre and its activities among users 2 banners, 260 stickers and 420 handbills were distributed in Beruwala and Dikowita fishery harbours and published the Fisheries Industry Outlook- 2022.

Publications

1. De Silva, D. W. L. U., Bandara, W. A. A. M., Dilhani, E. V. D., & Sadaruwan, K. P. G. L. (2023). The nexus between COVID-19 and finfish export from Sri Lanka to its main trading partners; the United States and the European Union. Tropical Agricultural Research and Extension. 26(3), 219-230. DOI: 10.4038/tare.v26i3.5671
2. Thilakarathna, M.T.N., Mittner, L., and Ashoka Deepananda, K.H.M. (2023). Conceptual framework for assessing social resilience in Fisheries Sector: Applying gender lenses, Abstract Proceeding, International Conference of Gender Disparities (ICGD'2023), Centre for Gender Studies, University of Kelaniya.
3. Sandaruwan, K.P.G.L., **Thilakarathna, M.T.N.,** Bandara, W.A.A.M., De Silva, D.W.L.U., Lakmali, H.P.D.A., Gunarathna.V.S., and Amaralal, K.H.M.L.(2023). Socio-economic analysis of Sea cucumber value chain in North and North-westerncoast of Sri Lanka, NARA Scientific Sessions, National Aquatic Resources Research and Development Agency (NARA), Colombo.
4. Bandara, W.A.A.M., Sandaruwan, K.P.G.L., De Silva, D.W.L.U., Anupama, P.G.D.M., Liyanapathirana, N., and Amaralal, K.H.M.L. (2023). Challenges in onboard handling of Skipjack tuna in multi-day fishery on the West coast of Sri Lanka. NARA Scientific Sessions, National Aquatic Resources Research and Development Agency (NARA), Colombo.

5.9 MONITORING AND EVALUATION DIVISION

Head of the Division : Mr. A.B.A.K. Gunaratne & Mr. P.A.D. Ajith Kumara

The Monitoring and Evaluation division is comprised with Information Technology unit, Library and Information unit. Monitoring and Evaluation division is responsible for project planning, monitoring and evaluation. It performs the duties of ensuring effective monitoring, evaluation and coordination of the research programmes. Preparation of the action plan, monthly progress monitoring of research projects, compilation of annual report, facilitation to knowledge sharing and dissemination are main responsibilities of the division.

Information Technology Unit

The mission of the Information Technology Division is to provide the highest quality technology-based services, and support to the organization for its strategic goals and objectives as it applies to research activities and provide effective technology support for audio/visual, multimedia, desktop and web based applications and services.

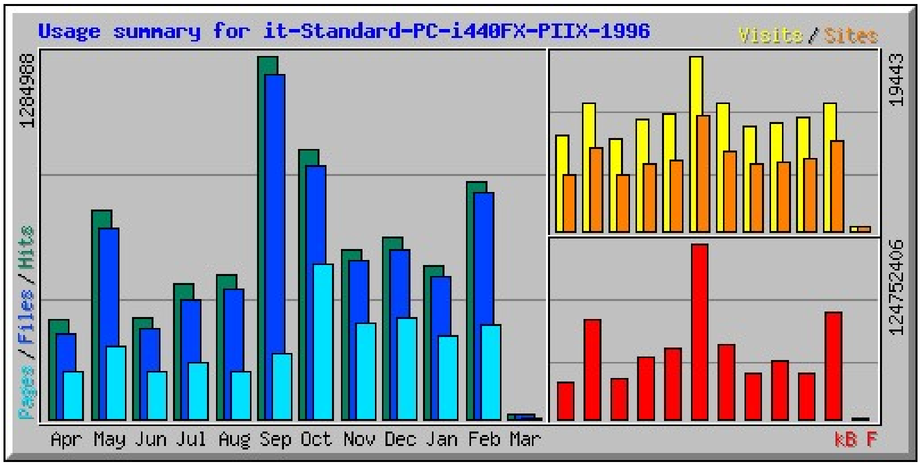
Information Technology Division conducts research using Geography Information system (GIS) and Remote Sensing (RS) for resources planning and identify suitable areas for aquaculture development and forecasting. GIS technologies applies in the diverse fields and committed to delivering high-quality spatial and attribute data to the internalresearches as to allow better decisions to be made based on the best available information. Information Technology Division acts as a store room of spatial data of marine and terrestrial areas. Division is intended to facilitate as a platform to pool all data/information available in respect to aquatic resources, environment and users and develop products for environmental friendly economic development and scientifically based management of aquatic resources/environment.

The Division is responsible to provide all aspects of IT and systems implementation for information gathering, processing, sharing and dissemination among all stakeholders for management, conservation and development of aquatic resources. It provides expertise in computing hardware and software support as well as LAN (Local Area Network) and WAN (Wide Area Network) connectivity to the staff and administrative support of computer networks. And also IT unit maintains IT contracts and software licenses, and coordinates the procurement of IT related hardware and software.

PROJECT NO: 9.1: INTERNET SERVICES AND ONLINE INFORMATION SYSTEM

Main objective of the project is to disseminate the information via World Wide Web and to provide other internet services for scientific staff of NARA and its stakeholder with a view of facilitating information sharing.

Modifications were carried out to the website 48 web pages were added to the site. Average visit per day to the web site was nearly 435 and observed the highest visit counts, 19433 on June 2023.



Summary by Month										
Month	Daily Avg				Monthly Totals					
	Hits	Files	Pages	Visits	Sites	kB F	Visits	Pages	Files	Hits
Nov 2023	29025	27671	11454	489	9941	75880876	14198	332185	802474	841746
Oct 2023	17512	16252	9559	406	7977	32689873	12599	296330	503837	542893
Sep 2023	20745	19258	11634	387	7617	41863154	12024	360656	597000	643105
Aug 2023	19865	18636	11270	384	7341	32707625	11546	338109	559100	595950
Jul 2023	30673	28875	17583	457	8870	53051557	14173	545089	895143	950874
Jun 2023	42832	40599	7738	648	12814	124752406	19443	232144	1217982	1284988
May 2023	16361	14707	5350	421	7925	49944150	13077	165853	455931	507194
Apr 2023	15372	13494	6487	403	7400	43785853	12497	201104	418317	476536
Mar 2023	11925	10617	5511	339	6298	28273850	10192	165346	318530	357768
Feb 2023	23731	21729	8314	455	9301	71142226	14106	257762	673616	735686
Jan 2023	11697	10004	5649	352	6164	25956244	10581	169471	300126	350923
Totals						**580047814**	**144436**	**3064049**	**6757238**	**6742056**

Other Works

Compiled the IEE Report for the Arugambay Lagoon development and submitted to Ministry of Fisheries

Library and Information Unit

As a special library in the field of Fisheries and Aquatic Resources subjects, NARA Library is mainly focused on assisting subject specialists, entrepreneurs, decision-makers and students and motivating their innovative research studies output. It mandates to collect, disseminate, preserve and provide information and data for easy reference. It holds over 30,000 documents, e-resources, and digital collections and open for access through open open-access catalogue. Its mission is to be the National and International Networked Information Centre on the subject of "Fisheries and Aquatic Resources" and serve effectively and competently in the rapid information evolution era.

Activities

Project	Activities	Allocation	Responsible Officers	Period
1. Collection Development	1.1.Procurement of Information 1.2.Collecting Research Reports and Papers 1.3. Obtaining donations 1.4.Obtaining resources on exchange basis 1.5.E downloads	0.4	Aruna Gunarathna Menaka Karunaratne	Yearly
2. Library Management	2.1.Add data, update library databases 2.2.Process work of Library resources 2.3.Maintain and regularly update the e-repository collection		Aruna Gunarathna Menaka Karunaratne	
3. Referral Services	3.1.Book circulation 3.2.Current Awareness Service 3.3.Selective Dissemination of Information Service (SDI) 3.4.Literature Survey 3.5.Inter-Library Exchange Service		Aruna Gunarathna Menaka Karunaratne	
4. Other Services	4.1 Reproducing Service - Photocopying -Scanning 4.2 Book Binding 4.3 Sale of Publications 4.4 Distribution of NARA publications (Exchange Basis)		Aruna Gunarathna Menaka Karunaratne D.H.T. Ajithwansa	

Performances

PROJECT NO :01

COLLECTION DEVELOPMENT

The library collection was developed by adding 09 books, 13 journals, 01 NARA report, and 17 Newsletters. NARA Scientific Sessions 2022 was uploaded to the e-repository of the library & information of NARA. National Geographic Journal continuously received to NARA library throughout the year 2022.

Renewed the IAMSLIC membership for 03 years from 2022-2025. NARA Library has renewed British Council Membership from November 2022 to November 2023 and it facilitates for our staff members to use resources of the British Council.

PROJECT NO :02

LIBRARY AND RESOURCES MANAGEMENT

Continuously update the library systems by adding, editing and deleting relevant data for accessing them easily and accurately.

PROJECT NO :03

PROVIDING SERVICES

1106 visitors used the NARA library and 248 books were circulated among NARA patrons. Rs. 90/= collected as overdue charges. 33 NARA Staff Member clearances were done. Provided information through emails and telephone conversations for 12 and 15 persons respectively. 53 persons used Computer and Internet facilities. A monthly update of the Visual Screen showing new arrivals to the library was carried out.

545 Documents were scanned and 208 photocopies were supplied to NARA staff. 13 bindings were done for NARA staff. Rs. 23,240/= was earned from the sale of publications. 113 times were reserved conference room facilities for discussions, meetings and workshops.

Extension Unit

In the year 2023, NARA had planned a large number of programs in terms of media and distribution, but the financial allocation was very minimal.

Project No : 9.3

Extension Services

01). Conducting educational exhibitions including the activities of NARA.

No	Location	Period
01	Kalutara, Kalutara College Educational Exhibition	2023/05/10-11
02	Educational Exhibition of Panwila Rajasinghe National School, Wathtegama, Kandy	2023/05/22-24
03	Turtle Conservation Education Exhibition held at Panadura Town Hall	2023/06/08-11
04	Education Exhibition held on the occasion of Science Day at Musius Girls College, Colombo	2023/08/ 10-11
05	Education exhibition held on the occasion of Science Day at Kadana Lakpahana Vidyalaya	2023/10/ 05-07
06	Poisonous Animal Show at Colombo National Hospital	2023/11/16-17
07	“Mahpola” Education and Trade Fair held at the Ja Ela Municipal Stadium	2023/12/13-17

02). Conducting awareness programmes / workshops.

- Implementation of several workshops to introduce a cooling system for the multi-day vessel in collaboration with the World Food Organization (FAO) and NARA in collaboration with the NARA Post Harvest Technology Division.
- Organizing several pilot programmes and several workshops with government agencies, tourist hotels, non-governmental organizations, private organizations and the fishing community in the area to create a beautiful city centered on the Negombo lagoon.








03). Conducting Educational Seminars

Every year, school children, university students, navy trainees and other external groups come to study the operation of NARA. We will manage these activities completely for them and thus for the year 2023;

- School Educational Tours – 03

No	Name of the institution	No of Student
01	Anuradhapura Tambuthtegama Sumangala Maha Vidyalaya	103
02	Mahinda Collage, Galle	26
03	St. Joseph's College, Negombo	158



- University Educational Tours - 07

No	Name of the institution	No of Student
01	Ocean University (on two occasions)	92
02	Eastern University	28
03	Uva Wellassa University	52
04	University of Colombo (on two occasions)	70
05	Rajarata University	28



- Educational tours of Navy trainees - 19

No	Name of the institution	No of Student
01	On notification of Naval Headquarters (on 05 occasions)	155
02	Trincomallee Naval Training School (on 14 occasions)	457

- Seminars and programmes were conducted.



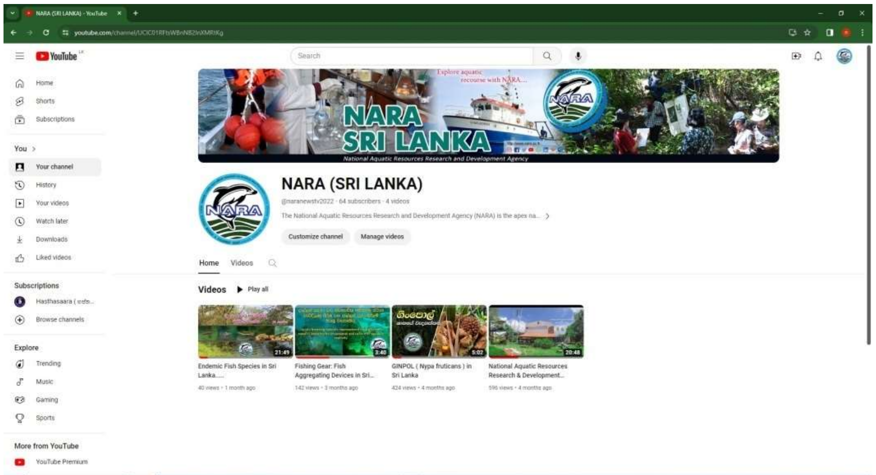




04). Creating a new official You Tube channel and an official Face Book page to inform people.

We launched a official You Tube channel and a Face Book page for our institute from August 2023, avoiding the previous deficiency as a way of revealing the activities of NARA through the use of a new medium of providing information to the public. Accordingly, it was possible to make the scientific research information of the NARA and other NARA news to the public through social media.

In parallel with these activities, we started publishing "Sayuru Netha" as an online edition, which we had published as a print edition until then.

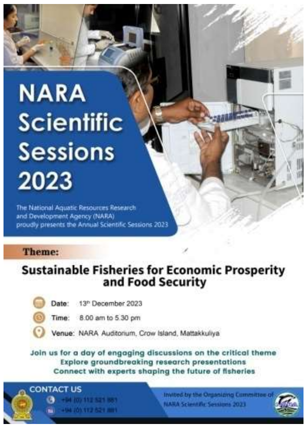


05). Providing necessary services for the success of the Annual NARA Science Session and the preparation of an Ocean Convention in Conjunction with the World Ocean Day.

A process of publication of research papers of NARA researchers is organized annually by the NARA Institute. For this, a large number of scientific papers prepared by NARA scientists with their knowledge will be forwarded to a scholarly committee and an open discussion platform will be made to display the scientific papers of national importance. On December 13, 2023, these activities were held at the NARA Auditorium under the leadership of the Minister of Fisheries and the State Minister of Fisheries. Invited guests from local and Foreign and a group of scholars participated in this.

NARA Media and Extension Unit worked to provide active contribution as the facility provider of this Scientific Session.

Also, in conjunction with the World Ocean Day, an expert discussion forum was held on 08/06/2023 at the NARA Head Office Auditorium to prepare an ocean strategy, and the Media and Extension Unit was deployed to act as a facilitator.



NARA Scientific Sessions 2023

The National Aquatic Resources Research and Development Agency (NARA) proudly presents the Annual Scientific Sessions 2023

Theme:

Sustainable Fisheries for Economic Prosperity and Food Security

Date: 13th December 2023

Time: 8.00 am to 5.30 pm

Venue: NARA Auditorium, Crow Island, Mattakkuliya

Join us for a day of engaging discussions on the critical theme
Explore groundbreaking research presentations
Connect with experts shaping the future of fisheries

CONTACT US

Invited by the Organizing Committee of NARA Scientific Sessions 2023

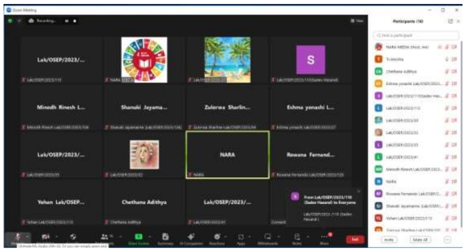
In addition to the above Online Education Programme, NARA has contracted with the International Ocean Institute to implement a three (03) year online education programme to equip school children, teachers and people interested in field government with knowledge related to aquatic environment and ocean education. arranged to provide us with a financial contribution of 5000 Euro. Accordingly, we received an amount of Rs. 1,724,191.45 for the first year.

We hereby;
05 online educational programmes for school children
As per the approval of the Ministry of Education for school education programmes, 10 schools were selected to cover all the provinces of Sri Lanka and accordingly this programme was implemented in the following manner.

Program No.	Name of the School/Schools	No of Students	Duration
01	Kurunegala Mahinda National School	42	2023/05/09 - 2023/05/25
	Kuliapitiya Saranath National School	40	
02	Mahinda Collage Galle	41	2023/05/30 - 2023/06/11
	Tangalla Girls' College	42	
03	Kandy Wathtegama Panwila	86	2023/06/27 - 2023/07/12

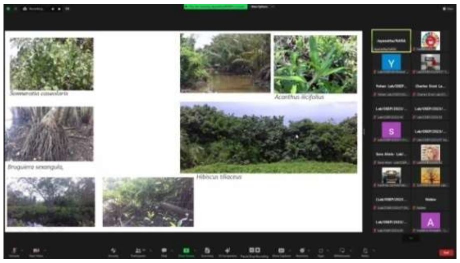
	Rajasinghe National School		
04	Gampaha Bandaranake College	Only a few students participated in the programme.	
	Matara Services National School	65	2023/09/07 - 2023/09/23
	Matara Mahanama National School	40	
05	Kadana Lakpahana College	87	2023/11/30 - 2023/12/18


Echinoderms වල වැදගත්කම




Importance and Benefits of the Ocean to Human Beings

KHML Amaralal
Principal Scientist and Head of Department
NARA



04 online education programs for people interested in the field/s Could be implemented.

No	Program Number	No. of Participant	Period
01	1st Programme	35	2023/08/17 – 2023/09/04
02	2nd Programme	38	2023/09/25 – 2023/10/12
03	3rd Programme	36	2023/10/18 – 2023/11/06
04	4th Programme	25	2023/11/11 – 2023/11/29

In the year 2023
- 10 programmes for school children
- 02 programmes for teachers
- 01 programme for those interested in the field

It was planned to implement online education programmes in this way, but it was not possible to implement the programmes as planned due to the delay of 03 months in receiving the financial support for this programme and the bad weather conditions in the country. Only 05 school programmes could be implemented. Also, although we have planned 01 programme for those who are interested in the field, 03 programmes were additionally conducted due to the increase in the number of applicants. It is intended to implement our targeted plan from the year 2024.

Challenges and Problems:

Our unit has;
- Main Auditorium
- Small Auditorium
- NARA Museum and
- Media & Extension Office.

External persons regularly visit the places owned by our unit and those places must be well maintained.

