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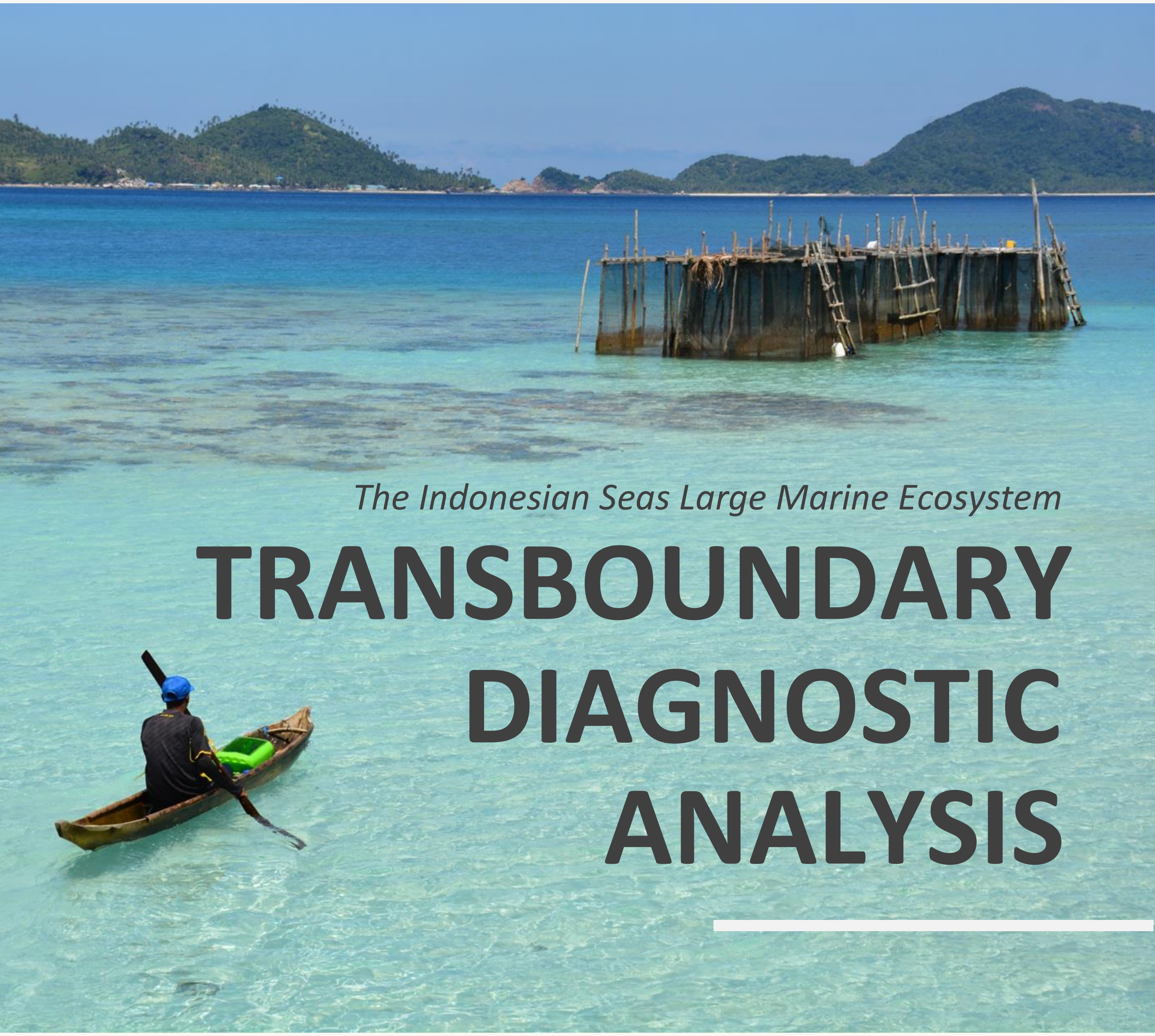

The Indonesian Seas Large Marine Ecosystem

TRANSBOUNDARY DIAGNOSTIC ANALYSIS

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INVESTING IN OUR PLANET

KEMENTERIAN KELAUTAN DAN PERIKANAN

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The Indonesian Seas Large Marine Ecosystem

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Cover photo: Small fishers use traditional boats to fish in Lombok, West Nusa Tenggara province, Indonesia. © FAO.

