Strategic Environmental Assessment (SEA) for the Aquaculture Development Programme of the Northern Province

Final SEA Report

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Consulting Engineers & Architects Associated (Pvt) Ltd.

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Abbreviations

ACBFSDP	Aquaculture and Culture Based Fisheries Sector Development Plan
ADB	Asian Development Bank
ADC	Aquaculture Development Centre
ADZ	Aquaculture Development Zone
ASA	Advisory Services and Analytics
BMP	Best Management Practice
BOI	Board of Investment
CARP	Center for Agriculture Research Policy
CBD	Convention on Biological Diversity
CBF	Culture-based Fisheries
CBFMCC	Culture-Based Fisheries Management Coordinating Committee
CBM	Community Biodiversity Management
CBO	Community Based Organization
CC&CRMD	Coast Conservation & Coastal Resource Management Department
CEA	Central Environmental Authority
CEB	Ceylon Electricity Board
CEAA	Consulting Engineers and Architects Associated (Pvt) Ltd
CFC	Ceylon Fisheries Corporation
CFHC	Ceylon Fishery Harbors Corporation
CSR	Cooperative Social Responsibility
CZCRMP	Coastal Zone and Coastal Resource Management Plan
DFAR	Department of Fisheries and Aquatic Resources
DMC	Disaster Management Center
DAPH	Department of Animal Production and Health
DS	Divisional Secretariat
DSD	Divisional Secretariat Division
DTR	Diurnal Temperature Change
DWC	Department of Wildlife Conservation
EA	Environmental Assessment
EAA	Ecosystem Approach to Aquaculture
EAFM	Ecosystem-based Approach to Fisheries Management
EBM	Eco System Based Management
EDB	Export Development Board
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPL	Environmental Protection License
ESF	Environmental and Social Framework
ESS	Environmental and Social Standards

FAO	Food and Agriculture Organization
FCR	Feed conversion Ratio
FCS	Fisheries Cooperative Society
FD	Forest Department
FFPO	Fauna and Flora Protection Ordinance
FGD	Focus Group Discussion
FO	Farmer's Organization
FMSY	Fishing pressure that gives the Maximum Sustainable Yield
GCE A/L	General Certificate of Education Advanced Level
GCE O/L	General Certificate of Education Ordinary Level
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GMP	Good Management Practice
GND	Grama Niladhari Division
GoSL	Government of Sri Lanka
GRC	Grievance Redress Committee
GRM	Grievance Redress Mechanism
GSMB	Geological Survey and Mines Bureau
HRA	High Risk Area
IAS	Invasive Alien Species
IBA	Important Bird Areas
ICCAD	International Centre for Coastal Aquaculture Development
IDB	Industrial Development Board
IEE	Initial Environmental Examination
IHE	International Institute for Hydraulic and Environmental Engineering
IMTA	Integrated Multi-Trophic Aquaculture
IMWI	International Water Management Institute
IPCC	Intergovernmental Panel on Climate Change
ISEA	Integrated Strategic Environmental Assessment
ITCZ	Inter Tropical Convergence Zone
IUCN	International Union for Conservation of Nature
LKR	Sri Lankan Rupee
LRA	Low Risk Area
LUPPD	Land Use Policy Planning Department
MC	Municipal Council
MEPA	Marine Environmental Protection Authority
MFAR	Ministry of Fisheries and Aquatic Resources
MPA	Marine Protected Area

MRA	Medium Risk Area
MSP	Marine Spatial Planning
NAFSO	National Fisheries Solidarity Organization
NAQDA	National Aquaculture Development Authority of Sri Lanka
NARA	National Aquatic Resources Research & Development Agency
NBSAP	National Biodiversity Strategic and Action Plan
NCAAAPHMQC Certification	National Center for Aquatic Animals and Aquatic Plant Health Management, and
NDC	Nationally Determined Contributions
NEA	National Environmental Act
NGO	Non-Governmental Organization
NIASP	National Invasive Alien Species Policy
NIRP	National Involuntary Resettlement Policy
NMAC	National Mine Action Centre
NOAA	National Oceanic and Atmospheric Administration
NPAMP	National Protected Areas Management Plan
NPD	Department of National Planning
NRC	National Research Council
NSF	National Science Foundation
NWS&DB	National Water Supply and Drainage Board
ODS	Ozone Depleting Substances
OFRP	Outboard engine fiberglass Reinforced Plastic
OIE	Office International des Epizooties
ORM	Opportunity and Risk Map
PA	Protected Area
PAA	Project Approving Agency
PAMA	Public Welfare Assistance Allowance
PAP	Project Affected Person
PHCI	Poverty Head Count Index
PL	Post Larvae
PMED	Planning, Monitoring & Evaluation Division
PPP	Private-Public Partnership
PS	Pradeshiya Sabha
RAP	Resettlement Action Plan
RAS	Recirculating Aquaculture Systems
RCP	Representative Concentration Pathway
RDC	Resource Development Center
RFS	Rural Fisheries Society
SAM	Special Area Management

SAMCC	Special Area Management Coordinating Committee
SAR	Synthetic aperture radar
SDG	Sustainable Development Goals
SEA	Strategic Environmental Assessment
SEACAM	Secretariat for Eastern African Coastal Area Management
SEO	Strategic Environmental Objective
SESMP	Strategic Environmental and Social Management Plan
SLSEA	Sri Lanka Sustainable Energy Authority
SLTDA	Sri Lanka Tourism Development Authority
SME	Small and Medium Enterprises
SPF	Specific Pathogen-Free
SPR	Specific Pathogen Resistant
SPT	Specific Pathogen Tolerant
TOR	Terms of Reference
TSF	Taprobane Seafood
UC	Urban Council
UDA	Urban Development Authority
UKMO	United Kingdom Meteorological Office
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climatic Changes
VRI	Veterinary Research Institute
WHH	Women-Headed Households
WSSV	White Spot Syndrome Virus

Executive Summary

The National Aquaculture Development Authority of Sri Lanka (NAQDA) has prepared the Aquaculture and Culture Based Fisheries Sector Development Plan (ACBFSDP) for 2021-2025 which aims to increase the production and export earnings from the coastal aquaculture and mariculture sub sectors. The World Bank is engaged with the Government of Sri Lanka (GoSL) in an Advisory Services and Analytics (ASA) works, in support of sustainable development of coastal aquaculture, which includes a Strategic Environmental Assessment (SEA) for the Northern Province. This SEA report has been prepared in accordance with the requirements outlined in the Terms of Reference (ToR) for the SEA provided by the World Bank.

The main purpose of the SEA is to ensure that strategic social, environmental and climate change concerns are appropriately and adequately integrated in the development and implementation of coastal aquaculture in the Northern Province.The SEA also provides opportunities to enhance the environmental and social performance of the Aquaculture and Culture Based Fisheries Sector Development Plan and will also provide suggestions for the sector plan, based on the findings of the SEA.

Aquaculture has developed as a major mode of seafood production world-wide. Though the development of this sector is slow and erratic in Sri Lanka, there is a vast potential for aquaculture. Currently the country has a limited, but stable, shrimp production and a developing finfish aquaculture production. During the last few years, several pilot projects and research trials have been carried out in different regions, including sea cages and land-based installations for culture species for the development of coastal aquaculture.

The most prominent aquaculture practices found in the Northern Province are sea cucumber and seaweed farming, while shrimp farming has been recently introduced to the Mannar district. Other aquaculture practices, mainly comprised of crab culture and finfish culture, are carried out on a small scale. The number of licensed aquaculture farms are recorded as 423, whereas the applications for the aquaculture management license which are being processed at present is recorded as 1573.

The Northern Province possesses 40% of Sri Lanka's coastline with the highest number of lagoons, substantial shallow marine areas, and adjoining unutilized lands which are suitable for coastal aquaculture development. Even though the province was significantly affected by the 30-year armed conflict, the Northern province is rich in diverse marine and coastal ecosystems, including mangroves, coral reefs, seagrass beds, lagoons, salt marshes, tidal flats, sand dunes, etc. For example, the Vankalai-Arippu-Silavaturai stretch and Vidataltivu to Jaffna stretches of coastline are rich in fringing coral reefs. Most of the productive seagrass beds occupy the shallow coastal areas of the Gulf of Mannar as well as the shallow coastal lagoons around Jaffna.

These ecosystems also harbor characteristic species assemblages, some of which are restricted to the nearshore habitats of the Northern Province. Especially, the extensive lagoons, mudflats, salt marshes, seagrass beds and shallow shores act as feeding grounds for migrant birds in Sri Lanka. The mud flats in Vankalai and Vidataltivu areas attract large numbers of migrant birds. Jaffna lagoon, Araly South-Punalai, Kayts Island-Mandathive, Amaipaddukkai, and Periyakalapuwa mouth (Vidatalativu) located within the SEA study area have been declared as Important Bird Areas (IBA). Also, there is a RAMSAR site (Vankalai Sanctuary) located within the study area. In addition to this there are 11 wildlife protected areas and 20 declared forest reserves identified within the SEA study

area located in Mannar, Kilinochchi, Jaffna, and Mullaitivu districts. In addition, there are several areas for Special Area Management Plans under the Coastal Zone Management Plan drawn up by the Coast Conservation and Coastal Resources Management Department (CC&CRMD), which are considered as being sensitive areas. Therefore, the coastal and nearshore areas in the Northern Province function as critical habitats for many marine and coastal species.

The above ecological characteristics of the Northern Coastal area illustrates the sensitive nature in the Northern Coastal zone, which could be severely impacted due to the haphazard development of aquaculture in the area. The SEA therefore provides a safeguard in terms of avoiding the extremely sensitive areas in the Northern Province by the identification and mapping of such areas.

The SEA study area was finalized in consultation with World Bank and NAQDA during the scoping phase. The land-based SEA study area comprises 1781 Sq. Km which represents around 20% of the total land area in Northern Province whereas the marine based study area comprises approximately 4222 Sq. Km.

A major component of the SEA study was the identification of the environmentally sensitive areas within the SEA study area and this information was obtained through consultation with the relevant government organizations such as the Department of Wildlife Conservation (DWC), Forest Department, Coast Conservation and Coastal Resources Management Department (CC&CRMD) and the Central Environmental Authority (CEA). Information on such environmentally sensitive areas were also obtained through past Research studies and EIA reports as well as the ISEA for Northern Province and "Conservation and sustainable use of biodiversity in the islands and lagoons of northern Sri Lanka" of the IUCN. Potential issues which may arise during the implementation of the NAQDA Plan, were identified during the provincial stakeholder meeting, individual consultations with the government stakeholders, and consultations with the Community Based Organizations (CBO), aquaculture operators and the local community.

The most important outcome of the SEA study was the preparation of an opportunity and risk map by mapping of the areas where coastal aquaculture projects should not be allowed, and areas where there will be Low/ Medium/High risk for siting of aquaculture projects. In order to determine the relative risks associated within the project area, initially the following areas which are considered as being high and medium risk areas for siting of aquaculture projects, were mapped using GIS.

- Declared and proposed wildlife protection areas within the SEA study area
- Declared and proposed Forest Reserves within the SEA study area
- Coral Reefs, Sea Grass, Mangroves, Sand Dunes and Other unprotected Sensitive Areas with SEA Study Area
- Gazetted archaeological reserves within the SEA Study area
- Fresh water/River Outlets and River basins within the SEA Study area
- Cyclone induced storm surge hazard map with projected storm surge levels -For 90 Years and 300 years Return Periods
- Fishery landing sites and Beach Seine areas (Madel Padhu Sites) within the SEA Study area
- Locations of tourist attractions and potential areas for marine tourism activities within the SEA study area
- Existing and planned Renewable Energy Development projects within the SEA study area
- Existing and proposed industrial zones and Salterns within the SEA study area

- Demining progress within SEA study area in Northern province
- High security zones and security camps within SEA study area
- Shipwrecks within marine study area of SEA

It should be noted that all low-risk areas identified in the Opportunity and Risk Map may not be suitable for the development of aquaculture projects, as the opportunity map denotes only the areas which have a lower risk for the development of aquaculture. However, there could be other factors and criteria determining the suitability of sites to establish an aquaculture farm. Therefore, the suitability of the low-risk areas identified in the SEA should be subjected to proper feasibility studies, in order to determine their suitability for aquaculture development.

Out of the above-mentioned areas, the areas where traditional fishing is being carried out pose the biggest impediment for the implementation of the proposed aquaculture projects. One of the obstacles identified was that these traditional fishing areas have not been formally identified or mapped, and such information was not available with the Department of Fisheries. Efforts were made to personally visit and meet with the Assistant Directors and Fisheries Inspectors of Fisheries Extension Offices in Jaffna, Mullaitivu, Mannar and Kilinochchi districts to obtain information regarding these traditional fishing areas and landing sites.

Three potential scenarios for development of coastal aquaculture in the Northern Province were also analyzed in the SEA. These three scenarios include,

- Option 1: The No plan scenario or the Business-as-Usual Scenario
- Option 2: Implementation of the NAQDA plan without environmental and social safeguards
- Option 3: Implementation of the NAQDA plan with the required safeguards including SEA recommendations and IEE/EIA for the proposed Aquaculture Development Zones and stand-alone aquaculture projects above a certain magnitude.

Out of the above-mentioned options, Option 3 is shown to be the most sustainable scenario while option 1 will have the highest environmental and social impacts as clearly illustrated in the scenario analysis. Furthermore, among the suggested aquaculture practices, shrimp pond culture and fin fish cage farming projected higher impacts compared to other aquaculture practices.

The socioeconomic characteristics of the study area that were elucidated through primary and secondary data sources show that the people and the economy of the area are still recovering from the impacts of the long lasted civil war. The traditional, non-formal knowledge and skill-transferring process that happened within their kin groups were also disturbed during this period. The remote nature of the islands in the Northern province shows the limited access to the services, opportunities for value addition of their primary produces and formal employment. The fishers of the Northern Province are small scale fishers, and they are dependent on coastal fishery since they cannot afford the mechanization and investment required for offshore fisheries. The restrictions imposed to access the deep sea during the civil war in consideration of national security also contributed to this scenario. The fishing capacity of the fishers increased with the resettlements after the civil war due to the increased accessibility to boats and fishing gear. However, the increased capacity didn't contribute to elevate their income of individual fisherman. Along with this small-scale fishery, agriculture, construction industries, and service sectors are the key employment generators of the study area, but their contribution is very low. The dense settlement pattern of the small-scale fishers along the coastal belt has limited their permanent asset level which further restrict their access to

external financial support to embark on capital-rich investments. The fishers' income is highly seasonal and the off-seasons are managed with the loan assistants received from their neighbours and other financial institutions. Very few of the small-scale fishers and external entrepreneurs have already started aquaculture farms in the study area on different scales.

The socio-economic conditions in the study area possess constraints as well as opportunities for the implementation of the NAQDA plan. The competition of the development plan with the existing livelihoods which are dependent on natural resources has been identified as a major constraint. The dependence of a significant portion of the population on capture-based fishery may impede the large-scale development of aquaculture. The saltwater extrusion schemes are established to facilitate paddy cultivation and coconut plantation along some of the coastal zones within the study area. Livestock rearing is a secondary livelihood that depends on the coastal extensive mangroves, mudflats, salt marshes, and other open and barren lands that are considered as non-formal grazing lands. The use of shallow marine water and the coastal land for aquaculture would restrict access to or impact the small-scale fishers' fishing grounds, farmlands, and grazing areas. The study encountered situations where the fishers have lost their fishing ground, or access to the fishing grounds because of the aquaculture especially sea cucumber farms in their vicinity. Fishers have to increase their efforts and invest additional money to recover the lost revenue due to such impacts.

The low financial capacity and the accessibility of the local fishers were identified as another constraint for making them a major stakeholder in the development plan. This will encourage the inflow of external entrepreneurs to the area that will risk the long-enjoyed traditional usage of the coastal resources by the local community. The fishers and other coastal communities mostly rely on natural resources for their livelihood and they are engaged in risk-free or low-risk livelihood activities that are technically and financially friendly for them. The lag time between stocking and harvesting, the non-availability of required technical services and facilities at an affordable cost, and the risk of crop loss due to diseases, disasters, and theft are major concerns to the locals as well as for entrepreneurs. The absence of insurance and other risk reduction/transferring facilities to offset or protect from such economical instabilities is considered a bottleneck for getting into aquaculture farming. Therefore, preparing the local population to accept a new value chain rather than the usual livelihood will be a hard task for the NAQDA to implement the ACBFSDP plan (2021-2025) successfully. The acceptance of the external entrepreneurs by the local communities, especially of those in the islands of Jaffna where the coastal villages are remote and the people are maintaining closed social interaction among the villagers is uncertain. Multiple displacements, resettlement, and relocation programmes due to the civil war have created a complex situation in land ownership. The land titling and the land registration process is still proceeding. This could delay the licensing process of land-based aquaculture projects.

The fascinating beaches, archaeological monuments, and religious places along the coastline of the Northern Province attract foreign and local tourists. Establishment of aquaculture sites near tourist sites could affect the aesthetic beauty of such locations and result in disturbances to the tourists. Though the post-war de-mining programs have achieved good progress in the area, there may be areas that are contaminated by the explosives. The clearance from the relevant regional office of the National Mine Action Centre is a pre-requisite for aquaculture site selection.

The lengthy licensing process due to the delays in the steps of aquaculture project approval procedure, affects the implementation of the ACBFSDP for 2021-2025. Therefore, in order to simplify the approval procedure, it is recommended to site the new aquaculture projects within the approved

Aquaculture Development Zones (ADZs) and to follow the new approval procedure suggested in the SEA. The absence of easily accessible mechanisms for grievance redress and compensation are also identified as a constraint.

At the same time, the NAQDA plan provides numerous opportunities such as provision of employment opportunities for unemployed youth and women and provision of investment opportunities. Aquaculture is also a sustainable alternative to the capture-based fishery as it avoids the overexploitation of marine capture fisheries. The study team had community consultations with fishers who have successfully converted their fishing ground into aquaculture farms, fishers who have earned a substantial profit from their aquaculture farms, fishers who are waiting to receive their aquaculture license, women and elderly people who have got regular employment from the aquaculture farms. Further, the evolving community awareness, acceptance of aquaculture, and hands-on experience are great opportunities for implementing the ACBFSDP (2021-2025).

The potential impacts of the development plan were also studied. The impacts on the coastal and marine ecosystems, coastal hydrology, capture-based fishery, and other development plans were identified as major potential impacts of the coastal aquaculture development. Among the suggested aquaculture practices, shrimp pond culture and fin fish cage farming projected higher impacts compared to other aquaculture practices.

Chemical and organic pollution risks are prominent in shrimp pond culture practices while seaweed and sea cucumber farming would create considerably less impact. Pollutants discharged from aquaculture practices may adversely affect the mangroves, seagrass beds and coral reefs around aquaculture development zones. Mangrove ecosystems remain highly threatened, especially with the proposed aquaculture project to be developed in the Vidataltivu area. Hence, special attention is required to be paid to the sustainability of the mangrove ecosystems in the Northern Province, especially in Vidattaltivu, Achchankulam, Nrivillukulum, Vankalai areas, during the selection of areas for aquaculture development.

Spread of diseases is a major limiting factor in aquaculture industry. The implications of the spread of disease in aquaculture practices should be mitigated by implementing biosecurity measures and Good Management Practices (GMPs). Haphazard development of aquaculture inevitably leads to environmental overload: nutrient and effluent build-up, impacts of fish farms on local wild fisheries with respect to disease and escaping, and environmental degradation due to the site's location. Intensive algal growth as a result of high nutrient levels is a major threat to coral reefs in the Northern region, such as Bar reef, Silavathurai reef and Arippu reef and to the seagrass beds.

The study encountered situations where the fishers have lost their fishing ground, or access to the fishing grounds because of the aquaculture farms in their vicinity. There were complaints about the effluent management of land-based aquaculture farms too. Fishers have to increase their efforts and invest additional money to recover the income they lost due to such impacts. The study team also met fishers who have successfully converted their fishing ground into aquaculture farms, fishers who have earned a substantial profit from their aquaculture farms, fishers who are waiting to receive their aquaculture license, women and elderly people who have got regular employment from the aquaculture farms.

It has been identified that NAQDAs' development plan can positively and negatively impact the socio-economic situation in the coastal areas of Northern province. This report presents the methods and mechanisms to minimize and mitigate such negative impacts. The active participation of the local

community in the development plan and the site selection and monitoring process is the key to the successful implementation of the plan. The careful site selection for the aquaculture project based on the Opportunity and Risk Map can reduce the constraints and avoid the negative impacts of the proposed plan. A careful social screening process, impact assessment, and social impact management plan prepared by the project developer consulting with the affected community and the stakeholders, with the assistance and the supervision of the NAQDA will narrow down the constraints and the negative social impacts of the project. The NAQDA can adopt the provisions of the NIRP and the Land Acquisition Act (1950) and its subsequent amendments for this purpose, even if the development doesn't involve land acquisition. The IEE/EIA process will handle the issue for the project that is greater than 4 Ha in extent. The SEA also outlined a multi-tier GRM that would benefit the project developer, local communities, and other stakeholder institutions to handle the grievances in real-time. The project developer should bear the cost related to the impact assessment, plan preparation/implementation, mitigations, and operation of the GRM. Meanwhile, the NAQDA has the responsibility to guide, facilitate and monitor the project developer and other stakeholders to ensure the adequacy of the planning and implementation. Establishment of an "Aquaculture Management committee" will narrow down the licensing process into a one stop shop. The PMED and RDC proposed in the ACBFSDP (2021-2025) will facilitate the monitoring role of the NAQDA. The financial and technical capacity of the local community should be improved, and strong grievance redress, compensation, and information disclosure procedure should be developed to ensure positive outcomes from the plan.

During the scoping study, the key impact areas related to coastal hydrology including coastal flooding, changes in rainfall pattern, freshwater supply to the sea and the impacts on coastal hydrology due to the proposed aquaculture development projects were also identified. Coastal flooding that generally occurs in low-lying areas is due to the storm surges, tsunamis and climate change induced sea level rise. Fluvial flooding is also a concern at the river deltas, estuarine low-lying areas, and at the lagoons. The flood prone areas were therefore identified in order to exclude such areas from the development of aquaculture due to the inherent risks associated with such areas. Variation of the rainfall in the Northern Province was studied using monthly rainfall data at 5 stations.

There are about 100 locations within the study area, where there is a potential for freshwater flow, high enough to disrupt cultured marine life during high rainfall. That includes the 24 river outlets, most of the major Thona outlets and the valley areas where the stormwater flow takes place during rainy periods.

The impacts on coastal hydrology due to the proposed projects are difficult to foresee at this stage as the site-specific development plans are not available. However, avoiding potential flood areas for land-based aquaculture facilities, avoiding enclosed sea areas with low water circulation potential, avoiding freshwater outlets for farming species that do not tolerate freshwater, planning aquaculture facilities in a way not to disrupt the natural stormwater drainage pattern, and coastal sediment transport pattern etc. will help to mitigate possible adverse impacts.

The Northern province has been identified as a hotspot for climate change. The coastal ecosystems and human livelihoods in the Northern province have been impacted by changes in ocean waters and monsoonal onset, duration, and intensity, etc. The mangrove ecosystems and other significant coastal and marine ecosystems which are important in aquaculture have been impacted by climate change. Sea level rise, rising sea surface temperatures, and extreme weather events such as

droughts, floods, storm surges, etc. associated with climate change could have both direct and indirect impacts on the proposed aquaculture projects.

Climate change related constraints detailed in this report may be foreseen and dealt with as effectively and economically feasible with the help of climate change mitigation and adaptation measures. To deal with new obstacles and problems brought about by adverse effects of climate change on aquaculture, it is necessary to improve general adaptive capacity to aid the impacted aquaculture communities. Managing the effects of greenhouse gas emissions that contribute to climate change should be given appropriate consideration, even though the aquaculture industry has been identified as one that emits relatively low amounts of greenhouse gases. The proposed Planning, Monitoring & Evaluation Division (PMED) in NAQDA plan can closely monitor and evaluate low carbon opportunities among the farmers. In addition to conducting research on greenhouse gas emissions, estimation of the carbon stocks in the coastal and marine ecosystems of the Northern Province is required to assess their contribution to carbon sequestration and climate change mitigation. Maintaining a reliable database with accurate measurements and statistics on variables such as sea surface temperature and sea level rise would be useful in assessing the consequences of climate change on the implementation of the suggested plan, as currently such measurements are at a preliminary stage. Thus, enhancing the research capacities on investigating climate change vulnerability is crucial.

In conclusion, it is clear that the preparation of a specific plan for the development of coastal and culture-based fisheries in the Northern Province is a step in the right direction, rather than allowing haphazard development of this sector, which will result in adverse impacts on the sensitive eco systems in the North and ultimately lead to the destruction of the industry itself as experienced in the Northwestern Province in the past. The completion of the SEA has resulted in the further refinement of this plan through the preparation of an opportunity and risk map which has identified potential lands with the lowest risk factor for aquaculture development. The implementation of the plan with inclusion of the SEA recommendations along with the existing regulatory requirements in the country such as subjecting the proposed Aquaculture Development Zones to IEE or EIA will contribute to the sustainability of the plan and will be a win-win situation with successful implementation of the plan along with conservation of the sensitive coastal ecosystems in the Northern Province.

1 Introduction

1.1 Scope

The National Aquaculture Development Authority of Sri Lanka (NAQDA) has prepared the Aquaculture and Culture Based Fisheries Sector Development Plan for 2021-2025 which aims to increase the production and export earnings from the coastal aquaculture and mariculture sub sectors. The World Bank is engaged with the Government of Sri Lanka (GoSL) in an Advisory Services and Analytics (ASA) work entitled 'Sri Lanka: Priorities for Sustainably Managing Sri Lanka's Fisheries and the Ecosystems that Manage Them'. As part of the ASA work carried out in support of sustainable development of coastal aquaculture, a number of analytical work including a Strategic Environmental Assessment (SEA) have been planned focusing on the Northern Province as the pilot area. Consulting Engineers and Architects Associated (Pvt) Ltd. (CEAA) has been assigned by the World Bank to conduct the SEA for the aquaculture development programme in the Northern Province. This report has been prepared in accordance with the requirements outlined in the Terms of Reference (ToR) for the SEA provided by the World Bank.

The main purpose of the SEA is to ensure that strategic social, environmental and climate change concerns are appropriately and adequately integrated in the planning, development and implementation of Aquaculture and Culture Based Fisheries Sector Development Plan (ACBFSDP) (2021-2025) in the Northern Province.

The SEA provides opportunities to enhance the environmental and social performance of the Aquaculture and Culture Based Fisheries Sector Development Plan. And will also provide suggestions for the sector plan based on the findings and recommendations of the SEA.

1.2 Rationale

SEAs are carried out for Policies, Plans and Programmes and is one way in which strategic level issues relating to the environment could be resolved at an early stage of a policy, plan or programme development. This will provide a planning context and framework for the subsequent Environmental Impact Assessment (EIA) process for the individual projects.

Although the SEA process is not yet legalized in Sri Lanka, many projects and programmes funded by the World Bank undergo a SEA prior to the EIA process for individual projects.

The SEA will basically ensure that any major environmental or social impacts during plan implementation will be identified in advance and either avoided or mitigated to the extent possible. The SEA will also ensure that there will be no conflicts with other plans and programmes prepared by other national/ provincial/ local government agencies as well as national and regional environmental management plans when the NAQDA plan is being implemented. The SEA will also study the potential issues which may arise from those who involved in traditional fishing activities within the project area.

A major issue faced during the implementation of development plans including aquaculture projects is the very high possibility of impinging on environmentally sensitive areas and/or protected areas under the Forest Ordinance, Fauna and Flora Protection Ordinance, Coast Conservation Act and the National Environmental Act. The Northern coastal areas consist of many vital and extremely sensitive areas of which some are protected while many are not. Through the early identification of such areas from the SEA, NAQDA would be provided guidance on the areas to be avoided in particular during the

identification of new lands for aquaculture projects, due to the presence of protected areas and/or environmentally sensitive areas. This would make the implementation of the proposed plan much easier as the presence of environmentally sensitive areas is a major impediment to implementation of aquaculture projects.

In addition, the SEA also consider the proposed development plans of other agencies such as the Department of Fisheries and Aquatic Resources (DFAR), Sri Lanka Tourism Development Authority (SLTDA), Board of Investment (BOI), Ceylon Electricity Board (CEB), Sri Lanka Sustainable Energy Authority (SLSEA) and the Ministry of Industries. It is possible that these institutions may have future plans within the areas being proposed for the development of aquaculture projects. The SEA therefore screen the proposed development plans of these agencies in order to ensure that there will be no conflict between the plans proposed by these agencies with the coastal aquaculture development plans proposed by NAQDA.

The SEA assesses the potential impacts of the proposed coastal aquaculture development plan at a strategic level, although it will not investigate detailed assessments of individual sites which will be done at the EIA stage. The SEA will improve the coordination during the EIA process and also resolve any issues or impediments to the implementation of new aquaculture projects. The SEA will ensure that the proposed aquaculture development projects do not cause conflicts with other development plans in the area or have impacts on protected areas as well as environmentally sensitive areas which are not yet protected.

Depending on their magnitude, aquaculture projects require to undergo an EIA or IEE where detailed environmental and social assessments will be made on an individual project basis. Since Aquaculture development projects of extent exceeding 4 hectares are listed as prescribed projects under the National Environmental Act, such projects require to undergo an EIA or Initial Environmental Examination (IEE) as the case maybe prior to implementation. The SEA will make the projects more environmentally sustainable as any environmentally sensitive areas or protected areas in close proximity to the projects will be identified through the SEA. Similarly, any potential social issues related to the identified projects will be identified at an early stage thereby providing an opportunity to resolve such issues at an early stage, thereby improving implementation of the plan.

1.3 Objectives of the Strategic Environmental Assessment (SEA)

The main objective of the SEA for the Aquaculture and Culture Based Fisheries Sector Development Plan (ACBFSDP) is to identify opportunities and risks so that plan implementation can promote sustainable aquaculture. The SEA will also identify any impediments to the implementation of the plan at the strategic level.

A major focus was the presence of any protected areas which are legally protected under the Forest Ordinance, Fauna and Flora protection Ordinance, Coast Conservation act No 57 of 1981 its Amendment Act No 49 of 2011 and the National Environmental Act of 1980 and its amendment acts mainly. The SEA will also identify the presence of any environmentally sensitive areas within the project area which may not yet been protected under the above-mentioned acts or any other act. Other aspects such as social and cultural issues will also be closely examined in the SEA study. The social impacts of the proposed plan could be both positive and negative depending on the sites identified for the new aquaculture projects.

A potential major issue is the conflict of the aquaculture projects with traditional fisheries in the region. There is a perceived threat to traditional fisheries in the region which is being expressed by fishermen organizations as well as the regional and district officers of Department of Fisheries and Aquatic Resources (DFAR). Stakeholder and Community consultations were carried out to identify potential conflicts for coastal aquaculture development.

In addition, pollution aspects relating to aquaculture projects and climate change related impacts on the proposed plan as well as the plan induced climate impacts were also studied.

The Objectives of this SEA as per the ToR issued by the World Bank are given below.

- Identify the likely significant social and environment impacts resulting from implementing the Aquaculture and Culture Based Fisheries Sector Development Plan (ACBFSDP) (2021-2025) for the Northern Province.
- Identify the most important environmental, social, and climate change-related constraints that will bear upon the performance of the proposed plan.
- Identify the opportunities for ACBFSDP to contribute for enhancing the state of the environment, socio-economic status of communities, building climate resilience and promoting low carbon development in the Northern Province.
- Adequacy of existing policies, laws, regulations and the institutional capacity of the national, provincial and regional authorities to addresses identified environmental/social impact and challenges related to coastal aquaculture development in the Northern Province.
- Strategies on how potential negative social, environmental and climate change related impacts can be minimized and how positive impacts can be optimized, with a particular focus on the adequacy of institutional capacities at the national and local levels, as well as of the regulatory framework, to address identified concerns associated with the implementation of the ACBFSDP.

2 Background of the Study

2.1 Coastal Aquaculture Sector in Sri Lanka, with particular reference to Northern Province

According to the statistics of Food and Agriculture Organization, aquaculture production in brackish water and marine water increased at a compound annual growth rate of 7.7 percent and 5.2 percent respectively from 2001 to 2018 (FAO, 2020). Although the development of this sector is slow and erratic in Sri Lanka, there is a vast potential for aquaculture, in terms of climate and resources. Traditionally, fish is an important commodity in Sri Lanka in relation to the protein supply to both coastal as well as inland population. Fish provides more than 60% of the animal protein requirement of people in the country. Thus, aquaculture is expected to increase rapidly in volumes and diversity of cultured species, and thereby become the main source of food and protein supply in the future. In 2019, the per capita fish consumption in Sri Lanka was reported as 15.1 Kg/year which is below the expected target which is 21.9 Kg/year defined in Millenium Development Goals (Fisheries Statistics, 2021). The total inland and aquaculture fish production was 101,810 Mt in 2020 which is 23.7% of the total fish production in the country (Fisheries Statistics, 2021). Out of the total export value in 2020, 24.2% consists of coastal aquaculture products (Fisheries Statistics 2021). Coastal aquaculture and culture production still consisted less than 4% of the annual fish production in 2020 (Fisheries Statistics, 2021).

Currently Sri Lanka has a limited, but stable, shrimp production industry and a developing finfish aquaculture production. Many farms are small scale in nature and aim in supporting smaller local communities with income and food supply. Numerous research trials have been carried out during the last few years, in different regions of the country including sea cages and land-based installations for fish and shrimps. With such know-how and outputs, small scale fin fish cage farming was widespread while there was a growing interest to install bigger sea cages with circumference up to 60 meters in the Northeast Sea area. It is envisaged that Sri Lanka will be developing as a target country for foreign investment in aquaculture since countries such as Norway, Scotland, Vietnam, Japan, USA, and Canada have made investments during the last decade mainly targeting the export market.

Table 1: Present status of Coastal Aquaculture in Sri Lanka (2021)

Type	Production (Mt.) in Sri Lanka	Production (Mt.) in Northern Province	Contribution from Northern Province (%)
Shrimp Farming	14,413	921.64	6.4%
Seaweed Farming	218.1	216.93	99.5%
Sea bass Farming	465.6	4.79	1.03%
Crab Farming	6.4	4.29	67.0%
Sea cucumber Farming	579.82	579.82	100.0%
Milk Fish Farming	5.09	2.03	39.9%
Other	509.92	5.01	1.00%
Total	16,198.6	1,735.0	10.71%

(Source: NAQDA)

With reference to the coastal line and lagoon details in Sri Lanka, Northern coastal sector accounts the highest values. As percentages, 30% of the total coastline, 52% of the total lagoon area, 44% of the total lagoon perimeter are located in the Northern coastal sector (Silva et el., 2013). Hence there is a high potential in aquaculture development in the Northern Province.

The species presently used or supposed for coastal aquaculture activities are *Penaeus monodon* (Black tiger shrimp), *Litopenaeus vannamei* (White leg shrimp), *Scylla serrata* (Mud crab), *Lates calcarifer* (Seabass /Barramundi), *Holothuria scabra* and other species, Sea cucumber *Chanos chanos* (Milk fish), *Crassostrea madrasensis* (Oyster), *Saccostrea cucullate* (Oyster) *Perna viridis* (Mussel), *Perna perna* (Mussel), *Kappaphycus alverezii*, *Eucheuma spinosum.*

In the proposed ACBFSDP, 2021-2025 plan, under the coastal aquaculture sub-sector, the main objective is to develop coastal and marine aquaculture of marine/brackish water fish/crustacean species to uplift the living standards of coastal fisher communities by engaging them in the farming of high valued fish/crustacean species, mainly targeted at the export market. It is expected that, the coastal fisher communities will acquire the necessary technical expertise through training and demonstration of farming techniques, eventually resulting in the development of prosperous livelihoods for the coastal fisher communities.

Overview of the different culture species proposed in the ACBFSDP is presented below.

Shrimp aquaculture

Shrimp aquaculture in Sri Lanka has been initiated with Penaeus *monodon* culture whilst *L. vannamei* has been recently introduced to coastal aquaculture in Sri Lanka to recover the regressing shrimp farming sector, which confronted with vast crop failures due to outbreaks of fatal White Spot Syndrome Virus (WSSV). With reference to the plan, the Culture of newly introduced *L. vannamei* is preferred in place of conventional *Penaeus monodon* with higher anticipated economic, environmental, and social benefits. Nearly 83% (20,450 Mt) of shrimp production is expected from pond and circular tank systems in Northern province by 2025.

Tolerance to a wide range of salinities (0 to 45 ppt), ability to use in high stocking densities, rapid gain in weight up to 20 g, column feeding habit, low dietary protein requirement (30–35%) and higher meat yield (65–70%) are the attractive advantages of selectively bred *L. vannamei* and other species (Briggs et al., 2004).

NAQDA has introduced four different grades in shrimp culture intensities with respect to their management and operation. At present all the operational farms are operated at intensive level and fall under Grade A of the NAQDA classification. The pond designs are either rectangular or circular in shape and the layout comprised of the main components such as culture tanks, sedimentation tanks and reservoir tanks.

Although, the initiatives made for establishing Recirculating Aquaculture Systems (RASs) it is still not well established in Sri Lanka. Intensive systems with RAS have the potential to reduce most of the anticipated environmental and social impacts caused by shrimp culture.

Seabass culture

Sea bass farming is recently started in Sri Lanka and culture practices are mainly seen in the Negombo lagoon, Mannar, Puttalam, Batticaloa and Galle. In Northern province, sea bass culture is practiced as lagoon cage culture in the Mannar, Kilinochchi and Jaffna districts and as pond culture in Mannar and Kilinochchi districts. According to the statistics 147,820 fingerlings were stocked and 340 Mt of Seabass were harvested in 2018 in community-based cage and pond culture at different districts in Sri Lanka.

Nearly 5% (28Mt) of total sea bass production of the country is expected from lagoon cage and pond culture systems in Northern province by 2026. The production expected from Northern Province is relatively low compared to other districts (7Mt each from Mannar, Kilinochchi, Jaffna and Mullaitivu districts).

Sea cucumber farming

The rapid development of the sea cucumber fishery in Sri Lanka occurred during the last few years due to the high demand for beche-de-mer on the international market. Hence, *Holothuria scabra* has been identified as the main preferred species for culture in the Northern Province due to its high market value, large areas of suitable habitat availability, no external feed inputs requirement, adaptation of simple grow out technique etc. Whereas the potential exists for culture of other species for instance *S. naso* for culture, it has not been well accepted for aquaculture due to its low market value. The main methods for culturing sea cucumber include pond farming, pen culture, sea ranching, and tank culture. Sea cucumber farming is mainly restricted to Mannar, Kilinochchi and Jaffna in the Northern Province Sri Lanka. The harvest during 2018 has been recoded as 196 Mt (wet) through pen culture. Well-functioning sea cucumber farms can be observed in Ariyalai of Jaffna district. Sea Cucumber production is targeted only in the Northern province and the estimated sea cucumber production (Wet) in 2025 is 1450 Mt.

According to available information, Sri Lanka has exported 503 Mt of processed sea cucumber and has a turnover of Rs 2272 million during the year 2019. Sea cucumber hatchery has been set up in the Olaithoduwai, Mannar in Northern Province through a PPP to fulfill the need of juveniles for rapidly developing sea cucumber farming industry. In 2018, 105,000 Sea cucumber juveniles had been produced facilitating Sea cucumber pen culture. It is expected to gradually intensify the production and to produce 1 Mn juveniles per annum.

Seaweed farming

Seaweed culture in Sri Lanka began with Indigenous species, *Gracilaria edulis* while, recently introduced exotic species *Kappaphycus alvarezii* has been found very encouraging as its high regenerative capacity, higher demand in the phycological industries. Seaweed culture in Sri Lanka has grown into a booming industry with commercial initiatives with *Kappaphycus alvarezii*, which is one of the most commercially important seaweed species being cultured by many Asian countries. *K. alvarezii* culture developed as a commercial level cultivation along the coastal belt from Mannar to Jaffna during the recent past. According to the statistics of 2018, 322 Mt of harvest was gained from around 60 Ha area. Commercial cultivation of *K. alvarezii* has a good potential to create additional income for coastal community of Sri Lanka through farming and production of quality dry seaweed for the carrageenan industries (Shanmugam et al., 2017). One of the potential roles that seaweed could play in rural development is to act as a facilitator for social progression by rendering extensive employment opportunities to the coastal communities (Ginigaddara and Lankapura, 2018). Seaweed farming could play a role in empowering women in coastal areas of Sri Lanka.

However, development of the coastal aquaculture sector could cause adverse impacts on the extremely sensitive environments around the Northern coastal belt consisting of coral reefs, seagrass beds, lagoons, etc., unless adequate precautions are adopted during plan implementation. Protection of these fragile eco systems will also ensure the continued sustainability of the aquaculture sector.

The development of sustainable aquaculture in coastal areas requires attention to policy, management, incentive structures, and institutional issues, including the need to determine the appropriate role of the Government in future development work.

Present Disease control mechanism

The current aquatic animal health activities are focused on shrimp production in the North Western and Northern provinces. The farming of *L. vannamei* has only recently been permitted (Previously P. monodon was the only significant shrimp species farmed). White spot disease syndrome (WSSV) has been detected in Sri Lanka, but other Office International des Epizooties (OIE) listed shrimp diseases are not recorded. *L. vannamei* broodstock are sourced from specific pathogen free sources. Post-larvae from the hatcheries are tested for 07 OIE listed and 01 non listed diseases by Department of Animal Production and Health, and only released from the hatchery when confirmed pathogen free. Also *P.monodon* broodstock are introduced from specific pathogen free sources. NAQDA had implemented zoning in the North-Western Province to control WSSV outbreaks. The province has been divided into zones which were stocked with shrimp at different time of the year according to the crop calendar with stocking of wild shrimps of *P. monodon*. Crop calendar system is not functioning after introduction of SPF broodstocks for the both species and partial harvest systems for *L. vannami* (According to the NAQDA). Farmers are aligned with the Good Management Practices (GMPs) introduced by NAQDA.

Diseases are checked with the other species on the incidental basis for other species with the involvement of relevant authorities including NAQDA, NARA and Veterinary Research Institute (VRI).

The Aquaculture Management (Disease Control) Regulations, 2000 and the Aquaculture (Monitoring of Residues) Regulations, 2002 adopted under the Fisheries and Aquatic Resources Act, regarding disease control and monitoring residues have very detailed provisions of procedures to be followed.

The Aquaculture Management (Disease Control) Regulations, 2000 enforces various cleaning and disinfection requirements for aquaculture enterprises. The Regulations empower the Director General to supervise the use of antibiotics in fish feed, and where necessary to issue guidelines. The regulation includes measures regarding use of use of artificial colouring agents in food fish and vaccination of fish against any of the diseases listed in the Schedule. The regulation suggests to maintain a logbook with information relating to stocking, feeding and harvesting, water renewal, disease prevention methods and descriptions of diseases discovered and measures taken to control them by the holder of an aquaculture management license.

Aquatic Animal Quarantine Overview

Once the aquatic animals are exported to Sri Lanka the quarantine facilities are provided at the receiving farm, and their design, facilities and biosecurity are inspected on arrival of the imported aquatic animals by an appointed Veterinary Quarantine Officer. Samples are randomly collected at the receiving farm on arrival for the fish showing clinical or behavioral signs of disease. The imported animals are then subjected to a quarantine period of two weeks at the receiving farm. For the fish showing clinical or behavioral signs of disease, analyzed during the quarantine period. The samples collected by the Veterinary Quarantine Officer are sent to analyze at the Veterinary Investigation Center (VIC). When required, diagnostic support is also provided by the Center for Aquatic Animal Disease Diagnostics and Research (CAADDR) and the Veterinary Research Institute (VRI).

2.2 Overview of Aquaculture and Culture Based Fisheries Sector Development Plan (ACBFSDP) (2021-2025)

The overall objective of the ACBFSDP (2021 – 2025) of NAQDA was to enhance freshwater and coastal aquaculture fish/shrimp production with the aim of fulfilling the nutritional needs of the people by providing a cheap source of protein to the rural population, while at the same time alleviating poverty, generating livelihoods and foreign exchange earnings through export of high-valued aquaculture products and services.

The plan targets to increase the total export earnings of aquaculture from Rs. 8,017.02 million in year 2020 to Rs. 91,973 million in year 2025 by increasing production from inland aquaculture, coastal aquaculture, and mariculture. The ACBFSDP (2021-2025) has separately evaluated the production targets envisaged under freshwater fisheries and aquaculture development, and coastal aquaculture since the strategies adopted for the two sectors are different from each other.

Coastal aquaculture production target by 2025 has been forecasted as 60,000 Mt while it is anticipated to develop 30,000 employment opportunities and 415 million USD in foreign exchange earnings. Specially, the overall objective of the Plan is to increase the coastal aquaculture production from 7,568 Mt in 2020 to forecasted production of 60,000 Mt in 2025. It is well depicted the strategies developed to achieve the production targets from coastal aquaculture by proposed commodities. Shrimp aquaculture has been specified with a highlight by introducing more potential species, for instance *L. vannamei*, indicating the benefits of intensification which need less energy use per metric ton of shrimp yield. Seabass, sea cucumber, seaweed, milkfish, and crabs are the other major aquaculture species considered in the plan.

The expected production targets of coastal aquaculture sector in Northern province given in ACBFSDP (2021-2025) are shown in Table 2. According to the ACBFSDP (2021-2025), a total of 24,560 Mt production is forecasted from shrimp, seabass, crab, sea cucumber, seaweed, and milk fish culture by 2025. The highest amount of production is expected from shrimp culture (20,450 Mt by 2025).

Table 2: Production targets for Coastal Aquaculture in Northern Province

Species	Culture System	District		2021	2022	2023	2024	2025
Shrimp	Ponds	Mannar	P. *monodon*	200	700	1,500	2,700	4,000
		Mannar	*L. vannamei*	3,800	5,400	6,000	10,000	12,000
		Jaffna			1,000	2,000	3,000	4,000
		Total		**4,000**	**7,100**	**9,500**	**15,700**	**20,000**
	Circular Tanks	Mannar	*L. vannamei*	94	105	146	154	230
		Jaffna		48	53	67	82	120
		Kilinochchi		24	29	34	38	50
		Mullaitivu		24	29	34	38	50
		Total		**190**	**215**	**270**	**312**	**450**
	Total Production (Ponds & Cages) -Mt			**4,190**	**7,315**	**9770**	**16,012**	**20,450**

Species	Culture System	District	2021	2022	2023	2024	2025
Seabass	Lagoon Cages	Mannar	3	4	5	6	7
		Kilinochchi	2	3	5	6	7
		Jaffna	2	2	4	5	6
		Total (Cages)	7	9	14	17	20
	Ponds	Mannar	13	18	20	20	20
		Kilinochchi	10	12	13	14	15
		Total (Ponds)	23	30	33	34	35
	Total Production (Ponds & Cages) - Mt		**30**	**39**	**47**	**51**	**55**
Crab	Ponds	Mannar	105	110	112	120	120
		Kilinochchi	5	5	5	6	8
		Jaffna	6	6	6	6	7
	Total Production (Ponds)-Mt		**116**	**121**	**123**	**132**	**135**
Sea Cucumber	Pen	Mannar	15	15	25	25	25
		Kilinochchi	420	620	1,175	1,175	1,350
		Jaffna	165	365	800	900	1,125
	Total Production (Mt) – Wet		**600**	**1,000**	**2,000**	**2,100**	**2,500**
Seaweed	Raft	Mannar	350	375	400	410	540
		Kilinochchi	400	450	500	500	600
		Jaffna	100	175	180	200	200
	Total Production (Mt) – Wet		**850**	**1,000**	**1,080**	**1,110**	**1,340**
Milk Fish	Ponds	Mannar	10	15	15	15	25
		Kilinochchi	5	5	5	5	5
		Jaffna	4	15	40	40	50
	Total Production (Mt)		**19**	**35**	**60**	**60**	**80**
Total Production-Northern Province (Mt)			**5,805**	**9,510**	**13,080**	**19,465**	**24,560**

(Source: ACBFSDP (2021-2025), NAQDA)

However, NAQDA has modified the production targets considering the performance in past two years (2021 and 2022). Revised targets of aquaculture for seabass and sea cucumber have been reduced while those for crab and shrimp culture have been increased in compared with the ACBFSDP (2021-2025). Further, shrimp culture targets have been remarkably increased creating higher land demand. Seaweed production targets have not been altered except the proposed new targets for the Mullaitivu district. In addition, land-based farming of crab, milk fish and seabass also have been newly targeted for Mullaitivu district. Production targets are estimated for shrimp up to 2030, while targets are estimated up to 2026 for other species. Revised production targets are given in the Table 3 and Table 4 below.

Table 3: Revised Production targets for Coastal Aquaculture in Northern Province

Species	Culture System	District	2021	2022	2023	2024	2025	2026
Seabass	Ponds	Mannar	2	4	4	6	6	7
		Kilinochchi	1	3	3	4	5	7
		Jaffna	1	3	3	3	5	7
		Mullaitivu			1	3	5	7
	Total Production (Mt)		**4**	**10**	**11**	**16**	**21**	**28**
Crab	Ponds	Mannar	80	90	100	110	120	130

Species	Culture System	District	2021	2022	2023	2024	2025	2026
		Kilinochchi	5	5	5	5	5	7
		Jaffna	5	6	5	5	6	7
		Mullaitivu	1	1	2	4	5	7
	Total Production (Ponds)-Mt		**91**	**102**	**112**	**124**	**136**	**151**
Sea Cucumber	Pen	Mannar	20	25	30	35	40	45
		Kilinochchi	250	300	350	400	450	500
		Jaffna	80	100	120	140	160	180
	Total Production (Mt) – Wet		**350**	**425**	**500**	**575**	**650**	**725**
Seaweed	Raft	Mannar	300	350	350	400	450	500
		Kilinochchi	400	400	450	500	550	600
		Jaffna	100	100	150	150	200	200
		Mullaitivu				100	150	250
	Total Production (Mt) – Wet		**800**	**850**	**950**	**1,150**	**1,350**	**1,550**
Milk Fish	Ponds	Mannar	12	12	12	15	15	15
		Kilinochchi	2	2	2	5	5	5
		Jaffna	3	3	3	5	5	5
		Mullaitivu			1	2	4	5
	Total Production (Mt)		**17**	**17**	**18**	**27**	**29**	**30**

(Source: NAQDA)

Table 4: Revised Production targets for Shrimp in Northern Province

Year	Target for Species (in Metric Tons)		Total (in Metric Tons)
	P.Monodon	***L.Vannamei***	
2020	0	2,231	2,231
2021	307	8,836	9,143
2022	363	13,053	13,415
2023	3,514	22,842	26,357
2024	7,995	29,982	37,978
2025	8,367	38,350	46,717
2026	9,203.7	42,185	51,388.7
2027	10,124.07	46,403.5	56,527.57
2028	11,136.48	51,043.85	62,180.33
2029	12,250.12	56,148.24	68,398.36
2030	13,475.14	61,763.06	75,238.2

(Source: NAQDA)

Calculated Land requirement (Ha) based on the revised targeted land based coastal Aquaculture production projections of NAQDA are given in following tables.

Land Extent required for shrimp culture to meet the projected targets of the NAQDA Plan 2020-2030(Assuming 3 cycles are conducted per year)

Table 5: Required Minimum Land Extent for Shrimp culture to meet the targets

Year	District (Land requirement in Hectares)				Total (in Hectares)
	Jaffna	Kilinochchi	Mannar	Mullaitivu	
2020	0	0	60	0	60
2021	0	0	266	0	266
2022	0	0	384	0	384
2023	101	20	811	0	932
2024	243	101	1143	40	1528
2025	371	142	1214	61	1787
2026	428	162	1295	81	1966
2027	486	162	1315	162	2125
2028	607	223	1336	202	2367
2029	688	324	1356	263	2631
2030	809	405	1416	283	2914

The total land area requirement for both the species of *P. monodon* and *L. vannamei* has been estimated using the assumptions of; Average production of *P. monodon* is 1.5MT/Ac; Average production of *L. vannamei* is 5MT/Ac; Three culture cycles will be conducted annually.

According to the revised production plan the envisaged required land extent for shrimp culture by 2030 is 809 ha in Jaffna; 405 ha in Kilinochchi, 1416ha in Mannar and 283 ha in Mullaitivu districts.

Land Extent required for other targeted aquaculture practices of the NAQDA Plan in 2026

Other main aquaculture practices depict in the plan comprised of lagoon crab pond culture, milk fish culture and seabass pond culture. According to the revised production targets by 2026 and the given assumptions, the calculated required land extents are shown in the Table 6 below.

Table 6: Required Minimum Land Extent for Other land-based aquaculture to meet the targets in 2026

District	Required Minimum land Extent in Hectares		
	Lagoon Crab-Pond Culture	Milk Fish-Pond Culture	Seabass pond culture
Mannar	44	7	6
Kilinochchi	2.5	3	6
Jaffna	2.5	3	6
Mullaitivu	2.5	3	6

According to the ACBFSDP (2021-2025), following assumptions were made to calculate the required land extent.

a) Seabass Production

Assumptions made for cage culture in coastal area: Survival rate: 80%, Culture cycle per year- 1, Average harvesting weight: 500g; Assumption for sea cage culture of seabass Survival rate: 70%, Culture cycle per year- 1, Average harvesting weight: 1 Kg; Assumption for pond culture of seabass Survival rate: 70% Culture cycle per year-1, Average harvesting weight- 800 g

b) Milkfish culture

Pond size: 10,000 m^2 (1 Ha), Stocking density: 5 fingerlings per m^2, Survival rate: 70%, Culture cycles per year: 2, Average weight: 300 g

c) Lagoon Crab culture

Survival -40%; Production – 8Mt /Ha; 70% for reservation & other activities

Calculated space requirement (Ha) in Marine based Study area based on the targeted Aquaculture production projections of NAQDA are given in the below table.

Table 7: Required Minimum space for marine based aquaculture to meet NAQDA targets in 2026

District	Required Minimum space in Hectares		
	Sea Cucumber	Seaweed	Seabass cage culture
Mannar	15	9	5
Kilinochchi	160	10	4
Jaffna	58	3	4
Mulaitivu	0	4	0

According to the ACBFSDP (2021-2025) following assumptions were made to calculate the space required.

d) Sea cucumber farming - assumptions for pen culture

Area of the pen: 4000 m^2, Stocking density of juveniles: 1.5 per m^2, Sea cucumber production Survival rate: 60%, Culture cycle per year- 1, Average harvesting weight: 500g, 25% of the total pen area was allocated for reservations and other purposes.

e) Seaweed raft culture

Culture Period: 45 Days, Culture cycles per year: Minimum 04 cycles, Growth Assumption 100g Seedlings grow 9 times of initial weight within 45 days, Production-20-23 Mt Wet Weight/Ha – Calculations were done based on wet weight as per the ACBFSDP (2021-2025) targets. 50% of the culture area was added for reservations and other purposes.

Sea cucumber and seaweed farming will be conducted around the shallow coastal areas and seabass culture is planned to conduct both in ponds and medium-size (4mx4mx2.5m) cages.

According to the estimate, sea cucumber farming in Kilinochchi district would occupy the largest extent of 160Ha followed by Jaffna. However, the space requirement is lower than the space required to achieve the target given in NAQDA Plan (2021-2025).

Likewise, the targeted seabass production of 28 Mt in the NAQDA plan can be easily achieved. There is a high potential for NAQDA to consider a higher target for seabass culture in future expansions.

The estimated targeted value for seaweed culture by 2026 is 1550 Mt which represents a much lower value and it's not comparable with the potential space availability and the NAQDA's proposed extents. Hence NAQDA can consider higher targets by revising the targets set in the strategic plan.

The three key policies considered in relation to the development plan included, People centric economic development, Sustainable Environmental Management, and Technology based Society.

Further, to achieve the envisaged targets in coastal aquaculture, NAQDA has planned new initiatives to establish aquaculture industrial parks, sea cucumber villages, hatcheries with new technology, new intensive shrimp farming units, farming with new technologies and the expansion of small-scale marine/ brackish water fish farming.

Capacity and value chain development strategies to achieve targets

The ACBFSDP provides Strategies to achieve the production targets from coastal aquaculture by introducing *L. vannamei* instead of conventional species, Black Tiger prawn, *Penaeus monodon*, expected to regain shrimp farming sector which was struggling due to frequent crop failures of black tiger shrimp, caused by the fatal White Spot Syndrome Virus (WSSV). Numerous advantages are expected from culturing of selectively bred *L. vannamei* over other shrimp species. These advantages are largely associated with their ability to close the life cycle and produce brood stock within the culture ponds. This eliminates the need of returning to the wild for brood stock or post larvae (PL) and allows domestication and genetic selection for favorable traits such as growth rate, disease resistance and rapid maturation.

Sea cucumber hatcheries have been established at Ariyalai, Jaffna and Olaithuduwai, Mannar to produce sea cucumber juveniles to promote sea cucumber farming in the Northern province of Sri Lanka.

Current practices of seaweed cultivation are predominantly based on traditional methods and most of the seaweeds are cultivated using seedlings produced by vegetative propagation from cultured germplasm. However, this farming method has some disadvantages, such as physiological variation in the seed stock and decreased genetic variability, which reduces the growth rate, carrageenan yield of the seaweeds. In order to increase the productivity, modern biotechnology via tissue culture can be considered as one of the best options to overcome the conventional breeding challenges including shortage of raw material for planting and seedlings destruction by epiphytes, subsequently facilitate the propagation of high-quality seaweeds.

The expected outcomes of the ACBFSDP (2021-2025) stated below would accomplish the need of reliable supply of healthy seeds for implementing of the plan.

- Establish 05 SPF *P. monodon* hatcheries with capacity 229 million PL/year
- Establish 08 SPF *L. vannamei* hatcheries with capacity 753million PL/year
- Establish sea bass hatchery at Northern province (Mannar) with capacity 0.15million FL/year
- Establish sea cucumber hatcheries to produce 8.3 million Juveniles per year at Northern province
- Produce 03 million seedlings/year (developed varieties of Tissue Culture seaweed seedlings)
- Establishment of milk fish hatchery at Northern province (Mannar) with capacity 0.25million FL/year

Further, ACBFSDP (2021-2025) suggests to achieve feed requirement and reduction of feed cost through strategies of live feed production within NAQDA, promote local investors to produce such live

feeds or come to an agreement with local producer to supply at agreed rate, utilize NAQDA's fish feed line at maximum capacity level (under PPP) and to reduce dependency on external feed suppliers and to promote local investors to invest in feed production.

One of the other concerns highlight access for farmers to practical technical training to increase skills and knowledge to ensure the viable culture of the commodities. Technical support available in Northern Province for advice and detection of critical culture parameters such as diseases, water quality, and effluent management is at a low level. The Seaweed farms of Veravila, Mannar district have been affected by a disease, which has not been identified. The fishers are reluctant to engage in aquaculture activities due to such a situation which could cause huge financial losses to them. The farmers should also learn the need of proper spatial planning of culture practices of any species which in turn helps to keep biosecurity and environmental health. Strengthening of NAQDA's Coastal Aquaculture Monitoring and Extension unit, Northern Province in collaboration with regional academic institutions such as Ocean University, University of Jaffna would play a major role in this regard. Establishment of the proposed International Centre for Coastal Aquaculture Development (ICCAD) will function as a training, demonstration and a technology transfer center and would be able to provide more in-depth training and research to educate the farmers and students for carry out modern aquaculture.

It is expected to charge a levy from coastal and marine aquaculture farms of high-valued species categories. It is suggested to utilize the funds for covering part or in full the cost of the NAQDA, to promote less developed areas, such as culture of sea weeds, sea cucumber, high value ornamental fish for export etc. and develop revolving funds to promote the industry.

Further, ACBFSDP suggests to promote online marketplace to facilitate meeting of aquaculture related suppliers and buyers. Thus, it would promote and ensure market for producers and suppliers for their end products while enabling them to find low-cost sources for their production intakes. It is anticipated to create a comprehensive database in order to network all the elements of aquaculture value chain; producers/farmers, vendors, importers, exporters etc. under the strategy.

2.3 Policy, Institution and Legal Framework

2.3.1 Legislation and Acts related to the implementation of Coastal Aquaculture Development Projects

The following are the legislative acts in Sri Lanka related to the implementation of Coastal Aquaculture Development Projects. These Acts relate to the development of aquaculture projects as well as protection of the environment.

Table 8: Legislative Acts related to the implementation of Coastal Aquaculture Development

Acts/ Regulations	Relevance	Main features
The Constitution of Sri Lanka		The constitution of Sri Lanka includes the following principles. • The rights to a clean and healthy environment. • Sets out principles on which land shall be held, used, and managed. • Empowers the state to regulate the use of land in the public interest • Regulates the sustainable exploitation, utilization, and management of natural resources.
National Aquaculture Development Authority Act (No. 53 of 1998) and the National Aquaculture Development Authority of Sri Lanka (Amendment) Act, No. 23 of 2006	Management and development of Aquaculture	This Act and amendments constitute the provisions for establishing and operating NAQDA. The principal act is mostly relevant to the administrative functions of NAQDA while there are some significant adjustments for developing aquatic resources and aquaculture industry. Consequently, NAQDA has the management function of aquaculture and medium to local private sector investment in aquaculture. The aquaculture regulations under the NAQDA Act includes, • The Shrimp Aquaculture Management (Operation of Crop Cycle) Regulations, 2008. • The Live Rock Culture for Export Regulations No. 1 of 2011 • The Aquaculture Management Regulations of 2011 • The Regulations of 2012 (Amendment to Regulations No. 1 2011)
Fisheries and Aquatic Resources Act No 2 of 1996 and amended (2016)	Management, regulation, and development of the Fisheries and Aquatic resources	This Act relates to the management, regulation, conservation and development of the fisheries and aquatic resources in Sri Lanka. Several regulations have been gazetted under the Act, which have an impact on aquaculture and aquaculture products.
National Aquatic Resources Research and Development Agency (NARA) Act, No. 54 of 1981 and amendment No 32 of 1996	Advisory services for Aquaculture Development	NARA was established under the National Aquatic Resources Research and Development Agency Act, No. 54 of 1981 and amendment No 32 of 1996 to conduct research and provide advisory and consultancy services on scientific, technological, and legal matters relating to exploitation, management, conservation and development of aquatic resources.

Acts/ Regulations	Relevance	Main features
The Animal Diseases Act (1992) and Animal Diseases (Control and Prevention) Regulations (1998)	Diseases Control and Prevention in Aquaculture	This Act lists a number of measures that can be taken by the Director of Animal Production and Health in case of animal diseases, including sealing of infected premises and areas, power to close roads to animal traffic, disinfection and destruction and disposal of animal products. The Act also deals with the import and export of animals and animal products. Import permits are issued by the Controller of Imports and Exports, on the recommendation of the Director, after submission of a health certificate from the country of origin. The permit and notification procedures and the powers that may be used by the Director to enforce the Act are further regulated in the Animal Diseases (Control and Prevention) Regulations (1998).
Board of Investment (BOI) Act (2002)	Facilitate Investment in Aquaculture sector	The Board of Investment (BOI) Act (2002) seeks to promote and facilitate investment in Sri Lanka and provides for the establishment of the Board of Investors. The Board has identified priority sectors for attracting foreign and local investments, including "shellfish and other products of mariculture and aquaculture".
Fauna and Flora Protection Ordinance No 2 of 1937 and its (Amendment) Act Nos. 49 of 1993 and amendment act no 22 of 2009	Protection of Wildlife protected areas during the implementation of Aquaculture Projects	This Ordinance provides regulations for the protection, conservation and preservation of the fauna and flora of Sri Lanka. The provisions in this law will apply to aquaculture projects, if the project is in close proximity to a sanctuary or National Park protected under the Fauna and Flora Protection Ordinance (FFPO) or has any impacts on such areas. According to this Act, any development activity of any description whatsoever proposed to be established within a National Reserve or within one mile from the boundary of any National Reserve, is required to be subjected to EIA/IEE, and written approval should be obtained from the Director General, Department of Wildlife Conservation prior to implementation of such projects. The FFPO follows a similar process as the National Environmental Act (NEA) in conducting scoping, setting the TOR preparation of Environmental Assessment (EA), review of EA and public consultation and disclosure.

Acts/ Regulations	Relevance	Main features
National Environmental Act (NEA) No 47 of 1980 and its Amendment Acts no 56 of 1988 and Act No 53 of 2000	Provision of environmental approval for aquaculture projects	The NEA is the main piece of legislation with provisions for environmental Management and Protection. There are two main regulatory provisions in the National Environmental Act which is relevant to the implementation of aquaculture projects as follows. • EIA procedure for large scale development projects which are "Prescribed Projects" • Environmental Protection Licensing (EPL) procedure for waste generating industries. The list of projects requiring an EA in the form of EIA or IEE is prescribed in the above Gazette notification. Aquaculture development projects of extent exceeding 4 hectares is listed as a "Prescribed Project" under the Part I of National Environmental Act.
Forest Ordinance no 16 of 1907 and its Amendment Act no 65 of 2009	Protection of Forest Reserves during the implementation of Aquaculture Projects	This Ordinance deals with conservation, protection, and sustainable management of forest resources which would be applicable to the forest resources found within the project area. Conservation forests are under the control of the Conservator of Forests and are subject to conditions and restrictions as prescribed. The Forest Ordinance has specifically stated the types of activities that are not permitted within such Reserve/Conservation forests. Therefore, such aquaculture projects will not be allowed to be established within such areas under protection status as per the Forest Ordinance.
Coast Conservation Act No 57 of 1981	Coast Conservation during the implementation of aquaculture projects	The sections of the coast conservation Act which will apply for coastal aquaculture projects are as follows. • Control of development activities within the coastal zone (section 16) • The declaration of "Conservation Areas" of any area in which special measures need to be taken for the protection of the coastal and aquatic eco system (section 22d) • Areas within or adjacent to the coastal zone can be declared as a "Special Management Area" in order to plan resource management within the area. (Section 22 e)

Acts/ Regulations	Relevance	Main features
Marine Pollution Prevention Act, No. 35 of 2008	Prevention of Marine Pollution during the implementation of aquaculture projects	This Act provides the administrative arrangements for the prevention, control and reduction of pollution in the territorial waters of Sri Lanka or any other maritime zone, its foreshore and the coastal zone of Sri Lanka. The act also provides for the establishment of the Marine Environmental Protection Authority (MEPA) and Marine Environmental Council, reception facilities and preventive measures against pollution, maritime casualties, prevention of pollution in respect of criminal and civil liability, and prevention of pollution when engaged in exploration of natural resources including petroleum or any related activity.
Antiquities Ordinance No. 9 of 1940 and Antiquities (Amendment) Act No. 24 of 1998	Avoiding archaeological sites and reservations during the site selection for aquaculture projects	This is an Ordinance to provide for the better preservation of the antiquities of Sri Lanka, and of sites and buildings of historical or archaeological importance in Sri Lanka. Subsequent to the declaration of monuments, a prescribed zone of 400 yard from the monument are reserved and erection of buildings, carrying on of ruining, quarrying or blasting operations are prohibited within such reserved zone. Nearly 200 archaeological sites have so far been identified in the Northern Province by the Department of Archaeology.
Land Acquisition Act No. 9 of 1950 and its amendments and regulations (2008 and 2013)	Land Acquisition for aquaculture development	Gives directives for land acquisition in the public interest and provides statutory and Ex-gratia payments and benefits to title holders and non-titleholders.
National Involuntary Resettlement Policy of 2001	Resettlement due to aquaculture development	• Avoid, minimize, and mitigate negative involuntary resettlement impacts by reviewing alternatives to the project. • Project affected persons are adequately compensated, relocated, and rehabilitated. • Assist the affected persons in dealing with any psychological, cultural, social, and other impacts caused by compulsory land acquisition and resettlement • Gender equality and equity should be ensured and adhered to throughout. It aims to ensure that people affected by development projects are treated fairly and equitably and ensure that they are not impoverished in the process.

Acts/ Regulations	Relevance	Main features
World Bank's Social Safeguard policies Environmental and Social Framework (2018)	Land Acquisition, Restrictions on Land use and Involuntary Settlement (ESS 5)	• Minimize involuntary resettlement and loss of land, structures, other assets, and incomes by exploring all viable options. • Resettlement of the project affected persons are planned and developed as an integral part of development interventions. Whenever community facilities such as social, religious, and cultural facilities are affected by development interventions those need to be restored in the relocation areas.
	Biodiversity Conservation and Sustainable Management of Living Natural Resources (ESS 6)	• Conserving biodiversity and their sustainable management. • Sustainable management of primary production and harvesting of living natural resources. • This recognizes the need to consider the livelihood of project-affected parties such as Indigenous Peoples, whose access to, or use of, living natural resources may be affected by a project.
	Assessment and Management of Environmental and Social Risks and Impacts (ESS 1)	• Helps Borrowers to manage the risks and impacts of a project, and improve their environmental and social performance, through a risk- and outcomes-based approach. • Sets out the Borrower's responsibilities for assessing, managing and monitoring environmental and social risks and impacts associated with each stage of a project.
	Resource Efficiency and Pollution Prevention and Management (ESS 3)	• Sets out the requirements to address resource efficiency and pollution prevention and management throughout the project life-cycle

2.3.2 Plans and Programmes by other government agencies that could interact with proposed ACBFSDP (2021-2025)

Table 9: Plans and Programmes by other government agencies that could interact with proposed ACBFSDP (2021-2025)

Policy/ Plan / Programme	Key objective /expectations	Year of formulation	Potential conflicts with ACBFSDP	Opportunities for ACBFSDP
Ten Year Development Policy Framework of the Fisheries and Aquatic Resources Sector (2007-2016) of Ministry of Fisheries	Improving the nutritional status and food security by increasing the national fish production while minimizing post-harvest losses, increasing employment opportunities and foreign exchange earnings while conserving the coastal and aquatic environment	2007	There may be conflicts with marine based aquaculture (Sea Cucumber etc.) when developing infrastructure such as fishery anchorages and landing sites.	The main targets of the framework include, the expansion of Coastal aquaculture and strengthening entrepreneurial skills, market links, and credit access for local communities, including women
National Policy for Conservation and Sustainable Utilization of Mangrove Ecosystems in Sri Lanka, 2020 of Biodiversity Secretariat, Ministry of Environment	Conserve the mangrove ecosystem and their sustainable utilization in Sri Lanka with the aim of integrating the policies of all government agencies for the protection of mangrove patches dispersed around the island	2020	The national policy for conservation and sustainable utilization of mangrove ecosystems in Sri Lanka is to be adopted by all agencies that have a stake in mangrove ecosystems both in already protected mangrove habitats and mangroves outside protected areas. There may be constraints in identifying suitable lands for aquaculture development.	
National Biodiversity Strategy and Action Plan (NBSAP) for 2016-2022, Biodiversity Secretariat,	Mainstream biodiversity conservation concerns into sectorial and cross-sectorial policies, plans and programs.	2016	Target 11 related to enhancing resilience and adaptation in ecosystems such as forest, wetlands, mangroves and coral reefs through ecosystem-based adaptations.	Target 7 relates the strengthening sustainable use of biodiversity; it is proposed to achieve in part by community-based resource management which

Policy/ Plan / Programme	Key objective /expectations	Year of formulation	Potential conflicts with ACBFSDP	Opportunities for ACBFSDP
Ministry of Environment				could be integrated with ACBFSDP.
National Climate Change Policy of Sri Lanka ,2012, Climate Change Secretariat, Ministry of Environment	Provide guidance and directions for addressing the adverse climate change impacts efficiently and effectively by all the relevant stakeholders.	2012		The policy has guiding principles and broad statements that could be transformed to action for addressing the challenges imposed by climate change.
Sri Lanka Coastal Zone and Coastal Resource Management Plan, 2018 of CC&CRMD	The plan was developed to ensure the long-term sustainable use of the coastal environment and resources, in line with the national development goals.	2018		This provides the anticipated future climate change impacts including those from sea level rise. The projected inundation areas in each district and the sea level exposure map for Sri Lanka are also included, and proposed action for mitigating the impacts from climate change are extensively dealt with.
Physical plan for the Northern Province, volume I, Ministry of Construction, Engineering services, Housing and Common amenities 2012 Extracted from Implication of National Physical Planning Policy and Plan Sri Lanka 2010-2030 by National Physical Planning Department	Strategies have been developed for economic, physical and environmental management and conservation. The Plan has been developed in accordance with the Town and Country Planning Amendment Act No. 49 and is aligned to and will deliver on the recently gazetted National Physical Plan. The Regional Plan is built with the vision to achieve by 2030.	2012	Overlapping activities	

Policy/ Plan / Programme	Key objective /expectations	Year of formulation	Potential conflicts with ACBFSDP	Opportunities for ACBFSDP
Economic Development Framework for a Northern Province Master Plan, A Report commissioned by the Central Bank of Sri Lanka, February 2019	Present a framework for a provincial development plan, highlighting the destruction, displacement and depopulation caused by the protracted war and their consequences, and identified the social and economic challenges of post-war development of the province.	2019		The framework proposes to set up a provincial development financing agency prioritizing micro, small and medium enterprise development including agriculture, fisheries, aquaculture, crafts and manufacturing in the north.
Mannar Development Plan 2018-2030 Volume 1, Northern Province – Urban Development Authority	Goal 3: 1. The existing natural ecosystem will be conserved and preserved by 2030. 2. Archeological value of cultural and historical sites of Mannar will be enhanced by 2030. To attract 3000 tourists to boost the marine tourism by end of 2030	2018	Potential conflicts with Industrial zones, and Tourism development zones	
National Policy on Tourism-Ministry of Tourism (Currently at draft stage, Effective date subject to Cabinet Approval)	Strategy 2.2 – Sustainable use and conservation of natural, cultural and other tourism assets To ensure a long-term preservation of cultural and natural heritage, the national tourism policy recommends to upgrade rules & regulations for cultural sites and National Parks (marine and terrestrial). It is recommended to undertake a capacity assessment and set a threshold in terms of carrying capacity and minimum standards for	2021	SLTDA in collaboration with Northern Province Tourism Bureau are currently working with other relevant stakeholders for the proper and sustainable development of tourism sector in Northern Province. Most of the identified tourism sites are located in coastal areas of Northern Province.	