However,

- The sound of the main auditory system is decayed. It should be repaired immediately. Air conditioning system is not serviced on time. These need to be rectified.
- There are many shortcomings in the mini auditorium.
- We can mention the NARA Museum as a place that has attracted a lot of people from outside. Electricity is not working properly here. These matters should be corrected.
- There are many deficiencies in the media and extension office. There is no studio of proper dimensions for video production. The exhibits have to be stored in the premises of the institution. Due to this, goods are being destroyed in a big way. The electrical circuit should also be properly calibrated. The external media is a place where company officials often come. It should be arranged so that they get a feel for the organization. These don't have to cost a lot to fix. These things can be fixed with very little money.

Human Resources :

In order to carry out the activities of our unit in a systematic manner, there should be a group of employees in the department as follows.

- Extension Officer - 01
- Development Officer - 01
- Management Assistant - 01
- Photographer - 01
- Audio Visual Technician -01
- Helpers – 02

But at present only one extension Officer, one Management Assistant and two helpers are employed. Although the Media and Publicity Unit has a photographer, he is assigned full-time to the Ministry.

Physical Resources:

- Video cameras - 01
- Still cameras - 01
- Audio-visual equipment systems - 02
- Additional Equipment –

The video camera in our unit is about 10 years old and the still camera is almost 15 years old. As these equipments are subject to constant technical faults, it has become difficult to provide effective quality service. Also, the audio-visual system installed in the main auditorium is many years old and malfunctions occur during operation. The whole system needs to be modernized, even if spare parts are added from time to time. Also, in order to provide quality service in the media and extension unit, there should be many additional equipments and their absence always causes problems.

5.10 REGIONAL RESEARCH CENTER - KADOLKALE

Head of the Division : Ms. S.H. Udeshika Chathurani

The regional research center is located at Kadolkele, Negombo in Western Province of Sri Lanka, 30 km north of Colombo on the North Western Coast. The research center lies adjacent to the Negombo Lagoon and situated in a mangrove area of 14 ha in extent, which is located in the heart of the Negombo town. The area of mangroves is the largest mangrove patch remaining in northern part of the Negombo lagoon and most significant for the lagoon's productivity and other ecological balance of the system.

Staff of Kadolkele consists of two research scientists and two helpers. Among them, one helper got migrated in 2023.

Main objective of the station

- Development of national mangrove research and educational center for research, education, sustainable development and conservation of the mangrove area of 14 ha bordering the upper reaches of the Negombo lagoon which is remaining as the only largest single land ward patch. Conservation of land will be immense important to enhance the productivity of the lagoon.

PROJECT NO : 10.5

MONITORING OF GREEN MUSSEL (*PERNA VIRIDIS)* CULTURE PRACTICES IN NEGOMBO LAGOON, SRI LANKA

Responsible officers : S.H.U. Chathurani , J.M.N.M. Jayasundara and Dr.Jayanthi Mallawarachchi

Objectives

- To investigate the capability rearing and growing green mussel in Negombo lagoon
- Livelihood development of fishery community in Negombo

Justification

Mariculture of bivalves greater importance in meeting the increasing protein demands of the human population. Bivalve groups such as oyster, mussel and clam are the most important cultivable organisms all over the world.

Sri Lanka is very rich in bivalves such as oysters (*Crassostrea madrasensis*, *Saccostrea cucullata*) mussels (*Perna viridis*, *P. perna*), clams (*Marcia opima*, *M. hiantina*, *Meretrix casta*) cockles (*Gafrarium tumidum*, *Anadara granosa*) and pearl oysters (*Pinctada vulgaris*, *P. margaritifera*) around the coastal areas. Fishermen harvest bivalves from natural habitats in Negombo, Chilaw, Kalpitiya, Mannar, Jaffna, Trincomalee and Southern coastal belt of the country. Though bivalve farming is not commonly practiced in the country, a very high potential is available in the above specified areas. Perna species (*Perna* perna and *Perna viridis*) are commonly found edible mussel species around the margin of territorial sea of Sri Lanka. It is seasonal seafood available only in few months per year.

Green mussel culture practices are rare in Gampaha district. Some fishermen engage in wild capturing of green mussel from lagoon. It is important to monitor and provide guidance to fishery community to enhance culture practices for sustainable development.

Activities conducted

Hatchery development (at head office)

Progress: by Dr. Jayanthi Mallawarachchi

Site selection and growth monitoring of existing mussels

In accordance with the project proposal, six potential sites across three locations were identified as beneficiaries for the cultivation of green mussel juveniles up to marketable size. Comprehensive assessments of six water quality parameters, namely Temperature, pH, Electrical Conductivity, Resistivity, Total Dissolved Solids, and Salinity, were conducted at the selected sites.

The brood stock, sourced from Trincomalee, was introduced to a singular location for cultivation. In the event that successful larval stages are achieved through breeding trials under controlled laboratory conditions, the intention is to distribute these larvae across all three selected sites.

Ongoing monitoring of length parameters, specifically standard length and width of the mussels within the existing stock, was undertaken to establish a baseline understanding of the rearing conditions. This foundational knowledge is essential for potential larval rearing applications, contingent upon the successful procurement of larvae under controlled laboratory settings.

Results and Discussion

Site selection

Three sites were initially selected as potential sites for green mussel rearing of the juveniles up to marketable size.

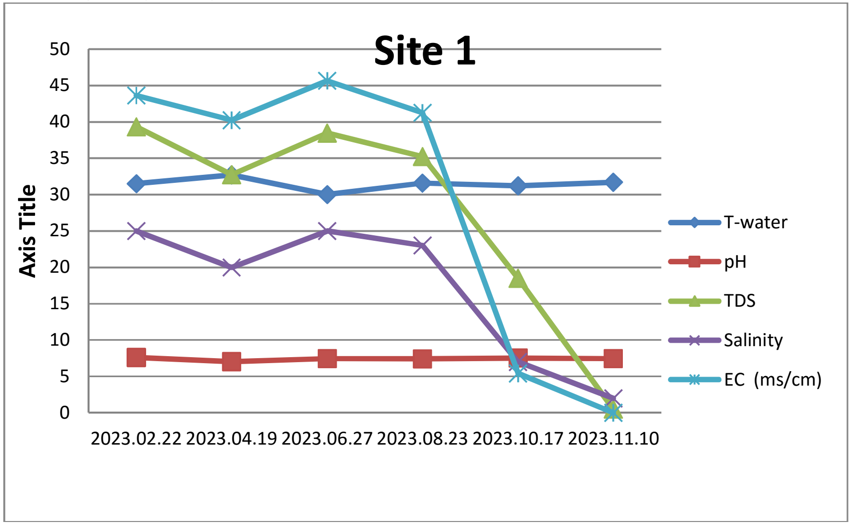
As per the Dr. Jayanthi Mallwarachchi's request another site was added in Munnakkaraya area when A. Anton Silva was added as a beneficiary of the project.

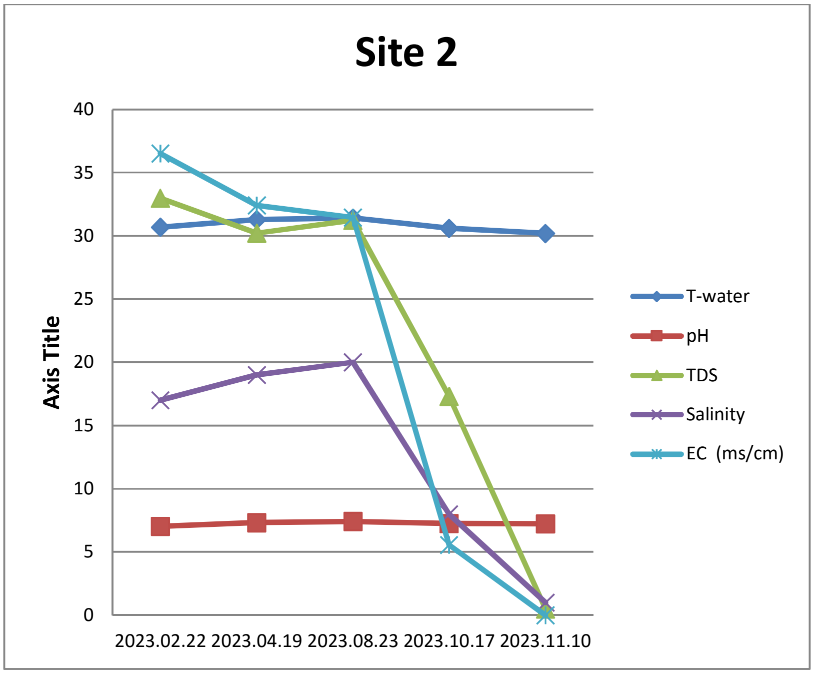
Selection of beneficiaries

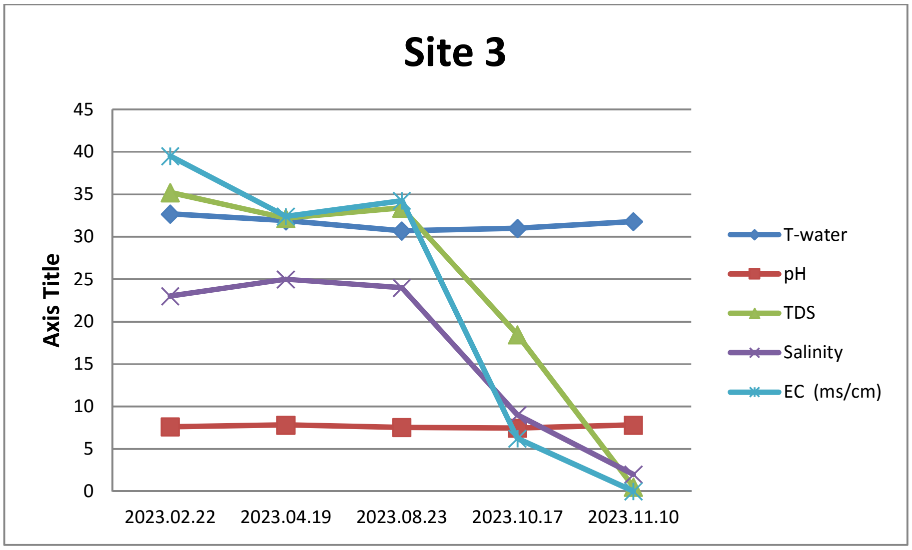
With respect to the project proposal, beneficiaries those who were selected by the end of second quarter as per the following,

No	Name	Address
1	W.Kristey jayantha fernando	No 930/A, Thelagaha road, Pitipana South, Negombo
2	B.Jude shantha Darinju	14/546 -22, Pitipana North, Negombo
3	W. Anthony Kumar	4/260, St.Nickola Road, Munnakkaraya
4	W.K.Kishor Laxman Perera	Siriwardana Pedesa, Munnakkaraya
5	Jude Namal Perera	14/546A, Pitipana North, Negombo
6	A. Anton Silva	3/142, Siriwardena pedesa, Munnakkaraya, Negombo

Water quality analysis of selected sites

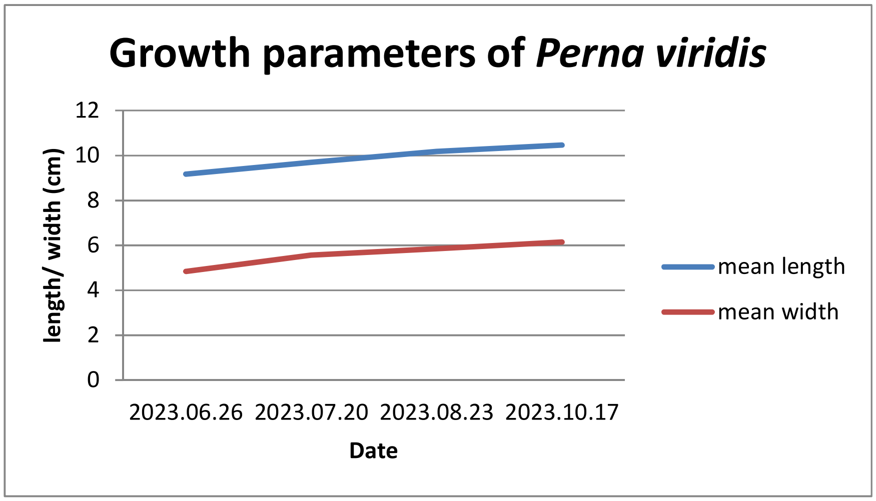






It was decided to monitor the existing green mussel stock in Negombo lagoon until it receive spat from laboratory conditions to achieve background knowledge on growth rates and maturity stages of the specie. Hence, location 1 at Munnakkaraya area was selected and a sample was used for continuous monitoring. During the month of June green mussel stock was collapsed due to salinity depletion. At that time duration the mean salinity level was 0 ppt.

Therefore, it was decided to collect brood stock from wild where they were naturally available (Trincomalee). The stock was monitored (growth rates and breeding) for four months time duration.



Growth parameters of *Perna viridis* stock collected from Trincomalee
During the month of September, sudden salinity depletion caused due to monsoon. The mean salinity level was 0 ppt at that time. The stock was collapsed.

With respect to the project proposal, the main objective was possibility of obtaining spat of green mussel under laboratory conditions. As it was conducted at head office by Dr. Jayanthi, it is needed to contact Dr. Jayanthi for updated of breeding trials and hatchery development.

Recommendation
With respect to the proposal, it is not suitable to rear green mussel from the stage of spat to marketable size stage in Negombo lagoon as salinity depletes multiple times within a year.

Constrains

- Lack of staff and facilities for research activities
- Breeding trials were not successful in laboratory and community development activities were not completed successfully

Publications

1. S.H.U. Chathurani., H.S. Badullage., T.T. Mallawaarachchi., H.P.S. Jayapala & P.B.Terney Pradeep Kumara., 2023. Diseases and pathogens associated with mangrove ecosystem; A systematic review. Proceedings of the 1stInternational Conference on Mangroves for Ecological & Economic Sustainability, The Open University of Sri Lanka. Pp 25-26
2. T.T. Mallawaarachchi., H.S. Badullage., H.P.S. Jayapala & S.H.U. Chathurani., 2023. Preliminary study of mangrove diseases in Kadolkele, Negombo, Sri Lanka. Proceedings of the 1stInternational Conference on Mangroves for Ecological & Economic Sustainability, The Open University of Sri Lanka. *Pp 23-24*
3. T.D.H.N. Silva., H.P.S. Jayapala & S.H.U. Chathurani., 2023. Mangrove associated macrobenthic fauna diversity in Kadolkele, Negombo, Sri Lanka. Proceedings of the 1stInternational Conference on Mangroves for Ecological & Economic Sustainability, The Open University of Sri Lanka. *Pp 19-20*
4. J.M.N.M. Jayasundara & S.H.U. Chathurani., 2023. Potential usage of selected bio stimulants for air-layering on endangered mangrove *Scyphiphora hydrophyllacea* in Kadolkele- Sri Lanka: Toward species conservation. Proceedings of the 1stInternational Conference on Mangroves for Ecological & Economic Sustainability, The Open University of Sri Lanka. *Pp 33-34*

5. S.H.U. Chathurani., 2023. Conservation and management of mangrove ecosystem: Way forward. Proceedings of the 1stInternational Conference on Mangroves for Ecological & Economic Sustainability, The Open University of Sri Lanka. *Pp 52-53*

Student supervision

Industrial Trainings

1. Suyama Sanjunee Dasanayake (FS/2019/036)- Ocean University of Sri Lanka
2. W.N.S. Sovis (BS/2018/151) – Department of Chemistry – University of Kelaniya
3. R.L.K. Saumya(BS/2018/141) – Department of Chemistry – University of Kelaniya
4. M.R.S. Mel (S/17/427) - Faculty of Science- University Of Peradeniya
2. Sachin Rodrigo (S/17/134) - Faculty of Science – University of Peradeniya
3. S.H.S.K. Gunarathna – Department of Animal Science and Export Agriculture - Uwa Wellassa University
4. R.S.P.K. Abhishek – Department of Animal Science and Export Agriculture - Uwa Wellassa University

Research Supervision

1. T.D Hashini Prapodha – 198544 – Wayamba University of Sri Lanka
2. W.N.S. Sovis (BS/2018/151)– Department of Chemistry – University of Kelaniya

Contribution for other Research studies

1. Hatchery Inspections and provide recommendation, Counting of Post Larvae (Ministry Project /V5771- NARA)
2. Supporting for MV-Xpress pearl data collection (With ESD, MBRD)
3. Participation for emergency studies (sample collection for fish kill incidents at Munnakkaraya, sample collection for oil spill incident at Sarakkuwa, Dungalpitiya)
4. Participation for field work with Indian deligates to promote aquaculture practices

Collaboration with Other Institutes

1. Collaborate with Department of Fisheries and NAQDA for propose a Aquaculture Development program for Negombo lagoon
2. Field inspection on “Development of efficient effluent treatment plant for dry fish factories at Negombo”- collaborated with MEPA, Municipal council-Negombo and CCD

Meeting/Workshop Attended

1. Introduce new technology for reduce post harvest losses in Tuna fishery- Fishery harbor corporation-Negombo – 2023/01/25
2. National expert committee meeting on mangroves- Ministry of environment- 2023/01/27
3. Conference at Arie Lagoon Negombo- Conducted by Oceans_Well (NGO)- 2023/05/10
4. World Ocean Day Celebration-NARA-2023/06/08
5. Workshop on climate change/ blue carbon at Kingsbury Hotel- 2023/07/10
6. Divisional Secretariat Meeting- A.G.A. Office- Negombo- 2023.07.14
7. International conference on Mangrove sustainability at open University of Sri Lanka- 2023/07/26
8. Provincial Secretariat Meeting (Environmental committee meeting) – Provincial Secretariat – Negombo – 2023.11.01
9. Workshop on “Plant Quarantine” – National Plant quarantine services, Katunayaka – 2023.11.27

Mangrove reforestation programs

1. Mangrove park clean up and reforestation 03/02/2023
2. World Mangrove Day celebration with CCD and Sethsarana- 2023/06/06 and 2023/06/07
3. Beach clean program with Sethsaraana Foundation- 2023/08/25

Meetings/Workshop/Lectures conducted

1. Waste Management meeting with fishery community- Kadolkele R.R.C.- 2023/08/24
2. Wate Management meeting with stakeholders- NAFSO- 2023/09/26
3. Waste Management meeting with relevent stakeholders – NAFSO , Negombo – 2023.10.25
4. Lecture on “ Conservation of Mangrove Eco-System” , St.Thomas College, Seeduwa – 2023.09.01

Awareness program

Nu	Date	Name of the school/institute/university	Number of participants
1	08/01/23	S. M. Nalaka (Private institute)	40
2	03/02/2023	Nanajaya Institute- Meerigama	120
3	02/03/2023	University of Kelaniya	50
4	27/04/2023	Open university of Sri Lanka	60
5	23/05/2023	Vidyalankara vidyalaya, Negombo	100
6	25/5/2023	Ocean University of Sri Lanka	20
7	9/06/23	University of Ruhuna	115
8	01/07/23	Open university of Sri Lanka	50
9	12/07/23	Newstead girls’ college	100
10	28/07/23	Newstead girls’ college	25
11	27/07/23	St. Thomas College	50
12	29/07/23	University of Colombo	31
13	25/8/23	Sethsarana institute	42
14	24/9/2023	University of Kelaniya	50
15	03/11/2023	University of Wayamba	42
16	17/11/23	National Institute of Education	02
17	03/12/23	University of Sri Jayewardenepura	160
18	21/12/2023	Ocean University of Sri Lanka	60

Income Generation by selling mangrove plants- Rs 7480.00

5.11 REGIONAL RESEARCH CENTER – REKAWA

Head of the Division : Dr.M. Gammanpila

PROJECT NO : 10.3

DEVELOPMENT OF LIVELIHOODS OF FISHER COMMUNITIES THROUGH INTRODUCTION OF PROPER AQUACULTURE TECHNOLOGIES, ENVIRONMENTAL MONITORING AND INTRODUCTION OF NATURE BASED ECOTOURISM IN REKAWA LAGOON, SOUTHERN SRI LANKA.