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Abbreviations

ADB	Asian Development Bank
AKABA	*Angka Kematian Balita* – Under five mortality rate
AKB	Angka Kematian Bayi – Infant mortality rate
AKN	Angka Kematian Neonatal – Neonatal mortality rate
AL	Angkatan Laut – Indonesian navy
ALKI	Alur Laut Kepulauan Indonesia – Indonesian Archipelagic sea lanes
ASEAN	*Association of Southeast Asian Nations*
ATSEA	Arafura and Timor Seas Ecosystem Action
Bakamla	*Badan Keamanan Laut* – Indonesian Coast Guard
Bapedal	Environmental Impact Management Agency
BAPPENAS	*Badan Perencanaan Nasional – Ministry of National Development Planning/National Development Planning Agency*
BIG	Badan Informasi Geospasial – Geospatial Information Agency
BKSDA	Balai Konservasi Sumber Daya Alam – Nature Conservation Agency
BMKG	Badan Meteorologi, Klimatologi, dan Geofisika – Meteorology, Climatology, and Geophysical Agency
BPS	Badan Pusat Statistik – Statistics Indonesia
Bscf	Billion standard cubic feet
BUMN	Badan Usaha Milik Negara – State-owned companies
CCA	Causal chain analysis
CCME	Canadian Council of Ministers of the Environment
CCRF	Code of Conduct for Responsible Fisheries
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CEPF	Critical Ecosystem Partnership Fund
CHL-a	Chlorophyll-a
CI	Conservation International
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMM	Conservation and management measures
COREMAP	Coral Reef Rehabilitation and Management Programme
COVID-19	Coronavirus Disease 2019
CPUE	Catch per unit effort
CSIRO	Commonwealth Scientific and Industrial Research Organization
CSR	Corporate social responsibility
CT	Coral Triangle
CTI-CFF	Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security
diss-As	Dissolved arsenic in water
DJPT	*Direktorat Jenderal Perikanan Tangkap* – Directorate General for Capture Fisheries
DKP	*Dinas Kelautan dan Perikanan* – Department of Provincial Marine Affairs and Fisheries Agency
DLH	*Dinas Lingkungan Hidup* – Department of Provincial Environment Agency
DPR	Democratic People's Republic
EAA	Ecosystem approach to aquaculture
EAF	Ecosystem approach to fisheries
EAFM	Ecosystem approach to fisheries management
EBM	Ecosystem-based management
e-CDTs	Electronic catch documentation and traceability systems
EEZ	Exclusive economic zone
ENSO	El Niño/Southern Oscillation