Policy/ Plan / Programme	Key objective /expectations	Year of formulation	Potential conflicts with ACBFSDP	Opportunities for ACBFSDP
	noise and carbon emission levels.			
National Energy Policy and Strategies of Sri Lanka, 2019, Ministry of Power and Energy	Ensure energy security through supplies that are cleaner, secure, economical and reliable, to provide convenient, affordable energy services.	2019	The main strategy of the policy is to securing land for future energy infrastructure which may conflict with the land availability for aquaculture.	
Long term Generation Expansion Plan 2022-2041, Ceylon Electricity Board (CEB)	Under the Plan, the economically exploitable wind power potential is identified which is mainly concentrated on Northern and North western coastal line of the country.	2021	CEB has planned to develop a total of around 2060 MW wind power plants in Northern and North western coastal line of the country. In addition, large scale solar PV parks in the scale of 50-100 MW are planned for future development in Northern Province. There may be conflicts in identifying suitable lands for aquaculture development.	
Renewable Energy Resource Development Plan 2021-2026, Sri Lanka Sustainable Energy Authority (SLSEA)	SLSEA has developed Renewable Energy Resource Maps for Solar, Wind, hydro and wave energy. SLSEA has set a goal to reach 70% of the electricity generation by Renewable Energy by 2030. Renewable energy sites selected from the prioritized sites to be made ready for tendering by end 2026.	2021	Several areas of the land-based study area in Northern Province have been identified by the SLSEA, as potential sites for Wind and Solar power development projects. The Ministry of Power and Energy has gazetted these areas as "Energy Development Areas" under section 12(1) of SLSEA act No. 35 of 2007. There may be conflicts in identifying suitable lands for	

Policy/ Plan / Programme	Key objective /expectations	Year of formulation	Potential conflicts with ACBFSDP	Opportunities for ACBFSDP
			aquaculture development.	

2.3.3 Applicable international treaties, conventions, agreements

The following conventions and agreements should be considered during the implementation of Coastal Aquaculture development programme in Northern Province.

- **Sustainable Development Goals (SDGs)**

Sustainable Development Goal (SDG) 14 – 'Life below water' focuses the conservation and sustainable use of oceans, seas and marine resources for sustainable development. One of the targets is to increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism by 2030. At the same time, it is expected to conserve at least 10 % of coastal and marine areas which may interact with coastal aquaculture development. Sri Lanka being an island, adopting a 'Blue Economy' strategy, it is important to achieve sustainable development of coastal aquaculture sector.

- **Commonwealth Blue Charter agreement,2018**

The Commonwealth Blue Charter was adopted by all Commonwealth countries including Sri Lanka in 2018 to actively cooperate to solve ocean-related challenges and to meet commitments for sustainable ocean action with emphasis on SDG 14 (Life Below Water). Commonwealth Blue Charter Action Groups which implement the Blue Charter, guide the development tools such as Commonwealth Clean Ocean Alliance, Coral Reef Protection and Restoration, Mangrove Ecosystems and Livelihoods, Marine Protected Areas, Ocean Acidification, Ocean and Climate Change, Ocean Observation, Sustainable Aquaculture, Sustainable Blue Economy and Sustainable Coastal Fisheries.

- **Cartagena Protocol on Bio Safety (2000)**

Sri Lanka ratified to Cartagena Protocol in April 2004. Objective of Cartagena Protocol is to contribute to ensuring an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health, and specially focusing on trans boundary movements.

- **United Nations Convention on Biological Diversity (CBD)**

Sri Lanka became a signatory to the Convention on Biological Diversity (CBD) in 1992 and ratified to this convention in 1994.

Sri Lanka has prepared the National Biodiversity Strategic Action Plan in collaboration with all relevant stakeholders to conserve biological diversity, sustainable use of its components and the fair & equitable sharing of benefits from use of genetic resources.

- **Convention on Wetlands of International Importance Especially as Waterfowl habitats (Ramsar)**

Sri Lanka ratified to RAMSAR convention in 1990 for conservation of wetlands/wetland associated species and wise use of them through local and national actions and international cooperation. Sri Lanka consists 6 RAMSAR sites managed by DWC. Among them, Vankalai sanctuary, which was declared as a RAMSAR wetland in 2010, is located within the SEA study area in Northern Province.

- **United Nations Framework Convention on Climatic Changes (UNFCCC) (1992)**

Sri Lanka ratified the United Nations Framework Convention on Climate Change (UNFCCC) in November 1993. UNFCCC aims stabilizing atmospheric concentrations of greenhouse gases (GHGs) to avoid dangerous anthropogenic interference with the climate system. To boost the effectiveness of UNFCCC, Kyoto Protocol and the Paris Agreement were adopted by the parties.

- **Kyoto Protocol (1997)**

Kyoto Protocol operationalizes the UNFCCC by committing industrialized countries and economies in transition to limit and reduce greenhouse gases (GHG) emissions in accordance with agreed individual targets. Sri Lanka ratified the Kyoto Protocol in October, 2002.

- **Vienna Convention for the Protection of the Ozone Layer (1985)**

The main objective of the Vienna Convention is the Protection of the Ozone Layer through international cooperation in the areas of scientific research, monitoring and of information exchange. Sri Lanka ratified the convention in December, 1989.

- **Montreal Protocol (1987)**

The Montreal Protocol is a landmark multilateral environmental agreement which regulates the production and consumption of ozone depleting substances (ODS) that has been ratified by Sri Lanka in December,1989.

- **United Nations Convention on the Law of the Sea (UNCLOS)**

UNCLOS governs the world's oceans and seas and promotes the conservation of marine biodiversity aiming to preserve marine environment. Sri Lanka ratified to this convention in 1994 and Ministry of Fisheries and Aquatic Resources Development is the implementing agency.

- **Agreement on the Network of Aquaculture Centres in Asia and the Pacific**

This is to assist the members in their efforts to expand aquaculture development for the purpose of increasing production, improving rural income and employment, diversifying farm production while minimizing direct and indirect effects.

Sri Lanka ratified to this agreement in 1989 and the Ministry of Fisheries and Aquatic Resources Development act as the implementing agency.

2.3.4 Other Relevant Regulations and Permits

Aquaculture Management License

As per the Aquaculture Management Regulations of 2011, in order to establish/operate an aquaculture activity/company, it is compulsory to apply and have an aquaculture management license issued by the Director General of NAQDA. A license is issued for a one-year period and is renewable upon application. The license application may be approved (or rejected) in a pre-determined procedure, which depends on the Category of aquaculture enterprise the Director General of NAQDA or licensing officers deem necessary.

Environmental Approval Process for New Aquaculture Projects

Since most of the proposed coastal aquaculture projects will be situated within the coastal zone the approval for such projects will be granted by the Coast Conservation and Coastal Resources Management Department (CC&CRMD) subsequent to an IEE or EIA depending on the scale and magnitude of the project. The Director General Coast Conservation has the discretion to decide whether an IEE or Full-scale EIA will be carried out for a given aquaculture project situated within the coastal zone. Most aquaculture projects within the coastal zone are approved by the CC&CRMD subsequent to an IEE. For aquaculture projects which are situated outside the coastal zone the CEA will act as the project approving agency which approves the IEE or EIA.

Environmental Impact Assessment (EIA) Process

If an aquaculture project is situated outside the Coastal Zone as defined in the Coast Conservation Act the provisions contained in the National Environmental Act will apply during the project approval process. The EIA process under the National Environmental Act applies only to the "Prescribed Projects" which have been published in the Government Gazette No 772/22 dated 24th June 1993 under section 23 Z of the National Environmental Act. This gazette notification lists two groups of projects that require an IEE or EIA before they can be implemented. Part 1 of the gazette notification lists seventeen different types of projects (excluding industries) that are considered as having significant environmental impacts. Aquaculture development projects of extent exceeding 4 hectares is listed as a "Prescribed Project" under the Part I of National Environmental Act.

The second list in Part 11 of the Gazette notification sets out very high polluting industries which need an IEE or EIA irrespective of where they are located. Part 111 of the Gazette notification lists environmentally sensitive areas within which any project, irrespective of its magnitude, will be caught up in the EIA process. The environmental sensitive areas gazetted under the EIA Regulations are as follows;

- Within 100 meters from the boundaries of or within any area declared under the National Heritage Wilderness Act/ the Forest Ordinance
- Any erodible area declared under the Soil Conservation Act (Chapter 450)
- Any Flood Area declared under the Flood Protection Ordinance (Chapter 449) and any flood protection area declared under the Sri Lanka Land Reclamation and Development Corporation Act No 15 of 1968 as amended by Act No 52 of 1982.
- 60 meters from the bank of a public stream as defined in the Crown Lands Ordinance (Chapter 454) and having a width of more than 25 meters at any point of its course.

- Any reservation beyond the full supply level of a reservoir.
- any archeological reserve, ancient or protected monument as defined or declared under the Antiquities Ordinance (Chapter 188)
- any areas declared under the Botanical Gardens Ordinance (Chapter 446)
- Within 100 meters from the boundaries of or within any areas declared as a Sanctuary under the Fauna and Flora Protection Ordinance. (Chapter 469)
- Within 100 meters from the high flood level contour of, or within, a public lake as defined in the Crown Lands Ordinance (Chapter 454) including those declared under section 71 of the said Ordinance.

Any project, irrespective of its magnitude will be required to undergo an Environmental Impact Assessment study if located partly or within the above mentioned environmentally sensitive areas.

Since most of the proposed coastal aquaculture projects will be situated within the coastal zone the approval for the IEE or EIA will be granted by the Coast Conservation Department under the provisions of the Coast Conservation Act. The Director General Coast Conservation has the discretion to decide whether an IEE or Full-scale EIA will be carried out for a given aquaculture project situated within the coastal zone. Most aquaculture projects within the coastal zone are approved by the Coast Conservation and Coastal Resources Management Department (CC&CRMD) subsequent to an IEE. For aquaculture projects which are situated outside the coastal zone the Central Environmental Authority (CEA)will act as the project approving agency which approves the IEE or EIA.

Environmental protection Licensing Procedure for Waste Generating Industries

In addition to the EIA procedure there is another regulatory procedure of the CEA namely the Environmental Protection Licensing (EPL) process for waste generating industries which also applies for aquaculture projects. Under the EPL regulation any industry or process which generates wastewater, air emissions, solid waste, hazardous waste, noise or vibration is required to obtain an Environmental Protection License (EPL) on an annual basis. The EPL for the specific industry will specify the environmental standards to be complied with by the industry when discharging wastewater, air emissions or noise into the environment. The industry is required to abide by the standards stipulated in the EPL and repeated violations of the standards could result in legal action being taken against the industry. Industries which require an EPL are given in gazette notification No 1533/16 dated 25.01.2008. In this gazette, Industries are classified as being High Polluting, Medium Polluting or low polluting.

Although aquaculture projects are not listed as requiring an EPL in this gazette notification, some of the aquaculture projects are caught up within the EPL regulation, as any industry which discharges more than 10 or more cubic meters of wastewater falls under part A of the gazette notification are considered as being high polluting industries. EPLs for such high polluting industries are usually issued by the CEA head office. Similarly, an aquaculture project discharging 3 or more cubic meters and less than 10 cubic meters of wastewater is considered as being a medium polluting industry and will require an EPL which is issued by the relevant regional office of the CEA. The standards required to be complied with by these projects are stipulated in the EPL and will depend on the final discharge point of the effluents.

Institutions involved in issuing Approvals/Permits required for Coastal Aquaculture projects

1) **National Aquaculture Development Authority (NAQDA)**

As per the Aquaculture Management Regulations of 2011 to establish/operate an aquaculture activity/company, it is compulsory to apply and have an aquaculture management license issued by Director General of NAQDA. The license application may be approved (or rejected) in a determined procedure, which depends on the Category of aquaculture enterprise the Director General of NAQDA or licensing officers deem necessary. For instance, if a farm belongs to Category A, the licensing officer could decide whether a license can be granted. But if it is in Category B and C the licensing officer could decide whether to grant or deem a license or it may need a consultation with the Aquaculture Management Technical Committee. If a farm belongs to category D, the licensing officer may call for approval under the National Environment Act or may request an EIA/IEE Report through the Aquaculture Management Technical Committee. Usually, the officers from regional centers are involved in field observations and informed the Aquaculture Management Technical Committee which is comprised of representatives of line agencies pertaining to the environment and aquaculture. The proponent of Category A to C farms should provide no-objection letters from the CEA, CC&CRMD or MEPA depending on the jurisdiction of the farm locality.

2) **Forest Department** – Approval is required if an aquaculture project is within or in close proximity to a conservation forest including mangroves.

3) **Department of Wildlife Conservation (DWC)** – The Department of Wildlife Conservation is responsible for protected areas declared under the Fauna and Flora Protection Ordinance. If an aquaculture project is located within a protected area declared under the Fauna & Flora Protection Ordinance such as a Sanctuary, or within 1 mile from the boundary of a protected area such as a National Park, approval is required from DWC.

4) **Central Environmental Authority (CEA)**-Aquaculture projects are required to go through an IEE or EIA depending on its magnitude and location.

   The other regulatory procedure under the National Environmental Act is the Environmental Protection Licensing (EPL) Procedure. According to the EPL regulation only aquaculture projects which discharge more than 10 cubic meters of wastewater (high Polluting category) and projects which discharge more than 3 cubic meters and less than 10 cubic meters of wastewater (medium polluting category) are required to obtain an annual license from the CEA.

   The EPL issued by the CEA will specify the environmental standards and criteria to be met, both during the project construction and implementation stage. This will include standards specified under the National Environmental Act such as water quality standards, air quality standards including both ambient air quality as well as air emission standards, Noise and vibration standards to be complied with. The EPL will specify the maximum limits allowed for any wastewater discharges as well as conditions to be complied with in disposing of solid waste generated by the aquaculture project during the operational stage. The stipulated wastewater standards will be decided on basis of the final discharge point of the wastewater.

5) **Coast Conservation and Coastal Resources Management Department (CC&CRMD)** - For the aquaculture projects to be located within the coastal zone, the approval need to be obtained from the CC&CRMD and subject to an EIA or IEE or both as specified by the CC&CRMD. The requirement of an IEE or EIA will be decided by CC&CRMD subsequent to a site visit to the proposed location. Depending on the scale of the project and potential impacts of the project on the surrounding environment, a decision will be made on the requirement of an IEE or EIA. In most aquaculture projects IEEs are usually carried out by the project proponent, based on the terms of reference issued by the CC&CRMD.

6) **Department of Fisheries and Aquatic Resources-**

The Department of Fisheries and Aquatic Resources represents the NAQDA Aquaculture Management Technical Committee. Department of Fisheries is mandatory for regulating the management of some aquaculture practices. Presently NAQDA requests no objection from the department of fisheries when approving the marine based aquaculture projects.

7) **Local Authority (Pradeshiya Sabha, UC, MC etc.)**

Approval from the relevant local authority is sought to complete the application for an aquaculture management license under the Aquaculture Management Regulations of 2011. Moreover, the local authorities are involved in issuing lands, and other infrastructure and business permits if applicable.

8) **Fisheries Cooperative Societies (FCS)/ Rural Fisheries Societies (RFS)**

The consent of the Fisheries Cooperative Societies (FCS) and Rural Fisheries Societies (RFS) which functions based on GNDs of the coastal villages, is a preliminary requirement for the licensing process. Department of Fisheries and Aquatic Resources (DFAR) are issuing no objection letter based on the consent received from relevant FCS or RFS.

3 Approach and Methodology

3.1 General Methodology adopted for the SEA Study

This SEA study consists of two phases, namely the scoping study and SEA study. The Scoping phase was aimed at the preliminary identification of the key environmental and social concerns during the implementation of the NAQDA plan, in order to focus the SEA study on these areas of major concern. Based on the findings of the scoping study, the SEA study was planned and several site visits were carried out to the selected sites in the Northern province. The SEA study focused efforts and recommendations for the potential major environmental, social, cultural and climate change related impacts identified at the strategic level during the scoping phase.

The potential key issues were identified and discussed during the provincial stakeholder meeting, individual consultations with the government stakeholders, community consultations and the consultations with the Community Based Organizations (CBO) and aquaculture operators. Those key issues were prioritized based on the opinion of the experts. The key issues were evaluated and analyzed to identify the recommendations at the SEA study phase. The secondary data were obtained from the relevant government institutions for the identification of sensitive areas where coastal aquaculture projects are not allowed.

Further, secondary data on the socio-demographic characteristics of the study area was collected from the resource profile reports of the divisional secretariats, the provincial statistical handbooks, and the statistical books of the Central Bank.

The most important outcome of the SEA study was mapping of the areas where coastal aquaculture projects should not be allowed and the areas where there will be Low/ Medium/ High environmental and social risk for siting of aquaculture projects. In order to determine the relative risks associated with the area, the following areas which are considered as being high and medium risk areas for siting of aquaculture projects were mapped using GIS.

- Declared wildlife protection areas within the SEA study area
- Declared and proposed Forest Reserves within the SEA study area
- Coral Reefs, Sea Grass, Mangroves, Sand Dunes and Other unprotected Sensitive Areas with SEA Study Area
- Gazetted archaeological reserves within the SEA Study area
- Fresh water/River Outlets and River basins within the SEA Study area
- Cyclone induced storm surge hazard map with projected storm surge levels -For 90 Years and 300 years Return Periods
- Fishery landing sites and Beach Seine areas (Madel Padhu Sites) within the SEA Study area
- Locations of tourist attractions and potential areas for marine tourism activities within the SEA study area
- Existing and planned Renewable Energy Development projects within the SEA study area
- Existing and proposed industrial zones and Salterns within the SEA study area
- Demining progress within SEA study area in Northern province
- High security zones and security camps within SEA study area

Out of the above-mentioned areas, areas where traditional fishing is being carried out pose the biggest challenge to the implementation of the proposed aquaculture projects. Therefore, special attention was paid to obtain information on such areas. One of the problems identified was that these traditional fishing areas have not been as yet formally recognized or mapped, and such information was not available with the Department of Fisheries. Efforts were made to personally visit and meet with the Assistant Directors and Fisheries Inspectors based in the Fisheries Extension Offices in Jaffna, Mullaitivu, Mannar and Kilinochchi districts in order to obtain information regarding these traditional fishing areas and landing sites, to produce a map denoting such areas for the SEA. Representatives from the Fisheries Organizations also participated at these meetings.

Opportunity and risk map was prepared showing key risks and challenges to implementation/expansion of coastal aquaculture projects. The classification consists of 3 main risk categories namely, high risk, medium risk, and low risk areas (unsuitable, intermediate, and suitable areas) for coastal aquaculture development.

It should be noted that all sites in the opportunity and risk map may not be suitable for the development of aquaculture projects, as the opportunity map denotes only the areas which have a lower risk for the development of aquaculture due to the absence of environmentally sensitive areas or other impediments such as development projects proposed by other agencies etc. The opportunity map produced by the SEA therefore only indicates areas of low risk for aquaculture development due to the absence of environmentally sensitive and/or protected areas, social and/or cultural impediments, as well as areas identified by other development agencies for implementation of development projects in the future. The suitability of individual sites for aquaculture development requires therefore to be assessed through appropriate feasibility studies.

With respect to the mapping of environmentally sensitive areas, information was obtained directly from the GIS databases of government agencies such as the Forest Department, DWC, CEA, CC&CRMD regarding areas within the study area which are declared and already under protected status. In addition, information related to areas which are being proposed to be brought under protection status was also obtained from these agencies and mapped.

3.1.1 Selection of Geographical Study Area for the SEA

The SEA study area was finalized in consultation with World Bank and NAQDA during the Scoping phase.

The land-based SEA study area comprises 1781 Sq. Km which represents around 20% of the total land area in Northern Province. Among the 5 districts in Northern Province, the SEA study focused on 4 coastal districts namely, Jaffna, Kilinochchi, Mullaitivu, and Mannar districts which are surrounded by the Gulf of Mannar and Palk Bay to the West, Palk Strait to the North West, the Bay of Bengal to the North and East.

The study area for the SEA study includes the following stretches of land-based area.

1. Stretch between the A32 road and Coast from Mannar to Pooneryn, including the Mannar island.
2. Islands in Jaffna and Kilinochchi districts (Kayts, Karainagar, Punkudutivu, Delft, Mandadivu, Nainativu, Eluvativu, Analaitivu, Palativu and Iranativu)

3. Stretch between Mullaitivu-Kokkilai Road (B297), Paranthan-Mullaitivu Road(A35) and coast in Mullaitivu District including Vadamarachchi Lagoon, Chundikkulam Lagoon, Nandikadal lagoon and Nayaru lagoon.

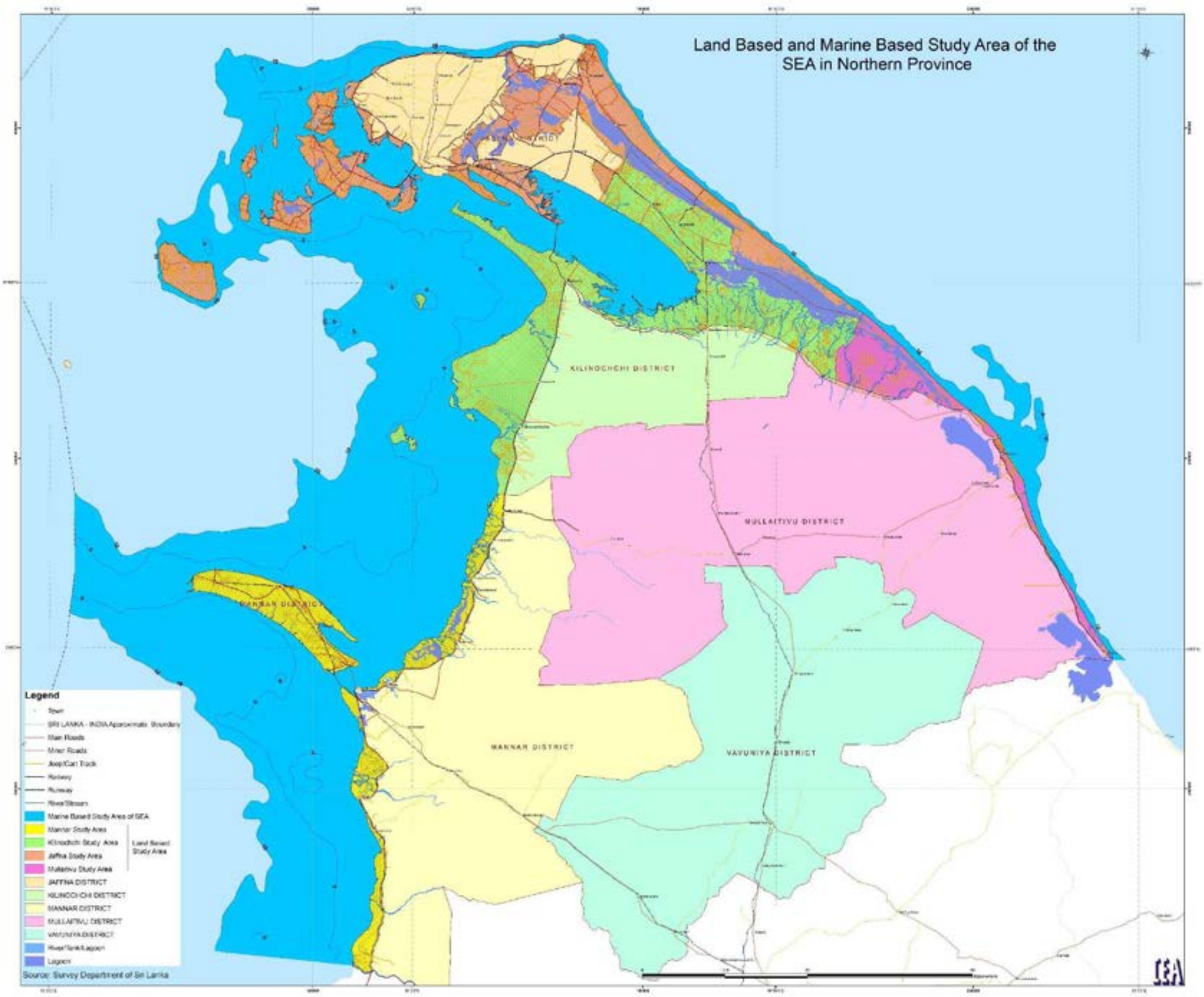
Accordingly, the landward boundary of the land-based SEA study area varies between 300 m and 13 Km landwards of the Mean High-Water line. Also, the study area includes rivers, streams, lagoons, or any other water bodies connected to the sea either permanently or periodically within that stretch.

The Study area of the SEA also includes the area up to 10 m depth contour seawards of the Mean Low Water line. Marine based study area comprises approximately 4222 Sq.km.

The map showing the Land and Marine Based Study Areas of the SEA in Northern Province is given in Map 01 below.

3.1.2 Scoping Study

A scoping study was carried out to identify the key aspects to be addressed in the SEA study and to identify the scope of the environmental and social baseline to be prepared in the SEA study. Final Scoping Report submitted to the World Bank is given in Annex 03.



Map 01: Map showing the Land based and Marine Based Study Areas of SEA

3.1.3 Rapid Ecological Surveys

Rapid underwater ecological surveys were conducted by the Marine Ecologist of the SEA team at following locations to identify ecologically sensitive areas within the marine based study area with special focus on potential sites identified by NAQDA for development of coastal aquaculture.

- Ariyalai, Jaffna lagoon (in an existing sea cucumber farm)- Jaffna district
- Around Vidataltivu Reef-Mannar district
- Around Pallitivu Island- Kilinochchi district
- Around Delft Island- Jaffna district
- Around Analaitivu and Nainativu Islands- Jaffna district
- Around Mandativu Reef – Jaffna district
- Around Point Pedro Reef- Jaffna district
- Vankalai Sanctuary- Mannar district
- Around Silavaturai area- Mannar district
- Around Arippu Reef- Mannar district

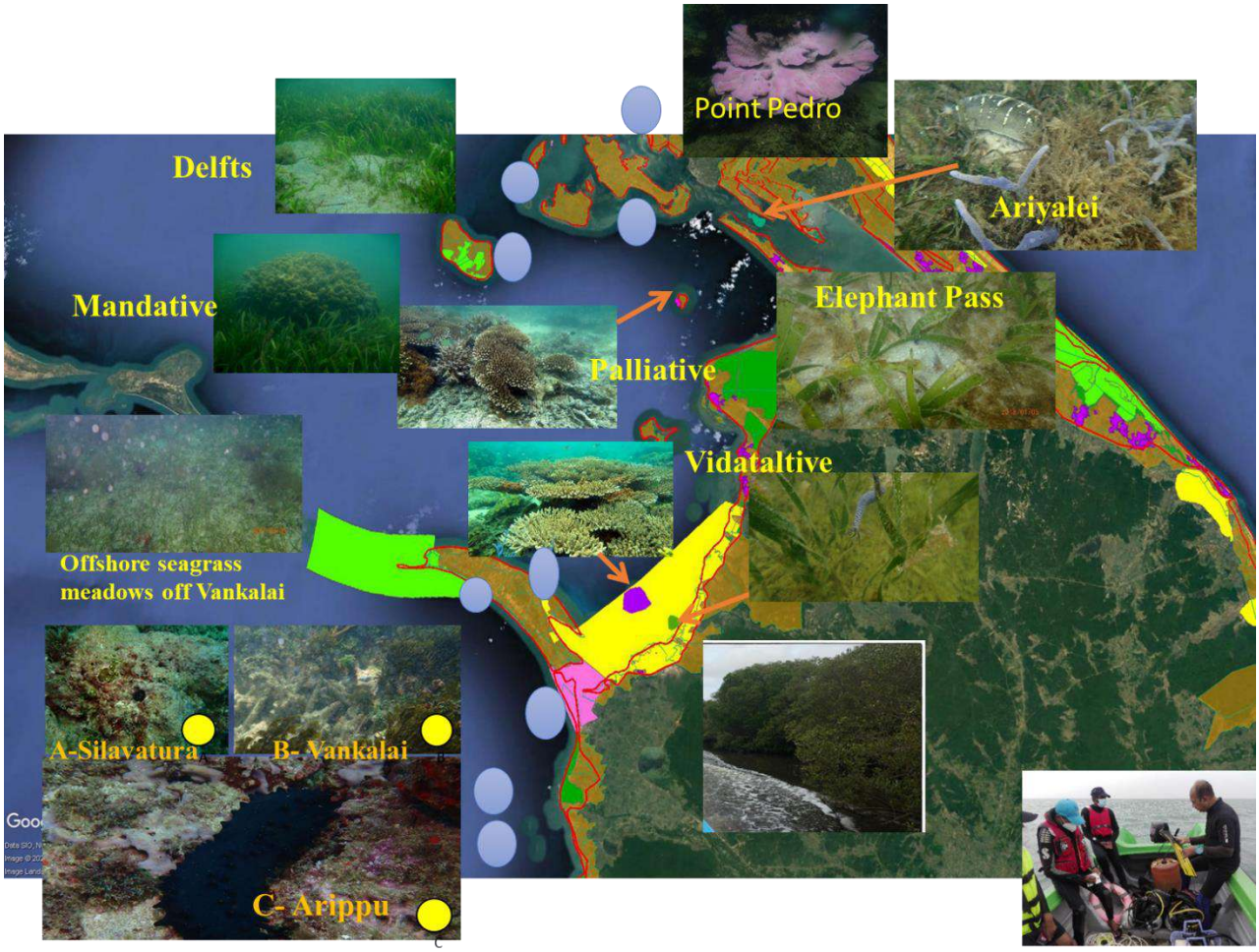


Figure 1: Locations of the Rapid Ecological Surveys Conducted

3.1.4 Questionnaire Survey and Key Informant Interviews

An additional effort was made to obtain any information available through the regional offices and field officers of the CEA, Forest Department, DWC and the CC&CRMD by distribution of a questionnaire. This was for the purpose of identifying any environmentally sensitive area in these districts which the local officials may be aware of, but which have not yet been identified for the purpose of protection.

3.1.5 Conducting Stakeholder Meetings

The views and perceptions of Stakeholders are important to identify potential impacts of implementing the coastal aquaculture development programme. Therefore, stakeholder consultation with the government agencies and community consultations were considered as key priorities. As part of the stakeholder consultation, Initial provincial level stakeholder meeting was conducted with the participation of around 75 representatives of the provincial level and district level government agencies in February 2022 to introduce the SEA study to the stakeholders and to identify the key aspects to be addressed in the SEA study.

Second provincial level stakeholder meeting was conducted in August 2022, to present the draft SEA report and to obtain the suggestions/concerns of the stakeholders for SEA findings with the participation of around 80 stakeholders.

Apart from that, individual consultations were carried out with the government stakeholders to obtain relevant information for the study.

3.1.6 Community Consultations

Community consultations were also conducted with Fisheries Organizations, Aquaculture Operators and other Community based Organizations (CBO) for further identification of socioeconomic consequences related to coastal aquaculture development. These consultations allowed the stakeholders to share their views and concerns. Also, the Consultations were helpful in identifying the constraints for coastal aquaculture development and impacts.

3.2 Identification of Environmental, Social, and other sensitive areas

3.2.1 Environmental and Cultural Sensitivity

In order to come up with an “Opportunity and Risk Map” for development of coastal aquaculture in the Northern Province, environmentally, socially, culturally sensitive areas as well as development areas already identified by other government agencies for development purposes for industrial, tourism, infrastructure, and power generation were identified. In addition, areas which are prone to periodic flooding as well as areas which have high freshwater inflows were considered as being unsuitable for the development of coastal aquaculture. These areas were all mapped in order to exclude such areas for the development of aquaculture projects as follows;

3.2.1.1 Exclusion of Existing and Proposed Protected Areas under DWC

In Sri Lanka, the Fauna and Flora Protection Ordinance (FFPO) No 2 of 1937 and its amendment Act No. 49 of 1993 and amendment act no 22 of 2009 provide the legal protection for protected areas such as Strict Nature Reserves, National Parks, Nature Reserves, Jungle corridors and Sanctuaries declared by the DWC. The SEA study area consists of 4 nature reserves, 4 sanctuaries, and 3 national

parks located in Mannar, Kilinochchi, Jaffna, and Mullaitivu districts. Vankalai Sanctuary is also designated as Wetland of International Importance under the UN Ramsar Convention. Vidataltivu, one of the largest intact mangrove ecosystems, has been declared as a Nature Reserve.

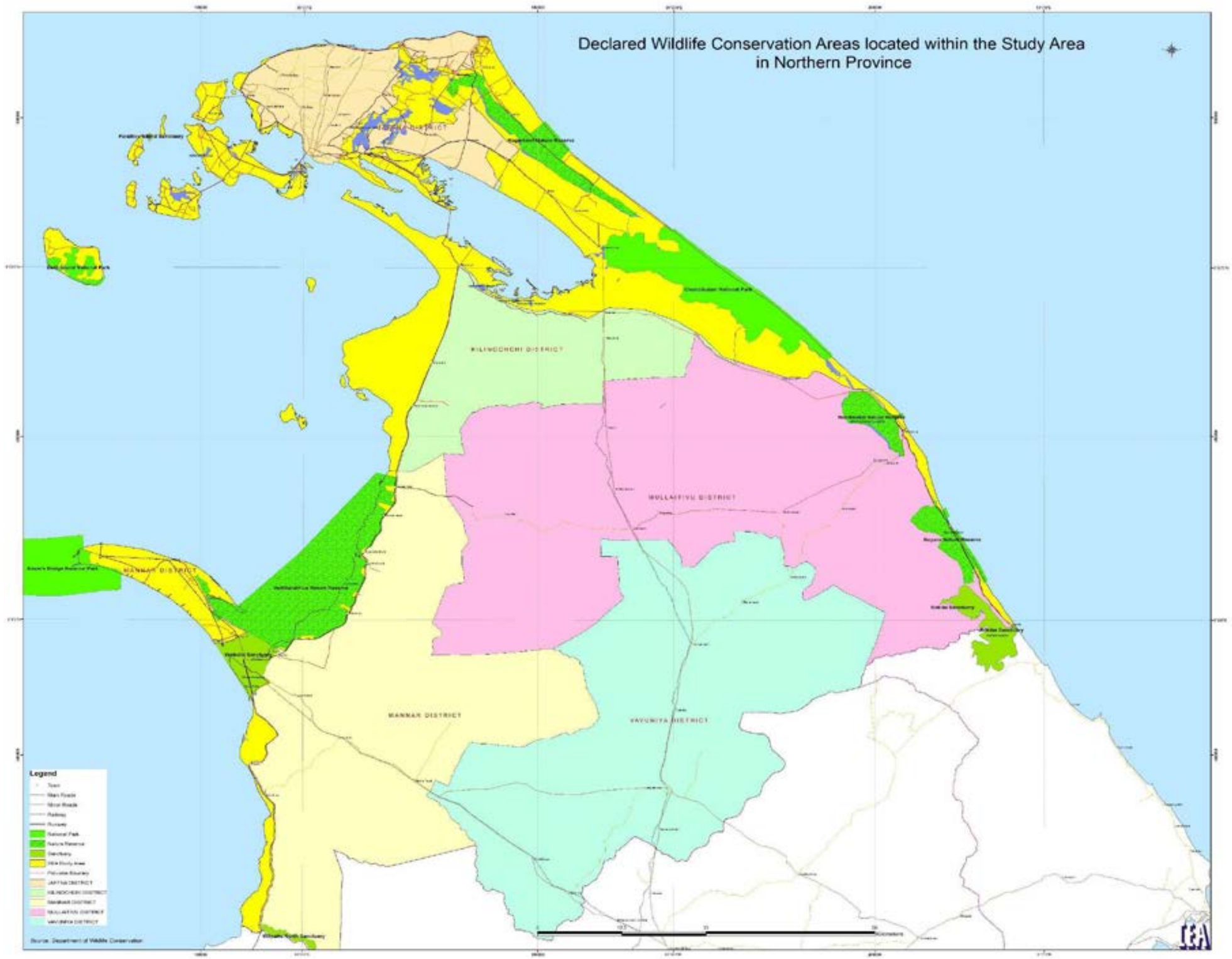
Those biodiversity rich areas have been identified as ecologically sensitive areas to be excluded while implementing the Coastal Aquaculture Development Programme. In addition, development activities are either prohibited or restricted within 1.6 Km (1 mile) of the boundary of Strict Nature Reserves, National Reserves, National Parks, Jungle Corridors, Marine Reserves. The details of the Protected areas within the SEA study area were obtained from the DWC and mapped by the SEA Consultant.

A map showing those declared wildlife protection areas within the SEA study area in Northern Province is given inMap 02 below.

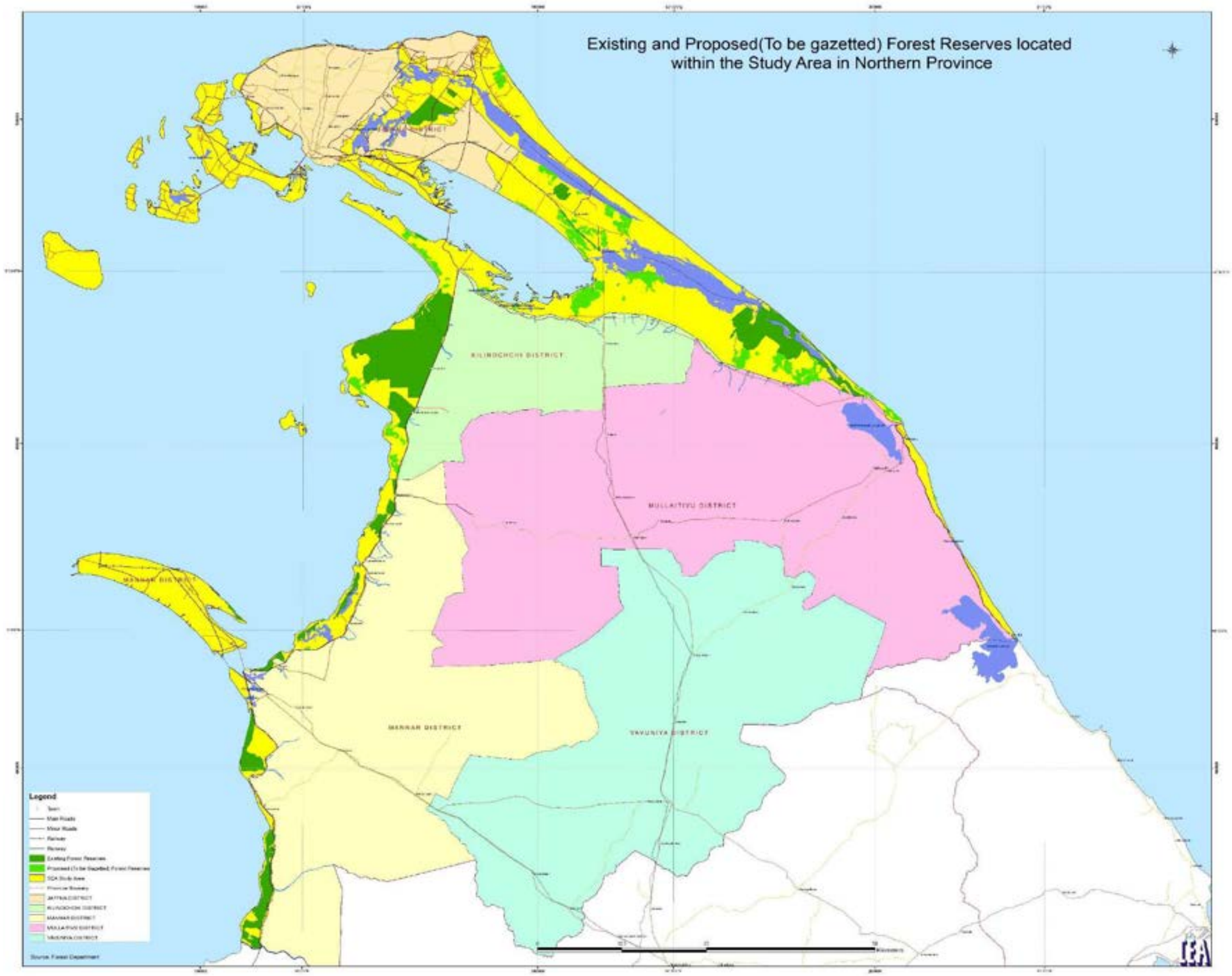
3.2.1.2 Exclusion of Existing and proposed Forest Reserves

The legal protection for the forest reserves is mainly derived from Forest Ordinance (FO) no. 16 of 1907 and its Amendment Act no. 65 of 2009. There are 20 declared forest reserves identified within the SEA study area located in Mannar, Kilinochchi, Jaffna, and Mullaitivu districts. Apart from the declared forest reserves, the Forest Department has proposed 42 reserves within the study area to be gazetted in the future. The geographical locations and the area of each forest reserve were obtained from the Forest Department and mapped using GIS.

A map showing the gazetted Forest Reserves as well as proposed Forest Reserves within the SEA study area in Northern Province is given in Map 03 below.



Map 02: Map of the declared wildlife Conservation areas located within the Study Area of Northern Province



Map 03: Map of the declared and proposed (To be gazetted) Forest Reserves located within the Study Area of Northern Province

3.2.1.3 Exclusion of Critical and Sensitive Coastal and Marine Habitats

Aquaculture practices result in various effluents such as harmful pollutants, suspended particles, excessive nutrients, etc., which may severely impact the critical and sensitive habitats. Therefore, it is mandatory to select sites away from such habitats and immediate impact zones of the aquaculture farms.

The Coastal and marine environment of the Northern Province encompasses a major share of Sri Lanka's coastal ecosystems, including mangroves, coral reefs, seagrass beds, salt marshes and thonas.

The existing maps showing critical coastal and marine habitats and sensitive areas in the Northern Province were updated with data obtained from the relevant authorities, other published reports including the Integrated Strategic Environmental Assessment for the Northern Province and the IUCN study on "Conservation and sustainable use of biodiversity in the islands and lagoons of Northern Sri Lanka". In addition, the rapid marine ecological surveys carried out by the coastal and marine ecologist of the SEA team were also integrated into the updated maps.

All these critical and sensitive habitats are already under multiple anthropogenic stressors and any development work has to be given due consideration to the health of the ecosystems. The SEA is mostly based on available national level data layers and a few gaps filling studies as described in sections 3.1.3, 3.1.4 and 3.1.5. As such, detailed studies require to be conducted during the EIAs for the individual projects prior to finalizing the aquaculture development projects.

3.2.1.4 Exclusion of Declared Archaeological and Cultural Reserves

Archaeological and cultural sites in Sri Lanka are protected through the Antiques Ordinance No. 9 of 1940 and its subsequent amendments by Acts No. 2 and 22 of 1955 and Act No. 24 of 1998. According to the Antiquities Ordinance,

a) any monument lying or being found in Sri Lanka which dates or may reasonably be believed to date from a period prior to the 2nd March, 1815 and
b) any other monument which has been declared to be an ancient monument by an Order published in the Gazette under section 16, and
c) any tree in respect of which an Order under section 17 has been published in the Gazette.

are defined as a Protected Monument.

According to the regulations, 400 yards (370m) are to be kept from the archaeological monument as a buffer zone. All development activities such as constructions, mining, and quarrying within these buffer areas are restricted.

Archaeological reserves are state lands that consist of archaeological remains which are under the direct control of the Department of Archaeology.

Department of Archaeology has declared around 200 Archaeological reserves and Protected Monuments within the Northern Province.

The archaeological sites and the 370 m reservation area have to be excluded when selecting the potential areas for coastal aquaculture development.

The geographical locations and information on archaeological reserves and protected monuments within the Northern Province were obtained from the Department of Archaeology and a map was prepared using GIS.

A map showing those gazetted archaeological reserves and protected monuments within the SEA Study area in the Northern Province is given in Map 04 below.

3.2.1.5 Avoidance of Shipwreck impacted areas

According to the National Shipwreck Database of Sri Lanka developed by the Maritime Archaeology unit of Central Cultural Fund, a total of 109 shipwrecks are scattered around the country. Over 100 of dive Sites in Sri Lanka are related to historical shipwrecks lie under the sea. Most of the identified historical shipwrecks belong to the colonial period, and the oldest shipwreck site is the Godawaya shipwreck site. Shipwreck preservation is important as they help to sustain the marine ecosystem.

Northern Province consists 12 shipwrecks. Highest number of shipwrecks have been recorded in Mullaitivu district (7), while Mannar district recorded 3 and Jaffna district recorded 2 shipwrecks. These shipwrecks lie in a depth of 0-14 m under the sea. Details of Shipwrecks found in Northern Province is given in Table 10 below.

Table 10: Shipwrecks found in Northern Province

No.	Site	Original Name	Depth(m)	Sank On	Administrative District
1.	SL/N/MULA/M/10	SS Indus	6 - 9	1885	Mullaitivu
2.	SL/N/ARIP/M/01	Battalangunduwa Barge	6 - 8		Mannar
3.	SL/N/ARIP/M/02	Arippu Wreck	7 - 8		Mannar
4.	SL/N/KKSN/M/04	KKS Wreck	10 - 12		Jaffna
5.	SL/N/PESA/M/03	MV Mission	2 - 8	1997	Mannar
6.	SL/N/VETT/M/05	Vettalakeni Wreck	11 - 14		Jaffna
7.	SL/N/MULA/M/06	MV Farah III	0 - 6	2006	Mullaitivu
8.	SL/N/MULA/M/07	Navy Vessel	7 - 10		Mullaitivu
9.	SL/N/MULA/M/08	Iron Wreck	1 - 10		Mullaitivu
10.	SL/N/MULA/M/09	MV Princess Kash	1 - 10	1998	Mullaitivu
11.	SL/N/MULA/M/11	New Wreck	0		Mullaitivu
12.	SL/N/PULM/M/12	MV Cordaility	8 - 10	1997	Mullaitivu

(Source: National Shipwreck Database of Sri Lanka, 2021)

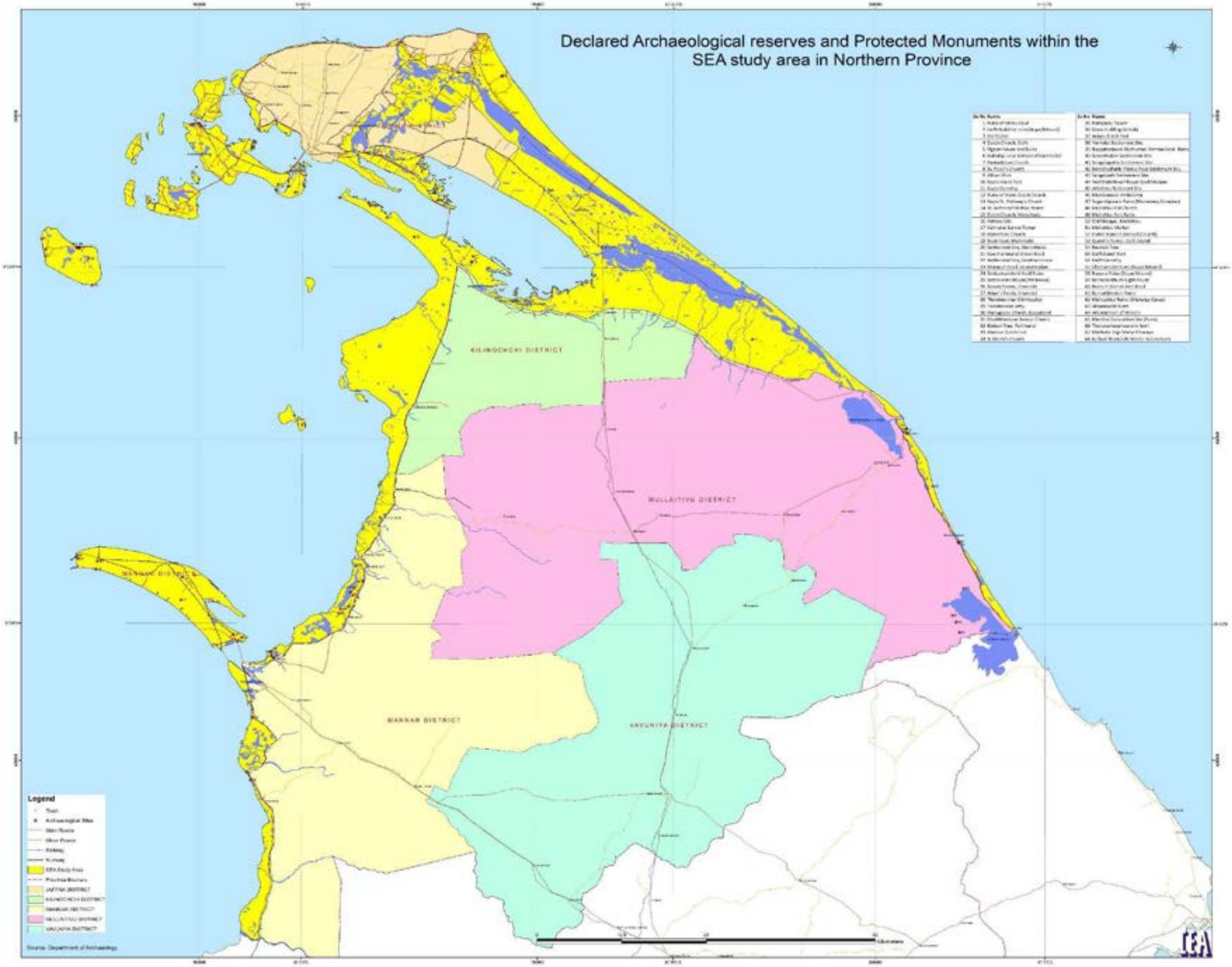
Shipwrecks recorded within Northern Province is given in Map 05 below.

3.2.1.6 Avoidance of Fresh water/River Outlets

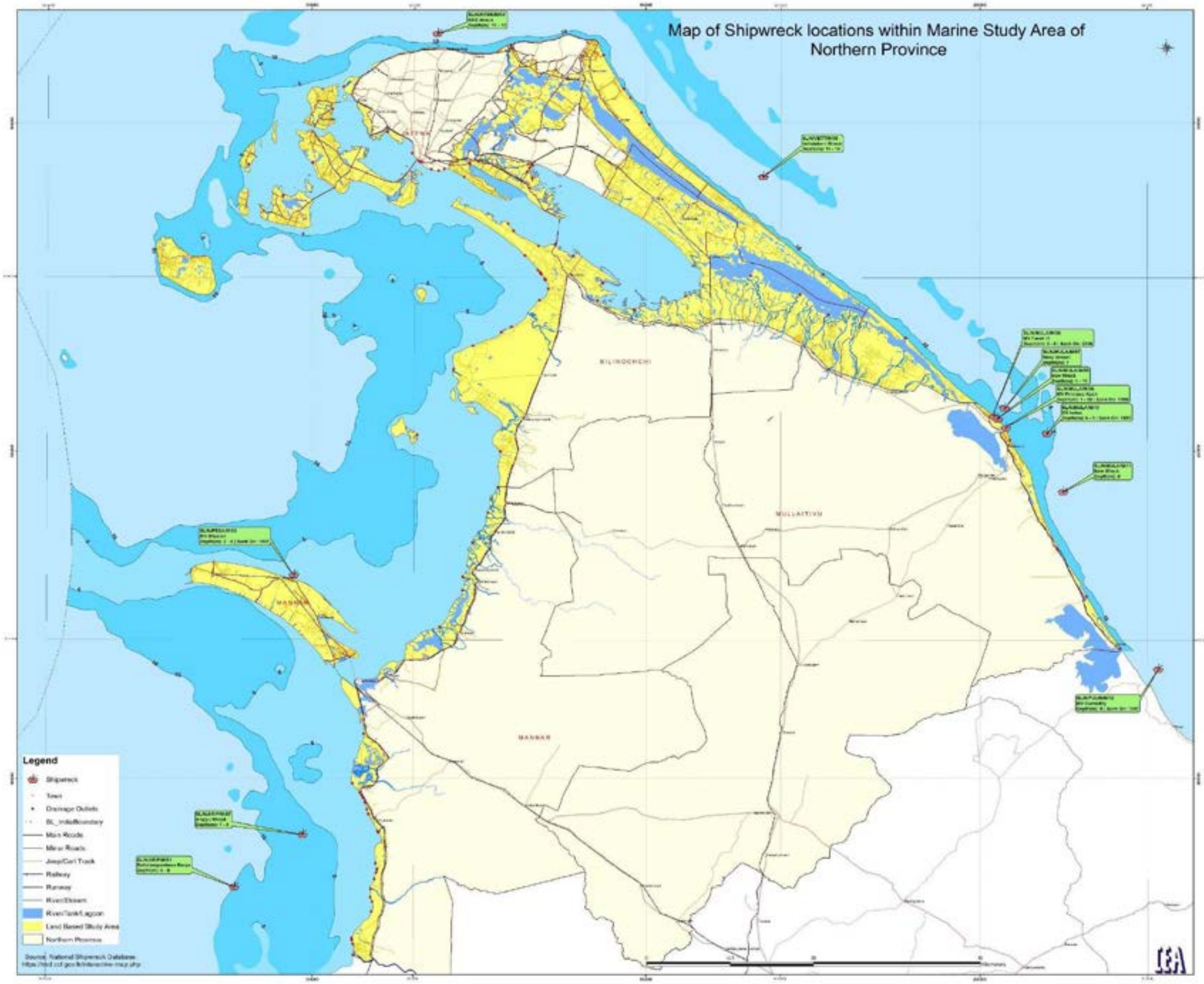
Most marine species which have limited, or no mobility do not tolerate salinity reduction due to freshwater inflows. Therefore, the locations where there are high freshwater inflows should be excluded when selecting the potential sites for coastal aquaculture. The areas in the vicinity of all the stream outlets and locations where the stormwater drains during rainfall need to be avoided. There are 101 Fresh water/ River Outlets within the SEA study area in the Northern Province.

A map showing the Fresh water/River Outlets within the SEA Study area and river basins within the Northern Province is given in Map 06 below.

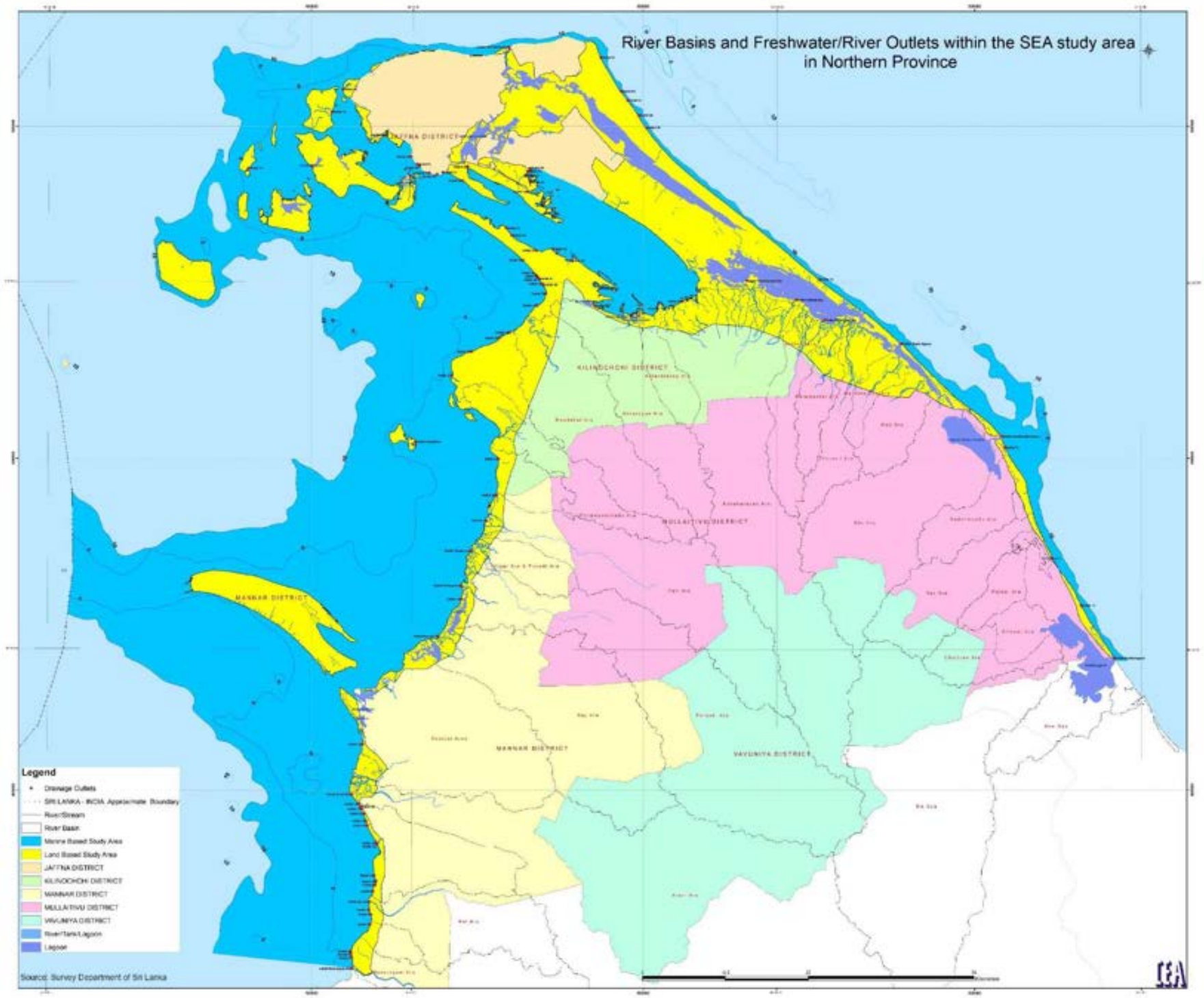
Some streams are draining through deltas with several outlets. Some drain into lagoons and tidal flats. Outlets of some streams migrate over time. Some outlets are completely closed during the dry season due to the sand bar formation. Therefore, some of the locations marked in the map should be considered as indicative locations and the exact length of the coastline where the salinity may drop due to the freshwater outflow should be verified at the site during the feasibility studies and/or in EIA stage.



Map 04: Map showing the declared archaeological reserves and Protected Monuments within land-based SEA Study area of Northern Province



Map 05: Map showing the Shipwrecks recorded within Northern Province



Map 06: Map showing the Fresh water/River Outlets within the SEA Study area and river basins within the Northern Province

3.2.1.7 Avoidance of Areas prone to Coastal Flooding

Coastal Flooding caused by long-term sea-level rise, storm surges and tsunamis can affect low-lying coastal areas in Northern Province. Further, at the river outlets, alluvial flooding during extreme rainfall is also a concern. Within the next 50 years, the sea level in Sri Lankan coastline is predicted to rise by about 0.1 to 0.2 m which is expected to inundate the low-lying areas. Figure 2 is an extract from the Hazard Profiles of Sri Lanka published by the Disaster Management Centre (DMC), Sri Lanka, 2012, showing the extent of inundation predicted in the year 2100 due to the sea-level rise.

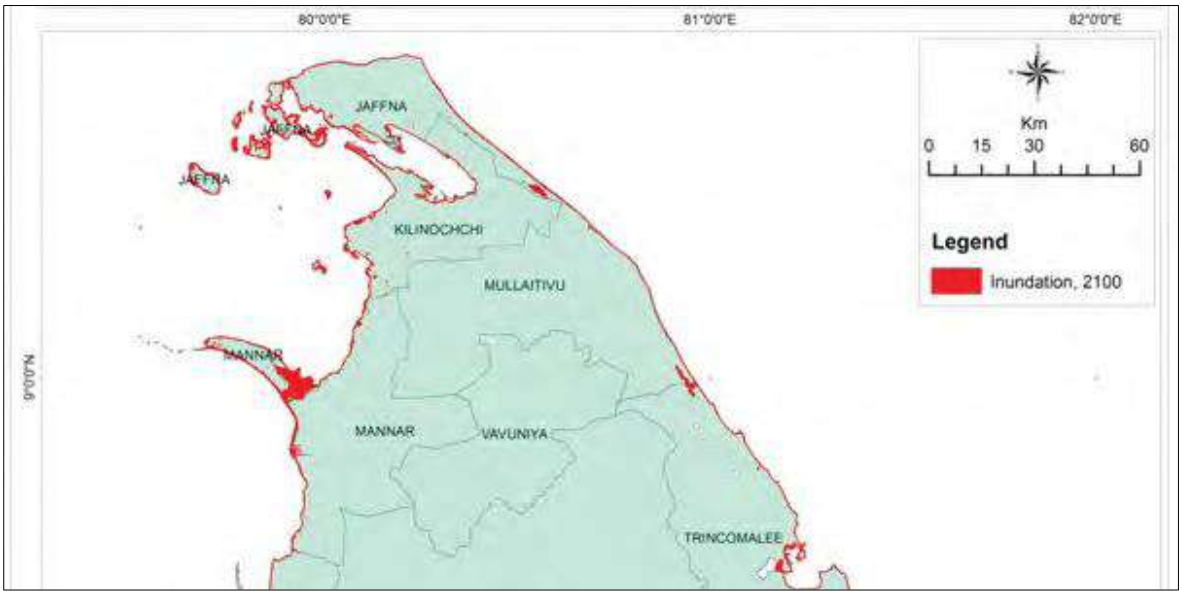


Figure 2: Coastal flooding due to sea level rise in year 2100
(Source: Extracted from the Hazard Profiles of Sri Lanka, Disaster Management Centre, Sri Lanka, 2012)

Flooding caused by rising sea water level due to the monsoon winds and cyclones is quite frequent mainly during the period from November to January in low-lying coastal areas in the Northern Province. Generally, the areas where the ground elevation is less than about 1 m above the mean sea level are highly vulnerable to coastal floods. For marine based coastal aquaculture, coastal flooding may not be a major issue but the possible highwater levels should be considered during the planning and designing of the required facilities. Therefore, flood prone areas should be excluded when selecting potential sites for land-based coastal aquaculture, involving ponds and other facilities which should always be kept above the flood levels.

The low-lying areas around the freshwater outlets are recognized as being flood prone and therefore, should be excluded from the potential sites for land-based aquaculture.

The SEA team consulted the DMC and CC&CRMD to obtain the possible inundation areas in the Northern province due to cyclone induced storm surges and predicted sea level rise in 25, 50, 75 and 100 year periods.

To show the indicative extents of the areas where the coastal flooding can happen, two maps have been developed based on the data compiled by the CC&CRMD on the storm surge flooding during the preparation of Hazard Profiles of Sri Lanka published by the DMC, Sri Lanka, 2012 (Map 07 and Map 08). The inundation extents of these maps are based on the storm surge model predictions for two different sustained wind speeds; 215 km/hr (90 years of return period) and 270 km/hr (300

years of return period). According to these maps, the shoreline facing the Gulf of Mannar and the Palk Bay are highly vulnerable to the storm surges.

Cyclone induced storm surge hazard map with projected storm surge levels for the land-based SEA Study area in the Northern Province is given in Map 07 and Map 08 below.

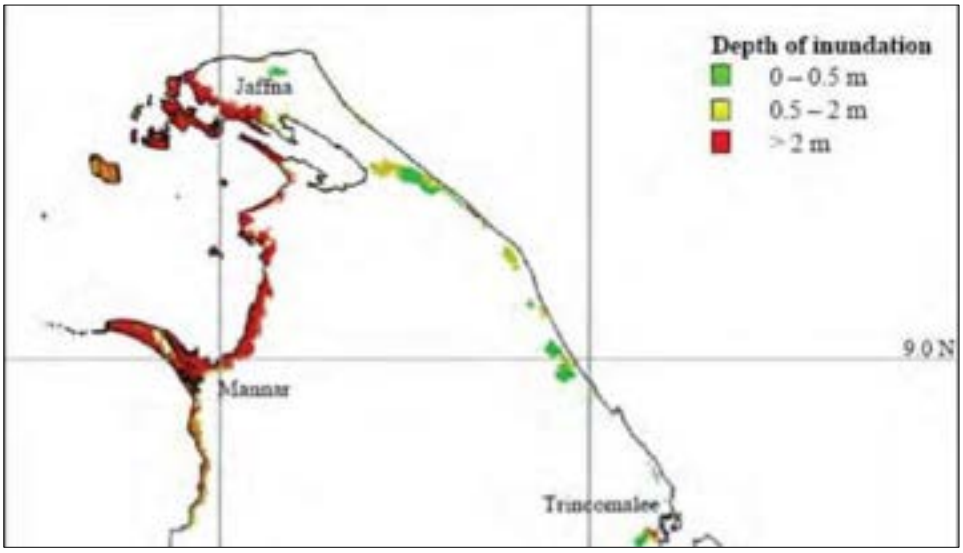
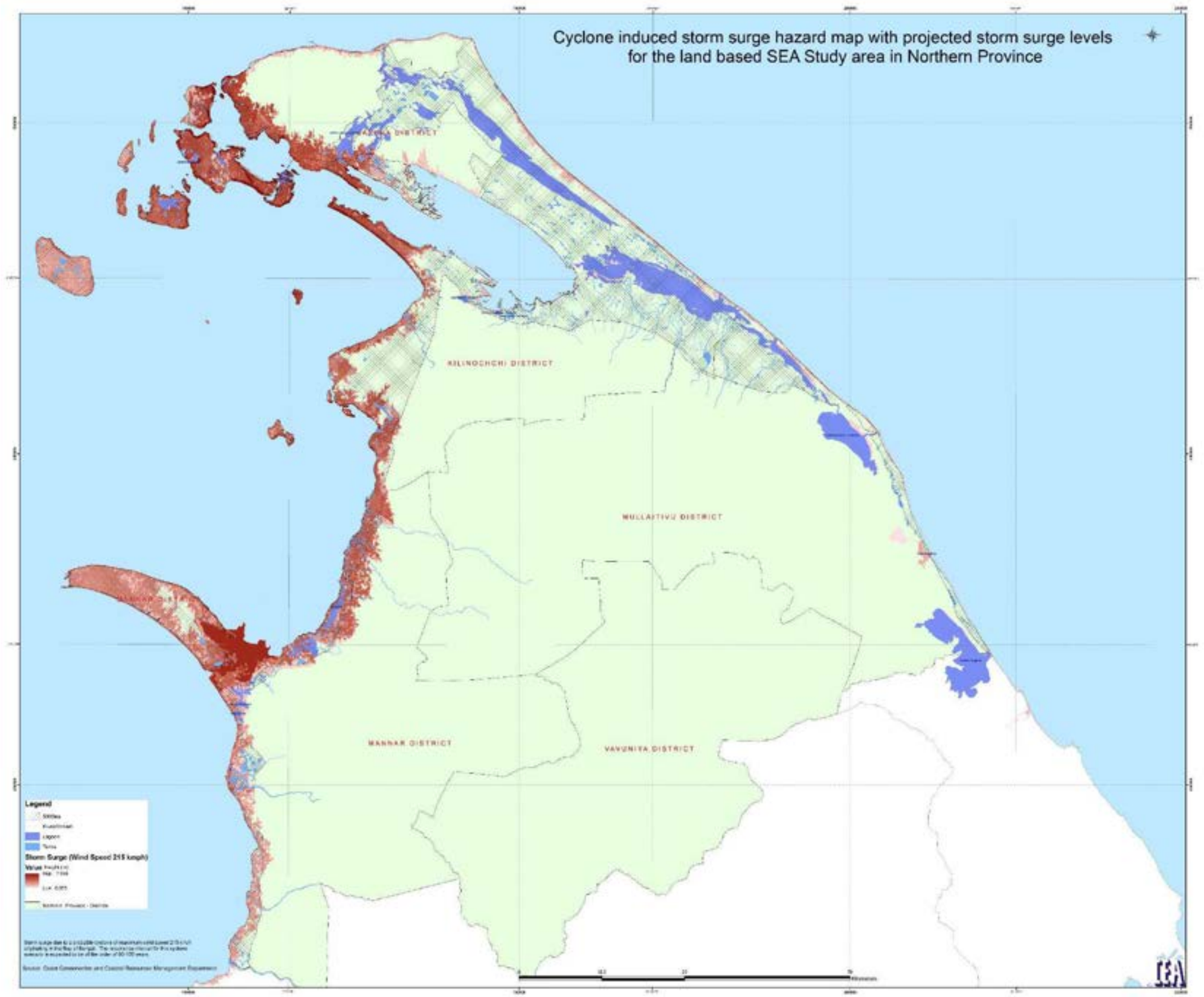


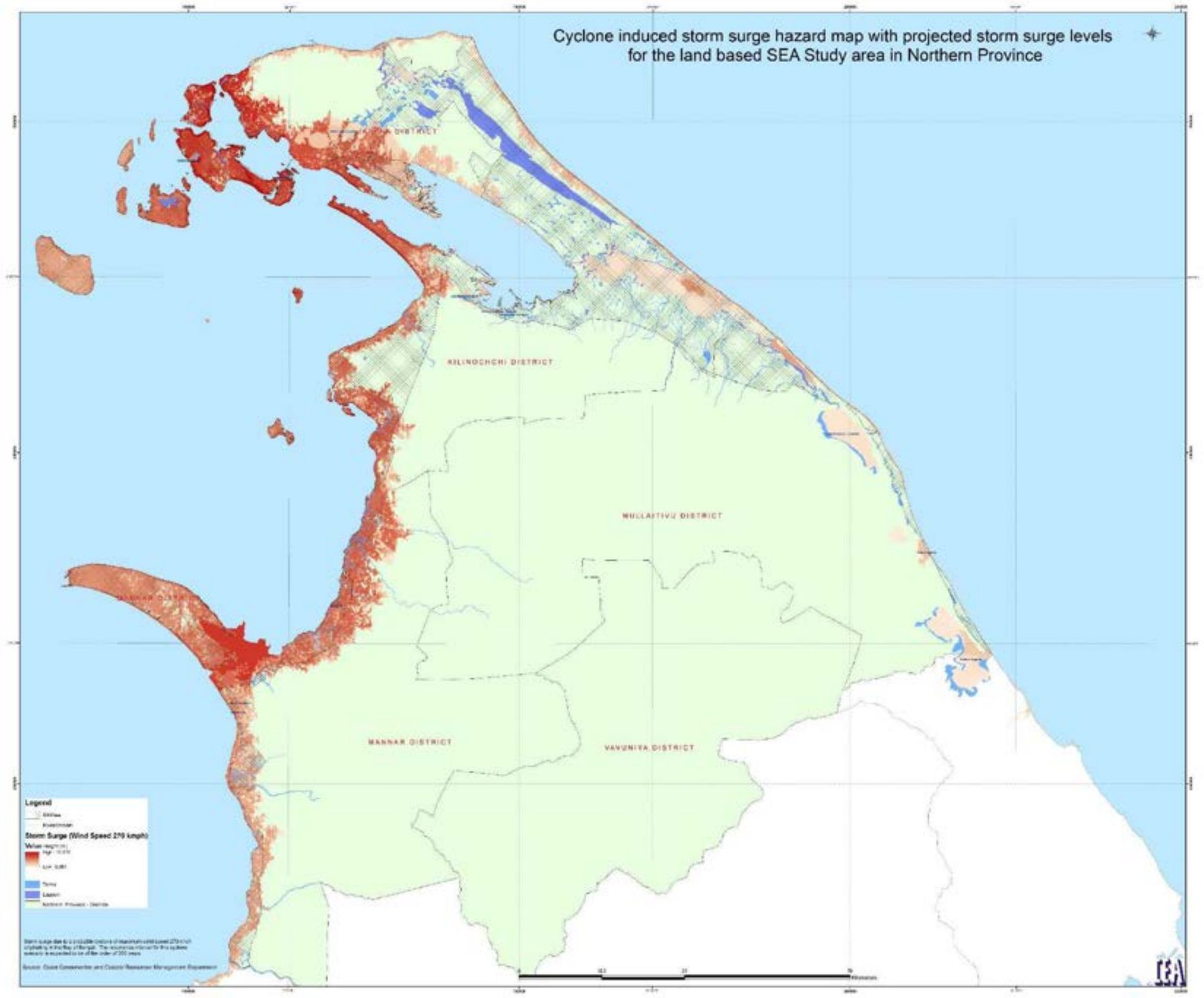
Figure 3: Coastal flooding due to storm surge with a recurrence interval of 90 years (For cyclones with sustained maximum wind speed 215 km/hr)

(Source: Extracted from the Hazard Profiles of Sri Lanka, Disaster Management Centre, Sri Lanka, 2012)

Therefore, land-based aquaculture in such areas should be avoided or carefully planned to avoid potential losses due to flooding. The low-lying areas of the south of Jaffna lagoon from Pooneryn to Elephant Pass, the West coast from Mannar to Pooneryn and the west coast of Jaffna Peninsula are the most vulnerable to floods due to the low ground elevation.



Map 07: Cyclone induced Storm Surge Hazard Map with projected storm surge levels for the SEA Study area (Surge Speed=215km/h)



Map 08: Cyclone induced Storm Surge Hazard Map with projected storm surge levels for the SEA Study area (Surge Speed=270km/h)

3.2.2 Screening of User Conflicts and Other Concerns

3.2.2.1 Capture based Fisheries

The contribution of capture-based coastal fisheries to the labor force and local food security is important, particularly in terms of animal protein supply to coastal communities. The coastal fishing communities are often poor, geographically isolated, and have very little access to the benefits of public infrastructure and services or coverage by social policies. The socioeconomic character of the coastal population has evolved bounding with coastal resources. Around 10% of the Northern province's population relies on the fisheries sector (both offshore and coastal). The fisheries sector in the Northern Province is mostly restricted to the coastal area due to the lower financial capacity of the fishermen and due to restrictions imposed during the civil war in consideration of national security to access offshore fishing. The stakeholders, including the fishermen, expressed their concern that aquaculture activities in shallow coastal areas will either reduce their fishing ground or disturb access to it. Concern regarding the impacts on wild fish stocks due to the effluents from both land-based and marine-based aquaculture projects, was also identified as a major issue during the consultations with the stakeholders.

The active fishing grounds have not been demarcated or mapped by DFAR in order for the SEA team to exclude such areas when recommending the potential areas for aquaculture development. Also, the fishermen change their fishing grounds according to the fishing season. In the absence of strong competition, the fishermen have the freedom of utilizing the entire fishing ground and the coastal resources for their livelihood.