Responsible Officer/s : M. Gammanpila, K. W. R. R. Amaraweera & W.K.Suwandhahannadi

Introduction

Rekawa Lagoon (6^0 05'N and 80^0 50'E) is comparatively small coastal lagoon, covering 240 ha of water surface area located in Hambantota District in the Southern Province, Sri Lanka. A considerable amount of the community in Rekawa area depends on lagoon fishery for their livelihood. Presently there are around 150 fisher members and around 70 fishing crafts operated in the lagoon. Further during shrimp season, some part time fishers are also involved in fishing. Fisheries in Rekawa Lagoon has been exploited under artisanal basis for years by small-scale fishers using different type of traditional fishing gears, drift gillnets, cast nets and fish kraals. Kraal fishery are seasonally operated with onset of shrimp mainly *Penaeus indicus*. There are number of aquaculture and tourism activities are implemented associated with the lagoon resulted a large range of possible pollutants from a catchment or wastewater discharge, thus it is essential to narrow the range of pollutants measured to include those most likely to be the cause of the problem. Additionally present fish production in the lagoon is very low and limited so that fisher communities around the lagoon need to find alternative livelihood opportunities. Nature-based ecotourism development can lead to increases in overall income of the station and facilitate for environmental education and conservation priorities.

Objectives

- Uplift the living standards of rural communities in the Rekawa lagoon area by ensuring sustainable use of inland/coastal water resources through the establishment of tilapia and Seabass (*Lates calcarifer*) cages as a livelihood activity and achieve food security and improved nutrition.
- Transferring of aquaculture technologies to the rural fishing community
- Regular monitoring of the status of environmental parameters in Rekawa lagoon due to aquaculture practices.
- Develop infrastructure facilities and supporting educational and awareness programs and cooperation with local communities towards sustainable development of the region including the long-term protection of coastal ecosystems and their biodiversity.
- Enhancement of nature-based tourism in order to establish innovative financing mechanisms to generate sustainable self-financing.

Methodology

All the physicochemical and biological parameters were measured in accordance with the APHA standard methods at eight sampling locations. In-situ parameters such as water temperature, pH, salinity, electrical conductivity, depth, and Secchi depth were measured whereas Ortho-phosphorus, Nitrate, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), chlorophyll-a, primary production, and plankton identification were the tests carried out in the laboratory. Data analyses were performed using ArcGIS 10.8 and the SPSS statistical package.

The project is also designed for the livelihood development of fishermen in Rekawa Lagoon. As a pilot project, 175 fingerlings of seabass were collected from the private hatchery in Trincomalee. These fingerlings were stocked in two cages (size 2×2×1m) with a mesh size of 1.0 cm in the Rekawa lagoon and cultured for a two-month period. After two months, fish were transferred to a net cage with a mesh size of 2.5 cm, and fish growth, survival rate, and water quality parameters were monitored fortnightly. Fish were fed using low-value fish, which were collected from the lagoon by their daily fishery activities. Further two fishermen were selected, and 400 tilapia fingerlings were stocked in four net cages with a size of 2×2×1m as a livelihood development program. The fisherman is encouraged to feed the fish most cost-effectively. Regular checking of stocks for diseases was done. Additionally, around 5000 tilapia fingerlings and 35 brood fish (lengths of 15-20 cm) were released to the Rekawa lagoon to enhance the lagoon fishery. Action was taken to initiate the development of a mangrove nature park with name boards as identification guides.

Results

The study revealed that the average water temperature of the lagoon was (mean ± SD) 29.66 ± 1.35 °C, whereas salinity, pH, DO, depth, EC, nitrate-N, and phosphate-P were recorded as 7.62 ± 3.38 ppt; 7.81 ±0.87; 8.09 ±4.43 mg/l; 94.13 ± 54.97 cm; 29.69 ± 0.51 mS/cm; 0.64 ± 0.33 mg/l, and 0.43 ± 0.13 mg/l respectively. One-way ANOVA indicated that the mean values of salinity (NE: 5.69±2.42, 1IM: 7.63±2.66, SW: 8.33±3.2, 2IM: 8.97±4.65 ppt), pH, and DO were significantly different ($p<0.05$) between the four monsoons. Further, it showed that the average values of salinity, depth, and temperature were significantly different ($p<0.05$) between sampling locations. Results revealed that the salinity levels of the lagoon were increasing from the NE monsoon to the 2IM period. Spatial distribution maps indicated that the highest salinity level was recorded in the narrow channel region of the lagoon in most monsoon periods (Figure 1).

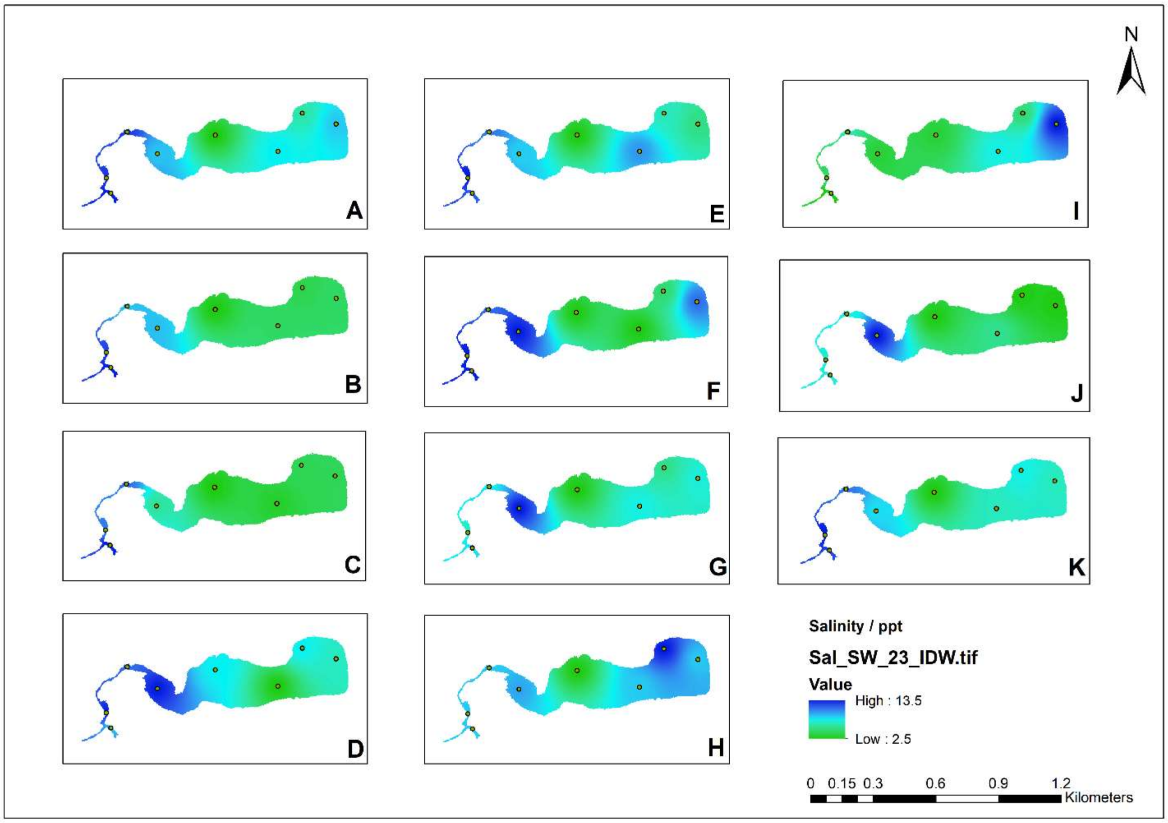
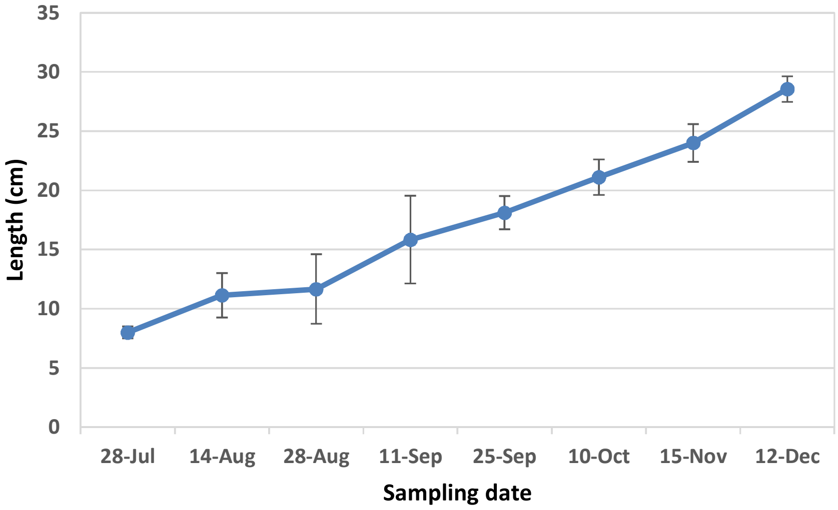


Figure 1: Salinity distribution maps of the Rekawa Lagoon (A: NE monsoon,2021; B: 1IM, 2021; C: SW monsoon, 2021; D: 2IM, 2021; E: NE monsoon,2022; F: 1IM, 2022; G: SW monsoon, 2022; H: 2IM, 2022; I: NE monsoon,2023; J: 1IM, 2023; K: SW monsoon, 2023)

One hundred seventy five seabass fingerlings, initially measuring around 8.00 cm with a variance of ±0.4 cm, were introduced into two 2×2×1m net cages installed in the Rekawa lagoon. After a period of 4 weeks under cultivation, the fish were transferred to net cages with a mesh size of 2.5 cm. After $4^{1}/_{2}$ months, the seabass exhibited significant growth, with an average length of 28.6±1.08 cm and an average weight of 322±38 g.

Figure 2: Sea bass cage culture- Rekawa lagoon



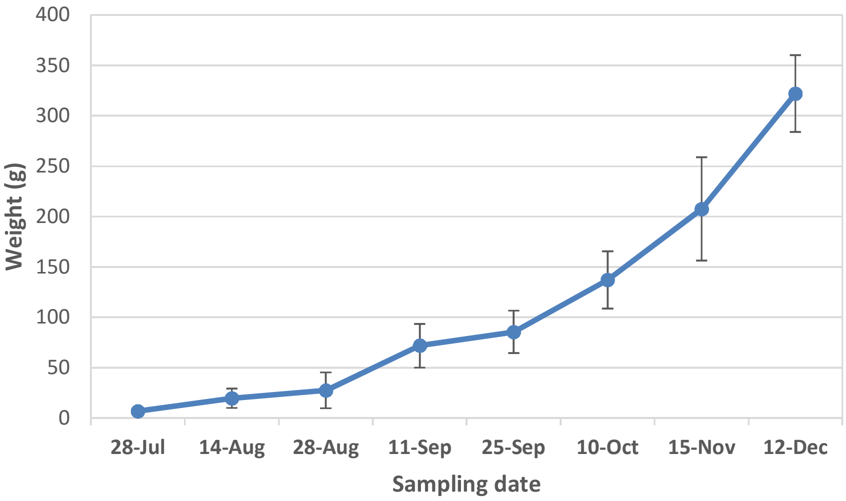


Figure 3: Variation of length (cm) and weight (g) data of sea bass culture in net cages at Rekawa lagoon.

Mangrove identification boards were prepared along the Rekawa lagoon area for educational purposes.

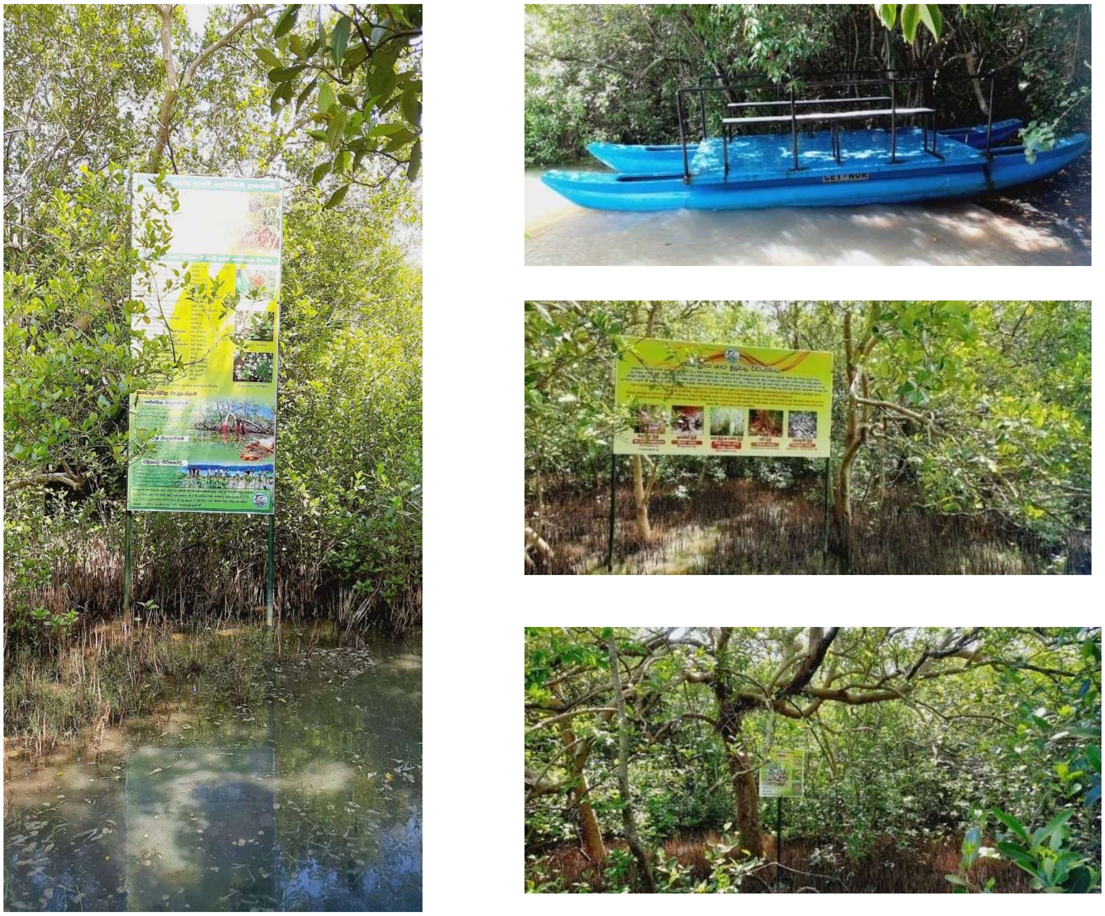


Figure 4: Installation of mangrove identification boards and renovation of canoe

Training/awareness programs.

Table 1: Awareness programs conducted by Rekawa/RRC in 2023

Date	Topic	Activities	Venue	Participant.	Total No.of participants
2023/02/24	World wetland day and mangrove (Collaborative with CEA, Hambanthota)	Awareness program	NARA-RRC - Rekawa	Ranna, Wadiyagoda Maha vidyalaya, Mamadala Maha Vidyalaya & Vitharandeniya Maha Vidyalaya Students– 49, Teachers – 6 Officials from CEA - 5	60
2023/06/15	Biodiversity of sensitive coastal ecosystems	Awareness Program	Puwakdandawa Girl's School	Puwakdandawa Girl's School & Coastal Conservation Department (CCD) Students– 150 Teachers – 10 Officials from CCD - 5	165
2023/07/05	Ornamental Fish breeding, Induce breeding, Hatchery maintenance, Fish feeding, Natural and artificial feeds	Presentation and Practical session	NARA-RRC-Rekawa	Netolpitiya Gamunu Maha Vidyalaya Students–60 Teachers – 2	62
2023/07/10	Identifying different types of mangroves and their associated flora and fauna	Field work and Presentation	NARA-RRC – Rekawa , Rekawa lagoon	Uwawellassa University Students–71 Staff members - 7	78
2023/08/09	Field experience regarding mangrove ecosystem	Field work (species identification, tree height, soil analysis, Water quality, bio diversity) & Presentation	NARA-RRC – Rekawa , Rekawa lagoon	H/Gatamanna South Maha Vidyalaya Students–50 Teachers – 6	56
2023/08/10	Mangrove eco system	Field visit and Presentation	NARA-RRC – Rekawa , Rekawa lagoon	H/Hakuruwela Vidyalaya (පරිසරනියමු unit) Students–26 Teachers – 4 CEA officials -2	32
2023/08/14	Field experience regarding mangrove ecosystem	Field work (species identification, tree height, soil analysis, water quality, bio diversity) & Presentation	NARA-RRC – Rekawa , Rekawa lagoon	H/Puwakdandawa Girl's School Students–55 Teachers – 4	59
2023/08/16	Field experience regarding	Field work (species identification, tree height, soil	NARA-RRC – Rekawa , Rekawa	H/Beligalla Maha vidyalaya Students–60 Teachers – 6	66

	mangrove ecosystem	analysis, water quality, bio diversity) & Presentation	lagoon		


Figure 5: Awareness programs conducted for education and conservation of mangroves

Technical support

1. Provide technical support for Initial environmental examination (IEE) study of the proposed 08 villas hotel project at Wellawatrhugoda, Rekawa west, Netolpitiya.
2. Analysis of water samples, fish diseases and site selection of ornamental fish farming in southern area.
3. Technical workshop was conducted on artificial and live feed preparation for 30 ornamental fish farmers in Galle district at Kattuwatta temple, Galle, organized by the Karandeniya divisional secretary office on 27.09. 2023.
4. Technical workshop was conducted on artificial and live feed preparation for 40 ornamental fish farmers in Galle district at Karandeniya divisional secretary office, Galle, organized by the Karandeniya divisional secretary on 31.10.2023.
5. Technical support on mangrove replanting at the Anantara Hotel, Tangalle, on 15.11.2023
6. Technical support for the development of Tangalle town planning program, at Tangalle, organized by the Urban Development Authority, Colombo on, 09.11.2023.