ESDM	*Energi dan Sumber Daya Mineral* – Ministry of Energy and Mineral Resources
ETP	Endangered, threatened, and protected
FAO	Food and Agriculture Organization of the United Nations
FMA	Fisheries management area
GDP	Gross domestic product
GDPC	Global Disaster Preparedness Centre
GEF	Global Environment Facility
GERHAN	*Gerakan Rehabilitasi Hutan dan Lahan* – Forest and Land Rehabilitation
GFSI	Global Food Security Index
GHG	Greenhouse gas
GIS	Geographic information system
GMF	Global Maritime Fulcrum
GRDP	Gross regional domestic product
GT	Gross tonnage
GVA	Gross value added
HAB	Harmful algal bloom
HBA	Hatchery-based aquaculture
HDI	Human Development Index
HNSI	*Himpunan Nelayan Seluruh Indonesia* – Fishers Union of Indonesia
IBCSF	Indonesia Blue Carbon Strategy Framework
IBSAP	Indonesian Biodiversity Strategy and Action Plan
ICM	Integrated coastal management
ICZM	Integrated coastal zone management
IDD	Indonesia deepwater development
IDHS	Indonesian demographic and health survey
IDR	Indonesia Rupiah
ILO	International Labour Organization
IMIC	Indonesian Maritime Information Centre
IMO	International Maritime Organization
IMTA	Integrated Multi-Trophic aquaculture
INDESO	Infrastructure Development for Space Oceanography
IOD	Indian Ocean Dipole
IOP	Indonesian Ocean Policy
IOTC	Indian Ocean Tuna Commission
IPB	*Institut Pertanian Bogor* – Bogor Agriculture University
IPCC	Intergovernmental Panel on Climate Change
IPG	*Indeks Pembangunan Gender* – Indonesia's Gender Development Index
IPOA	International Plan of Action for the Management of Fishing Capacity
ISLME	Indonesian Seas Large Marine Ecosystem
ITCZ	Inter-Tropical Convergence Zone
ITF	Indonesian Throughflow
IUU	Illegal, Unreported, and Unregulated (fishing)
JPDA	Joint Petroleum Development Area
K/L	*Kementerian/Lembaga* – Ministry/Institution
K3LL	*Kesehatan Keselamatan Kerja dan Lindung Lingkungan* – Safety, Health, and Environmental Protection
KKJI	*Direktorat Konservasi dan Keanekaragaman Hayati Laut KKP* – Directorate of Conservation and Marine Biodiversity MMAF
KKP	*Kementerian Kelautan dan Perikanan* – MMAF Indonesia
KKP3K	*Kawasan Konservasi Perairan, Pesisir, dan Pulau-Pulau Kecil* – Water, Coastal, and Small Islands Conservation Areas
KLHK	*Kementerian Lingkungan Hidup dan Kehutanan* – MOEF Indonesia
KOMNAS	Kajiskan *Komisi Nasional Pengkajian Sumber Daya Ikan* –

	National Commission on Fish Stock Assessment
KPPPA	*Kementerian Pemberdayaan Perempuan dan Perlindungan Anak* – Women Empowerment and Child Protection
KSNT	*Kawasan Strategis Nasional Tertentu* – Special National Strategic Area
LBS	*Luas Lahan Baku Sawah* – Indonesia's Total Rice Field Area
LCDI	Low Carbon Development Initiative
LCDP	Low Carbon Development Plan
LCS	Litter Classification System
LIPI	*Lembaga Ilmu Pengetahuan Indonesia* – Indonesian Institute Sciences
LME	Large Marine Ecosystem
LMMA	Locally Managed Marine Area
LNG	Liquid Natural Gas
LPP	*Lembaga Pengelola Perikanan* – Fisheries Management Institution
LSE	Lesser Sunda Ecoregion
MAF	Ministry of Agriculture and Fisheries Timor-Leste
MCS	Monitoring, control, and surveillance
METT	Management Effectiveness Tracking Tool
MJO	Madden-Julian Oscillation
MLE	Medium and large establishments
MMAF	Ministry of Marine Affairs and Fisheries Indonesia
MMR	Maternal mortality rate
MMSCFD	Million metric standard cubic feet per day
MMstb	Million stock barrels of oil
MoA	Memorandum of agreement
MOEF	Ministry of Environment and Forestry
MP3EI	Masterplan *Percepatan danPerluasan Pembangunan Ekonomi Indonesia* – Masterplan of Acceleration and Expansion of Indonesia's Economic Development
MPA	Marine Protected Area
MSC	Marine Stewardship Council
MSE	Micro and Small Establishment
MSP	Marine Spatial Planning
MSY	Maximum Sustainable Yield
MTOE	Millions of Tonnes of Oil Equivalents
MYS	Mean Years of Schooling
NAP	National Action Plan
NEET	Not in Employment, Education, or Training
NGO	Non-Governmental Organization
NIS	Native and Invasive Species
NOP	National Ocean Policy
NPOA	National Plan of Action
NSAG	National Scientific Advisory Group
NTB	Nusa Tenggara Barat – West Nusa Tenggara
NTT	Nusa Tenggara Timur – East Nusa Tenggara
NTZ	No Take Zone
PAD	*Pendapatan Asli Daerah* – Local Government Revenue
PCA	Priority Conservation Area
PDO	Pacific Decadal Oscillation
PDSKP	*Direktorat Jenderal Penguatan Daya Saing Produk Kelautan dan Perikanan* – Directorate General for Increasing Competitiveness of Marine and Fishery Products
PEC	Priority Environmental Concern
PEL	Probable Effect Levels
PEMSEA	Partnerships in Environmental Management for the Seas of East Asia
PERMEN-KP	*Peraturan Menteri Kelautan dan Perikanan* – Marine and Fisheries Ministerial Regulation
PERPRES	*Peraturan Presiden* – Presidential Decree
PES	Payment for Ecosystem Services
PeskAAS	Fisheries Automated Analytics System
PIPP	*Pusat Informasi Pelabuhan Perikanan* – Fishery Port Information Center