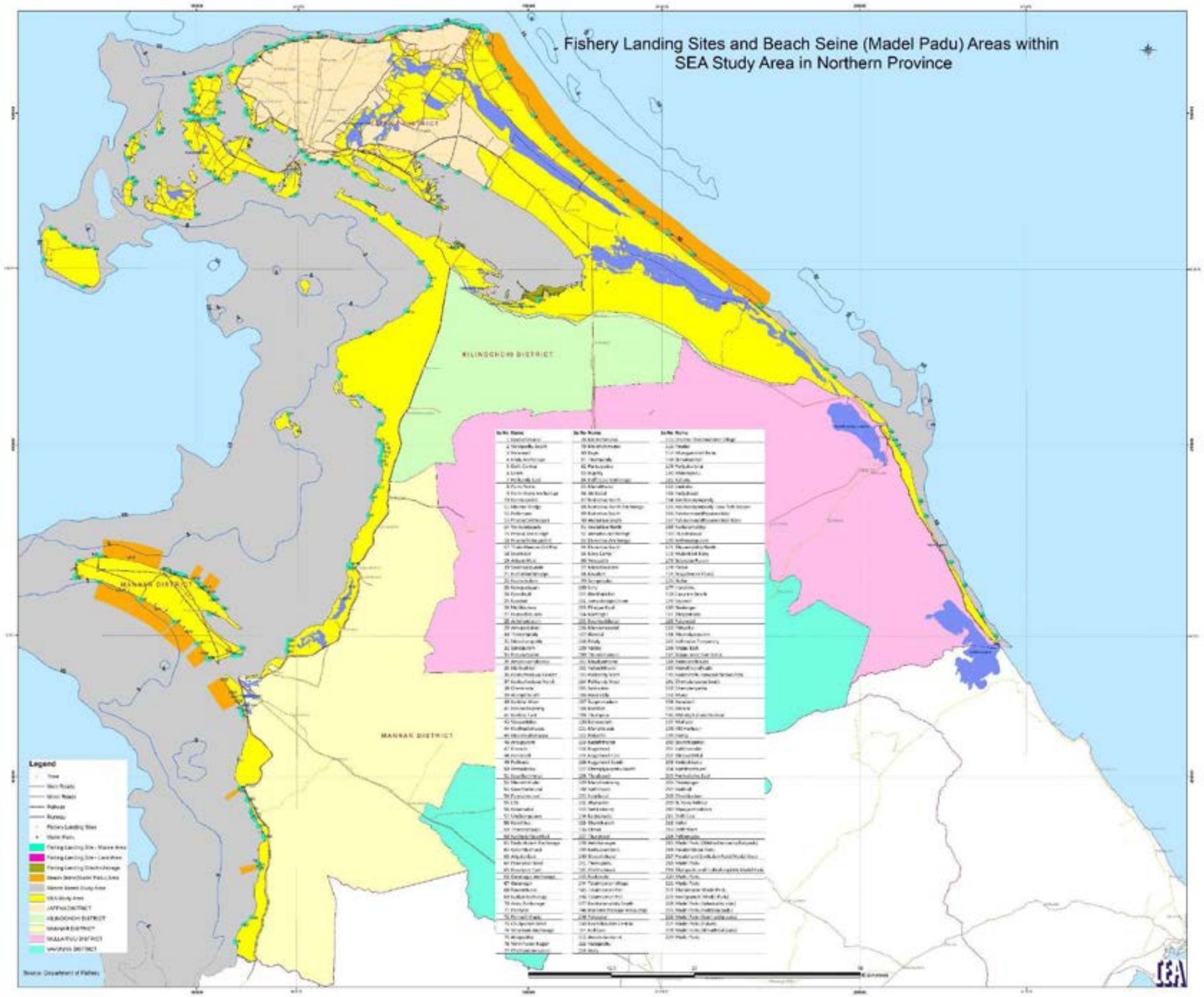
In this background, the proposed coastal aquaculture development programme could compete with the capture-based fishery for the space, by disturbing the access to fishing grounds and polluting them and putting pressure on the wild fish stock in the area. This competition may push the poor fishermen away from their fishing grounds and such situation will significantly impact the capture-based fisheries sector and the fishermen's livelihood.

However, there are aquaculture farms, especially sea cucumber pen culture and seaweed raft culture within or very close to the fishery landing sites and fishing grounds, that are operating cooperatively with the fishing activities. The SEA study is proposing a methodology to implement the coastal aquaculture development avoiding conflict with capture-based fishery resources.

The SEA team had meetings/consultations with district officials of DFAR and the representatives of the Fisheries Organizations in order to identify potential conflicts with capture-based fisheries. Accordingly, access routes to Fishery landing sites and active Beach Seine areas (Madel Padhu Sites) should not be disturbed by the structures of aquaculture farms.

The SEA team prepared a map of the Fishery landing sites and Beach Seine areas (Madel Padhu Sites) within SEA Study area in the Northern Province in consultation with Fisheries Inspectors/Officers attached to the district offices of the DFAR and representatives of the Fisheries Organizations in Jaffna, Mannar and Kilinochchi districts. However, SEA team didn't conduct similar consultation for Mullaitivu district since a map of Fishery landing sites and Beach Seine areas in Mullaitivu district was available.

A map showing the Fishery landing sites and Beach Seine areas (Madel Padhu Sites) within the SEA Study area in Northern Province is given in Map 09 below.



Map 09: Fishery landing sites and Beach Seine areas (Madel Padhu Sites) within the SEA Study area in Northern Province

3.2.2.2 Tourist Attractions and Conflicts with Marine Tourism Activities

The Northern province is rich in cultural and heritage sites and such heritage sites can have a very positive influence on tourism development. Most of these tourist destinations are interconnected with the ancient Jaffna kingdom and the colonial era. It is common to see attractive beaches, archaeological monuments, and religious places along the coastal regions of the province.

The Tourism Bureau in Northern province is responsible for the promotion and development of tourism in accordance with the national policy on tourism. However, these cultural heritage sites and marine tourism activities could be affected by the unplanned development programmes. Establishment of aquaculture farms near tourist sites could affect the aesthetic beauty of such locations and result in disturbances to the tourists.

Therefore, information on tourist attractions within the SEA study area were obtained from the Tourism Bureau in the Northern province and mapped, in order to avoid conflicts with the proposed aquaculture development programme.

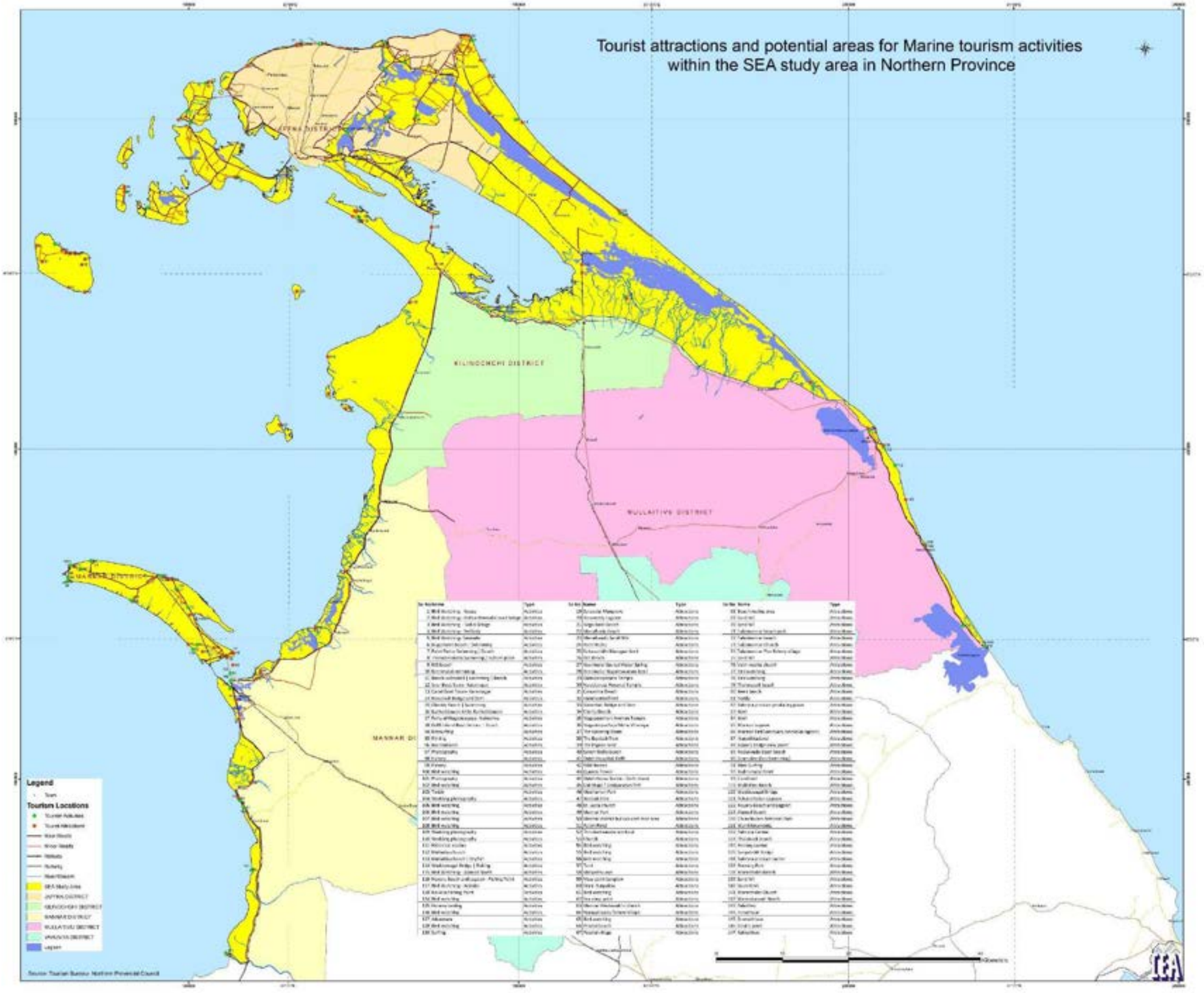
The map showing the locations of tourist attractions and potential areas for marine tourism activities within the SEA study area is given in Map 10 below.

3.2.2.3 Existing and Proposed Development Projects and Reservations

Development activities in the Northern Province which was at a standstill were re-started after the ceasing of the civil conflict. After 30-years of conflict in the Northern Province, the government has launched a multi-faceted programme called "Uthuru Wasanthaya" for the development of the North. However, restoration of the Socio economic and infrastructure conditions in the Northern Province are still in progress.

Several social and infrastructure projects are being implemented and the relevant government agencies have reserved zones for development programmes under their respective subject areas. The Coastal Aquaculture development programme is one such development programme being proposed by NAQDA under its mandate. Similarly, other institutions like the Board of Investment, Ministry of Industrial Development, Industrial Development Board, Department of Irrigation, Urban Development Authority, Sri Lanka Sustainable Energy Authority, Ceylon Electricity Board, and others along with relevant local government institutions have reserved or are in the process of reserving zones for their respective development programmes. The NAQDA plan has to avoid or minimize any conflicts with such development programmes to the extent possible.

The SEA team coordinated with the government agencies to obtain the details and maps of the planned development projects within the SEA Study Area.



Map 10: Locations of tourist attractions and potential areas for marine tourism activities within the SEA study area in Northern Province

Renewable Energy Development Projects

Several areas of the land-based study area have been identified by the Sri Lanka Sustainable Energy Authority (SLSEA) and the Ceylon Electricity Board (CEB), as potential sites for Wind and Solar power development projects. The Ministry of Power and Energy has gazetted these areas as energy development areas under section 12(1) of SLSEA act No. 35 of 2007. Details of the planned energy park projects by CEB and SLSEA within the SEA study area are given in the

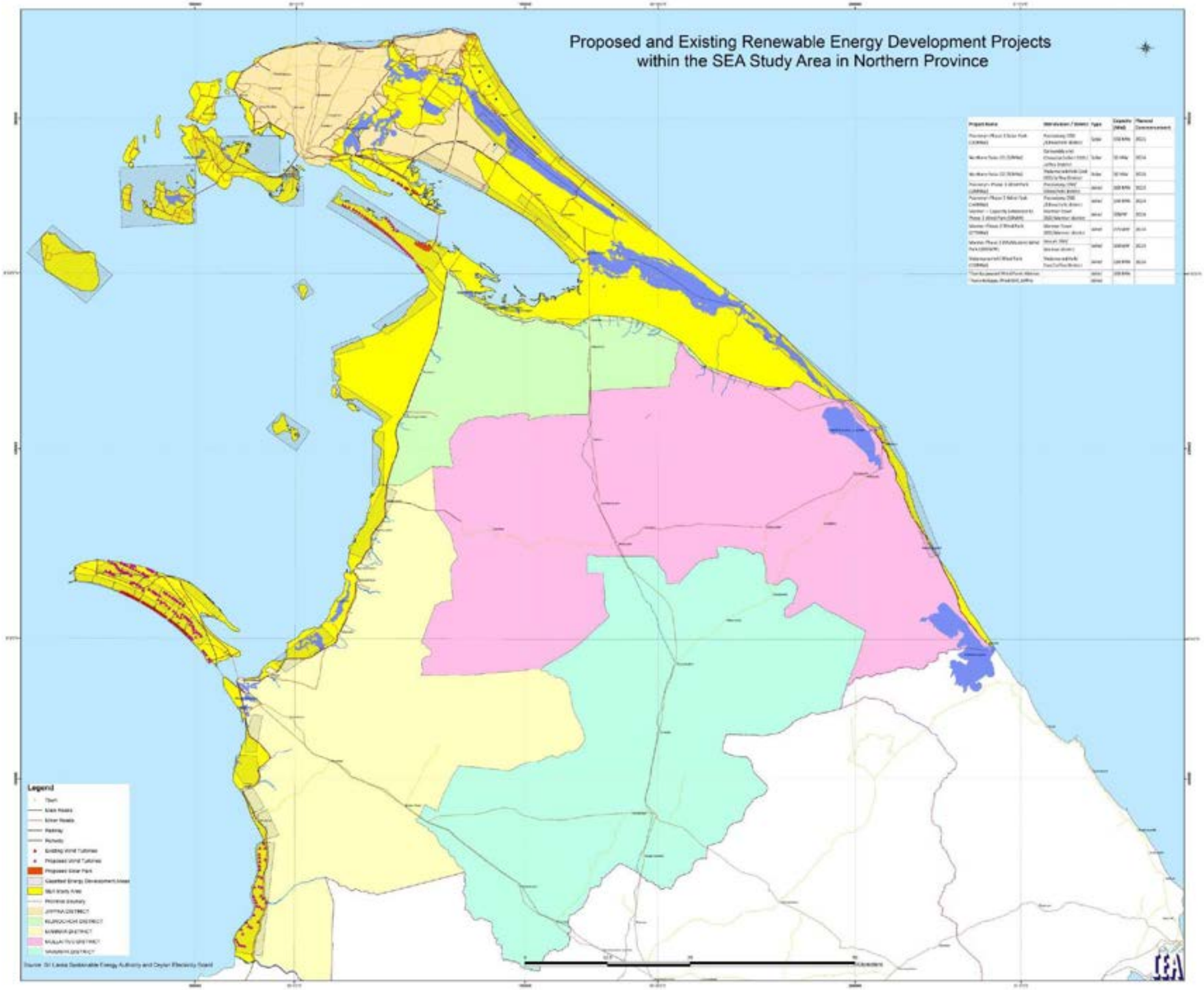
Table 11 below.

Table 11: Planned Renewable Energy Development Projects within the SEA Study Area

Project Name	DSD division / District	Type	Capacity (MW)	Planned Commencement
Pooneryn- Phase 1 Wind Park	Poonakary DSD/ Kilinochchi district	Wind	100 MW	2023
Pooneryn-Phase 2 Wind Park	Poonakary DSD /Kilinochchi district	Wind	134 MW	2023
Pooneryn-Phase 3 Solar Park	Poonakary DSD /Kilinochchi district	Solar	150 MW	2025
Mannar – Capacity Extension to Phase 1	Mannar Town DSD/Mannar district	Wind	50MW	2024
Mannar-Phase 2	Mannar Town DSD/Mannar district	Wind	286MW	2023
Mannar Phase 3 (Mullikulam Wind Park)	Musali DSD/ Mannar district	Wind	100MW	2024
Vadamarachchi	Vadamaradchchi East/Jaffna District	Wind	130 MW	2026
Northern Solar (Chavakachcheri)	Karaveddy and Chavakachcheri DSD / Jaffna District	Solar	50 MW	2024
Northern Solar	Vadamaradchchi East DSD/Jaffna District	Solar	50 MW	2026

(Source- Renewable Energy Resource Development Plan, 2021-2026, SLSEA)

A Map showing the existing and planned Renewable Energy Development projects within the SEA study area in the Northern Province is given in Map 11 below.



Map 11: Map showing the existing and planned Renewable Energy Development projects within the SEA study area in the Northern Province

Industrial Zones/Sites including Salterns

The Ministry of Industries, Industrial Development Board (IDB) and Northern Provincial Department of Industries is responsible for the establishment as well as the management and regulation of Industrial zones in the Northern Province.

Details of existing and proposed industrial zones in the Northern Province were obtained in consultation with the Northern Provincial Department of Industries. There are also some salterns located within the SEA Study area which are administrated by Manthai Salt Limited. The locations of these industrial zones/estates and salterns were mapped in order to avoid any conflicts with the coastal aquaculture development programme.

Table 12: Existing and Proposed Industrial zones in Northern Province

No	Location	Coordinates	Ownership	Remarks
01	Achchuveli Industrial Estate	9°46'9.55"N 80° 6'1.69"E	IDB	Existing
02	Industrial Zone -Weli oya	8°59'23.02"N 80°46'8.54"E	Ministry of Industries	Existing
03	Industrial Estate -Vavuniya	8°45'53.14"N 80°30'55.92"E	IDB	Existing – Outside the SEA Study Area
04	Industrial Estate -Mannar	8°59'31.05"N 79°54'14.24"E	Ministry of Industries	Existing
05	Industrial Zone-Mankulam (Proposed)	9° 8'7.43"N 80°26'13.34"E	UDA	Proposed

Map showing the existing and proposed industrial zones/estates and Salterns within the SEA study area in the Northern Province is given in Map 12 below.

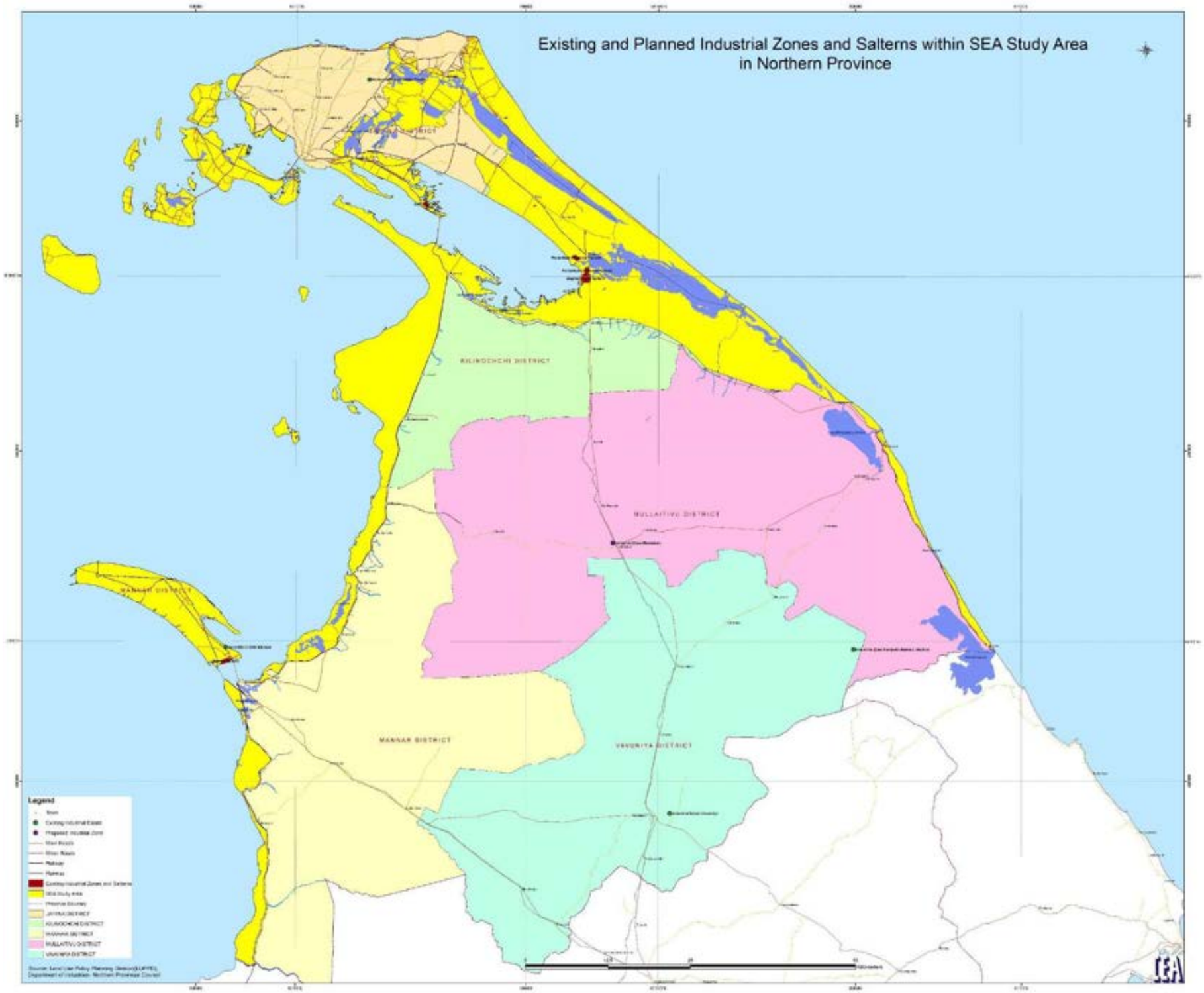
3.2.2.4 High Security Zones and Mine Clearance

The Northern province was extensively contaminated by land mines and explosive remnants due to three decades of the armed conflict. The National Mine Action Centre is responsible for the demining process through manual clearance, mechanical clearance and through humanitarian demining through the use of mine detection dogs. Although these de-mining programs have achieved good progress, there are still areas which remain uncleared to date.

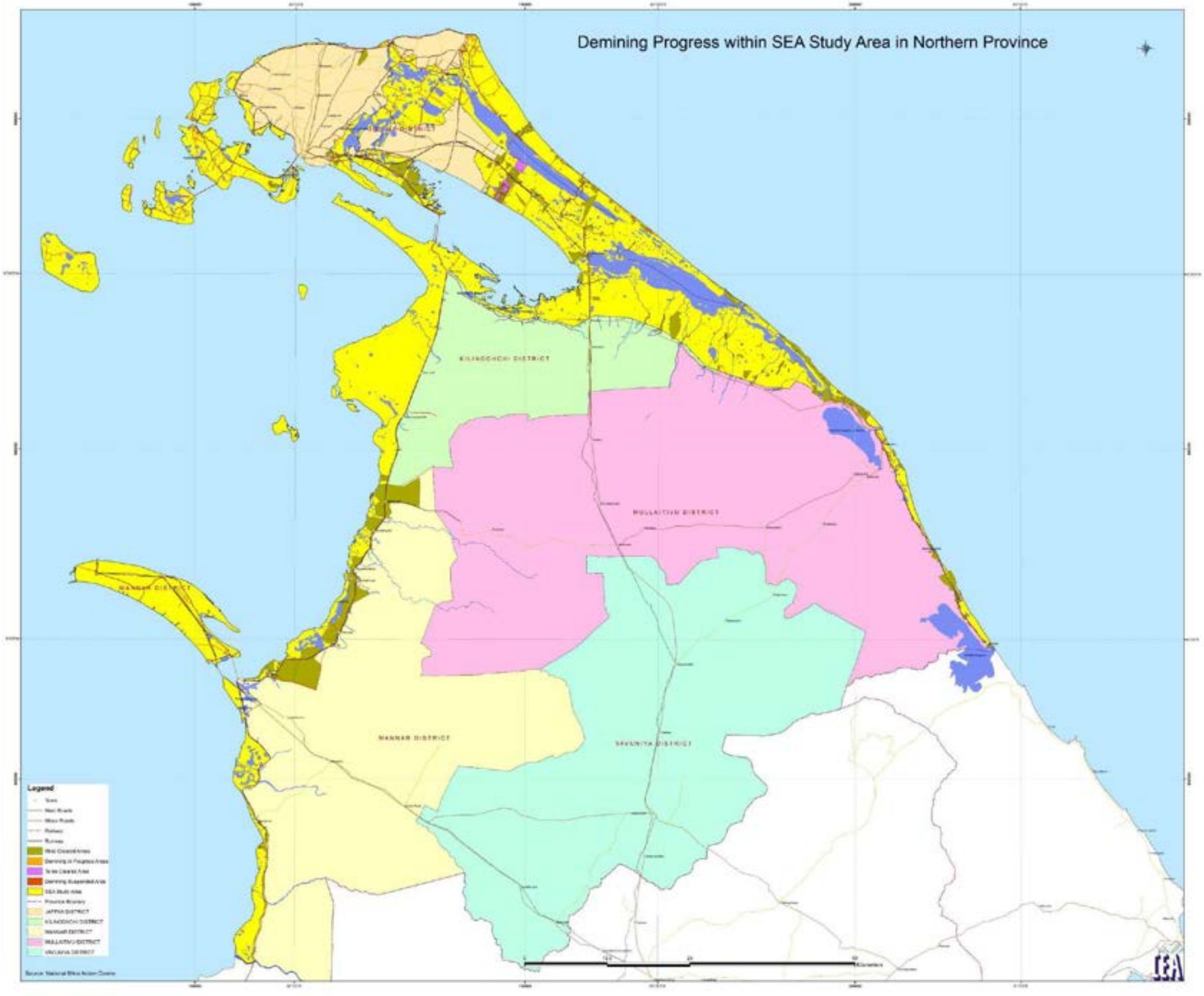
The geographical locations of mine cleared areas, Demining work in progress areas, and future clearance areas were obtained from the Regional Mine Action office, Kilinochchi.

A map showing the demining progress within SEA study area in Northern province is given in the Map 13 below. It is recommended to consult National Mine Action Centre to obtain the mine clearance for proposed sites for land-based aquaculture development.

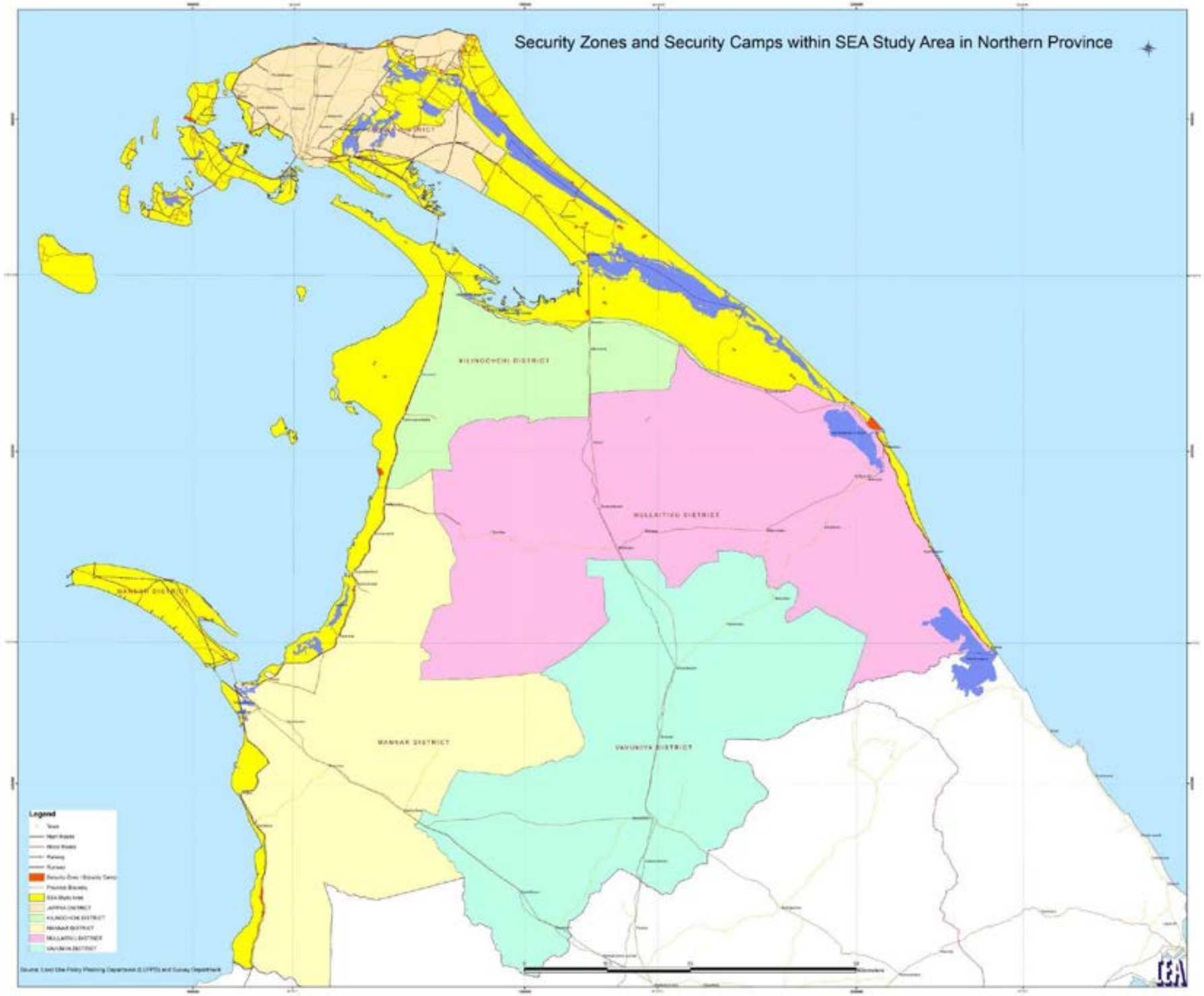
The SEA team also mapped the high security zones with security camps within the SEA study area which should be considered for siting of aquaculture projects. A map showing the high security zones and security camps within SEA study area in Northern province is given in the Map 14 below.



Map 12: Map showing the existing and proposed industrial zones/estates and Salterns within the SEA study area in the Northern Province



Map 13: Map showing the Demining progress within SEA study area in Northern province



Map 14: Map showing the high security zones and security camps within SEA study area in Northern province

3.3 Preparation of Opportunity and Risk Maps

3.3.1 Introduction

Opportunity and risk mapping helps to identify the potential areas for coastal aquaculture development through risk-based zoning and siting. The aim of opportunity and risk mapping is to ensure the most sustainable and equitable use of coastal and marine space in the Northern province for aquaculture development while minimizing the conflicts with other uses and maintaining environmental integrity. This can help in avoiding environmentally sensitive areas and the areas particularly vulnerable to climate risks, disasters and social conflicts. It will also assist NAQDA in selecting sites which have not been identified by other development agencies for implementation of development projects and infrastructure. The overall process allows minimizing possible economic losses arising from the inappropriate siting of aquaculture projects.

The opportunity and risk mapping include identification of the main impediments to implementation of coastal aquaculture projects. The classification consists of 4 main risk categories namely, No-go zones, high risk areas, medium risk areas, and low risk areas for coastal aquaculture development. Environmental, inter-sectorial, and social risks of aquaculture development in coastal and marine areas are assessed through a set of indicators listed as follows.

- Environmental risks (habitat vulnerability)
- Inter-sectorial risks (conflicts with other users and activities)
- Socio-economic and cultural risks (visual impact, distance from cultural heritage and tourism sites)

The above No go zones, high risk areas, medium risk areas and low risk areas for aquaculture development were identified based on:

(i) Stakeholder and community consultations had with different levels of stakeholders and the community in the Study area.

(ii) Structured interviews with key informants.

(iii) Opinion of the experts of the SEA team

Furthermore, Socio-economic risks were assessed through an indicator of visual impact (merging a population density layer with a distance buffer) and distance-based indicators reflecting the magnitude of aquaculture impact on traditional fisheries, archaeological sites and tourist attractions. Whenever there are vector data or if the data are not available as polygons, buffers and reservations were applied based on legislative guidance.

3.3.2 Mapping of Conflicts and Other Uses

GIS based data layers related to environmental and culturally sensitive areas (described under 3.2.1), user conflicts and other uses (described under 3.2.2) was obtained from relevant stakeholder agencies through Ministry of Fisheries.

Information sources for various GIS data layers obtained by SEA team and other related information are given in Table 13 below.

Table 13: Information sources for GIS Data layers

No.	Data Layer	Data Source	Year	Remarks
1	Topographical data (Administrative Boundaries, Transportation, Water Features, General Features)	Survey Department of Sri Lanka	2011	
2	Land use and Land Cover	Land use Policy Planning Department	2018	
3	Gazetted /Protected wildlife areas (Strict Nature Reserves, National Parks, Nature Reserves, and Sanctuaries)	Department of Wildlife Conservation	2021	
4	Gazetted and Proposed (to be gazetted) Forest Reserves	Forest Department	2022	
5	Declared and Proposed (to be gazetted) Mangrove Reserves	Forest Department	2022	
6	Other Mangrove areas	Land use Policy Planning Department	2018	
		Conservation and sustainable use of biodiversity in the islands and lagoons of northern Sri Lanka, International Union for Conservation of Nature (IUCN)	2020	
7	Coral Reefs	Conservation and sustainable use of biodiversity in the islands and lagoons of northern Sri Lanka, International Union for Conservation of Nature (IUCN)	2020	Verified through the surveys conducted by Marine Ecologist of the SEA Team
8	Sea Grass Beds	NARA	2015	
		Conservation and sustainable use of biodiversity in the islands and lagoons of northern Sri Lanka, International Union for Conservation of Nature (IUCN)	2020	
9	Salt Marshes, Sandy areas and Sand dunes	Land use Policy Planning Department	2018	
10	Declared Archaeological and Cultural Reserves	Department of Archaeology	2022	
11	Fishery landing sites		2022	

No.	Data Layer	Data Source	Year	Remarks
12	Beach Seine areas (Madel Padu Sites)	Department of Fisheries and Aquatic Resources (DFAR)- In consultation with district officials of DFAR and the representatives of the Fisheries Organizations		Beach Seine areas in Mullaitivu district could not be mapped.
13	Planned Renewable Energy Development Projects (Wind and Solar)	Sri Lanka Sustainable Energy Authority (SLSEA)/ CEB	2022	Obtained KMZ Files and converted into GIS Shape Files
14	Locations of tourist attractions and potential areas for marine tourism activities	Provincial Tourism Burearu- Northern Province	2022	Obtained KML Files and converted into GIS Shape Files
15	Population Density of the Divisional Secretariat Areas	Relevant Divisional Secretariats in Northern Province	2020/ 2021	Obtained from Divisional level Resource Profiles
16	High Security Zones and Security Camps	Land use Policy Planning Department	2018	
17	Cyclone induced storm surge hazard map with projected storm surge levels for wind speeds -215 km/h and 270 km/h	Coast Conservation and Coastal Resources Management Department (CC&CRMD)	2012	
18	Predicted tsunami inundation depths along the shoreline prepared based on the tsunami model studies	Coast Conservation and Coastal Resources Management Department (CC&CRMD)	2012	
19	Demining Progress in Northern Province	National Mine Action Centre (NMAC)	2021	
20	Recorded Shipwrecks within the Marine Study area	National Shipwreck Database of Sri Lanka	2021	Digitize the interactive map available in https://nsd.ccf.gov.lk/ interactive-map.php

3.3.3 Opportunity and Risk Map -Land based Study Area

Areas categorized as No go Zones (NGZ), High risk areas (HRA), medium risk areas (MRA) and low risk areas (LRA) in the land-based study area is given below.

No go Zones: Protected/Declared wildlife areas under DWC (Strict Nature Reserves, National Parks, Nature Reserves, and Sanctuaries), Proposed wildlife areas, Gazetted Forest reserves, Proposed Forest reserves, Gazetted Environmental Protection areas under CEA, Declared Archaeological reserves and buffer zones (400 m), Mangrove reserves.

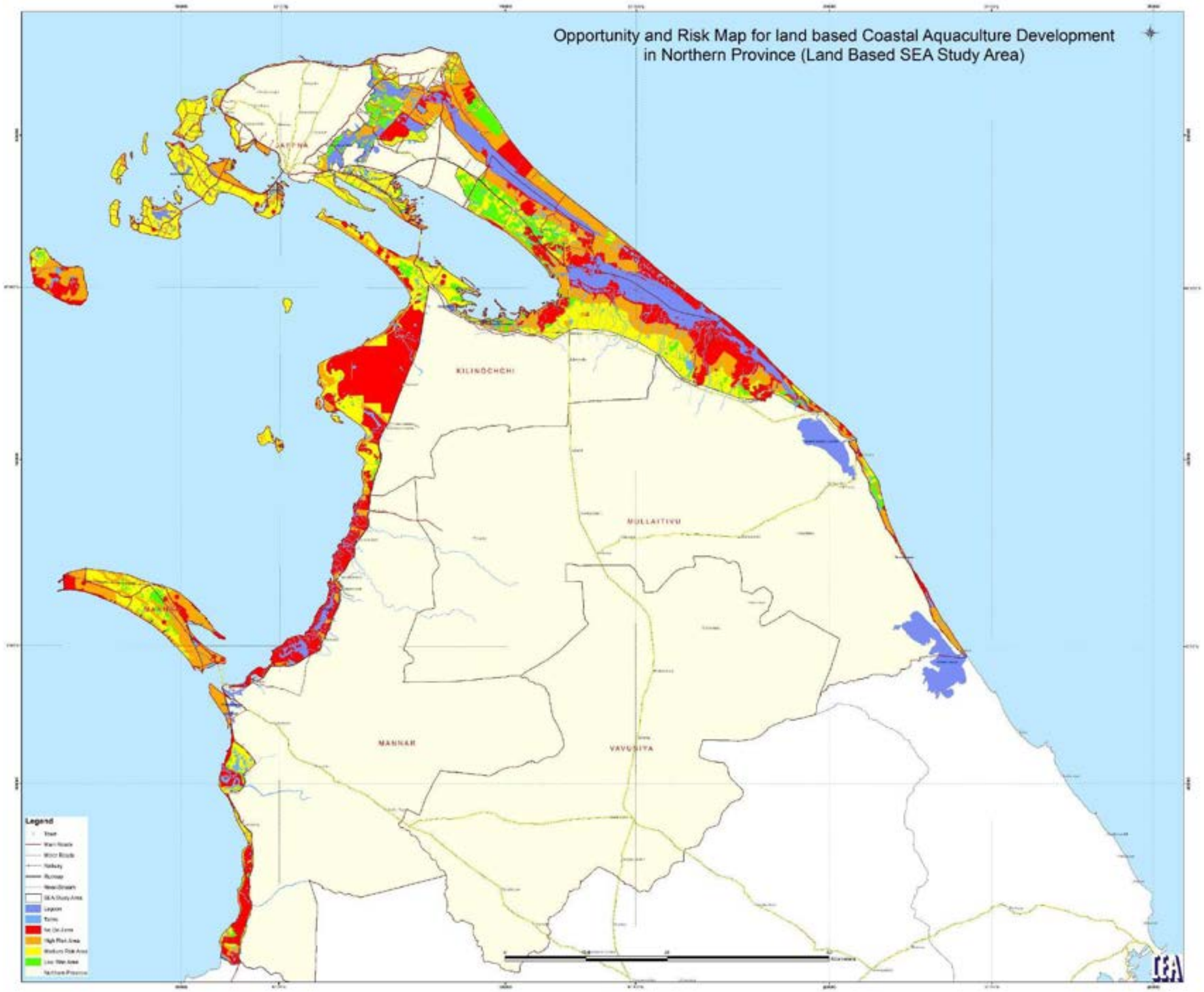
High Risk areas: High Security Zones/Allocated areas for Security Camps, locations of tourist attractions and potential areas for future tourism activities, Fresh water/River Outlets, Proposed areas for Renewable Energy Development Projects and Industrial zones, Fishery landing sites and Beach seine (Madel Padu) areas, Other environmental sensitive areas such as Salt marshes/Tidal Flats and sand dunes, Urban Centers and developed areas, sensitive areas identified but not protected, 1.6 km Buffer zone for protected wildlife areas under DWC (National Parks, Nature Reserves and Strict Nature Reserves), Other dense forest areas (Not gazetted)

Medium Risk Areas: Inundation areas due to cyclone induced storm surges (Areas with projected inundation heights of more than 2 m), Paddy lands, , , Home gardens.

Low Risk areas: Remaining land areas after exclusion of No go zones, high and medium risk areas

Rivers, streams, tanks, other inland surface water bodies, roads, rail tracks, runways, their reservations and other existing infrastructure facilities have been excluded from all of the above categories.

The Opportunity and Risk map developed for the land based coastal aquaculture development as a result of the SEA is given in Map 15 below. Accordingly, the land extents for No go zones, high risk, medium risk and low risk areas for land based coastal aquaculture development in each district is given in Table 14 below.



Map 15: Opportunity and Risk map developed for the land based coastal aquaculture development.

Table 14: Classification of land-based study area in the Northern Province for aquaculture development

District	Land Classification	Area (Ha)	Area (%)
Jaffna District	No go Zone	7,978.03	14.48
	High Risk	16,678.00	30.28
	Medium Risk	24,174.00	43.89
	Low Risk	6,254.20	11.35
Mannar District	No go zone	9,948.16	35.08
	High Risk	8,703.00	30.69
	Medium Risk	7,634.00	26.92
	Low Risk	1,775.55	6.26
Killinochchi District	No go Zone	22,622.12	36.36
	High Risk	13,202.00	21.22
	Medium Risk	18,594.94	29.89
	Low Risk	7793.52	12.53
Mullaitivu District	No go Zone	6,368.71	41.21
	High Risk	4,747.00	30.72
	Medium Risk	3,088.00	19.98
	Low Risk	1250.57	8.09

3.3.4 Opportunity and Risk Map - Marine based Study Area

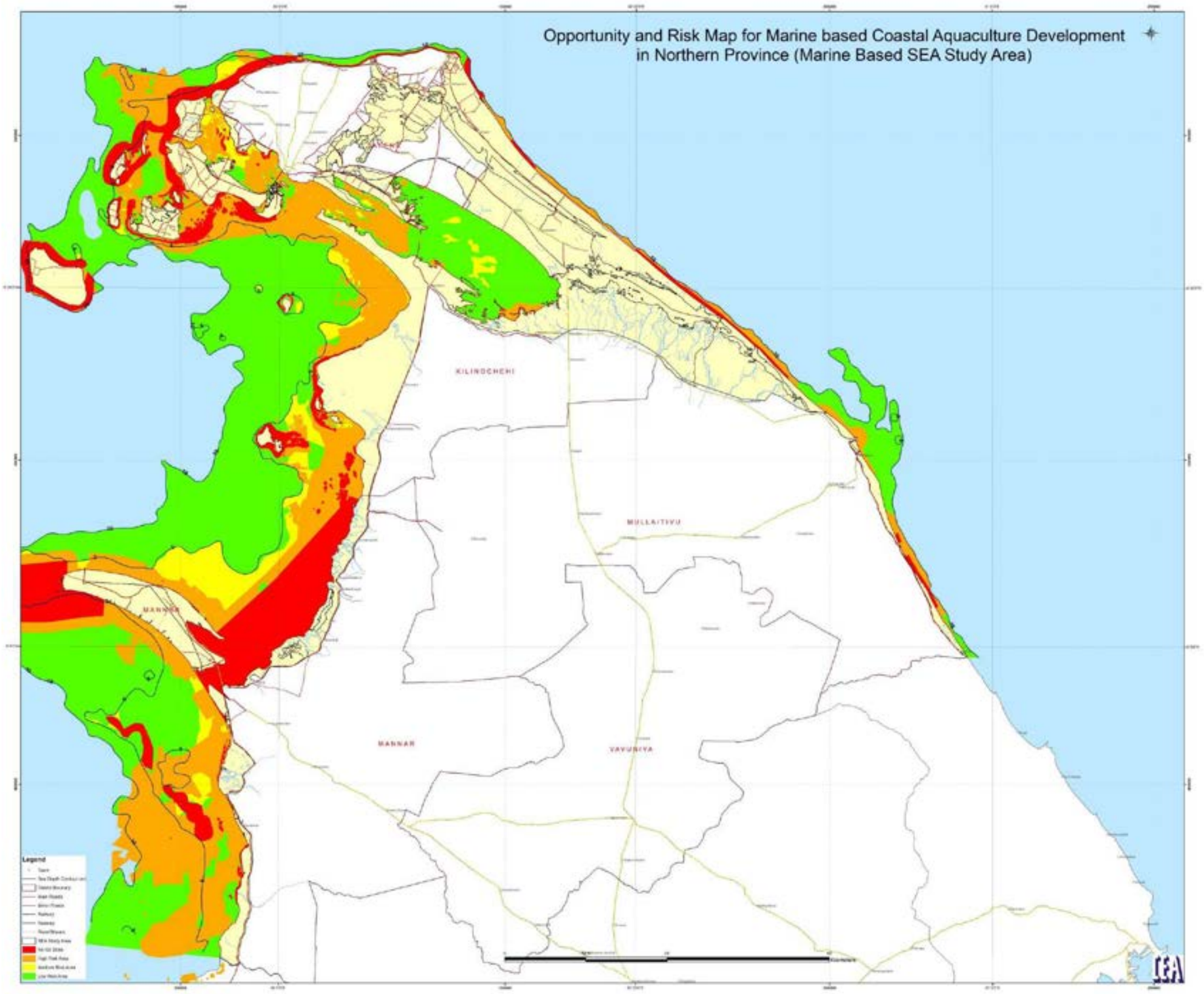
No go Zones: Declared Marine Protected areas and proposed Marine protected areas under DWC (National Parks, Nature Reserves etc.), Areas with Coral Reefs ecosystems, Shipwrecks (100 m buffer zone)

High Risk: Approaching routes to Navy Camps, Potential areas for Marine tourism activities, approaching routes to Fishery landing sites and Fishery anchorages, Beach seine (Madel Padu) areas, Sea grass areas (Impacts will be high for sea grass beds, if used for Finfish cage culture) , 1.6 km Buffer zone for Marine protected areas (Marine National Parks and Nature Reserves)

Medium Risk: Sea grass areas (Seaweed and Sea Cucumber can be cultured in sea grass areas with low impacts), Sea grass areas with ecofriendly aquaculture (Sea weed and Sea Cucumber can be cultured in sea grass areas with low impacts)

Low Risk: Other areas excluding above high risk and medium risk areas

The Opportunity and Risk map developed for the marine based coastal aquaculture development as a result of the SEA is given in Map 16 below. Accordingly, the extent for No go Zones, high risk, medium risk and low risk areas for marine based coastal aquaculture development in each district is given in Table 15 and Table 16 below.



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Map 16: Opportunity and Risk map developed for the marine based coastal aquaculture development

Table 15: Classification of Marine based study area (within 10m depth contour) in the Northern Province for aquaculture development

District	Land Potential	Area (Ha)	Area (%)
Jaffna District	No go Zone	13,825.00	15.59%
	High Risk	17,800.00	20.07%
	Medium Risk	11,825.00	13.33%
	Low Risk	45,243.00	51.01%
Mannar District	No go Zone	41,950.18	19.92%
	High Risk	42,643.53	20.25%
	Medium Risk	32,500.00	15.43%
	Low Risk	93,500.00	44.40%
Killinochchi District	No go Zone	9,755.86	9.10%
	High Risk	28,231.00	26.34%
	Medium Risk	12,867.00	12.00%
	Low Risk	56,342.00	52.56%
Mullaitivu District	No go Zone	981.15	6.20%
	High Risk	3,992.13	25.22%
	Medium Risk	0.00	0.00%
	Low Risk	10,854.66	68.58%

Table 16: Classification of Marine based study area (within 5m depth Contour) in the Northern Province for aquaculture development

District	Land Potential	Area (Ha)	Area (%)
Jaffna District	No go Zone	7,221.00	18.47%
	High Risk	13,420.00	34.33%
	Medium Risk	8,723.00	22.32%
	Low Risk	9,725.00	24.88%
Mannar District	No go Zone	34,834.00	32.52%
	High Risk	19,432.00	18.14%
	Medium Risk	28,321.00	26.44%
	Low Risk	24,523.00	22.90%
Killinochchi District	No go Zone	8,720.00	12.13%
	High Risk	27,821.00	38.70%
	Medium Risk	11,023.00	15.33%
	Low Risk	24,334.00	33.85%
Mullaitivu District	No go Zone	126.00	1.70%
	High Risk	3,992.00	53.99%
	Medium Risk	-	0.00%
	Low Risk	3,276.00	44.31%

The SEA study strongly recommends the use of the Opportunity and Risk Map given in the SEA report when identifying new sites/areas for aquaculture development zones, sea cucumber villages and/or stand-alone aquaculture projects. As illustrated in the Opportunity and Risk Map it is recommended to exclude the No go Zones (NGZ) when selecting the potential areas for coastal aquaculture projects. Low Risk Areas (LRA) and Medium Risk Areas (MRA) are recommendable to be utilized during the siting of new aquaculture projects.

3.4 Limitations of the SEA and assumptions made

1. Since this is a SEA, the analysis was carried out at a strategic level utilizing available information, rather than conducting extensive field studies. However, field studies were conducted as necessary along with several consultations with stakeholder agencies and the community. It was not possible to carry out in-depth field surveys covering the total study area, with the limited time frame allocated for the SEA study. However, special attention was given to carry out field studies in areas which had been already identified for the establishment of aquaculture zones. Recent research studies were used for data collection and several marine ecological surveys were carried out covering marine-based study areas where there are data gaps. However, detailed stakeholder and community consultations and key informant interviews were carried out especially covering the Jaffna, Kilinochchi and Mannar districts.

2. Although the Opportunity and Risk map produced through this SEA denotes areas which are High Risk, Medium Risk and Low Risk for aquaculture, it does not indicate the suitability of such sites for aquaculture development per se, as the factors necessary for aquaculture development were not included in the analysis such as species and site specific factors which include topography/ bathymetry (i.e., available flat land or open water), temperature, current velocity, and water quantity and water quality (e.g. salinity, hardness), Soil quality, socio economic concerns etc. These areas denote the risk level with respect to environmental, social and cultural factors only. Therefore, it is recommended that appropriate feasibility studies are carried out in order to finalize the most suitable sites for aquaculture within the low-risk areas in the opportunity and risk map.

3. A major assumption made is that site-specific IEE/EIA will be conducted for the Aquaculture Development Zones identified under the plan, in addition to any new stand-alone aquaculture projects, prior to implementation of the plan. It is assumed that comprehensive field studies will be carried out for each zone covering site specific environmental and socio-economic baseline information during the IEE/EIA process.

4. A specific questionnaire was prepared by the SEA team in order to be circulated among the local district offices of the Forest Department, DWC, CEA and the CC&CRMD in order to obtain additional information regarding environmentally sensitive areas which are not yet under protection status or are to be protected. However, this survey did not yield as much information as expected.

5. There were no maps available with the Department of Fisheries regarding the traditional capture-based fishing grounds, fishery landing sites and beach seine (Madel Padu) areas. Therefore, all efforts were made to obtain this information through consultations with the relevant officials of Department of Fisheries in Jaffna, Mannar, and Kilinochchi districts and representatives of the Fisheries Organizations and a map was prepared.

6. There were limitations experienced in terms of sourcing the complete, correct and most recent environmental spatial data (Sea water temperature etc.) for determining aquaculture development zones. Hence, limited threshold values such as marine water depth and salinity were considered.

7. This assessment only considers coastal and mariculture activities as listed. It does not consider risks associated with related activities, such as product processing, packaging, and transport.

8. This assessment provides a broad-scale sensitivity rating across each of the land based and marine based study areas in the Northern Province. While the assessment attempted to be spatially explicit, several sensitivity indicators could only be identified as geo-referenced points. It was not possible, within the scope of this assessment, to accurately define all sensitive zones as GIS polygons. Spatially scaled sensitivity demarcations within the study areas will need to be refined prior to the use of these maps for permit allocations.

9. The fishermen's interest of maintaining their daily accounts data is almost negligible. This data gap was identified as a critical factor in assessing the impacts of recently established aquaculture farms on the decline of the income from capture-based fishery.

10. Though the fishers were commenting that their income was reduced due to the reduced catch as a result of the aquaculture farms, the impacts of other social and environmental factors on this reduced catch have not been considered by the fishers due to their limited knowledge on these factors.

11. Though the resource profiles of each divisional secretariat were used as a major secondary data source for the SEA study, their data formats were non-homogenized. Therefore, it was challenging to analyze and compare such data.

12. The absence of real data related to the number and the legality of fishing gear being used by the fishers was a limitation when identifying the economic pattern of capture-based fishers in the area.

13. Hydrology-related data except for rainfall data was not available in the Northern province. This factor limited the extent to which the analysis could be carried out including the accuracy of the predictions.

14. Site-specific development plans for Aquaculture development zones have not been finalized yet. Therefore, it was not possible to identify the exact hydrological impacts due to siting of aquaculture projects.

4 Stakeholder Engagement and Community Consultations

Identification of key stakeholders and their interests was a major output of the scoping stage of the SEA study. Stakeholder mapping was done to identify the key stakeholder interests and influence through their mandate and legal authority as part of the scoping study. Further stakeholder analysis was carried out, and based on their influence over the project and the impacts of the project on them, the stakeholders were ranked. Stakeholder consultation and community consultations were also conducted at the scoping stage. Final Scoping Report submitted to the World Bank is attached in Annex 03.

4.1 Description of key stakeholders

The following section describes the key stakeholders in aquaculture development including their responsibilities and the community consultations which were carried out during the SEA study.

Ministry of Fisheries and Aquatic Resources (MFAR)/ State Ministry of Ornamental Fish, Inland Fish and Prawn Farming, Fishery Harbour Development, Multiday Fishing Activities and Fish Exports

The Ministry of Fisheries and Aquatic Resources (MFAR) is responsible for the administration of the marine fisheries sector in the Exclusive Economic Zone (EEZ) of 517,000 square kilometers and 489,000 hectares of the brackish & freshwater fisheries sectors.

To sustainably manage these resources MFAR directly engages itself in the formulation of policies, strategies and plans in consultation with the departments and agencies under its purview.

The agencies which come under the purview of MFAR (Cabinet Ministry) include, the Department of Fisheries and Aquatic Resources (DFAR) and Northsea Ltd.

The agencies which come under the purview of the State Ministry include, NAQDA, NARA, Ceylon Fisheries Corporation (CFC), The Ceylon Fishery Harbors Corporation (CFHC) and Cey-nor Foundation Ltd.

The National Aquaculture Development Authority (NAQDA)

The NAQDA, under the provisions in the National Aquaculture Development Authority Act (No. 53 of 1998), is the leading state-sponsored organization mandated with the task of developing the aquaculture and inland fisheries sector in Sri Lanka. Presently, it comes under the purview of the Ministry of Fisheries and Aquatic Resources. NAQDA is the proponent of the aquaculture development plan. Further, NAQDA has the overall authority and responsibility to facilitate, regulate, and monitor the implementation of this plan. NAQDA is also responsible for ensuring that the targets given in the plan are achieved. Although this plan has reached the SEA stage there was not much consultation during the preparation stage of the NAQDAs plan. As such the views and opinions of the connected stakeholders are yet to be incorporated in the plan.

The Director (Coastal Aquaculture Development) under the Director General of NAQDA is responsible for the overall implementation and monitoring of coastal aquaculture development projects. Coastal Aquaculture Monitoring & Extension unit in Northern Province was established in 2017 in order to monitor and regulate coastal aquaculture in the Northern Province.

The Assistant Director, Coastal Aquaculture Monitoring and Extension Unit, Pooneryn, Kilinochchi is responsible for monitoring and regulating coastal aquaculture in the Northern Province. Four Aqua culturists for Jaffna, Mannar, Kilinochchi and Mullaitivu has been appointed under the Assistant Director.

For projects which do not require an IEE/EIA under the Coast Conservation Act or National Environmental Act, NAQDA will grant the approval for the project through the Aquaculture Management Technical Committee subject to no objection letter from the relevant agencies.

Department of Fisheries and Aquatic Resources (DFAR)/ District Fisheries Extension offices

The DFAR comes under the purview of the Ministry of Fisheries & Aquatic Resources. It is the foremost institute responsible for the development and management of the fisheries sector in the country. There are four district-level DFAR offices within the SEA study area. Under these district-level offices, fisheries inspectors, social development assistants, and fisheries resources management assistants regulate and monitor fishery-related activities. Further, the Brackish Water Fisheries Management division of the department is responsible for the conservation and development of lagoons by further identifying the existing potential in the sector and formulating the necessary legal system.

There are 291 coastal Grama Niladhari divisions (GND) under the 23 Divisional Secretariat (DS) Divisions belonging to 4 Coastal (fishery) districts in the Northern Province. Out of the five districts, Vavuniya District does not have a coastal area. As the aquaculture industry could conflict with the traditional fisheries sector, the DFAR could influence the implementation of the aquaculture development plan. The SEA team consulted the DFAR at the National and District level in this regard.

National Aquatic Resources Research and Development Agency (NARA)

The NARA is the apex national institute vested with the responsibility of carrying out and coordinating research, development, and management activities on aquatic resources in Sri Lanka. NARA has conducted numerous scientific studies in the field of fisheries and aquatic resources. The research activities of NARA include the improvement of fishing equipment and methods, assessment of social and economic aspects of the fishing industry, oceanography and hydrology, and management of processing, preservation and marketing of aquatic products. Apart from that, NARA also provides advisory and consultancy services for the development and sustainable utilization and conservation of living and non-living aquatic resources. When developing NARAs' annual action plans, NAQDA is consulted with a view to including NAQDAs' goals with regard to expansion of aquaculture.

Ministry of Environment

The Ministry of Environment is responsible for policy formulation in relation to managing the environment and natural resources of the country. The Ministry's Environment Planning and Economics Division integrate sustainable development principles into the national policy and planning process. The ministry was consulted through key-informant interviews and formal communication to get information related to Environmental sensitive areas, National Policy Framework on Biodiversity, climate change, chemical and waste management, etc.

Central Environmental Authority (CEA)

Under the National Environmental Act, No: 47 of 1980, the CEA is responsible for integrating environmental considerations into the country's development process. The CEA possesses broad regulatory powers under the National Environmental (Amendment) Acts No: 56 of 1988 and No: 53 of 2000. The aquaculture industries situated outside the coastal zone are required to obtain environmental clearances from the CEA depending on the magnitude of their farms. All aquaculture projects outside the coastal zone which are above 4 Ha will require to undergo IEE/EIA. However, projects which are below this threshold level are not required to be subjected to IEE/EIA. The CEA will specify the necessary environmental assessments and licenses required for the aquaculture industry. The CEA was consulted through key-informant interviews and formal communication to obtain information about the environmental protection areas, pollution aspects, environmental standards, waste management and requirements of the EIA process and the Environmental Protection License process for aquaculture projects etc.

Department of Wildlife Conservation (DWC)

The DWC is the principal government institution responsible for the protection of wildlife resources of the country over its entire land and sea territories. DWC also bears the legal authority to establish and manage the country's network of Wildlife Conservation Areas. The total wildlife conservation area in the Northern Province is around 43,497 ha, which includes National Parks, Strict Nature Reserves, Nature Reserves and Sanctuaries. The DWC may influence the project's site selection criteria. No development is allowed within certain declared areas such as Strict Nature Reserves and National Parks, while traditional human activities are allowed to continue in Nature Reserves. Sanctuaries may consist private owned lands where human activities are allowed to continue and permission is not required to enter into those areas. Any development within 1.6 km from the boundary of a protected area needs DWC clearance based on an EIA/IEE.

The SEA team consulted the DWC to gather information on wildlife conservation areas in the study area.

Forest Department (FD)

Forest Department is responsible for conservation of forest reserves in Sri Lanka. Its mission is to protect and expand Sri Lanka's forests and woodlands. There is 478,685 Ha of forest conservation areas in the Northern Province including mangrove reserves. As like the DWC, the FD has the mandate to exclude NAQDA's interventions within their reservation.

The SEA team consulted the Forest Department regarding forest reserves which are already declared or are to be declared under Forest Ordinance and other forest areas in the Northern Province.

Coast conservation and coastal resource management Department (CC&CRMD)

The jurisdiction on the coastal zone is with the Coast Conservation and Coastal Resource Management Department (CC&CRMD). The approval should be obtained from the CC&CRMD for the land-based and marine based aquaculture projects if they fall within the coastal zone. Environmental assessments for aquaculture projects will be at the discretion of the DG and the Coast Conservation Advisory Council.

A permit from the CC&CRMD is required for aquaculture development projects within the coastal zone, except for prescribed development projects where EIA/IEE is required. Upon request for a permit, an EIA or IEE may be requested by the relevant authority depending on the magnitude of the activity.

Irrigation Department

All the drainage channels in the areas subject to flood and the parts spreading up to the coast along with the rivers to which drainage channels join, come under the jurisdiction of the Irrigation Department. All the main rivers and medium scale tanks and connected rivers and drainage channels belong to the Irrigation department. There is a limited amount of paddy fields in the coastal belt of the Northern Province which are fed by the irrigation systems of the Irrigation Department.

The tanks that do not belong to the Irrigation Department (of the central government) and of which the command area is over 200 acres and all the connected canal systems comes under the Northern Provincial Irrigation Department. Therefore, the paddy fields and farmlands under these tanks are governed by the Provincial Irrigation Department.

Agrarian Services Department

The Agrarian Services Department has the authority over the small irrigation systems with command areas less than 200 acres, streams and drainage canals that do not come under any of the above categories. There may be conflicts in between the Coastal aquaculture operators and paddy farmers to share the natural resources.

Department of Archaeology

As per the ISEA (N) report, the Northern Province of Sri Lanka possesses a special place in history with over two million pre-historic sites and over 4 million historical locations. However, during the last hundred years, only 10,000 such identified sites had been properly listed. From Pre-historic time up to the colonial Regime, this particular area has presented a unique social profile. Anticipated rapid development may induce significant pressure on the archaeological monuments and sites. The proposed development plan could impact such identified or unidentified archeological monuments and locations. The department of archeology was consulted to gather the details and maps of the archeological sites within the Study area.

Ministry of Lands/Survey Department of Sri Lanka/Department of Land title Settlement

The Ministry of Lands is responsible for formulating and implementing state land policies, conserving state lands, and implementing activities related to land settlement and land acquisition for public purposes including coastal aquaculture development.

Disaster Management Center (DMC)

The Disaster Management Centre (DMC) is mandated with the responsibility of implementing and coordinating national and sub-national level programmes for reducing the risk of disasters. Its' main activities are research and development, mitigation, planning preparedness, dissemination of early warning for the vulnerable population, emergency response, coordination of relief and post disaster activities in collaboration with other key agencies.

District Disaster Management Coordinating Units of Jaffna, Mannar, Kilinochchi and Mullaitivu districts were consulted during the SEA process.

Marine Environment Protection Authority (MEPA)

The MEPA is under the purview of the State Ministry of Urban Development, Coast Conservation, Waste Disposal, and Community Cleanliness. Marine Pollution Prevention Act No 59 of 1981 and a new act Marine Pollution Prevention Act; No 35 of 2008; provides for the prevention, reduction and control of pollution of Sri Lankan marine waters either from marine or land-based sources and gives effect to international conventions for the prevention of pollution of the marine environment.

The authority has the mandate to regulate aquaculture farms in the marine environment. MEPA is therefore an essential and highly influential stakeholder.

Sri Lanka Tourism Development Authority (SLTDA)/Provincial Tourism Bureau

Sri Lanka Tourism Development Authority (SLTDA) is the government authority tasked with planning, development, regulation, and policy implementation of tourism and related industries. Before SLTDA was established in 2007, these functions were carried out primarily by the Ceylon Tourist Board/Sri Lanka Tourist Board/Sri Lanka Tourism Board.

Provincial Tourism Bureau of the Northern Province is responsible for the promotion and development of tourism in the province. The Provincial Tourism Bureau was consulted in order to identify the tourist locations and proposed plans of tourism that could interact with the proposed aquaculture development plan.

National Water Supply and Drainage Board (NWS&DB)

There are some water bodies in the Northern Province, which are used as water sources for the drinking water supplies, which are administered by the NWS&DB.

District Secretariats (Jaffna, Kilinochchi, Mannar, Mullaitivu) / Divisional Secretariats

The divisional secretariats are the hub for most of the central governments' departments. The divisional secretary should approve the land utilization (state) for aquaculture industries. The SEA team gathered land use maps and Divisional Resource Profiles to extract the required socio-economic baseline data required for the SEA.

Northern Provincial Council

The Northern Provincial Council has legislative power over a variety of matters including agriculture, education, health, housing, local government, planning, road transport and social services. The Following Ministries/ Departments/ institutions which come under the purview of the Northern Provincial Council were consulted during the SEA.

1. Provincial Department of Industries
2. Provincial Department of Social Service
3. Provincial Department of Animal Production and Health
4. Provincial Department of Agriculture
5. Provincial Department of Irrigation
6. Provincial Tourism Bureau

Ministry of Defense/ Sri Lanka Navy/ SL Army

Sri Lanka Navy and Sri Lanka Army under the Ministry of Defense is responsible for national security, first and foremost safeguarding the aspirations of the people of Sri Lanka. There are high security zones within the SEA study area declared by the Ministry of Defense/ Security Forces. The SEA team consulted the Ministry of Defense regarding security-wise sensitive areas and other restrictions being imposed in the Northern coastal areas.

The Private Sector Entities Engaged in Coastal Aquaculture

There are very few large-scale private sector aquaculture farms in the Northern Province at present. Taprobane Seafood (TSF) is one of the region's large-scale aquaculture and seafood processing industries. Their contribution to national seafood export and the introduction of the latest technologies to the area is substantial. This agency was consulted in order to identify the industry's socio-economic constraints and the mitigation measures taken, the economy of aquaculture in the area, availability of labor, financial and technical supply in the region, and for suggestions for developing the industry in the region.

Also, the Prospective large scale aquaculture farmers (Annai Sea Food and Suganth International, Jaffna) were also consulted to obtain information on the approval process adopted by local and other institutions, support of the local financial and technical institutions, opinion and feedback of the host communities, adoption of design and scope changes to mitigate or satisfy the host community and other stakeholders.

The Community Operated, Small Scale Aquaculture Farms

NAQDA facilitates small-scale aquaculture farms, especially seaweed farming, owned and operated by poor and vulnerable households in the study area. Poverty reduction is the main objective of these farms. The SEA considered them as critical stakeholders to communicate, with the aspect of seeing aquaculture as a livelihood for the poor and vulnerable communities. The traditional fishermen who share the same fishing area were also consulted.

Government or Non-Governmental Technical/ Training Institutions

The availability of skilled workers in the area is a crucial factor for successful aquaculture and to avoid the impacts of labor influx. Department of Fisheries Science of the University of Jaffna, Ocean University in Jaffna, Vocational training authority of Sri Lanka, German Tech in Kilinochchi district contribute to provide formal education relevant to the sector. The SEA team consulted these institutions on their capacity and technical relevancy.

Local community and representing CBOs in projects' direct and indirect impact area including Fishers/Farmer/Women/Youth organizations and Fishermen/Farmers, residents of the area, and CBOs representing them.

One of the primary stakeholders of the proposed development plan is the local community. The local community realize and react to the positive and negative impacts of the proposed project. Similarly, there are people operating aquaculture farms on a small scale in the study area. The NAQDA assists the local community, including women who own and operate aquaculture activities, especially the seaweed culture projects. The SEA team captured the positive and negative impacts of the local community and the beneficiary/owner of the small and large-scale aquaculture industries. The CBOs

that represent the local community, workers of the farms, fishers operating in nearby marine and lagoon of large-scale aquaculture farms, women's group of the villages involved in seaweed farming were consulted in this regard.

Major CBOs related to fisheries and aquaculture in Northern Province are as follows.

1. National Fisheries Solidarity Organization (NAFSO)
2. Sea Cucumber Association of Jaffna
3. Jaffna District Fishermen's Co-operative Society Unions' Federation (Ltd)
4. Jaffna district Fisheries Solidarity Movement
5. Mannar District Fishing Federation
6. Mannar district Fisheries Solidarity Movement
7. Mullaitivu district Fisheries Solidarity Movement
8. Kilinochchi District Fisheries Solidarity Movement

In addition, a Fisheries Cooperative Society (FCS) or a Rural Fisheries Society (RFS) is established in Grama Niladhari Division level in each coastal villages/islands in Northern Province.

Migrant Fishers

Anglers in other areas migrate seasonally to the Northern Province for fishing and collection of sea cucumber. The interaction between their fishing practices and the proposed development plan were studied through an FGD and included in the SEA report.

Local governments (Municipal Councils, Urban Councils, and Pradeshiya Sabha)

The local government has the authority to approve the land use for aquaculture purposes. There are incidents where land requests for aquaculture projects were rejected or delayed for approval in the Northern Province. The SEA team consulted with the local authorities to identify their concerns, adequacy of the existing legal frameworks, and capacity in this regard.

Non-Governmental Organizations (NGOs) related to Environment Protection

There are several registered NGOs/Non-profit organizations engaged in addressing the national and global environmental issues such as Climate Change, land degradation, bio-diversity degradation, marine pollution etc. Some of the major organizations engaged in national level are given below. These Organizations may have interest in implementing aquaculture development projects especially marine based coastal aquaculture.

- Environmental Foundation (Guarantee) Limited
- Wildlife and Nature Protection Society
- Center for Environmental Justice
- The Green Movement of Sri Lanka
- Eco Friendly Volunteers (ECO-V)
- Sri Lanka Environment Exploration Society
- Bird and Wildlife Team (Pvt) Ltd.
- Ruk Rakaganno – The Tree Society

4.2 Stakeholder and Community Consultations Carried Out

4.2.1 Stakeholder Consultation

Provincial level Stakeholder Meeting-01

First provincial level stakeholder meeting for the Northern Province was conducted in February 2022 at the Auditorium of the Jaffna District Secretariat, with the participation of the representatives of around 75 stakeholders of the provincial level and district level government agencies in Northern Province. The key prioritized issues in fisheries and aquaculture sector have been identified based on the responses of stakeholders. Please refer to the Minutes of the Stakeholder Meeting-01 given in Annex 04-A.

Plate 01: Mr.B. Nirooparaj (Assistant Director/Coastal Aquaculture-NP) delivering the Welcome Address

Plate 02: Mr.T. Krishnaraja (Socio Economist-SEA Team) conducting a presentation on Social Aspects

Plate 03: Participants of the Stakeholder Meeting

Plate 04: Stakeholders presenting their suggestions and concerns

Provincial level Stakeholder Meeting-02

The second provincial level stakeholder meeting was conducted in August 2022, to present the draft SEA report and to obtain the suggestions/concerns of the stakeholders for SEA findings with the participation of around 80 stakeholders.

During the stakeholder meeting, representatives of the Jaffna District Federation of the Fisheries Cooperative Societies expressed their concerns related to the ongoing aquaculture activities. Further, it was suggested to consider the proposed projects in the process of preparing the Opportunity and Risk Map. The concerns raised are discussed under Chapter 6.

Minutes of the Stakeholder Meeting-02 is given in Annex 04-B.

Plate 05: Mrs. Ramani Ellepola (Team Leader) presenting the SEA findings

Plate 06: Participants of the Stakeholder Meeting

Plate 07: District Secretary/Jaffna delivering the welcome speech

Plate 08: Stakeholders raising their concerns

4.2.2 Other individual Consultations with the Government Stakeholders

The individual consultations and Key Informant Interviews were carried out with the following stakeholders during the Scoping Stage.

- Mr. Gamini Wijesinghe, Additional Secretary (Environmental Projects), Ministry of Environment
- Secretary, State Ministry of Wildlife Conservation
- Assistant Director (Protected Areas), Department of Wildlife Conservation
- Mr. J. Suthagaran, Assistant Director, Department of Fisheries and Aquatic Resources, Jaffna District Office.

- Mr. I. M. G. S. Chandranayake, Assistant Director, Department of Fisheries and Aquatic Resources, Mannar District Office.
- Mr. Sumithra Gunathilaka, Assistant Conservator of Forests, GIS Division, Forest Department
- Mr. K. Mohan Kumar, Assistant Director, Department of Fisheries and Aquatic Resources, Kilinochchi District Office.
- GIS Division, Central Environmental Authority (CEA)
- Mr. T. Suboharan, Director, Central Environmental Authority, (Northern Province)
- Mr. Stanley Mascarenhas, Chairman, Tourism Bureau, Northern Provincial Council
- Mr. Sujeewa Ranawaka, Chief Engineer, Coast Conservation Department
- Senior Scientist, National Institute of Oceanography and Marine sciences, NARA
- Mr. Damith Perera, NARA
- Mr. K.W. Indika, Scientist, Oceanography Division, NARA
- Mr. Susantha Udagedera, Director, Blue Resources Trust
- Mr. Ranjith Premalal, Former Director General/Meteorology
- Mr. S. Kokularaja, District Disaster Management Center Unit, Kilinochchi
- Mr. N. P. Iddamalgoda, Operations Officer, Regional Mine Action Centre, Kilinochchi

4.2.3 Community Consultations and Consultations with CBOs, Aquaculture Operators

Community consultations were conducted with Fisheries Organizations, Aquaculture Operators (seaweed, shrimp, sea cucumber) and other Community based Organizations (CBO) for the identification of socioeconomic consequences related to coastal aquaculture development. The outcomes of the community consultations were important in identifying the constraints and opportunities for implementing the ACBFSDP (2021-2025) and the impacts of coastal aquaculture development.

Community consultations carried out by the SEA team are as follows.

- Representatives of the Fisheries Organizations in Jaffna district
- Representatives of the Fisheries Organizations in Poonakary area, Kilinochchi district
- Representatives of the Fisheries Organizations in Mannar district
- Fisheries Organization in Achchankulam, Mannar District
- Employees of the Sea weed farm in Marichchakaddi, Mannar
- Employees of the Sea weed farm in Thuraipoor, Velanai, Jaffna
- Employees of the Shrimp farm in Vidathalativu area, Mannar
- Employees of the Taprobane Sea Food Group's Shrimp Farm, Erukkalampity, Mannar.
- Women group collecting wild sea cucumber juveniles in Anthoniyarpuram, Iluppaikadavai, Mannar
- Fishermen who lost their fishing grounds due to a Sea Cucumber farm in Anthoniyarpuram, Iluppaikadavai, Mannar
- Sirakualai fisherman who lost his fishery ground due to a Sea Cucumber farm in Gurunagar, Jaffna
- Fishermen in Eluvathivu Island
- St. Thomas Fishermen's Co-Op Society in Eluvativu

- Fishermen's Society in Madathtaweli, Punkuduthivu, Jaffna District
- Fishermen's Co-Op Society in Iruppiti, Punkuduthivu, Jaffna District
- Fishermen in Iruppiti, Punkuduthivu
- Owner and Employees of Sea Cucumber Farm, Puwmpukar, Ariyalai, Jaffna
- Fishermen's society of Valaippaadu, Pooneryn, Kilinochchi
- Management and employees and of Annai Sea Food, Jaffna
- Management and employees and of Suganth International, Jaffna
- Members of the "Kaddu valai" fisheries rural association, Erukkalampitty, Mannar
- Sirakuvalai (kalnkaddi) Fishermen engage in sea cucumber farming in Gurunagar, Jaffna

Annex 05 refers to the minutes of the community consultations.