Publications

Full papers

1. Suwandhahannadi, W.K., Wickramasinghe, D., Dahanayaka, D.D.G.L. and Le De, L.,2023. Blue carbon storage in a tropical coastal estuary: Insights for conservation priorities. Science of The Total Environment, p.167733.
2. Menake Gammanpila (2022). Application of a community-based management approach for sustainable governance of Ja-kotu fisheries in Sri Lanka. The manuscript was submitted to the journal "journal "Fish and Fisheries" on 13th March 2023.

Abstracts

1. Suwandhahannadi, W.K., Wickramasinghe, D., Dahanayaka, D.D.G.L. and Le De, L.,2023, Assessment of blue carbon stocks in tropical mangrove forests, Rekawa Lagoon, Sri Lanka, National aquatic resources Research and Development Agency (NARA) scientific sessions,2023
2. Suwandhahannadi, W.K., Wickramasinghe, D., Dahanayaka, D.D.G.L., Loic Le De, Gammanpila, M., (2023), Identification of potential areas for aquaculture using spatiotemporal dynamics of water quality in the Rekawa Lagoon (Conference presentation abstract). Proceedings of the ANNUAL RESEARCH SYMPOSIUM 2023, University of Colombo, 227
3. Suwandhahannadi, W.K., Wickramasinghe, D., Dahanayaka, D.D.G.L., Loic Le De, (2023), Community perception of lagoon Ecosystem Services and conservation priorities: a case study from Rekawa Lagoon, Sri Lanka (Conference presentation abstract). Proceedings of the annual research symposium 2023, University of Colombo, 228

4. Rajapaksha, R.D.T., Suwandhahannadi, W.K., Dahanayaka, D.D.G.L., (2023), Satellite based analysis of spatial distribution and dynamics of mangrove ecosystems and other land uses in Rekawa, Lagoon, Sri Lanka, Proceedings of the 1st International Conference on Mangroves for Ecological & Economic Sustainability, 58-59.
5. Suwandhahannadi, W.K., Wickramasinghe, D., Dahanayaka, D.D.G.L., Loic Le De, Gammanpila, M., (2023), Effect of monsoons on species composition, density of zooplankton assemblages, and water quality of Rekawa Lagoon, Sri Lanka (Conference presentation abstract). Proceedings of the fifth research symposium of ocean university of Sri Lanka, 2023, 26
6. Amaraweera,K.W.R.R., Deepananda, K.H.M.A., and Jayasinghe, U.A.D., 2023, Assessment of heavy metal contamination in shallow sediments of Nilwala River flood plainin Matara, Sri Lanka, National aquatic resources Research and Development Agency (NARA) scientific sessions,2023

Conclusion

1. Results showed that the salinity levels of the lagoon were increasing from the North East monsoon (Dec to Feb) to the Second Inter Monsoon (Oct to Nov) period.
2. The present research study indicates that the water quality of the lagoon is favorable for brackish water fish and prawns specially the restocking of black tiger shrimp (*P. monodon)* and Seabass (*Lates calcarifer)* aquaculture during the South West (SW) monsoon period except extreme rainfall not occurred throughout the year.
3. Spatial distribution maps indicated that the highest salinity level was recorded in the narrow channel region of the lagoon in most monsoon periods. Highest water depth was recorded in the narrow channel region of the lagoon in all monsoon periods. Therefore, the maximum depth and higher salinity of that region are suitable for introducing seabass cage culture as a livelihood development activity.

Recommendations

1. It is recommended to stock sea bass fingerlings during the south west monsoon period while avoiding extreme rainy conditions to reduce mortality.

Outcomes

1. To use aquaculture as a poverty alleviation tool. Introducing sea bass cage culture enhance the livelihood opportunities of individual in Rekawa lagoon. Since culture period ($4^{1}/_{2}$ months) is not enough to harvest, economic analysis was not conducted.
2. Introducing the Rekawa mangrove forest area as an ecotourism development area.

Outputs

- Data base maintenance on variation of environmental parameters in Rekawa Lagoon.
- Operation and maintenance of effective fish farming system to increase income of the fisher community.
- Awareness and education on coastal environment and mangroves

Progress: Financial: 100% Physical: 95%

Constraints:

- Lack of financial support for repairing and purchasing instruments/chemicals
- Delay in the purchase of net material

5.12 REGIONAL RESEARCH CENTER - KALPITIYA

Head of the Division : Dr. R.P.P.K. Jayasinghe

Research Staff : The Regional Research Centre, Kalpitiya (RRC-Kal) consists of 02Scientists, 01 Assistant Bungalow Keeper and 4 Helpers.

Overview of the year:

The main task of the RRC-Kalis to decentralize of the programmes and facilities of field-oriented research and coordinate and involve in regional activities with NARA's mandate.

Twotreasury-funded research projects with project components were carried out by RRC-Kal in 2023. Apart from treasury-funded projects, RRC-Kal supported regional organizations and communities in solving issues in fisheries and aquatic resources. The RRC has close contacts with regional government bodies such as the Sri Lanka Navy, the Department of Fisheries, the Department of Wildlife Conservation, the Department of Coast Conservation, the Sri Lanka Tourism Development Authority,and the District Secretariat. In addition to that local and regional fishing communities contact the RRC when they need advice or technical support.

Treasury-funded projects carried out by RRC-Kal in 2023:

No	Project	Amount in million LKR
10.4	Present status of trammel net shrimp fishery in Kalpitiya coastal waters with some biological and socioeconomic aspects	0.5
2.3.2*	Fisheries independent shrimp trawl survey and biomass estimates in the Kalpitiya trawling ground in 2023	0.6

*research conducted collaboratively with MBRD and NIOMS.

PROJECT NO: 10.4

PRESENT STATUS OF TRAMMEL NET SHRIMP FISHERY IN KALPITIYA COASTAL WATERS WITH SOME BIOLOGICAL AND SOCIOECONOMIC ASPECTS

Objectives

The present study was carried out to fulfill the research need by considering of following objectives

- Identify the major fishing grounds and landing sites of the trammel net fishery in Kalpitiya
- Study the fishing gear and fishing techniques in a particular fishery
- Find out the species composition and study the biological aspects via independent fishery methods
- Find out the monthly and seasonal variation pattern in resource exploitation
- Figure out the socio-economic well-being on trammel net fishery in Kalpitiya
- Provide the recommendations and management strategies to ensure the sustainability of particular fishery resource

Findings

Fisheries information:

About 07 major trammel net operated fishing grounds (Periya arichchalai, Kudiyawala, Pasadimunnai, Illupanthivu, Gangewaadiya, Serakkuliya and Pookulam) have been identified in Kalpitiya coastal waters. Among that Pookulam and Kuttiyawala are noted as predominant fishing sites, Pookulam is very nearest and partially shares previous trawl fishing ground. In all sites, along with trammel net, there are several other fishing practices such as gill net fishery for crab and finfish also carried out, and according to the small-scale fishermen point, due to the trawl ban their fishing activity goes smoothly with comparatively higher catch rates of shrimps in their fisheries.

Fig 1. Trammel net fishing grounds and landing sites

Two types of trammel nets have been used in Kalpitiya region (in all identified fishing grounds), small meshed trammel net (outer layer mesh size: 5" - 6";mid-line mesh 1 ¾ "; gear length: 1500-3000 eyes; gear height: 38-41eyes) and large meshed trammel net (outer layer mesh size 8" - 10"; mid-line mesh 2 ¾"; gear length: 3000 eyes; gear height: 60 eyes). The type of operated crafts depends on the distance of fishing grounds from the shoreline, for instance, Pookulam and Kuttiyawala fishing groundsare mostly approached by OFRP boats, and others are dominated by non-motorized craft such as Theppam and Vallam. Approximately 700 fishing vessels in the Kalpitiya region are involved in trammel net fishery, with over 90% actively operating during the peak season (October to February/March) and nearly 50% during the rest of the year.

The average number of fishing days per week is about 5 days and the average number of fishing days for a month is about 20 days. The fishing period and number of fishing days mostly depend on the daily tidal water currents and lunar tidal cycle. Fishing activities are conducted throughout the year. Fishing is limited to the early morning period from 04:30 to 08:00, and the average duration for gear deployment is approximately 1.5 hours. Typically, fishermen engage in fishing activities once a day.

The major target species are noted as *Peneaus merguiensis* and *Peneaus indicus*. The harvest of *Peneaus semisulcatus* (Target shrimp species in trawl fishery) is very low in comparison, it may be due to the inefficiency of trammel net fishing gear to this particular species and its habitual features. *Penaeus monodon*is also occasionally captured but it is the prominent species in the Gangewadiya site where fresh water inflow is high. The primary bycatch fish in this context is Leognathidae (Karalla), with additional species such as Ariidae, Mugilidae, Gerridae, Terapontidae, and others also being reported.

Fig 2. Trammel net catch composition and major shrimp species

Catch Per unit Effort (CPUE) and variations

The catch and effort data were analyzed to determine the monthly Catch Per Unit Effort (CPUE) for trammel net fisheries in the Kalpitiya region. The annual average CPUE for a trammel net is calculated at 10.1 ± 3.3 kg. trip^{-1}.deploy^{-1}. Significantly, shrimp constitute approximately 41% of the catch (3.9 ± 2.3 kg. trip^{-1}.deploy^{-1}), with the remaining 59% consisting of bycatch (6.2 ± 3.1 kg. trip-1.deploy-1) (Fig 3). The trammel net, recognized for its non-selective passive fishing nature, is associated with a higher bycatch rate.

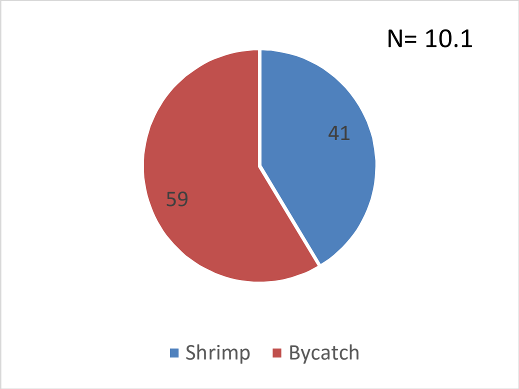


Fig 3. Percentagecomposition of the annual average CPUE of Kalpitiya trammel net fishery

In concern of major caught penaeid shrimp species, *Penaeus indicus* and *Penaeus merguiensis* shows higher domination with 44% and 40% of the total catch respectively. *Penaeus semisulcatus*currently contributes only about 12% to the total trammel net catch, however, this species was previously a prominent target in the trawl fishery of Kalpitiya, accounting for over 80% of the total catch.*Penaeus monodon* only serves about 4% of the catch and it is mostly restricted to near river influx fishing sites.
Regarding the catch of penaeid shrimps, the highest CPUE was reported in October at 9kg. trip^{-1}.deploy^{-1}, while the lowest was observed in June at 2 kg. trip^{-1}.deploy^{-1}. The period from April to August exhibited a lower rate of shrimp catch. In contrast, the CPUE for finfish bycatch peaked in July at 11 kg. trip^{-1}.deploy^{-1}and hit its lowest point in December at 3 kg. trip^{-1}.deploy^{-1}. A higher bycatch was reported during the period from June to October. These findings highlight a notable and sharp monthly variation in shrimp production and bycatch entanglement.

When examining the seasonal fluctuation of shrimp, the 2nd inter-monsoon (IM2) demonstrates a higher mean CPUE at 7.3 ± 1.2kg.trip^{-1}.deploy^{-1}, followed by the Northeast monsoon (NE) with value of 5.6 ± 0.8kg.trip^{-1}.deploy^{-1}. The 1st inter-monsoon (IM 1) and Southwest monsoon (SW) show lower CPUE valuesat 3.1 ± 1.1kg. trip^{-1}.deploy^{-1}and 2.1 ± 0.8kg. trip^{-1}.deploy^{-1} respectively. In contrast, the mean CPUE of bycatch exhibits higher values during the SW monsoon and IM 2, with 8.0 ± 3.0kg. trip^{-1}.deploy^{-1}and 7.0 ± 2.4kg. trip^{-1}.deploy^{-1} respectively. During the NE monsoonal period, bycatch is reported in the lowest value as 3.1 ± 0.7kg. trip^{-1}.deploy^{-1}.

Total shrimp production

The estimated total shrimp production in the Kalpitiya region through trammel net fisheries for the year 2023 was approximately 544 metric tons. About 40% of the total shrimp production was gained during the NE monsoonal season followed by 34% during theIM 2 season (Fig 4). Conversely, the IM 1 period exhibited the lowest production compared to other seasons.The results indicate that the trammel net shrimp fishery in Kalpitiya experiences its peak production during the Northeast and 2nd inter-monsoon periods.

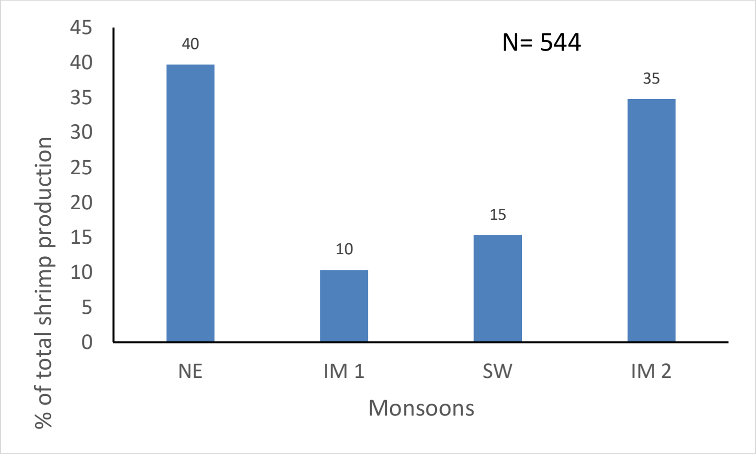


Fig 4. Seasonal fluctuation of total shrimp production Kalpitiya trammel net fishery

Independent survey andbiological analyses findings

The detailed study on species composition in trammel net fishery concludes, four species of penaeid shrimps have been identified as target species. Additionally, the bycatch includes a diverse array of 29 species representing 21 families including finfish, crabs and cephalopods.Among the identified species, approximately 61% exhibit demersal, benthic, and benthopelagic habitat associations, indicating a strong affinity for the seafloor and midwater regions. This characteristic aligns well with the operational nature of bottom-setnonselectivegear, making it highly favorable for capturing these species.

In the context of *P. indicus* and *P. merguiensis* populations weighing less than 10g, they comprise over 80% and 60% of the catch respectively, during IM 1 and SW monsoons. Contrarily, larger-sized individuals, exceeding 20g, are notably harvested during the NE monsoon for *P. indicus* and during the IM 2 and NE monsoon periods for *P. merguiensis*.Meantime the *P. indicus* and *P. merguiensis* populations, 10 – 12 cm and 12 – 14 cm size classes consistently exert a significant influence on the overall catch, particularly stating higher dominance during IM 1 and SW monsoons. Notably, larger-sized shrimps within the 14 – 18 cm range of these species exhibit a noteworthy contribution, particularly during the NE monsoon period.Regarding the maturity variation pattern of penaeids in trammel net harvest, the data indicates a prevalent dominance of the immature and mature stages in the penaeid shrimp catch. Notably, for the primary species caught, *P. indicus* and *P. merguiensis*, there are no significant reports of matured shrimp harvest by trammel nets during the IM 1 and SW monsoonal periods.

Socioeconomic wellbeing of trammel net fisheries

The age of fishermen engaging in trammel net fishery in the Kalpitiya region is ranged from 25 to 62 years, with experience of 5 to 48 years. On average, each fishing craft sees the active participation of 2 ± 1 fishermen, while at the landing site, an average of 1 ± 1 female per fishing craft is involved in activities such as fish sorting and other related tasks. This underscores the clear and significant role of women in specific fisheries, contributing substantially to the overall livelihood dynamics of the community. The average net income per fishing day for a motorized craft and non-motorized craft was estimated as LKR. 6000.00 ± 3000.00 and LKR. 4000.00 ± 3000.00 respectively. The average cost for the purchase of a theppam, vallam, and OFRP was estimated as about LKR. 250,000.00, LKR. 120,000.00 and LKR. 700,000.00 respectively. The average cost for the purchase of a typical-sized trammel net is estimated as about LKR. 150,000.00. Fishermen need to replace their fishing gear at least once annually to ensure the sustained efficiency of the fishing practice.

Recommendations

Penaeus indicus and *Penaeus merguiensis* as the primary contributors to trammel net fishery, their catch size variations, influenced by seasonality, play a pivotal role in shaping shrimp fishery dynamics.

The harvest of these shrimps at optimal marketable sizes in specific regions through trammel nets distinctly demonstrates that SW and IM 2 periods are optimal and productive. The total catch rate further supports this observation, displaying comparatively higher rates during these monsoonal periods.In terms of effective management and recommendations, it is advisable to consider reducing fishing efforts or implementing closure seasons, particularly during the SW monsoon. This approach aims to mitigate the risk of growth overfishing of the target shrimp species, ensuring sustainable resource management and long-term viability of the fishery.

The yield of *Penaeus semisulcatus*, previously a targeted shrimp species in trawl fisheries, is notably low in trammel net fishery. This could be attributed to the inefficiency of trammel net fishing gear when applied to this particular species, considering its distinct features and habitat characteristics. Following the imposition of a trawl ban in Kalpitiya, the exploitation of this particular shrimp has witnessed a sudden decline, despite its robust demand in commercial fisheries. To ensure the efficient utilization of this valuable shrimp resource, it is imperative to introduce an alternative and suitable fishing practice.

Meanwhile, various illegal fishing practices, such as sangili dhal, olai dhal and lagoon draggingare commonly occurring in the coastal areas of Kalpitiya. So, the Department of Fisheries (DFAR) must urgently monitor and regulate illegal fishing in this area to support resource sustainability and protect the livelihoods of small-scale fishermen.