PKSPL *Pusat Kajian Sumberdaya Pesisir dan Lautan* – Center for Coastal and Marine Resources Study

PMK *Peraturan Menteri Keuangan* – Minister of Finance's Regulation

PNTL Policia Nacíonal de Timor-Leste - National Police of Timor-Leste

POKMASWAS *Kelompok Masyarakat Pengawas* – Community-based Monitoring Groups

PP *Peraturan Pemerintah* – Government Regulation

PPI *Pangkalan Pendaratan Ikan* – Fish Landing Centres

PPN *Pelabuhan Perikanan Nusantara* – Archipelagic Fishing Port

PPP *Pelabuhan Perikanan Pantai* – Coastal Fishing Port

PPP Public Private Partnership

PPS *Pelabuhan Perikanan Samudra* – Oceanic Fishing Port

PSMA Port State Measures Agreement

PUG *Pengarusutamaan Gender* – Gender Mainstreaming

PUPR *Kementerian Pekerjaan Umum dan Perumahan Rakyat Republik Indonesia* – Ministry of Public Works & Housing

PUSDATIN *Pusat Data dan Teknologi Informasi* – Center for data and information Technology

Puskesmas *Pusat Kesehatan Masyarakat* – Community Health Center

RBFM Rights-based Fisheries Management

REDD+ Reducing Emissions from Deforestation and Forest Degradation

RFMO Regional Fisheries Management Organization

RPJMN *Rencana Pembangunan Jangka Menengah Nasional* – National Medium-Term Development Plan

RPOA Regional Plan of Action

RPP *Rencana Pengelolaan Perikanan* – Fisheries Management Plan

RRR Reserve replacement ratio

RTP *Rumah Tangga Perikanan* – Marine fishing household

RTRW *Rencana Tata Ruang Wilayah* – Regional Spatial Planning Policy

RTTG Regional TDA-SAP Technical Group

RZWP3K *Rencana Zonasi Wilayah Pesisir dan Pulau-Pulau Kecil* – Coastal and Island Zone Zoning Plan Small Island

RZKAW *Rencana Zonasi Kawasan Antar Wilayah* – Inter-Regional Zoning Plan

RZKSNTPPKT *Rencana Zonasi Kawasan Strategis Nasional Tertentu Pulau Pulau Kecil Terluar* – Zoning Plan for Small Outer Islands

SAP Strategic Action Programme

SATGAS *Satuan Tugas* – task force

SBT Southern bluefin tuna

SDS-SEA Sustainable Development Strategy for the Seas of East Asia

SDGs Sustainable development goals

SEAFDEC Southeast Asian Fisheries Development Center

SEAFINE Seamos-South Fine Grid Hincast

sed-As Adsorbed arsenic in sediment

SEZ Special economic zone

SIPI *Surat Izin Penangkapan Ikan* – Fishing license

SKK MIGAS *Satuan Kerja Khusus Pelaksana Kegiatan Usaha Hulu Minyak dan Gas Bumi* – Task force for upstream oil and gas business activities

SLR Sea level rise

SNA System of National Accounts

SPSN *Sistem Informasi Pengelolaan Sampah Nasional* – National Waste Management Information System