Plate 09: Discussion with the President of Fisheries Organization-Achchankulam (Proposed area for 20 Acre Crab Culture in Achchankulam, Mannar located closer to the Achchankulam Fisheries landing site)

Plate 10: Discussion with the Owner of existing sea weed farm in Marichchakaddi, Mannar

Plate 11: Discussion with the employees of existing Shrimp farm in Vidathalativu area, Mannar

Plate 12: Both Circular tanks and ponds system are using in the shrimp farm (L. vannamei)

Plate 13: Community Consultation with fishermen in Eluvathivu Island

Plate 14: Discussion with President and Treasurer of the Eluvativu St. Thomas Fishermen's Co-Op Society

Plate 15: Women Participation for fisheries related activities- Eluvativu Island

Plate 16: Discussion with the Fishermen's Society in Madathtaweli, Punkuduthhivu who are willing to start a sea Cucumber Farm


Plate 17: Discussion with the employees of existing sea weed farm in Thuraipoor, Velanai, Jaffna

Plate 18: Discussion with Fishermen's Co-Op Society in Irupptti, Punkuduthivu

Plate 19: Discussion with Fishermen in Irupptti area who are willing to start Sea Cucumber Farms

Plate 20: Discussion with the Owner of the existing Sea Cucumber Farm, Puwmpukar, Ariyalai, Jaffna

Plate 21: Discussion with the employees of the existing Sea Cucumber Farm, Puwmpukar, Ariyalai, Jaffna

Plate 22: Community Consultation with fishermen's society of Valaippaadu, Pooneryn, Kilinochchi

Plate 23: Meeting with Fisheries Officers and Fisheries Organizations at DFAR District Office-Mannar

Plate 24: Meeting with Fisheries Officers and Fisheries Organizations at DFAR District Office-Jaffna

Plate 25: Meeting with Women Group engaged in collecting Sea Cucumber Juveniles at Iluppaikkadavai, Mannar

Plate 26: Meeting with Assistant Director (Fisheries)-Mannar District at DFAR District Office-Mannar

Plate 27: Meeting with Assistant Director (Fisheries)-Jaffna District at DFAR District Office-Jaffna

Plate 28: Meeting with Fisheries Organizations of Kilinochchi District at the Community Hall of Poonakary Fishermen's Co-OP Societies Union Ltd, Pooneryn

5 Environmental, Socio Economic and Climate Change Baseline of the SEA Study Area

5.1 Geographical characteristics of the SEA Study Area

The SEA study is based in the Northern Province comprising 8884 sq. Km which represents around 13% of the total land area in Sri Lanka. It consists of 5 administrative districts, namely Jaffna, Kilinochchi, Mullaitivu, Mannar, and Vavuniya. The Northern province comprises of 33 Divisional Secretariat Divisions, 931 Grama Niladhari and 3,235 villages. Among these 5 districts, the SEA study focused on 4 coastal districts namely, Jaffna, Kilinochchi, Mullaitivu, and Mannar districts which are surrounded by the Gulf of Mannar and Palk Bay to the West, Palk Strait to the North West, the Bay of Bengal to the North and East.

The land-based SEA study area comprises 1781 Sq. Km which represents around 20% of the total land area in the Northern Province. The land-based study area includes 336 Grama Niladhari divisions in 25 Divisional Secretariat Divisions. The terrain of the area is relatively flat and includes a coastal plain.

The annual rainfall is brought in by the North-East monsoon and it varies from year to year. The rainy months of November, December, and January account for 90% of the total rainfall. The average temperature is around 28° to 30° for the year. The coolest month is January, while the warmest month is May.

5.2 Land use and land cover in the SEA Study Area

The SEA team obtained the updated Land use map of the Northern Province from the Land Use Policy Planning Department (LUPPD). Land use Characteristics within the SEA Study area of the Northern Province is given in the Table 17 below.

Table 17: Land use Characteristics of the SEA Study Area

Land Use Patterns	Districts				Total Extent (Ha)	%
	Jaffna (Ha)	Kilinochchi (Ha)	Mannar (Ha)	Mullaitivu (Ha)		
Abandoned Paddy	608.44	1,573.48	0.00	114.25	2,296.17	1.33%
Paddy	8,599.04	13,101.67	1,942.34	1,452.22	25,095.27	12.71%
Homesteads / Home Garden	9,794.04	6,309.94	4,206.15	2,903.88	23,214.00	21.12%
Seasonal Crops	2,357.95	364.09	103.13	549.71	3,374.88	2.32%
Coconut	557.54	2,498.59	970.03	482.87	4,509.03	1.92%
Cashew	34.07	171.98	0.00	0.35	206.40	0.03%
Palmyrah	4,579.98	4,696.96	5,794.31	0.00	15,071.25	7.31%
Agricultural Farms	0.00	0.00	84.10	0.00	84.10	0.03%
Dense Forest	185.92	14,467.17	59.99	3,336.52	18,049.61	4.07%
Open Forest	0.00	220.61	1,443.89	292.66	1,957.17	1.64%
Scrub Land	6,810.28	4,605.58	3,402.25	2,246.34	17,064.46	6.70%
Grass Land	3,817.43	17.04	48.32	0.00	3,882.79	3.59%
Forest Plantation	344.01	92.38	0.00	47.28	483.68	0.21%
Mangroves	614.95	576.52	2,259.62	1.68	3,452.77	1.79%

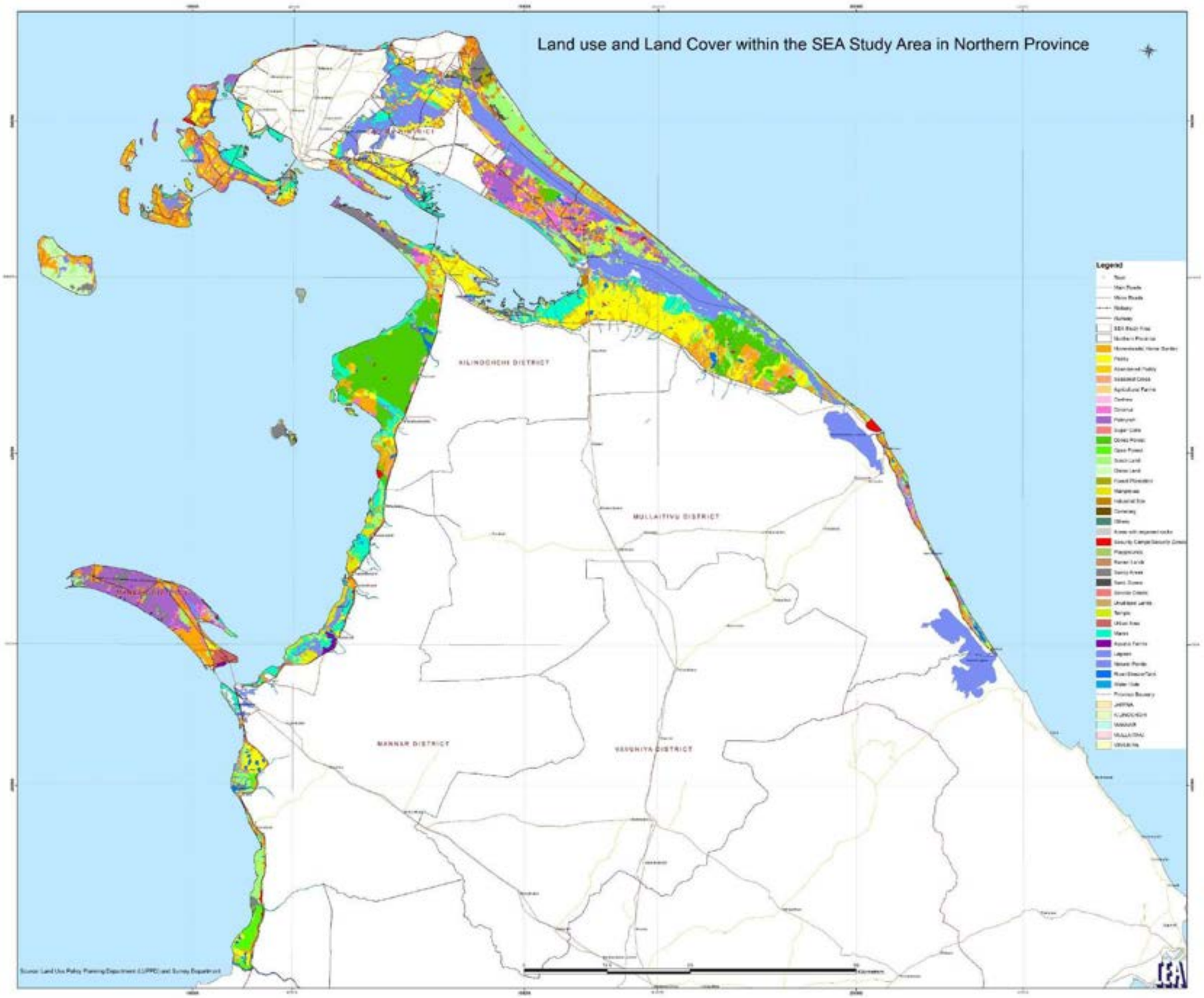
Land Use Patterns	Districts				Total Extent (Ha)	%
	Jaffna (Ha)	Kilinochchi (Ha)	Mannar (Ha)	Mullaitivu (Ha)		
Marsh	5,278.56	5,892.73	3,394.74	225.58	14,791.60	11.71%
Lagoon	13,593.22	6,914.65	280.61	1,441.08	22,229.57	9.35%
Aquatic Farms	0.00	4.10	434.81	0.00	438.92	0.20%
Security Camps / Security Zones	202.92	255.22	106.06	322.23	886.44	2.47%
Urban Area	0.00	0.00	644.40	0.00	644.40	0.19%
Industrial Site	0.00	208.45	0.00	6.17	214.62	0.04%
Barren Lands	1,077.90	63.82	523.46	151.67	1,816.84	0.88%
Unutilized Lands	0.00	0.00	242.51	673.87	916.38	0.63%
Other	602.17	147.69	0.00	41.03	790.89	0.64%
Sand Dunes	283.37	77.41	121.32	0.00	482.10	0.20%
Sandy Areas	2,115.71	3,114.63	1,412.48	379.53	7,022.35	4.95%
Areas with exposed rocks	87.10	0.00	0.00	0.00	87.10	0.08%
Tank-River	177.66	1,270.15	840.93	248.04	2,536.78	1.41%
Natural Ponds	887.53	1,350.49	71.60	463.02	2,772.64	1.10%
Sea	256.26	3,269.26	157.42	26.16	3,709.10	1.35%
Service Center	0.00	0.00	0.00	22.52	22.52	0.01%
Water Hole	0.00	14.28	0.00	0.00	14.28	0.00%
Total	62,866	71,278.88	28544.5	15428.7	178,118	100%

The Map showing the land use and land cover within the SEA study area in the Northern Province is given in Map 17 below.

Homesteads in the rural areas of the Northern Province has sufficient land for home gardens. It helps the province to self-sustain its primary production. Around 21% of the study area consists of homesteads and home gardens. The home gardens are usually cultivated with vegetables and other field crops. The extent of these home gardens varies from a few perches to several acres. The cultivation is usually for self-consumption and to sell the remaining for cash. The home gardens are mostly operated by family workers and used to hire additional workers as and when necessary.

The urban areas within the study zone are minimal (0.19%) and Mannar Island is the only such area. Mannar Island has an area under the Urban Council (UC), the DS division's population density (324 persons/sq. Km) is less than that of the national average. However, there are GNDs with a population density more than that of the national average though they are not falling within a UC area.

Furthermore, there are scrubland, unutilized land, and barren land within the study area compromising of 8.5% (19,181 Ha) of the study area. Part of this area may have the potential for aquaculture and other economic activities.



Map 17: Land use and land cover within the SEA study area in the Northern Province

5.3 Physical characteristics of the SEA Study Area

5.3.1 Climate and Meteorological Characteristics of the SEA Study Area

The Northern Province of Sri Lanka has a tropical monsoon-driven climate, which is hot and dry in the dry season (February to September) and rainy in the wet season (October to January).

5.3.1.1 Rainfall

The Northern province is relatively dry with an annual average rainfall of about 1000 mm which is less than the average potential evaporation that exceeds 1500 mm. The rainy months of November, December, and January account for 90% of the total rainfall. Second inter monsoon (October - November) and northeast monsoon (December - January) are the major rainfall seasons in the Northern Province. Southwest monsoon (May- September) is a dry season for Northern Province however there is a possibility to get quite heavy rainfall during early part of May due to development of atmospheric disturbances, low pressure area and from the Inter Tropical Convergence Zone (ITCZ) which comes to the vicinity of Sri Lanka.

The province's Eastern region receives the highest rainfall, while the Western region receives the least (Piratheeparajah, 2015). Therefore, the dependence on rainwater and groundwater is very high. Rainfall characteristics of the study area were analyzed using the monthly rainfall data at 5 rain stations, Mannar, Vavuniya, Trincomalee, Iranamadu and Jaffna which generally evenly cover the SEA study area.

Figure 4 to Figure 8 below shows the seasonal rainfall variation during the past three decades at the above meteorological stations. The seasonal rainfall at all the stations shows some short-term trends over several years. However, when the whole data period is considered (about 26 to 30 years), there is no apparent trend as the scatter of the data points is so high and they do not show any clear trend. Non-parametric Mann-Kendall test does not recognize any trend in these data sets at the standard 95% confidence level (Table 18). However, for Mannar, the annual rainfall shows an increasing trend with a confidence level of 90% and the wet season rainfall also shows an increasing trend at 85% confidence level.

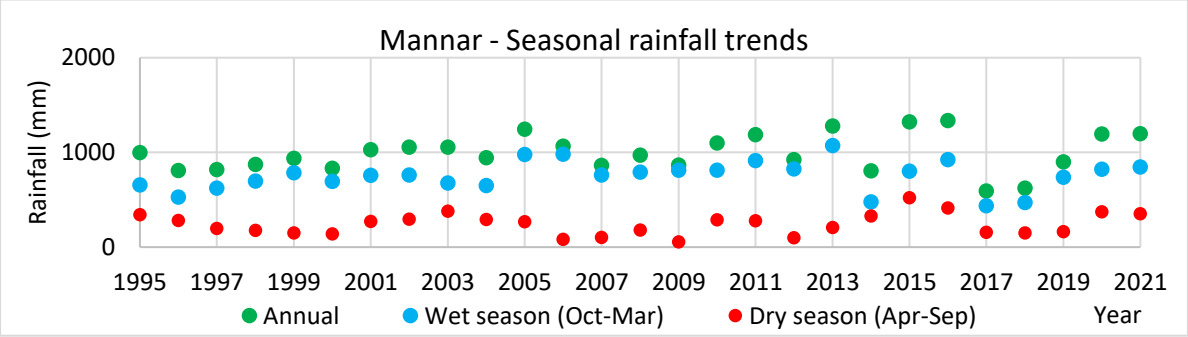


Figure 4: Mannar seasonal rainfall variation from 1995 to 2021

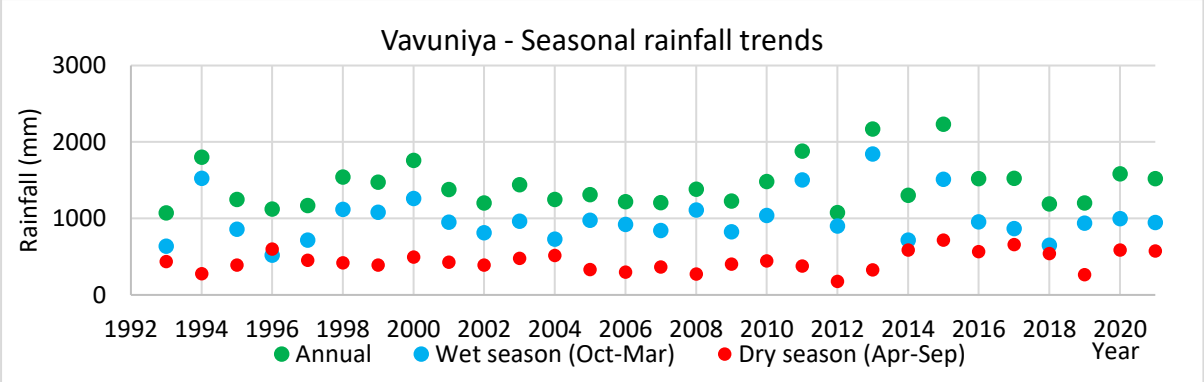


Figure 5: Vavuniya seasonal rainfall variation from 1992 to 2021

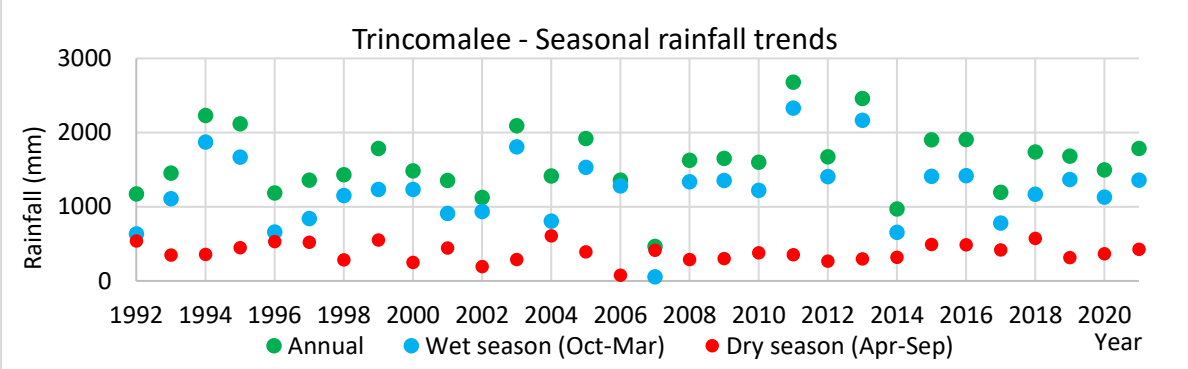


Figure 6: Trincomalee seasonal rainfall variation from 1992 to 2021

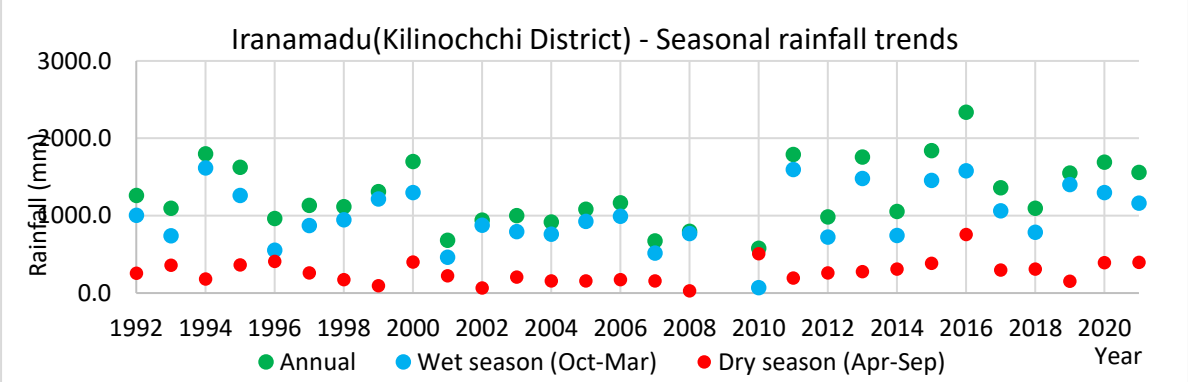


Figure 7: seasonal rainfall variation from 1992 to 2021 in Kilinochchi District

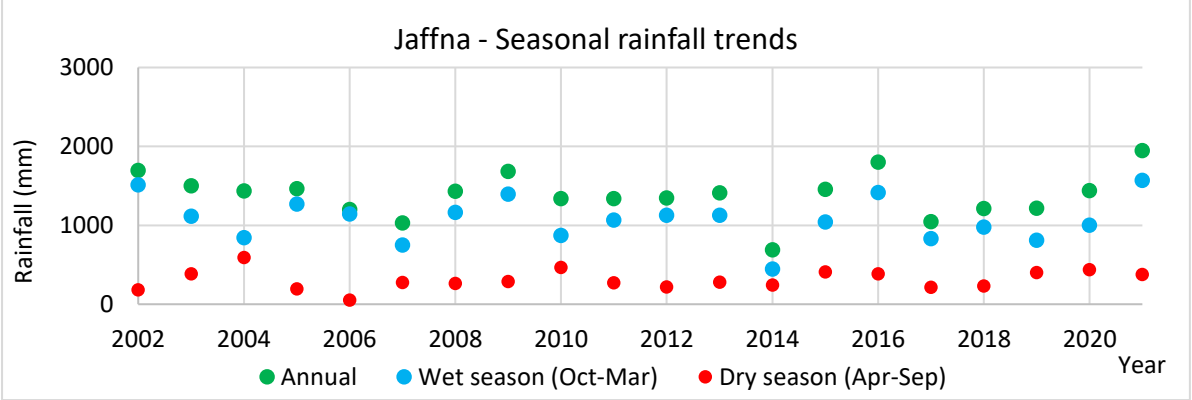


Figure 8: Jaffna seasonal rainfall variation from 2002 to 2021

Table 18: Rainfall trend analysis using non-parametric Mann-Kendall test

Station	Mannar			Vavuniya			Trincomalee			Iranamadu			Jaffna		
Confidence level %	95	90	85	95	90	85	95	90	85	95	90	85	95	90	85
Annual	N	Incr	Incr	N	N	N	N	N	N	N	N	N	N	N	N
Wet season	N	N	Incr	N	N	N	N	N	N	N	N	N	N	N	N
Dry season	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Note: N – No trend, Incr – Increasing trend

The Jaffna peninsula receives around 635–1400 mm of rainfall from the Northeast Monsoon from October to March and little or no rainfall is reported during the rest of the year. According to the analyses conducted by the Consultant based on the rainfall data of the Northeast Monsoon from 2001 to 2020 obtained from Department of Meteorology, statistically non-significant increasing trends could be identified. (Figure 9).

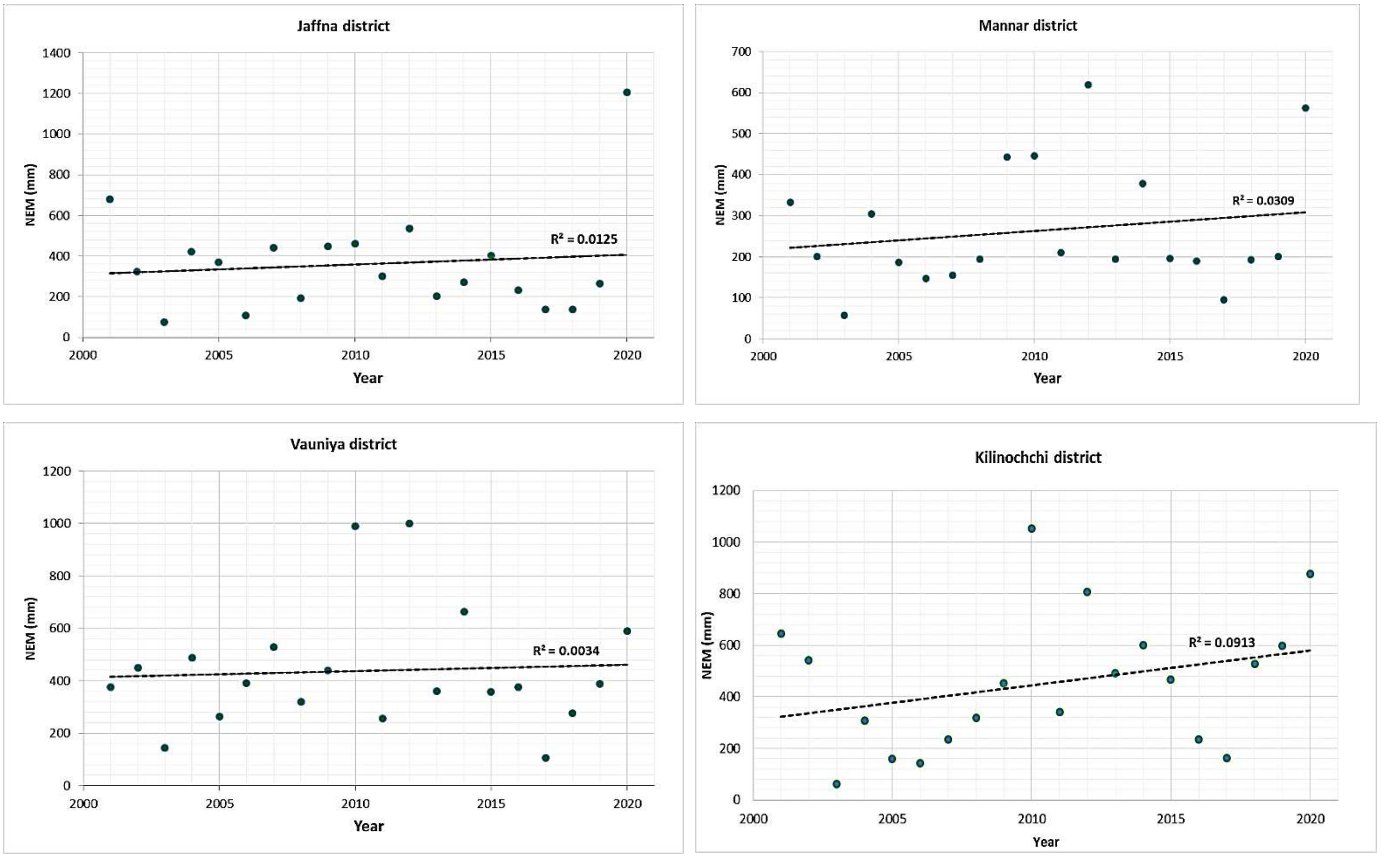


Figure 9: Trends in Northeast monsoon rainfall in Northern Province
(2001-2020; NEM-Northeast monsoon rainfall)

A flood is an occurrence of overflowing of water that submerges land which is usually dry. Floods take various forms and are classified by its type in the forms of rainfall related (aerial), riverine, estuarine and coastal, urban or storm water and catastrophic flooding. The heavy effects of flood generated from aerial floods may be followed by a river flood as water moves away from the flood plain into local rivers and streams etc. Recorded heavy flooding was experienced in Sri Lanka in many decades back in 1917, 1947, 1954 with significant floods recorded in recent years in 1978,

1982, 1986, 1989, 1990, 1992, 1993, 1994, 1999, 2000, 2003, 2004, 2005, 2006, 2008, 2010, 2011, 2014, 2016, 2017, 2018 and 2021 make heavily affected on large number of people with destroying and damaging of infrastructure.

5.3.1.2 Temperature

According to a study by Nagamuthu (2016), which analyzed the temperature patterns in the Northern Province of Sri Lanka from 1972 to 2014, average air temperature was 28.4 ^{0}C for the Northern Province. The average temperature during the first inter monsoon season was 29.2 ^{0}C and has not exceeded 28.8 ^{0}C during the Second Inter Monsoon Season. The highest annual average temperature was found in Mannar district. The average temperature has varied every month and year, and geographical factors determine the spatial variations of temperature and rainfall. The district-level annual temperature average/s for the period 1972-2012 are provided in Table 19 below. The hottest month in the Northern Province is July, with an average temperature of 29.6 ^{0}C. December is the coldest month, which has an average temperature of 27.7 ^{0}C (Nagamuthu, 2016). Recent climate analysis in Sri Lanka indicates an increasing trend in both maximum and minimum temperature with higher increasing trend in minimum temperature leading to decreasing trend in Diurnal Temperature Change (DTR) (Jayewardene et.al. 2018). The relative humidity fluctuates from 70% during the day to 90% at night (Mallawatantri et al., 2014).

Table 19: Average temperatures of the districts in Northern Province (1972 – 2012)

District	Average annual temperature (^{0}C)
Jaffna	27.8
Kilinochchi	27.7
Mannar	28.2
Mullaitivu	27.9
Vavuniya	27.6

Source: (Nagamuthu, 2016)

5.3.1.3 Cyclones

Cyclones only occur occasionally in Sri Lanka and normally affect the Northern Province during November and December. With the projected climatic changes in the Northern Province, the frequency of occurrence and potential impacts could increase in the future.

The 1964 Rameswaram cyclone (also known as the Dhanushkodi cyclone) was regarded as one of the most powerful storms to ever strike Sri Lanka on record. This cyclone caused catastrophic damage to the Northern province with storm surge levels of 4.5 m (15ft).

Burevi was the first cyclone to hit Sri Lanka directly since the 2000 cyclone. The satellite images given in Figure 10 below shows the flooding that occurred during cyclone Burevi from 2nd to 4th December 2020. The area that was inundated during cyclone Burevi is the low-lying area that is vulnerable to floods during cyclones and storm surges.

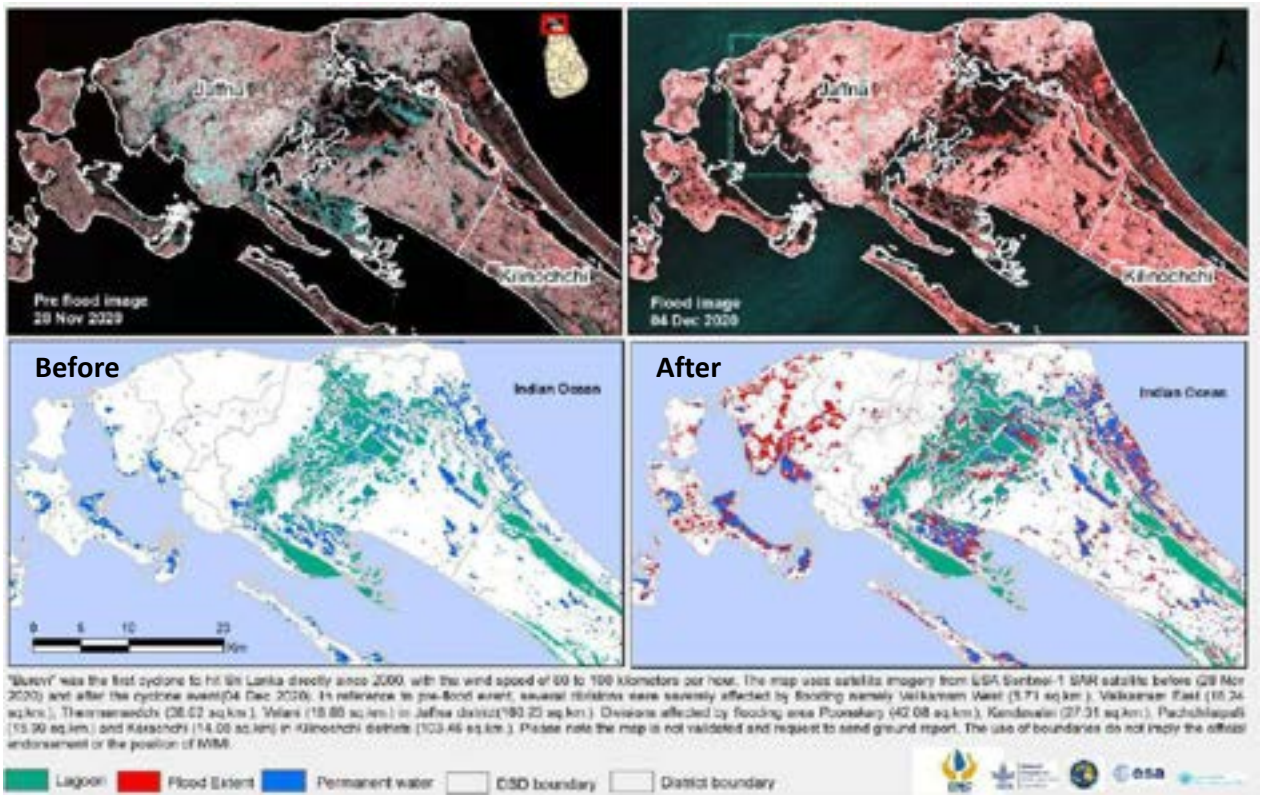


Figure 10: Flood extent in Jaffna district due to "Burevi" Cyclone from on 4th December 2020 (Source: Map produced by the International Water Management Institute (IMWI) based on the SEA Sentinel-1 SAR satellite images)

Land-based aquaculture in these areas should be carefully planned in order to avoid potential losses due to flooding. The low-lying areas south of Jaffna lagoon from Pooneryn to Elephant Pass and the East coast of Jaffna Peninsula were flooded due to the low ground elevations.

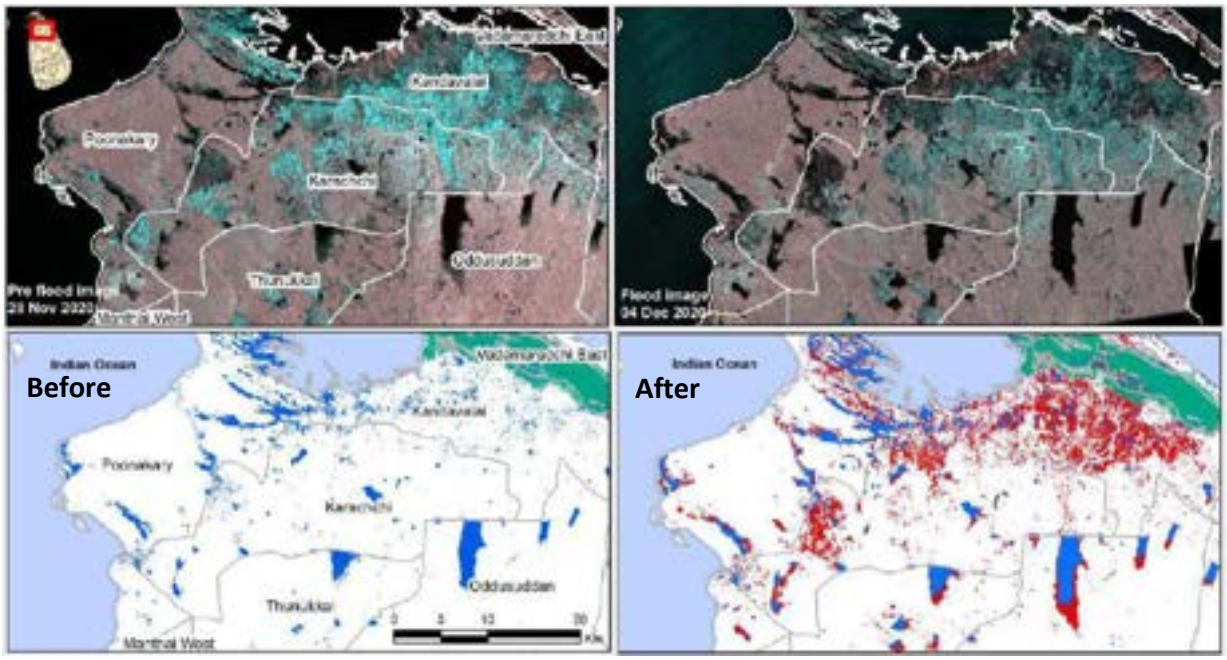


Figure 11: Flood extent in Kilinochchi and Mulaittivu districts due to "Burevi" Cyclone from on 4th December 2020 (Source: Map produced by the International Water Management Institute (IMWI) based on the SEA Sentinel-1 SAR satellite images)

5.3.1.4 Tsunamis

The possibility of coastal flooding due to tsunamis is extremely rare. The Map 18 given below shows the predicted tsunami inundation along the shoreline prepared based on the tsunami model studies data compiled at the CC&CRMD in 2012 for the preparation of Hazard Profiles of Sri Lanka which was published by the DMC. Vulnerability to tsunamis is limited to the Eastern and Northern coasts and the small islands off Jaffna, as the other areas are generally sheltered from far field tsunamis.

5.3.1.5 Sea Level Rise

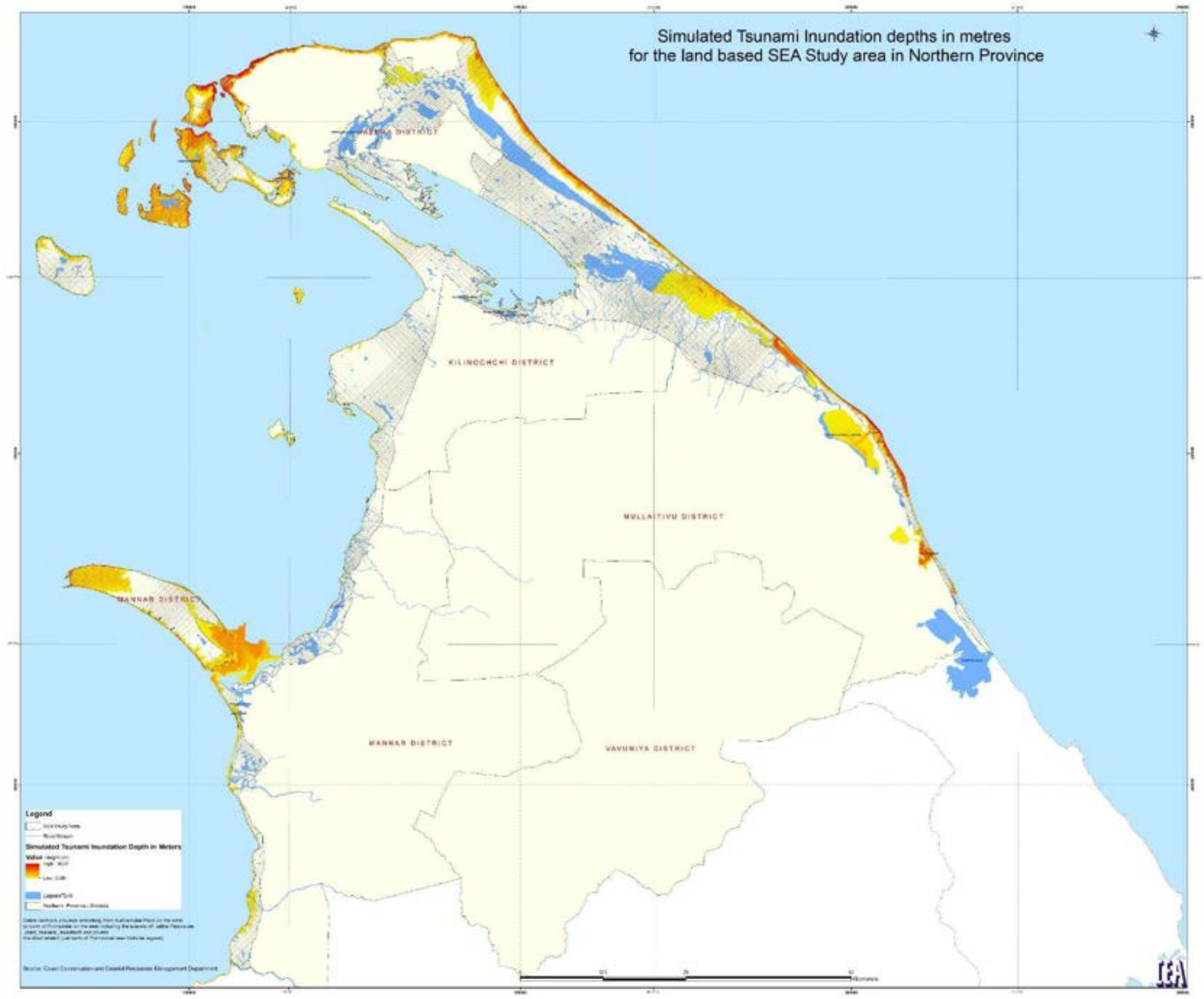
Sea level rise in the Northern Peninsula has been estimated as 2.9 mm year^{-1}, which is slightly lower compared to the sea level rise (i.e., 3.12 mm year^{-1}) observed in southern coast (Oceanography Division, NARA, 2022). Higher monsoon intensity due to climate change has been anticipated for several Asian locations (IPCC, 2001), and the northern province of Sri Lanka is no exception. Kilinochchi is one of the flood prone districts during the rainy season, which is influenced by the North-East monsoon.

Based on the sea level rise predicted, inundation areas due to sea level rise at the end of 25-, 50-, 75-, and 100-year periods (DMC/UNDP, 2015) are given in the Table 20 below.

Table 20: Inundated area due to sea level rise in Northern Province

Total inundated area (ha) - including water bodies				
District	25 Year	50 Year	75 Year	100 Year
Mannar	8024	8262	8518	8758
Jaffna	10321	11164	12014	12891
Mullaitivu	912	1004	1092	1180
Additional inundated area (ha) - excluding water bodies				
District	25 Year	50 Year	75 Year	100 Year
Mannar	248	486	741	981
Jaffna	864	1706	2557	3434
Mullaitivu	88	180	268	355

(Source: DMC/UNDP, 2015)



Map 18: Simulated Tsunami Inundation Depths for the SEA Study Area in Northern Province

5.3.2 Hydrological characteristics of the SEA Study Area

5.3.2.1 Surface water drainage pattern

The coastline on the west side of the Northern Province (Mannar to Pooneryn) is generally a sandy beach where there are many river deltas. Tidal flats on the Southern bank of Jaffna lagoon (Pooneryn to Elephant-Pass) are also a prominent landscape. Northside of the Jaffna lagoon (Manalkadu, Chavakachcheri and Jaffna) are sheltered bay areas with very shallow lagoon waters. The beach in the Northern coastline of Jaffna peninsula is relatively steep and made of sandstone and dead corals, where Thondamanaru is the main freshwater outlet. The coastline on the East is generally a wide sandy beach where the lagoons, Chundikulum, Chalai, Nanthikadal, Nayaru and Kokilai are the main hydrological features. Most of the rivers drain into these lagoons rather than directly discharging into the sea.

There are 24 river basins in the Northern province. In addition, Jaffna peninsula, the Islands and some coastal areas do not have streams, but the stormwater drain into the sea through a large number of minor creeks and man-made drains. Eight river basins have relatively large reservoirs which regulate the river flow during rainy seasons and the irrigation return flows from the reservoir command areas supplement the river water availability during the cultivation seasons. Additionally, there are more than 30 small village irrigation tanks in the upstream areas of these watersheds that increase the water availability to some extent during the dry seasons. Rivers in larger basins such as Ma Oya, Kanakarayan Aru, Parangi Aru and Aruvi Aru (Malwathu Oya) have some water discharging into the sea during average dry seasons. They have well-developed river estuaries with rich ecosystems, and they are the main sources of freshwater supply to the sea. However, most river outlets are blocked by sandbars during the dry season which prevents seawater ingress into the estuary and freshwater outflow into the sea. The small streams are not perennial and completely dry up during average dry periods.

A map showing the Fresh water/River Outlets within the SEA Study area and river basins within the Northern Province is given in Map 19 below.

There are 101 Fresh water/River Outlets within the SEA study area in the Northern Province.

Average seasonal freshwater flow at these outlets is given in Table 21 below.

Table 21: Average seasonal freshwater flow at Fresh water/River Outlets in Northern Province

Stream	**Watershed area (km^2)**	**Wet season (October - March)**		**Dry season (April - September)**		**Drain into**
		Weighted seasonal specific yield (Ha.m/ km^2)	Average seasonal freshwater discharge (million m^3)	Weighted seasonal specific yield (Ha.m/km^2)	Average seasonal freshwater discharge (million m^3)	
Ma Oya	1063	35	372	6	64	Kokilai lagoon
Churiyan Aru	88	35	31	5	4	
Chavar Aru	58	38	22	5	3	
Outlet 72	8	35	3	5	< 1	East coast
Paladi Aru	59	36	21	5	3	Nayaru lagoon
Nay Aru 2	241	35	84	5	12	

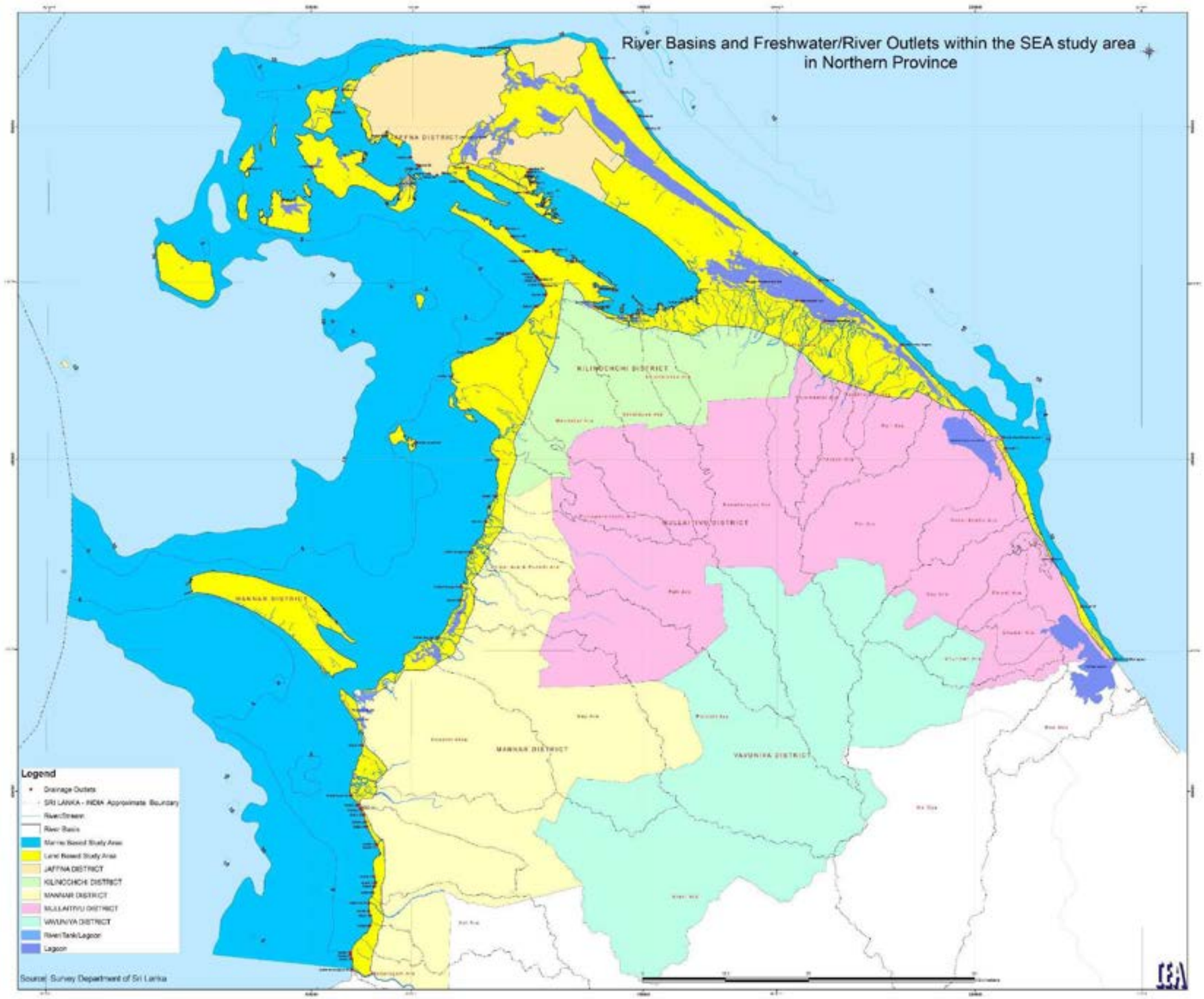
Stream	Watershed area (km^2)	Wet season (October - March)		Dry season (April - September)		Drain into
		Weighted seasonal specific yield (Ha.m/ km^2)	Average seasonal freshwater discharge (million m^3)	Weighted seasonal specific yield (Ha.m/km^2)	Average seasonal freshwater discharge (million m^3)	
Outlet 71	14	35	5	5	1	Eastcoast
Kodalikkallu Aru	94	39	37	5	5	Nanthikadal lagoon
Per Aru	479	30	144	5	24	
Pali Aru 1	107	32	34	5	5	Chalai lagoon
Maruthapillay Aru	60	32	19	5	3	
Outlet 70	3	30	1	5	< 1	Eastcoast
Outlet 69	9	30	3	5	< 1	Eastcoast
Outlet 68	8	30	2	5	,< 1	Eastcoast
Outlet 67	10	30	3	5	1	Eastcoast
Outlet 66	13	30	4	5	1	Eastcoast
Outlet 65	7	30	2	5	< 1	Eastcoast
Thondamanaru	120	30	36	5	6	Northcoast
Outlet 64	2	30	1	5	< 1	Ponnalai coast
Outlet 73 (Punkuduthivu)	11	30	3	5	1	Toward north of Isle
Outlet 74 (Analaitivu)	1	30	< 1	5	< 1	Toward west of Isle
Outlet 75 (Karainagar)	8	30	2	5	< 1	Karainagar east coast
Outlet 76 (Kayts)	20	30	6	5	1	Suruvil coast
Outlet 63	70	30	21	5	4	Arali coast
Outlet 62	22	30	7	5	1	Navanthurai coast
Outlet 61	1	30	< 1	5	< 1	Jaffna lagoon
Outlet 60	2	30	1	5	< 1	
Outlet 59	2	30	1	5	< 1	
Outlet 58	2	30	1	5	< 1	
Outlet 57	6	30	2	5	< 1	
Outlet 56	4	30	1	5	< 1	
Outlet 55	88	30	26	5	4	
Outlet 54	4	30	1	5	< 1	
Outlet 53	3	30	1	5	< 1	
Outlet 52	23	30	7	5	1	
Outlet 51	2	30	1	5	< 1	
Outlet 50	2	30	1	5	< 1	
Theravil Aru	111	28	31	5	6	

Stream	Watershed area (km^2)	Wet season (October - March)		Dry season (April - September)		Drain into
		Weighted seasonal specific yield (Ha.m/ km^2)	Average seasonal freshwater discharge (million m^3)	Weighted seasonal specific yield (Ha.m/km^2)	Average seasonal freshwater discharge (million m^3)	
Piramenthal Aru	91	25	23	5	5	
Methali Aru	124	25	31	5	6	
Kanakarayan Aru	905	24	217	5	45	
Outlet 49	30	20	6	5	2	
Kalwalappu Aru	64	20	13	5	3	
Outlet 48	15	25	4	5	1	
Outlet 47	16	25	4	5	1	
Outlet 46	12	25	3	5	1	
Outlet 45	11	25	3	5	1	
Outlet 44	1	20	< 1	5	< 1	
Outlet 43	2	20	< 1	5	< 1	
Outlet 42	1	20	< 1	5	< 1	
Outlet 41	1	20	< 1	5	< 1	
Outlet 40	1	20	< 1	5	< 1	Palk Bay
Outlet 39	1	20	< 1	5	< 1	
Outlet 38	0.5	20	< 1	5	< 1	
Outlet 37	0.5	20	< 1	5	< 1	
Outlet 36	0.5	20	< 1	5	< 1	
Outlet 35	0.5	20	< 1	5	< 1	
Outlet 34	0.5	20	< 1	5	< 1	
Outlet 33	0.5	20	< 1	5	< 1	
Outlet 32	9	20	2	5	< 1	
Akkarayan Aru	260	20	52	5	13	
Outlet 31	5	17	1	5	< 1	
Mandakal Aru	336	18	60	5	17	
Outlet 30	5	17	1	5	< 1	
Outlet 29	5	17	1	5	< 1	
Outlet 28	29	17	5	5	1	
Outlet 27	37	17	6	5	2	
Outlet 26	14	17	2	5	1	
Outlet 25	8	17	1	5	< 1	
Outlet 24	2	17	0	5	< 1	
Pallavarayan Aru	179	17	30	5	9	
Outlet Iranathivu	1	17	< 1	5	< 0	
Outlet 23	6	13	1	5	< 1	

Stream	Watershed area (km^2)	Wet season (October - March)		Dry season (April - September)		Drain into
		Weighted seasonal specific yield (Ha.m/ km^2)	Average seasonal freshwater discharge (million m^3)	Weighted seasonal specific yield (Ha.m/km^2)	Average seasonal freshwater discharge (million m^3)	
Outlet 22	16	13	2	5	1	
Pali Aru 2	474	17	81	5	24	
Chappi Aru	75	13	10	5	4	
Parangi Aru	875	18	158	5	44	
Outlet 21	11	14	2	5	1	
Nay Aru 1	537	15	81	5	27	
Outlet 20	50	15	8	5	3	Gulf of Mannar
Aruvi Aru	3183	30	955	9	286	
Outlet 19	0.5	15	< 1	5	< 1	
Outlet 18	0.5	15	< 1	5	< 1	
Outlet 17	1	15	< 1	5	< 1	
Outlet 16	10	15	2	5	1	
Outlet 15	0.5	15	< 1	5	< 1	
Outlet 14	4	15	1	5	< 1	
Outlet 13	14	15	2	5	1	
Outlet 12	0.5	15	< 1	5	< 1	
Outlet 11	2	15	< 1	5	< 1	
Outlet 10	1	15	< 1	5	< 1	
Outlet 9	2	15	< 1	5	< 1	
Outlet 8	1	15	< 1	5	< 1	
Kal Aru	277	16	44	5	14	
Outlet 7	1	16	< 1	5	< 1	
Outlet 6	1	16	< 1	5	< 1	
Outlet 5	3	16	< 1	5	< 1	
Outlet 4	0.5	16	< 1	5	< 1	
Outlet 3	1	16	< 1	5	< 1	
Outlet 2	1	16	< 1	5	< 1	
Modaragam Aru	1142	23	263	8	91	

* Specific yields were estimated based on the seasonal yield curves given in (Ponrajah AJP, 1984; Dharmasena, GT, 1997)

Average freshwater volumes given in the above table are in million cubic meters over the 6-month period for wet and dry seasons. However, as the rainfall is not evenly distributed over the entire season, the freshwater supply is not uniform but highly varies with the rainfall. This is prominent during the dry periods where the flow happens only during a few rainy days and the creek is dry during the whole season.



Map 19: Map showing the Fresh water/River Outlets within the SEA Study area and river basins within the Northern Province

5.3.2.2 Tide and Waves

Tidal range around Sri Lankan waters is about 0.7 m during spring (high) tide conditions. It is a semi -diurnal type water level fluctuation. Tidal fluctuations at Pesalei, Kayts Island, Delft Island, Point Pedro and Trincomalee are shown in Figure 12 to Figure 16 below. Tide at Pesalei, Delft Island, Pont Pedro and at Trincomalee generally covers the full tidal range of the Sri Lankan coastline as the locations are at open sea. However, the tidal fluctuation at Kayts Island is only about half of the full tidal range as this Island is sheltered from the open sea by the other Islands. The low tidal range severely affect the water circulation in the sheltered areas as it is the tidal water level variation which generates the tidal current.

Sea waves also help in water circulation by creating turbulence when they break at the shore. Due to the sheltering effect of the Indian subcontinent, waves at the Palk Bay side (Western coastline) are generally weak. This severely limit the mixing and water circulation capability of the coastal waters. Whereas the wave heights at the shoreline from Point Pedro to Mullaitivu is very high due to the direct exposure to the open sea and therefore, the nearshore water circulation is very good. Wave heights inferred from different literature is summarized in Table 22 below.

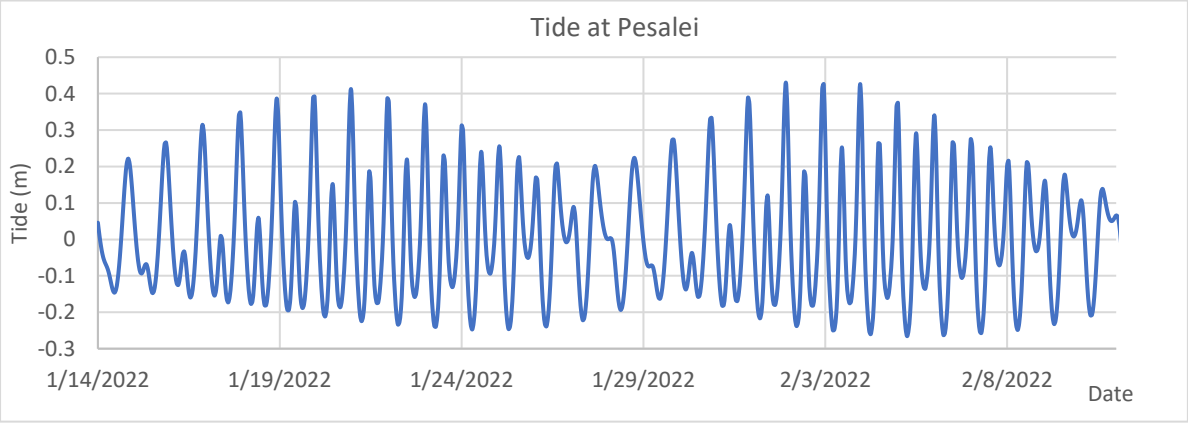


Figure 12: Tide at Pesalei in Mannar

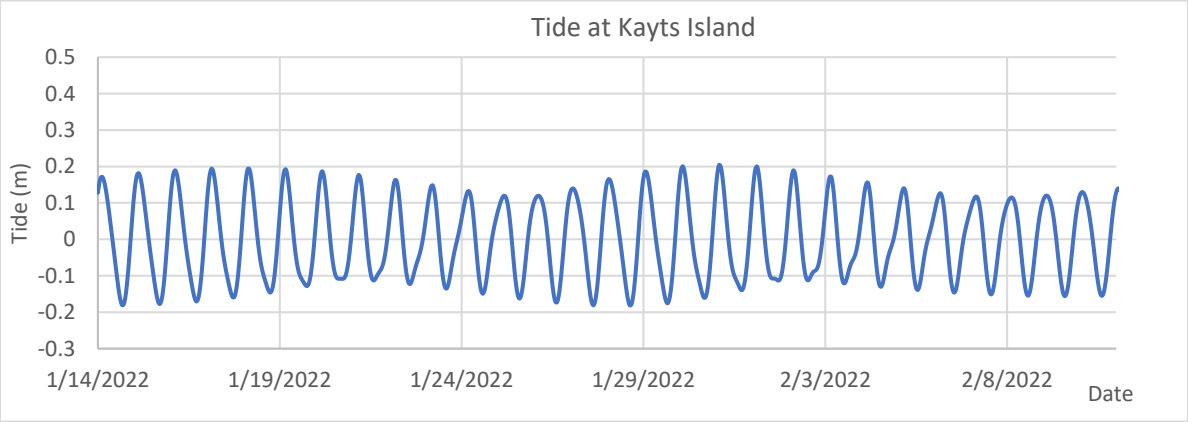


Figure 13: Tide at Kayts Island

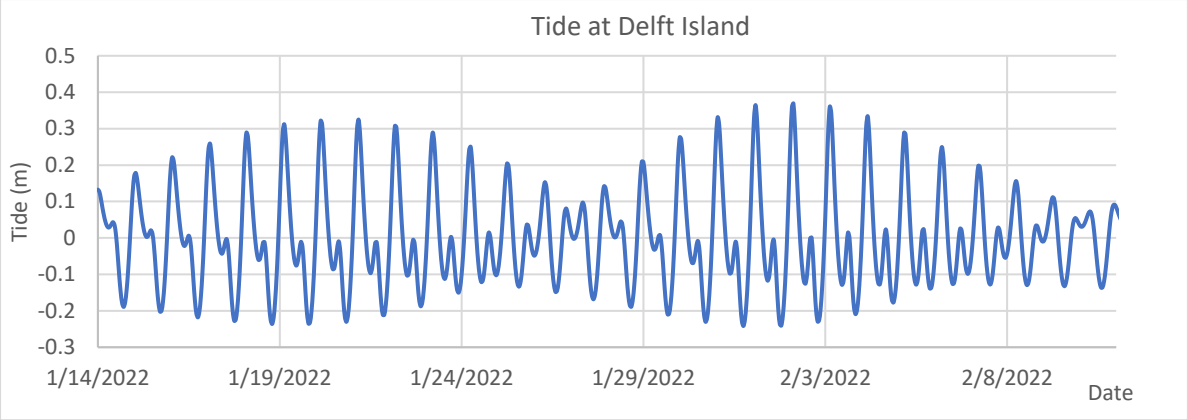


Figure 14: Tide at Delft Island

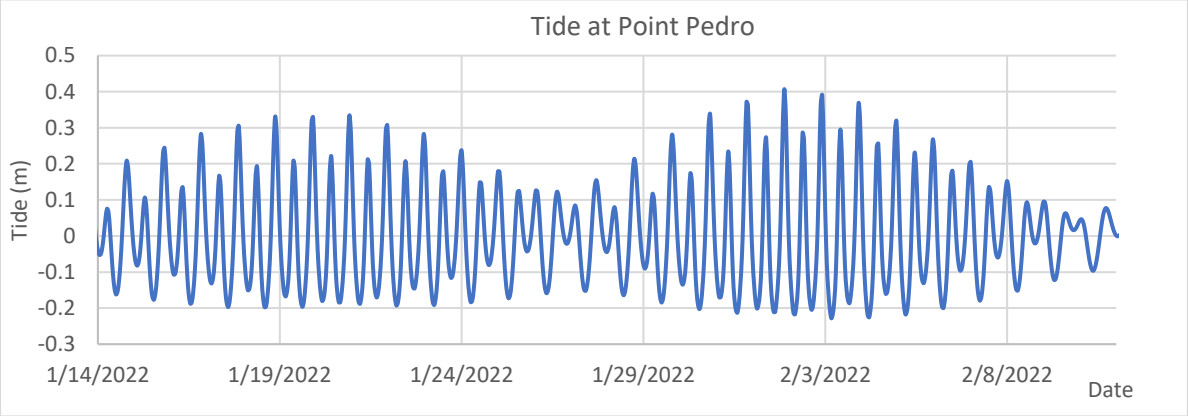


Figure 15: Tide at Point Pedro

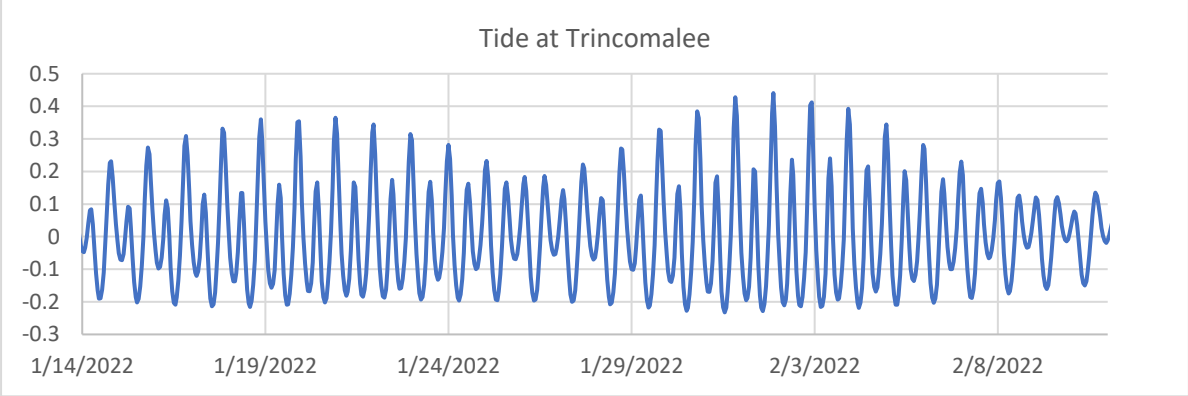


Figure 16: Tide at Trincomalee

Table 22: Wave heights

Location	Average annual wave height	Source
Pesalei	No waves for about 230 days 0.4 to 0.7m for about 72 days Above 0.8m for about 3 days	Comprehensive Modelling of Longshore Sediment Transport at Pesalai, Gurunagar, Point Pedro and Mullaitivu, Sri Lanka, UNESCO-IHE and ADB, 2016
Gurunagar	No or very weak waves	
Point Pedro	No waves for about 224 days 4 to 0.7 m for about 87 days Above 1 m for about 21 days	
Mullaitivu	No waves for about 115 days 0.4 to 1m for about 186 days Above 1 m for about 14 days	
Vadamarachchi	Annual average 0.25m Above 1 m for about 150 days	Jaffna And Kilinochchi Water Supply Project - Seawater Desalination Plant and Potable Water Conveyance System, National Water Supply and Drainage Board, 2017

5.4 Ecological characteristics of the SEA Study Area

The Northern Province encompasses nearly 40% of the country's coastline. The marine environment from Mannar basin to Palk Bay and Palk Strait are relatively shallow and wide and are affected by both Southwest and Northeast monsoons. Currents are also very strong at the Adams Bridge and Palk Strait's narrow passages, especially during the Northeast monsoon. These factors have created a unique setting in the Northern coastal and marine environment.

The Northern Province encompasses diverse coastal ecosystems, including mangroves, coral reefs, seagrass beds, brackish and freshwater lagoons, salt marshes, tidal flats, and sand dunes etc. (Plate 29 to Plate 38). These ecosystems also harbor characteristic species assemblages, some of which are restricted to the nearshore habitats of the Northern Province. Therefore, the coastal and nearshore areas in the Northern Province function as critical habitats for many marine and coastal species.

Plate 29: Coral reefs in Palaitive Island

Plate 30: Coral reefs in Vidataltive

Plate 31: Mangroves in Vidataltive Nature Reserve

Plate 32: Seagrass beds at Ariyalai, Jaffna (Sea cucumbers are cultured in similar habitats)

Plate 33: Seaweeds found in Palaitive Island reefs

Plate 34: Sand dune in Manalkadu, Jaffna

Plate 35: Salt marsh in Vidithaltive

Plate 36: Offshore areas: Eluvativu Island

Plate 37: Brackish water habitats in Jaffna lagoon

Plate 38: Fresh water habitats in Uppu Aru lagoon

5.4.1 Wildlife Protection Areas

Table 23 below shows the existing Wildlife Protection Areas located within the SEA study area. There are no proposed Protected Areas under DWC at the moment.

Table 23: Declared Wildlife Protection Areas located within the SEA study area

No.	National Park/ Reserve/ Sanctuary	District	Declared Area	Declared Year
National Parks				
01	Adam's Bridge Marine National Park	Mannar District	18,990 ha	2015
02	Chundikulam National Park	Kilinochchi District	19,565.33 ha	2015
03	Delft Island National Park	Jaffna District	1,846.28 ha	2015
Sanctuaries				
04	Vankalai Sanctuary (Vankellei)	Mannar district	4839 ha	2008
05	Kokilai Sanctuary	Mullaitivu District	1995 ha	1951
06	Wilpattu North Sanctuary	Mannar District	632 ha	1938
07	Paraitivu Island Sanctuary	Jaffna District	97.10 ha	1973
Nature Reserves				
08	Nayaru Nature Reserve	Mullaitivu District	4,464.35ha	2017
09	Nandikadal Nature Reserve	Mullaitivu District	4,141.67ha	2017
10	Vidattalitivu Nature Reserve	Mannar District	29,180ha	2016
11	Nagar kovil Nature Reserve	Jaffna District	7,882 ha	2016

(Source- Department of Wildlife Conservation, 2021)

A map showing those declared wildlife protection areas within the SEA study area in Northern Province is given in Map 02 in Page 35.

5.4.2 Forest Reserves

The Declared/gazetted Forest reserves located within the SEA Study area are presented in the Table 24 below.

Table 24: Declared Forest reserves within the SEA Study area

No	Forest Reserve	District	Gazette No.	Gazetted date	Area (Ha)
1	Kaudarimunai	Kilinochchi	2188/9	2020/08/10	75.69
2	Sarasale	Jaffna	2150/32	2019/11/20	1598.23
3	Chalai	Mullaitivu	2150/28	2019/11/20	4559.25
4	Achchankulam	Mannar	2145/36	2019/10/16	1405.80
5	Thirukeshwaram	Mannar	2145/36	2019/10/16	328.02
6	Erukkulampiddi	Mannar	2145/36	2019/10/16	166.28
7	Munrampiddi	Mannar	2145/36	2019/10/16	517.42
8	Yakaraya	Jaffna	2145/35	2019/10/16	115.15
9	Pallikuda	Kilinochchi	2145/37	2019/10/16	239.88
10	Vedithalathivu	Mannar	1834/13	2013/10/28	501.92
11	Palakaimunai	Mannar	1834/13	2013/10/28	300.20
12	Mullikulam	Mannar	1757/2	2012/05/21	5283.77

No	Forest Reserve	District	Gazette No.	Gazetted date	Area (Ha)
13	Ponnaveli	Kilinochchi	1757/2	2012/05/21	1638.14
14	Madduvilnadu	Kilinochchi	1757/2	2012/05/21	1765.22
15	Kumalamunai	Kilinochchi	No Data	No Data	1225.98
16	Kalaru Marichchikatti	Mannar	No Data	No Data	2480.10
17	Pirimandan aru	Kilinochchi	No Data	No Data	962.43
18	Mandakalr	Kilinochchi	No Data	No Data	8355.88
19	Nagapaduwan	Kilinochchi	No Data	No Data	4025.93
20	Pallai	Kilinochchi	No Data	No Data	424.86

(Source- Forest Department, 2022)

The Proposed/To be gazetted Forest reserves located within the SEA Study area are presented in the Table 25 below.

Table 25: Proposed Forest reserves (To be gazetted) within the SEA study area

No	Forest Reserve	District	Area (Ha)
1	Kovilwayal	Kilinochchi	1.707
2	Aiyaweli	Kilinochchi	0.160
3	Veddukkadu	Kilinochchi	1.401
4	Manalkadu	Kilinochchi	0.624
5	Muhavil	Kilinochchi	2.373
6	Aiyaweli	Kilinochchi	0.536
7	Kiranchi	Kilinochchi	0.299
8	Danduwannochchi	Kilinochchi	0.270
9	Weerawandiyalmunai	Kilinochchi	2.431
10	Nochchimunei	Kilinochchi	2.008
11	Waleippadu	Kilinochchi	0.232
12	Wadali Aru	Kilinochchi	0.021
13	Murusamodei	Kilinochchi	0.206
14	puwaliyam Wayalam	Kilinochchi	0.918
15	Alimankada	Kilinochchi	0.119
16	Maduvilnadu west	Kilinochchi	3.624
17	Pninrakulam	Kilinochchi	11.778
18	Pallikuda	Kilinochchi	0.162
19	Weemanthelleithivu Reserve	Mannar	0.221
20	Arippu	Mannar	0.078
21	Widaththelleithivu	Mannar	0.012
22	Irattamadu	Mullaitivu	0.141
23	Kewepuram pekulam	Mullaitivu	1.988
24	Kewepuram A	Mullaitivu	6.296
25	Keewepuram	Mullaitivu	0.063
26	Iranapalei	Mullaitivu	0.671
27	Thimbiliya	Mullaitivu	0.096

No	Forest Reserve	District	Area (Ha)
28	Akapilo	Mullaitivu	0.184
29	Mongilaru North	Mullaitivu	0.103
30	Irattamadu	Mullaitivu	0.423
31	Pudumathalan	Mullaitivu	1.360
32	Mulliwaikkal	Mullaitivu	1.708
33	Almpil	Mullaitivu	0.122
34	PiramandanAru	Mullaitivu	0.051
35	Sundaranpuram	Mullaitivu	6.759
36	Pudumathalan	Mullaitivu	0.098
37	Almpil	Mullaitivu	0.039
38	Ammalawonpokkanei	Mullaitivu	0.174
39	Daduwalkoddi	Kilinochchi	7.882
40	Mandalkadu	Kilinochchi	3.932
41	To be named	Kilinochchi	22.807
42	To be named	Mullaitivu	0.170

(Source- Forest Department, 2022)

A map showing those gazetted Forest Reserves as well as proposed Forest Reserves within the SEA study area in Northern Province is given inMap 03 of page 36.

5.4.3 Special Management Areas under the Coastal Zone Management Plan

A number of sites have been identified by CC&CRMD to be declared as Special Area Management Sites within the SEA study area. The list of sites to be declared as Special Area Management Areas within Northern Province is given in Table 26 below.

Table 26: List of sites in the SEA Study area to be declared as Special Area Management sites under the Coastal Zone Management Plan 2018

District	Site
Jaffna	Manalkadu Dunes
	Jaffna Estuary (town area)
	Thondaimanaru Lagoon
	Kankesanthurai and Keeramalai coastal area
	Mandativu, Delft, Nainativu Islands
	Karainagar (including Casuarina beach) coastal area
	Navali Coastal Area
Mullaitivu	Nanthikadal Lagoon
	Nai Aru Estuary
Mannar	Gulf of Mannar
	Thalaimannar coastal area
	Silavathurai, Arippu and Aruvi Aru coastal area and Bay of Kondachchi
	Veditaltivu coral reef and associated ecosystem

(Source: CZMP, 2018)

5.4.4 Coral Reefs

Diverse fringing coral reefs are found in the shallow coastal waters South of Mannar to the Northern most areas of the Jaffna Penninsula and around the isolated islands and from Devil's Point to Kiranchi up to 8 m depth. Some offshore patch reef is found in Maldiva Bank South-east of the Palk Bay. The Jaffna Peninsula's coral reefs are mostly sandstone and rocky reefs (Rajasuriya et al. 2002) found near islands in Palk Bay and along the Palk Strait's Northern coast. As per the ISEA, 2014, Kankasanthurai area has the highest coral cover (57.5%), followed by Punkuduthivu reef and Eluvathivu reef. 57 species of hard corals have been recorded in the Palk Bay and Palk Strait. Large colonies of *Porites lutea* and *P. lobata* of 3-4 m in diameter are common along the Northern coast of the Jaffna peninsula and on the fringing reef from Erumaitivu to Kakkativu. Dead coral and coral rubble are widespread on many islands including Delft, Mandaitivu, Punkudutivu, Palaitivu, and Kachchativu. Soft corals are common especially along the Northern coast of the Jaffna Peninsula. Sea fans/ gorgonians are very rare in the Palk Bay.

However, underwater ecological studies conducted for the present SEA study revealed that the fringing reefs in Palaitive Island and Viditaltivu areas are diverse with over 20% live coral cover.

Plate 39: Healthy and diverse reefs recorded around Palaitive Island in Kilinochchi during the rapid underwater surveys conducted for the SEA Study

Plate 40: Present status of the Vidataltivu Coral reef in Mannar observed during the rapid underwater surveys conducted for the SEA Study

Coral reefs located within Marine study area of the SEA is shown in Map 20 below.