Outputs

- Time series data on resource utilization and total production on trammel net fisheries
- Exploitation pattern and catch rates of penaeid shrimps related to the length, weight, sex, and maturity categorizations and its seasonal fluctuations in trammel net fisheries
- Socio-economic status and related Kalpitiya trammel net fisheries
- Recommendations for sustainable fishery resource management
- Scientific reports

PROJECT NO: 2.3.2

FISHERIES INDEPENDENT SHRIMP TRAWL SURVEY AND BIOMASS ESTIMATES IN THE KALPITIYA TRAWLING GROUND IN 2023

Objectives

- Scientific monitor on the trawling ground of Kalpitiya
- Produce fishery-independent biomass and abundance estimates for shrimps and bycatch species for fishery management
- Study the impact on shrimp and bycatchbiomass related to the temporary trawl ban on particular fishing ground

Findings

In total 89 species were recorded within the defined trawling ground, including shrimps, finfish, shellfish, and echinoderms. All together 2491 individual shrimp and fish were sampled for one or more individual parameters such as length, weight, maturity, sex and carapace length. The total biomass of all species combined was estimated to 221.173 ± 53.20 tons within the defined 4.3 nm^2 trawling ground and the density of all recorded species within the area was calculated as 51.43 $tons/nm^2$ (14.99 $tons/km^2$). The biomass consisted of 0.551 tons of shrimps, 187 tons of ponyfishes (Karalla) and 33.622 tons of other by-catch species (Fig 1).

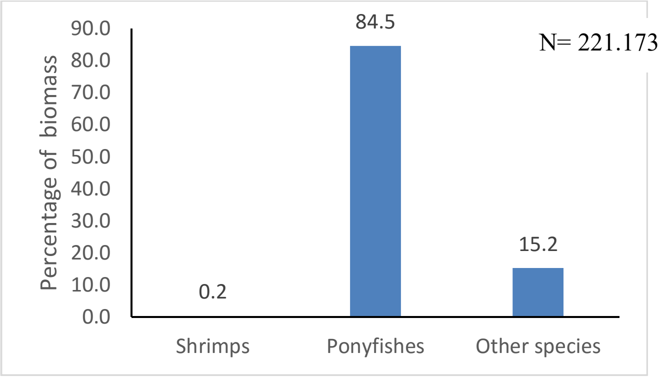


Figure 1. Biomass (%) distribution in the defined trawl ground/survey area (N= Total Biomass)

Biomass and abundance of shrimp species

With regards to shrimp, a total of five species (Penaeus semisulcatus, P. merguiensis, Metapenaeus affinis, M. moyebi and M. dobsoni) were recordedduring the survey. The total shrimp biomass was 0.551 tons within the defined 4.3 nm^2 survey area, and the total shrimp density was derived as 0.128 tons/nm^2. Each shrimp species with their respective biomass and abundance value is tabulated below (Table 1). The estimated total shrimp biomass was smaller compared with the 2021 survey which had 1.66 tons.

Table 11:Biomass and abundance estimates of shrimp species

SN	Shrimp species	Total biomass (kg)	Total Abundance (No of individuals)	Density (No of individuals /sq nm)	Density (kg/sq nm)
1	*Penaeus semisulcatus*	237	10136	2357.21	55.12
2	*Penaeus merguiensis*	304	8878	2064.65	70.70
3	*Metapenaeus affinis*	7.5	366	85.12	1.74
4	*Metapenaeus moyebi*	1.6	386	89.77	0.37
5	*Metapenaeus dobsoni*	1.0	99	23.02	0.23
Total		**551.1**	**19865**	**4619.77**	**128.16**

P. semisulcatus is the most abundant shrimp species) representing around 51 % of total shrimp abundance (Fig2), while *P. merguiensis* is the second most (45 % of total abundance). Furthermore, *M. affinis, M. moyebi* and *M. dobsoni* were rarely recorded during the survey. Although, *P. semisulcatus* showed the highest abundance, *P. merguiensis* contributed mainly to the biomass of shrimps. Meantime, *P. semisulcatus*had the second highest biomass and other shrimp biomass was also insignificant.

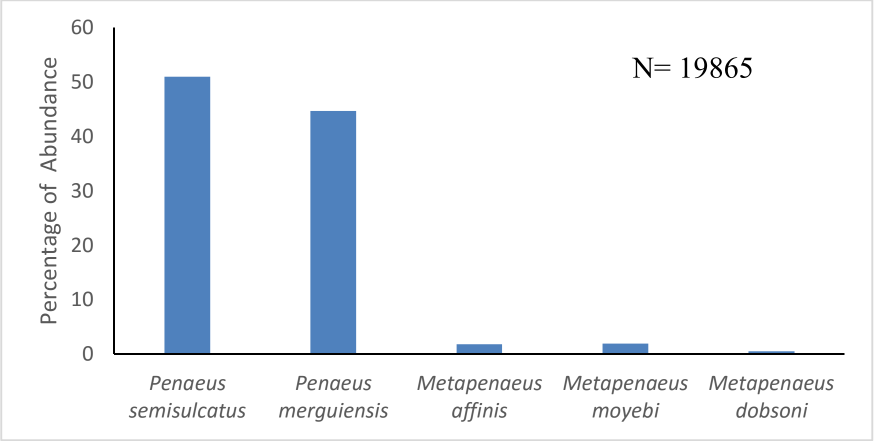


Figure 2. Abundance (%) variation among recorded shrimp species in Kalpitiya trawl ground

A bootstrap method with the replacement of the trawl stations was applied to get measures of the sampling variance. A high CV will indicate that the true abundance might be found within a vast range on either side of the mean estimate. This scenario is very unfortunate and may jeopardize the possibility of seeing trends in a survey time series, and thereby the development of the stock over time. In our case, however, the CV for the main target species *P. semisulcatus* was very low, at 0.18. This indicates that the sampling design and effort was good and provides a good estimate of the abundance within the survey area.

Length and weight distribution of shrimp species

For the most prominently caught shrimp species P. semisulcatus and P. merguiensis length distribution given in Figures 3 and 4 respectively.

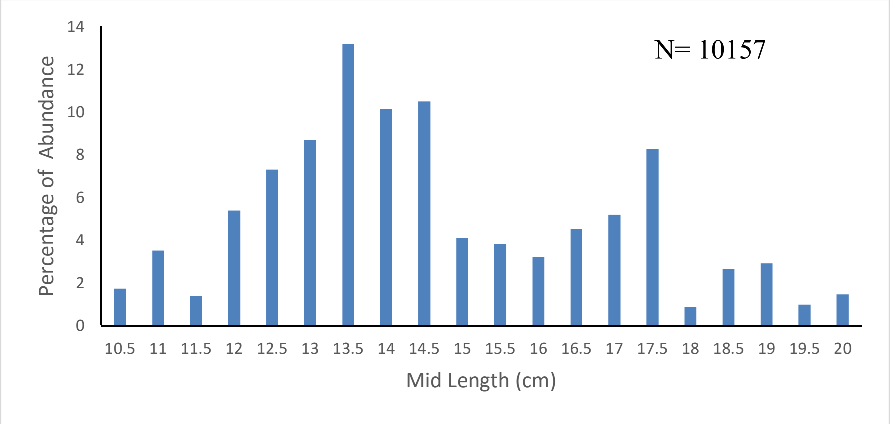


Figure 3. Length class distribution pattern of *Penaeus semisulcatus*

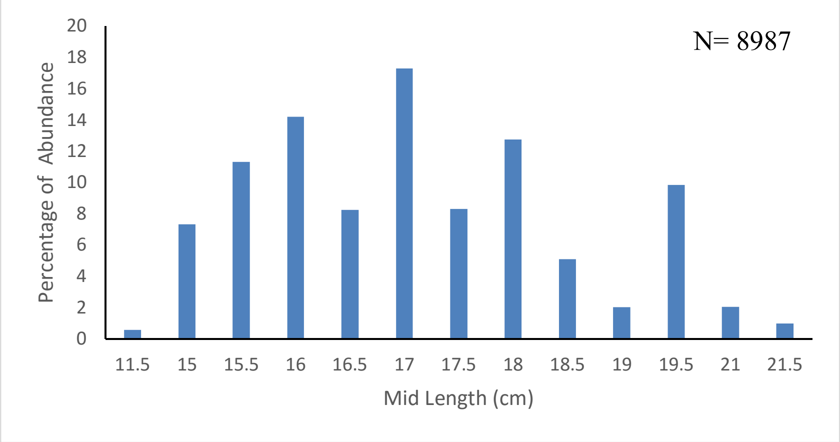


Figure 4. Length class distribution pattern of *Penaeus merguiensis*

Table 2 shows the mean values of individual total length and individual weight of different shrimp species that represent defined trawl ground.

Table 2: Mean individual length and weight distribution pattern of different shrimp species

	Individual Length (cm)			Individual Weight (g)		
Species	Min	Mean	max	Min	Mean	max
Metapenaeus affinis	13.5	14.4	15.5	17.0	20.6	25.5
Metapenaeus dobsoni	1.0	6.8	12.5	8.0	10.0	12.0
Metapenaeus moyebi	7.0	8.6	10.5	2.0	4.3	7.0
Penaeus merguiensis	11.5	17.1	21.5	14.3	34.3	72.6
Penaeus semisulcatus	10.5	14.7	20.0	5.7	23.5	61.0

Shrimp populations and individual mean sizes (length, weight) are considered as valuable parameters to provide information on sustainable fishing activity, especially with time series data. For instance, any reduction of size in one year compared to previous years, may indicate overfishing and it can help to resurge the sustainability. Similar to present survey, *P. semisulcatus* was the prominent shrimp species in the 2021 survey followed by *P. merguiensis*. The shrimp species, *P. indicus*, *P. monodon*, *P. vannamei* and *P. canaliculatus* which were recorded in the previous survey (2021) were absent in the present survey. Furthermore, *M. affinis* and *M. dobsoni* were newly recorded in present survey. The mean length of *Penaeus semisulcatus* (14.7 cm) was reduced compared to the 2021 survey (15.5 cm). In the other hand, *Penaeus merguiensis* mean length is increased from 15 cm to 17.1 cm.

In the analyses of abundance related to the maturation stage of shrimp species, the *P. semisulcatus* immature stage represents around 80% of the total population. The immature population of *P.indicus* slightly overrules the matured ones. However, matured individuals (about 85%) of *P.merguiensis* recorded in the 2021 survey has been reduced about 45 % in the present survey.Overall results among the whole shrimp communities in defined trawl ground, the most abundant shrimp *P. semisulcatus* dominated by females where no adult males were recorded. The second most abundant shrimp *P. merguiensis* also dominated by females.

Even though the trawl fishing activity is carried out by bottom trawl net, pelagic fish species are highly caught by the net. This may be explained by the shallow depth of the water column, trawl net design and swimming behaviour of fish. From the survey, the depth range within the survey area was between 6 - 9 m. During the trawl operations, highly migratory fast-swimming species could escape and slow movable species such as ponyfish could easily get caught.

Recommendations

The survey, when conducted over the years, will provide data that can be utilized to identify trends in stock development. The 23 trawlers previously operated 6 days a week in the small 4.3 square nautical mile trawling ground. Each week 100% of the seabed in the area was trawled, but still, catches are reasonable. This shows that there is a constant refilling of shrimps and fish from the surrounding areas into the trawling ground. It is likely to assume that overfishing and decline of the stock would be reflected in the declining refilling rate and consequently in future abundance estimates.

Declining trends may also be reflected in the average and maximum individual length and weight. Continued monitoring and establishment of time series surveying is therefore important. In combination with landing statistics, fisheries survey timeseries could give a good basis for the sustainable management of these resources.

In general, survey time series must be conducted in a consistent way from year to year so that the estimates are not influenced by a change in survey method or sampling gear. Due to the sudden trawl ban of 2022, the entire ecosystem seems to have undergone a complete shift between the two surveys. Consequently, any changes in abundance, species composition etc., cannot directly be attributed to fishing pressure or natural environmental changes, but rather to a human induced change of the ecosystem.

The time-series data directly contributes to the implementation of sustainable management strategies for the fish stock by considering the biomass and abundance estimates changes over years. This will reveal the degree of exploitation of the fishery resources and will help to resurge the sustainability of resources once overexploited. Sustainability can be achieved through the implementation of fishing restrictions, closed seasons, gear modifications, etc. So, this particular independence survey should be continuously carried out at a regular interval (one year or two years) for the better sustainability of shrimp resources in Dutch Bay.

Outputs

- Biomass and abundance time series data on penaeid shrimps and other bycatch species in Kalpitiya trawlfishing ground
- Abundance pattern of penaeid shrimps related to the length, weight, sex and maturity categorizations in Kalpitiya trawlfishing ground
- Comparison on the fishery resource existence in trawlfishing ground between previous and present survey
- Recommendations and future concernsfor the sustainable fishery resource management on Kalpitiya trawl fisheries
- Scientific reports

Other activities undertaken by RRC-Kalpitiya

- Circuit Bungalow: Accommodation facilities for researches and visitors. A considerable amount of funds has been earned by the RRC from the circuit bungalow
- Boat facilities are provided for research. RRC-Kal has boats and could be used in research activities
- Depuration of oysters with a cost. Income generating activity for NARA
- Educational guiding program and scientific supports for school and university students
- Site inspections for clearing the investor's application for the approval of development project by Sri Lanka Tourism Development Authority (SLTDA)

Workshops/ seminar/ meetings attended by RRC-Kal Scientists

1. Panelist (Dr. R.P.P.K. Jayasinghe): Panel discussion on "Biodiversity Beyond National Jurisdiction Agreement". Organized by the Laksman Kadiraganmar Institute and the European Union. 24 November 2023
2. Keynote Speaker (Dr. R.P.P.K. Jayasinghe): China-Sri Lanka Joint Symposium of Coral Reef Ecology. Speech on "Knowing the unknown: the way forward in coral taxonomy". Organized by the University of Ruhuna and the South China Sea Institute of Oceanology, Chinese Academy of Sciences (CAS)
3. Resource Person (Dr. R.P.P.K. Jayasinghe) for the Online workshop on "The Ocean Governance Training Programme" conducted by the International Ocean Institute (IOI) & NARA from 17th August to 10th September 2023
4. Training workshop on techniques on fisheries independent surveys (swept area trawl survey acoustic survey & sea cucumber stock assessment) via StoXsoftware package conducted by Mr. Totland Atle(IMR/Norway) under NOR-LANKA Bilateral Project
5. Management development Program on "New Paradigms in Fish Stock Assessment" organized by Bay of Bengal Program (BOBP) and NARA, held in Colombo, Sri Lanka during 25thMay – 01stJune 2023
6. Online Workshop on "Techniques in Freshwater Fish Stock Assessment" (A Sequel to the MDP on New Paradigms in Fish Stock Assessment), held on 12thJuly 2023
7. Online workshop on "The Ocean Governance Training Programme" conducted by International Ocean Institute (IOI) & NARA from 17th August to 10th September 2023
8. Trainingworkshop on CPUE standardization, stock and risk assessments conducted by Dr. Tom Nishida, held in NARA, Colombo from 25th September to 05th October 2023
9. FAO Workshop on "Mainstreaming Climate Change into International Fisheries Governance: the Case of Regional Fisheries Bodies in the Indo-Pacific Region", held in Tamil Nadu, India from 16th-19th of October 2023
10. Regional workshop on "Fisheries-related other effective area-based conservationmeasures in the Bay of Bengal and Southeast Asia" conducted by FAO & IUCN, held in Bangkok,Thailand from 6th to 8thDecember 2023

Foreign Travels

1. Indian Ocean Tuna Commission (IOTC) organized the 21st Working Party on Billfish (WPB21) 06-09 September 2023, La Reunion
2. Mini-Symposium and Forum of the EAF-Nansen Programme (FAO) in Maputo, Mozambique, 30 October-2 November 2023
3. 26th Scientific Committee Meeting (SC26) of Indian Ocean Tuna Commission (IOTC), 4-8 December 2023, Mumbai, India
4. FAO Workshop on "Mainstreaming Climate Change into International Fisheries Governance: the Case of Regional Fisheries Bodies in the Indo-Pacific Region", held in Tamil Nadu, India from 16th-19th of October 2023
5. Regional workshop on "Fisheries-related other effective area-based conservationmeasures in the Bay of Bengal and Southeast Asia" conducted by FAO & IUCN, held in Bangkok,Thailand from 6th to 8thDecember 2023

Committees Served

1. National Expert Committee Member on Biological Diversity (NECBD) coordinated through the Biodiversity Secretariat, Ministry of Mahaweli Development and Environment (Dr. R.P.P.K. Jayasinghe)
2. Dr. R.P.P.K. Jayasinghe has been appointed as the President for Sri Lanka Association for Fisheries and Aquatic Resources (SLAFAR) 2023/2024.
3. Kalpitiya RRC is serving as a member of the Puttalam Lagoon Management Committee and the Fisheries Management Committee. Puttalam District Secretariat chairs these committees.