SR Saving ratio

SS Single species

SST Sea surface temperature

TAC Total allowable catch

TDA Transboundary diagnostic analysis

THE Total health expenditure

TNC The Nature Conservancy

TNC-MOW The Nature Conservancy's Mapping Ocean Wealth

TPI	*Tempat Pelelangan Ikan* – Fish Auction Places
TRITON	Triangle Trans-Ocean Buoy Network
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNCLOS	United Nations Convention on the Law of the Sea
UN	United Nations
UNDP	United Nation Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
USAID	United States Agency for International Development
USD	United states dollars
UTM	Universal transverse mercator
VF	Vulnerability factor
VMS	Vessel monitoring system
WGS	World geodetic system
WPP	*Wilayah Pengelolaan Perikanan* – Fisheries management area
WWF	World Wildlife Fund for Nature
YKAN	*Yayasan Konservasi Alam Nusantara* – Indonesian NGO (Non-Governmental Organization) affiliate of The Nature Conservancy

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Executive summary

The Indonesian Seas Large Marine Ecosystem (ISLME) plays a role of significant global ecological importance in terms of fisheries production, biodiversity richness and global climate regulation. The ISLME covers an area of about 2.3 million km² (232 million hectares), consisting of the territorial waters of Indonesia (98 percent) and Timor-Leste (2 percent). It is situated in the centre of the Coral Triangle, featuring shallow waters in the Java Sea and deeper seas such as the Banda Sea, Sulawesi Sea, Maluku Sea, Bali Sea, Flores Sea, Ombai-Wetar Strait and Timor Sea. The region offers huge ecosystem goods and services potentials for the well-being of about 185 million people relying on its diverse ecosystems, fish and seafood supplies from wild capture and aquaculture, oil and gas, minerals, sand and gravel, renewable energy resources, tourism potential, and biological diversity.

The region has unique hydrodynamics, influenced by ocean currents, winds, tides, and monsoons, including the Indonesian Throughflow (ITF) which influence the distribution and abundance of phytoplankton, zooplankton, nutrients, and other key components of the ecosystem. The tropical climate with surface temperatures between 25 °C and 30 °C is a favourable condition for abundant primary productivity and a wide array of marine species in the region. Indeed, the ISLME is known as one of the world's most productive marine ecosystems, harbouring over 2 500 fish species, more than 500 coral species, and numerous crustaceans and cephalopods. Climatic drivers such as El Niño/Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), and Pacific Decadal Oscillation (PDO), as well as seasonal monsoons determine the climate in the region. The warm waters of the ISLME region act as a heat engine of global atmospheric circulation, with complex ocean-atmospheric dynamics.

ISLME is known for its high productivity of valuable commodities such as tuna, snapper, grouper, scad and sardine, among many other species from capture fisheries. Fishing pressure is high in most parts of the ISLME, and management rules are often not well complied with. Seaweed, milkfish, shrimp and lobster are some of its key aquaculture commodities. Its mangrove forests encompass 11 872 km^2 with at least 55 mangrove species and 75 mangrove-associated species found along the coastline. Unfortunately, the level of mangrove deforestation in Indonesia alone reached a total of 182 091 hectares from 2009 to 2019. There are also around 110 marine protected areas (MPAs) with several newly established MPAs to protect important habitats and support fisheries and marine resources restoration, however, management of these MPAs is not yet optimal. Both countries have enacted laws for the conservation and protection of endangered species, megafauna such as marine mammals, sea turtles and sharks, but there are gaps in compliance. Since 2009, Indonesia has implemented both the ecosystem approach to fisheries management (EAFM) and the ecosystem approach to aquaculture (EAA) with improved fisheries policies and regulations and co-management, and Timor-Leste also to introduce EAFM. However, more needs to be done to enforce resource management regulations and strengthen governance in the region. Various anthropogenic factors, driven by population growth, economic pressures, and climate change, have become growing threats to ISLME resources sustainability and this requires clear actions to address them.