5.4.5 Mangroves

Mangroves are one of the key sensitive habitats found in the study area. Extensive areas of sea fronting mangroves are found in Jaffna lagoon, North of Mannar Island and the Kilinochchi District. However, the exposed Northern shoreline is mostly devoid of them or sparsely dispersed.

Jaffna: Important mangrove habitats can be found in the West end of the Jaffna Peninsula (Kayts Island), Thondamanaru Lagoon, Upparu and Chalai lagoons. The largest mangrove patch is found near the Mandativu island.

Killinochchi: The distribution of mangroves in Kilinochchi district is very scarce and relatively small in nature. Mangrove reserves are found in Kaudarimunai and Pallikuda in Pooneryn Peninsula.

Mullaitivu: A large mangrove patch is found in Nandikadal lagoon. The Nayaru and Kokilai lagoons are also surrounded by some mangroves dominated by *Rhizophora mucronate.*

Mannar: Notable mangrove patches are found in Achchankulam, Narivillukulum, Erukkulampiddi, Vankalai, and Veditaltivu Nature Reserve, North of Mannar town. A rare mangrove species *Pemphis acidula* has been discovered in Achchankulam.

The Declared/gazetted mangrove reserves by Forest Department located within Northern Province are presented in the Table 27 below.

Table 27: Existing Mangrove Forest Reserves in Northern Province

District	Name of Mangrove Reserve	Area (in Hectares)	Gazette No.	Gazette Date
Jaffna	Chadrapuram	87.9	2145/35	2019/10/16
Jaffna	Yakaraya	115.2	2145/35	2019/10/16
Jaffna	Mandathivu	462.2	2145/35	2019/10/16
Jaffna	Sarasale	1598.2	2150/32	2019/11/20
Jaffna	Sierthivu	35.8	2145/35	2019/10/16
Kilinochchi	Kaudarimunai	75.7	2188/9	2020/08/10
Kilinochchi	Pallikuda	239.9	2145/37	2019/10/16
Mannar	Achcankulam	1405.8	2145/36	2019/10/16
Mannar	Thirukeshwaram	328.0	2145/36	2019/10/16

District	Name of Mangrove Reserve	Area (in Hectares)	Gazette No.	Gazette Date
Mannar	Erukkulampiddi	166.3	2145/36	2019/10/16
Mannar	Munrampiddi	517.4	2145/37	2019/10/16
Mannar	Vedithalathivu	501.9	1834/13	2013/10/28
Mannar	Palakaimunai	300.2	1834/13	2013/10/28
Mulaithivu	Chalai	4559.3	2150/28	2019/11/20
Mulaithivu	Kokilai	2432.4	2150/28	2019/11/20
Total Extent of Mangrove Reserves (in Ha)		12,826.1		

(Source-Forest Department, 2022)

The Proposed/To be gazetted mangrove reserves by Forest Department located within Northern Province are presented in the

Table 28 below.

Table 28: Proposed Mangrove Reserves in Northern Province

District	Proposed Name of Mangrove Reserve	Area (in Hectares)
Kilinochchi	Manalkadu	62.4
Kilinochchi	-	39.2
Kilinochchi	Sinnathim	90.9
Kilinochchi	Sinnathim	11.5
Mannar	Vidathalativu	1.2
Total Extent of Proposed Mangrove Reserves		205.3

(Source-Forest Department, 2022)

Declared/gazetted Mangrove reserves, Mangrove reserves proposed to be declared and other mangrove areas located within SEA Study area of Northern Province is shown in Map 21 below.

5.4.6 Seagrass beds

The shallow coastal waters as well as the lagoons in the Northern Province harbour rich seagrass beds. They are extensive around Palk Bay in the Jaffna Peninsula and in Gulf of Mannar. Seagrass meadows in the Gulf of Mannar provide critical habitat for the threatened Dugong (*Dugong dugon*), as well as other conservation needed species such as sea turtle. These are critical habitats for many species and at the same time, these habitats are used for sea cucumber and seaweed culture.

Plate 41: An extensive eelgrass patch observed in Vidataltivu observed during the rapid underwater surveys conducted for the SEA Study

Jaffna: The shallow coastal bays of Thondamaanar, Kurikadduwan, Punkudutivu, Mandaitivu, and the Jaffna lagoon have extensive seagrass beds. The most common species found are *Halophila ovalis, Cymodacea serulata,* and *C. rotundata.*

Killinochchi: In the Kiranchi at Nachchikuda, *Enhalus acaroids, C. rotundata, C. serulata, S. isotifolium,* and *H. ovalis* have been found.

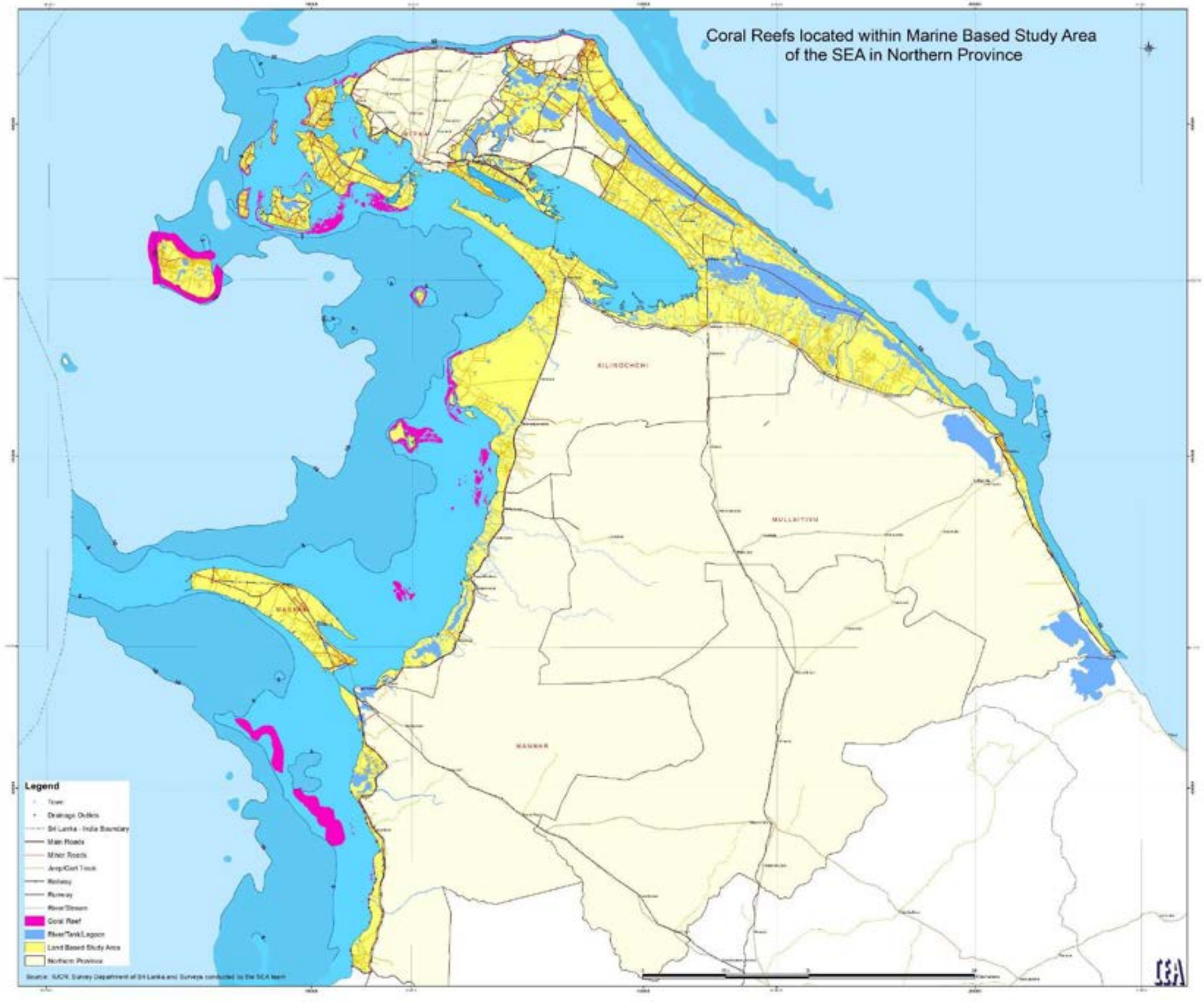
Mullaitivu: Seagrasses *C. rotundata, C. serulata,* and *S. isotifolium* have been found along the Mullaitivu coast.

Mannar: *Enhalus acaroids* is the most abundant seagrass species found in the shallow coves of the Mannar Sea. *C. rotundata, C. serulata, Syringodium isotifolium, Halodule pinifolia, H. uninervis,* and *Halophila ovalis* are among the other species found in the area.

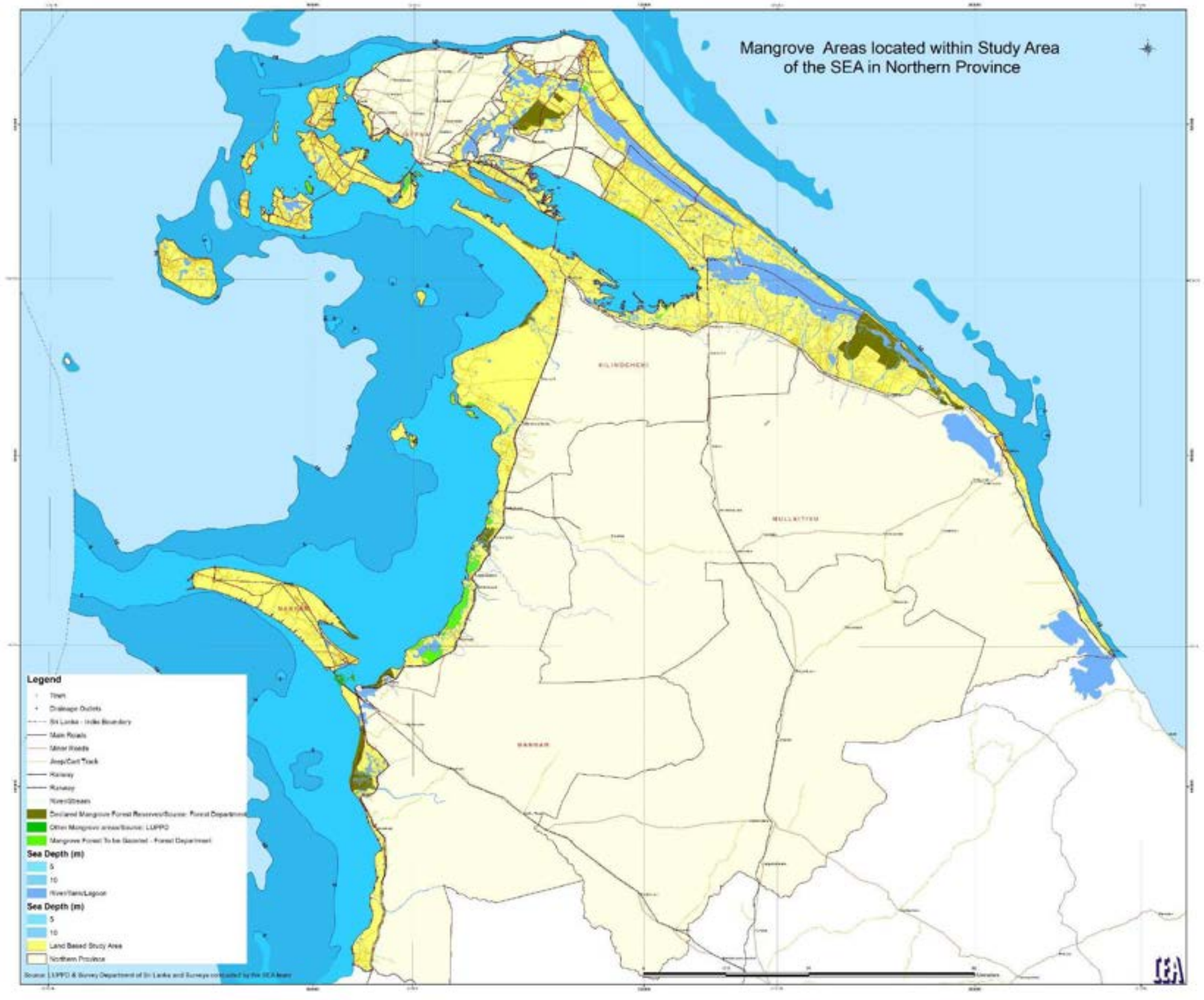
Areas of Sea grass beds located within marine SEA Study area of Northern Province is shown in Map 22 below.

5.4.7 Seaweed

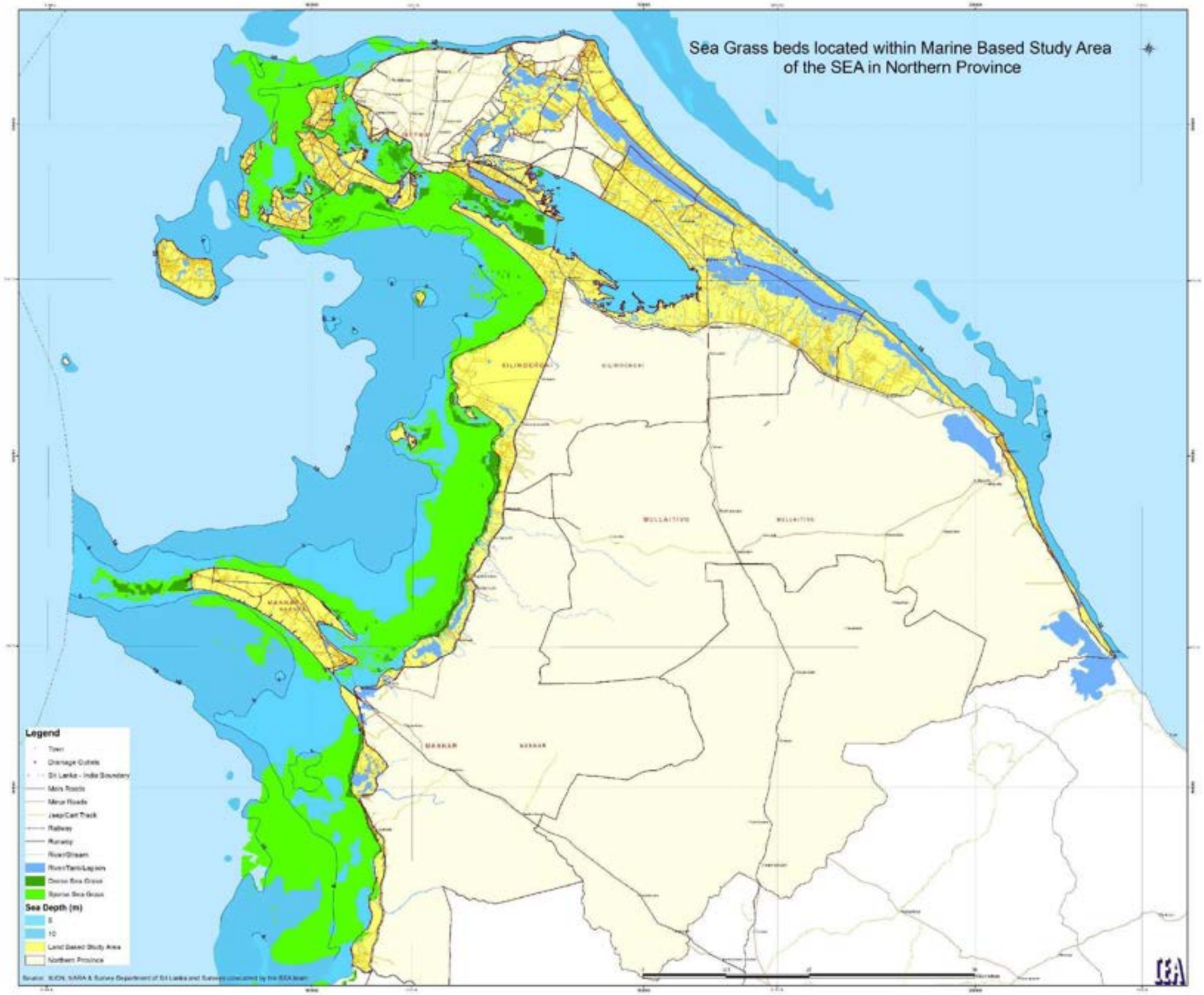
Seaweeds such as *Turbinaria* and *Sargassum spp*., dominate in the shallow Northern coastal waters and in the Jaffna lagoon in particular. Several species of Gracilaria are found in association with seagrasses. *Gracilaria edulis, G. salicornia, G. corticata, Halimina spp., Codium spp., Sargassum spp., and Turbinaria spp* have been recorded in Killinochchi in association with seagrass beds.



Map 20: Coral reefs located within Marine based study area of the SEA in the Northern Province



Map 21: Declared/gazetted Mangrove reserves, Mangrove reserves proposed to be declared and other mangrove areas located within SEA Study area of Northern Province



Map 22: Areas of Sea grass beds located within marine SEA Study area of Northern Province

5.4.8 Tidal flats

Tidal flats are found associated with estuaries, lagoons, and salt marshes in the coastal stretch from Mannar to Jaffna. These ecosystems support invertebrates and fish species and are a critical feeding ground for a large number of shore and wading birds.

Extensive tidal flats occur in the coastal belt from Manthai to Vankalai in Mannar district and patches of tidal flats can be observed especially in Mannar island and Kayts island. Vankalai Sanctuary is a Ramsar site with tidal flats. These tidal flats function as carbon sinks, mud and pollutant catchers, and natural physical buffer for absorbing storm energy while supporting the coastal biodiversity and sustaining coastal fisheries.

5.4.9 Salt marshes

Salt marshes are found in association with tidal mud flats as well as sheltered shorelines, lagoons, and estuaries, mainly along the coast of Mannar District.

According to the Coastal Zone and Coastal Resource Management Plan (CZCRMP), largest area of salt marshes is found between Manthai and Vankalai coastal belt. 56 species of vegetation have been recorded in this stretch of salt marshes. Vankalai salt marshes located within the Vankalai sanctuary in Mannar district, is a shrub-dominant tropical salt marsh and provides home to variety of unique flora and fauna species. Currently, the salt marsh habitats face threats due to the spread of invasive species (*Prosopis juliflora*), dumping of garbage and due to unplanned shrimp farming activities. Other than that, salt marshes are found in southern and western parts of Jaffna peninsula and the islands especially in Mandaitivu, Thanankilappu, Navali South, Arali- Navali, Ariyalai East and Chavakachcheri.

5.4.10 Sand dunes

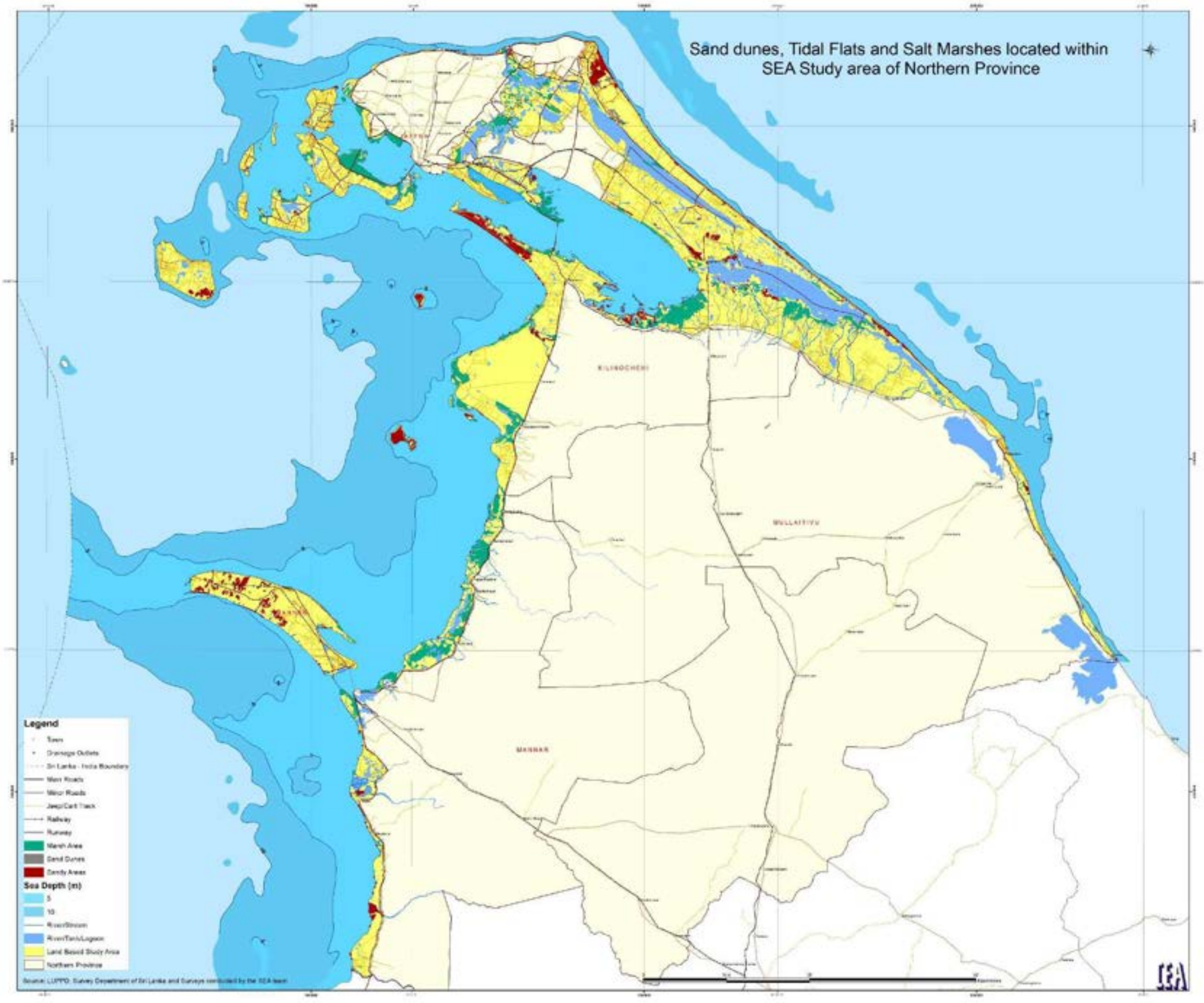
Sand dunes are found along the North-East and East of the Jaffna peninsula, Palk Bay, Mannar island and Pooneryn in the Kilinochchi District. Extensive sand dunes are found in the East coast of Jaffna from Point Pedro, Ampan, Nagar Kovil and Chundikulam areas.

Well-developed sand dunes can be observed along the northeast coast between Mullaitivu and Point Pedro, between Elephant Pass and Chavakachcheri, across Mannar Island and Pooneryn Peninsula with the presence of shallow-sloped beaches (Katupotha, 2007). Manalkadu sand dunes which extends up to Point Pedro are famous as many ruins are buried in these dunes.

The northwest, north and northeast coasts are rich in highly weathered reddened dunes. Unlike the younger dunes, the older dunes are usually secured with scrub forest. Foredune ridges and secondary transgressive sets of dunes can be observed on the southern side of Mannar Island, on the southern shores of Pooneryn peninsula in a low wave energy environment.

These dunes provide protection against storm surge and wave driven flooding. Apart from that, the lower slopes of sand dunes covered with natural vegetation provide nesting sites for endangered marine turtle species (Miththapala, 2008).

Tidal Flats, Salt Marshes and Sand dunes located within land based study area of SEA in Northern Province is given in Map 23 below.



Map 23: Salt Marshes, Sandy areas and Sand dunes located within land based study area of SEA in Northern Province

5.5 Socio-economic and Cultural characteristics of the SEA Study Area

This section describes the socioeconomic and cultural characteristics of the SEA study area, and the key social and economic features and indicators in the province as relevant.

The Northern Province of Sri Lanka consists of five Administrative Districts, namely, Jaffna, Kilinochchi, Mullaitivu, Mannar, and Vavuniya. These five districts are divided into 34 Divisional Secretariats (DS) divisions consisting of 921 Grama Niladhari Divisions (GND).

Map showing the administrative boundaries within the land-based SEA study area is given in Map 24 below.

All four religious groups (Hindus, Muslims, Christians, and Buddhists) are living in the province. There are 3702 Hindu temples, 919 churches, 166 mosques, and 55 Buddhist temples in the province. The Tamils comprise 89.2% of the total population in the province while 8.15% are Muslims and 2.6% are Sinhalese.

5.5.1 Demographic Characteristics of the Northern Province

The total population of the province is 1.253 million (in December 2019). The Northern population has gone through multiple displacements due to the civil war. With the cessation of the war in 2009, a major portion of the displaced population has been resettled. As of December 2019, only 6,976 families have to be resettled in their places of origin. 81.35% of the province's population live in rural areas. The female population of the province is 2.6% higher than the male population.

Table 29: Population Information of the Northern Province

District	Population			
	Male	Female	Total	Percentage
Jaffna	299,027	317,435	616,462	49.2%
Kilinochchi	71,054	74,943	145,997	11.6%
Mullaitivu	67,779	70,542	138,321	11.0%
Mannar	79,946	83,150	163,096	13.0%
Vavuniya	92,809	97,452	190,261	15.2%
Total	610,615	643,522	1,254,137	100.0%
Percentage	48.7%	51.3%	100.0%	

Source: Statistical Handbook of Northern province (2020), Northern Provincial Council

The major portion of the population (71.2%) represents Hindus whereas 18% of the population are Christians, 8.15% are Muslims, and 2.5% are Buddhist. In contrast, the Christians and Muslims outnumber Hindus in the Mannar District.

The civil war which prevailed for three decades devastated people's lives in several ways, such as loss of lives, multiple displacements, loss of properties and economic deprivation, unemployment, and poverty. Hence, the Northern Province is the lowest contributor (contributes 4.1% in 2017) to the national GDP. It comprises Agriculture (including fisheries and livestock) (14.12%), Industry (22%), and services and others (63.88%). The region missed the opportunity of developing the service and industry sectors due to the war. Their livelihood is highly dependent on natural resources such as land, forest, and water (sea, lagoon, and freshwater tanks). Agriculture (Including the Fisheries and livestock rearing) is the dominant sector in the province which provides 29.3% of

the employment in the province. In 2019, the province produced around 300,000 Mt of paddy harvest and around 90,000 Mt of fish catch. Livestock rearing is considered as an additional income source and milk, meat, and eggs are produced mainly. Open grazing is the common feeding method for livestock.

In 2019, the Northern Province had a 5% unemployment rate which was 0.2% higher than the national average. Though the province's unemployed male population (3%) is less than that of the national level (3.3%), the unemployed female population (10.3%) is higher than that of the national level (7.4%). Around 61% of the population are paid employees and 31% are self-employed. 29.3% of the population has been employed in the agricultural sector and another 23.1% in the industrial sector. The service sector accounts for 47.5% of the employment.

The province reached 88% of adult literacy rate in 2016, while the Jaffna and Mannar district achieved more than the national average (92.6%).

The Poverty Head Count Index (PHCI) of the province is 7.7% while the national level index is 4.1%. But, the Kilinochchi district shows the highest PHCI (18.2%) along with the Mullaitivu District (12.7%). The war and other social aspects have generated more women-headed households (67,102 WHH families in which 7,595 are war widows), disabled persons (18,799 persons), and orphans (1,041 persons).

Table 30: Number of Women headed families according to the age group of those women

Districts	Age groups of women Headed Families					
	<20	21-30	31-50	51-60	>60	Total
Jaffna	58	1,905	8,910	8,908	20,011	39,792
Kilinochchi	44	832	3,451	1,871	1,671	7,869
Mullaitivu	35	462	2,235	1,700	2,035	6,467
Mannar	5	194	1,549	1,850	3,233	6,831
Vavuniya	7	142	2,692	1,480	1,822	6,143
Total	149	3,535	18,837	15,809	28,772	67,102
Percentage	0.2%	5.3%	28.1%	23.6%	42.9%	100%

(Source: Statistical Handbook of Northern province (2020), Northern Provincial Council)

Around 47.25% of the province's families are living below the poverty level. The Provincial Social Services Department issues "Public Welfare Assistance Allowance" for 63,370 persons and around 43% of the province's population receives "Samurdhi Welfare" assistance from the central government. The Fishermen's Pension and Social Security Benefit Scheme Act, No. 23 of 1990, was initiated by the government to provide periodic pensions to fishermen in their old age, provides insurance against physical disability, or a gratuity in the event of the death of a fisherman, and later discontinued. However, around 8,000 fishermen in the province have been included into the scheme already and benefiting through this scheme.

5.5.2 Demographic Characteristics of the SEA Study Area

336 Grama Niladari Divisions (GNDs) of 25 DS divisions of four districts (except the Vavuniya District) are falling within the study area fully or partially. The land-based study area covers around 1781 square kilometers of the geographical area along the coastline of the Northern Province and the islands of the Jaffna, Kilinochchi and Mannar districts.

Table 31: Extent of the land-based SEA Study area in each DSD

District	Divisional Secretariat Area (DSD)	Area of DSD (Ha)	DSD Area within SEA Study Area (Ha)	Percentage
Jaffna	Chankanai	4859.79	1157.05	0.65%
	Chavakachcheri	23640.28	10369.75	5.82%
	Delft	4844.48	4767.48	2.68%
	Jaffna	1091.76	50.80	0.03%
	Karainagar	2359.70	2356.49	1.32%
	Karaveddy	8859.81	5840.44	3.28%
	Kayts	3248.68	3245.42	1.82%
	Kopay	10940.63	3550.48	1.99%
	Nallur	3308.82	1210.35	0.68%
	Point pedro	931.96	439.70	0.25%
	Sandilipay	4785.40	350.57	0.20%
	Vadamaradchy east	18864.37	18864.37	10.59%
	Vadamaradchy north	2889.64	1554.62	0.87%
	Valikamam north	6066.69	87.18	0.05%
	Velanai	9027.27	8999.69	5.05%
Kilinochchi	Kandavalai	25885.72	22671.74	12.73%
	Karachchi	43296.06	1732.89	0.97%
	Pachchilapalli	18496.01	18496.01	10.38%
	Poonakary	45221.08	28378.25	15.93%
Mannar	Mannar town	21527.45	13316.89	7.48%
	Manthai west	61192.69	7873.35	4.42%
	Musalai	46340.94	4141.04	2.32%
	Nanaddan	14287.40	3213.19	1.80%
Mullaitivu	Maritimepattu	69537.27	8783.94	4.93%
	Puthukkudiyiruppu	32972.10	6644.74	3.73%
Total Area (Ha)		482,824.37	178,118.08	100.0%

Table 32: The administrative divisions within SEA Study area

District	Number of DS divisions within SEA Study Area	Number of GN Divisions within SEA study Area
Jaffna	15	184
Kilinochchi	4	49
Mannar	4	74
Mullaitivu	2	29
Total	25	336

There are 135,038 families within the GNDs located in the SEA study area. The total population of those GNDs is 417,218. The average household size is 3.08 which is significantly lower than that of the National level (3.7). The Sri Lankan coastal region is characterized by a higher density of population and a greater degree of urbanization than the rest of the country. This higher population density facilitates labor-intensive fishing practices. Resembling the same phenomena, 134 GNDs of

the study area show a population density more than that of the national average (350 persons/sq. Km). Out of these 134 GNDs, 45 GNDs have a population density of more than 1000 persons/sq. Km. However, around 73 GNDs have less than 100 persons/sq. Km population density. At the same time, the district-level population densities of the Mullaitivu, Mannar, Kilinochchi, and the Jaffna are 51, 81, 114, and 604 persons/sq. Km respectively. The Northern Province is sparsely populated other than in a few urban areas.

Table 33: Population density of the GNDs covered by the study area

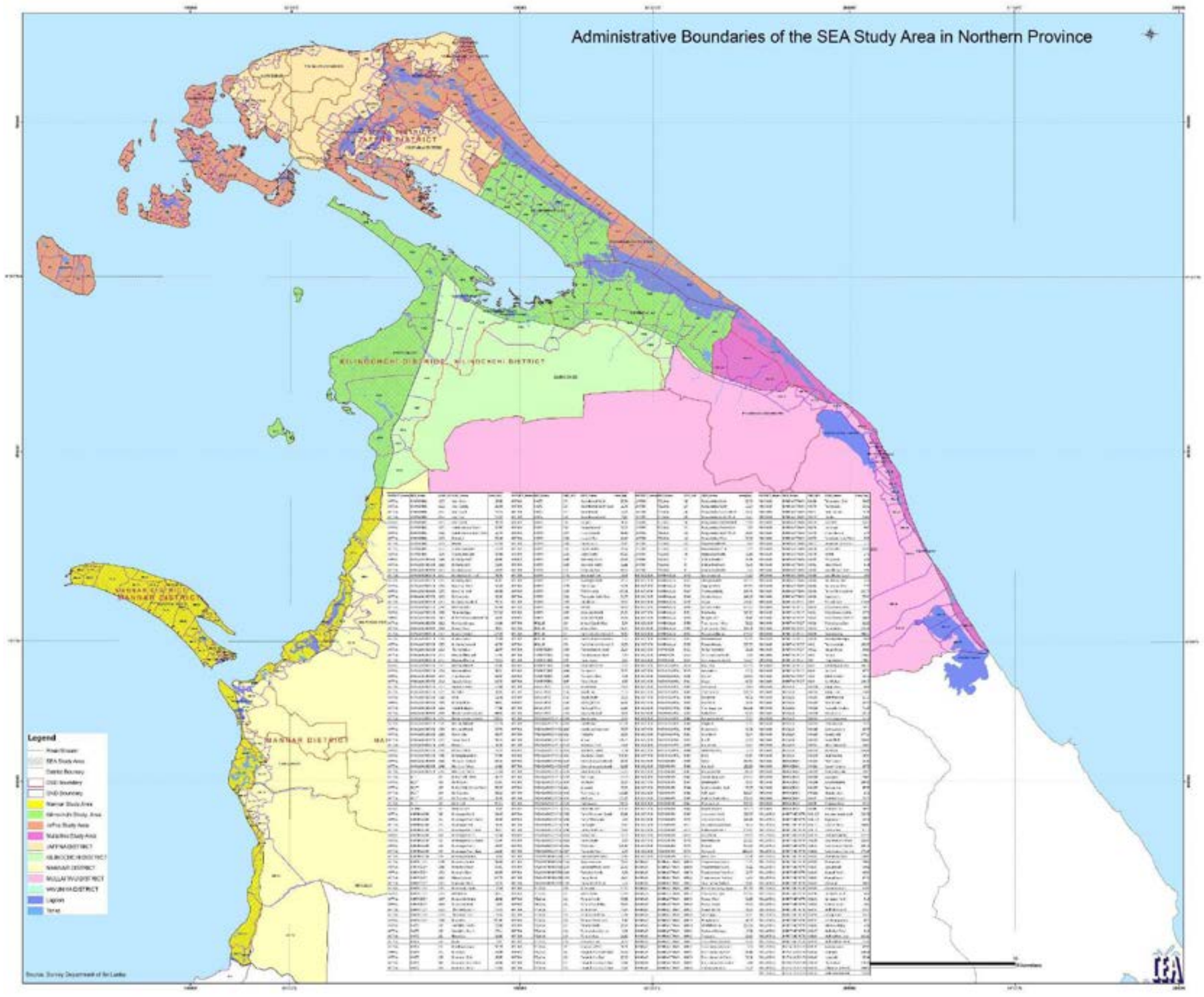
District	Number of GNDs with the Population Density (Persons/sq. Km) of		
	less than 300	Between 300 and 1000	More than 1000
Jaffna	64	79	22
Kilinochchi	45	4	0
Mullaitivu	15	3	5
Mannar	35	21	18
Total	159	107	45
Percentage	51.1%	34.4%	14.5%

* Details of 25 GNDs were not available

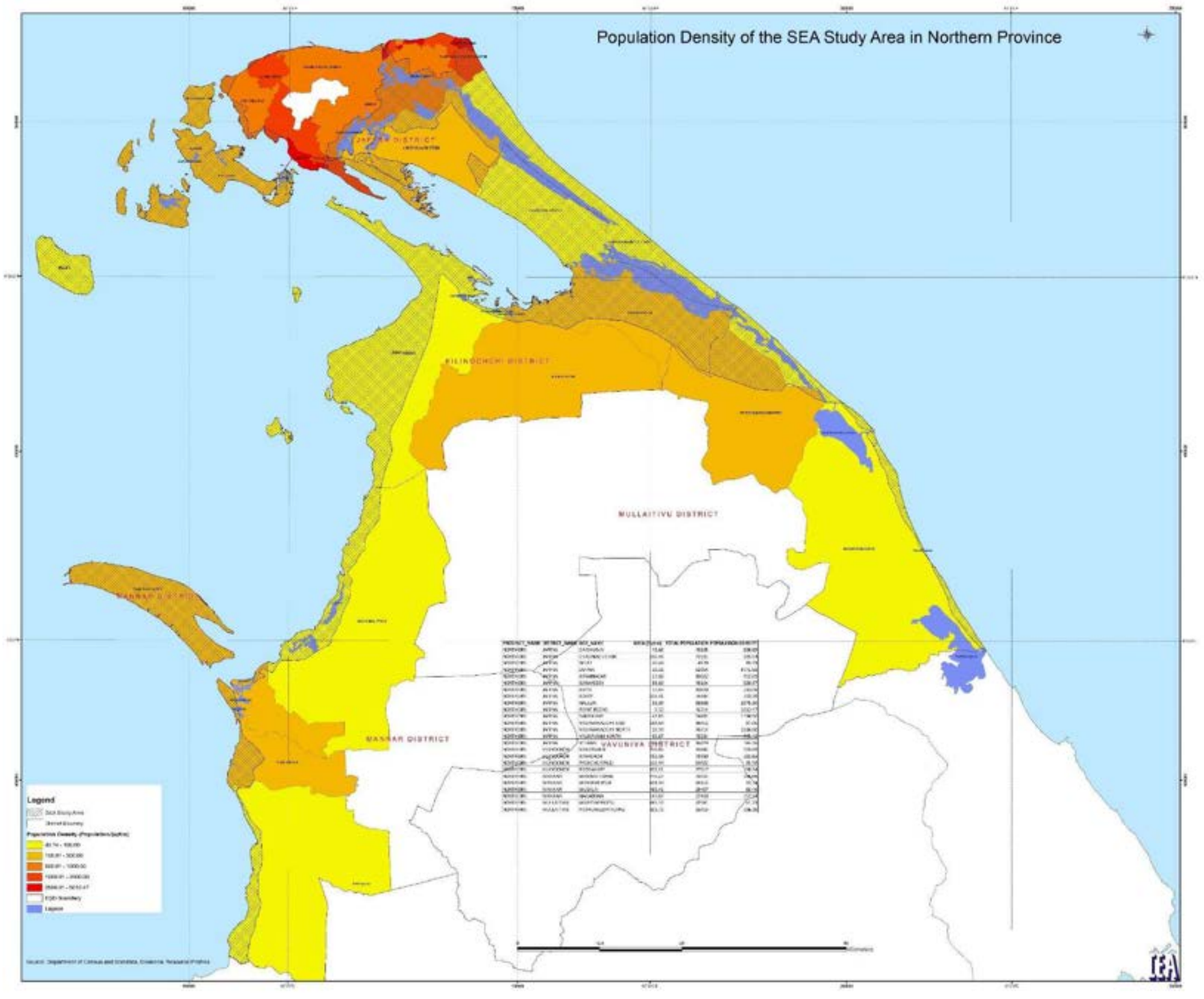
Map showing the Population density of the divisional secretariat areas within the SEA study area is given in Map 25 below.

The Tamils are the majority of the population along with Muslims and very few Sinhalese. Accordingly, Hinduism is the religion of a significant portion of the population followed by Christianity, Islam, and Buddhism.

The monthly household income of around 66% of the households in the GNDs covered by the study area is less than 15,000 rupees. Only 2.7% of the households earn more than 50,000 rupees monthly.



Map 24: Map showing the administrative boundaries within the land-based SEA study area in Northern Province



Map 25: Map showing the Population density of the divisional secretariat areas within the SEA study area in Northern Province

5.5.2.1 Demographic Characteristics of the Islands within the SEA Study area

The study area also covers the islands of Jaffna. Those islands administratively fall within four DS divisions of the Jaffna district include the Delft, Karainagar, Kayts, and Island South (Velanai). The socioeconomic features of these islands are highly influenced by the limited access to the mainland, the Jaffna peninsula. The major livelihood and source of income of the Jaffna Islands are fishing and related service vending. The lack of connectivity with the mainland has created several constraints to their livelihood and other service availability.

The islands of Jaffna cover around 196.25 square kilometers with a population of 42,236 consisting of 13,544 families. The female population (21,582) is higher than that of the male population (20,654), resembling the province's pattern. Population density of the Karainagar DS is higher than the National average (350 persons/sq. Km), while the Delft and Velanai show comparatively low population density.

Table 34: Population details of the Jaffna Islands

DS Division	Families	Population			Area (Sq. Km)	Population density (persons/sq.km)
		Male	Female	Total		
Delft	1387	2027	2028	4055	47.5	85
Karainagar	3591	5217	5465	10682	21.74	491
Kayts	3384	5278	5542	10820	32.51	333
Velanai	5182	8132	8547	16679	94.5	176
Total	13544	20654	21582	42236	196.25	271
Percentage		48.9%	51.1%			

(Source: Divisional level Resource Profiles)

The predominant ethnic group in the islands is Tamil and there are very few Muslim and Sinhala communities. Hinduism and Christianity are the major religions of the residents in these islands.

Table 35: The religions and the ethnic groups of the population of Jaffna Islands

DS Division	Religious				Ethnics		
	Hindus	Christian	Islam	Buddhist	Tamil	Muslim	Sinhala
Delft	1468	2587	-	-	4055	-	-
Karainagar	10284	398	-	-	10682	-	-
Kayts	5978	4842	-	-	10816	-	4
Velanai	12420	4029	231	3	16445	231	3
Total	30150	11856	231	3	41998	231	7
Percentage	71.38%	28.07%	0.55%	0.01%	99.44%	0.55%	0.02%

(Source: Divisional level Resource Profiles)

60% of the island's population represents the working-age group. Around 17% of the population are students. The elderly population is 11% of the total population which is significantly higher than the national average (7.84%). The out-migration due to the war could be the reason contributing to this feature.

Table 36: Age group of the population of Jaffna Islands

DS division	Age groups of the population					Students
	0-19 years	20-34 years	35-49 years	50-64 years	>65 years	
Delft	1,220	1,046	761	612	416	585
Karainagar	3,162	2,643	1,975	1,590	1,312	1,527
Kayts	3,191	2,834	2,020	1,832	1,251	1,778
Velanai	5,221	4,309	2,974	2,399	1,776	3,246
Total	12,794	10,832	7,730	6,433	4,755	7,136
Percentage	30.07%	25.46%	18.17%	15.12%	11.18%	16.77%

(Source: Divisional level Resource Profiles)

Fishing is the major form of livelihood of 4,323 male population (35%) in the islands other than the Velanai. Around 220 female population (1.7%) are also involved in fishing actively. Collecting sea cucumber and shrimp from the shallow seabed is the major fishing activity in which they are involved in. In addition, the women assist their family members in cleaning and mending fishing nets ashore. There is a considerable number of agricultural activities ongoing in Velanai DS division. There are 4,495 farmers and farm laborers (10.6% of the total population) on the islands. The farmers utilize around 4,500 hectares of paddy land and around 150 Ha of highland for their farming activities. Paddy, vegetables, and other field crops are being cultivated. The cultivations are mainly rain-fed. The employees of the government and non-government institutions are 1,899(4.5% of the population) in Jaffna Islands. The construction industry also provides sizeable employment to the area. Masonry, carpentry, welding, plumbing, bar-bending, and painting are some of the major employments provided by the construction industry to the residents.

Table 37: Major employments of the Jaffna Island population

DS division	Government institutions, NGOs and Banks	Farmers and farm labors	Fishing	Construction industry workers
Delft	324	247	680	85
Karainagar	489	996	1,155	294
Kayts	453	610	724	127
Velanai	633	2,642	2,103	160
Total	1,899	4,495	4,662	666
Percentage	16.2%	38.3%	39.8%	5.7%

(Source: Divisional level Resource Profiles)

While the coastal and offshore fishing industry of the Jaffna islands produced around 4,880 Mt of fish, around 3,821 families depend on fishing. The fishermen are small-scale fishermen using multiple fishing methods such as Kalanhaddy, Prawns Net, Valichchal Net, Crabs Net, Thirukhai Net, Vallam, Kaddumaram, and Thoondil. Population depends on fishing in Delft, Karainagar and Velanai islands is 15,301.

Table 38: Fishing population and Fish Production of the Jaffna Islands

DS division	Fishing			
	Families	Population	Active Fishers	Fish Production (Mt)
Delft	560	1,950	680	890
Karainagar	1,381	5,607	1,155	1,284
Kayts	N/A	N/A	724	446
Velanai	1,880	7,744	2,103	2,262
Total	3,821	15,301	4,662	4,882

N/A- Data not available/(Source: Divisional level Resource Profiles)

The islands are famous for goat and cattle farming. These animals are fed through open grazing and a major constraint in this livelihood is the drought from June to August of the year. Animals face difficulty in obtaining water and foraging during this period.

There are 2,434 (27.7%) women-headed households and 752(5.63% of Household heads) disabled in Karainagar and Velanai. 2,117 individuals (7.7%) receive Public Welfare Assistance Allowance (PAMA) and 3,536 families (40.3%) receive Samurdhi welfare assistance.

The dug wells are the major source of drinking water in the area, along with pipe-borne water. The NWS&DB and Pradeshiya Sabhas operate drinking water supply schemes. Postal services, hospitals, schools (up to Advance level), and banking services are available within the islands.

Residential home gardens, grasslands, and barren lands are the major land use types in the area. A significant portion of the land is covered with Palmyrah, paddy, coconut and other field crops. The Palmyrah cultivation is underutilized at the moment due to the unavailability of laborers to tap the resource.

Table 39: Land use and Land cover of the Jaffna Islands

DS division	Land Use (Ha)												
	Barren and Scrub Land	Coconut	Field Crops	Forest Plantation	Grass Land	Residential and Home Gardens	Mangroves and Marsh	Natural Ponds	Other service Centers	Paddy Land	Palmyra	Rock out crops	Sandy Areas
Delft	555	499	26	15	2,657	18		193	5	29	196	44	16
Karainagar	1	73	3	9	65	1,159		22	5	567	165		69
Kayts	95	16	448		378	1,164	133	50		298	343	6	47
Velanai	2,274	79	521			2,767	1,196	150	9	1,064	782	17	47
Total	2,925	667	998	24	3,100	5,108	1,329	415	19	1,958	1,486	67	179
Percentage	16.0%	3.6%	5.5%	0.1%	17%	28%	7.3%	2.3%	0.1%	10.7%	8.1%	0.4%	1.0%

(Source: LUPPD, 2018)

The islands contain remnants of colonial structures which act as tourist attractions. Also, there are 209 Hindu temples, 77 churches, 3 mosques, and 2 Buddhist temples located in these islands.

5.5.2.2 Demographic Characteristics of the Kilinochchi District

Because of the land and water-based diverse form of livelihood and more than ten years of history of Aquaculture farming in the area, the socioeconomic feature of the Poonakary DS division in Kilinochchi district can be used for a case study. The SEA study covers around 63% (284 square kilometers) of the DS division. The study area falls across 15 GNDs of the division fully/partially. The total population of the Poonakary DS division is 27,017 belonging to 8,065 families. The average household size is 3.35. Though the household size is slightly higher than in the Jaffna Islands, it is less than the national average. The larger area (around 51%) covered with forests, marshy areas and sand dunes could be the reason for the lower population density in the DS division.

Table 40: Population details of the Poonakary DS division, Kilinochchi District

Families	Population			Area (Sq. Km)	Population density (persons/sq. Km)
	Male	Female	Total		
8,065	13,501	13,516	27,017	620.09	74.41

(Source: Divisional level Resource Profile, Poonakary Divisional Secretariat)

The division's predominant ethnic group is Tamil. Hinduism and Christianity are the major religions the population follows with a few Islamic and Buddhists. There are 81 registered Hindu temples, 47 churches, and five mosques within the DS division.

Table 41: Religious and ethnic groups of the Poonakary DS division, Kilinochchi District

Religious				Ethnics		
Hindus	Christian	Islam	Buddhist	Tamil	Muslim	Sinhala
18,085	7,122	1,804	6	25,206	1,805	6

Only 54.6% of the population is employed while 63.1% of the population is within the age range of the economically contributable population (18 to 60 years). Also. 7.78% of the population with qualifications above GCE O/L are also unemployed.

Table 42: Unemployment details of the Poonakary DS Division, Kilinochchi District

Economically Contributable Population (%)	Employed Population (%)	Unemployed (%)			
		Below O/L Qualifications	O/L Qualified	A/L Qualified	Graduates
63.1%	54.6 %	0.73%	4.61%	3.15%	0.02%

The data collected from the Nallur Fisheries Cooperative Society (FCS) of the Poonakary DS division indicates that only 3 members of the society is under 25 years old out of 68 members. It is only 4.5% of the total members of the FCS and one of those three is a woman. Furthermore, around 25% of FCS's members in Kilinochchi district are women with the age between 24 to 63 years. Among the members, 20% own a Wooden boat (Theppam)while 23% own a fishing net, 13% own a Shrimp net, 4% of them own OFRP boat and 66% own non-of the fishing gears or Crafts. Several members who don't have the Crafts are involved in collecting shrimps by hand picking. Nine members of the Nallur FCS expressed their interest to get involved in shrimp, crab, and sea bass farming.

The Poonakary DS division's livelihoods depend on natural resources. Around 6,821 (25.2%) people are employed in agricultural sector. There are 2,527 (9.25% of the population) active fishermen in Poonakary DS division, while 1,327 (around 5% of the total population) are working in government and non-government sectors. As per the divisional resource profile report for 2021, around 55% of the household possess less than 5,000 LKR of monthly income while 25% of the households possess a monthly income higher than 10,000 LKR.

Around 753 (9%) households don't have an electricity in their houses. The postal service, schools, banking, and health services are available within the DS division. The student population of the division is 6,064 (around 22% of the population) and there are 410 teachers in the schools. 839 (10% of the total households) families are living in semi-permanent or temporary houses in the division and are waiting for proper housing facilities. Dug wells are the major source of drinking water.

The provincial social services department provides monthly PAMA assistance to 1969 persons (7.2% of the total population) and 49.5% (3,991) of the families are receiving Samurdhi welfare assistance. The disabled population of the division is 684(2.53%).

This division is a predominant area for agriculture in the Kilinochchi district. The paddy cultivation is famous along with fruits, mainly Mango, Papaw, and Bananas. Though the division lost a large number of coconut plantations due to the prolonged civil war, this division still has a significant coconut production. In addition to Paddy cultivation different types of grains such as Black gram, Green gram, Cowpea, Nuts, Gingelly, etc. Vegetables and Yams are cultivated during the Maha season using rainwater as well as, Small Irrigation Tanks, Medium Tanks, wells, and Tube wells.

Half of the land area of Poonakary DS division consists of forest (44.2%) and Marshy land (6.69%). In addition, the greater extent of the paddy land, home garden, and area with field crops also contribute to the division's livelihood and economy. Palmyrah and coconut are major perennial crops that support livelihood.

Table 43: Land use pattern of Poonakary DS division, Kilinochchi District

Land Extent and Percentage	Barren Land	Coconut	Field Crops	Forests	Home Gardens	Lagoon	Mangroves	Marsh	Natural Ponds	Paddy Land	Palmyra	Sandy Areas	Scrub Land
Sq. Km	8.4	7.8	11.9	274.0	57	4.9	6	41.4	18.5	84.9	8.4	2.02	37.8
%	1.36	1.26	1.92	44.2	9.2	0.8	0.97	6.69	2.99	13.7	1.36	3.27	6.1

The Poonakary DS division has access to both the Sea and Lagoon (Jaffna lagoon) thus significantly contributing to the fishing industry.

5.6 Major Economic Resources and activities of SEA Study Area

The Northern province is an agriculture dominant province, and it also has high potential for fisheries, aquaculture, and tourism. At the same time Northern province is rich in forest cover, wildlife, and other natural resources which were not much affected during the period of the civil

war. An intact forest cover could be observed in Kilinochchi, Mullaitivu and Mannar districts while Jaffna has no significant forest areas. In addition, the study area consists of mineral deposits such as sand, quarry metal, limestone deposits, clay and beach mineral sand. Apart from that, the study area has historical sites with exceptional archaeological value, especially in Jaffna and Mannar districts.

5.6.1 Agriculture

As a common feature, agriculture in the coastal area is less prominent than the other economic activities. However, the coastal area of the Mannar and Kilinochchi districts still contribute to the province's agricultural production. Irrigated and rainfed paddy cultivation is in practice in a small scale along the coastal area around the Northern Province. The economic insignificance and vulnerability toward natural disasters like floods, drought, and saltwater intrusion are concerns of this cultivation.

The stakeholder consultation revealed that there are illegal sand mining activities within the paddy land area of Manthai West DSD of the Mannar district. There were around 50 saltwater extrusion schemes in Jaffna (34 schemes) and Kilinochchi (16 schemes) protecting around 11,500 Ha of paddy land from saltwater. Around 13% of the study area (In both coastal areas and isolated islands) represent paddy lands. Highest coverage has been observed in Kandavalai DS division of Kilinochchi district. The representatives of the DMC who attended the provincial stakeholder consultation stated that a few of the saltwater intrusion barriers along the coastal line are dilapidated due to several causes including illegal sand mining which challenges coastal paddy cultivation. Furthermore, around 1.3% (2,113 Ha) of paddy lands has been abandoned. Most of these abandoned paddy lands were found in the Poonakary DS division of the Kilinochchi district.

5.6.2 Sand mining

Illegal sand mining has become a major problem in the Northern Province due to the shortage of sand prevailing in the North as several construction projects are in progress. It was revealed that One tipper load of sand which was purchased around 17,000 LKR during the war period, costs around 50,000 LKR due to the high demand. Therefore, people tend to illegal mining for obtaining the sand freely. In Kilinochchi district alone, around 47 locations have been identified as illegal sandmining sites in the areas of Pannankandi, Thiruvaiyaaru, Akkaraayan, Konavil, Murippu, Kilali, Kandawalai, Pooneryn, Kowtharimunai, Elephant Pass and Kallaru (Sandran Rubatheesan at el, 2017). According to the Mines and Minerals Act of 1992, miners must obtain both an industrial mineral license and a transportation license to explore for, or mine, transport, process, trade in or export sand. According to the Pachchilaipalli Divisional Secretariat of Kilinochchi district, no permits have been issued for sandmining in villages such as Killau, Iyakkachchi, Allipalai, Muhavil, and Chundikulam yet illegal mining goes on not only on private land but also on state-owned land. People in these areas have further expressed their concerns over sand mining to a depth lower than the Mean Sea Level, as the villages close by are facing a risk of sea erosion.

Illegal sand mining is practiced in Thoththavadi, Illupaikadavai, Koorai, Madu, Palampidy, Aruvaiyaaru and Kallaru areas in Mannar. In Jaffna district, illegal sand mining can be observed in Thenmarachchi, Kachchai beach, Kayts, Chatti, Mankumban, Nagar kovil and Kudarappu areas. Usually, large scale illegal sand mining is conducted during the night hours.

As safe drinking water has become the major issue in the northern coastal areas, with underground water polluted with saline water, water quality would be worsened if sandmining is carried out continuously as mentioned by the residents of these affected villages. (Sandran Rubatheesan at el, 2017).

5.6.3 Status of Coastal Aquaculture in the SEA Study Area

The most prominent aquaculture practices found in the Northern province are sea cucumber and seaweed farming, while shrimp farming has been recently introduced to the Mannar district. Other aquaculture practices, mainly comprised of crab culture and finfish culture, are carried out in a small scale. The number of licensed aquaculture farms are recorded as 423, whereas the applications for Aquaculture management license in the process is recorded as 1573.

Summary of licenses/Permits issued to Coastal Aquaculture farms in Northern Province is presented in Table 44 below.

Table 44: Summary of licenses/Permits issued to Coastal Aquaculture farms in Northern Province

	Species	No of year wise licensed farms										No of applications for Aquaculture Management License being processed
		2014	2015	2016	2017	2018	2019	2020	2021	2022	Total licenses issued up to now	
1	Sea cucumber	2	6	17	1	4	6	11	177	59	283	1456
2	Seabass	0	0	0	0	5	4	0	0	0	9	20
3	Seaweed	0	0	0	0	11	39	42	0	8	100	59
4	Lobster	0	0	0	1	0	0	0	0	0	1	0
5	Crabs	0	0	0	1	25	0	0	0	0	26	14
6	Shrimp/ *L. vannamei*	0	0	0	0	2	0	1	1	0	4	21
7	Shrimp stock enhancement programs	0	0	0	0	0	0	0	0	0	0	3
	Total	2	6	17	3	47	49	54	178	67	423	1573

(Source: Coastal Aquaculture Monitoring and Extension Unit- NAQDA, Pooneryn)

Present Status of Coastal Aquaculture Production in Northern Province is presented in Table 45 below.

Table 45: Present Status of Coastal Aquaculture Production in Northern Province

Species	District	Production (Mt)							
		2014	2015	2016	2017	2018	2019	2020	2021
Crabs	Mannar				34.114	47.93	45.40	12.64	4.24
	Kilinochchi					0.26	0.53		
	Mullathivu					0.23		0.64	0.05
	Jaffna						0.37	0.10	
	Total	0	0	0	34.114	48.414	46.297	13.372	4.29
	Kilinochchi	700	4760	199	302.36	171.26	128.26	282.94	143.13

Species	District	Production (Mt)							
		2014	2015	2016	2017	2018	2019	2020	2021
Sea weed (Wet)	Jaffna				335.09	42.61	38.82	25.53	51.41
	Mannar				54.88	107.73	77.48	92.19	22.39
	Total	700	4760	199.3	692.327	321.596	244.557	400.656	216.93
Sea cucumber (wet)	Jaffna	11.00	115.95	0.80	3.12	65.85	67.25	64.02	195.97
	Mannar				3.17	4.48	10.45	9.89	32.19
	Kilinochchi	33.10	97.00	198.90	22.46	125.65	202.43	266.21	351.66
	Total	44.10	212.95	199.70	28.75	195.98	280.13	340.11	579.82
Seabass	Mannar				15.77	1.05	1.280	0.518	4.19
	Jaffna						0.270		
	Mullathivu							0.400	0.59
	Kilinochchi					0.39	0.539		0.006
	Total	0	0	0	15.77	1.44	2.089	0.918	4.79
Milk Fish	Mannar				9.32	0.20	4.89	0.389	2.03
	Jaffna					0.63	1.76		
	Kilinochchi						1.17		
	Total	0	0	0	9.32	0.83	7.826	0.389	2.03
Lobstaer	Jaffna					18.7	11.34	5.28	2.92
	Total	0	0	0	0	18.697	11.34	5.283	2.92
Grouper	Mannar						0.62	0.075	0.89
	Mullathivu							0.028	
	Total	0	0	0	0	0	0.62	0.103	0.89
Salin Tilapia	Mannar							0.071	1.20
	Total	0	0	0	0	0	0	0.071	1.20
Shrimp	*L. vannamei*						543	725	905.09
	P. monodon							17	16.55
	Total	0	0	0	0	0	543	741.9	921.644
Production (Mt)		744	4,973	399	780	587	1,136	1,503	1,735

(Source: Coastal Aquaculture Monitoring and Extension Unit- NAQDA, Pooneryn)

Shrimp farming with intensive practice showed the highest production values in the Northern province (921.64 Mt in 2021). As this farming is highly intensive in closed systems confined to a comparatively smaller area, production per unit area is very high.

Shrimp production target for the Northern Province in 2025 is around 20,000 Mt which consists of 80% of *L. vannamei* and 20% of Black Tiger prawn, *Penaeus monodon.* Conventionally, shrimp aquaculture in Sri Lanka was aimed at the culture of the Black Tiger prawn, *Penaeus monodon*. *L. vannamei* has been recently introduced to coastal aquaculture in Sri Lanka and this was done to revive the regressing shrimp farming sector, which was struggling due to frequent crop failures of black tiger shrimp, caused by the fatal White Spot Syndrome Virus (WSSV). Subsequently, *L.*

vannamei aquaculture has been introduced to the Mannar district which is conducted through an intensive farming system with minimum release of effluents.

The second highest production is recorded from sea cucumber farming which is now profusely growing in the shallow coastal areas of the Northern Province. The decline in sea cucumber capture fisheries has prompted an increase in sea cucumber aquaculture in Sri Lanka. Also, it has been identified as one of the most culturable species in the shallow coastal areas in the Northern Province. The tropical sandfish (*Holothuria scabra*) has been reared and produced with mixed success. Though, the commercial sea cucumber culture activities have been initiated recently but it has been conducted in the past by growing wild-collected H. *scabra* juveniles in sea pens to a marketable size. Artisanal Fishers in the Northern Province used to participate in the export fishery for sea cucumber as a source of income.

Sea cucumber culture activities have been initiated with the culturing of wild-collected *H. scabra* juveniles in sea pens to a marketable size. Although the grow-out culture of wild-collected *H. scabra* to a larger size (~500 g) in sea pens is a useful practice to restore damaged fisheries (Bell, Purcell & Nash 2008), this practice created huge conflicts among sea cucumber resource users in Sri Lanka. Therefore, the fattening of wild-collected small sea cucumbers was restricted in 2011 and artificial breeding and larval rearing of *H. scabra* were initiated at the experimental stage. Sea cucumber hatchery has been set up in the Olaithoduwai, Mannar in Northern Province through a PPP to fulfill the need of juveniles for rapidly developing sea cucumber farming industry. In 2018, 105,000 Sea cucumber juveniles had been produced facilitating Sea cucumber pen culture. However, the current supply is not adequate to meet the demand. It is expected to gradually intensify the production and to produce 1 Mn juveniles per annum.

Studies on sea cucumber fattening in enclosed pens at 3 sites viz Gurunagar, Mandaitivu and Navanthurai in Jaffna lagoon has revealed that the latter site was identified as the best in respect of growth and survival of *Holothuria scabra* and it was recommended that Gurunagar area was not suitable for pen culture (*Haran et al 2012*). Also, it has recorded a high growth rate and survival rate for Mandaitivu (*Jayanthi et al. 2012*). Further, sea cucumber fattening activities are being carried out in Allaipitty and Velanai area by collecting juveniles from the wild in which salinity range from 32.53% to 37.94% according to *Kuganathan, S., 2014* and *Kuganathan, et al., 2015*. None of the sea cucumber species were recorded in commercial fish catches in the area for several decades.

The recent expansion of sea cucumber farming in the Jaffna lagoon has attracted many community/fisheries organizations and individuals due to its lucrative income generation. All together 283 permits have been already issued and 1456 applications are in processing stage in the Northern Province (Table 45).

The suitable sites for sea cucumber culture have already been selected to establish the concept of sea cucumber villages and demarcated by NAQDA with the assistance of NARA. The areas consist of shallow coastal waters and seagrass beds are commonly found in those areas in Palk Strait and Palk Bay. Most of the farms are to be located in the Palk Strait surrounding island habitats. The aquaculture commodity has been supplied as “beach-de-mer”, a luxury dried seafood, for centuries by the coastal communities in the Northern province. The sea cucumber village concept may open community-based management of sea cucumber farming to achieve sustainability with the holistic management of natural resources, human resources, and environmental factors.

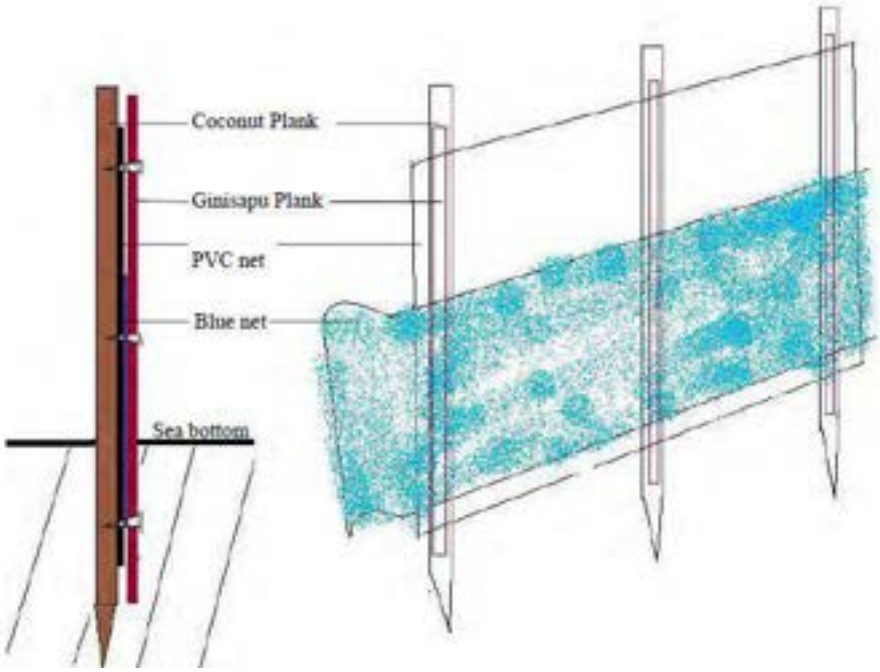


Figure 17: Detail Sketch Drawing of Pen Structure (Source: NARA, 2011)

Plate 38: Sea Cucumber Pen Structures in existing Sea Cucumber Farm in Ariyalai, Jaffna

Plate 39: The candidate species, tropical sandfish (Holothuria scabra) in Sea Cucumber Farm in Ariyalai

Seaweed farming is mostly found in sheltered coastal areas of Kilinochchi, Mannar, and Jaffna districts, which is distributed in a similar manner to sea cucumber farming. Because of its low production cost and simplicity of use, it has attracted a large amount of coastal dwellers. Seaweeds are autotrophic organisms that live at the bottom of the aquatic food chain, absorbing nutrients from the water, generating dissolved oxygen during the day and utilizing oxygen for respiration at night. In the Northern Province, seaweed farming is typically done in shallow nearshore waters employing lines and nets which are either fixed to the bottom or attached to floating rafts and buoys. *Kappphycus alvarezii* is the most commonly cultivated species in Sri Lanka.

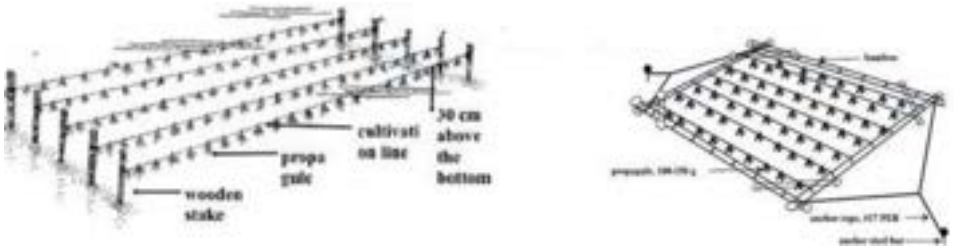


Figure 18: Fixed-off bottom cultivation(A) *Single raft long-line cultivation technique (B)Technique of Kappphycus alvarezii*

Plate 40: Production of existing sea weed farm in Thuraipoor, Velanai,Jaffna

Plate 41: Production of existing sea weed farm in Marichchakaddi, Mannar

Crab culture is restricted to a few areas and is currently halted due to a significant disease outbreak that is being investigated by authorities. Another thriving industry with high importance and demand is the mud crab industry, which has recently been devastated with disease conditions.

Seabass farming, milk fish culture, and other fin fish species are produced at present which is expected to grow on a promising scale in the future.

5.6.4 Traditional Fisheries in the study area

Traditional fisheries in the northern province are most significant in the Jaffna lagoon and associated islands, while the shallow areas of Kilinochchi and Mannar also occupied with traditional fishing practices. The lagoon area of Jaffna district is 45,525 ha in extent which is much greater than the extent of that in Kilinochchi district (11,917 ha). The shallowest coastal and lagoon area is found in Mannar district which is 3828 ha in extent. Although the recorded lagoon area in Mullaitivu district is 9233 ha (Fisheries Statistics 2020), most of the areas have been declared as protected areas.

There are around 40,000 active fishers belonging to 35,000 fishing families within the 336 GNDs of the SEA study area. There are around 224 registered fisheries cooperative societies (FCS) and 215 fishery landing sites and anchorages within the study area. Details of FCS in each district is given in the Table 46 below.

Table 46: Fishermen Cooperative Societies (FCS) in each District

District	No. of Registered FCS	No. of members in FCS
Jaffna	121	26,976
Kilinochchi	27	5,006
Mannar	41	12,574
Mullaitivu	35	4,642
Total	224	49,198

(Source: Statistical Hand Book, 2022, Northern Provincial Council)

Most of them are small-scale fishers who use simple technologies for fishing due to low financial capacity. These small-scale fishers use small, traditional fishing crafts and employ family labor. The Northern Province mainly depends on Outboard engine fiberglass reinforced plastic boats (OFRP) as most of them are small scale fishers, and there is not enough capital for deep-sea fishing (Increased mechanization and investment in off-shore fisheries, which is not affordable for small scale fishers), and lack of appropriate knowledge and experience on using Multi day boats and Storage systems. It was revealed from the consultation with the fishers that there was a 30 years gap in transferring the knowledge and skills of the fishery to the next generation due to the war-induced displacement and restrictions on fishing. The fishers didn't have the chance to transfer their skills to the next generation. Furthermore, certain fishing methods like deep-sea fishing (multiday boats), Beach seine are labor and skill intensive and there is a shortage of such labor within the province. The laborers were hired from Negombo and Chillaw areas most of the time for these purposes. More than 90% of the fishers are involved in the coastal fishery. There are around 145 inboard engines multiday boats, 11,043 OFRP boats, 1,660 traditional Mechanized boats, and 2,892 traditional non-mechanized boats involve in the coastal and offshore fishery in the province. (Statistical Hand Book, 2022, Northern Provincial Council)

Table 47: No. of Fishing families within the GNDs covered by SEA Study Area

District	No. of Fishing Families
Jaffna	23,128
Kilinochchi	4150
Mullaitivu	3,842
Mannar	10,547
Total	41,667

(Source: Statistical Hand Book, 2022, Northern Provincial Council)

5.6.4.1 Jaffna District and Jaffna Lagoon

The Jaffna lagoon, which is the largest lagoon in the country, belongs to both Jaffna and Kilinochchi districts. The Jaffna lagoon is one of the important brackish water sources for capture-based fishery and is being targeted by the culture-based fishery at the moment. A significant number of sea cucumber pen cultures were observed in this lagoon, and it can be considered as the best example of the interaction between the capture-based and culture-based fishery in the province. A study (Ragavan at el, 2019), identified that 5340 fishers confined to 39 landing sites were actively engaged in fishing in Jaffna lagoon using 12 different fishing methods. Fyke nets (71%) followed by stake nets (10%), lagoon seines, and lagoon boat seines (6%) were the widely used fishing methods.

Both mechanized (59%) and non-mechanized (41%) crafts are used in the lagoon fishing practices. History of Fyke nets lasts a long time irrespective of modified forms could be observed at present. Most traditional fishing gears target shrimp fisheries in both the lagoon and island surrounding areas in Jaffna. Shrimp trap, cast net and hook and line are reported to be used to catch fish and shellfish for their day-to-day consumption. Fish trap (parikoodu) is reported as a combined fishing gear commonly used with stake net, Fyke net, and crab net, which are used by approximately 35% of fishers at present. Operation of main two types of gears such as Fyke nets and lagoon seine (drag nets) mainly target shrimp while finfish are targeted by the stake nets. Operation time of the fishing gears area differs based on the situation of the gears. Being fixed in the close areas to the shore stake net and fyke net operations lasts for 04 hours. Stake net fishers owned 03 stake nets per fisher, and they do fish around 20-24 days/month while 5 sets of fyke nets could be possessed by a fisherman and the operation is restricted to 12-16 days. Seine nets are in operation throughout the year from 7.00 pm to 5.00 am of following day. The nets are operated manually as usual practice, but they used mechanized boats to draw especially during the southwest monsoon period (Ragavan *et al 2021*).

Crab nets are operated at around 1.5 m depth of the lagoon, and the gear is usually deployed at night, mainly around 7.00 pm, and the average fishing time varies from 7-10 hours. The crab fishing is carried out throughout the year, reporting an average of 15 to 20 fishing days per month.

Out of the 12 fishing methods operated in the Northern coast, lagoon boat seine and Kandi fishing methods seem to be unique to the Jaffna lagoon fishery. Jaffna lagoon fishery to the total coastal fish production in Sri Lanka is significant and it was 2% in 2018 (NARA 2018).

In Jaffna, the ownership of Stake net fishery (Kalankaddy) and Shrimp trap fishery locations pass through generations (customary territorial rights). However, the rights will be void if the lawful person abandoned the site for more than fifteen days.

Plate 42: Stake net fisheries common in the shallow sea in the Northern coastal waters

5.6.4.2 Kilinochchi District

The number of fishermen in Kilinochchi district are approximately 4190. The number of mechanized traditional boats and non-mechanized traditional crafts operated are 78 and 225 respectively (Department of Fisheries, 2019). The main gear type used for coastal traditional fishery is the stake nets. Some of the coastal areas where traditional fishing practices are being conducted in Kilinochchi district are identified as Kawutarimunai, Pallikuda, Nachchikuda, Walepadu and Kiranchi. Some of the fishermen in the area have expressed their willingness for shifting from stake net fishery to sea cucumber farming due to the lucrative income of the sea cucumber farming. There is no recently published data available on traditional fishing practices in Kilinochchi area.

5.6.4.3 Mannar District

Mannar has remarkable marine environmental resources suitable for traditional fishing and the boats used for traditional fishing are referred to as Kaddumaram (theppam), and vallam. Non-mechanized and mechanized fishing vessels were recorded as 1118 and 390 respectively. Main fishing method used in the shallow areas is small stake nets (siragu valai). Those nets are used in the shallow areas of the northern part of Mannar district from Thevampiddy to Konthaipiddy. Its size has been limited, and only wooden poles were used, and they are permitted to be used only in lagoon areas (Augustin, 2015).

Locally the stake nets are called siragu valai or patti valai or set nets. Two types of stake nets are used in the Mannar area, i.e. small stake and large stake nets. Small stake nets are used in shallow area of the northern part of Mannar but cannot be used in the coast. The stake net has a long history in the Mannar District, but its use has always been limited to the lagoon and shallow water area from Thevampiddy to Konthaipaddy. But subsequent metal poles used for the stake net described above, is significantly different and affecting existing sustainable fishing methods.