Postgraduate students'research works supervised by Head/RRC-Kal

1. P.G.J.B. Gamage, Ph.D. Student. Department of Chemistry, University of Colombo
2. Supun Bandara Pallemulla, M.Phil. Student. Department of Fisheries, University of Jaffna

Publications

Full papers

1. R.P.P.K. Jayasinghe, K.H.K. Bandaranayake, S. Thanusanth. 2023. Application of DPSIR framework in tuna fisheries management in the Indian Ocean with special reference to Sri Lanka.*IOTC Working Party on Methods*. IOTC-2023-WPM14-09_Rev1.
2. W.K.A.M.T.S. Aththanayaka, H.M.U. Ayeshya, S. Thanusanth, S.C.V.U. Senevirathna, C.B. Madagedara and R.P.P.K. Jayasinghe. 2021. Present status of mangroves and sea grasses in the upper western border of the Puttalam Lagoon, Sri Lanka. *Journal of the National Aquatic Resources Research and Development Agency*. 48-50: 59-73.(Published in 2023)
3. K.H.K. Bandaranayake, S.S. Gunasekera, R.P.P.K. Jayasinghe and R. Maldeniya. 2023. Present Status and Future Developmental Perspectives of Pole and Line Fishery in Sri Lanka. Sri Lanka Journal of Aquatic Sciences 28(2): 55-64.
4. K.H.K. Bandaranayake, S.S. Gunasekera and R.P.P.K. Jayasinghe. 2023. Effect of bait types on catchability of billfish in tuna longline fishery in Sri Lanka. IOTC Working Party on billfish. IOTC-2023-WPB21-24_Rev1.
5. K.H.K. Bandaranayake, S.S. Gunasekara, R.P.P.K. Jayasinghe, D.R. Herath,V.K. Ranasinghe and S. Yatawaka. 2021. Reproductive morphology, morphometric aspects and molecular identification of *Scylla* (Mud Crab) species in Sri Lanka. Journal of the National Aquatic Resources Research and Development Agency 48-50: 14-25. (Published in 2023)
6. M.P. Hendawitharana, R.P.P.K. Jayasinghe, M.M.C. Karunarathne and S.S.K. Haputhantri. 2021. The present status of the shallow reef patches at the Bar Reef Marine Sanctuary, Sri Lanka. Journal of the National Aquatic Resources Research and Development Agency 48-50: 74-80. (Published in 2023)

Abstracts:

1. S. Thanusanth, R. Srikrishnan, M.M.A.S. Maheepala and R.P.P.K. Jayasinghe. 2023. Preliminary study on biological, fisheries and socio-economical aspects of Gastropod fisheries in Kalpitiya area, Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023.
2. S. Thanusanth, R. Srikrishnan and R. P. P. K. Jayasinghe. 2023. Exploring the fisheries aspects of fyke net fishery in Puttalam Lagoon, Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023.
3. H.A.D.N.N Happitiya, C. M. Nanayakkara, K. G. S. U. Ariyawansa, S. S. Ediriweera, N. N. Wijay-awardene, R. P. P. K. Jayasinghe, Don-Qin Dai, S. C. Karunarathna. 2023. Antibacterial Activities of Lichen-associated Fungi in Mangrove Ecosystems in Sri Lanka as Potent Candidates for Novel Antibiotic Agents. Proceedings of SLIIT International Conference on Advancements in Sciences and Humanities, 1-2 December, Colombo, 397-403.
4. P. H. H. J. Bandara, D. A. Arokkiam, S. S. Ediriweera, C. M. Nanayakkara, K. G. S. U.Ariyawansa, N. N. Wijayawardene, R. P. P. K. Jayasinghe, Don-Qin Dai, S. C. Karunarathna. 2023. Extracellular enzymatic activities of halophilic fungi in Kalpitiya area of Puttalam Lagoon, Sri Lanka. Proceedings of the 43rd Annual Sessions of Institute of Biology, Sri Lanka. 80p.
5. M.A.S. Ranjula, P. Jayasinghe, and M. I. G. Rathnasuriya. 2023. Larval fish assemblage in Western coastal waters of Sri Lanka: Seasonal and spatial structure. Proceedings of 46th Annual Larval Fish Conference, Lisbon, Portugal. 71p.
6. M. K. D. Fernando, S. S. Ediriweera, C. M. Nanayakkara, N. N. Wijayawardene , R. P. P. K. Jayasinghe, Don-Qin Dai, S. C. Karunarathna, K. G. S. U. Ariyawansa. 2023. Diversity of fungal endophyte morphotypes of Mangrove plant *Avicennia marina* in the Puttalam Lagoon, Sri
7. Lanka. Proceedings of the 43rd Annual Sessions of Institute of Biology, Sri Lanka. 79p.
8. D.P.T.H.De Silva, W.N.N. Dabarera, S.S. Ediriweera, C.M. Nanayakkara, K.G.S.U. Ariyawansa, N.N. Wijayawardene, R.P.P.K. Jayasinghe, S.C. Karunarathna, D.Q. Dai. 2023. In vitro evaluation of the antioxidant activity of selected fungal endophytes isolated from two species of family Pandanaceae in Sri Lanka. Proceedings of the 43rd Annual Sessions of Institute of Biology, Sri Lanka. 81p
9. R.G.S. Anurangi, C.M. Nanayakkara, S.S. Ediriweera, N.N. Wijayawardene, R.P.P.K. Jayasinghe, Dong-Qin- Dai, S.C. Karunarathna, K.G.S.U. Ariyawansa. 2023. Diversity and industrial potential of endophytic fungi isolated from *Avicennia marina* in the Puttalam Lagoon, Sri Lanka. Proceedings of the 43rd Annual Sessions of Institute of Biology, Sri Lanka. 84p
10. K.H.K. Bandaranayake, S.S.K. Haputhantri and R.P.P.K. Jayasinghe. 2023. Recolonization of macro-zoo benthos in sand dredging site located off shore Negombo, Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023. 78p.
11. Y.C. Aluwihare, R.P.P.K. Jayasinghe, S.S.K. Haputhantri1, S. Fernando 2, M.S. Gunasinghe, R.D.C. Ranasinghe, M.A.S. Ranjula, T.N. Weerakoon and P.N. Psomadakis. 2023. The first record of a very rare adult Pacific squaretail, *Tetragonurus pacificus* from the Indian Ocean. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023. 34 p.
12. A.A.S.H. Athukoorala, K.R. Dalpathadu, S.S. Gunasekara, M.P. Hendawitharana, M.M.C. Karunarathne, M.D.I.C. Kumara, J.A. C. Prasad, S.C.V.U. Senevirathna, R.P.P.K. Jayasinghe. Stock status of Sea cucumbers on the North East coast of Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2023. 22 p.

5.13 REGIONAL RESEARCH CENTER – KAPPARATHOTA

Head of the Division : Mr. Upul Liyanage

PROJECT NO : 10.1

STUDYING THE SUITABILITY OF DETERRENT PINGERS AGAINST DEPREDATION OF HOOKED YELLOWFIN TUNA AND MITIGATION OF FISHERIES AND MARINE MAMMAL INTERACTIONS.

The depredation of valuable fish species trapped to the longline poses a significant challenge for pelagic fishermen. This issue encompasses economic losses, unreported catches, and the risk of entanglements, compounding the concerns associated with sustainable fishing practices. This concerted effort aims not only to comprehend the complexities of these encounters but also to formulate effective mitigation strategies. The exploration of such strategies holds paramount importance, serving as a proactive response to strike a harmonious balance between sustainable fishing practices and the conservation of cetacean populations.

The current study revealed that 25% of the yellow fin tuna catch of the Sri Lankan pelagic long liners were destroyed by the four species of marine mammals annually. Depredation index, Damaged rate and Depredation rates are consequently 1.25, 26% and 33%. The estimated depredation indices underscore the significant challenge that depredations pose for lonliners. Furthermore, a questionnaire survey revealed that no entanglement of marine mammals occurred during operations in 2023. Consequently, the available data on pinger trials is insufficient to draw a robust conclusion regarding the efficacy of the pingers for depredation control. Despite facing a notable increase in depredation in the equatorial region compared to the Bay of Bengal and Arabian Sea, fishermen have exhibited a preference for this challenging zone.

A comprehensive examination of cetacean diversity and abundance was conducted off Mirisa; the most sensitive marine ecosystem in Sri Lanka. According to the study 13 species of marine mammals were recorded. Blue whale (*Balaenoptera musculus indica*), exhibited reduced frequency off Mirissa in 2023, similar to the previous years. This decline in abundance raises the need for a comprehensive study to understand the potential medium-term negative consequences stemming from the Xpress Pearl disaster.

Publications : Manuscript is in the process of preparing

Meetings attended:

- Stake holder meeting regarding declaration of the Mirissa sanctuary held at Prim minister’s office (comments and technical assistance were given).
- Many meetings held at Foreign Ministry regarding shifting of Traffic Separation Scheme (TSS) (Facts given).
- Meeting held at International Maritime Organization (UK).

Training

Training was given for the selected longliners on how to use deterrent pingers.

5.14 REGIONAL RESEARCH CENTER – PANAPITIYA

Head of the Division : Mr. D. A. Athukorala, Dr.G.S.C.Perera & Dr. W. Rajapakshe

DEVELOPMENT OF ORNAMENTAL FISH FEED AND ORNAMENTAL FISH CULTURE AT REGIONAL RESEARCH CENTER, PANAPITIYA, NARA.

Officer/s responsible : Dr. G. S. C. Perera, Dr Wasantha Rajapaksha, Mr. D. A. Athukorala
Budget : 1.4 Mn

Introduction

The ornamental fish industry in Sri Lanka provides an excellent business opportunity for the people due to the prevailing high demand for ornamental fish in the local and international markets. In addition, at the moment the government has identified ornamental fish exports as one of the key strategies that can be used to increase export earnings to overcome the current economic crisis in Sri Lanka. However, one of the major challenges facing ornamental fish farmers is the high operational cost of fish farming. However, the lack of cost-effective, quality ornamental fish feeds on the local market is one of the main issues in this industry. Although some fish farmers are tempted to produce the fish feed they need by themselves, they are unable to produce quality and cost-effective fish feed due to the lack of proper knowledge of it. Therefore, this component aims to introduce developed ornamental fish feeds and low-cost feed formulas to ornamental fish farmers and small-scale ornamental fish feed producers.

Even though many people are engaged in ornamental fish farming on a small scale, most of them do not have enough space or special facilities to maintain a proper brood stock on the farm. Therefore, most ornamental fish farmers tend to purchase the seeds from other breeders and raise them into fingerlings or advanced fingerlings in their limited cement tanks or mud ponds. However, one of the major problems faced by ornamental fish farmers is the inability to get enough seeds on time. Koi brooders were supplied to the required farmers and the other varieties of ornamental fish such as guppy, and swordtail were raised to generate income and also to use the available space properly.

Objectives

- To introduce cost-effective, quality ornamental fish feeds to small-scale ornamental fish farmers as an alternative to imported ornamental fish feeds.
- To introduce scientifically tested feed formulas to small-scale fish feed producers to produce cost-effective, quality feed for ornamental fish farming.
- To generate income by selling ornamental fish feeds.
- To supply good quality KOI Carp and other popular ornamental fish fingerlings and brooders for the ornamental fish farmers.
- To generate income by selling KOI Carp and other popular ornamental fish fingerlings and brooders.

Activities carried out

- Conducted and completed four experiments on aqua feed and nutrition.
- Produced and sold the aqua feeds.
- Developed and improved the fish feed formulas.
- Bred, reared, and sold ornamental fish.
- Conducted workshops.
- Consulted the farmers on aqua feed production and ornamental fish production.

International Publications

Topic	Replacing the unsustainable and wild-caught fishmeal with field cricket (*Gryllus bimaculatus*) meal in Catla (*Catla catla*) fry diet: Effect for growth, *in vivo* digestibility, carcass composition liver functions and disease tolerance.
Authors	G.S. Champika Perera, M.R. Afridin, A.M.A.N. Adikari, P.P.M. Heenatigala, K.L.W.T. Maduka, S.B.K. Dunusinghe
Journal & Publisher	Aquaculture International (Springer Nature)
Country	Netherland
Impact Factor	2.953
Citations	
Contribution for policy development/ country economy	Sri Lanka spends a considerable amount of foreign money to import aqua feeds. One of the main issues in producing local fish feed is the higher price of fish meal, which is the crucial ingredient. Simultaneously, there is international pressure to use alternative sources of fishmeal because they are not sustainable and go against the U.N.'s sustainable goals. Insect meal has been identified as an eco-friendly and sustainable substitute for fishmeal. There is a great potential to produce it locally. Therefore, the results of the experiment will help to save foreign money in the long term

Topic	Fishmeal replacement by House cricket (*Acheta domesticus*) and Field cricket (*Gryllus bimaculatus*) in Tilapia (*Oreochromis niloticus*) fingerling feed
Authors	G.S. Champika Perera, Anusha D. Perera, Chonikarn Piyavoraskul, Suntree Pumpuang
Journal & Publisher	Aquaculture Studies (Central Fisheries Research Institute, Turkey)
Country	Turkey
Impact Factor	0.72
Citations	3
Contribution for policy development/ country economy	(Same contribution mentioned in the above.)

Experiments completed

1. Replacing the fishmeal with Black soldier fly meal in Nile tilapia fry feed: Effect for growth, carcass composition, and histopathological alterations.
2. Usage the shrimp feeds as an ornamental fish diet: Effect for growth, liver functions, and pigmentation.
3. Replacing the fishmeal with ground cricket meal in Nile tilapia diet: Effect for growth.
2. Growth performance and immune response of Koi Carp (*Cyprinus carpio*) to different concentrations of Hathawariya leaves (*Asparagus racemous*) against (*Aeromonas hydrophilla*).

INCOME GENERATION THROUGH ORNAMENTAL FEED AND ORNAMENTAL FISH PRODUCTION:

Total Income for the year: Rs. 1,444,057.50

Fish Feed Production Progress

Table 1: Fish feed production by category

Category	Production (Kg)
Feed production for internal usage	620.05
Feed production for sale	1535.23
Feed balance as at 31.12.2023	66.38
Total production	2221.66

Total production for the year: 2221.66 Kg (2.22 Tones)

Table 2. Monthly Fish feed production progress by different types of feed

Month	**Nursery Feed (Kg)**	**02 mm Grower (Kg)**	**05 mm Grower (Kg)**	**Breeder Feed (Kg)**	**Feed Amount (Kg)**	**Feed Income (Rs.)**
January	76.25	18.25	96.26	0.00	190.75	110,815.00
February	58.50	44.00	74.90	0.00	177.40	111,722.00
March	9.75	24.25	59.00	0.00	93.00	63890.00
April	7.50	7.25	40.00	0.00	54.75	37010.00
May	19.50	32.25	53.00	0.00	104.75	71652.00
June	22.25	44.75	96.75	0.00	163.75	110102.50
July	7.25	16.75	71.25	0.00	95.25	69181.00
August	26.75	32.75	140.00	0.00	199.50	132070.00
September	11.00	20.25	64.50	0.00	95.75	64070.00
October	12.00	27.00	76.50	0.00	115.50	78978.00
November	22.25	45.00	124.25	1.00	192.50	127191.00
December	13.25	10.00	21.58	7.50	52.33	36686.00
Total	286.25	322.50	917.99	8.50	**1535.23**	**1013367.50**

Total fish feed income - Rs. 1,013,367.50

Ornamental fish production progress

Table 3: Ornamental fish production by category

Category	Amount
Number of fish sold	9039
Income Generation	Rs. 430690.00

Table 4. Monthly ornamental Fish production by species

Month	Koi Carp	Guppy	Sword Tail	Platy
January	6	46	300	80
February	10	386	585	586
March	0	0	594	185
April	0	52	36	30
May	0	116	1434	91
June	516	150	348	232
July	96	150	212	258
August	61	60	118	40

September	172	34	102	0
October	131	36	137	32
November	267	17	102	357
December	370	204	286	14
Total	**1629**	**1251**	**4254**	**1905**
Grand Total	**9039**			

Table 5: Monthly ornamental fish selling income

Month	**Fish Income (Rs)**
January	24491.00
February	46998.00
March	12880.00
April	2275.00
May	20335.00
June	90475.00
July	39500.00
August	27435.00
September	35780.00
October	37900.00
November	49216.00
December	43405.00
Total	**430690.00**

Training providing for the university students

Table 6: Information of the trained student at Panapitiya RRC

	Student Name	University	Faculty	Program	Duration
1	H.G. Nethmi	Ocean University of Sri Lanka	Fisheries and Ocean Science	Diploma in Aquaculture and Aquatic Resources Management	06 months (20.02.2023-17.08.2023)
2	D.K. Gihani	Ocean University of Sri Lanka	Fisheries and Ocean Science	Diploma in Aquaculture and Aquatic Resources Management	03 months (20.02.2023-22.05.2023)
3	W.D.V. Harshana	University of Ruhuna	Agriculture	B.Sc. in Agriculture	02 months (17.08.2023-18.10.2023)
4	M.C.KS. Salgadu	University of Ruhuna	Fisheries, Marine Sciences, and Technology	B.Sc. in Fisheries and Marine Sciences	02 months 14.12.2023-15.02.2024)
5	D.R. Sandaruwani	University of Ruhuna	Fisheries, Marine Sciences, and Technology	B.Sc. in Fisheries and Marine Sciences n	02 months (14.12.2023-15.02.2024)
6	S.A.D.N. Senanayake	University of Peradeniya	Agriculture	B.Sc. in Agricultural Science and Technology	02 months (27.12.2023-)

Training and Workshops

Table 7: Workshops conducted at Panapitiya RRC

Date	Topic	No. of Participants
15.03.2023	Identifying the issues in the commercial aquatic plant production industry	23
18.08.2023	Solutions for identified issues in the commercial aquatic plant production industry	32

Progress: Physical : 94% Financial :100%

Output

- Developed ornamental fish feed formulas
- Economical ornamental fish feed production for ornamental fish farmers
- Quality ornamental fish brooders and other ornamental fish stages for ornamental fish farmers.
- Income generation

Outcome

- Increased production of locally made economical ornamental fish feeds
- Reduction of money spend on foreign ornamental fish feeds

Constraints

- Extruder parts have been overused and therefore, it affects the physical quality of the feeds.
- Insufficient water supply in dry weather period which led to low ornamental fish production.

6. ANCILLARY SERVICES

6.1 PURCHASING & SUPPLY UNIT

Head of the Divison : Mr.N.S.Hewagama

Purchasing & Supply Officer : Ms A.T.P.Kumari De Silva

Introduction

The premier function of the division is to provide all necessary services and supplies in a formal and systematic manner in accordance with procurement guide lines in order to carry out research & development activities of divisions of National Aquatic Resources Research & Development Agency and Regional Research Centers.

Overview of the Division

Purchasing & Supply Division was established with effect from 23/05/2007.The functions and responsibilities of the unit are as follows.

- Supply goods and services relevant to the all divisions
- Handle all tender works
- Procurement works relevant to all divisions
- All insurance matters
- Prepared by payment voucher
- Air freight and clearance of goods
- Auction work relevant to disposal items
- Provide details to all divisions on their requirement

Performance

1. According proper tender procedures Mainly purchase of ongoing projects,

- Purchase of Lab Equipment & Chemical Items
- Purchase of marine diesel for vessel & maintenance
- Purchase of Boat equipments & Net
  - Boat/spare parts for repair for boat
  - All diving equipment
  - Covering net

2. Purchase of equipments & materials for work sites

- Iron /Aluminum goods
- Brick/Cement
- All types of electrical accessories

3. Purchase of all vehicle Parts & Service

- Supply of Tyre, Battery
- Upholstering, supply of canopies for vehicle
- Supply of vehicle DVD, radio, reverse camera

4. Purchase of all technical equipment & Accessories

- Computer/ Laptop computer
- Photocopy machine, Printer
- Air conditioner
- CCTV camera etc,

5. Purchase of Stationery Items

- Library books

- Stationery required for office
- Photocopy & Printer Toner

6. Purchase of sanitary items
- Soap & all cleaning equipment

7. Furniture & other goods
- Office Cupboard
- Office table &,chair

8. Construction for office building
- Minior repairing
- Aluminium works
- Construction for building (ICTAD/NCCAL)

9. Supply of Services
- Supply of meals & festival equipment for ceremonies
- Printing work
- Security service & Cleaning service
- Office Transport service
- Custom clearance & forwarding work
- Currating & Tailoring work for office

In the year 2023, no new suppliers were registered, and in the year 2022, the registered suppliers were re-approved and bids were made using Rainbow Pages and newspaper advertisements. Calling of tenders, Bid from local and foreign supplies for goods /equipments /Lab equipments/Chemicals following tender procedures as per the given specifications. Purchase of goods for day to day use by utilizing a petty cash Imprest and maintain records.

For the year 2023, the division has maintained about 054 Tenders following the tender procedures & 137 major files are process.

1. Clearance of goods received as donations, purchase of goods from foreign sources or airfreight of goods for repairs. Take actions where necessary to obtain tax relief when clearances of goods received from foreign sources are done & sending equipments for repair Etc: Abroad subject to normal mail & airfreight charges.

2. Insure all vehicles /motor- cycles/equipment of NARA through proper tender procures. Obtain insurance coverage for the personal perform duty at sea and land.