The project, entitled "Enabling transboundary cooperation for sustainable management of the Indonesian Seas" (ISLME), supported by the Food and Agricultural Organization of the United Nations (FAO) through funding by the Global Environment Facility (GEF),-assists Indonesia and Timor-Leste in (i) the development of Transboundary Diagnostic Analysis (TDA) and Strategic Action Programme (SAP); (ii) strengthening national capacities for ecosystem-based management for fisheries and aquaculture; and (iii) sharing valuable expertise and experience with the national and regional forums to accelerate progress in LME management.

The project facilitated the TDA development, a scientific process to identify drivers, immediate and root causes of various transboundary issues threatening the region's sustainability. This rigorous process involved a series of activities such as data collection and analysis, as well as intensive national and regional technical consultations in close collaboration with the Ministry of Marine Affairs and Fisheries (MMAF) of the Republic of Indonesia, the Ministry of Agriculture and Fisheries of the Republic of Timor-Leste, a panel of marine and fisheries experts and members of the National Scientific Advisory Groups (NSAGs) from both countries. The final regional TDA consultation was held in Bali, 25–27 May 2023 to validate and finalize the TDA document.

The TDA provides comprehensive insights into the ISLME: its biophysical characteristics, as well as important economic sectors. There is detailed information on the current status of marine-fisheries resources, habitats, biodiversity, institutional and policy aspects, including governance and implementation of ecosystem-based management. This information is further analysed in a rigorous process called the causal chain analysis (CCA) of the transboundary problems, and complemented by the stakeholder analysis. The report identifies the following five priority environmental concerns (PECs) under the CCA section:

1. Unsustainable fishing and aquaculture practices

- illegal, unreported, and unregulated (IUU) fishing (overfishing, destructive fishing) and catching of immature fish;
- very high level of artisanal, subsistence and small-scale fishers;
- high feed demand for fish farm and limited aquaculture practices;
- excess fishing capacity, multispecies and multigear fisheries (non-selective fishing gear); and
- high level of fisheries bycatch and discards.

2. Degradation and loss of coastal and marine habitats

- the high level of development in coastal areas;
- the ongoing practice of IUU fishing;
- the introduction and spread of alien and invasive species;
- the worsening phenomenon of climate change; and
- the high level of anthropogenic activities.

3. Marine and land-based pollution

- huge volumes of garbage, including plastics, entering the LME from both land and sea-based sources on a continuous basis;
- the decline in water quality and its impact on coastal and marine ecosystems; and
- improper land use, limited catchment, and agricultural practices.

4. Decline and loss of biodiversity and key marine species
- unsustainable and destructive fisheries practices;
- the legal and illegal trade of marine species; and
- degradation and loss of critical habitats of key marine species.

5. Impacts of climate change
- climate variability (rising of temperature, greater heat stress, prolonged droughts);
- change in precipitation pattern (more intense rainfall events, riverine flooding, and droughts);
- extreme weather events (strong winds, storms, storm surges, and cyclones);
- change in ocean conditions (change in oceanographic processes); and
- ocean acidification and sea level rise (SLR).

These concerns are rooted in governance, environmental, and socioeconomic factors, necessitating effective management with improved governance and strong stakeholder involvement; resource allocation with investments in knowledge generation, capacity development, availability of reliable data, technological adoption and research to address the complexities of these interconnected issues. These are reflected in the leverage points – areas of potential interventions with expected high impact or effect – and proposed priority actions provided as recommendations.

The scientific findings presented in this TDA document allow deeper understanding of the transboundary challenges facing the ISLME region and will be used to inform the formulation of the SAP, detailing priority policies and clear interventions to address the identified threats, to be implemented in a coordinated manner as well as jointly by both countries. The TDA findings will help pave the way to effective management, foster strong ownership and resourcefulness among policy and decision-makers, academia, civic society organizations, small fishers/farmers and coastal communities in the region to contribute from their respective domains to address the problems. They will also assist both Indonesia and Timor-Leste in their efforts to meet targets, commitments and obligations under international treaties and conventions. Ensuring marine and fisheries resources health and the goods/services that the Indonesian Seas ecosystems provide are crucial for poverty eradication, zero hunger, good health and well-being of communities and sustainable life under water, which are all included in the Sustainable Development Goals (SDGs).