The traditional passive gear “Jakotu” (Fyke-net) which is very commonly used, plays a prominent role in lagoon fishery as well as in coastal waters in the shallow coastal areas of Mannar. It is widely used throughout the year targeting both finfish and shellfish species, mostly the Penaeid shrimp species. A total of 417 fyke-nets has been encountered in the vicinity of Vidithalathivu nature reserve. The Fyke nets are mostly set around the sea grass abundant areas where the breeding and nursery grounds of shrimps and other fishes are found.

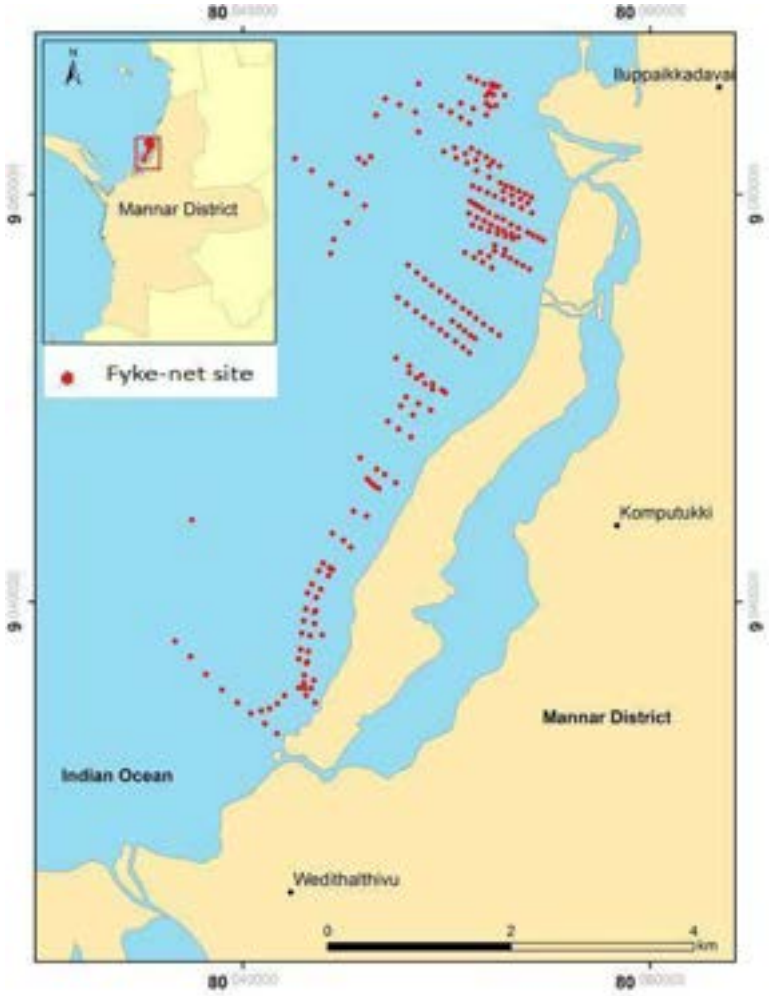


Figure 19: Map of the shallow sea area at Vedithalativu in Mannar district showing Fyke-net sites (source: NARA)

5.6.4.4 Beach seine fishery (Madel Padhu)

The beach seine fishery in the Northern province is carried out by both locals and fishers in Negombo and Chillaw for generations. Though the DFAR has gazetted several Beach seine fishery sites through the Madal Regulations 1984 Gazette Extraordinary No. 337/48 dated 1985.02.21, several locations are abandoned due to the decline in fish catch and shortage of workers.

A number of 115 beach seine locations were gazetted for the beach seine fishery in the Mannar district. However, licenses of only around 60 are routinely renewed and nearly 30 of them are in operation at the moment.

There are 136 beach seine net fisheries in operation along the eastern coast of Jaffna District from Chundikkulam to Katkovalam. There are no beach seine net fisheries along the western coastline of the Jaffna district.

The beach seine along the eastern coastline of the Jaffna and Mullaitivu are operated by both the locals and Outsiders (From Negombo and Chilaw). The annual fish catch is around 90,000 Mt. The catches are sold mainly to the local market and the fishers are financially dependent on money lenders or intermediaries.

5.6.5 Tourism and related self-employment

The Northern Province has exceptional archeological, cultural, and religious values. Coastal-based tourism in the province still in an immature stage. Though the northern coastal area attracted a significant number of tourists after the conflict period, the sector is yet to be improved. At the end of the year 2020, the total number of establishments in the registered list of accommodation at Sri Lanka Tourism Development Authority (SLTDA) amounted to 42,750 rooms. The capacity of guest rooms located in Northern Province is 753, which is only 1.76% of the capacity of guest rooms in the Country. Number of guest rooms located in each district and their occupancy rates during the year 2020 is given in the Table 48 below.

Table 48: Details of Guest rooms located in Northern Province

District	Available Capacity of guest rooms	Occupancy rate in the year of 2020
Jaffna	522	14.5%
Vavuniya	81	10.6%
Kilinochchi	63	0.0%
Mullaitivu	50	0.0%
Mannar	37	0.0%
Total	753	11.2%

(Source- Annual Statistics Report-2020, SLTDA)

Occupancy rate of guest rooms in Northern Province during 2020 is only 11.2%. However, the occupancy rates of guest rooms in Northern province during the years 2018 and 2019 are 68.5% and 48.5% respectively. This decline of occupancy rates in 2020 is observed in whole country not only in the Northern province due to the easter Sunday bombings and Covid 19 restrictions.

Foreign guest nights in graded accommodations in Northern province is 40937 (0.42%) in 2019, compared to the 9,772,128 in the whole country. Local guest nights in graded accommodations in Northern province is 10404 (0.7%) in 2019, compared to the 1,487,402 in the whole country. (SLTDA, 2020).

A map showing the locations of tourist attractions and potential areas for marine tourism activities within the SEA study area is given in Map 10 of Page 50.

People of these coastal areas involve in handicraft production as their major or subsidiary livelihood activity. Handicraft production has much more than economic significance. Types of handicrafts are closely connected with history, tradition, and the culture of a particular area. The abundancy of Palmyra trees is the major supplier of raw materials for rural handicrafts.

6 Evaluation of environment-related risks, constraints, and opportunities for Implementation of (ACBFSDP) (2021-2025)

6.1 Potential Risks and Constraints

6.1.1 Environmental Constraints

6.1.1.1 Cumulative effects of Aquaculture, with existing issues in the marine and coastal ecosystems

The coastal habitats such as mangroves, coral reefs and sand dunes, etc. in the northern province, play a vital role in building coastal resilience to the impacts of climate change, coastal protection, as well as sustaining fisheries. Therefore, it is important not to further damage marine and coastal ecosystems and pay attention to restore them. However, the marine and coastal ecosystems in the northern province, with other areas of the country, are already under threat due to multiple stressors including overconsumption of resources, habitat destruction, marine pollution, changing the ocean chemistry, etc. Aquaculture would add another dimension to aggravate these issues.

Plate 43: Section of the Palaitive Island coral reefs mostly dead and degraded (left) and extensive macroalgae growth on coral rubbles: an example for level of degradation of the reefs in north.

6.1.1.2 Conflict with existing protected areas, national and international rules, and regulations

Sri Lanka is committed to achieve SDG 2030 goals and to integrate blue economy concepts for national development. In particular goal 14: Life below water where we have a mandate for protection of significant coastal and marine resources. Conserving at least 10 % of the coastal and marine areas, consistent with national and international laws has been indicated as one of the targets of goal 14.

A few measures have been adopted by the government in order to conserve and protect the marine and coastal ecosystems such as enactment of legislation namely National Environment Act, Coast Conservation Act, Marine Environment Protection Act, Fauna and Flora Protection Ordinance. Sri Lanka has also agreed to collaborate with the Commonwealth Blue Charter program and pledged to protect critical coastal habitats. In March 2019, Sri Lanka submitted a resolution along with Indonesia, to the United Nations Environmental Assembly, calling world leaders to take global action to preserve mangroves. In 2020, a National Policy was formed to conserve and sustainably

utilize Mangrove Ecosystems in Sri Lanka with the aim of integrating the policies of all government agencies for the protection of mangrove patches dispersed around the island.

Vidataltivu Nature Reserve which spreads over 1493 ha was declared as a protected area by an Order made by the Minister of Wildlife and Sustainable Development, published in Gazette Extraordinary No.1956/13 of 01. 03. 2016. This nature reserve has been included in National Protected Areas Management Plan (NPAMP) as well as in National Biodiversity Strategic Action Plan (NBSAP 2016-2022), and it has been identified as an internationally recognized Important Bird Area (IBA). Further, variety of National Red List species have been reported within the particular nature reserve.

It has been planned to degazette a 169 Ha area of the Vidataltivu nature reserve for an Aquaculture Industrial Park which is proposed by the NAQDA. However, there are limitations in the legal framework to degaztte 169 Ha in order to develop the culture practices in the coastal stretch from the North of Mannar in Vidataltivu area. In terms of the FFPO, altering/ceasing of an already declared Nature Reserve can only be done at the discretion of the Minister and is subjected to FFPO terms which sets out that “In the case of any change of boundaries or the disestablishment of a National Reserve, a study should be conducted including the ecological consequences of the proposed change”.

NARA has already conducted an Environmental Assessment Study regarding degazetting a section of this nature reserve in 2018. The study suggests not removing the site 03 in the basis of proximity to the Ramsar site and a section of site 02 in North-western side of the proposed site due to the presence of mangrove forests and Nay Aru River system. The study conducted by NARA has recommended removal of site 1 (169 Ha) from protection status with minimum impacts on the rest of the nature reserve. Further, the study suggests alternative sites for this Site in north or the eastern side to the Vidataltivu Nature Reserve.

Ecologists and environmentalists warn that the significant biodiversity of Vidataltivu could be lost forever and obvious ecological impacts could result from the fragmentation of the ecosystem if a section is degazetted. A myriad of ecological impacts would result from de-gazetting the nature reserve including the loss of diverse mangroves, loss of nursery grounds for fish and shellfish, loss of biodiversity in the habitat as well as other adjacent ecologically connected littoral ecosystems such as mud flats and salt marshes, seagrass beds and coral reefs.

Therefore, de-gazetting a part of Vidataltivu Nature Reserve and using a part of the area would create long term ecological impacts which requires serious reconsideration.

6.1.1.3 Lack of scientific understanding on sustainable aquaculture

Among the several barriers to the development of aquaculture, the greatest factor is the lack of proper scientific knowledge and understanding on aquaculture which eventually contributes to a negative public perception and difficulties in setting up new coastal aquaculture developments. Therefore, it requires understanding of the science behind sustainable culture practices in order to implement a sustainable aquaculture project. The process also requires to be participatory, involving regulators, stakeholder agencies, developers as well as the public who will be affected by aquaculture development. Similarly, the development of aquaculture should not disturb the natural setting of the cultural environment and needs to provide due consideration to the environment,

which is referred to as ecosystem approach. Ecosystem approach to aquaculture ensures that there will be no degradation of the environment and also takes into consideration all sectors involved.

One way to achieve this is by adopting the carrying capacity approach. Carrying capacity is a key concern in ecosystem-based management which helps to set upper limits for aquaculture production taking into consideration the environmental limits and social acceptability of aquaculture and to avoid unacceptable changes to both the natural environment as well as social factors.

6.1.2 Climate Change related Constraints

The Northern Province of Sri Lanka has been identified as a top hotspot for climate change (Mani et al., 2018). However, climate change related constraints have not been adequately addressed in the NAQDA plan, which is one of the concerns of the stakeholders. The changes in monsoonal onset, duration, and intensity have affected the coastal ecosystems and livelihoods of people; fishers have been experiencing a lower catch due to changes in ocean waters which could be attributed to changes in the surface ocean temperatures and monsoonal patterns. The fishermen in northern coastal areas have also been experiencing lowered numbers of fish landing sites due to shrinking shores. Thus, climate change has economically impacted the fishermen in the North. Lagoons and mangrove areas provide the best environment for Aquaculture. Jaffna district has the second largest area under district wise mangrove forests (2276 Ha) and it has the largest area of lagoons (45,525 Ha) within it. Mangroves are distributed among 60 Grama Niladhari divisions in Jaffna district (Rajkumar et al., 2019). However, climate change has affected the mangrove ecosystems and the other important coastal and marine ecosystems as described below.

Climate change impacts on aquaculture has also been documented in several literature sources (e.g., Yazdi and Shakouri, 2010; Soto and Brugere, 2008; Hall, 2015; Jayasinghe et al., 2019). The potential climate change impacts on the aquaculture systems in the Northern Province are summarized in Figure 20 below.

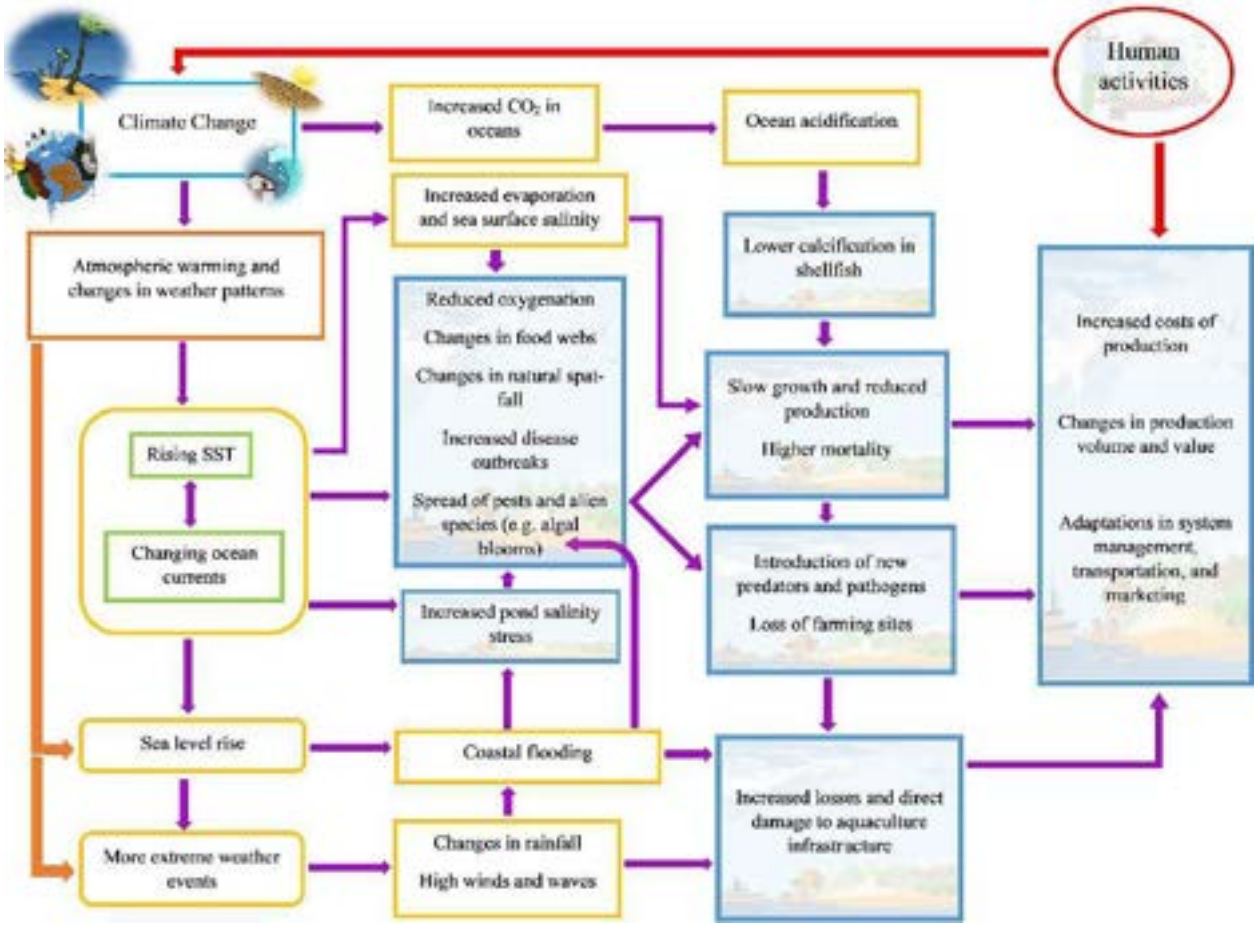


Figure 20: Potential climate change related impacts on aquaculture systems

The planned aquaculture projects might be directly and indirectly affected due to sea level rise, increased sea surface temperatures, and extreme weather events (i.e., droughts, floods, storm surges, etc.) associated with climate change, and effective adaptation measures need to be taken.

Sea surface temperatures have been increasing due to global warming. The appropriateness of species for a specific site may be affected by changes in water temperatures. Northern Province has already experienced increases in the sea surface water temperatures and spread of various pathogens/diseases, affecting the aquaculture species (e.g., sea weeds, shrimp). Most heat-related issues due to increasing water temperature will also arise as a result of poor water quality, low oxygen levels, increased stress and illness, and poor feeding and development performance, etc. (Handisyde et al., 2014; Maulu et al., 2021). Changes in feed composition and feeding schedules may be used as adaptive techniques to cope with rising water temperatures. Records of sea surface temperatures are currently not available for Northern Province, and the data recorded for Colombo, based on satellite data provided by the National Oceanographic and Atmospheric Administration (NOAA; USA) are shown in Figure *21* below.

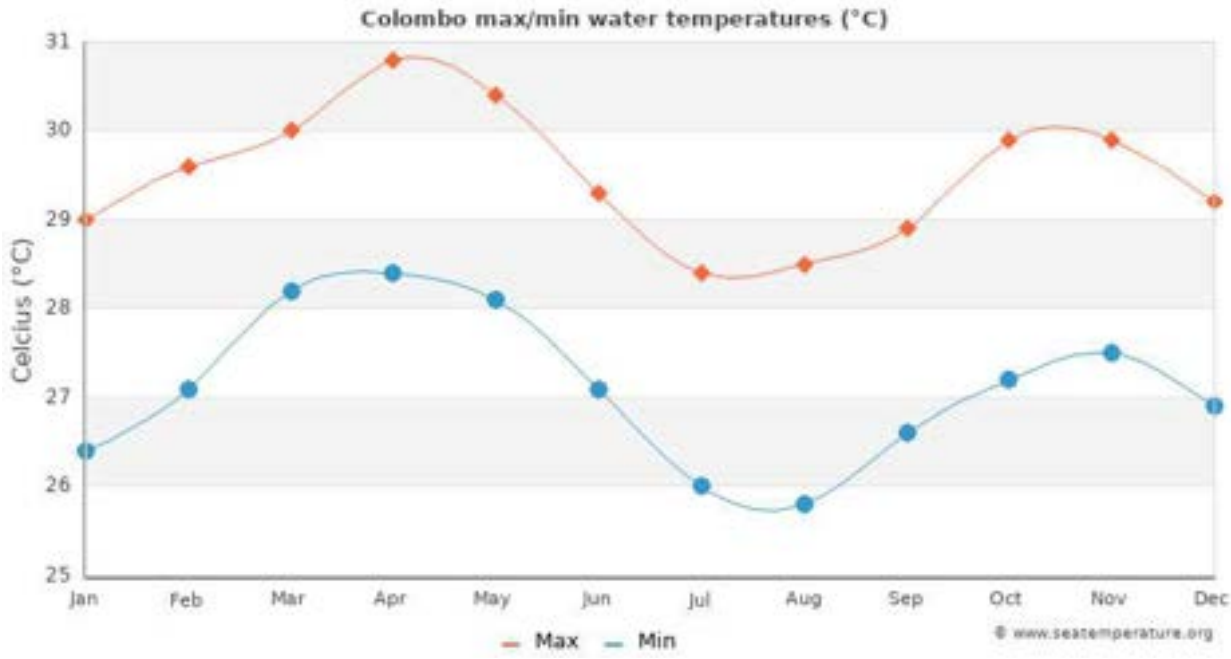


Figure 21: Monthly variation of sea surface temperatures based on historical data for Colombo (Source: https://www.seatemperature.org/asia/sri-lanka/colombo.htm)

Frequent extreme events including droughts and floods could impact farming of aquaculture species such as sea cucumber and sea weed; this could happen due to high temperatures and shallow sea water due to evapotranspiration during droughts (Handisyde et al., 2014), and reduced salinity and unfavorable conditions due to flooding.

Droughts could occur more frequently in all five districts in the Northern Province (S. Premalal, Stakeholder Consultation, 2022, Figure 22), due to a potential increase in temperature. Drought map of Sri Lanka prepared under ESA National Scaleup project of Ministry of Environment is given in Figure 22 below. Limited rainfall is already a characteristic of Jaffna peninsula (Alahacoon & Edirisinghe, 2021; Gopalakrishnan & Kumar, 2020). Regions in Jaffna peninsula receive rainfall for three months per year, from October to December. The lift irrigation technology, which extracts groundwater from limestone aquifers, is used in this region. Apart from lack of rain, this region is also affected by seawater intrusion in coastal areas (Gopalakrishnan & Kumar, 2020).

Aquaculture activities might have to be limited only to certain suitable locations in the future, due to anticipated drought conditions (Figures 22 and 23). Drought conditions and sea level rise could increase the salinity intrusion, leading to unfavorable conditions, requiring more attention.

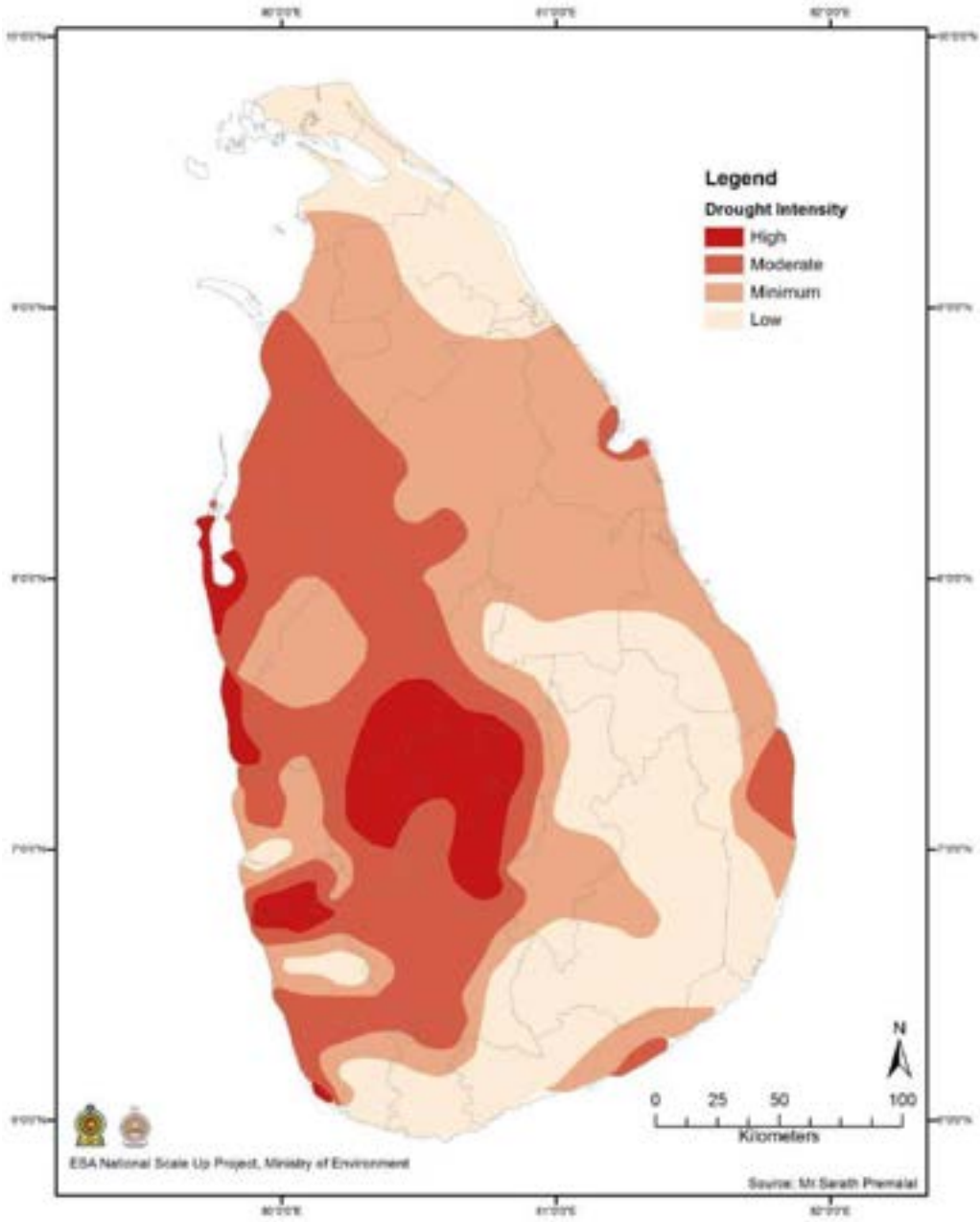


Figure 22: Drought map of Sri Lanka
(Source: ESA National Scaleup project, Ministry of Environment)

Droughts have become more frequent in Mannar district and Mullaitivu district. As mentioned in De Silva (2013) based on the outputs of the Hadley Centre for Climate Prediction and Research model (HadCM3), predictions of 1.93 ^{o}C increase in temperature, 23% decrease in the rainfall from North-East Monsoon and 10% decrease in potential runoff have been made for the year 2050. The reduction in annual runoff will have a significant impact on the water storage capacity of existing community tanks, or "Kulam", which may affect the farming activities. Also, the continued increasing temperatures could highly impact the water availability, due to increased evapotranspiration.

Prediction of future climate mainly depends on the amount of GHG emission in the future as well as the change of land use pattern (Major greenhouse gas (GHG) is CO_2 and the main source of

absorption of CO_2 is plants). Future GHG emissions highly depend on peoples living condition, economic activities, and change of energy use, size of the population and the climate policy of the country.

The Representative Concentration Pathways (RCPs), which are used for making projections based on these factors, describe four different GHG emission scenarios and atmospheric concentrations, air pollutant emissions and land use. The four (4) RCPs are as follows.

- Stringent mitigation scenario (RCP2.6),
- Two intermediate scenarios (RCP4.5 and RCP6.0)
- Very high GHG emissions (RCP8.5).

Future trends of maximum, minimum and average temperature in Jaffna, Kilinochchi Mannar, Vavuniya and Mullaitivu for the periods 2021-2040, 2041-2060, 2061-2080, 2081-2100 (Base period 1976-2005) with the greenhouse gas emission scenario under Representative Concentration Pathway (RCP) 8.5 is presented below.

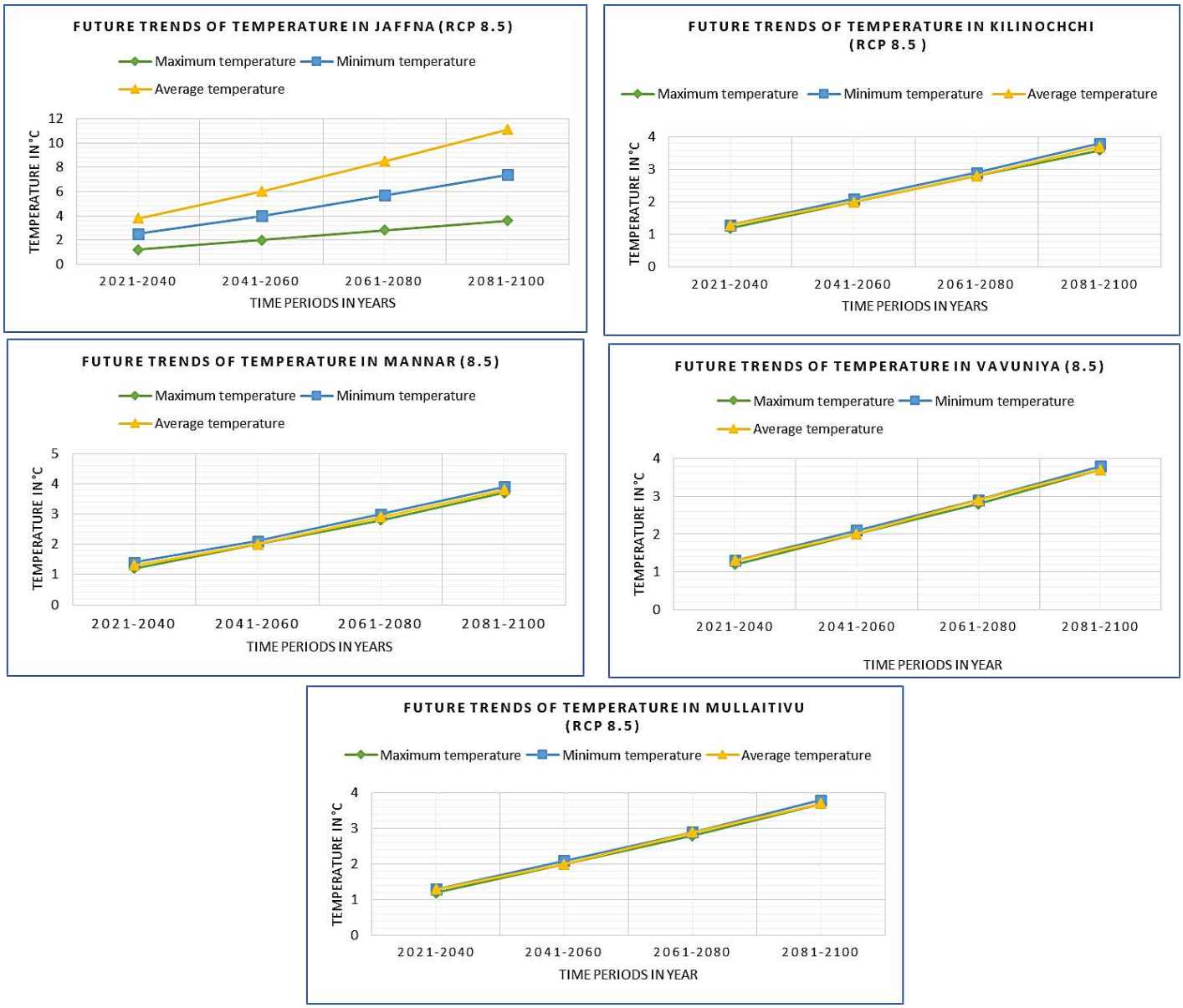
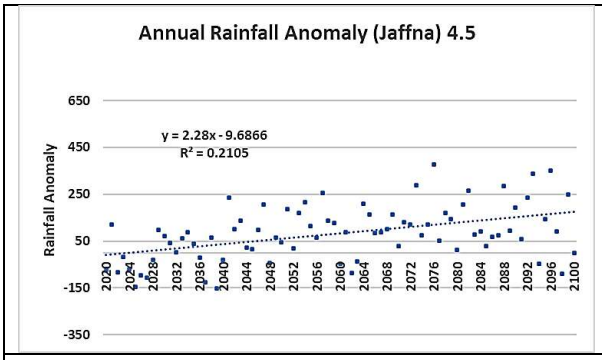


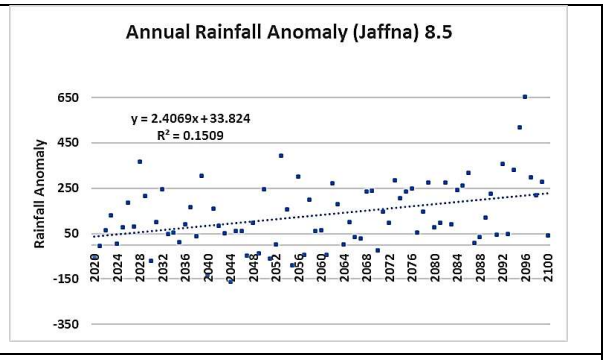
Figure 23: Future trends of maximum, minimum and average temperature in Jaffna, Kilinochchi Mannar, Vavuniya and Mullaitivu for the periods 2021-2040, 2041-2060, 2061-2080, 2081-2100 (Base period 1976-2005) with the greenhouse gas emission scenario under Representative Concentration Pathway (RCP) 8.5 defined by IPCC (IPCC, 2014)

During droughts, there will also be a competition with agriculture, industry, and home consumers, etc. for a restricted water supply (Handisyde et al., 2014). The lagoon areas are frequently affected by saltwater intrusion, affecting drinking water and paddy farming, with droughts and sea level rise. Therefore, if aquaculture activities lead to further increment of salinity intrusion, it will definitely affect crop agriculture and other livelihoods.

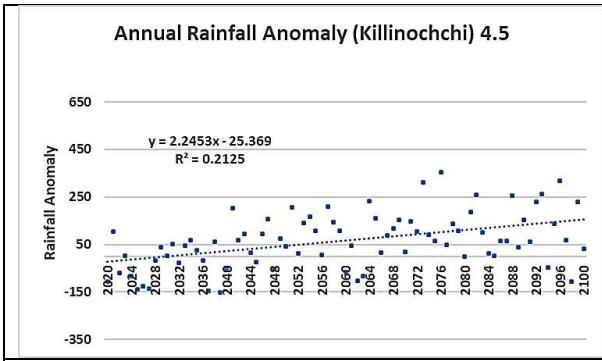
Increasing trends in annual rainfall has been predicted for the districts of Jaffna, Kilinochchi, Mannar, Mullaitivu and Vavuniya, with moderate confidence (Figure 24a - 24j),under the greenhouse gas emission scenarios indicated by Representative Concentration Pathways (RCPs) 4.5 and 8.5 defined by the IPCC (IPCC, 2014).



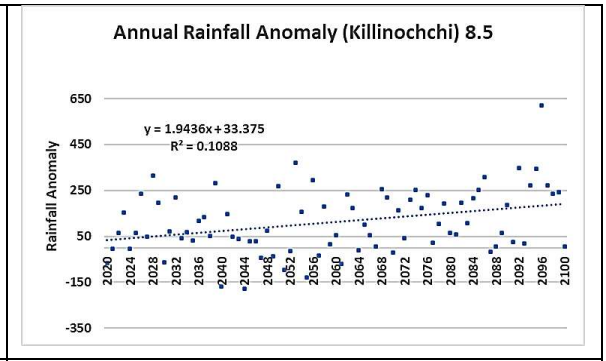
(a) Annual Rainfall anomaly (Jaffna) RCP 4.5



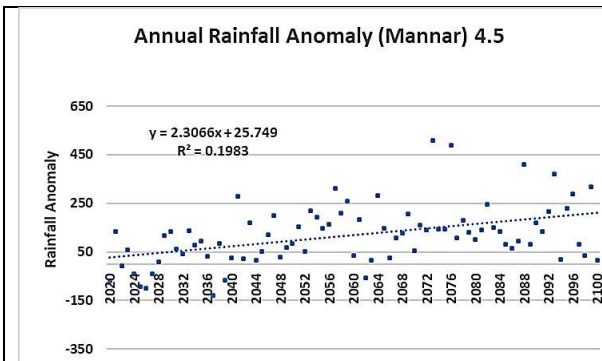
(b) Annual Rainfall anomaly (Jaffna) RCP 8.5



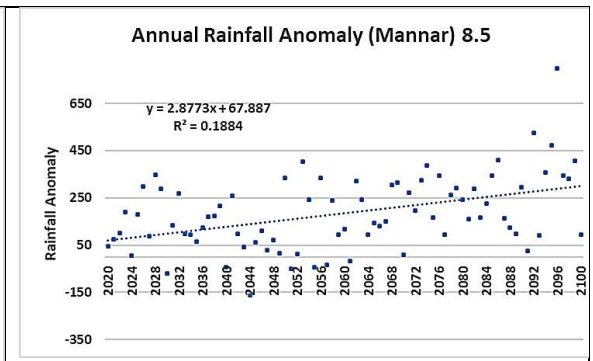
(c) Annual Rainfall anomaly (Kilinochchi) RCP 4.5



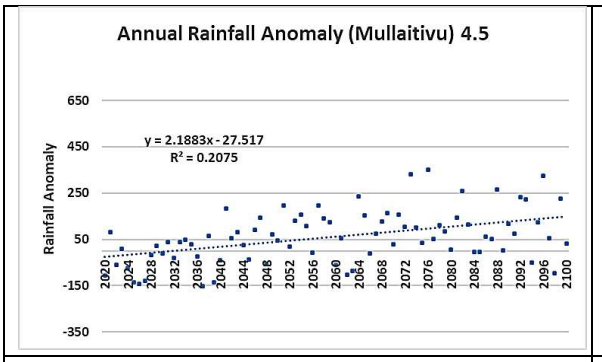
(d) Annual Rainfall anomaly (Kilinochchi) RCP 8.5



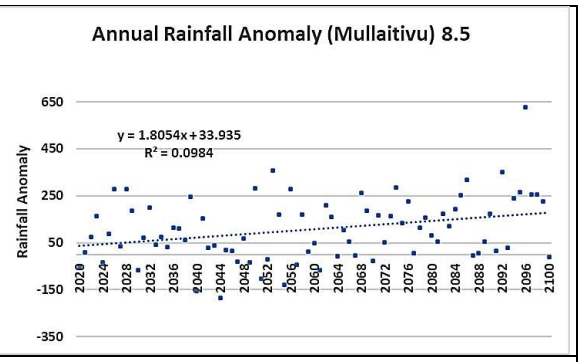
(e) Annual Rainfall anomaly (Mannar) RCP 4.5



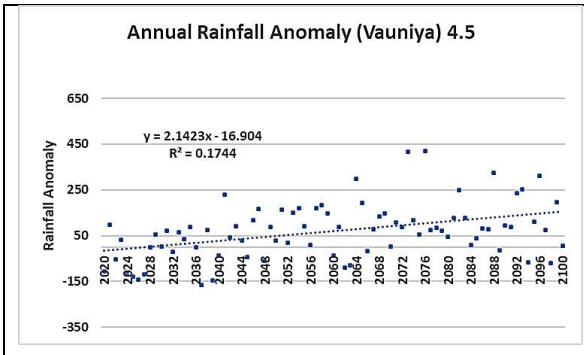
(f) Annual Rainfall anomaly (Mannar) RCP 8.5



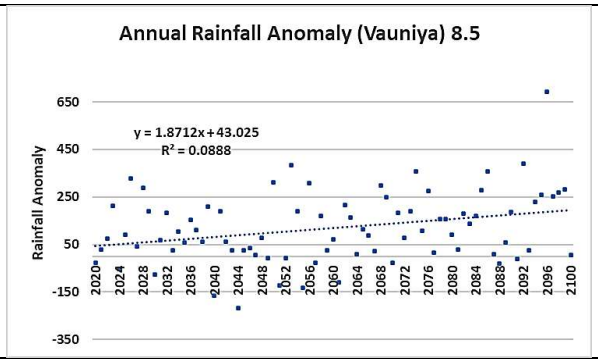
(g) Annual Rainfall anomaly (Mullaitivu) RCP 4.5



(h) Annual Rainfall anomaly (Mullaitivu) RCP 8.5



(i) Annual Rainfall anomaly (Vauniya) RCP 4.5



(j) Annual Rainfall anomaly (Vauniya) RCP 8.5

Figure 24: Annual rainfall anomalies in districts of Jaffna, Kilinochchi, Mannar, Mullaitivu and Vauniya under RCPs 4.5 and 8.5 (Source: S. Premalal, 2022)

Sea level rise in the Northern Peninsula has been estimated as 2.9 mm year^{-1}, which is slightly lower compared to the sea level rise (i.e., 3.12 mm year^{-1}) observed in southern coast (Oceanography Division, NARA, 2022). Higher monsoon intensity due to climate change has been anticipated for several Asian locations (IPCC, 2001), and the northern province of Sri Lanka is no exception. Kilinochchi is one of the flood prone districts during the rainy season, which is influenced by the North-East monsoon. In some years, total annual rainfall exceeds 1800 mm, resulting in seasonal floods (Yushanthi & Nianthi, 2021). Flooding can occur because of the increased precipitation, causing damage to infrastructure as well as marine ecosystems.

Changes in the onset of northeast monsoons, increased intensity of rainfall, increased occurrence of extreme events including coastal flooding, strong winds and high tides with wave height of around 2 ft have been observed especially in lagoon areas of Kilinochchi district. increased high tides have moved sea water further landward, and it has affected fishing equipment and boats, etc., at times (District Disaster Management Center Unit, Kilinochchi ,2022).

Based on the sea level rise predicted, Jaffna district could also have a significant area inundated due to sea level rise at the end of 25-, 50-, 75-, and 100-year periods (; DMC/UNDP, 2015).

Table 49: Inundated area due to sea level rise in Northern Province

Total inundated area (ha) - including water bodies				
District	25 Year	50 Year	75 Year	100 Year
Mannar	8024	8262	8518	8758
Jaffna	10321	11164	12014	12891
Mullaitivu	912	1004	1092	1180
Additional inundated area (ha) - excluding water bodies				
District	25 Year	50 Year	75 Year	100 Year
Mannar	248	486	741	981
Jaffna	864	1706	2557	3434
Mullaitivu	88	180	268	355

(Source: DMC/UNDP, 2015)

Seawater intrusion due to sea level rise could have important socioeconomic impacts (Climate Change Secretariat, 2016). According to the projections based on RCPs or IPCC emission scenarios under different socioeconomic assumptions (IPCC, 2014), the total land area of the Jaffna Peninsula directly inundated will be 6.8–13% by 2050, rising to 10–35 % by 2100 (Figure 25). The locations closest to the lagoons and nearby islands have been identified as the most vulnerable areas to sea

level rise by Gopalakrishnan and Kumar (2020). Sea level rise can change the salinity levels within coastal ecosystems.

Infiltration of seawater also raises the salinity levels in the surface, ground, and soil. Saltwater intrusion and mixing with groundwater have been happening for a long period of time in the Jaffna Peninsula, affecting agriculture and other livelihoods of the inhabitants (Gopala and Kumar, 2020). Salinization of the ground water could limit the amount of freshwater available for aquaculture (Handisyde et al., 2014). Sea level rise could lead to a permanent loss of lands due to floods and erosion, which will also have a significant impact on fisheries and aquaculture. Mangroves and salt marshes could be lost with the increasing sea levels (Kibria et al., 2017).

Salinity levels in lagoons are rising, affecting marine fish breeding grounds and habitats, resulting in lower catch quantity and quality, as well as negative consequences for fishery livelihoods (Eeswaran, 2018). Sea level rise could lead to landward migration of species within the coastal ecosystems such as salt marshes and tidal flats; salinity changes due to sea level rise can adversely affect certain species.

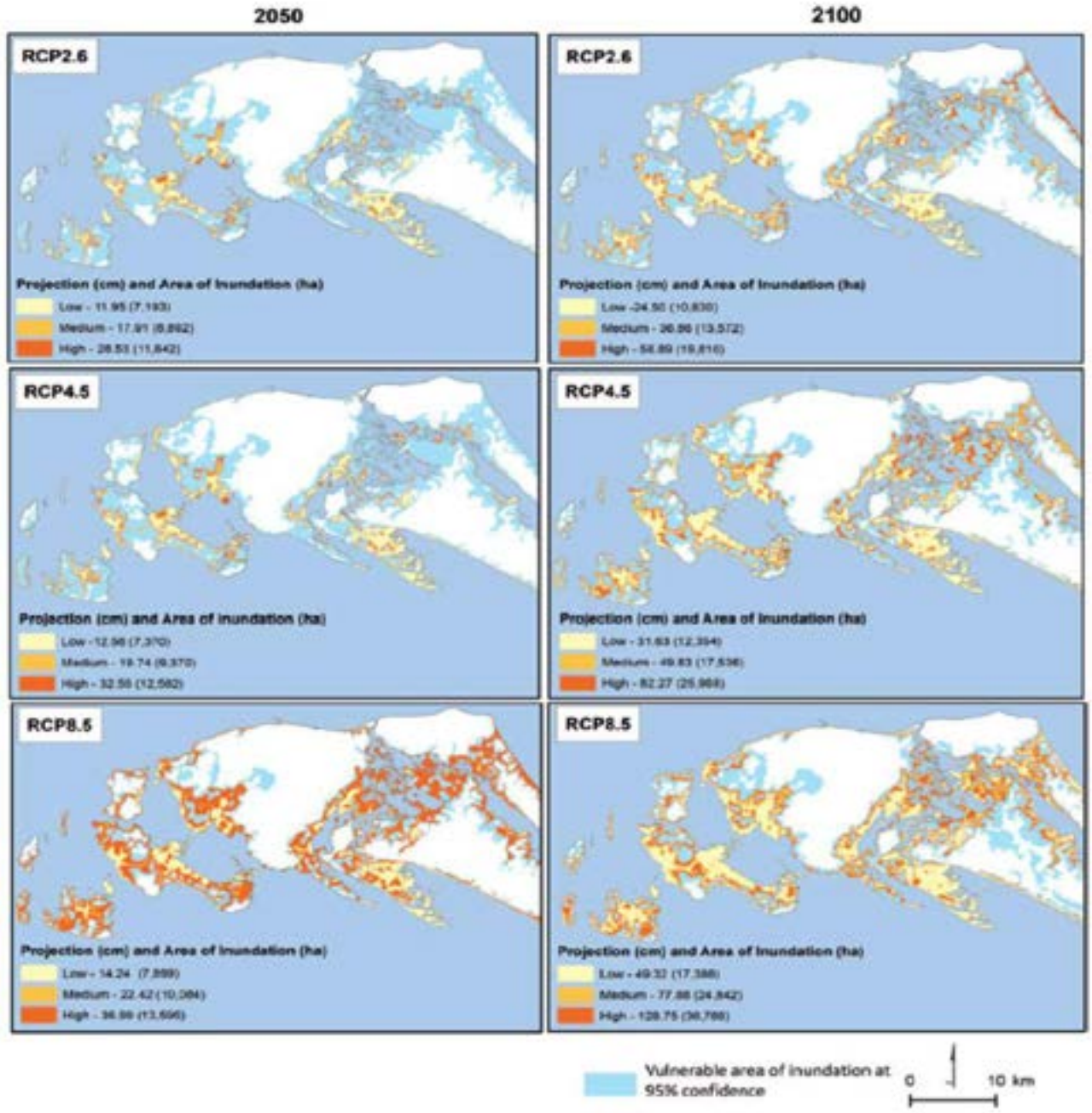


Figure 25: Potentially inundated areas due to sea-level rise under Representative Concentration Pathway (RCP) scenarios 2.6, 4.5, and 8.5, showing low, medium, and high projections by 2050 and 2100. Under medium projections, light blue denotes areas of uncertainty linked with delineations (source: Gopalakrishnan & Kumar, 2020).

Storm surges may also become more powerful as a result of rising sea levels, which will lead to the loss of natural defenses including mangroves and coral reefs. Storm surge inundation in the areas of Northern province is shown in Figure 26 and Figure 27 below. Structures used for shellfish production such as cages and platforms may be damaged by high winds and waves (Handisyde et al., 2014), which can cause serious financial consequences for aquaculture. Therefore, necessary adaptation measures need to be taken.

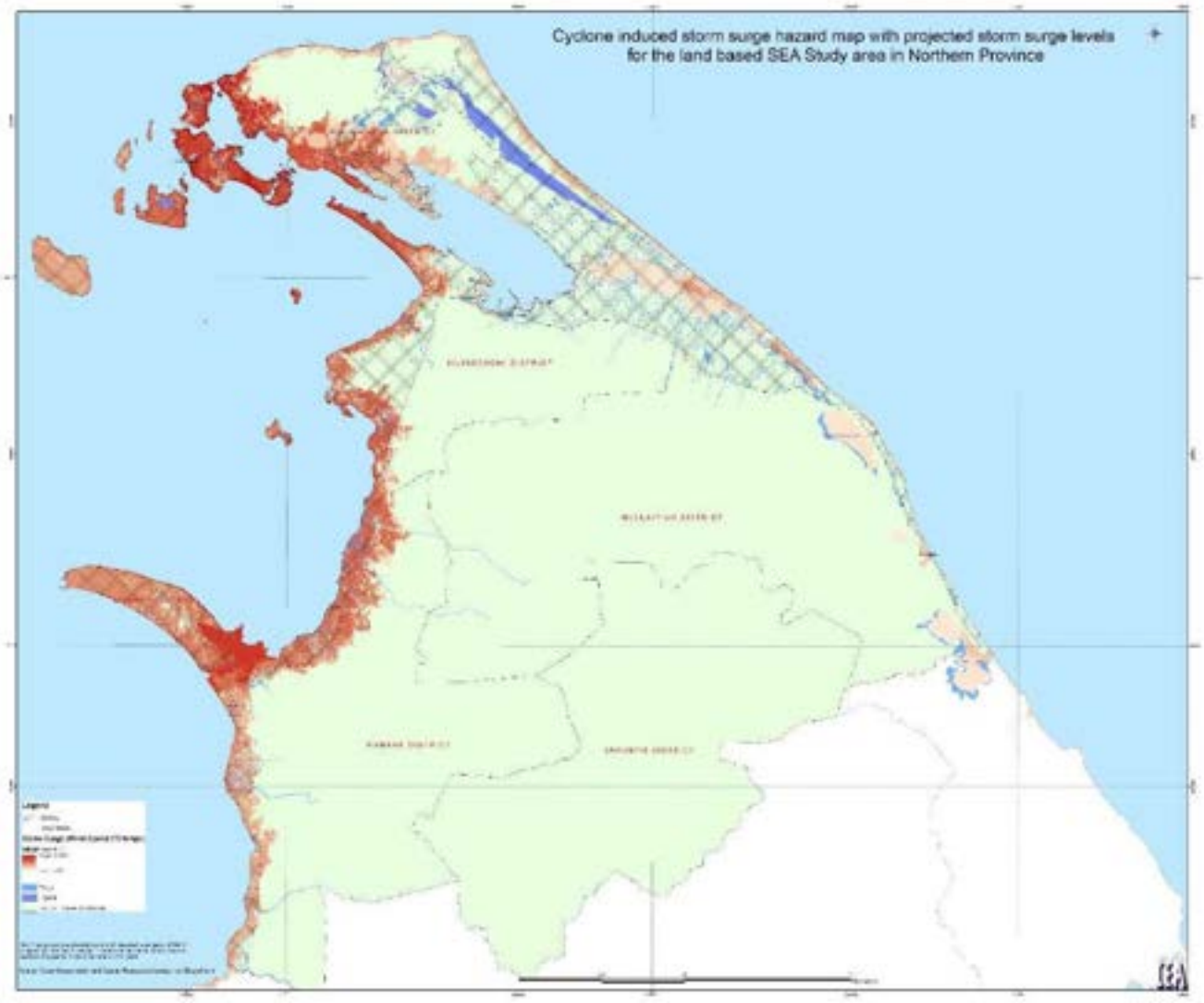


Figure 26: Storm surge inundation based on a static projection of storm surge levels near shoreline (Created the figure using the storm surges maps (wind speed = 270 Km/h) published by Coastal Research and Design, Coast Conservation and Coastal Resource Management with the assistance from Disaster Management Centre, Sri Lanka, May 2012)

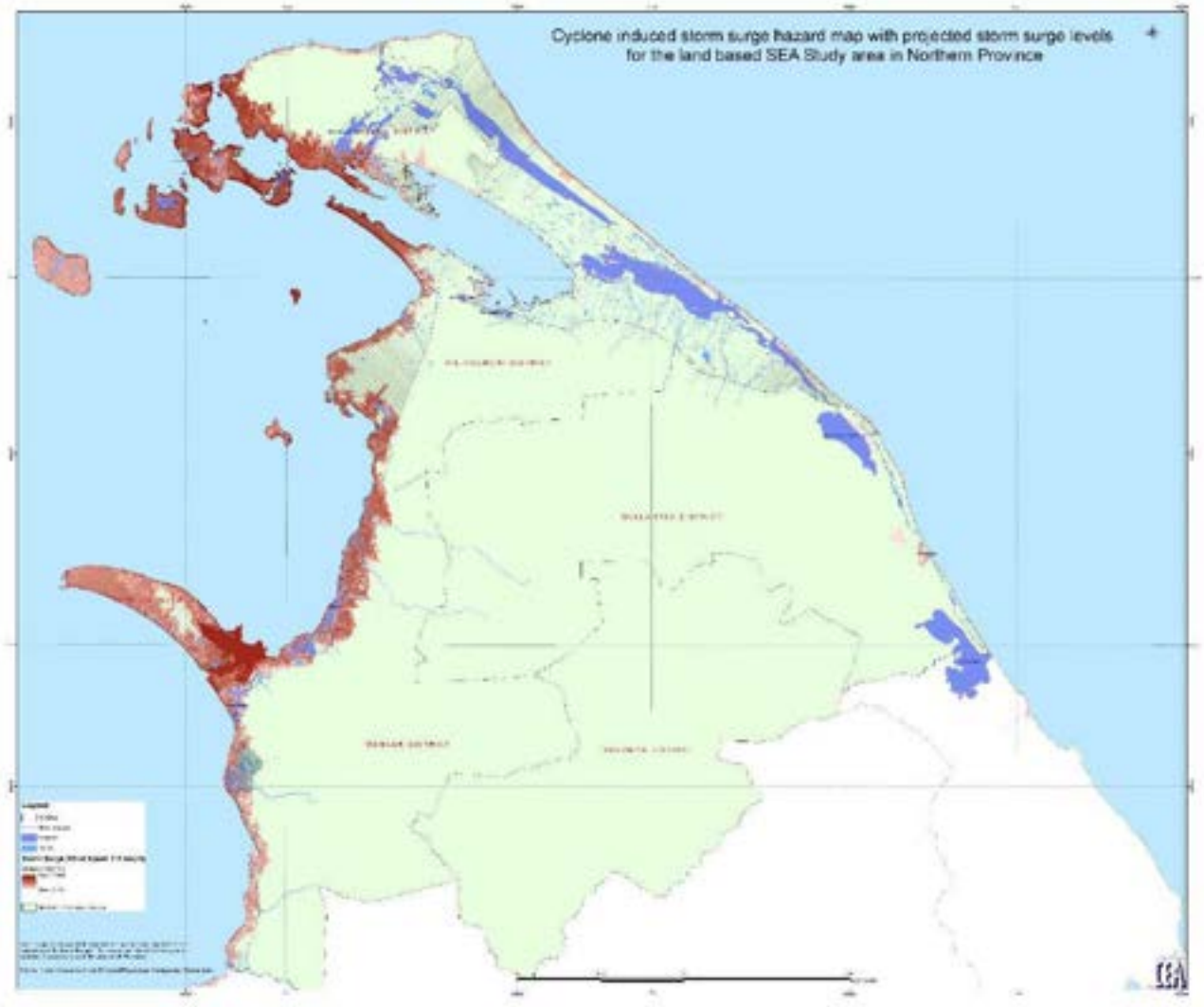


Figure 27: Storm surge inundation based on a static projection of storm surge levels near shoreline (Created the figure using the storm surges maps (wind speed = 215 km/h) published by Coastal Research and Design, Coast Conservation and Coastal Resource Management with the assistance from Disaster Management Centre, Sri Lanka, May 2012)

The human, natural, financial, social, and physical assets that make up the livelihood framework can be related to climate change consequences on aquaculture communities (Badjeck, 2004). The indirect effects of Climate change on aquaculture might be subtle, complicated, and difficult to detect or measure. Impacts can occur at different scales, from local to global, and community-level research will almost certainly be required to unravel the mechanisms involved (Handisyde et al., 2014).

Mitigation and adaptation action may aid in preparing for the above climate change-related constraints and dealing with those as effectively and efficiently as possible (Maulu et al., 2021). Producers and other stakeholders in aquaculture may be able to play a substantial role in mitigating the consequences of climate change by making appropriate modifications to production techniques targeting a reduction of GHG emissions. This includes techniques and technologies that are ecologically beneficial, such as solar energy and sustainable wastewater treatment (Barange et al., 2018; VGREEN, 2012), and silvo-aquaculture practices, etc. Because mitigation is a long-term

strategy, it is recommended that it should be used in tandem with adaptation measures for the best and most effective effects (IPCC, 2019).

The stakeholder consultation provided us with more evidence and additional information relevant specifically to the Northern Province, as described below. According to the officials of the coastal aquaculture monitoring units of NAQDA in the Northern Province, heavy storms have occurred in the Northern Province, especially in the last two years. Changes in rainfall patterns have also been commonly observed. Aquaculture systems in the province have been influenced by storm surges and changes in rainfall patterns associated with climate change, and changes in fish growth and feeding patterns have been observed especially during the past three years. These impacts have an influence on crab and seabass farming.

Structural damages to pens due to storm surges is another negative impact of climate change on aquaculture farming. Also, the escape of fingerlings and juveniles out of farming systems due to floods, increased mortality rates of aquatic species, and reduced income for aquaculture farmers have occurred. Avoiding storm areas and rebuilding farming structures which can withstand harsh weather conditions are needed as climate change adaptation strategies in coastal aquaculture. According to the NAQDA officials in the Northern Province, the Northern Province experiences very low tides during June to August; however, the tidal fluctuations have increased, and unexpected weather has occurred during the recent past, and the fishers have had a hard time in planning fishing activities. During stakeholder consultation, it was revealed that the fish catch has also been reduced, mostly due to climate-related impacts. The increased number of fishers and overfishing has also affected the per capita and per km fish catch in the ocean. Changes in sea level has affected the life stages of sea cucumber, especially the attachment stage, affecting their survival. Cyclones normally affect the Northern Province during November and December. With the projected climatic changes for the Northern Province, the frequency of occurrence and potential impacts can increase in the future.

Adaptation entails effective changes and taking such changes into account in both short- and long-term decision-making. It can take several forms, such as technical modifications, changes in the behavior of resource users/ producers, or changes in the governance structure. Institutions and management, livelihood adaptation, and resilience and risk reduction have been identified by FAO (2018) as three important priority areas for effective adaptation programmes. Because the effects of climate change on aquaculture vary by region, adaptation is not a one-size-fits-all solution. According to the IPCC (2019), successful adaptation in a changing climate will be determined by the ability of producers in a specific country or region. Livelihood diversification (Bell et al., 2013; Zolnikov, 2019), shifting to less vulnerable or more resilient species and techniques (Sae-Lim et al., 2017; Dabbadie et al., 2018), enhancing the effective management of aquaculture farms and practices to deal with extreme weather conditions, utilization of local and indigenous knowledge (Makondo & Thomas, 2018), introduction and promotion of insurance schemes among the producers, especially small-scale farmers (Barange et al., 2018), are some globally used climate change adaptation solutions for aquaculture, which were also suggested by some stakeholders.

The coastal and marine ecosystems in the study area should be protected against climate change impacts; especially the carbon storage in those ecosystems help mitigate carbon dioxide emissions and climate change. If the sites selected for the proposed activities affect the carbon stocks in any of the existing coastal ecosystems, such activities should be carried out without affecting those ecosystems or alternative sites should be chosen. The practice of integrated mangrove-shrimp

aquaculture (or Silvo aquaculture) is suggested for the new shrimp farming units, where mangrove trees are planted along the margins of the shrimp farms, allowing reestablishment of mangrove forests. Also, the fishery industry must adapt by acquiring vessels and gears capable of pursuing the relocated and redistributed fish resources due to climate change (Arulananthan, 2017). This could be considered in establishing proposed hatcheries in Northern Province, based on the NAQDA plan.

Developing general adaptive capacity to assist the impoverished aquaculture communities is crucial in dealing with new challenges and difficulties due to negative impacts of climate change on aquaculture. In dealing with adaptation, those practices with mitigation co-benefits (e.g., Protecting and enhancing vegetative surfaces) need to be promoted.

6.1.3 Socio-Economic Constraints

6.1.3.1 Dependence on Capture Based fishery

The NAQDA's ACBFSDP (2021-2025) targets the coastal land and shallow marine areas (less than 10m deeper) that are continental shelf, lagoons, extensive areas with brackish water and mangroves, and salt marsh as a suitable environment for coastal aquaculture development. Though the province contains a 580km longer coastal line, a greater portion of the coastal belt of Mullaitivu and half of the Jaffna district would be excluded from the scope of the ACBFSDP (2021-2025) as that area is not very conducive for aquaculture due to the narrow continental shelf and heavy wave action. The remaining shallow marine areas with less than 10m depth and the lagoons already serve the livelihood of more than 35,000 (around 90%) fishers of the province. Lagoon fishery has contributed to 6 % of the coastal fish production in Sri Lanka in 2013. The Jaffna lagoon being the largest in the country has contributed to one-third of this production (Silva et al. 2013). The fishers of the Northern Province are small scale fishers, and they are dependent on coastal fishery since they cannot afford the mechanization and investment required for offshore fisheries. The restrictions imposed to access the deep sea during the civil war in consideration of national security also contributed to this scenario.

Further, the extensive mangroves, mudflats, and salt marshes provide a seasonal livelihood for coastal villagers, mostly women. Villagers used to collect crabs and shrimp by hand picking seasonally which is a subsidiary livelihood for them. The consultation with the FCS of the Achchankulam village in the Mannar district exposed this pattern of livelihood though there are no specific data available in this regard.

The space requirements of the marine based-coastal aquaculture would compel the fishers to give up their fishing grounds. Furthermore, the fishers will be forced to change their fishing grounds and fishing methods that are skill and finance intensive. The small-scale fishers of the province cannot afford such skills and financial requirements because of their socioeconomic conditions. At the same time, very few financially capable local fishers, fishers who supply inputs to the aquaculture farms, fishery businessmen and other internal and external entrepreneurs show interest in aquaculture farming because it generates a considerable income. In this background, the ACBFSDP (2021-2025) gets a mix of feedback. Anyhow, customary territorial rights over the fishing grounds would influence and somewhat constrain the implementation of this development plan.

Furthermore, aquaculture farms construct or erect structures for multiple purposes including protection. The consultation with the host communities and stakeholders of aquaculture farms, both the Sea cucumber pen culture and pond culture of shrimp in the Jaffna and Mannar district

revealed that the aquaculture farmers construct/erect additional structures, other than the approved/minimum required for farming. The farm owners commented that they have been forced to invest in additional structures to protect their farms from the host community, especially, when the relationship with the host community is not smooth. The total farm installation capital and working capital have been increased significantly to ensure the security of those farms from poaching. According to the consultation with the Assistant Director, DFAR/Jaffna and the FCS in Jaffna, conflicts between somesea cucumber farmers and fishers have been reported to the DFAR. DFAR, Jaffna district Office maintain a Sea Cucumber Complaint register for recording purposes and to follow up whether the grievances are addressed by NAQDA. DFAR, Jaffna district Office coordinate with NAQDA to resolve the grievances of fishermen. The host community complains that these farms and the connected structures are disturbing their access to the fishing grounds. The host community of a shrimp farm in Mannar commented that they have been compelled to find alternate routes to their fishing ground because this particular farm blocks their access path. This additional cost incurred for the aquaculture farmers to ensure the security of their farms, growing conflicts between those farmers and the fishers about the same matter, and possible disturbances on the local fisher's movements are significant constraints for aquaculture development.

The intense use of coastal resources for capture-based fishery in the province will be the major constraint for the culture-based fishery in the province.

6.1.3.2 Dependence on Agriculture and livestock rearing

The northern coastal areas, especially in Kilinochchi and Mannar districts, show a considerable agricultural land use pattern such as paddy, other field crops, coconut and palmyrah. Existing agricultural lands located within SEA study area is given in Table 50 below. Accordingly, 24.3% of the SEA study area has an agricultural land use pattern. Also, livestock rearing, which contributes to a secondary income to the coastal population also utilize coastal vegetations intensively as their forages. There can be objections when converting these grazing lands into aquaculture farms.

Table 50: Existing agricultural lands located within SEA Study area

Cultivation Type	Districts				Total Extent (Ha)	Percentage (%)
	Jaffna (Ha)	Kilinochchi (Ha)	Mannar (Ha)	Mullaitivu (Ha)		
Paddy	8,599.04	13,101.67	1,942.34	1,452.22	25,095.27	12.71%
Seasonal Crops	2,357.95	364.09	103.13	549.71	3,374.88	2.32%
Coconut	557.54	2,498.59	970.03	482.87	4,509.03	1.92%
Cashew	34.07	171.98	0.00	0.35	206.40	0.03%
Palmyrah	4,579.98	4,696.96	5,794.31	0.00	15,071.25	7.31%
Agricultural Farms	0.00	0.00	84.10	0.00	84.10	0.03%
Total	16,129	20,833	8,894	2,485	48,341	24.32%

6.1.3.3 Land ownerships and land rights

The coastal water and connected environments, capture-based fishers were using for their livelihood belongs to the state and is being treated as public property. The fishers were exploiting the resources with no ownership barriers. All the people of the area have equal rights to use these

resources for their livelihood purpose. At the same time, the aquaculture farms that are operating in the province show different ownerships. Few of those farms in coastal water are being owned by local fishers who are the capture-based fishers of the same water. Some other marine based aquaculture farms belong to private entrepreneurs who have no relationship with the area's capture-based fishery. There are also farms being operated under public-private partnerships where the local fishers are the public partners with private entrepreneurs. It indicates that the people will lose their user rights of these coastal resources when the coastal water or the land is allocated for aquaculture farms. The FCS of the Achchankulam expressed this concern that they may lose their common productive fishing grounds due to the establishment of aquaculture farms, which will affect the future of the fishers. The risk of losing their customary rights to natural resources will be a constraint for the implementation of NAQDA's development plan.

The land titling is not completed in the Northern Province due to the civil war, and the land registration process is still ongoing. Other than in the Jaffna district, greater extents of the lands of the province are state lands that have been temporarily allocated or encroached by the people for residential and livelihood purposes. Multiple displacements, resettlement, and relocation programs due to the civil war have created a complex situation in land ownership.

A community consultation carried out at Gowtharimunai GND in Poonakary DSD of Kilinochchi District revealed that the people were living close to the coastal area prior to the onset of civil war with a land title. Due to several displacements, the landowners have lost their land documents and they are not in a position to claim such lands back. At the same time, the land tenure study carried out within the same GND revealed that there are lands with no claimants, and the government is also not in the position to claim those lands as state owned lands. The complex nature of land ownership in the province will pose constraints to identifying suitable land for land-based aquaculture.

The risk of losing customary rights of coastal population to natural resources, and the uncertainty of land ownership will be major constraints during the implementation of the ACBFSDP (2021-2025).

6.1.3.4 Aquaculture licensing process

It was witnessed that although the local fishers or external entrepreneurs identified the space for their aquaculture farm with the participation of the Fisheries societies and other stakeholders, the aquaculture licensing process takes a long time. It was reported at the community consultations that the aquaculture farmers of Veravila in the Kilinochchi district are waiting for the aquaculture license for more than three years and they are not aware of the reason for such delay. The prolonged delays during the licensing process is a significant bottleneck to locate a site for an aquaculture farm.

The consent of the Fisheries Cooperative Societies (FCS) and Rural Fisheries Societies (RFS) of the coastal villages which functions based on GNDs, is a preliminary requirement of the licensing process. However, fishing grounds are shared by the fishers of more than one FCS or RFS. Therefore, fishers who look forward to implementing an aquaculture farm should obtain the consent of all the fisheries societies who share the same fishing ground to avoid conflicts. In the absence of well-defined guidelines with the FCS/RFS, obtaining the consent of all the FCS/RFS is time consuming and an impossible task for a proponent.

A few of the aquaculture farm operators that the SEA team consulted stated about the CSR activities that are carrying out by them for the host community to obtain their support. Though it is not a necessity, there is a rising pressure for Voluntary CSR initiatives from the host community. In the absence of a well-defined socioeconomic impact assessment and impact mitigation measures for this purpose, it is uncertain whether the impacts of the farms are adequately compensated by such CSR activities and whether such CSR activities are unnecessarily burdening the farm operators.

6.1.3.5 Availability of Other inputs and services required for aquaculture industries

Other inputs and services need for aquaculture production include the availability of seed, feed, water, energy and various material, supplies and services at acceptable costs. This also includes the logistic facilities required for the farm.

Access to a regular supply of juveniles/seeds is a prime need in to be addressed in implementation of ACBFSDP. The reliable supply of healthy seeds is an issue identified in some areas. Seed supplied from existing commercial hatcheries/nurseries are not up to standard level and they experience a high mortality rate. The sea cucumber farms in Mannar and Jaffna districts are now depending mainly on juveniles collected from the wild. However, the continuous supply of wild-collected juveniles and the pressure on wild sea cucumber stocks are constraints to the ACBFSDP (2021-2025). Current practices of seaweed cultivation are predominantly based on traditional methods and most of the seaweeds are cultivated using seedlings produced by vegetative propagation from cultured germplasm. However, this farming method has some disadvantages, such as physiological variation in the seed stock and decreased genetic variability, which may reduce the growth rate, carrageenan yield of the seaweeds. However, the plan offers suggestions in fulfilling the seed requirements in Section 2.2.

Another constraint includes lack of good quality low-cost feed for different species. Some intensive aquaculture systems involve supplementary feeding, and in many instances, this requires supply of manufactured feed. Hence it is suggested to develop feed industry in parallel to the aquaculture development and the plan suggest to increase live feed production at low-cost rates and fish feed production through NAQDA and local investors, and to reduce dependency on external feed suppliers who import feed to sell at higher costs.

In conventional aquaculture systems, energy requirement, such as electricity, or mechanical power is minute while offshore aquaculture operations require energy to power standard safety, navigation, and maintenance equipment; automatic fish feeders, refrigeration and ice production, marine sensors, recharging of transport vessels etc. The closed systems or RAS which are aligned with environmental concerns can result in high energy dependency and greenhouse gas emissions. This phenomenon would find in RAS shrimp farming, where increased pumping of water, instead of tidal exchange, would result in significantly higher consumption.

Sea cucumber is a high value species vulnerable for poaching, so that those farms are equipped with electrical lamps around the farms for the night time security.

Aquaculture operations that require power have traditionally relied on diesel or kerosene generators set with battery backup. Small shore-based aquaculture operations generally have a less need of power, anyhow in some cases they may use battery power alone. With the recent tendency to use solar power in Sri Lanka, low-cost solar thermal aerators can be developed to improve aquaculture, and solar panels could be used to generate electricity to oxygenate fish tanks, charge

and maintain battery systems. Compared to the rising cost of fuel and its uncertain supply, the use of wind, solar and water power in aquaculture would make economically sound practices.

6.1.3.6 Absence of risk reduction and safeguard mechanism

Aquaculture, despite being a successful and profitable commercial activity, also involves the risk of production loss due to diseases, parasites, oxygen depletion, freshwater kill, etc. This is a strange phenomenon for fisher folks. The Seaweed farmers and Sea cucumber farmers of Mannar, Kilinochchi, and Jaffna district have experienced severe economic loss due to the freshwater flow during the heavy rain periods of the year especially during the northeast monsoon. Both Seaweed and Sea cucumber are very sensitive to freshwater. However, fishers have managed to pay back the bank loans with their income from other sources such as capture-based fishery due to the absence of insurance and other risk reduction/transferring facilities for aquaculture. This phenomenon has been considered by the local fishers as a bottleneck for getting into aquaculture farming.

Further, there is no proper mechanism for aquaculture farmers, fishers, and other users of coastal resources to offset and compensate for the losses caused by natural disasters and diseases. The situation is the same with respect to resolving of grievances related to the aquaculture.

6.1.4 Financial Constraints and lead time for income generation

The civil war which prevailed for nearly three decades in the Northern Province and the Tsunami in 2004 increased the vulnerability and poverty among the coastal dwellers. The monthly income of around 62% of the households within the SEA study area is less than 15,000 LKR. Another 18% of the households earn 15,000 to 25,000 LKR monthly. The weak financial capacity of the coastal population has made them dependent on coastal capture-based fishery as offshore fishing requires investments in technology and infrastructure. The small-scale aquaculture activities that operate and are about to commence are financed by the input of NAQDA and other donor agencies. The Aquaculture farmers of Veravila stated that there are no banking facilities available in their area to obtain loans to establish the farms. Also, the loan facilities for aquaculture are very rare since the industry is not common in the area.

Also, the requirements of the financial institutions to provide loans, are not compatible with the capability of the small-scale entrepreneurs proposing aquaculture farms. The loan applicants have to submit two personal guarantees from state employees in order to obtain a personal loan to invest in aquaculture. Finding such guarantors and mortgages are almost impossible for small scale entrepreneurs such as fishermen.

Further, the fishers who have invested in aquaculture farming continue their capture-based fishery activities stating that aquaculture does not generate a daily income. A Seaweed culture takes a minimum of 45 days and Sea cucumber takes a minimum of 9 months to generate an income. At the same time, the fishers have experienced a loss of harvest from their farms due to natural disasters such as floods and cyclones. As such fishers cannot rely only on aquaculture farming.

The weaker financial capacity, the different pattern of income generation than their conventional livelihood (capture-based fishery), and the risk of income losses are considered major constraints to embarking on aquaculture activities.

6.1.5 Non availability of Insurance Schemes for aquaculture farms

Due to the high level of risk associated with fisheries and aquaculture sectors, private insurance companies are reluctant to get involved. DFAR has directly involved in providing insurance coverage for the loss and damage to fishing vessels, gear, engines, as well as personal accidents of the crew.

But there isn't any insurance scheme available for aquaculture farms at present. Asset risks, production and management risks, market risks, and personal and health risks should be covered by the insurance of an aquaculture farm. NAQDA should involve in formulating insurance policy and setting up schemes. Also, NAQDA should encourage the aquaculture farmers and the Insurance companies to participate and provide insurances.

However, aquaculture is a technically difficult industry to insure, requiring specialist expertise to gauge the risk of loss. There are instances in developed countries that, insurance companies have offered insurance without an adequate technical approach and lead to significant losses.

In other case, if the premiums are high and the full cost of insurance cover is borne by the insured, aquaculture farmers will be unable to afford coverage and therefore will be reluctant to join insurance schemes. It was reported that high premiums were the main constraints to the implementation of insurance schemes in countries such as Thailand. (FAO, 1999)

6.1.6 Socio-cultural constraints

The fishers and other coastal communities mostly rely on natural resources for their livelihood. They prefer risk-free or low-risk livelihood activities which are technically and financially friendly. Aquaculture development carries with it, the risk of disease, natural disasters, and a new value chain thereby discouraging the population.

The islands of Jaffna and most other coastal villages are remote, and it is very rare to see strangers in those areas. It has created ownership and closed social interaction among the villagers. When an external entrepreneur enters such villages to run an aquaculture farm, the villagers consider that the normalcy of their village is affected. The villagers think that the outsiders are exploiting their resources which will affect their sustainability in their ancestral land.