3. To provide a smooth service to the NARA,the staff of the unit has been responsibility.

6.2 SERVICE AND OPERATION DIVISION

Head of the Division : Eng.S.K.S.Liyanaarachchi

ENGINEERING & MAINTENANCE DIVISION

Overview of the Year

Engineering & Maintenance Division is a supportive division of the institution. The Engineering& Maintenancedivision provides and maintains all the services and develops the infrastructure facilities in line with the work programs of the institution.

Activities

Engineering & Maintenance Division has several activities. They are categorized as follows;

1. Rehabilitation works of NARAH/O & regional Canters' buildings.
2. Installation and maintenance of air conditioners &electrical/electronic appliances & maintenance of electrical distribution system.
3. Mechanical & other maintenance works.
4. Repair & maintenance work of SamuddrikaResearch Vessel.
5. Repair & maintenance of vehicles.

For the year 2023, in addition to that, day-to-day maintenance, below below-mentioned workshave been completed.

Rehabilitation of NARA & other regional center buildings.

- HEAD OFFICE
  - Repair of furniture (office chairs, office tables etc.)
  - Repair of aluminum doors
  - Repair of the canopy roof-pond area of the main building
  - Repair of ceiling-labor quarters room
  - Renovation of quarters building
  - Repair of the roof-iarad old building
  - Repairing work of finance toilet
  - Painting work of the metal display cupboards-coral unit
  - Repairing work of FTD toilet
  - Upgrading of existing building adjoins to the cleaning service room
  - Painting work of Wadiya building
  - Painting work of fish model on out site
  - Sandblast sticker applying & amp; painting work of conference hall-library
  - Plant tissue culture laboratory
  - Painting work of the main building's front wall & lobby area

- REKAWA
  - Observation of hut roof work

- KALPITIYA
  - Renovation of circuit bungalow
  - Renovation of the rainwater gutter of the main building

- KAPPARATOTA
  - Repair of office buildings

- Painting work of office buildings
- Aluminum window repair work for buildings
- Painting work of old buildings
- Repair of front buildings
- Repair of front buildings
- Repair of front buildings -phase 2

Installation and maintenance of air conditioners &electrical/electronic appliances

- Renewal of service agreements of A/C units & installation of new units.
- Renewal of Service Agreement for Office Equipment (Fax, Photocopy Machine, PABX system, Fingerprint Machines).
- Renewal of Service Agreement for Lab Equipment (IPHT & IARAD)
- Maintenance and servicing of laboratory equipment.
- Maintenance and servicing of the PABX.
- Maintenance and servicing of photocopy machines, printers, and fingerprint machines.

Mechanical &Other Maintenance

- Renovate the seawater circulate system at the IARAD hatchery.
- Renovatethe steel structure of the net house at the IARAD hatchery.
- Renovate fish summoning unit at IPHT (Login new Amino sheets, fabricate new steel frame and painting.)
- Fabricate steel grills for the IARAD office area.
- Fabricatealuminum fish measuring boards for MBRD.
- Fabricate fish pellet entrader machine for IARAD.
- Renovate the Water supply system at Kadolkele RRC.
- Renovate steel roof structure at Moiua Heeding Tonus at IARAD.

Maintenance Work of Samuddrika Vessel

Provided required spare parts & services for the day-to-day maintenance of the research Vesseland maintain as per the Bureau Verities Classification requirements.

- Dry docking and repairs of the RV Samuddrika – Total Repair cost Rs. 31, 762,114.57

Rehabilitation of Vehicles

There are 20 vehicles&06Motorcyclesin the NARA fleet and 26out of fleet taken for rehabilitationduring the year. The vehicles that underwentrehabilitation were;

Reg No. –
61-4803
61-6251
32-2951
PA 5935
PA 5262
PC-4035
GY -0027
PB-8107
PH-1712
PF-7675
PH-0667
PH-0673

PH-0676
PB 7365
NA -7487
NB - 1486
NC-5724
300-7308
KX - 8224
GD -8084
JR-8530
JR-8552
US-5160
US-5197
US-5254
VL-2710

In addition to the above, Rs.5,996,791.35spent for services, running repairs, license, and insurance of the fleet during the year. 20 vehicles &6Motorcycleswere effectively utilized for the running of 285,447km during the year.

Annual Fleet Cost –Year 2022

a) Rehabilitation running repairs and services cost Insurance & License fee (From recurrent Budget)	Rs. 5,996,791.35
b) Vehicle Monitoring System	Rs. 336,155.17
c) Fuel Cost	Rs. 10,390,937.64

* Excludingdriver's salary, overtime, subsistence and maintenance staff cost.

NATIONAL AQUATIC RESOURCES RESEARCH AND DEVELOPMENT AGENCY

STATEMENT OF FINANCIAL POSITION AS AT 31 ST DECEMBER 2023

	Notes	31.12.2023 Rs. Cts.	Restated 31.12.2022 Rs. Cts.
ASSETS			
CURRENT ASSETS			
CASH AND CASH EQUIVALENTS	1	201,511,816.03	28,763,189.91
TRADE AND OTHER RECEIVABLES	2	29,636,893.59	30,532,650.83
INVENTORIES	3	1,494,404.86	1,513,019.44
PREPAYMENTS	4	1,721,522.84	2,136,832.70
		234,364,637.32	62,945,692.88
NON-CURRENT ASSETS			
RECEIVABLES-DISTRESS LOAN	5	14,660,121.76	11,078,373.88
INFASTRUCTURE, PLANT AND EQUIPMENT	6	148,213,581.50	194,436,413.45
LAND AND BUILDINGS	6	3,491,427,332.59	3,537,384,720.06
CAPITAL WORK IN PROGRESS	7	23,123,278.43	23,593,927.00
			150,242,239.67
		3,677,424,314.28	3,916,735,674.06
TOTAL ASSETS		3,911,788,951.60	3,979,681,366.94
LIABILITIES			
CURRENT LIABILITIES			
ACCOUNTS PAYABLES	8	99,871,356.27	128,686,621.99
ACCRUED EXPENSES	9	27,448,707.06	25,878,728.30
		127,320,063.33	154,565,350.29
NON-CURRENT LIABILITIES			
PROVISION FOR GRATUITY	10	128,661,617.25	135,923,268.75
		128,661,617.25	135,923,268.75
TOTAL LIABILITIES		255,981,680.58	290,488,619.04
NET ASSET		3,655,807,270.44	3,689,192,747.90
ACCUMULATED FUNDS	11	216,338,859.45	300,296,402.79
RESERVES	12	3,439,468,411.10	3,388,896,344.10
TOTAL EQUITY AND LIABILITIES		3,655,807,270.55	3,689,192,746.89

THE SIGNIFICANT ACCOUNTING POLICIES AND NOTES ANNEXED FORM AN INTEGRAL PART OF THESE FINANCIAL STATEMENTS.

…………………………	…………………………	…………………………
G.W.N. PAVITHRA	**N.S. HEWAGAMA**	**DR. T.D.K.D. TENNAKOON**
ASSISTANT DIRECTOR (FINANCE)	**DIRECTOR (FINANCE)**	**DIRECTOR GENERAL**

APPROVED AND SIGNED ON BEHALF OF THE BOARD.

…………………………………	…………………………………
DR. NIMAL KUMARASINGHE **CHAIRMAN**	**BOARD MEMBER**

COLOMBO 08th APRIL 2024

NATIONAL AQUATIC RESOURCES RESEARCH AND DEVELOPMENT AGENCY

PERFORMANCE STATEMENT FOR THE YEAR ENDED 31 ST DECEMBER 2023

		31.12.2023	Restated 31.12.2022
	NOTE	Rs. Cts.	Rs. Cts.
REVENUE			
GOVERNMENT GRANT	13	475,918,793.20	462,021,998.69
OTHER INCOME	14	65,681,489.55	19,095,550.18
AMORTIZATION OF LOCAL & FOREIGN GRANT	15	118,359,400.78	113,069,355.57
PROJECT CONSULTANCY INCOME	16	11,731,747.01	98,206,013.08
TOTAL REVENUE		671,691,430.54	692,392,917.52
EXPENSES			
PERSONNEL EMOLUMENTS	17	293,267,231.72	327,416,156.20
TRAVELLING & SUBSISTENCE	18	1,311,664.61	166,373.00
SUPPLIES & CONSUMABLES USED	19	3,891,982.82	3,485,367.50
MAINTENANCE EXPENDITURE	20	63,905,978.98	17,390,743.24
CONTRACTUAL SERVICES	21	58,020,244.47	41,083,668.61
EXPRESS PEARL BURNING SHIP	22	7,235,623.33	
RESEARCH & DEVELOPMENT EXPENDITURE	22	48,303,793.20	60,542,646.26
DEPRECIATION & AMORTIZATION EXPENSES	23	118,359,400.78	113,069,355.56
OTHER OPERATING EXPENSES	24	15,122,667.60	11,659,427.36
PROJECT CONSULTANCY EXPENDITURE	25	11,731,747.01	79,491,371.35
TOTAL EXPENSES		621,150,334.52	654,305,109.08
SURPLUS (DEFICIT) FOR THE YEAR		50,541,096.02	38,087,808.44

THE SIGNIFICANT ACCOUNTING POLICIES AND NOTES ANNEXED FORM AN INTEGRAL PART OF THESE FINANCIAL STATEMENTS.

NATIONAL AQUATIC RESOURCES RESEARCH AND DEVELOPMENT AGENCY

CONSOLIDATED CASH FLOW STATEMENT FOR THE YEAR ENDED 31 ST DECEMBER 2023

	31.12.2023	31.12.2022
CASH GENERATED FROM OPERATING ACTIVITIES		
OWN INCOME	6,466,501.60	10,649,323.85
OTHER INCOME	159,891,769.11	48,817,389.69
RECURRENT GRANT	427,615,000.00	400,500,000.00
CONSULTANCY RECEIPTS	5,262,327.58	90,457,202.93
PROJECT EXPENDITURE	(62,062,928.46)	(42,759,703.66)
	537,172,669.83	**507,664,212.81**
PAYMENTS		
GRATUITY PAYMENTS	15,047,720.86	11,581,229.96
OTHERS	291,924,277.15	474,766,079.48
PERSONAL EMULUMENTS	254,186,048.75	9,173,204.33
CONSULTANCY EXPENDITURE	8,561,943.67	55,576,957.92
	569,719,990.43	**551,097,471.69**
CASH GENERATED FROM OPERATING ACTIVITIES	**(32,547,320.60)**	**(43,433,258.88)**
CASH FLOWS FROM INVESTING ACTIVITIES		
PURCHASE OF PROPERTY PLANT AND EQUIPMENT	(3,626,362.00)	(18,904,661.00)
WORK IN PROGRESS	(97,730.95)	(1,264,295.39)
FIXED DEPOSIT INVESTMENTS	380,242,239.67	(150,000,000.00)
FIXED DEPOSIT INVESTMENTS	(230,000,000.00)	
CASH GENERATED FROM INVESTING ACTIVITIES	**146,518,146.72**	**(170,168,956.39)**
CASH FLOWS FROM FINANCING ACTIVITIES		
CAPITAL GRANT RECEIVED	58,778,000.00	34,920,000.00
CASH FLOWS FROM FINANCING ACTIVITIES	**58,778,000.00**	**34,920,000.00**
INCREASE/ (DECREASE) IN CASH AND CASH EQUUIVALENTS DURING THE YEAR	**172,748,826.12**	**(178,682,215.27)**
CASH AND CASH EQUIVALENTS AT THE BEGINNING OF THE YEAR	**28,762,989.91**	**207,445,405.18**
CASH AND CASH EQUIVALENTS AT THE END OF THE YEAR	**201,511,816.03**	**28,763,189.91**

NATIONAL AQUATIC RESOURCES RESEARCH AND DEVELOPMENT AGENCY

STATEMENT OF CHANGES IN EQUITY FOR THE YEAR ENDED 31ST DECEMBER 2023

	ACCUMULATED FUND							
	GOVERNMENT CONTRIBUTION	FOREIGN GRANT	LOCAL GRANT	ACCUMULATED EXPENDITURE OVER INCOME	REVALUATION RESERVES	OWN INCOME 5%	NON FUNCTIONAL PROJECTS	TOTAL
BALANCE AS AT 1ST JANUARY 2022	360,585,181.00	18.792.465.12	43,296,334.03	(757,717,197.64)	4,087,954,743	2.754,064.20	5,306,016.35	3,760,971,606.06
FUNDS RECEIVED DURING THE YEAR	34,920,000.00		2,397,130.00	15,009,893		2,211,649.70		54,538,673.11
FUNDS UTILISED DURING THE YEAR	(61,524,498.69)							(61,524,498.69)
FUNDS TRANSFERS DUE TO REALLOCATION	(104,036,020.89)	(7,722,920.73)	(2,228,071.97)	(3,728,781)				(117,715,794.51)
ADJUSTMENTS								
ADJUSTMENTS FOR THE YEAR								
NET SURPLUS/ (DEFICIT) FOR THE YEAR				67,477,464.00				67,477,464
BALANCE AS AT 31.12.2022	229,944,661.42	11,069,544.83	43,465,392.06	(678,958,621.15)	4,087,954,743	4,965,713.90	5,306,016.35	3,703,747,450.41
BALANCE AS AT 01ST JANUARY 2023	229,944,661.42	11,069,544.83	43,465,392.06	(678,958,621.15)	4,087,954,743	4,965,713.90	5,306,016.35	3,703,747,450.41
FUNDS RECEIVED DURING THE YEAR	58,778,000.00						(454,471.57)	58,323,528.43
FUNDS UTILISED DURING THE YEAR	(48,303,793.20)			19,794,933.14				(28,508,860.06)
ADJUSTMENTS	(4,232,609.95)	28,467,509.29	5,350,448.36	(49,680,998.56)				(20,095,650.86)
ADJUSTMENTS	3,171,487.02		6,987,620.29					10,159,107.31
FUNDS TRANSFERS DUE TO REALLOCATION	(100,975,967.39)	(12,630,853.00)	(4,752,580.28)					(118,359,400.67)
NET SURPLUS/ (DEFICIT) FOR THE YEAR				50,541,096.02				50,541,096.02
BALANCE AS AT 31ST DECEMBER 2023	138,381,777.90	26,906,201.12	51,050,880.43	(658,303,590.58)	4,087,954,743	4,965,713.90	4,851,544.78	3,655,807,270.55

THE SIGNIFICANT ACCOUNTING POLICIES AND NOTES ANNEXED FORM AN INTEGRAL PART OF THESE FINANCIAL STATEMENTS.

FLS/A/NARA/1/F/A/2023/01 07 October 2024

Chairman
National Aquatic Resource Research and Development Agency

Report of the Auditor General on the Financial Statements and Other Legal and Regulatory Requirements of the National Aquatic Resource Research and Development Agency for the year ended 31 December 2023 in terms of Section 12 of the National Audit Act, No. 19 of 2018

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1. Financial Statements

1.1 Qualified Opinion

The audit of the financial statements of the National Aquatic Resource Research and Development Agency for the year ended 31 December 2023 comprising the statement of financial position at 31 December 2023 and the statement of financial performance, statement of changes in equity and cash flow statement for the year then ended, and notes to the financial statements, including a summary of significant accounting policies including a summary of significant accounting policies, was carried out under my direction in pursuance of provisions in Article 154 (1) of the Constitution of the Democratic Socialist Republic of Sri Lanka read in conjunction with provisions of the National Audit Act No. 19 of 2018, National Aquatic Resources Research and Development Agency Act No. 54 of 1981 and Finance Act No. 38 of 1971. My report to Parliament in pursuance of provisions in Article 154 (6) of the Constitution will be tabled in due course.

In my opinion, because of the significance of the matters discussed in the basis for qualified opinion section of my report, the accompanying financial statements give a true and fair view of the financial position of the Agency as at 31 December 2023, and of its financial performance and its cash flows for the year then ended in accordance with Sri Lanka Public Sector Accounting Standards.

1.2 Basis for Qualified Opinion

(a) According to the Section 29 of Sri Lanka Public Sector Accounting Standard 2, in preparing the Cash Flows Statement under the Direct method, the net flow from operating activities should be compared with the surplus generated from normal activities and should be shown as part of cash flow or as a note in the financial statements but it had not been dealt with accordingly.

(b) In the Cash Flow Statement of the year under review, although Rs. 3,626,362 were shown as purchases of property, plant and equipment under investing activities, since the actual purchase value was Rs. 9,197,117, the investing activities had been understated by Rs. 5,570,755.

(c) According to Section 20 of Sri Lanka Public Sector Accounting Standard No. 10, the consulting service income related to 05 research projects which started in the year 2023 and covered the year 2023 with a total value of Rs. 63,699,742, without taking into account the project's completion status and then accounting project revenue, an amount of Rs. 11,731,747 which equal to the expenditure of the reviewed year of those projects, had been recognized in the accounts as nominal consultancy income.

(d) Since the research allowance of Rs. 1,112,652 related to the previous years was accounted as salary and remuneration expenses in the year under review, the profit of the year under review had been understated and the retained earnings had been overstated.

(e) Due to the fact that, the unpaid research allowance of Rs. 1,717,276 for the period from 23 December 2021 to 21 June 2023 was not adjusted in the financial statements, therefore, the expenses payable in the year under review had been understated by Rs. 1,717,276 and the profit for the year by Rs. 565,677 and the retained earnings had been overstated by Rs. 1,151,599.

(f) Due to the fact that, the uncollected amount of Rs. 2,432,290 from the advance paid, for the construction of the Marine Hatchery Centre was not accounted as advance but as work in progress, current assets had been understated by that amount and Non-current assets had been overstated by that amount.

(g) The Panapitiya Regional Research Centre’s fish feed and fish sales income of Rs. 1,443,758 had not been accounted under the income receipts of the year under review and had been accounted under the D5503 project. From that account, the balance of Rs. 1,464,456 including the opening balance of Rs. 535,547 after adjustment of expenses for the year of Rs. 514,849 had been accounted as project creditors. As a result, the profit of the year and the cash flow generated by other operating activities in the cash flow statement had been understated by Rs. 928,909.

(h) In the year under review, the amount of Rs. 2,080,000 received for nautical charts prepared for an international ship of a private shipping company had not been accounted under income in the financial statements and had been accounted under project creditors.

(i) Due to the fact that, any source documents had not been submitted in respect of 65 journal vouchers such as settlement of advances amounting to Rs. 83,675,867, accrued expenses, error corrections; the correctness of those journal vouchers could not be verified.

I conducted my audit in accordance with Sri Lanka Auditing Standards (SLAuSs). My responsibilities, under those standards are further described in the Auditor’s Responsibilities for the Audit of the Financial Statements section of my report. I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my opinion.