CHAPTER 1

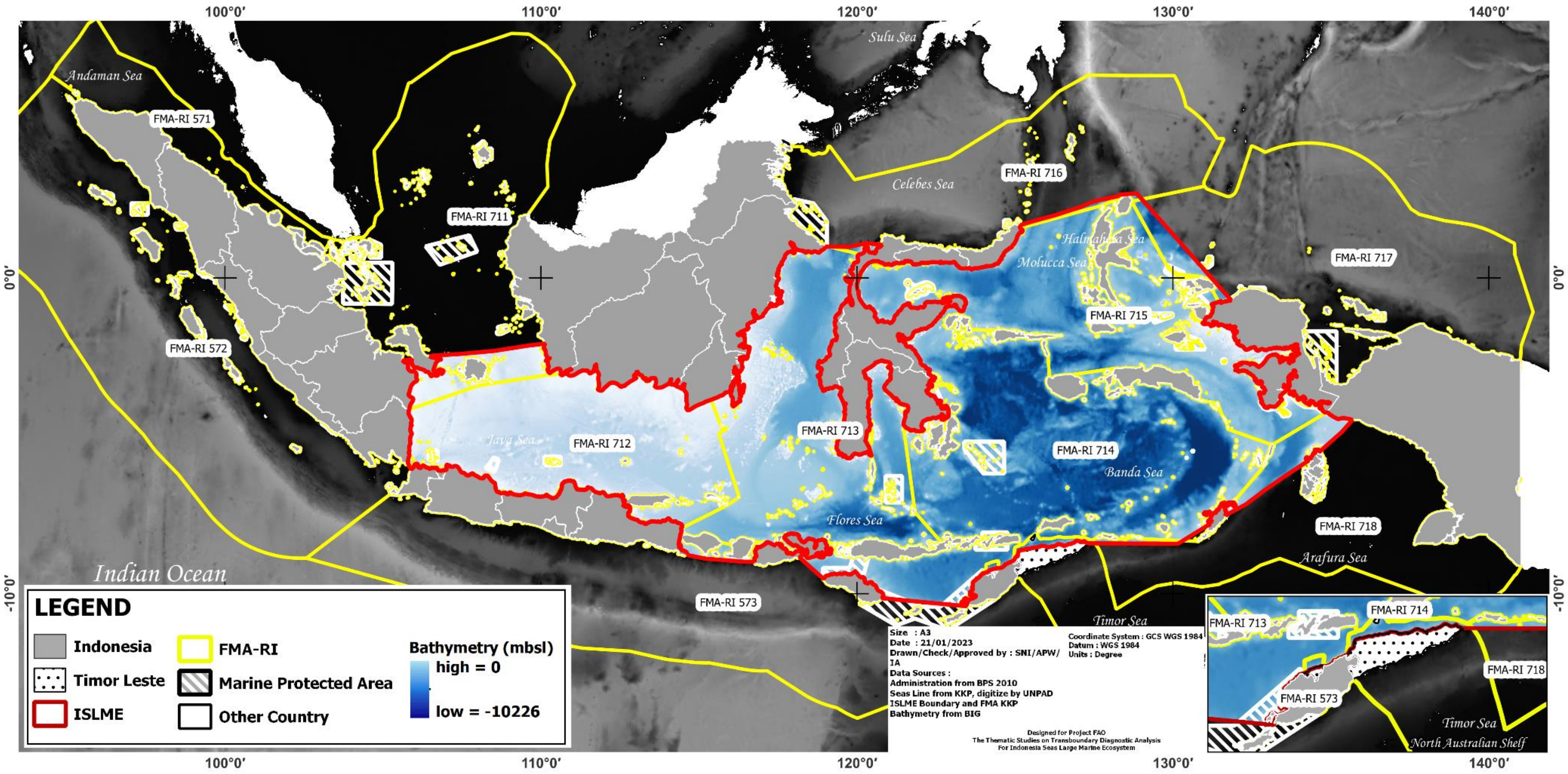
Introduction

1.1 Background to the Indonesian Seas Large Marine Ecosystem region, its global and regional significance

Large marine ecosystems (LMEs) are defined as vast areas of the Earth's oceans that include coastal zones, estuaries, continental shelves, and major ocean currents (Sherman, 1991). These regions typically cover a minimum area of 200,000 km² and are identified based on their unique bathymetry, hydrography, productivity, ecological region, and trophic populations (Sherman, and Duda, 2001). In general, LME areas have higher levels of productivity than the open ocean (Mercado-Santana *et al.,* 2017). In the global context, there are 66 LMEs, and the Indonesian Seas Large Marine Ecosystem (ISLME) is considered LME #38. The ISLME is home to an estimated 185 million people, with almost 900 000 residing in Timor-Leste and the rest in Indonesia. It covers an area of 2.33 million km². In ISLME waters, daily water productivity as seen from chlorophyll content is 1 000 to 1 500 mg C/m^2. The ISLME is situated at the confluence of the Pacific and Indian Oceans, and is bordered by Indonesia and Timor-Leste, both connected by the Indonesian Throughflow (ITF). The majority of the ISLME lies 98 percent within Indonesia's territorial waters, with only 2 percent situated within Timor-Leste's territorial waters (IWLearn.net). Adjacent to the ISLME, there are four other LMEs: to the north, the Sulu and Celebes Seas LME (also known as the Sulu Sulawesi Marine Ecoregion, LME 37). To the west, the Bay of Bengal (LME 34), to the southeast, the North Australian Shelf LME (LME 45), and to the east, Arafura and Timor Sea, which can also be considered an LME (ATSEA, 2011a; BOBLME, 2015a; SSMETC, 2013a).

Of the total area of the ISLME, 829 346 km² is considered shelf area that extends from the shore to a depth of 200 metres, whereas 580 605 m² is inshore fishing area that stretches from the shore to either 50 km offshore or the 200 m depth contour, whichever comes first. About 4 percent of the region is protected, and it is home to 