6.2 Opportunities

6.2.1 Availability of Natural Resources

The potential for coastal aquaculture sector development in Sri Lanka is significant with a total coastline of approximately 1,700 Km. The total extent of lagoons and estuaries has been estimated as 121,000 Ha. Adjoining to these estuaries and lagoons, there are extensive area of low-lying delta lands estimated as 70,000 Ha. (Drengstig A, et al, 2020)

The Northern Province accounts for 40% of Sri Lanka's coastline. The province's coastal stretch is around 949km in length from Mannar to Kokkilai lagoon including 22 coastal islands. Four districts in the Northern Province except Vavuniya have significant coastal access. With this lengthy coastline the Northern Province is blessed with major opportunities for fisheries and aquaculture. The Northern Province has the highest number of lagoons (10) in Sri Lanka, extended over 804 km^2(80,400 Ha) area. The largest lagoon is the Jaffna Lagoon with a surface area of 441 Km^2 (44,100 ha). Other lagoons are Nanthi Kadal Lagoon, Chundikkulam Lagoon, Thondaimanaru Lagoon, Vadamarachchi Lagoon, Uppu Aru Lagoon, Kokkilai lagoon, Vidattaltivu Lagoon, Nai Aru Lagoon and

Chalai Lagoon. These Lagoons are extremely important in the sustenance of coastal fisheries. Many edible shellfish and fish are found in lagoons, estuaries and their associated habitats such as mangroves and seagrass beds.

The Palk Bay and Palk Strait are both impacted by the Southwest and Northeast monsoons. To the South of Mannar Island, there is a broad and shallow continental shelf. The Northern coastal and marine environment has become a unique setting in the country as a result of these factors.

The Northern province can be considered as the most feasible area for coastal aquaculture in Sri Lanka, due to ideal environmental conditions such as the presence of shallow marine areas and large coastal areas. The most favorable places for seaweed and sea cucumber cultivation are located in the Northern Province. Furthermore, there are several neighboring coastal lands suitable for land-based coastal aquaculture which are unutilized at the moment.

There are 22 coastal islands located in Gulf of Mannar and the Palk Bay. Most of these islands (Iranaitivu, Paalative, Eluvativu, Analaitivu, Punkudutivu etc.) have substantial shallow marine areas and adjoining unutilized lands suitable for coastal aquaculture development. NAQDA has already identified these islands as potential sites for sea cucumber, sea bass and seaweed farming.

6.2.2 Availability of Investment Opportunities and Market Availability

According to FAO, about 50% of the World's seafood production comes from aquaculture, yet 90% of Sri Lanka's seafood is still wild caught (Drengstig A, et al, 2020). This represents a good business opportunity for international aquaculture technology suppliers, investors and distributors. Aquaculture is now changing from a subsector into a concentrated commodity production, aiming for an advanced technology level with development towards a sustainable industry in all water bodies (freshwater, brackish water and at sea). The future potential for aquaculture in Sri Lanka is unique in Asia which can reduce wild caught supply from 90% to 10% and where aquaculture can fill the gap. (Drengstig A, et al, 2020).

The availability of local and export markets for aquaculture produce is paramount. The increasing local market price of fish and fishery products clearly shows the increasing demand. There is a huge competition in the Northern province to purchase the fish catch and companies engaged in the export of fishery products tend to enter into aquaculture farming since the local supply of capture-based fish is inadequate for their business.

This ever-existing demand and readily available market can be considered as an opportunity for aquaculture development in the area.

6.2.3 Decline in fish catch and income reduction from capture-based fishery

According to the resource profiles of the divisional secretariats within the SEA study area, there is a decline in the annual fish catch. Consultations with the fishers also confirmed this phenomenon. Also, the market price of fishery products has increased according to the fishers. One of the leading fish collecting and exporting enterprises in the Northern Province (Annai Sea Food), which is collecting fishery products all around the coastal belt, stated that they have witnessed this decline. They believe that the capture-based fishery has gone beyond its capacity and proper initiatives are necessary to protect it.

At the same time, Normann et al. (2003) reports that the province's fish resource could be considered over-exploited if the annual catch exceeds 35,000 Mt. The current catch is more than double, and more fishing efforts have been put over the lagoons and other coastal environments as offshore fishing is not conducive for every fisher at the moment. The Northern Province is blessed with favorable environmental conditions such as extensive areas of clean, shallow water on the nearshore and availability of adjacent coastal lands to develop coastal aquaculture. Coastal aquaculture is considered as one of the opportunities which could help to improve rural livelihoods and food security, alleviate poverty, and generate increased foreign exchange revenues. Coastal aquaculture could play an ever-more-significant role in supplementing the wild captured fish catch in the Northern Province.

This issue in the capture-based fishery has been realized by the local fishers and other entrepreneurs in the area and they are looking for a sustainable alternative. Aquaculture can provide food, income, and employment opportunities; it also contributes to the diversification of primary production and compensates for the low growth rate of capture fisheries. The consultations with the fishers in Iluppaikadavai and Mulankavil have identified that fishers are considering aquaculture as a means of diminishing the overexploitation of capture-based fishery if proper finance and technical support is readily made available to them.

6.2.4 Increasing Awareness and Experience in Aquaculture Practices

According to the fishers and the entrepreneurs who are successfully involved in the aquaculture business sector, awareness on aquaculture has been built among the local community. The communities seem to have a positive impression on aquaculture and are showing interest in it. There are instances where the Fisheries Cooperative Societies (FCSs) are encouraging their members to get involved in culture-based fishery. The FCS of Eluvaitivu, Punkudutivu, and Veravila expressed their interest and shared their success stories with the SEA team regarding aquaculture.

The fishers and external entrepreneurs have identified suitable spaces to set up their aquaculture farms with the support and participation of the FCS and other stakeholders including NAQDA. This has ensured that fishing grounds have been avoided, access to the fishing ground and other facilities are intact, and the aquaculture farm has got "broad community support". It was revealed that the careful selection of farming location with the participation of the fishers, FCS, and relevant stakeholder will avoid the conflicts or damages to the capture-based fishery and other resource utilization. Aquaculture farming is considered as a part-time employment at the moment as they are small in scale. The fishers take care of their farms and fishing activities simultaneously. At the same time, they are confident that a significant number of local fishers will embark on coastal aquaculture if proper financial facilities are available for this purpose.

This evolving community awareness, acceptance of aquaculture, and hands-on experience is a great opportunity for implementing the ACBFSDP (2021-2025).

6.2.5 Formal employment Opportunities for unemployed youth including women

Based on the data of 47 GNDs that are covered under the SEA study, 4,398 youth with GCE O/L qualifications, and 2,903 GCE A/L qualified people are unemployed. Further, the Province's unemployment rate is 5%. The adult literacy rate of the province is 88%.

It reveals that there is a demand for proper employment in the area. The ACBFSDP (2021-2025) proposed that it will generate around 30,000 employment opportunities. This scenario would be a good opportunity for the NAQDA to implement the plan and attract unemployed youth for aquaculture.

The Community consultations SEA team had with the women who are working in fish processing centre, Punkudutivu island, Jaffna revealed that they were happy about the employment opportunity they have got and were expecting the expansion of employment opportunities in fisheries and aquaculture sector. It was observed that recently women are heavily involved in small-scale aquaculture such as sea cucumber and seaweed farming.

The feedback of the young women who are working on a Shrimp farm was also the same and they were grateful for the opportunity of getting regular and formal employment within the village itself, since cultural barriers prevented them from seeking employment outside their village.

7 Alternative Scenario Analysis

In conducting the SEA, the likely significant environmental and social effects of implementing the plan or programme and any reasonable alternatives required to be appraised. It is a normal practice to propose different ways of fulfilling its objectives when developing a plan or programme. Scenario analysis were conducted under two different themes such as management and culture intensity targeting the growth of achieving targets. Three different options or scenarios were considered in this SEA. The term "options" here is used for different scenarios or alternatives.

Four colour codes for each likely effects have been used in the assessment for easy interpretation.

Unlikely to be mitigated, need special attention

Potential conflict with the Environment. Impact likely to be mitigated

Likely positive impact on the Environment.

No potential impacts to the Environment

7.1 Management Scenario

Tables below indicates the likely impacts under under the different sub scenarios/options conducted in the two-scenario analysis, as such management scenario consist of three development plan options; namely, Business as usual or No Plan Option: NAQDA Plan implementation without environmental safeguards and NAQDA Plan implementation with environmental safeguards (with SEA recommendations and EIAs for individual aquaculture projects). Each option was evaluated for positive as well as negative effects including uncertainties about the nature and significance of effects.

Option 1: In the No plan option (option 1) it is assumed that aquaculture projects will continue to grow within the Northern Province in a haphazard manner with no regulatory controls. This means that a large number of unauthorized and illegal aquaculture sites will be established. Since there will be no regulatory controls on these projects the adverse impacts on the environment as well as social and cultural impacts will be higher than when a proper plan is implemented.

Option 2: If the ACBFSDP (2021-2025) of NAQDA is implemented without the adoption of the recommendations of the SEA and without individual EIAs for the proposed aquaculture projects the environmental and social damage will be less than option 1 but it will still create significant adverse impacts on the environment, along with social and cultural issues as no safeguards are in place.

Option 3: In option 3 the ACBFSDP (2021-2025) of NAQDA will be implemented along with the recommendations of the SEA and with individual IEE/EIAs being conducted for each aquaculture development zone/project prior to implementation. This is clearly the most suitable option with least damage to the ecological and social environment during implementation.

Option 01: Business as Usual or No Plan Option Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Salinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alterations of water circulation patterns &wave regimes	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Seaweed Culture																								
Site selection and preparation of culture area																								
Culture operation and routine management																								
Harvesting and transportation																								
Sea Cucumber Culture																								
Site selection and preparation of area																								
Culture operation and harvesting																								

Option 01: Business as Usual or No Plan Option Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Salinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alterations of water circulation patterns &wave regimes	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Finfish cage Culture																								
Siting & cage deploying																								
Culture operation and harvesting																								
Shrimp Pond culture																								
Site selection and Land acquisition																								
Clearing and preparation																								
Culture operation and harvesting																								

Option 01: Business as Usual or No Plan Option Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Salinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alterations of water circulation patterns &wave regimes	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Shrimp Culture RAS																								
Site selection and land acquisition																								
Clearing and preparation																								
Culture operation and harvesting																								

Option 02: NAQDA Plan implementation without SEA and/or Individual IEE/EIA for projects Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Salinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alteration of water circulation patterns and wave regimes	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Seaweed Culture																								
Site selection and preparation of culture area																								
Culture operation and routine management																								
Harvesting and transportation																								
Sea Cucumber Culture																								
Site selection and preparation of area																								
Culture operation and harvesting																								

Option 02: NAQDA Plan implementation without SEA and/or Individual IEE/EIA for projects Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural								
	Impacts on Surface Water	Impacts on Ground Water	Salinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alteration of water circulation patterns and wave regimes	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Finfish cage Culture																									
Siting & cage deploying																									
Culture operation and harvesting																									
Shrimp Pond culture																									
Site selection and land acquisition																									
Clearing and preparation																									
Culture operation and harvesting																									

Option 02: NAQDA Plan implementation without SEA and/or Individual IEE/EIA for projects Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Salinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alteration of water circulation patterns and wave regimes	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Shrimp Culture RAS																								
Site selection & land acquisition																								
Clearing and preparation																								
Culture operation and harvesting																								

Option 03: NAQDA Plan implementation with SEA and and IEE/EIA for Individual Projects Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Salinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alteration of water circulation patterns and wave regime	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Seaweed Culture																								
Site selection and preparation of culture area																								
Culture operation and routine management																								
Harvesting and transportation																								
Sea Cucumber Culture																								
Site selection and preparation of area																								

Option 03: NAQDA Plan implementation with SEA and and IEE/EIA for Individual Projects Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Salinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alteration of water circulation patterns and wave regime	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Culture operation and harvesting																								
Finfish cage Culture																								
Siting & cage deploying																								
Culture operation and harvesting																								
Shrimp Pond culture																								
Site selection and land acquisition																								
Clearing and preparation																								

Option 03: NAQDA Plan implementation with SEA and and IEE/EIA for Individual Projects Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Salinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alteration of water circulation patterns and wave regime	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Culture operation and harvesting																								
Shrimp Culture RAS																								
Site selection & land acquisition																								
Site selection and preparation																								
Culture operation and harvesting																								

It is clear from this analysis that option 3 is by far is the most sustainable option with the least adverse impacts on the environment.

7.2 Culture method/ growth scenario

Alternative analysis was also carried out with respect to the growth or culture methods. Three sub scenarios/options were analyzed for likely impacts, assuming that the ACBFSDP (2021-2025) of NAQDA will be implemented along with the recommendations of the SEA and with individual IEE/EIAs being conducted for each aquaculture park/project prior to implementation.

Option 1: Extensive culture methods adopted for proposed species with slow growth to achieve the target

Option 2: Semi intensive culture methods adopted for proposed species with intermediate growth in achieving targets

Option 3: Intensive culture methods adopted for proposed species with higher growth rates

Four similar colour codes for each likely effects as per the management scenario has been used in the assessment.

	Unlikely to be mitigated, need special attention
	Potential conflict with the Environment. Impact likely to be mitigated
	Likely positive impact on the Environment.
	No potential impacts to the Environment

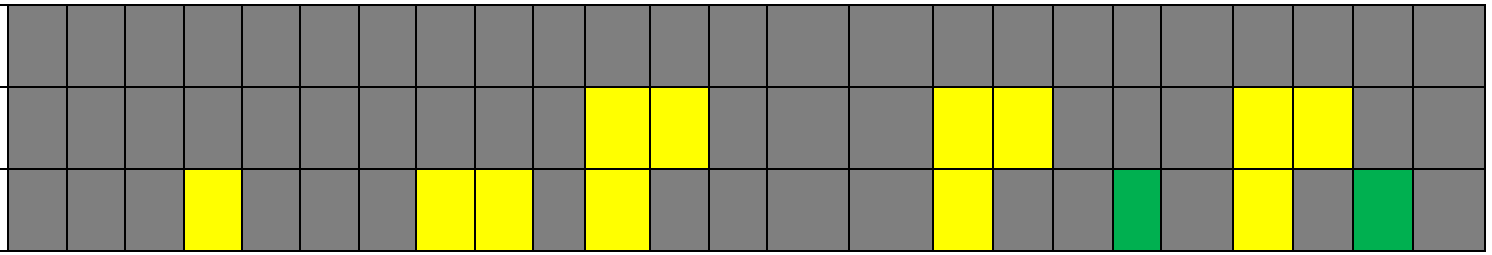
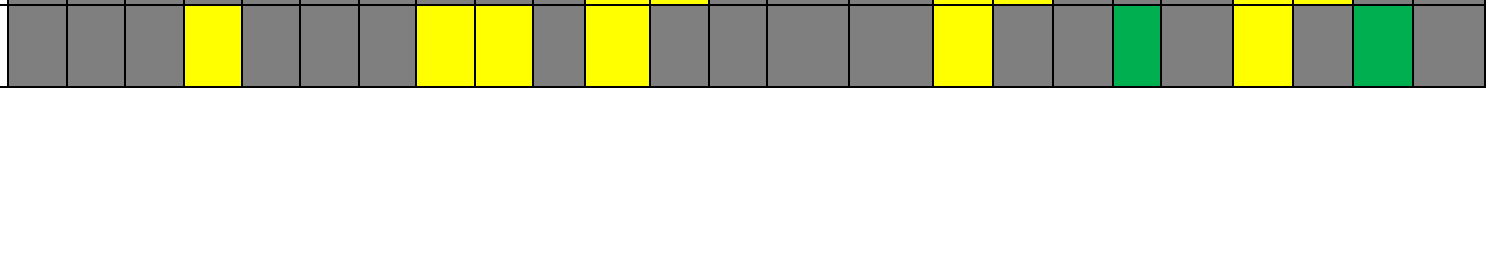
Option 01: Extensive culture methods adopted for proposed species with slow growth to achieve the target Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Stalinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alterations of water circulation patterns &wave regimes	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Seaweed Culture																								
Site selection and preparation of culture area																								
Culture operation and routine management																								
Harvesting and transportation																								
Sea Cucumber Culture																								
Site selection and preparation of area																								

Option 01: Extensive culture methods adopted for proposed species with slow growth to achieve the target Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Stalinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alterations of water circulation patterns &wave regimes	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Culture operation and harvesting																								
Finfish cage Culture																								
Siting & cage deployment																								
Culture operation and harvesting																								
Shrimp Pond culture (extensive)																								
Site selection and Land acquisition																								

Option 01: Extensive culture methods adopted for proposed species with slow growth to achieve the target Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Stalinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alterations of water circulation patterns &wave regimes	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Clearing and preparation																								
Culture operation and harvesting																								

Option 02: Semi intensive culture methods adopted for proposed species with intermediate growth in achieving targets Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Salinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alteration of water circulation patterns and wave regimes	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Finfish cage Culture																								
Siting & cage deployment																								
Culture operation and harvesting																								
Shrimp Pond culture (Semi intensive)																								
Site selection and land acquisition																								
Clearing and preparation																								
Culture operation and harvesting																								

Option 03: Intensive culture methods adopted for proposed species with higher growth rates Project Activity	Physical					Ecological				Coastal/Hydrological							Social/Cultural							
	Impacts on Surface Water	Impacts on Ground Water	Salinization/Acidification of Soils	Sedimentation	Chemical and Organic Pollution Risks	Impacts on Protected areas	Impacts on Other Sensitive Marine Ecosystems	Impacts on Mangroves and Salt Marshes	Introduction of Invasive Alien Species	Impacts on the Coastal Morphological Stability	Impacts on Fresh water Resources	Impacts on the existing coastal structures	Disturbance to the natural storm water drainage	Impacts on the rivers, streams, Thonas and their sea outlets	Alteration of water circulation patterns and wave regime	Emission of Green House Gases	Impacts on Land Ownership and Rights	Impact on Capture based Fishery	Impacts on the local economy	Impacts on other development projects	Impacts on Agriculture	Impacts on Animal Husbandry	Impacts on tourism and other industries	Impacts on Cultural Heritages and religious places
Sea Cucumber Culture																								
Site selection and preparation of area																								
Culture operation and harvesting																								
Finfish cage Culture																								
Siting & cage deployment																								
Culture operation and harvesting																								
Shrimp Culture RAS																								

Site selection & land acquisition	
Site selection and preparation	
Culture operation and harvesting	

For Seaweed culture only the extensive method is used without supplementary feeds. Hence the impacts are similar to management scenario option 3 and the potential impacts can be mitigated. Since large surface areas are required for viable seaweed culture, benthic communities and primary productivity in the water column are possibly affected. Sedimentation of organic matter from off-bottom culture units may also result in changes in benthic communities, particularly where water current velocity has been decreasing. The use of plastic attachments (i.e., tie-ties; TTs) for hanging seedlings on cultivation lines contributes to plastic pollution in the oceans. A shift in innovation from simple cultivation methods to a more technical phyconomic approach is imperative in order to sustain positive outcomes, such as the adoption of sound, ecosystem-based management principles and sustainability of operations, including resiliency to climate change.

There is some evidence that the biological process of Sea cucumbers benefits seagrass beds by providing nutrients to support growth, and more below-surface space for root extension (Arnull et al., 2021). The extensive system of targeted sea cucumber farming also occupies a large space in the nearshore coastal waters. There are potential impacts with improper pen structures and their setting/positioning which may negatively impact hydrological movements, consequently impacting the sensitive ecosystems and fish movements and habitats. Such negative impacts could be anticipated in coastal fisheries by proper settings of the pen structures.

Intensive culture may reduce the impacts caused by the occupation of pen structures in large spaces. However, it needs supplementary formulated feeds to feed the sea cucumber which in turn may cause severe impacts on surface water resources which could in turn affect sensitive ecosystems. However, farming in continuous cycles is preferable in order to optimize site potential, especially at sites where the available surface area for sea cucumber farming is limited. This method allows an intensification of production by maintaining the total biomass close to the carrying capacity of the site with good management practices.

Extensive systems may cause less surface water pollution and for sustainable production, while in semi-intensive systems it is anticipated environmental consequences of nutrient loading, could result in negative impacts, not only on cage culture operations per se but also on the capture fisheries of such water bodies. Accumulation of anoxic sediments below cages due to faecal and waste feed build-up is the major environmental consequences in cage culture. Maintenance of a minimum depth between the cage bottom and sea bottom may facilitate flushing the accumulated waste. In addition, it should consider, biomass/production limits, management of feed quality and quantity, appropriate site selection to maximize dilution and dispersal of any waste discharges and regular monitoring of water quality and disease conditions. Coastal finfish farming is still predominantly dependent on the direct use of trash fish/low-value fish, so that remains a contentious issue on many grounds such as resource use, environmental pollution, irregular supply and poor feed conversion efficiency (high FCR). Irrespective of the system there is a potential for escaping fish through the nets resulting in exotic species being introduced to the environment. Based on the data available, it could be decided that the semi-intensive system is the most sustainable cage culture system to culture suggested species in the coastal area of Northern Province.

Shrimp culture has been suggested to be cultured in extensive, semi-intensive and intensive systems. Due to larger space requirements in extensive culture systems, potential impacts on surface water, ecosystem, coastal/hydrology and socio-culture were identified and the impacts are likely to be mitigated.

The farming of the exotic species *L. vannamei* is suggested in semi-intensive and intensive systems, the analysis showed a likely impact of the Introduction of Alien Species to the environment with regard to semi-intensive systems may need special attention.

The closed systems or RAS are motivated by environmental concerns such as eutrophication, escapes and spread of disease/parasites but other concerns include the high cost of maintenance. However, shrimp as a lucrative export-oriented species is much more viable in terms of environmental safety than the semi-intensive or extensive systems. Also, it solves the problem of land /space allocation for shrimp culture which will indeed be an issue in shrimp farming.

8 Evaluation of Potential Impacts (Environmental, Climate change related and Socio Economic)

8.1 Potential impacts on coastal and marine ecosystems

The environmental impact of aquaculture is dependent upon the culture systems, species being farmed, the intensity of production and the location of the farm. Among the number of known impacts of aquaculture on marine and coastal environments, the following are commonly seen.

- Alteration and loss of coastal habitats for aquaculture pond construction
- Enrichment of nutrient and organic matter and potential eutrophication of recipient waters
- Release of chemicals used for maintenance of water quality and disease control
- Effects from escaped culture species
- Potential spread of non-native (exotic) species
- Biofouling on submerged structures
- Potential interaction with other livelihoods such as fisheries, agriculture etc.
- Increase use of wild small-pelagics for fish meal/oil for feed production
- Unsustainable demand for wild seed or juveniles (i.e., fattening crabs, sea cucumber etc.)
- External events such as catastrophic events, climate change impacts

8.1.1 Alteration and loss of coastal habitats

Habitat loss is one of the foremost impacts of aquaculture arising mainly due to the haphazard siting of aquaculture projects without due consideration to their impact on sensitive ecosystems. It is one of the major direct environmental impacts of aquaculture, and include habitat loss in critical ecosystems (e.g., mangroves, sea grasses, wetlands), effluent (nutrient) loading that contributes to poor water quality, the introduction of invasive species, and the spread of disease in the adjacent environment. Coastal wetlands such as mangrove swamps are amongst the most productive ecosystems sustaining the ecological integrity and productivity of adjacent coastal waters and are important breeding and nursery grounds for many commercially exploited fish and shellfish species.

The project proposes to grow fish and shellfish, including exotic Shrimp species, *L. vannamei*. Growing pond-based Shrimp farming has largely been an enterprise which has serious implications in Sri Lanka (and elsewhere in the world) as seen in the abandoned lands from Mundel to Puttalam due to disease outbreaks and pollution.

Shrimp farming was a lucrative aqua farming industry which prevailed in Sri Lanka for 03 decades, especially in the North-Western Province. At the commencement, Shrimp aquaculture ponds/farms were developed in an ad-hoc manner, and management was largely focused on siting, licensing, and monitoring performance and impact at the individual farm level. This perspective failed to recognize the cumulative impact of a large number of farms and the fact that aquaculture industries are dependent on a common pool of resources viz. water and space which are part of the ecosystem.

There was an incident reported in Northwestern province where that 653ha of coastal habitat was utilized for shrimp farming and once abandoned, the shrimp ponds have been converted into salt pans (Wergaodathenna & Gunarathna 2015).

The fact that these ecosystems are edaphically, physio-chemically and ecologically interconnected has been ignored in recent development projects, in particular the development of aquaculture in the country. The growth in the shrimp farming industry between 1986-2016 indicates that Sri Lanka has lost a significant percentage of its mangroves and salt marshes. This loss was propelled by the aquaculture of *Penaeus monodon* (Tiger Shrimp) and crabs specially in the Northwestern and Eastern provinces of the island. Mangrove ecosystems remain highly threatened, especially with the proposed aquaculture project to be developed in Vidataltivu area.

Pollutants discharged from aquaculture practices includes suspended particles/ faecal matter, excessive nutrients, pesticides, antibiotics, Chlorine and other chemicals used for regulating water quality, which may adversely affect mangroves, seagrass beds and coral reefs around aquaculture development zones.

Further, fishing, and other mismanagement practices in the coastal and shallow marine areas of the Northern Province are already causing irreversible damages to marine and coastal ecosystems and resources in this area.

Plate 44: Shells and corals that are piled at a fish landing site in Mandativu.

8.1.2 Destruction of mangrove forests

Aquaculture has been blamed for the destruction of millions of hectares of mangrove forests in countries where large scale aquaculture projects are implemented. In Sri Lanka the Northwestern province lost 62% of its mangrove areas during the past 38 years due to clearing and conversion to shrimp ponds (Wergaodathenna & Gunarathna 2015), often accompanied by the salinization of soils.

The loss of mangrove forests contributes to severe environmental consequences. Mangrove forests provide nutrients and shelter for many fish species that breed and rear young, as well as providing habitat for many other animals such as birds, reptiles, and amphibians. They are also beneficial for the coastal community by acting as a physical barrier to coastal erosion and storm damage. These farms can quickly become nonviable, sometimes as rapidly as 10 years after commencement, due to sludge build-up. Most of them will be abandoned, leaving behind soils that are highly acidic and contaminated which therefore cannot be used for any other activity.

Destruction of mangrove forests further results in the destruction of vital trees that are particularly good at absorbing Carbon Dioxide (CO_2) and so has implications for climate change. There are

studies which have estimated that a pound of shrimp produced by clearing mangrove forests results in the addition of one ton of CO_2 to the atmosphere which is more than ten times the equivalent of beef on rainforest cleared land. (Kauffman at el., 2017)

ACBFSDP (2021 – 2025) of NAQDA has planned to produce shrimp species such as *L. vannamei* and P. *monodon* species with the target of increasing the volume from 400 Mt to 20,000 Mt in the period from 2021 to 2025 in the Northern Province. Based on data in the plan, the proposed targeted volume through production ponds and supporting area could be achieved through approximately 2000 ha of land use in the coastal area. Hence, special attention is required to be paid for the sustainability of the unique mangrove ecosystems in the Northern Province, during the selection of areas for aquaculture development.

8.1.3 Impact on seagrass beds and associated communities

Most of the productive sea grass beds are encountered in the shallow coastal areas of the Gulf of Mannar as well as shallow bays around islands in the Palk Bay and Palk strait in the Cauvery basin. Salt marshes arise in areas which are influenced by tides. Salt marshes are mostly available in association with mangroves.

Some of the potential negative environmental impacts envisaged include the reduction of light availability to the bottom dwellers or shading by profusely growing seaweed, attenuation of waves and water currents leading to sedimentation. The negative impact of reduction of primary productivity in the water column is significant in seaweed culture as a large surface area is required for a viable culture. As a consequence, decline of zooplankton & benthos densities, displacement, or changes of community structure of organisms could occur. Sedimentation of organic matter from off-bottom culture units may also result in changes in benthic communities, particularly where water current velocity is decreased.

Carbon sequestration is another striking ecosystem service of seaweed culture practices.

There is also research evidence that sea cucumber aquaculture could positively impact seagrass meadows, increasing the growth rate of certain species.

Sea cucumbers help in the oxygenation of sediments and nutrient cycling between sediment layers on the seafloor. They ingest and excrete large amounts of sediment, enriching the surrounding areas with dissolved nutrients. These processes benefit the seagrass beds by providing nutrients to support growth, and more below-surface space for root extension (Arnull et al., 2021).

Increasing levels of suspended solids due to soil erosion have threatened the survival of seagrass species, sensitive to excessive siltation. During the SEA, a rapid under-water survey was conducted in an existing sea cucumber farm in Ariyalai to investigate any noticeable impact from sea cucumber farming on seagrass beds. A noticeable difference was not observed in terms of percentage cover of seagrass beds within the sea cucumber farm and in the lagoon outside of the farm (Plate 45). However, long-term studies and monitoring are needed in order to fully understand the potential impacts of farming on seagrass beds.

Plate 45: A comparison of seagrass cover (Left Side: Inside a sea cucumber farm, Right Side: Natural habitat in the lagoon just outside the farm).

Plate 46: Fencing and other structures may impact movement of mobile fauna and also possibility of biofouling
(Underwater Ecological Surveys conducted by SEA Team)

Plate 47: Dense growth of seaweed would limit the light penetration to seagrass beds underneath-
(Underwater Ecological Surveys conducted by SEA Team)

Additionally, seagrass ecosystems are significantly affected by largescale commercial trawling, especially in the Gulf of Mannar area where extensive seagrass meadows are available.

Seagrass beds are also affected by other stressors including salterns and land reclamation. In recent years, several harbour and fish landing site developments coupled with increasing number of mechanized boats tend to pollute the remaining seagrass beds with chemical residue.

8.1.4 Impacts on coral reefs

The Vankalai-Arippu-Silavaturai stretch, Vidataltivu to Jaffna stretches of coastline showcases several excellent fringing coral reefs. Sedimentation increased suspended solids, organic wastes and nutrients will have detrimental direct and indirect impacts on coral reefs. Intensive algal growth as a result of coral mortality, high nutrient levels and a decrease in herbivores can be considered as a major impact on reefs in the Northern region, such as Bar reef, Silavathurai reef and Arippu reef. This may also impact the ability of these reefs to recover following incidents of mass coral mortality.

8.1.5 Impacts on Mud Flats/Salt Marshes

Mudflats are sedimentary inter-tidal habitats created by mud deposition in low-energy coastal environments, particularly in sheltered areas during the low tidal season. Vidataltivu Nature Reserve is one of the largest saltwater biomes in Sri Lanka, which consists of salt marshes and mud flats. Erukkalampiddy area within the Nature reserve is rich in tidal mud flats. These habitats act as a feeding ground for migratory water birds, most of which use tidal flats during stopovers such as Vankalai, Vidataltivu mud flats.

NAQDA has proposed several sites within the Vidataltivu Nature Reserve for aquaculture development. The proposed site named as Nay Aru site, is rich in seasonal salt marshes (66.53%). The riverine mud flats and mangrove associated area at the Vidataltivu area closer to the proposed Nay Aru project site seems to be important habitats that are home to most of macro benthos. Therefore, the salt marshes of the proposed site may have potential impacts associated with loss of biodiversity and ecosystem function.

8.1.6 Enrichment of nutrient and organic matter

Haphazard development of aquaculture inevitably leads to environmental overload: nutrient and effluent build-up, impacts of fish farms on local wild fisheries with respect to disease and escaping, and environmental degradation due to the site's location.

Nutrient buildup is mostly due to high density of fish in a farming system. Fish produce waste, and their waste have the potential to build up in the surrounding area creating algal blooms which then deplete Oxygen levels resulting in dead zones. Usage of antibiotics to prevent disease creates a serious concern about the effect of the drugs on the ecosystem around the cages, including wild fish. There is a concern that the escape of nonnative fish would cause wild fish to compete for food, potentially displacing the native fish.

Antibiotic use could have impact on culture species, human health as well as other associated species in culture systems and adjacent waters.

With recent advances in aquaculture, antibiotic use is declining, and safe and effective vaccinations have since been developed for farmed fish and also disease resistant species are being introduced.

Effects of nutrient and effluent buildup are well understood along with the implementation of measures to prevent these. Siting the aquaculture farm in an area with strong currents to disperse the effluent, as well as replacing the farms from time to time to prevent impacting one specific area are some ways the industry is combatting this environmental issue.

8.1.7 Use of freshwater resources & salinity intrusion

Sivakumar (1993) and Kumara et al. (2013) reported that the over extraction of water in Jaffna from a sandy/limestone aquifer pulls the underlying saltwater upward, forms up coning effect along the interface, and mix up with the fresh water above and deteriorate the water quality. According to past research studies, digging of deep wells and over extraction of groundwater for extensive agricultural activities are the major causes for saltwater intrusion into the groundwater (Rink et al., 2016; Janen and Sivakumar, 2014). Higher level of saltwater intrusion has been observed in the areas around Vadamarachchi lagoon and Uppuaru lagoon in Jaffna district.

Freshwater is required to be pumped in to land based aquaculture farms and hatcheries and a large amount of energy is required for water pumping, cleaning, and filtering processes. However, the amount of fresh water required for Closed systems is substantially less than the open systems. Extraction of ground water resources for aquaculture projects could lead to problems of salinity intrusion if overextraction takes place.

8.1.8 Introduction of Exotic/Invasive Species and escaped fish

Escaped fish from aquaculture farms have potential impacts on wild fish populations by outcompeting with them for food and other resources. This not only affects the wild fish populations but also the local fisherman in the area.

This impact is hard to monitor, and it is difficult to create improvements within the industry. The main impacts of escaped fish are on the commercial fishing industry and conservation rather than on aquaculture. The spread of invasive species may be accelerated by increased pollution, degradation of ecosystems and loss of other species.

The proposed plan anticipates scaling up the culture of *L. vannamei*, exotic species which is already been introduced to the country considering its potential benefits over the widely cultured *P. monodon*. However, its ability to act as a carrier of various viral pathogens exotic to Asia has been identified as the main impact.

It is suggested to establish specific pathogen-free (SPF) shrimp stocks as an alternative to overcome the potential disease problems associated with shrimp aquaculture.

For the issue of escaped fish from farms, real time monitoring with underwater cameras can be used to closely monitor cages and regular inspection of cages by divers.

8.1.9 Threat of macro and micro-plastics

Macro and micro-plastics are also becoming a major threat, with very limited scientific understanding. Aquaculture can serve as significant source of plastics to marine and coastal waterbodies.

8.2 Contribution to Greenhouse Gas Emissions

Aquaculture sector is a relatively low greenhouse gas emitting sector, and so far, no emissions have been estimated or specific mitigation action has been planned for this sector within the country. Globally, the aquaculture sector contributed 0.49 percent of anthropogenic greenhouse gas (GHG) emissions in 2017 (The World Fish Centre, 2019). Managing impacts and greenhouse gas emissions leading to climate change should be given due consideration. For instance, under drought conditions that cause high evapotranspiration and saltwater intrusion, getting the required freshwater supply for shrimp farming, etc., could be costly and energy consuming, leading to increased levels of greenhouse gas emissions; appropriate adaptation measures with mitigation co-benefits are required in such cases.

Aquaculture feed production is also regarded as the sector's largest source of greenhouse gas emissions (VGREEN, 2012). The existing shrimp farms mostly use Recirculating Aquaculture System (RAS) that does not require fish feed addition; however, if feed is required in the future, it should be carefully planned to minimize any emissions associated with feed utilization. The types of feed may vary based on the culture species, and according to VGREEN (2012), sinking food has a slightly lower global warming potential, compared to floating feed.

- The existing coastal and marine ecosystems in the Northern Province have a high carbon density in their vegetation and soil. Any clearing of such important areas could lead to the release of stored carbon as carbon dioxide emissions, causing positive feedback on impacts related to climate change. Therefore, further research on quantification of the carbon stocks in the coastal and marine ecosystems in the Northern Province is needed to evaluate their role in carbon sequestration and climate change mitigation. Suggested Planning, Monitoring & Evaluation Division (PMED) within NAQDA for environmental assessments monitoring purposes could make a significant contribution in this regard.
- The proposed Planning, Monitoring & Evaluation Division (PMED) in NAQDA plan can closely monitor and evaluate low carbon opportunities among the farmers. The overall greenhouse gas emissions at farm level can be calculated considering the Carbon Dioxide (CO_2) emissions in energy usage, including lighting, pumping water, and transportation (i.e. feed transportation and any other transportation) and any Carbon sequestration in any associated plants, including mangroves, and emissions associated with the use of organic fertilizer, need to be estimated.
- Due to lack of data, the emission-related activities need to be further investigated during the implementation of the proposed plan as well.
- Organic fertilizer production has been indicated under the key results given for the usage of sedimentation tanks in shrimp aquaculture, ACBFSDP (2021-2025). This can be considered as one of the climate friendly activities, as Nitrogen fertilizers are not used. Nitrogen fertilizers release Nitrous Oxide which has a much higher global warming potential compared to Carbon Dioxide.
- According to the NAQDA plan, seaweed farming will be facilitated in the shallow marine areas of Jaffna peninsula and nearby islands. By absorbing carbon emissions, rebuilding marine ecosystems, producing biofuel and recyclable plastics, and providing marine protein, seaweed can play a significant role in combating climate change. According to Mashoreng et al. (2019), maricultural seaweed could sequester 57.64 tons CO_2/ha/year

whereas pond-cultured seaweed could sequester 12.38 tons CO_2/ha/year. Seaweed farming can also provide habitats for fish and help mitigate local effects of ocean acidification, in addition to its role in sequestering Carbon.

8.3 Impacts on Coastal Hydrology

8.3.1 Impacts on the Coastal Morphology

The Northern coastline of Sri Lanka is generally stable. However, sand accretion is dominant in the East coast and the potential for beach erosion is generally high along the Northern coastal areas of Jaffna peninsula. In the other areas, coastal sediment budget is generally at an equilibrium state where the coastal currents and waves are very weak.

In general, if the proposed coastal aquaculture projects interfere with the sand movement across or parallel to the beach, shoreline will try to readjust resulting in beach erosion in some areas and excessive sand accumulation in a nearby area. Further, the sand supply to the beach will be restricted if barriers are built in the streams and their flood plains. Therefore, the potential constructions, such as water intake structures, facilities for breeding and raising the fish such as ponds, loading unloading facilities etc. need to be considered to determine a certain section of the beach will be affected.

Potential sediment transport rates obtained from the report of UNESCO-IHE and ADB, (2016); Comprehensive Modelling of Longshore Sediment Transport at Pesalai, Gurunagar, Point Pedro and Mullaitivu, Sri Lanka are shown in the Table 51 below. In places where the sand transport rates are very high, the potential for shoreline adjustments are high. However, to trigger a change in the sand movement, the beach or the nearshore area must be disturbed by a marine facility of the aquaculture farms. Common marine structures used in aquaculture such as fences, nets, cages, etc. are generally permeable enough for sediment movement and therefore may not affect the morphology. However, the places where the structures that can interfere with the sediment movement need to be identified at the time of planning of potential aquaculture development activities. At this stage of the SEA, as the details of the exact site-specific plans are not available, it is not possible to identify the locations where the coastal morphology will be affected. However, as the Table 51 shows in Jaffna Peninsula and on the West coast in Mannar, sediment movement rates are low and the impacts of coastal morphology due to aquaculture practices will be low. However, the sediment transport rates in the North (Point Pedro) and East (Mullaitivu) are high and therefore, there is a potential of morphological changes if the sediment transport pattern is disturbed. Sediment accretion on the east of Point Pedro Jetty and erosion on the west side and the sand accumulation on the south side of the ship Farah III that ran around in Mullaitivu are precedence of what could happen if the sand movement pattern is disturbed in those beaches.

Table 51: Annual sediment transport rates

Location	Net annual alongshore sediment transport rate (m^3/year)	Gross annual alongshore sediment transport rate (m^3/year)	Average sediment size D_{50} (µm)
Pesalai (North side of Mannar Peninsula)	10,000 from east to west	1,000 from west to east 11,000 from east to west	320
Gurunagar (Jaffna Bay)	5,000 from west to east	5,000 from west to east	200
	30,000-150,000 from east to west		430

Location	Net annual alongshore sediment transport rate (m^3/year)	Gross annual alongshore sediment transport rate (m^3/year)	Average sediment size D_{50} (µm)
Point Pedro (North side of Jaffna Peninsula)		30,000-150,000 from east to west	
Mullaitivu	North of inlet 10,000-65,000 to north South of inlet - 30,000(to south) 20,000 (to north)	North of inlet 10,000-65,000 to north South of inlet – 30,000(to south) 20,000 (to north)	480

(Source: Table 4.1, Comprehensive Modelling of Longshore Sediment Transport at Pesalai, Gurunagar, Point Pedro and Mullaitivu, Sri Lanka, UNESCO-IHE and ADB, 2016)

8.3.2 Impacts on the natural stormwater drainage

Constructions across the natural stormwater drainage paths, mainly the fish farming facilities, pipelines, access roads, excavation material dumps etc. can block the flow passages and may lead to localized floods, water stagnation and water quality issues.

Possibilities of blocking the natural drainage paths should be studied by overlaying the development plans on a map of natural drainage network. However, the project development activities are still in the initial stages of planning and the potential sites and site layout plans are not available. Therefore, it is not possible to identify where the issue would arise at this stage. Generally, the flood plains, low-lying areas, and valleys where the stormwater will flow during rain should be avoided. Specially the areas close to the drainage outlets identified in this study are generally low-lying and the farm layouts should be planned to avoid water paths.

8.3.3 Impacts on the existing structures on the beach and streams

Planned development activities can have impacts on the stability and the usage of the existing structures. That must be assessed on a case-by-case basis which is beyond the scope of this SEA. Generally, the fishery anchorages, jetties, beach landing sites, storm water drains, pipelines, sea water intakes, road embankments, culverts, bridges etc. can be affected by the hydrodynamic and sediment transport changes due to the infrastructure to be built for aquaculture. Therefore, the places where there are highly vulnerable structures, development activities require to be restricted. However, at locations where the hydrodynamic conditions are very calm, impacts on the structures will be insignificant. Therefore, in the areas inside Jaffna Bay and the lagoons and some sea areas sheltered by the islands, there will be no adverse impacts on the existing structures.

8.4 Impact on Capture Based Fishery

Changes that happen within the fisheries sector will more frequently impact itself and other sectors. In this background, the NAQDA's plan could compete with the capture-based fishery for space, disturbing the access to and polluting fishing grounds and putting pressure on the wild fish stock in the area. This competition will push the poor fishers away from their fishing grounds and such a situation will significantly impact the capture-based fishery sector and the fisher's livelihood.

As per the fishers and the DFAR, the fishing grounds of the province have not been demarcated and mapped yet. There are instances where the fishing grounds are being shared by multiple villages.

Also, the fishers change their fishing grounds according to the fishing season. In the absence of strong competition, the fishers had the freedom of utilizing the entire fishing ground and the coastal resources for their livelihood.

Though fishers lose their fishing grounds either willingly or unwillingly for aquaculture, different consequences in their socioeconomic features were identified through consultations and face-to-face interviews with victims of aquaculture farming. Though the number of capture-based fishers who are affected by aquaculture in past is not known, the stakeholders including the Fisheries Society representatives are pointing out this as one of their issues and concerns.

- The fishers who are using the shallow marine areas (up to 2m) for their livelihood are the vulnerable population due to aquaculture development, especially due to the Sea Cucumber pen cultures and seaweed raft culture at the moment.
- While few fishers stated that the recently initiated aquaculture projects have encroached on their traditional fishing grounds, a few others mentioned that they have consented to these projects, or have converted their fishing area to aquaculture farms and moved to another place for fishing. A fisherman in Gurunagar, Jaffna stated that he is losing around 10,000 LKR a month as his fishing ground (Lagoon trawling for shrimp) has been occupied by a sea cucumber pen culture. One of the fishers who has converted the customarily owned fishing ground to aquaculture stated that he had to face some family issues from his siblings because the fishing ground was owned by his family, while the aquaculture project was only operated by him.
- Fisherman of Illuppaikadavai, Mannar said that though he lost his fishing ground earlier to aquaculture, he managed to recover his livelihood by changing his fishing methods and the fishing ground.
- “Sirakuvalai” is one of the fishing gears used in shallow water by small-scale fishers. Each fisher owns a few Sirakuvalai units. A 55-year-old Sirakuvalai fisherman mentioned that he lost 50% of his fishing area due to establishment of a sea cucumber pen culture and his monthly income has been reduced to 20,000 LKR from 30,000 LKR. It is around a 30% reduction in his monthly income caused by an aquaculture farm.
- Though the exact level of impacts is not reported, the host communities of aquaculture farms are complaining that aquaculture farms and the connected structures are disturbing their access to the fishing grounds. Similarly, the host community of a shrimp farm in the Mannar district expressed their concerns that the farm discharges effluent water into the fishing ground which causes health implications to the fishers. The DFAR of the Mannar district said that the fishers were complained regarding this issue earlier and they directed it to the NAQDA.
- NAQDA has identified a potential site for culturing crabs and shrimp in the vicinity of Achchankulam landing site, Mannar district. The representatives of the Fisheries Cooperative Society (FCS) of Achchankulam commented that they won’t accept aquaculture farming (even though the earmarked site is a state land) adjacent to their landing site as the mudflats and seasonal ponds act as traditional fishing grounds for women in the area. Women in the area used to collect Shrimps, crabs, milkfish, and mullet juveniles/fries in the seasonal ponds and it generate an additional income during rainy seasons. The establishment of aquaculture farm in the area will inhibit such seasonal activities.

- The "Shrimp trawl (Manual)" fishers also expressed the impacts they face due to the pen culture in the Jaffna lagoon. They said, the space remaining after the pen culture is inadequate for trawling. Though they are switching the fishing methods targeting the little deeper area of the lagoon and sea, the additional capital requirements, competition with other fishers in the new area, and seasonal issues are problems. Shrimp trawling can be practiced throughout the year along the shallow sea. But it is only possible only for six months period in the new location, according to them. They suggested that organizing the pen structures in a way to keep enough space to allow the trawling can avoid this situation.
- A fisherman in Anthoniyarpuram of Illuppaikadavai in Mannar district mentioned that though he lost his fishing ground for a sea cucumber farm, he managed to maintain his monthly income by switching the fishing ground and the fishing methods. He further stated that he had to invest around 75,000 LKR for this switching.
- Though there are no proper records available, few of the fishers and FCS believe that fishermen are selling their traditional fishing grounds to the aquaculture entrepreneurs and using that money to purchase fishing gears to move to a new location. A "Sirakuvalai" fisherman should invest around 2.5 million LKR to purchase new gears to move toward the deeper (<10m) sea.
- A "Sirakuvalai" fisherman in Mandaitivu, Jaffna mentioned that he has converted one of his traditionally owned "Sirakuvalai" fishing grounds into a sea cucumber pen culture farm. Though he had to invest around 6.5 million LKR as an initial investment for the Sea cucumber farm, his earnings from the first harvest were around 10.7 million LKR. He further stated that he was able to enjoy around 4.5 Million rupees of net income from his 2 acres of sea cucumber farm. He said that his living standard and social status is changed now, and he feels better physically and psychologically.
- A woman who is also the breadwinner of her family in Illuppaikadavai mentioned that her present income is regular and increased up to 30,000 LKR monthly after she started collecting Sea Cucumber Juveniles for the sea cucumber farms in her area. She said that her earlier income was not significant when she was collecting matured sea cucumber for the processing.

However, almost all the Fishery Societies and the fishers the SEA team met have experienced and understood the increasing trend of fishing effort and the declining trend of capture-based fishery production even before the commencement of the aquaculture farming at a large commercial scale in the province. In Jaffna lagoon, the number of fishers and the number of crafts used for fishing has increased since 2009, but the total landings declined gradually after reporting their maximum value of 6,958 Mt in 2012. A rough estimate of the maximum sustainable yield of the fishery of the Jaffna lagoon was 6,694 Mt with the annual fishing effort (FMSY) of 1007 crafts. The current fishing effort is higher than the FMSY, and the most significant portion of the catch was contributed by destructive fishing methods and gears. Normann et al. (2003) report that the province's fish resource could be considered over-exploited if the annual catch exceeds 35,000 Mt. The current catch is more than double that. More fishing efforts have been put over the lagoons and other coastal environments as offshore fishing is not conducive for every fisher at the moment Offshore fishery is also over exploited with dwindling fish stocks. Further, it was understood that there is no way to exclude newcomers enter into the fishery or to control the exploitation level of the existing

traditional fishery. The more the fish caught by the fishermen, the more the economic well-being of his family. There are no systems to encourage the fishers to conserve fish stocks.

The capture-based fishing industry that supports more than 40,000 fishermen families in the province could collapse in a long run due to the over-exploitation of the sensitive coastal environment. The ACBFSDP (2021-2025) proposes to produce 60,000 Mt of annual production and 30,000 employments through culture-based fishery by 2025. In this view, the culture-based fishery could be considered an alternate livelihood and opportunity to avoid over-exploitation of the coastal environment.

- A fisher group in Punkudutivu mentioned that they have chosen a shallow marine area through a participatory method for establishing a sea cucumber and sea bass farm. The FCS representing the fishers of the area, NAQDA, and other stakeholders together involved in the site selection process. This participatory site selection process could avoid most of the conflicts that aquaculture creates with the capture-based fishery regarding the space.
- Because he experienced a decline in the income from his "Sirakuvalai" fishery, a fisherman in Mandaitivu, Jaffna has converted one of his traditionally owned "Sirakuvalai" fishing grounds into a sea cucumber pen culture. He was able to establish 02 acres of Sea cucumber pen culture within the space he used to operate one unit of "Sirakuvalai" net. He stated that the annual net income he earned from the Sea Cucumber farm was almost 400% more than that of the "Sirakuvalai" fishery. And he further said that this income was generated without exploiting the declining wild fish stock. He is also happy that he has got enough leisure time to spend with his family and he is no more a fisherman but an entrepreneur now. He feels healthy and safe that he doesn't want to do a risky diving job to install "Sirakuvalai" nets now. According to him, aquaculture has impacted his socioeconomic status positively.
- A fishing women group in Iluppaikadavai, Mannar said that they have got together to start a sea cucumber pen culture. From their savings, they have accumulated part of the investment capital required for this purpose and looking to fill the gaps through any external financial assistance.
- The seaweed farmers of "Veravila" in Kilinochchi District also got into aquaculture activity while they were involved in fishing. They are very much positive about aquaculture and stated that they have the confidence that the aquaculture will be the solution to the socio-economic issues faced by the capture-based fishery. This shows that the small-scale aquaculture activities could reduce the pressure on wild stocks and can impact the local fisher's socioeconomic status positively.
- The FCSs are playing a great role in managing the fishery and solving the conflicts among their member fishers. In addition, they act as a bridge between the fishers and other related stakeholders. The DFAR and the NAQDA are dependent on the FCSs consent to issue an aquaculture license.

Meantime, the constraints and the bottlenecks the fishers facing at the moment to embark on the culture-based fishery should be tackled to have sustainable aquaculture as the NAQDA expects. The constraints and the bottlenecks identified through the SEA study are as follows.

- Financial constraints to commence the aquaculture farms
- Lengthy licensing procedures

- Lack of Insurance facility for aquaculture farms to get compensated for damages due to natural disasters such as cyclones and floods
- Lack of healthy stocking materials
- Lack of Participatory monitoring and Grievance handling system
- Lack of facilities for storage and value addition
- Concerns regarding security clearances from the security forces to access the aquaculture farms at any time

The NAQDA's plan can offset the present issues of capture-based fishery and the fishers while significantly contributing to the National GDP.

8.5 Chemical and organic pollution risks for aquatic environment and fisheries

Chemical and organic pollution risks in aquaculture may differ vastly from operation to operation. One of the main distinctions in aquaculture is closed versus open systems. Open aquaculture systems often involve a cage/pen/raft in water where fish are reared, fed, and then caught for processing. Closed aquaculture systems are systems that are land-based and utilize filtration and recirculation systems thereby removing the pollution risk of effluents being discharged into natural water bodies. However, semi closed systems have the risk of releasing treated/non treated effluent to adjacent water bodies. Likewise, comparison of alternatives such as intensive vs. extensive systems, monoculture vs polyculture and open water vs closed recirculating systems generate different levels of pollution risks.

Chemical impacts included pollution from organic and inorganic nutrients, and pollution from anthropogenic sources including toxic compounds, pharmaceuticals, and metals. Aquaculture can take a number of different forms and operate at various scales. It can vary from subsistence-level 'backyard' fish farming in the family pond to the industrial-scale production of thousands of tons from a single site, often destined for overseas markets. Aquaculture systems have mainly been characterized by their productivity, for example, from simple pond farms to high yield re-circulation systems.

Because mangrove habitats are intertwined with seagrass ecosystems, the loss of mangrove ecosystems could result in the loss of seagrass ecosystems in the lagoons. As a result, it could have an impact on fisheries in the related lagoon systems, as well as altering sedimentation patterns and land use configurations, which could lead to organic contamination.

Anticipated pollution impacts of the main coastal aquaculture practices suggested in the NAQDA plan are described below.

8.5.1 Seaweed culture in the shallow coastal areas

Site selection, preparation of culture area, culture operation and routine management, harvesting and transportation are the main activities carried out during seaweed farming.

Cultivation of seaweeds could contribute to mitigation of eutrophication in coastal waters through the significant uptake of dissolved Nitrogen (N) and Phosphorous (P) which contributes largely to eutrophication. Thus, seaweed farms can help to maintain or improve water quality through a process referred to as bioremediation or bio-extraction.

Extreme nutrient deprivation, on the other hand, may have an influence (oligotrophy), modifying the composition of primary producers and negatively influencing fishing production.

Furthermore, no further pollutant conditions have been projected as a result of seaweed cultivation.

8.5.2 Sea cucumber culture

Sea cucumber plays an important role in bioremediation, as they feed on seabed detritus, which is broken down internally, removing pollutants and toxins in the process. Hence, they can assist in the process of cleaning the seabed.

Hence, Chemical and organic pollution risks in sea cucumber culture is minimum.

8.5.3 Shrimp culture

Most common potential impacts of unregulated and unplanned shrimp farming are described below;

It is also useful to distinguish between extensive, semi-intensive and intensive farming systems when considering environmental effects of a shrimp aquaculture operation. According to the plan culture of *L. vannamei* will undergo through semi-intensive and intensive practices. In semi-intensive aquaculture, cultured organisms are kept at higher densities than in extensive systems. The culture media are often fertilized and supplementary feed may be provided. In intensive aquaculture, cultured organisms are kept at high densities and feeding is regular, usually in the form of especially prepared/manufactured feeds. Accordingly, higher chemical and organic pollution may have anticipated with semi-intensive systems. Closed intensive aquaculture systems are systems that are land-based and utilize filtration and recirculation systems thereby removing the pollution risk of effluents being discharged into natural water bodies. However, semi closed systems have the risk of releasing treated/non treated effluent to adjacent water bodies.

8.5.4 Fish cage culture

One of the most harmful aquaculture systems is open net-cage farming, which often takes place on the coasts of large bodies of water. It involves the use of large mesh fishing nets to hold the farmed fish, and there is no way to prevent waste from escaping into the water. Aquaculture waste can be separated into solid and dissolved waste, specifically carbon, nitrogen, and phosphorous. Solid waste is derived from uneaten and/or spilled feed and from fish feces. Dissolved waste comes mostly from metabolites excreted by the fish. These two types of pollutants grow within a location and eventually will reduce the water quality of that particular system. This waste can contain antibiotics, pesticides and fish feces which pollutes the open water and makes it unsafe for human drinking, recreational use, and for other wildlife.

Hence fish cage culture may negatively impact the environment through overfeeding fish and marine life. Lack of regulation combined with a lackluster feed plan can result in numerous negative influences on the environment. Nutrients that are not absorbed by the marine life are released out into the environment and the ecosystem must adapt to this pollution.

8.6 Spread of Diseases and Parasites

Spread of diseases is a major limiting factor in most aquaculture production. Disease epidemics, either from imported animals or from poor management can quickly decimate production. Disease management and surveillance is highly important in protecting wild stocks from infecting diseases and parasites from cultured species.

In addition, irresponsible use of antibiotics may increase local resistance to the diseases. Introduced exotic species such as *L. vannamei has the potential* to act as a carrier of various viral pathogens exotic to Asia.

The ACBFSDP suggests the adoption of intensified shrimp production in existing farms, use of Best Management Practices (BMPs) and use of Specific Pathogen-Free (SPF) shrimp stocks. The terms SPF denote the health status of a shrimp stock while Specific Pathogen Resistant (SPR) and Specific Pathogen Tolerant (SPT) status of shrimps, define genetic characteristics of stocks with reference to pathogens and disease. The plan further suggests to seek the possibility of combining strategies such as SPF+SPR, SPF+SPT or SPF+SPR+SPT in order to help shrimp farmers prevent disease outbreaks in grow-out ponds.

A phenomenon known as 'ice-ice' has been reported at farming sites of *Kappaphycus alvarezii* in the Northern province. The characteristic bleaching to white of the thalli gives 'ice-ice' its name; it is recognized as an indication of abiotic, physiological stress (e.g., due to fluctuations in salinity and temperature which seem to be the main causative agents) rather than being initially induced by a pathogen. The microbial "attack" is a secondary phase affecting the apical macroalgal tissues after being weakened by the physiological stresses. This, secondary effect is obvious in the form of complete necrosis of the thalli due to both bacteria and fungi, which were isolated from the affected thalli.

The most common pathogenic agents reported from cultured sea cucumbers are Bacteria and parasites. Cultivated holothuroids may suffer from a bacterial disease, called skin ulceration disease, that affects their body wall. The disease affects juveniles reared in a hatchery and the adults of *H. scabra* grown in sea pens.

8.7 Genetic impacts on wild stocks

Escaped fish have potential impacts on wild fish populations by outcompeting with them for food and other resources. The main reported problems are the displacement of native species, competition for space and food, and pathogens spread. The negative impacts of the "biological contamination" for the introduction of exotic aquacultural species on the native populations have been well documented (Naylor et al 2000; Shelton & Rothbard, 2006).

L. vannamei is an exotic species which is already introduced to the country and planned to be scaling the volume by the proposed aquaculture development plan indicating the benefits of intensification which need less energy uses per metric ton of shrimp yield.

Furthermore, it is documented that *L. vannamei* offers numerous advantages over *P. monodon* for the Asian shrimp farmer. These are largely associated with the ability to close the life cycle and produce brood stock within the culture ponds. This removes the necessity of returning to the wild for brood stock or post larvae (PL) and permits domestication and genetic selection for favorable traits such as growth rate, disease resistance and rapid maturation. This will be a positive impact of introducing *L. vannamei.*

There are, disadvantages to the importation of *L. vannamei*, including the main impact of its ability to act as a carrier of various viral pathogens exotic to Asia. However, the plan suggests to establish specific pathogen-free (SPF) shrimp stocks as an alternative to overcome the potential disease problems associated with shrimp aquaculture.

Kappaphycus alvarezii is another exotic species which has been already introduced to Sri Lanka. It has been introduced into the Gulf of Mannar Biosphere Reserve during the 1990s and it's recorded that escaped algae from cultivation sites have paved the way for its invasion into the coral reef ecosystem of Kurusadai Island in India (Kamalakannan *et. al*. 2014). Although it has been introduced to Sri Lanka in the same era, no invasive effects have been reported as yet.

8.8 Impacts on other non-formal resource utilization (agriculture, livestock farming, and other non-formal livelihood activities)

8.8.1 Potential Impacts on Agricultural activities

Though coastal land has low agricultural potential, rain-fed paddy cultivation being practiced with the aid of several saltwater extrusion schemes along the coastline of Jaffna and Kilinochchi districts.

Though there were no issues on the agricultural land use reported to any of the stakeholders until now, land-based aquaculture could have an impact on agricultural land use in the long run. The local authorities and departments made efforts to construct around 50 saltwater extrusion bunds to prevent saltwater intrusion along the coastal area of Jaffna and Kilinochchi. While these extrusion bunds improve the groundwater re-charge, they support paddy cultivation near the coastal area (around 1150ha). The land-based aquaculture farms could lead to saltwater intrusion, and they will usurp the purpose of the saltwater extrusion schemes. At the same time, owners of abandoned paddy land are engaged in illegal sand mining using aquaculture licenses. This has been reported in the Mannar district.

The aquaculture licensing process goes through the Divisional Secretariat of the area where land ownership and land-use patterns are assessed carefully before the recommendation for the license is given. The Divisional Secretaries who attended the stakeholder consultation stated that they do not encourage using productive agricultural land for aquaculture activities. The recommendation of the Department of Agrarian Services is vital in order to use paddy land for culture-based fishery activities. At the same time, NAQDA should ensure that aquaculture farms will adopt measures to prevent seawater intrusion and that no pollution is caused to adjacent agricultural land and the groundwater.

At the same time, the productivity of the coastal land is limited due to the salty and sandy soil. Furthermore, significant extents of barren and unutilized lands were observed within the study area. Utilization of this unproductive land for aquaculture will be a beneficial intervention for the people of the area.

The conversion of paddy land for any other purpose requires approval of the Agrarian Development Department. This can prevent the improper use of paddy lands for aquaculture. In addition to this, the NAQDA may include the consent from relevant farmer's organizations (FO) in the aquaculture licensing process. The FO can participate in the land-based aquaculture site selection process and their consent for the same should be mandated in order to issue the license.

8.8.2 Potential Impacts on Animal Husbandry

Animal husbandry is a significant subsidiary livelihood activity in the Northern coastal areas. It is the secondary source of protein of the coastal population and act as a means of livelihood during the off seasons of fishing. Cattle and goat rearing is significant along with backyard poultry rearing in the study area. Almost all the herds are managed extensively and allowed to open graze since there are no formal grazing lands. The entire open lands including the wetland, salt marsh, mangroves, and barren lands either state or private serve as grazing land for livestock throughout the coastal area. The development of land-based aquaculture will exert pressure on the availability of such grazing lands. The loss of these non-formal pasture lands will result in the economic displacement of individuals.

However, approximately 25,638 hectares of land (14.4% of SEA study area) within SEA study area found as open forests, grass lands, barren lands, grassland, scrub lands and other unutilized/unproductive lands are suitable for livestock grazing. Part of these lands can be converted into aquaculture farms under a careful land selection criterion.

8.9 Impacts on tourism

Although tourism is not a significant sector in the province, the Northern coastal area has well-known tourist locations attracting tourists throughout the year. The Northern tourist attractions Consist of a mixture of colonial charm and vibrant tamil culture, the string of remote temples, Hindu and Buddhist alike, beaches, and more off-beat attractions along the coastlines and islands. The Casuarina Beach in Karainagar, Nagadipa Purana Vihara, Naga Pooshani Ambal Temple, Delft Island, and Mannar Islands are a few such destinations. Northern tourism relies greatly on the natural and scenic beauty of the area, especially the coastal lands, water bodies, and islands.

The stakeholders pointed out that aquaculture farming within the Jaffna lagoon has heavily impacted the scenic beauty of the lagoon. The deterioration of the aesthetic value of such locations results in disturbance to tourism activities.

The tourism sites and potential areas for marine tourism activities should be avoided when selecting the potential sites for culture-based fishery activities. Also, the NAQDA can provide a standard design and specifications for aquaculture farms which will ensure the aquaculture facilities are visually attractive to tourists and are environmentally friendly. The aquaculture industry will attract specific groups of tourists like business groups, academics, students, and researchers to the area.

8.10 Impacts on Cultural heritages and religious places

The aquaculture farming sites may disturb the access paths to cultural heritage or sacred sites. It is common to see archaeological monuments and sacred places along the coastal regions of the Northern province.

The locations with cultural heritages and religious places should be avoided when selecting the potential aquaculture sites. A participatory site selection process for aquaculture projects may be the best method to ensure such places are not adversely affected.

8.11 Impacts on the Local Economy

As described under section 8.4, loss of fishing grounds, loss of access to fishing grounds and landing sites, loss of harvest due to pollution, and exploitation of wild aquatic life for aquaculture purposes would negatively affect the fisher's income and thereby the local economy. The dependence of a

larger portion of the fishers (around 35,000 families) on coastal fishing in the study area makes this impact severe and significant. The current socioeconomic condition, which is highly vulnerable and depends on coastal resources, will worsen this impact. While the province's contribution to the National GDP is very insignificant, agriculture, including livestock and fishery, contributes 14% of the province's GDP.

However, the revenue earned from aquaculture from a unit area is very much higher than the capture-based fishery. The sea cucumber pen culture farmer has earned 400% higher income than he was earning from his "Sirakuvalai" fishing. In addition to this, aquaculture creates several permanent and temporary employment opportunities as discussed in section 6.2.5.

Animal or aquaculture feed crop cultivation within the province is not common at the moment. Almost all the feed materials and formulated feeds for animal husbandry and aquaculture farming are brought into the province from other parts of the country or from other countries. As per the Export Development Board (EDB), in the year 2017, the total feed produced by the Sri Lankan feed industry was around 1,182 Mt and this is only 57.4% of the total requirement. The shortage and higher demand for such feeds have already made their price very high. It has already increased the cost of production of aquaculture. The further development of aquaculture as being proposed by NAQDA will drastically increase the demand and price of the feed materials which will negatively affect the animal husbandry industry. The micro and macroeconomic impact of shifting essential/staple crop (Paddy, vegetables, and other field crops) production into commercial crops (Soy, Maize, etc), usage of low-priced proteins (trash fish, slaughterhouse wastes), and the importation of feed materials should be studied well as it will affect the value chain of other industries too.

8.11.1 Risks and intolerable losses due to disease and natural disaster

Aquaculture, despite being a successful and profitable commercial activity, also involves the risk of large-scale losses due to diseases, parasites, oxygen depletion, freshwater kill, and more. This is a strange phenomenon for fisher folks. The Seaweed farmers and Sea cucumber farmers of Mannar, Kilinochchi, and Jaffna districts stated that they have faced severe economic loss due to the freshwater intrusion during the heavy rain periods of the year. Both the Seaweed and the Sea cucumber is very sensitive to fresh water. The affected aquaculture farmers stated that they have managed to pay back the bank loans with their income from other sources like capture-based fishery through the aquaculture failed to generate income in such instances.

Convenient financial facilities, insurance facilities, and technical support should be made available within an accessible distance to the aquaculture farm operators.

8.11.2 Becoming dependent on private industries and value chain

The capture-based fishers engage in fishing where fish is available and sell the catch to a particular buyer or in the open market. But aquaculture is mostly a part of value chain, since farmers rely on input from suppliers and limited buyers. The seaweed farmers in the study area commented that they were bound to supply their harvest to a particular buyer due to the monopoly or a forward sale agreement they have entered with the buyer. This phenomenon may create a situation where the independent local community would become dependent on other external entities for their survival.

8.11.3 Substantial and Subsidiary income to local communities

While a few local level entrepreneurs invest in aquaculture to generate substantial income, it was observed that the capture-based fishers showed interest in embarking on aquaculture. They consider it as an alternate method to earn a subsidiary or substantial income. Investing an insignificant time on a few units of seaweed raft daily will earn a subsidiary income for the family.

The proposed aquaculture development program is also likely to generate direct and indirect employment opportunities at the local level concerning civil works and farming activities. This creates an opportunity for locals to enroll in formal employment with connected social safety net provisions within their locality. 02 acres of Sea Cucumber pen culture can be established within a space used for a unit of the "sirakuvalai" fishery. This farm can be shared among two beneficiaries, and it will generate 5 full-time employments (security cum pen maintenance persons), 80 person days of employment for sea cucumber juvenile collectors (if the wild-caught juveniles are used as stocking material), and another 100 person days employment for pen installation. People who are retired from fishing due to aging are employed as full-time employees. Same time, the wild juveniles' collections are mostly done by women. In such a way, aquaculture produces comparatively more employment opportunities for a unit area and gives employment opportunities for vulnerable people. The substantial increase in aquaculture will positively affect the fishing population, especially the younger generations. This would be a great advantage and opportunity for women too.

Additionally, this will create service providers to cater the needs of in-migrant laborers such as restaurants/food stalls, owners of rental accommodation, transportation providers, etc.

8.11.4 Women and the vulnerable become active income generators

Though segregated data on women's contribution to the fishing industry is not available, women significantly contribute to the fishing industry of the province. They are involved in activities such as net repairing, net mending, sorting of catches, selling fishery products, dry fish production, and collection of seashells. With the development of aquaculture, women's involvement in seaweed farming, sea cucumber farming, and collection of wild sea cucumber juveniles for culturing became significant. The women's working hours per day varies with the season.

A 55-year-old woman in Illuppaikadavai, Mannar involves in sea cucumber collection since her 15 years of age. She said the income was very minimal earlier that only larger animals had the market. But later when the sea cucumber pen culture was commenced in her area, a market also opened for wild-collected sea cucumber as stocking material. She is engaged in collecting juveniles and her current monthly income is between 30,000 LKR to 50,000 LKR. Though her daily income is highly varying, she had earned around 13,000 LKR on the day the SEA team met her. Around 75 women are engaged in sea cucumber collection. They are very positive about sea cucumber farming, and stated that they are getting organized as a group to start their own sea cucumber pen culture.

Handling the fishing gear of capture-based fishery could be a difficult task to be involved for women. But aquaculture in shallow water, especially seaweed farming might be a promising income generation activity for women to become an independent income generator within family.

8.12 Impacts on Land Ownership and rights

The land titling is in a premature stage in the Northern Province due to the 30 years conflict period, and the land registration process is ongoing. It should also be noted that many people have yet to

claim ownership of their lands after the civil war. While these land parcels may be categorized as unknown or state land (based on land use), there is a possibility that the owners might claim the land at a later stage. The proposed aquaculture development plan has a potential physical and economic resettlement impact, and no avoidance criteria have been proposed in the program.

When considering the marine-based aquaculture farms, the territorial customary right of the fishers that have been passed through their generation is at risk, especially when the farm is licensed to an external entrepreneur. Further, the conflicts may arise within the family when other members of the family are opposing the conversion of a family-owned fishing territory into an aquaculture farm by a family member. This situation creates social vulnerability among the fishing communities.

However, the participatory site selection process and the licensing process being adopted for aquaculture projects can avoid land losses and can ensure the industry doesn't cause physical or economical displacement. NAQDA can adopt the National Involuntary Resettlement Policy of Sri Lanka and the Social safeguard Policy of the World Bank to mitigate any physical or economic resettlement impacts along with other applicable policy frameworks in this regard.

8.13 Labour Influx and Labour Welfare

Though the stakeholder consultations conducted by the SEA team couldn't identify any negative impacts due to the labor influx due to the aquaculture industries, there could be a gap in the experience and educational attainment of the local labor force to get involved in proposed aquaculture activities. In this case, the aquaculture industries will hire laborers from outside the project area. The existing large-scale private aquaculture farms bring skilled workers from overseas (from India especially). The interaction between the local community and migrant laborers may create interpersonal and communal conflicts due to differences in cultures, beliefs, social practices, food habits, etc. These interactions can also lead to the spread of infectious diseases. Furthermore, the influx of laborers in the short term will increase the demand for necessities and burden local resources, including water, food, electricity, etc. This may result in additional pressure on scarce resources such as water for the local community.

Anyhow, the consultation with the host community of a large-scale land-based shrimp farm in the Mannar district revealed that no negative impacts are being felt in this regard. The shrimp farmworkers recruited from other areas are mostly spending their time on the farm and very rarely visit the villages. The interactions with the villagers are very minimal. Same time, the farms are giving priority to the local labor force to handle this issue. The owner of a shrimp farm that is under construction in Mannar stated that 100% of his workforce will be recruited from Mannar and they will be trained and supervised by an external consultancy firm. He trusts that this arrangement will solve most of the issues connected to labor welfare.

9 Identified Major Gaps on different aspects in aquaculture development

Gaps identified by the SEA team through the Consultation of government and private stakeholder agencies and community consultations are presented below.

9.1 Site selection

Ad hoc site selection by the project proponents has been identified as a major shortcoming of the aquaculture industry. Because of this, individual aquaculture projects require to undergo lengthy, complex and expensive approval processes.

Siting and managing aquaculture at the farm level is not sufficient to mitigate the cumulative negative environmental impacts of all resource users, and often prove detrimental to aquaculture industries by creating user conflicts and failing to protect aquaculture from the impacts of other industries.

Improper site selection in relation to culture species, without conducting proper feasibility studies may affect the success of the operations and economic viability of the projects.

9.2 Licensing (Aquaculture Management License) procedure

The current requirements for permission to engage in coastal aquaculture activities reveals several overlaps between various approval processes across multiple levels of authority and involves submission of separate applications to multiple authorities which result in delays in the approval process. The major gaps identified in the existing licensing procedure are follows;

- Delays in the obtaining no objection/ consent from the host community and FCS/RFS
- Community objections/ complaints since socioeconomic screening or assessments are not mandated for small-scale aquaculture farms where EIA/IEE is not required
- Delays in obtaining consent/approval from individual stakeholder agencies (as it is required to submit separate applications to multiple agencies such as Divisional Secretary, Local authority, DFAR, CEA, CC&CRMD etc.)
- Delays in obtaining environmental clearance (EIA/IEE approval) for individual aquaculture projects
- Delays in the annual renewal of license
- Absence of a properly designed GRM to address environmental and social related grievances

9.3 Management and monitoring of aquaculture farms

Prevailing institutional capacity for the management and monitoring of aquaculture farms is not in an adequate level for the implementation of the scaling up of aquaculture according to the ACBFSDP (2021-2025) in the Northern Province.

At present, disease management mechanism exists for shrimp farming which is the major export commodity of aquaculture in Northwestern and Eastern Provinces. Mechanisms or surveillance programmes for other species are lacking.

Even though farmers had knowledge of biosecurity, the lack of financial resources was a major impediment to improved disease control especially for the smallholder farmers.

9.4 Monitoring of social aspects in aquaculture projects

The post-licensing social monitoring of the aquaculture industries is absent at the moment. According to the FCS representatives, the aquaculture proponents actively interact with them to obtain the consent of the society for licensing purposes. The fishers expressed their dissatisfaction regarding the lack of interactions between aquaculture farmers and them after obtaining the consent of FCS for Aquaculture Management License.

The impacts the aquaculture industries cause on the host communities have not been studied yet and a transparent mechanism for monitoring and evaluating such impacts is not available. The host communities are of an opinion that the relevant stakeholders are inadequately regulating the farms, which causes risks to their livelihood. It was also observed that the FCSs approach several stakeholders to limit or restrict the expansion of aquaculture in their vicinity to protect the traditional fishing grounds. The FCSs are dissatisfied that their efforts are failing to produce favorable results and that none of the stakeholder agencies listen to their grievances positively.