1.3 Other Information included in the Agency's 2023 Annual Report

The other information comprises the information included in the 2023 Annual Report but does not include the financial statements and my auditor’s report thereon, which I have obtained prior to the date of this auditor’s report. Management is responsible for the other information.

My opinion on the financial statements does not cover the other information and I do not express any form of assurance conclusion thereon.

In connection with my audit of the financial statements, my responsibility is to read the other information identified by the Agency above when it becomes available and, in doing so, consider whether the other information is materially inconsistent with the financial statements or my knowledge obtained in the audit or otherwise appears to be materially misstated.

Agency’s 2023 Annual Report, if I conclude that there are material misstatements therein, I am required to communicate that matter to those charged with governance for correction. If further material uncorrected misstatements are existed those will be included in my report to Parliament in pursuance of provisions in Article 154 (6) of the Constitution that will be tabled in due course.

1.4 Responsibilities of Management and Those Charged with Governance for the Financial Statements

Management is responsible for the preparation of financial statements that give a true and fair view in accordance with Sri Lanka Public Sector Accounting Standards, and for such internal control as management determine is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, management is responsible for assessing the Agency’s ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the Agency or to cease operations, or has no realistic alternative but to do so.

Those charged with governance are responsible for overseeing the Agency’s financial reporting process.

As per Section 16 (1) of the National Audit Act No. 19 of 2018, the Agency is required to maintain proper books and records of all its income, expenditure, assets and liabilities, to enable annual and periodic financial statements to be prepared of the Agency.

1.5 Auditor’s Responsibilities for the Audit of the Financial Statements

My objective is to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor’s report that includes my opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with Sri Lanka Auditing Standards will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

As part of an audit in accordance with Sri Lanka Auditing Standards, I exercise professional judgment and maintain professional scepticism throughout the audit. I also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for my opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.

- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Agency's internal control.

- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by the management.

- Conclude on the appropriateness of the management's use of the going concern basis of accounting and based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Agency's ability to continue as a going concern. If I conclude that a material uncertainty exists, I am required to draw attention in my auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify my opinion. My conclusions are based on the audit evidence obtained up to the date of my auditor's report. However, future events or conditions may cause the Agency to cease to continue as a going concern.

- Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

I communicate with those charged with governance regarding, among other matters, significant audit findings, including any significant deficiencies in internal control that I identify during my audit.

2. Report on Other Legal and Regulatory Requirements

2.1 National Audit Act, No. 19 of 2018 includes specific provisions for following requirements.

2.1.1 Except for the effect of the matters described in the basis for qualified opinion, I have obtained all the information and explanation that required for the audit and as far as appears from my examination, proper accounting records have been kept by the Agency as per the requirement of section 12 (a) of the National Audit Act, No. 19 of 2018.

2.1.2 The financial statements presented is consistent with the preceding year as per the requirement of section 6 (1) (d) (iii) of the National Audit Act, No. 19 of 2018.

2.1.3 The financial statements presented includes all the recommendations, except the recommendations mentioned in the paragraph 1.2 (e) by me in the previous year as per the requirement of section 6 (1) (d) (iv) of the National Audit Act, No. 19 of 2018.

2.2 Based on the procedures performed and evidence obtained were limited to matters that are material, nothing has come to my attention;

2.2.1 To state that any member of the governing body of the Agency has any direct or indirect interest in any contract entered into by the Agency which is out of the normal cause of business as per the requirement of section 12 (d) of the National Audit Act, No. 19 of 2018.

2.2.2 To state that the Agency has not complied with any applicable written law, general and special directions issued by the governing body of the Agency as per the requirement of section 12 (f) of the National Audit Act, No. 19 of 2018 except for following observations.

Reference to Law/ Direction	Observation
Cabinet Decision No**.** 17/2512/725/037 dated 22 November 2017	The Cabinet Decisions were advised to pay back the outstanding employees' provident fund contribution of Rs. 39.93 million from the year 2006 to October 2015 within 2 years from their earnings. Although fixed deposit interest income of Rs. 36,389,679 had been received in the year under review, the employees' provident fund contribution of Rs. 17,237,045 had not been settled.

2.2.3 To state that the Agency has not performed according to its powers, functions and duties as per the requirement of section 12 (g) of the National Audit Act, No. 19 of 2018.

2.2.4 To state that the resources of the Agency had not been procured and utilized economically, efficiently and effectively within the time frames and in compliance with the applicable laws as per the requirement of section 12 (h) of the National Audit Act, No. 19 of 2018.

2.3 Other Audit Observations

(a) Out of trade and others receivables balance of Rs. 29,636,894 under current assets in the financial statements as at 31 December 2023, there were uncertainties in the recovery of advances of Rs. 3,083,897 over 05 years, other debtors and employee loans.

(b) Rs. 1,590,592 had been spent from the year 2021 to the year 2023 for the research project on the introduction of a type of snack food related to aquatic resources and the production methods related to dried fish, which had been started in the year 2021, and even though, 3 years had been completed by the date of the audit, its works had not been finished. As a result, the primary objective of the research project, which is to produce and introduce an aquatic resource snack with fish protein, had not been fulfilled.

(c) The vessel Samudrika is used for research and survey work and the institute had not been achieved the desired objectives and targets and Rs. 37,816,050 for the repair and maintenance of the vessel during the year under review had been spent. Since the Memorandum of Understanding with the Navy had expired from February 2023, the operation of the vessel had to be stopped.

(d) The NARA Amendment Act No. 32 of 1996 has specified the collection of hydrometric scientific data and related charting activities (National Charting Program) as a primary function of the agency and for that Rs. 1,995,152 had been spent. Based on the hydrometric scientific data that was to be carried out from Colombo to Negombo and from Colombo to Weligama, only the data collection activities of the charting programs had been done and only 50 percent physical progress had been achieved.

(e) Four laboratory equipment used for testing in Post-Harvest Technology Division (Analytical Chemistry Laboratory) had not been used for any sample testing in the year and only 58 samples had been tested with 02 other equipment. Accordingly, Rs. 27,536,564 in 4 laboratory equipment and 02 equipment whose value could not be recognized, had not been achieved a proper level of efficiency.

(f) The fish feed production machine with an estimated value of Rs. 16,868,610 was leased to a private company on 15 March 2016 and the machine had been handed over to the agency in the year 2021. The arrears of lease amounting to Rs. 4,650,000 related to the period from 05 June 2020 to 31 months had not been recovered from that company. This machine was leased to another private company in May 2023 and the lease agreement was not submitted for audit and the lessee also reported defects in the machine and had not been paid the monthly rentals. However, the management had not been taken any action regarding the termination of the agreement related to this machine or the charging of installments as per the agreement.

(g) A 3-acre land was leased for a period of 30 years from 16 February 2022 for the construction of a multi-species fish hatchery complex in Kuduwa area of Kalpitiya, but before the ownership was handed over, an expenditure of Rs. 1,631,963 was incurred for the development of the land in the year 2020. This land was not used for the relevant purposes and had been remained underutilized until now.

(h) According to the staff details approved by the management department of the agency on 31 December 2023, there are 3 senior positions and 50 tertiary scientific positions at senior management level, 9 tertiary positions at management level, 87 secondary level positions including 12 secondary level positions and 36 posts of Management Services Research Assistant and 57 primary level labor posts at junior management level were vacant. As a result, the audit observed that the majority of positions in the research technology department are vacant, which can directly affect the performance of research projects.

(i) The “Tharani Yatra”, which was produced at a cost of Rs. 12 million in the year 2011, had been remained idle for more than 10 years due to technical defects.

(j) A stock of 9391 models of oysters with a value of Rs. 7,512,800 had been remained unused for many years.

W.P.C. Wickramaratne
Auditor General

NARA/FA/2023 13/02/2025

The Auditor General,
National Audit Office,
No. 306/72,
Polduwa Road,
Baththaramulla

THE REPORT OF THE AUDITOR GENERAL ON FINANCIAL STATEMENTS AND OTHER LEGAL AND REGULATORY REQUIREMENTS OF THE NATIONAL AQUATIC RESOURCES RESEARCH AND DEVELOPMENT AGENCY FOR THE YEAR ENDED 31ST DECEMBER 2023 AS PER SECTION 12 OF THE NATIONAL AUDIT ACT NO. 19 OF 2018.

The actions taken by considering the Audit and Management Committee recommendations of the Institute regarding the queries in the above report depicted by the Auditor General are hereby submitted for information and necessary actions.

Section of the Audit	Observations of the Report of the Auditor General	Actions Taken to Adjust
1.2 (a)	When preparing a cash flow statement in the direct method as per Section 29 of Volume 2 of Sri Lanka Public Sector Accounting Standards, the net cash flow of operating activities has to be adjusted with the excess generated by normal activities, and it should be shown as a part of cash flow or in the financial statements. However, actions had not been taken accordingly.	Steps will be taken to rectify this when preparing the financial statements next time.
(b)	During the year under review, Rs. 3,626,362/= had been adjusted as purchasing property, plant and equipment under investing activities of the cash flow statement. However, the actual value of purchasing is Rs. 9,197,117/=. Therefore, investing activities had been shown with a deficit of Rs. 5,570,755/=.	Steps will be taken to rectify this when preparing the financial statements next time.
(c)	Considering the completion of the project and as per Section 20 of Sri Lanka Public Sector Accounting Standards 20, the revenue from consultancy services of five research projects initiated in the year 2023 and covering the year 2023, with a total value of Rs. 63,699,742/=, was not accounted as project income. However, a nominal consultancy revenue of Rs. 11,731,747/= equivalent to the expenditure of those projects in the year under review, had been identified in the accounts.	Actionswill be taken as per the instructions given by the Institute of Charted Accountants of Sri Lanka.

(d)	The research allowance of Rs. 1,112,652/= relating to previous years had been accounted as expenses related to salaries and wages in the year under review. Therefore, the profit for the year under review was depicted in a reducing amount, and retained earnings were depicted in an increasing amount.	Necessary steps will be taken to rectify the shortcoming in next financial statements by making adjustments relevant to previous year.
(e)	The research allowance of Rs. 1,717,276/=, which was not paid from 23/12/2021 to 21/06/2023, had not been adjusted in financial statements. Therefore, Rs. 1,717,276/= of expenses, which should be paid for the year under review, were depicted with a deficit, and the income of the year amounted to Rs. 565,677/=, and Rs. 1,151,599/= of retained earnings were depicted in an increasing amount.	Necessary steps will be taken to rectify the shortcoming in next financial statements by making adjustments relevant to previous year.
(f)	An amount of Rs. 2,432,290/=, which was not credited from the advance payment made for the construction of the Marine Breeding Centre, was not accounted as advances but accounted as work in progress. Therefore, current assets were depicted with a deficit by that amount, and non-current assets were depicted in an increasing amount.	Necessary steps will be taken to rectify the shortcoming in next financial statements by making adjustments relevant to previous year.
(g)	The income of Rs. 1,443,758/= gained by selling fish feed and fish at the Panapitiya Regional Research Centre was not accounted as receivables in the year under review but was accounted under the D 5503 project. After adjusting Rs. 514,849/= of expenses from that account for the year, the balance of Rs. 1,464,456/=, including the opening balance of Rs. 535,547/=, had been accounted as project creditors. Therefore, the profit of the year and the cash flow generated by other operating activities in the cash flow statements were depicted in a reducing amount of Rs. 928,909/=.	Steps will be taken to rectify this when preparing the financial statements next time.
(h)	The amount of Rs. 2,080,000/= gained for nautical charts prepared for an international ship of a private ship company in the year under review was not accounted under revenue in the financial statements but accounted under project creditors.	Necessary steps will be taken to rectify the shortcoming in next financial statements by making adjustments relevant to previous year.

(i)	No source documents were received for error-corrected 65 journal vouchers amounting to Rs. 83,675,867/= pertaining to advance settlements, accrued expenses, etc. Therefore, the accuracy of those journal vouchers could not be observed.	Although corrections were made and submitted later, necessary steps will be taken to prevent such mistakes.
Law/Order Reference	Observations	
Cabinet Decision No. 17/2512/725/037 dated 22/12/2017	Instructions were given by the cabinet decision to pay off the Rs. 39.93 million debt to the Employees' Provident Fund over two years. Fixed deposit interest of Rs. 36,389,679/= has been received in the year under review. However, the Employees' Provident Fund's arrears of Rs. 17,237,045/= remained unpaid.	The Agency also faced the same economic recession prevailed in the country during the Covid-19 pandemic era. Thereafter, the Governing Board took steps to rectify this matter and planned to settle this amount within three years.
2.2.3	According to the necessity indicated in Section 12(g) of the National Audit Act No. 19 of 2018, the Agency had not performed according to the commission's (National Audit Office's) powers, functions, and duties.	Steps have been taken to rectify this in future.
2.2.4	According to the necessity indicated in Section 12 (h) of the National Audit Act No. 19 of 2018, the resources of the Agency had not been procured and utilized economically, efficiently, and effectively within the time frames and in compliance with the applicable laws.	Instructions were given to avoid this from happening again in future.
Other Audit Observations 2.3 (a)	As of December 31, 2023, out of the balance of Rs. 29,636,894/= under current assets as trade and other receivables in the financial statements, Rs. 3,083,987/= of advances, other debtors, and employee loans over 5 years were in an uncertain condition.	The Audit and Management Committee has recommended to write-off the amount of Rs. 239,550/= that should be credited by the Presidential Secretariat. Steps are taken to credit other receivables.
(b)	An amount of Rs. 1,590,592/= has been spent from 2021 to 2023 for a research project on introducing aquatic snack variety and dried fish-related production methods, which was started in 2021. Although 3 years had passed since the project was initiated, its work had not	This project consisted of 2 phases. Extraction of protein was completed in the first phase. Equipment in the University of Sri Jayawardenepura is required for the completion

	been completed by the audit date. Therefore, one of the main objectives of that project to produce and introduce an aquatic snack with fish protein has not been accomplished.	of the second phase. The equipment is inactive by now, and the remaining works will be done after repairing the equipment. However, steps have been taken to inquire from the researcher.
(c)	The vessel Samuddrika is utilized for research and survey purposes. An amount of Rs. 37,816,050/= has been spent on the renovation and maintenance of the vessel without reaching expected goals and objectives. The operational purposes of the vessel have to be stopped due to the termination of the agreement signed between NARA and the Sri Lanka Navy.	The current issues have been solved and steps have been taken to enter in to a Memorandum of Understanding with the Sri Lanka Navy again for operational and maintenance purposes.
(d)	One of the vital functions mentioned in the NARA amended Act No. 32 of 1996 is collecting hydrographic data and conducting the National Charting Programme, and Rs. 1,995,152/= has been spent for that. However, only data collection activities had been carried out in the hydrological data-based charting programmes scheduled to be carried out from Colombo to Negombo and from Colombo to Weligama, and only 50% physical progress had been achieved.	The provision allocated for the year is Rs. 2.8 million. Out of that amount, Rs. 1.9 million has been spent for the collection of planned data. Data analysis is being carried out for preparing nautical charts. Due to the monsoon conditions and lack of necessary provisions, completion of surveying the total sea area this year is not possible, and this work has to continue also in next year. Preparing nautical charts will be carried out after completing a survey of the whole area.
(e)	Four laboratory equipment items were used for research purposes in the analytical chemistry laboratory of the Institute of Post-harvest Technology Division and were not utilized this year, and only 58 samples were researched by the other two pieces of equipment. Accordingly, four laboratory equipment amounted to Rs. 27,536,564/=, and two equipment whose value could not be identified had not been able to reach the proper efficiency level.	Steps have been taken to enter into service agreements with the suppliers regarding maintenance activities of these equipment items. Researchers of the relevant Division were trained regarding some equipment. Arrangements have been made to utilize the equipment.
(f)	A fish feed manufacturing machine valued at Rs. 16,868,610/= was leased to a private company on 15th March 2016,	This machine was donated to NARA by the Food and Agriculture Organization of

	and in 2021, this machine was reacquired by the Agency. Arrears of Rs. 4,650,000/= that should be received for 31 months starting from 5th June 2020 was not received from the company. This machine was leased again to another private company in May 2023, and that lease agreement was not submitted to the audit. That buyer also has not paid monthly lease amounts showing defects of the machine. However, the management has not taken steps to terminate the agreement or credit the monthly installments.	the United Nations (FAO). This machine was leased to the Agri Star Compost (Pvt) Ltd., and the manufacturing of fish feed was not continued due to deficiencies of the machine. After calling Expressions of Interests, this machine was handed over again to KMN Aqua Services Pvt. Ltd. The current leaser also showed deficiencies of the machine, and the committee report prepared as per the recommendation of the 132nd Audit and Management Committee meeting was submitted to the 133rd Audit and Management Committee meeting. According to this report, it was reported that the machine is defective. Crediting installments has been stopped as per recommendations of the 132nd and 133rd Audit and Management Committee meetings. This matter was discussed in the 133rd and 134th Audit and Management Committee meetings, and the recommendation was to remove the machine from usage following a suitable method if further maintenance of the machine is impractical. Actions are being taken accordingly.
(g)	A land of 3 acres located in Kudawa, Kalpitiya, had been acquired by NARA on a leasing basis for 30 years from 16th February 2022 for the construction of multi-species fish breeding complex. However, an amount of Rs. 1,631,963/= had been spent for the development of the land in 2020 before acquiring. This land had been underutilised without fulfilling its objectives.	Actions are being taken to secure necessary funds to utilize this.
(h)	According to staff positions of NARA as at	Steps had been taken in

	31st December 2023 approved by the Department of Management Services, 03 Senior Positions at Higher Managerial Level, 50 Tertiary Level Scientist Posts, 09 Tertiary Level Managerial Posts, 87 Secondary Level Posts including 12 Secondary Level Posts at Junior Management Level, 36 Research Assistant Posts (Management Assistant), and 57 Labour posts at Primary Level were vacant. Therefore, the audit observed that the majority of positions in Research Technology Divisions were vacant, which could directly affect the performance of research projects.	2024 to make appointments of 03 Senior Posts at Managerial Level, 06 Tertiary Posts at Managerial Level, 04 Secondary Level Posts at Junior Management Level, 11 Research Assistant posts and 01 Technical Assistant posts.
(i)	"Tharani" vessel which was manufactured by spending Rs. 12 million in 2011 had been idle for over 10 years without obtaining any usage.	Steps have been taken to make the vessel to be used for educational purposes by the end of March 2025.
(j)	9391 Oyster shell modules valued Rs. 7,512,800/= had been idle for over many years without obtaining any usage.	This matter was taken into consideration and arrangements have been made to implement some research programmes in 2025.

N.S. Hewagama
Director of Finance

Dr. K.H.L. Amaralal
Deputy Director General

Dr. K. Arulananthan
Director General

Dr. SanathHettiarachi
Chairman