Furthermore, the entrepreneurs believe that the absence of a social monitoring mechanism for their farm causes them unlimited social responsibilities. As per their views, a lot of CSR activities are being carried out for the betterment of the host communities.

9.5 Non-compliance with Resettlement Policies

The National Involuntary Resettlement Policy (NIRP) prescribed to prepare a Resettlement Action Plan (RAP) to handle the involuntary resettlement induced by a land acquisition for any development projects. The aquaculture projects those are greater than 4Ha in extent will be subjected to IEE/EIA process as per the NEA. Socio-economic impact assessment will be an inbuilt requirement for such projects as per the NIRP, which is an integral part of the IEE/EIA as the CEA is the responsible authority to implement the NIRP.

In other cases, community consultations and socioeconomic screening or assessments are not mandated for small-scale aquaculture farms. Accordingly, the regulation related to the social safeguard of the aquaculture projects that are less than 4 Ha on extent is unclear.

However, the NIRP highly looks into the impacts that are relevant to the land acquisition-induced resettlement impacts. The aquaculture activities, either land based or water-based, cause non-land losses such as economic losses by competing for livelihood resources, restricting access to the resources, polluting the natural resources that are being used by local communities, etc.

None of the stakeholder organizations have legally sound compensation and resettlement process for the non-land economic losses the aquaculture causes to the capture-based fishers. The NAQDA's development plan does not mention regarding the application of the NIRP and other local and international social safeguard policies during the implementation of small scale (less than 4 hectare in extent) aquaculture projects.

However, adopting a safeguarding policy, especially an international policy, to assess and mitigate the potential social impacts of the ACBFSDP (2021-2025) is crucial to ensure the acceptability of the industry both locally and internationally. Additionally, a legally sound policy will facilitate licensing process too.

9.6 On Financial incompetence of local fishermen

The requirements of the financial institutions to provide loans, are not compatible with the capability of the small-scale entrepreneurs proposing aquaculture farms. The loan applicants have to submit two personal guarantees from state employees in order to obtain a personal loan to invest in aquaculture. Finding such guarantors and mortgages are almost impossible for small scale entrepreneurs such as fishermen.

9.7 On Evaluating the climate change related impacts

Measurements and information related to climate sensitive areas and a proper data base on parameters such as sea surface temperature and sea level rise, etc. are not available for the Northern Province. This factor limited the extent to which the analysis could be carried out including the accuracy of the predictions.

10 Recommendations

10.1 Recommendations on Aquaculture development process

10.1.1 Site selection

The Opportunity and Risk map developed under this SEA should be utilized during the establishment of new Aquaculture Development Zones as well as new standalone industrial scale, Small and Medium Enterprises (SME) type or community led aquaculture projects.

The Opportunity and Risk map has proposed a zonation of the Northern Province coastal belt (as described in Section 3.3) with four different categories to guide future coastal aquaculture development and expansion.

- No Go zones where aquaculture development should be strictly prohibited. These are legally protected under relevant legislation such as the Forest Ordinance, Fauna and Flora Protection Ordinance, Coast Conservation Act, National Environmental Act and Antiquities (Amendment) Act No. 24 of 1998
- High Risk Zones where aquaculture development should not be allowed excepting in exceptional circumstances where benefits of a proposed aquaculture investment would far outweigh the losses through necessary economic and environmental studies and with the required mitigation measures that will mitigate and/or offset unavoidable impacts.
- Medium Risk Zones where aquaculture development should be allowed with proper environmental and social due diligence and sound mitigation strategies.
- Low Risk zones are most suitable for aquaculture development and should be prioritized for investments following the necessary due diligence process.

The above classification should be read in conjunction with Tables 14,15 and 16 on pages 66 and 68 where the spatial dimensions in terms of extent in hectares and as a % of total available space for coastal aquaculture farming in every district, under each category both in the marine and land areas, have been estimated.

It should be noted that, the Opportunity and Risk map provides a broad-scale sensitivity rating across each of the land based and marine based study areas in the Northern Province. While this SEA attempted to be spatially explicit, several sensitivity indicators could only be identified as geo-referenced points. Spatially scaled sensitivity demarcations within the study areas will need to be refined prior to the use of these maps for permit allocations.

It is strongly recommended that NAQDA should identify potential Aquaculture Development Zones (ADZ) for each species proposed in the ACBFSDP (2021-2025). Aquaculture farming zones should be identified for both land-based and marine -based aquaculture development and the activities allowed within a given Aquaculture Development Zone should be clearly set out. Priority should be given to siting new aquaculture projects within these planned zones as far as possible. Standalone aquaculture projects which are outside approved Aquaculture Development Zones should be discouraged other than for community led aquaculture projects.

Establishment of new aquaculture projects within approved Aquaculture Development Zones has several very important advantages for the aquaculture developers as well as NAQDA and other regulatory institutions.

Since all the low and medium-risk areas depicted in the SEA may even not be suitable for aquaculture development, proper technical feasibility studies should be conducted prior to the selection of new Aquaculture Development Zones to determine sites' suitability for aquaculture investments.

The major factors that define the viability of a zone for aquaculture practices are basic topography/ bathymetry (i.e., available flat land or open water), temperature, current velocity, and water quantity and water quality (e.g., salinity, hardness). These factors determine whether the species that can be cultured efficiently in a particular area, and give a broad indication of the production system that is best suited. The existing aquaculture farms also has an influence on where new aquaculture farms should be placed. In addition to the general suitability, the presence of critical infrastructure, such as roads, power facilities, access to feed and processing facilities etc. should be considered for clustering of aquaculture farms.

Comprehensive EIA/IEEs should be carried out for the proposed Aquaculture Development Zones, complete with public consultation and disclosure as required under the NEA, where the baseline ecological and social conditions will be recorded, and appropriate measures proposed in order to minimize any adverse impacts on these areas and the surrounding receiving environments. Aquaculture projects which will be sited within the approved Aquaculture Development Zones will benefit from the zone level EIA/IEE and need not to undergo detailed IEE/EIA prior to establishment of operations. Therefore, the SEA recommends a simplified approval process for individual projects sited within ADZs that consists of a basic assessment process comprising of a detailed screening questionnaire and a site-specific verification by Aquaculture Technical Committee which consists of representatives of line agencies, to prepare a compliance statement confirming the suitability of the site using supporting documentation provided by the applicant such as site plans, technical drawings of facility layout, title deed and/or valid lease agreement, species to be cultured, culture methods as well as pollution minimization methods if any.

Projects within the ADZ will be required to abide by the approval conditions imposed on the ADZ during the EIA/IEE approval process for the zone. As such, the approval of individual aquaculture projects within the ADZ has to be subject to strict conditions imposed by the regulatory institutions and should be explicitly referred to in the Aquaculture Management License.

Investors should be encouraged to establish new aquaculture projects only within approved Aquaculture Development Zones as far as possible, as this makes the monitoring of the projects easier for the regulatory agencies. However, there may be standalone aquaculture projects, outside the Aquaculture Development Zones proposed by community/Fisheries Cooperative Societies. In the event that a new aquaculture development project is proposed outside an approved Aquaculture Development Zone, it should follow proper environmental and social safeguards due diligence as suggested in the section 10.1.2 below.

10.1.2 Licensing (Aquaculture Management License) procedure and safeguards due diligence.

At present, the issuance of an Aquaculture license follows a cumbersome process which is a barrier for attracting investments and mobilizing private sector capital to develop the sector (described under 9.2). To address these legislative barriers and to reduce the inherent delays in the multi-layered approval process the SEA strongly recommends the development of an integrated decision-making platform for coastal aquaculture projects – a 'one-stop-shop' that will simplify, systematize and unify of all government approvals to issue the operating license as a comprehensive service to prospective aquaculture investors.

The aquaculture licensing process, including its renewal, should be streamlined as per the following suggested approval procedure in order to avoid unnecessary bureaucratic delays. It is proposed that NAQDA first develops a streamline approval process and enter into MOUs with respective key stakeholders. The MOU will outline terms of conditions of the agreement reached between NAQDA and the stakeholder agency based on the understanding that aquaculture development in the Northern Province would conform to the environmental and social risk minimization plan proposed in this SEA. The MOU should well define each parties' responsibility in executing the agreement to ensure each organizations' mandates and requirements are addressed. It is suggested that the new Resource Development Center (RDC) proposed in the ACBFSDP (2021-2025) takes a lead role in coordinating the streamlined aquaculture licensing procedure. A comprehensive checklist should be developed to be part of the application for Aquaculture Management License that will indicate the 'approvals' required for the proposed project, processing time and fees. An online platform would be most suitable for this purpose where the prospective investor could check the status of his application at a given time.

Proposed Procedure for environment and social safeguards due diligence to be followed when issuing Aquaculture Management License for new aquaculture projects

The SEA recommends that all aquaculture projects approved by NAQDA need to follow an appropriate environmental and social due diligence process, irrespective of the magnitude, commensurate with the anticipated risks and impacts identified through the screening checklist/questionnaire. In order to expedite the approval procedure without compromising safeguards due diligence, the SEA recommends a simplified processes to be followed in approving new projects within and outside approved aquaculture development zones (ADZs), as described below.

1. **Aquaculture projects that are within an approved ADZ:**
   For this category, NAQDA would be required to apply the simplified approval procedure. This procedure would consist of a (i) basic assessment of the site within the ADZ with a safeguards screening checklist and (ii) a site-specific verification by Aquaculture Technical Committee which consists of representatives of line agencies, to prepare a compliance statement confirming the suitability of the site using supporting documentation provided by the applicant such as site plans, technical drawings of facility layout, title deed and/or valid lease agreement ,species to be cultured , culture methods as well as pollution minimization methods if any. . It must be noted that this procedure could be applied for the ADZ which has already undergone an IEE or EIA with required national level clearances and

approvals. SEA strongly recommends that new aquaculture projects in the Northern Province are sited within approved Aquaculture Development Zones (ADZs).

2. Aquaculture projects that are outside ADZ:

First step in exercising environment due diligence for projects located outside the approved ADZ, is to verify the geographical location of the project with the Opportunity and Risk Map prepared during the SEA study. Aquaculture projects are strictly prohibited within the No Go Zones and not recommended for high-risk zones whereas the other two zones are recommended for aquaculture development with well-planned mitigatory measures.

All projects outside ADZ falling within the medium and low risk areas indicated in the Opportunity and Risk map, should be screened for anticipated type and scale of impacts to determine the need and extent of environmental analysis required, using a comprehensive screening checklist/questionnaire. This questionnaire should be comprehensive enough for NAQDA and the other environmental agencies to evaluate the potential impact of the project on the natural and social environment and should contain required details regarding the project, anticipated generation of wastewater and solid waste quantities generated, proposed method of management of such waste, key characteristics of the surrounding environment etc.

The screening outcome will determine action under two scenarios.

Projects with aquaculture farms exceeding a total extent of 4 hectares: The National Environmental Act requires that all aquaculture farms that are more than 4 hectares in extent to be subjected to environmental approval under the National Environmental Act, for areas outside the legally defined coastal zone. As such, all farms exceeding this hectarage, the national EIA approval system will kick in. It is envisaged that for proposed projects within low-risk areas identified in the map, an IEE would suffice and for those falling within medium risk areas would require an IEE/EIA depending on the screening decision.

The relevant PAA and the environmental evaluation procedure (IEE/EIA) for high risk, medium risk, and low risk areas will be determined by the scoping committee which consists of CEA, provincial CEA, CC&CRMD, Forest Department and DWC depending on the locality.

Projects with aquaculture farms under a total extent of 4 hectares: These projects will not be required to undergo the environmental approval process under the National Environmental Act. It is strongly recommended that the Aquaculture Technical Committee ensures that a minimum environmental due diligence process is followed, as per the outcome of the screening process. For example;

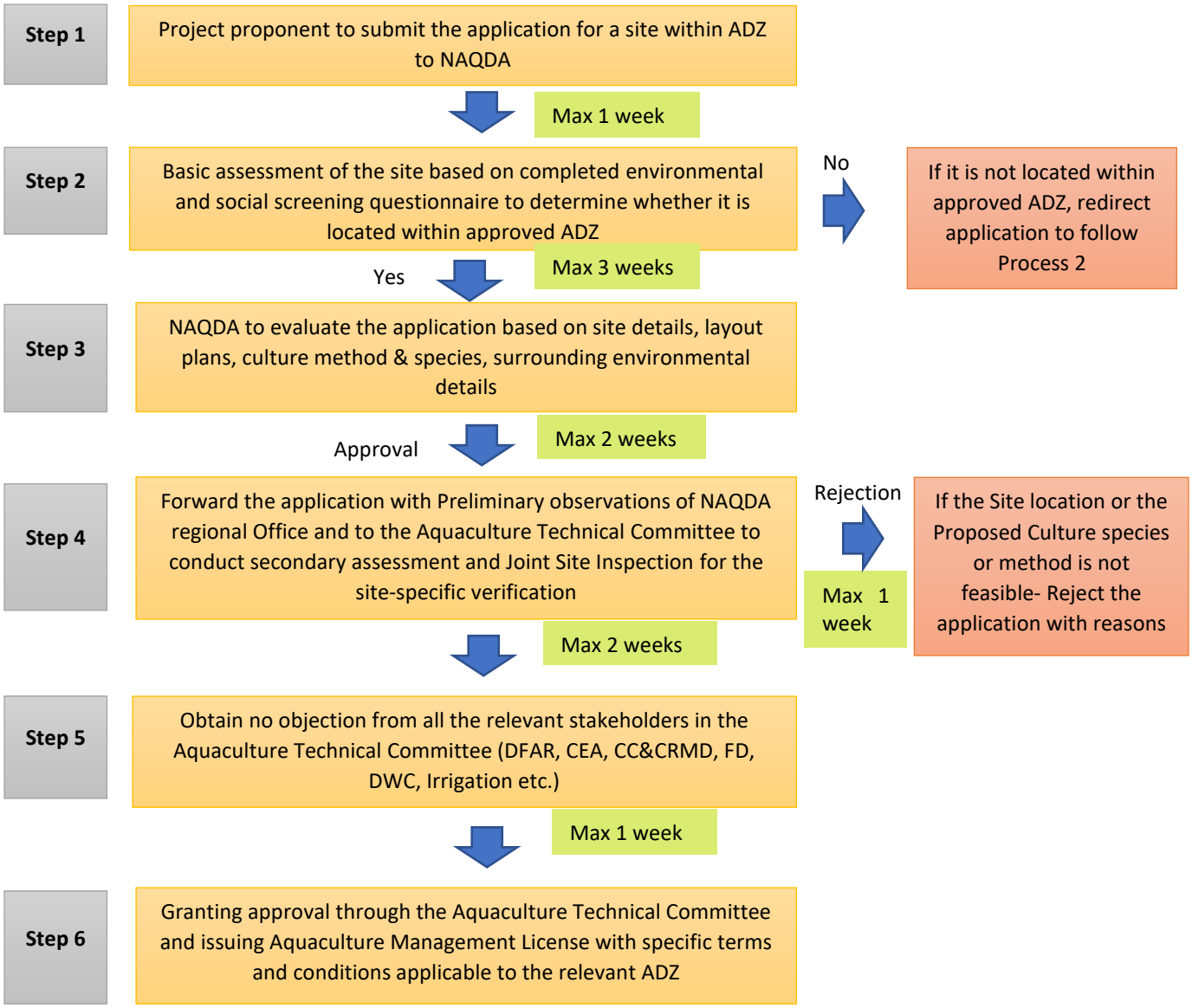
- SME type of aquaculture projects: A site specific Environmental and Social Management Plan be prepared covering the constructional and operational phases.
- Community/CBO owned aquaculture projects: Environmental and social good practices in the form of code of conduct be made available and included in any MOU that may exist between the CBO and NAQDA.

Projects within Coastal Zone and within buffer zones of wildlife protected areas: In the event the proposed site falls within the coastal zone or the buffer zones of, as defined in the coastal

resources and coastal zone management act, a decision on the level of environment assessment will be taken by the CC&CRMD and the DWLC as per the laws governing the respective area. For unified and streamlined environmental approval for new aquaculture projects outside ADZ, NAQDA should aim to reach consensus with CEA, CC&CRMD, DWLC and other key stakeholders on the due diligence process outlined above.

For the Medium Risk Areas, IEE or EIA will require to be carried out only if the proposed site is above the threshold limit (4 ha in extent) as specified in the NEA. However, for the sites below the threshold limits (<4 Ha) in Low and Medium risk areas, Aquaculture Management License could be offered by the Aquaculture Technical Committee, after obtaining the No objection from relevant stakeholders. If the proposed site falls within the High-Risk Area under any exceptional circumstances, an IEE/EIA should be carried out irrespective of the magnitude of the project.

Process 01: Approval Procedure for proposed aquaculture projects within approved Aquaculture Development Zones (ADZ)



Process 02: Approval procedure for proposed aquaculture projects situated in Low Risk, Medium Risk, High Risk zones outside the approved aquaculture zones

Step 1 — Project proponent to submit the application to NAQDA with project details (location map with geographical coordinates, layout map)

↓ Max 1 week

Step 2 — Questionnaire based assessment to determine whether the site is located within/outside the approved ADZ

↓ Yes

Step 3 — NAQDA to determine the geographical location of the proposed project in relation to the ORM defined zones (NGA, HRA, MRA, LRA) in the SEA

→ No: If the site falls within NGZ reject or recall application with an alternative site

↓ Approval — Max 5 weeks

Step 4 — Forward the application with Preliminary observations of NAQDA regional Office, to the Aquaculture Technical Committee to conduct secondary assessment and Joint Site Inspection for the site-specific verification

→ Rejection: If the Site location or the Proposed Culture species or method is not feasible- Reject the application with reasons

↓ Max 1 week

Step 5 — Determine the requisite environment evaluation procedure (IEE/EIA) & the relevant PAA based on the magnitude and the geographical location of the proposed site in relation to the ORM

5A - Site located in LRA - undergo an IEE or simplified Checklist/Questionnaire for the sites above the threshold limit (4 Ha)

5B - Site located in MRA- an IEE or EIA will require to be carried out only if the proposed site is above the threshold limit (4 ha in extent) as specified in the NEA

5C - Site falls within an HRA- an IEE or EIA should be carried out irrespective of the magnitude of the project

→ Max 2 weeks: For <4 ha farms of 5A and 5B, obtain no objection from relevant stakeholders and granting approval and issuing Aquaculture Management License through the Aquaculture Technical Committee

↓ Max 8 weeks

Step 6 — Submission of the IEE/EIA to the PAA by the project proponent (To be decided by Project Proponent)

↓ Max 2 weeks

Step 7 — PAA to Review IEE/EIA and grant environmental approval or reject with reasons, and decision informed to NAQDA

↓ Max 1 week

Step 8 — Granting approval through the Aquaculture Technical Committee and issuing Aquaculture Management License with specific terms and conditions applicable to the relevant ADZ

10.1.3 Management and monitoring of aquaculture farms

a) Monitoring of aquaculture projects

Monitoring of aquaculture projects during operation is crucial in order to ensure that these projects are functioning in a sustainable manner and are adhering to the approval conditions imposed during the environmental approval process. It is important that NAQDA develops a robust Environmental Monitoring Framework (EMF) for coastal aquaculture projects which will provide comprehensive guidelines and protocols on how environmental monitoring, both compliance and environmental trends, should be conducted and reported in order to inform decisions about future activities and management of existing activities.

For ADZs monitoring is recommended to be conducted at two levels:

1. **Compliance monitoring of wastewater quality** - testing of effluent discharge by individual farms and the final discharge from the zone to the external environment as per frequency specified by the EPL or a minimum of two samples a year. Compliance monitoring should be carried out by the aquaculture operators and reported to NAQDA and the CEA for renewal of the aquaculture license and EPL, respectively.

2. **Environmental quality monitoring of the receiving environment** – Monitoring changes to biodiversity, sediment/soil, water quality etc. The responsibility of carrying this will be with NAQDA through an independent consultant with financial contributions from the individual businesses operating within the zone in the form of a management fee. It is important to ensure that this environmental monitoring be carried out by an independent third-party reporting directly to NAQDA for the purpose of monitoring the cumulative impact of cluster farms within a selected aquaculture zone.

For aquaculture farms operating outside ADZs monitoring is recommended to be done at two levels:

1. **Compliance monitoring of wastewater quality**: It is suggested that for the large scale aquaculture projects greater than 4 ha in extent located outside ADZs are made to self-monitor and submit the required wastewater quality and other reports to NAQDA at least on a bi-annual basis. These reports should contain information such as the species farmed, stocking volume, production achieved, sales channel (domestic or export), diseases/mortalities encountered, feed used, ambient water quality and effluent quality reports, as a mandatory requirement. The renewal of the annual license should be based on submission of self-monitoring reports. The performance of the farms on waste management should also be linked to the Environmental Protection License (EPL) which is required to be obtained by large scale aquaculture farms which release wastewater exceeding the permissible levels into the environment.

   The relevant agencies including NAQDA, CEA and CC&CRMD could then carry out monitoring as and when required, in order to confirm the data included in the self-monitoring reports prepared by the project proponent on bi-annual basis and for

annual license renewal purposes. As such NAQDA should arrange an accountability mechanism for the large-scale farms.

2. **Environmental quality monitoring of the receiving environment**: For areas that hold standalone farms, SME type and community led cluster farms Annual Environmental Monitoring reports prepared by NAQDA is recommended. However, for large scale stand-alone farms exceeding 10Ha in extent, the annual environmental monitoring report should be prepared by the project proponent through a recognized independent consultant.

It is important to note that monitoring should be carried out in an area outside the identified zones for aquaculture production that is free from pollution to be used as a reference site against which negative impacts from aquaculture on the environment can be assessed, and within each area to assess impact where approvals and/or licenses have been issued. Monitoring should be carried out in the approved and/or permitted area before production begins as a baseline study to assess conditions, which will form part of the EIA/IEE baseline study. For the aquaculture projects where IEE/EIA is not required, baseline environmental measurements of ambient water quality and ground water quality should be carried out before production begins in order to assess baseline conditions. Further monitoring should be carried out at specified intervals once the site is in operation, in order to detect pollution trends.

b) Development of Good Management Practice (GMP) guidelines and technical manuals

Good Management Practice (GMP) Guidelines for aquaculture should be developed by NAQDA in consultation with NARA that would result in improved yields, reduction of disease occurrence and high profitability. These guidelines should be made freely available to both large and small-scale aquaculture developers within ADZ as well as outside ADZ.

It is recommended to develop these GMP guidelines and technical manuals in the local language (Tamil and Sinhala), for each candidate species and culture systems planned in the ACBFSDP (2021-2025). These should aim to provide aquaculture farmers sensible and practical guidelines to follow in the planning, management and operation of their farms. Such guidelines will be useful in ensuring the continued sustainability of aquaculture projects. Lessons learned from the past as well as international practices and the latest scientific research findings could incorporate to these guidelines. The GMP guidelines will encourage responsible and sustainable production by both investors and local community while improving their skills, capacity and practices.

In addition, each ADZ or management unit should have an operational manual containing production guidelines and management measures following the good management practices and serve as the guideline for all the activities inside the ADZ.

The guideline should cover zone and farm location, layout and design, biosecurity sanitation and hygiene, waste storage and removal, good farm management measures, including feeds and feeding, farm effluent treatment, worker health and safety, disease diagnosis, treatment and chemical use, harvesting, post-harvest, traceability and food safety.

This must be balanced with providing sufficient space between 2 farms, so that effluents and diseases from one farm cannot be transferred into another.

c) Biosecurity, genetics, and disease control

Aquatic animal biosecurity as a whole can be defined as being a component of overall aquatic animal health management.

A high level of biosecurity management and planning is required within hatcheries, holding tanks and aquaculture production systems in order to limit the introduction of pests and diseases and to effectively identify biosecurity risks. Farm operators should undertake routine surveillance in and around coastal and marine farm structures, associated vessels and infrastructure for indications of non-native fouling species.

Suitable management practices should be ensured in each ADZ identified by NAQDA, and planning measures should be in place to limit the possibility of genetic interactions between farmed stock and wild populations. A well-maintained control system is required to reduce the possibility of escape and to develop and implement recovery procedures for escapees from farms regarding to the exotic species introduced.

Quarantine of seeds should be ensured for each candidate species considered in the NAQDA Plan. Also, necessary action should be taken to eliminate pathogens using therapeutic chemicals or improved farm management. Implementation of pre-determined carrying capacities for each species would help to limit the spread of diseases and parasitic infections.

Stock health monitoring programmes for each species should be formalized through regular inspections, record keeping on treatments. Only approved veterinary chemicals should be used for the treatment of disease and parasites. It is suggested that the National Center for Aquatic Animals and Aquatic Plant Health Management, and Certification (NCAAAPHMQC) should be the focal point for the purpose.

Prevailing disease management system and GMPs for shrimp culture in Northwestern Province could be adopted in the Northern Province shrimp culture health management. Further, disease surveillance plan for all the cultured species should be established with the involvement of relevant stakeholders such as regional universities, NARA and the private sector by NAQDA as there is no implemented surveillance, monitoring and reporting system for aquatic animal diseases in Sri Lanka. Enhancing contingency planning for responding to a disease emergency is also necessary. To achieve such results, it is necessary to maximize the existing resources and organize the laboratories appointed to investigate such occurrences under systematic approach. There should be a well-equipped disease diagnose laboratory established in the Northern Province for health management of proposed aquaculture. Aquaculture farmers should aware on available different laboratory facilities and disease reporting systems.

d) Compliance with wastewater discharge standards

To regulate the discharge of wastewater with high nutrient inputs, particularly from intensive shrimp aquaculture practices proposed in the plan, it is recommended that the prevailing standards for the discharge of wastewater into inland water bodies and/or into Marine Coastal Waters gazetted by the CEA, are imposed through the aquaculture license as well as the annual Environmental Protection License (EPL).

The required treatment methodology for wastewater discharges from pond and hatchery aquaculture should be made freely available to the project proponents in order for them to adopt such treatment measures within their farms. The environmental guidelines should be supported by technical manuals and decision-making management tools for farmers.

Further research on low cost, effective pollution control methodologies should be conducted by NARA, which could then be popularized among aquaculture developers.

e) Regulations for Chemicals to be used

At present permissible levels of chemicals and drugs for culturing different species in different stages from hatchery to grow out farming are being practiced according to available technical manuals and trainings by NAQDA and the other relevant authorities. Moreover, as the competency authority, Department of Animal Production and Health regulates unauthorized substances, veterinary drugs and contaminants usage. However, according to NAQDA there were dialogues on updating the lists according to current needs in local and international trade of aquaculture.

The Aquaculture (Monitoring of Residues) Regulations, 2002 include a national residue monitoring plan, which sets out national measures for the detection of residues of the substances specified in Schedule I which lists the unauthorized substances, veterinary drugs and contaminants, of which residues must be detected. As such Group A of the schedule 1 lists unauthorized substances such as (l) Chloramphenicol (2) Nitrofurans (including furazolidone) (3) Malachite green while Group B of that lists veterinary drugs and contaminants such as (1) antibacterial substances, including sulphonomides, quinolones (2) Other substances and environmental contaminants such as Organochlorine compounds including PCBs, Chemical elements and Mycotoxins.

Hence, above controls should be imposed on chemicals and drug usage in aquaculture, including appropriate evaluation/approval procedures for new chemicals and drugs. This could be achieved through the Aquaculture licensing procedure as well as the Environmental Protection License for large scale farms.

f) Sustainable utilization of natural feed

The promotion, management, and sustainable utilization of natural feed, including microorganisms (biofilm, biofloc) are considered as a promising strategy for the culture of shrimps and fishes.

Since supplemental feed is considered as the main source of contamination in shrimp and fin fish aquaculture systems and effluent receiving ecosystems, the improvement of these feed, as well as the feeding strategies could be considered as an important part of the solution for sustainable aquaculture. The feedstuffs must be improved through better and more precise formulations for the particular species to be cultured with higher hypo stability, attractiveness and palatability to avoid nutrient loss into the water column, which is the main path of organic and chemical pollution.

Pellet feed should ensure that it has a minimum amount of fine particles or feed dust which are not consumed by aquatic animals nor added to the nutrient load in the water. The pellet size also should be matched to the life-cycle stages of the species (e.g. smaller pellets for fry or

juvenile and larger pellets for adult animals lead to reduce the unconsumed fraction). Regularly monitoring of feed uptake is necessary to determine and to adjust feeding rates with the consumption. Feed waste due to overfeeding or incorrect feeding should be avoided. Increasing daily feeding frequency, especially in the juvenile stage will allow better access to food, better feed conversion ratios and less waste. Feed storage is another factor to be considered and the storage conditions should be maintained to avoid nutrient loss and prevent moldy conditions which may cause spreading diseases in the culture systems.

Adhering to Animal Feed Act (1986) which regulates, supervises, and controls the manufacture, sale and distribution of animal feed, also applicable to aquaculture farms.

g) Regulation for maximum stocking density

Management controls should be employed for estimating the carrying capacity of farming areas and to stipulate a maximum stocking density of targeted aquaculture species in the sector plan.

In cage culture of seabass and milk fish, it is a prerequisite to stipulate a maximum allowable distance between the sea bed and bottom of nets and/or cages at low tide under normal growing conditions to allow water movement and dispersal of wastes from the cages, and for stipulating a fallow period or relocation of cages.

It is recommended that cage and pen sites to be fallowed before restocking, as this process allows the seabed to rest and recover (Zhulay *et al.* 2015). Fallow periods (temporary cessation of production) are often used in aquaculture to mitigate the environmental effects of pollution from organic enrichment due to the stocking of fish, i.e., wastes from fish food and feces. The fallowing may happen automatically in the sea cucumber pen culture and coastal cage culture in Sri Lanka with prevailing unfavorable weather conditions with monsoonal impacts and discontinuous seed stocks availability for farming. The sea cucumber farmers also used to abandon culture areas after 3 years of continuous farming when the sites become unproductive. As such, in the instance of demarcated ADZs are formed there should be a definite fallow periods of minimum 03 to 06 months between culture cycles to avoid environmental effects cause to the site by farming. Although the relocation of culture sites may not be practical within the demarcated zones for instance sea cucumber farming. The fallow period could coincide with unfavorable weather periods or seed deficient periods. However, requirement of fallow periods could be incorporated in the aquaculture management license issued by NAQDA as the site and species-specific guidelines.

h) Disease control mechanism

The disease control mechanism for shrimp farming currently implementing in the Northwestern Province could also be implemented for the Northern province with adoptive management practices.

Regulations should be strictly followed to obtain compliance with the disease management practices implemented by NAQDA with special attention to the small holder farmers who are reluctant to adhere with the basic biosecurity practices due to financial constraints.

However, shrimp as a lucrative export-oriented species is much more economically viable. Hence a mechanism should be developed to reserve the funds from the farmers' own profits for biosecurity and health management of consecutive culture cycles.

Disease control mechanism and surveillance system should also be adopted for other major species such as sea cucumber and seaweeds to be scaled up in the Northern Province.

10.1.4 Monitoring of Social Aspects in Aquaculture Projects

Participatory monitoring and an appropriate Grievance Redress Mechanism (GRM) should be established with the participation of the host communities and other relevant stakeholders. A multi-layer GRM would handle the grievances effectively. The layers and the composition of the mechanism, frequency of the monitoring practices, time frame to handle the grievances, etc. should be well defined. Also, NAQDA should ensure the legal validity of this Mechanism. The proposed GRM is given in Chapter 11.2.

Also, the efforts that the investors of large-scale aquaculture farms have taken towards social and environmental safeguards, and contribution to the local and national economy should be well disseminated to the local community in order to build trust.

A third-party, non-profitable, and independent institution that has a real interest in social and environmental safeguards can be appointed to carry out third-party monitoring of farming practices. Further details of the proposed monitoring procedure are presented in Strategic Environmental and Social Management Plan.

10.1.5 Adopting an international policy on social safeguard

This SEA recommend that NAQDA's development plan should mandate the project developers to follow with the provisions of the NIRP and the Land acquisition act to assess and mitigate the social impacts resulting from land based or marine-based aquaculture projects, irrespective of the scope of the acquisition. Completing the environmental and social screening checklist/questionnaire should be a standard practice for all the aquaculture projects, irrespective of their scale, scope, technology, proponents, beneficiary etc.

In this background, a policy that mandates community consultation, social screening, social impact assessment, impact mitigation, livelihood restoration, and Grievance redress throughout the project planning and implementation, irrespective of the project's scope should be adopted for this purpose.

An international policy on social safeguard can be adopted to cover the gaps to address the socioeconomic impacts the aquaculture projects causes and also to fill the gaps in the country's safeguard systems. eg.: the Environmental and Social Framework (ESF) of the World Bank. The cost and the responsibility of the assessments, preparation of plans and compensating the social impacts should be borne by the project developer.

The adoption of an Internationally recognized social safeguard policy would ensure,

1. Meaningful consultation with the project affected parties (especially the traditional fishers in this case) in site selection, impact assessment, project implementation, and impact mitigation.
2. Environmental and Social screening of the project irrespective of the project magnitude
3. Preparation of resettlement instrument (Resettlement document) irrespective of the project's scope and impacts. Each project would require preparing an environmental and

social screening checklist, social screening report, an abbreviated resettlement plan, or a full resettlement plan depending on the level of impact.

4 The affected parties that are having legal rights, customary rights will be covered by the policy to ensure their rights are protected and impacts are mitigated.
5 Impact mitigations are accomplished before the project implementation is commenced
6 An easily accessible GRM
7 Institutional mechanism for social impact monitoring

10.1.6 Financial capacity building of local fishermen

Government banks have introduced special loan schemes to offer credit facilities under a lower interest rate with a view of accelerating the development of shrimp farming industry in Sri Lanka. Permanent members of the Sri Lanka Aquaculture Development Alliance can obtain loan facilities within a value range of one Million to Rs. 100 million rupees under these loan schemes.

NAQDA should formulate a similar procedure for the small-scale aquaculture entrepreneurs engaged in culturing other aquaculture species to facilitate the credit facilities from government banks.

10.1.7 Evaluation of the climate change related impacts

A proper database should be developed with consistent measurements and data on parameters such as sea surface temperature and sea level rise, etc., in evaluating the climate change impacts on implementation of the proposed plan, as currently such measurements are at a preliminary stage. The existing predictions for the climate change in the Northern Province (as described in section 6.1.2) need to be confirmed through more research and modeling activities. Therefore, more training and collaborative effort within the organizations such as the Department of Meteorology, NARA, DMC and CC&CRMD is required, to conduct such activities at a regional scale (i.e., regional offices within the Northern Province).

According to the consulted stakeholder agencies such as CC&CRMD and NARA, no proper sea level recording has been done in the Northern province so far; currently sea level is monitored using automated tide gauges established by NARA in Trincomalee, Kirinda, Colombo and Mirissa to cover the entire country; the data from these stations are superimposed with satellite data in predicting the sea level rise. A tide station will be established in Point-Pedro by NARA in near future, which is still under construction. Therefore, more human resource inputs and training are required.

Sensitive areas for climate change in Northern province need to be well defined and demarcated considering the impacts from sea level rise, floods, and droughts so that additional precautionary measures can be taken in implementing developmental activities including those under the NAQDA plan. Collaborative efforts by the CC & CRMD, DMC officials within the province and research organizations such as NARA, Universities are required for this.

Due to lack of data, the emission-related activities need to be further investigated by NAQDA during the implementation of the proposed plan as well. Awareness creation and capacity building of the NAQDA regional officials in dealing with climate related issues (including the estimation of emissions) is required with the assistance of CEA and Climate Change Secretariat.

10.2 Further Research Requirements

With the establishment of the proposed Planning, Monitoring & Evaluation Division (PMED) within NAQDA, which will be conducting research related to aquaculture (as proposed in the ACBFSDP), the capacity for conducting research and addressing environmental and climate-related issues can be further strengthened with the recruitment of suitable officials with research capacity. The proposed other divisions to be established under the NAQDA's plan and research support gained through potential collaboration from NARA and universities (University of Jaffna etc.), Private-Public Partnership (PPP), and Community-Based Organizations (CBOs), etc., can further strengthen the overall capacity required for the development of the aquaculture sector in the Northern Province.

In conformity with the ACBFSDP suggestions, Identification of research needs and priorities has to be done with the participation of all stakeholders. Research plans could make available to the public, research and development institutions, Universities and even the private sector are expected to be involved in research. The primary government agency mandatory for fisheries and aquaculture development research is NARA. The main Institutions that provide research funding opportunities are, the National Science Foundation (NSF), the Center for Agriculture Research Policy (CARP) and the National Research Council (NRC). National Universities also provide funds for their academic staff for research activities. Some of the researches can be conducted with the collaboration of the Universities as undergraduate and postgraduate research projects.

The research needs and priorities identified during the SEA are as follows;

A. Research required for functional aquaculture practices.

1. Ecosystem Based Aquaculture Zonal Planning planning

- **Carry out zonal planning in priority Provinces**
    - Focusing on environmentally moderate/low risk areas identified in SEAs
    - Identify aquaculture zones (sharing same water supply) within such areas, also considering infrastructure availability such as power and transportation.
    - Involve stakeholder consultations and negotiations to resolve conflicts with other stakeholders
    - Establishes rules of operation within each zone:
        - Carrying capacity analysis – determine production amounts by target species, feed quantity, chemicals quantity, stocking density (propensity to disease) for sustainable production.
        - Regulations for monitoring and reporting

The Studies to identify issues in the implementation of a spatial planning process within aquaculture development zones under an ecosystem approach to aquaculture including, Optimum distance between pen structures, between farms and within a farm to ensure natural water flow, shading impacts on benthic habitats and effective biosecurity.

2. Carrying capacity

Determination of carrying capacity modelling for different species and proposed Aquaculture Development Zones with a stakeholder engagement process that seeks to reduce social conflicts and environmental conflicts.

3. Technology and Systems

- Continued engineering research related to productivity through the enhancement of production systems and technologies for both coastal and offshore production need to be further developed.
- Research focuses on intensive cultural conditions in response to increasingly limited space for open systems.
- Key technology advances to improve filtration will be necessary for the development of zero-exchange Recirculating Aquaculture Systems (RAS) and the energy requirements of RAS must be significantly reduced to improve sustainability.
- Research on zero waste requirements (reuse and recycling of all waste streams from aquaculture), such as processing solid wastes in the form of bio-deposits, will be required.
- Development of research on Introduction of Integrated Multi-Trophic Aquaculture (IMTA) Intensification of sea cucumber culture could increase local and global environmental benefits, but further research is necessary to design rearing units that can optimize production and/or bioremediation and that can be practically integrated into existing finfish monoculture units. Sea cucumbers (class Holothuroidea*)* are interesting candidates as deposit feeder species for IMTA systems due to their ability to consume particulate waste excreted by other cultured organisms. This is particularly relevant for fed finfish open-water aquaculture systems, for which reducing the benthic impact is a major ecological challenge.
- Adoptive research on developed hatchery technology to combat low survival and High mortality rates of hatchery produced juveniles.

4. Health and Survival

Research on practical ways to improve biosecurity of aquaculture facilities; cost-effective disease surveillance programs, and improved understanding of the epidemiology of emerging pathogens can lead to prevention and reduced spread of diseases.

Introduction of GMPs, good farm management practices and disease management practices are crucial to the sustainability of aquaculture businesses. Best practice in production techniques, along with good biosecurity measures which can mitigate impacts from disease occurrence without the use of chemicals and drugs.

5. Genetics

- Aquaculture genetic selection and classic selective breeding programs leading to promotion of domesticated species need to be expanded. In future, trait selection will

most certainly be driven by industry demands, which will include achieving excellent growth (also driven by global climate change), other consumer-appealing product characteristics, and disease resistance.

- Specific pathogen-free (SPF) and specific pathogen-resistant population status, particularly for species with well-established SPF production systems.
- Regularly assess key SPFs and harvest and postharvest activities with introduced *L. vannamei.*

B. Significant indirect research requirements identified in developing sustainable aquaculture.

1. Research on assessing the vulnerability and impact of climate change

- Research capacity for assessing the vulnerability and impact of climate change on estuaries and lagoons, coral reefs, and coastal wetlands is needed. Also the research on changes in species distribution and coastal habitats , negative impacts on mangroves, coral reefs, and coastal wetlands, influence of ocean warming and sea level rise on fish stocks and coastal aquaculture, seeking suitable sites for locating artificial reefs and managing reef habitats, tracking health concerns due to climate change, projecting ocean status for possible ocean-based extreme events, constructing shore infrastructure and fishing vessels to resist extreme events, and potential positive impacts are required.
- Further research and capacity for quantification of the carbon stocks in the coastal and marine ecosystems in the Northern Province are needed to evaluate the role of those ecosystems in carbon sequestration and climate change mitigation.
- Long-term regional monitoring of water quality and other parameters expected to be affected by climate change are needed to model the likely effects. Open aquaculture sites and species will be exposed to extreme events of global climate change and complex physicochemical interactions of CO_2 with more important water quality parameters. In the absence of adequate long-term data, it is difficult to assess modifications that will be needed to manage aquaculture production facilities in the future.
- While the catastrophic events will be difficult to predict, data on trends and expected seasonal extremes can guide production cycles, potential changes in target species selection, and/or species selection for future production cycles.

.2. Research on cost-effective Pollution control Methods for Aquaculture projects

In order to minimize environmental impacts from aquaculture it is imperative that projects which discharge any wastewater are in compliance with the standards specified by the CEA.

Aquaculture projects which discharge wastewater will be required to ensure that the wastewater discharged will be in compliance with the CEA standards depending on the final point of discharge. It is important to develop effective and low-cost pollution control methods which could then be popularized among aquaculture developers. This will ensure that the environmental impact of these projects will be minimized to a great extent.

3. Research related to impacts on seagrass habitats by near shore aquaculture practices.

4. Studies related to impacts on fish migrating patterns and fisheries mainly by sea cucumber and seaweed farming structure layouts and cage culture practices.

10.3 Recommendations on Capacity Enhancement of the regulatory institutions and Optimal Arrangements to implement the ACBFSDP (2021-2025) in Northern Province

The Strategic Environmental and Social Management Plan (SESMP) given in the Section 11.1 present the actions for implementations and responsible institutions, which align with SEA recommendations. In addition, SEA recommends a Coastal aquaculture management committee in order to coordinate and expedite the procedures. To fulfill the suggested activities present capacity of the relevant institutions are inadequate to implement the ACBFSDP (2021-2025).

10.3.1 Institutional strengthening of the NAQDA regional Office

The National Aquaculture Development Authority (NAQDA) which comes under the purview of the Ministry of Fisheries, is mandated with the task of development of the aquaculture and inland fisheries sector. This includes the issuance of permits for aquaculture projects.

The Director (Coastal Aquaculture Development) under the Director General of NAQDA is responsible for overall implementation and monitoring of coastal aquaculture development projects. The Coastal Aquaculture Monitoring & Extension unit – Northern Province was established in 2017 in order to monitor and regulate coastal aquaculture in the Northern Province.

The Assistant Director, Coastal Aquaculture Monitoring and Extension Unit, Pooneryn, Kilinochchi is responsible for monitoring and regulating coastal aquaculture in the Northern Province.

One aquaculturist is assigned to each district under the Assistant Director of Northern Province (coastal aquaculture). The present capacity of the Coastal Aquaculture Monitoring and Extension Unit, Northern Province is clearly insufficient for the purpose of monitoring all the aquaculture projects suggested in the ACBFSDP (2021-2025). Hence institutional strengthening through the allocation of more field officers is strongly recommended in order to ensure the sustainability of the existing aquaculture projects as well the projects which are being planned under the ACBFSDP (2021-2025).

The IEE/EIA requires the project proponent to conduct a socio-economic assessment for the aquaculture farms greater than 4ha in extent. In other cases, community consultations and socioeconomic screening or assessments are not mandated for small-scale aquaculture farms. Coastal Aquaculture Monitoring & Extension unit – Northern Province of NAQDA doesn't possess the capacity to conduct a socioeconomic screening to identify the requirements of the social impact assessments. NAQDA should deploy social safeguard officers to monitor and recommend the social safeguard related assessments especially for aquaculture farms below EIA/IEE Threshold. An adequate number of Environmental Officers should also be recruited to the Coastal Aquaculture Monitoring & Extension unit – Northern Province for environmental monitoring of aquaculture projects.

It is strongly recommended that an Environmental and Social division be established under the NAQDA head office. Key tasks of this division will be,

- Preparation of guidelines for environmental safeguards and monitoring
- Using Ecosystem based aquaculture for spatial planning.
- Identification of potential areas for aquaculture
- Monitoring of environment, effluent monitoring, prevention of self-pollution
- Evaluation of EIA/IEE reports
- Biodiversity and climate change and sustainability issues related to aquaculture.
- Oversee and guide the Environmental and Social officers assigned to provincial offices

10.3.2 Establishment of Culture-Based Coastal Aquaculture Management Coordinating Committee

A Culture-Based Fisheries Management Coordinating Committee (CBFMCC) has been suggested in the NAQDA plan for inland aquaculture sector. It is also recommended the establishment of a separate Coordination Committee for the coastal aquaculture sector which will resolve issues related to the development of the coastal aquaculture sector in the Northern Province. Regulatory agencies which have the overall responsibility of environmental protection and management require to be included in the committee, in order to maintain interdepartmental or interagency coordination.

The mandate of the proposed Committee is to;

- Monitor the implementation of the recommendations of the SEA
- Identify and resolve any impediments/ constraints in implementing the recommendations
- Act as a coordinating body for avoiding unnecessary delays in licensing process for new aquaculture projects

The proposed Committee should be established by NAQDA with the participation of officials from the following agencies involved in environmental management and protection and therefore support an Ecosystem Approach during aquaculture project approvals and management;

i. Assistant Director, Coastal Aquaculture Monitoring and Extension Unit for Northern Province (Chairman)

ii. The officer in charge (Aquaculturist) of the Aquaculture Extension Office of the Coastal Aquaculture shall be the secretary of the coordinating committee of each district and shall convene its meetings under the guidance of Assistant Director Coastal Aquaculture Monitoring and Extension Unit for Northern Province;

iii. Up to 02 persons elected among members of the Coastal Aquaculture Associations in the district representing each different aquaculture practices.

iv. A representative of the District Secretary of the administrative district.

v. The Divisional Secretary of the Divisional Secretary's division within which the aquaculture is practiced.

vi. The Additional Director of Department of Fisheries of the District.

vii. An officer of the NARA nominated by the Director General of the Agency;

viii. An officer of the Department of Wildlife Conservation (DWC) nominated by the Director General of DWC;

ix. An officer of the Forest Department nominated by the Director General of Forest Department.

x. An Officer from the Provincial Office of Central Environmental Authority (CEA)

xi. An officer of the Sri Lanka Navy nominated by the Commander of Sri Lanka Navy for the district.

xii. An Officer from the District Office of CC&CRMD

A group or committee representing all key stakeholders that have a role in the assessment of an application for an aquaculture development could function as a one-stop-shop to assess the application to recommend granting permission or issuing licenses for aquaculture developments. However, different Institutions of the committee, abide to different laws and regulations could agree upon a collective decision with prescribed requirements of project approval.

The proposed committee could act as the Technical Evaluation Committee for the EIA process so that all the agencies will be kept informed of the approval process for such new projects. Additional expertise required for the Technical Evaluation Committee to carry out functions such as scoping for the IEE/EIA, evaluation of the IEE/EIA report could be obtained by including experts in the field of aquaculture, fisheries, ecology, pollution control etc. as and when required from the universities.

10.3.3 Capacity Enhancement of other regulatory institutions

Organizations such as CC&CRMD, CEA, Forest Department, DWC, DFAR, MEPA, DMC, NARA, etc., are considered as being important stakeholders in relation to addressing environment and climate related issues during the implementation of the NAQDA plan. However, it is noted that almost all of these agencies possess a limited number of officials handling the activities related to the Northern Province.

The CEA or the CC&CRMD will require to grant approval for the large-scale aquaculture parks/Sea cucumber villages which are subjected to an IEE or EIA as per the provisions in the Coast Conservation Act and the National Environmental Act. Projects approved subsequent to an IEE or EIA require to be regularly monitored by the EIA approving agency.

It should be noted however, that both the CC&CRMD and CEA handle several other projects in addition to aquaculture projects. In view of this regular monitoring of approved aquaculture projects may not take place at the desired frequency due to resource limitations including most importantly human resource limitations. As such it is recommended that monitoring activities be carried out in a coordinated manner according to an established timeline with close coordination between NAQDA, CEA and the CC&CRMD.

10.3.4 Capacity Enhancement of education and skill development institutes

The University of Jaffna and the Ocean University of Sri Lanka are the major educational institutions in the Northern Province that produce qualified professionals (Graduates and Diploma holders) related to fishery and aquaculture. These institutions are providing One-year to four-year courses. The representative of the Department of Fisheries Science, University of Jaffna stated in the provincial level stakeholder consultation that the department is operating with limited resources and additional resources are required to increase the number of enrollments for the courses. At the same time, the curriculum modifications to reflect the latest changes in the industry are also required. Since the NAQDA's plan is to achieve the specified targets by 2025, the available resources and the time frame to produce the required skilled personnel as expected by the NAQDA's development plan is a critical target.

Ministry of Fisheries should closely work with Ministry of Higher Education and University Grants Commission to increase those institution's resources and annual intake, assisting on curriculum revisions to match the present and future requirements and the technology advancements, and on collaborations on research and development activities. NARA has to facilitate undertaking curriculum revisions and research requirements identification forum collaborating with the University of Jaffna, the Ocean University of Sri Lanka, and other relevant stakeholders to ensure the human resources that are developed by the local institutions are meeting the industry requirements. The NAQDA also required to forecast the skill requirements to accomplish the development plan and to disseminate the information to the academic institutions.

10.4 Proposed revisions to the sector plan and targets.

The targeted production of aquaculture candidate species in each district in the northern province should be aligned with the available extent of lands suitable for aquaculture.

Allocation of sites for coastal aquaculture should be based on the "Opportunity and Risk Map" produced through the SEA study so that there will be minimal damage to the environment. The SEA recommends that the proposed coastal aquaculture development projects should be sited within low-risk areas identified. Medium Risk areas can also be utilized for aquaculture projects with minimum environmental and social impacts.

Maximum land area required and land availability for land-based coastal aquaculture in Northern Province according to the Opportunity and Risk map prepared by the SEA team is given in the Table 52 below.

Table 52: Maximum land area required and land availability for land-based aquaculture in Northern Province

District	Species to be cultured	Land Requirement (Hectares)	Total Area required (Hectares)	Available low Risk area (Hectares)	Percentage of Available Low Risk Area
Jaffna District	Shrimp	809	820.5	6254.20	13.12%
	Lagoon Crab	2.5			
	Milk Fish	3			
	Sea bass	6			
Mannar District	Shrimp	1416	1473	1775.55	82.96%
	Lagoon Crab	44			
	Milk Fish	7			
	Sea bass	6			
Kilinochchi District	Lagoon Crab	2.5	416.5	7793.52	5.34%
	Milk Fish	3			
	Sea bass	6			
	Shrimp	405			
Mullaitivu District	Shrimp	283	294.5	1250.57	23.55%
	Sea bass	6			
	Lagoon Crab	2.5			
	Milk Fish	3			

The low-risk areas available for land based coastal aquaculture in the Kilinochchi district is the highest followed by, the districts of Jaffna, Mannar and Mullaitivu which has the least low-risk area in the Northern Province for land-based aquaculture. The highest land requirement for the proposed land-based aquaculture in the sector plan is in the Mannar district which is ~83% of the available calculated low-risk area. However, the all low-risk areas identified in the opportunity and risk map may not be suitable for the development of aquaculture projects, as the opportunity and risk map does not study the technical suitability to establish aquaculture farms. The required land extent for land-based aquaculture in the sector plan is well aligned with the low-risk land availability in Jaffna, Kilinochchi and Mullaitivu districts (13.12%, 5.34% and 23.55% respectively).

Sector plans should be revised according to the land availability for each species with long term sustainability in mind. Shrimp aquaculture practices should be more focused on semi-intensive to super-intensive practices as greater intensification will result in less energy use per metric ton of shrimp yield in comparison to a less intensive culture. Intensification reduces the land use per unit of shrimp production. Analysis of the alternative scenario shows that intensive L. *vannamei* farming in RAS has scored the highest for the likely effect of "No Potential Impact on the Environment" (Chapter 7 of this Report). In accordance with the pond culture of shrimp, Option 3 which is aligned with the implementation of the SEA recommendations and with individual IEE/EIAs being conducted for each Aquaculture Development Zone or standalone project prior to implementation would ensure the reduction of potential adverse impacts on the environment.

Maximum space required and space availability for marine based coastal aquaculture in Northern Province according to the Opportunity and Risk map prepared by the SEA team is given in the Table 53 below.

Table 53: Maximum water area required for marine-based coastal aquaculture in Northern Province (Within 5m Depth Contour)

District	Species to be cultured	Water area Requirement (Hectares)	Total Area required (Hectares)	Available low Risk area (Hectares)	Percentage of Available Low Risk Area
Jaffna District	Sea Cucumber	58.0	61.0	9,725.0	0.63%
	Sea Weed	3.0			
Mannar District	Sea Cucumber	15.0	24.0	24,523.0	0.10%
	Sea Weed	9.0			
Kilinochchi District	Sea Cucumber	160.0	170.0	24,334.0	0.70%
	Sea Weed	10.0			

As the most striking aquaculture practice in the Northern province, sea cucumber occupies the shallow coastal area and the aforesaid overlay analysis revealed that the low-risk area availability within the 5m depth contour is highest in Mannar district followed by Kilinochchi and Jaffna districts. The space requirement for sea cucumber farming according to the sector plan is highest in Jaffna district denoting less than 1% of the low-risk area which is obviously not challenging. However, spatial allocations for the farming practices need to be well planned with the SEA recommendations even in low-risk areas.

The proposed medium-scale fish cage farming is conducted within the area comprising of 5 m-10 m contour depths which shows the availability of sufficient land extents comprising of the low-risk areas. In addition, the scenario analysis showed the need for adopting the SEA recommendations in order to overcome potential adverse impacts.

The risk incurred with seaweed culture to the environment is considered as being low and sufficient areas are available in the low-risk category according to the sector plan targets.

The sector plan does not indicate the intensities of cultural practices other than for shrimp farming. Hence targeted production could be revised to the degree of intensification which would be economically viable, environmentally sustainable, and socially acceptable in each aquaculture-focused zone.

10.5 Other Criteria to be considered in screening potential aquaculture areas

Key variables in selection of potential aquaculture areas include presence of water resources, dams, saltwater barriers, annual runoff, sea surface temperature, water quality and salinity. Moreover, technical suitability for aquaculture includes topography, slope, sedimentation, turbidity and marine water depth.

Species-specific thresholds with regards to sea surface temperature, marine water depth and salinity were identified for mariculture species. Optimal and tolerable ranges for these thresholds were established with research outputs, field experience and stake holder outputs (Table 54).

Table 54: Optimal and tolerable marine water depth and sea surface temperature ranges for mariculture species considered in the SEA process

Culture Practice	**Marine water depth(m)**		**Sea surface temperature (^{0}C)**		**Salinity (ppt)**	
	Optional	Tolerable	Optional	Tolerable	Optional	Tolerable
Seaweed	2 - 3	1 - 5	25-28	24-36	25-33	20-35
Sea Cucumber	0.8 - 4	0.5- 4	25-29		25-32	20 - 32
Seabass (medium cages)	5 - 10	5- 15	22-35	15-40	26-32	15-38

Elevation (or depth) in reference to mean sea level is a unique criterion because it is relevant to all marine coastal aquaculture systems. Shrimp culture in the supratidal zone is now the preferred technology, but pumping costs and sea water intrusion into freshwater aquifers limit pond construction to elevations less than 5 m. The tidal range along most of the coast of Sri Lanka is less than 1 m, practically eliminating the possibility of intertidal pond construction. Furthermore, pond construction in the intertidal zone conflicts with mangrove and salt marsh conservation.

Submerged culture systems employing rafts or cages require sufficient clearance between the culture system and the sea floor. Fin fish cages should be sited in at least 5 m depth to allow adequate cage depth and water circulation.

11 Monitoring and Management

11.1 Strategic Environmental and Social Management Plan

Gap/ Issue	Recommendation	Specific action for Implementation	Timeline	Responsibility	Targets	Monitoring & follow up	Funds
Site Selection							
Ad hoc site selection by project proponents for new Aquaculture Projects	Establishment of approved ADZ in feasible locations and encourage investors to submit applications/propose projects for the sites within ADZ	Study the feasibility of Low Risk and Medium Risk areas in the Opportunity and Risk Map (ORM) for coastal aquaculture development and propose feasible areas as ADZ.	3 years	NAQDA with the Support of NARA	Reduce the No. of aquaculture sites established outside the ADZ	Proposed Coastal Aquaculture Management Coordinating Committee	External donor Agencies
Improper site selection in relation to culture species	Proper feasibility studies should be conducted for the culture species during the selection of new ADZ and encourage investors to submit applications/propose projects for the sites within ADZ	Same as above	3 years	NAQDA with the support of NARA	Ensure feasibility studies are conducted for each identified ADZs	Proposed Coastal Aquaculture Management Coordinating Committee	External donor Agencies
Exceed the social and ecological carrying capacity of the aquaculture sites	Conduct broad Carrying capacity estimations for the identified ADZs and issue Aquaculture licenses without exceeding Carrying Capacity	Conduct site / zone-specific carrying capacity estimations for the targeted species	Once the ADZs are identified	NAQDA through NARA or private consultants	Set an upper limit for the number of farms within ADZs and their intensity of production that retains environmental and social impacts at manageable and/or acceptable levels	Coastal Aquaculture Management Coordinating Committee	Government /External funding agencies
Lack of ecological and socioeconomic	Carry out baseline surveys to ensure sustainable aquaculture development	Conduct ecological and socio-economic surveys in the potential aquaculture development areas		NARA and Universities	Establish integrated environmental monitoring system for filling data gaps in	Coastal Aquaculture Management	Government / External funding sources

Gap/ Issue	Recommendation	Specific action for Implementation	Timeline	Responsibility	Targets	Monitoring & follow up	Funds
baseline data in the Northern province					medium to high-risk areas of the ORM	Coordinating Committee	
Approval and Licensing							
Delays in obtaining no objection/ consent from the host community and FCS/RFS	Capacity enhancement of NAQDA regional office to screen and assess the socioeconomic impacts unless an IEE/EIA is required	Recruit relevant officers/ train NAQDA officials to conduct participatory assessments such as Participatory Rural Appraisal (PRA), Socio-economic assessments	Within 1 year	NAQDA through NARA, Universities and Private sector	NAQDA officers should be able to assess social impact of aquaculture operations	Coastal Aquaculture Management Coordinating Committee	Government through increased licensing fees
	Enhance the capability of FCS to understand the coexistence of aquaculture with fisheries and positive impacts of aquaculture to the local economy	Conduct awareness programmes for the officials of the FCS (president, secretary, etc.)	On regular basis	NAQDA in collaboration with DFAR	To obtain consent of the FCS for the new aquaculture farms without delays and for unbiased decision making	Coastal Aquaculture Management Coordinating Committee	External grants from donor agencies
Community objections/ complaints since socioeconomic screening or assessments are not mandated for small-scale aquaculture farms	Social screening procedure should be mandated for all the aquaculture projects	Follow the proposed approval process under SEA study	Within 1 year	NAQDA Technical Committee	To ensure small scale farm development does not disenfranchise people or result in net economic losses to local communities.	PMED, Coastal Aquaculture Management Coordinating Committee	Should be borne by the Project Proponent
Delays in obtaining approval from individual agencies	Development of an integrated decision-making platform rather than submitting separate applications to multiple authorities	The committee representing all key stakeholders could function as a one-stop shop to assess the application	New approval procedure proposed in SEA to be in place within 1 year	NAQDA Technical committee	Expedite the approval procedure	Coastal Aquaculture Management Coordinating Committee	Project proponent (licensing fees)

Gap/ Issue	Recommendation	Specific action for Implementation	Timeline	Responsibility	Targets	Monitoring & follow up	Funds
Delays in obtaining environmental clearance for individual aquaculture projects	Identification of suitable ADZ and obtain environmental approval for the proposed ADZ (individual projects within the ADZ will not require to undergo IEE/EIA)	Conduct IEE/EIA according to the process suggested in SEA, Section 10.1.2	Once the ADZs are identified	NAQDA	Expedite the environmental approval process for individual projects within ADZ	Ministry of Fisheries and Aquatic Resources	Government / External funding sources
Constraints in the renewal of license	Establish a well-coordinated system in the renewal process of license aligned with recommendations of the SEA	Develop an online license management system for coastal and marine aquaculture development to provide efficient service	6 months	NAQDA	Efficient renewal of license	Coastal Aquaculture Management Coordinating Committee	Should be borne by the Project Proponent (Through Renewal Fees)
Absence of a proper mechanism for addressing grievances of Fishermen and host community	Establishment of an effective and easily accessible Grievance Redress Mechanism (GRM)	Composition and action plan for establishing GRM is given in Chapter 10.2	6 months	NAQDA	Effective GRM in place and address the complaints efficiently through GRM	Coastal Aquaculture Management Coordinating Committee	Not applicable
Aquaculture farm operation (management and monitoring)							
Regulatory gaps	Actions are needed to fill the regulatory gaps; e.g.: maximum stocking density	Include maximum stocking density, species and culture method as an aquaculture management license condition for individual farm	After completing carrying capacity assessments	NAQDA, NARA	Farm operations are maintained with the guidelines provided with the Aquaculture Management License	Coastal Aquaculture Management Coordinating Committee	Not applicable
Lack of financial facilities for fishermen/local community to initiate small-scale aquaculture farms	Formulate a mechanism to assist the credit facilities from government banks	Initiate discussions with government banks in order to introduce special loan schemes under a lower interest rate for small-scale aquaculture developers	With immediate effect	Central Bank of Sri Lanka	Financially strengthening of the fishermen (FCS/RFS) to initiate small scale aquaculture operations	Ministry of Fisheries and Aquatic Resources	Government
Insufficient Monitoring of	Enhancement of the Capacity of the Coastal Aquaculture Monitoring and Extension	Allocation of more field officers to Coastal Aquaculture	Within 1 Year	NAQDA	Recruitment of minimum number of	Ministry of Fisheries and	Government

Gap/ Issue	Recommendation	Specific action for Implementation	Timeline	Responsibility	Targets	Monitoring & follow up	Funds
aquaculture farms for compliance	Unit, Northern Province to carryout monitoring of aquaculture farms	Monitoring and Extension Unit, Northern Province			Coastal Aqua culturists/ Officers (Jaffna- 3, Mannar-3, Kilinochchi-2, Mullaitivu-1)	Aquatic Resources	
Lack of training and awareness of the aquaculture farmers regarding environmental management	Stipulate regular farmer training and awareness programmes related to aquaculture	Establish a branch of Fisheries and Coastal Aquaculture Training Institute in Northern Province	Within 2 Years	Ministry of Fisheries and Aquatic Resources	To enhance farmers' knowledge of environmental management practices	Coastal Aquaculture Management Coordinating Committee	Government /External funds
Environmental and Socioeconomic impacts due to lack of knowledge on Good Environmental Practices	Development of Good Management Practice (GMP) guidelines and technical manuals	Develop GMPs and technical manuals for each and every species targeted to ADZs and management areas outside the ADZs.	Within 1 Year	NAQDA in collaboration with NARA	Environmental and Social safeguard through the Compliance with GMP guidelines	NAQDA	External funds through donor agencies
Environmental pollution issues due to wastewater discharge	Management controls within an Aquaculture Development Zone	Conduct regular monitoring of wastewater discharge from the ADZ	Once the ADZs are formulate d	NAQDA NARA CC&CRMD CEA	Reduction of pollution through the compliance with environmental standards	Coastal Aquaculture Management Coordinating Committee	Government
	Controls on Chemicals (Disinfectants, Antifoulants and Medicines) to be used for aquaculture practices	Encourage farmers to use strict hygiene procedures to prevent diseases and monitoring use of chemicals	With Immediat e Effect	NARA, NAQDA	To have regulated usage of chemical substances in aquaculture	PMED/ Coastal Aquaculture Management	Government

Gap/ Issue	Recommendation	Specific action for Implementation	Timeline	Responsibility	Targets	Monitoring & follow up	Funds
						Coordinating Committee	
	Enforcing Annual reporting requirements	Introduce a self-assessment and reporting system for the large-scale farms (>4Ha)	With Immediate Effect	Self - monitoring by the Project proponent	To reduce the burden of monitoring on NAQDA and other regulatory agencies	Coastal Aquaculture Management Coordinating Committee	Project proponent
		ADZ based reporting system for small scale (<4Ha) farms	With Immediate Effect	NAQDA	To reduce the burden of monitoring on regulatory agencies	Coastal Aquaculture Management Coordinating Committee	Government through license renewal fees
Lack of Research on sustainable Aquaculture Management	Conduct more research on sustainable Aquaculture Management for different species and culture methods (Refer Section 9.2 for Research Requirements)	Identification of Research needs and priorities and disseminate to the NARA and Universities (Some of them can be conducted as undergraduate and postgraduate research projects.)	With Immediate Effect	NARA in collaboration with universities	Ensure the sustainable management of aquaculture farms through research findings	Coastal Aquaculture Management Coordinating Committee	Through external grants (NSF, CARP and NRC)
Biosecurity and disease control-related issues	Biosecurity management and planning is required within hatcheries, holding tanks and aquaculture production systems	Formulation and regular review of biosecurity plans and procedures including emergency biosecurity incidents in different ADZs. Establishment of ACBFSDP suggested National Center for Aquatic Animals and Aquatic Plant Health Management, and Certification	Within 2 years	NAQDA NARA	To ensure the farm biosecurity plan continues to address biosecurity risks effectively.	NAQDA	External grants

Gap/ Issue	Recommendation	Specific action for Implementation	Timeline	Responsibility	Targets	Monitoring & follow up	Funds
		Establishment of a fish quarantine facility					
Climate Change related							
Absence of a proper database in evaluating the climate change related impacts	Maintenance of proper records on fish- and aquaculture production data, proper records of meteorological data (including precipitation, relative humidity, land- and sea surface temperature, and sea level rise information)	Keeping Records on Species-specific production data and measurements (and records) of district wise meteorological data and sea level rise	On regular basis	collaborative effort within Department of Meteorology, NARA, DMC and CC&CRMD, NAQDA	Parameters to be monitored and key responsible parties identified; a comprehensive database in place by 2025	Ministry of Environment/Climate Change Secretariat	Not Applicable (and to be borne by the respective agencies)
Lack of proper equipment/infrastructure for continuous measurement and monitoring of weather/climate-related impacts	Infrastructure development (i.e. more automated weather stations to be established within the Northern Province; tide station to be established in Point Pedro by NARA)	Purchase of equipment; development/establishment of required infrastructure	Within a Year	CC&CRMD, NARA, Department of Meteorology	Proper measurement/monitoring mechanism/s to be established by 2025	Ministry of Environment/Climate Change Secretariat	Through Donor Agencies
Lack of mapping on climate sensitive areas	Climate sensitive areas need to be well defined and demarcated	Determination of such areas using the existing climatic trends (i.e. droughts, storm surges and level of coastal flooding, etc.)	With Immediate effect	Collaborative efforts by the CC&CRMD, DMC, NARA, Universities	Mapping to be completed by 2025	Ministry of Environment/Climate Change Secretariat	
Lack of data on emission-related activities	Further investigation of emission-related activities by NAQDA	Site visits and questionnaire surveys/interviews, etc., and identification of all such activities	With Immediate effect	NAQDA	Inventory of all emissions with activities to be established by 2025	NAQDA/ Climate Change Secretariat of the Ministry of Environment	
Research on climate change vulnerability and adaptation (and capacity building in	Research for assessing the vulnerability and impact of climate change on estuaries and lagoons, coral reefs, and coastal wetlands is needed/	Hiring/Consulting Research personnel and recruiting Research Assistants with suitable qualifications and or experience for conducting	With Immediate effect	NAQDA, NARA, CC & CRMD, DMC	Vulnerability profile developed by 2025, considering different types of ecosystems/ Estimation of carbon	NAQDA/ Climate Change Secretariat of the Ministry of Environment	Research grants/ funds from potential

Gap/ Issue	Recommendation	Specific action for Implementation	Timeline	Responsibility	Targets	Monitoring & follow up	Funds
this area)/ Research on carbon storage in coastal and marine ecosystems as a way of climate change mitigation	Research and capacity for quantification of the carbon stocks in the coastal and marine ecosystems in the Northern Province	research; get the support of universities in conducting research by channeling research funds			stocks in key ecosystem types by 2030		donor agencies

11.2 Grievance Redress Mechanism (GRM)

11.2.1 Introduction

The SEA team learned about the absence of a properly designed Grievance Redress Mechanism (GRM) to effectively address the grievances related to aquaculture farming. Neither the farm operators nor the local communities are having an easily accessible, and legally sound GRM.

During the Provincial level stakeholder meeting, it was revealed that there is no mechanism for DFAR district officials to address the grievances/complaints received from fishermen related to an aquaculture. Both DFAR and NAQDA don't have a multi-layer GRM and the stakeholder's capacity for handling, facilitating, and recording the grievances needs to be improved. A sample of the multi-tier GRM that can be used for this purpose is attached. The responsibility of establishing and operating the GRM is remained with the project developer and the NAQDA will oversee and issue the appointment letters to the members of the GRM to ensure the legal validity of the GRM. The NAQDA has the responsibility of monitoring entire process of establishing and operating the GRM. The NAQDA should have the authority to cancel the project developer's license if the developer is failed to establish and operate the GRM.

11.2.2 Grievance Redress Mechanism (GRM)

A multi-tier mechanism will be adopted to deal with the issues and grievances during the project implementation and the operation period. The mechanism will provide the opportunity to lodge grievances/complaints of project-affected parties easily, with zero inconveniences, without any discrimination, and obtain an effective solution timely, through a transparent process, respecting their local customs. It is well known that grievances are not avoidable in any development project. But the mechanism which satisfies the affected parties that their grievances have been heard and the solutions being given treating them equally with zero inconveniences would build a positive rapport with the project which will ensure sustainability and timely implementation of the project. Usually, the people aggrieved about the impact mitigations the project developer implements and other disturbances the developer causes to the nearby community.

This multi-tier GRM will provide affected parties and the project to solve issues early on without allowing them to be taken up at formal, legal institutions that will be too costly and time consuming for the affected parties and the project developer.

The project developer should ensure that the public is well aware of the available mechanisms to solve their grievances and the methods for accessing those mechanisms promptly. Grievance registries and the contact detail of the GRM will be made available at public places (GN office/Post offices, etc) that are proposed by the community for people to access the GRM easily. The project developers will frequently (weekly) check those registries for any grievances and will update their registry and forward the grievances to the NAQDA. The master registry of the grievances will be maintained at the NAQDA office to record and track all the grievances properly. The cost of establishing and operating the GRM should be bear by the project developer. The GRM will record and respond to all the grievances effectively, whether those are verbal or written.

11.2.2.1 Grievance redresses at the "Site level"

A designated officer of the project developer at the site level will attend to the grievances lodged by the affected parties. The NAQDA's Extension officer or the Aqua culturist at the site level also joins at this level. Also, the project can form a panel at the field level to find the solution for the grievances.

The panel may comprise of:

I. A site level officer (Extension Officer/Aqua culturist) of the NAQDA (Chairman)
II. A designated officer of the project developer at the site level (Secretary)
III. Grama Niladhari of the area (If required)

If the panel is unable to resolve the grievances within one week or the affected person is not satisfied with the solution given, the grievance will be forwarded to the next level.

11.2.2.2 Grievance Redresses Committee (GRC) at the "Divisional Level"

This level of GRM comprises representatives of relevant stakeholders with the representatives of the affected community.

I. Divisional Secretary of the Division (chairman)
II. Divisional Level Extension officer of the NAQDA (Co-chairman)
III. A designated officer of the project developer (Secretary)
IV. Representatives of the relevant Stakeholders (as required related to the grievances)
    a. Representatives of the Local Authority
    b. Representatives of the DFAR
    c. Representatives of the CEA
    d. Representatives of the CC&CRMD
    e. And other as necessary
V. Two respectable citizens from the local community (one of whom should be a woman).
VI. Two (Maximum) representatives of the aggrieved party

This GRC will gather depending on the number of grievances received from the projects. If not, the grievances are solved within one week, the grievance will be forwarded to the next level of the GRM.

11.2.2.3 Grievance Redresses Committee (GRC) at "Provincial Level"

This level of GRM comprises representatives of relevant provincial level stakeholders with the representatives of the affected community.

I. The District Secretary (chairman)
II. Assistant Director, Coastal Aquaculture and Extension Unit, NAQDA (Co-chairman)
III. A designated officer of the project developer (Secretary)
IV. Representatives of the relevant Stakeholders (as required related to the grievances)
    a. Representatives of the Northern Provincial Council
    b. Representatives of the DFAR
    c. Representatives of the CEA
    d. Representatives of the CC&CRMD
    e. And other as necessary

V. Two respectable citizens from the local community (one of whom should be a woman).
VI. Two (Maximum) representatives of the aggrieved party

If not, the grievances are solved within one week, the grievance will be forwarded to the next level of the GRM.

11.2.2.4 National level Grievance Redress Panel

Affected Persons can appeal to the National Level Grievance Redress Panel established at the national level with the staffs representing the institutions at the national level.

I. Representatives from the NAQDA Head Office (Chairman)
II. Representatives from the project developer (Secretary)
III. Representatives of the relevant Stakeholders (as required related to the grievance)
    a. Representatives of the Ministry of Fisheries and Aquatic Resources
    b. Representatives of the DFAR
    c. Representatives of the CEA
    d. Representatives of the CC&CRMD
    e. And other as necessary
IV. A person representing the Affected Party

If the decision given by National Level Grievance Redress Panel is not acceptable to the affected party, they can recourse to legal action. Thus, the PAPs have four level grievance redress mechanisms to resolve their grievances.

11.2.2.5 Monitoring and reporting of GRM

The secretary of the GRM at each level has the responsibility of recording the GRM process, prepare and circulate the minutes of the GRM with the approval of the chairman of the relevant GRM within three days the GRM session conducted. The language of the minutes and other correspondence should be in the language understandable to all the participants of the GRM, especially to the aggrieved party.

The performance of the GRM will be monitored by the NAQDA. The monitoring system would assess the overall effectiveness and the impact of the GRM. Such evaluations will take place quarterly, and their results would contribute to improving the performance of the GRM in addition to providing valuable feedback to subproject management.