6.9 percent of the world's coral reefs. The ISLME includes several seas, such as the Java Sea, Bali Sea, Flores Sea, Banda Sea, Halmahera Sea, Makassar Strait, Molucca Sea, Aru Sea, Savu Sea, and Seram Sea. Its eastern extent covers the western part of Irian Jaya (Papua) south coast, the Aru Islands, and the Tanimbar Islands, following the 200 m depth contour along the boundary with the Arafura Sea to the eastern tip of Timor-Leste north coast (Figure 1). Its southern extent forms the northern coasts of the Sunda Islands, apart from Savu Sea, which is included in the ISLME.

Figure 1. Area of Indonesian Seas Large Marine Ecosystem ISLME which is bordered by major islands of Indonesia and Timor-Leste



Sources:Badan Informasi dan Geospasial (BIG). 2023. Main Page. (n.d.). https://www.big.go.id/; BPS. 2021. Badan Pusat Statistik Indonesia - Main Page. https://www.bps.go.id [Accessed 24 March 2024]; MMAF. 2023. Satu Peta KKP - Main Page. https://satupeta.kkp.go.id/gis/home/ [Accessed 24 March 2024], modified by UNPAD for ISLME project.

The ISLME plays a key role of significant global ecological importance because of its crucial role in supporting fisheries production, biodiversity, and global climate regulation. The relatively high nutrient content is a result of the input of water from rivers in islands around the ISLME and the important pathways from the Pacific that passes through the ISLME region, known as the Indonesian Throughflow (ITF), with warm temperatures and low salinity characteristics (Purba *et al*., 2021; Gordon *et al*., 2010). The circulation over this area is complex with several phenomena including El Ni̇ńo Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), Pacific Warm Pool water in the north of Papua, monsoonal situation, tides pattern, and seamounts. Because of its complex characteristics, this region has been studied already in the 19th century by Alfred Russel Wallace, an explorer and naturalist from England, when he was developing the theory of natural selection. It is classified as a Class I ecosystem because of its high productivity and accounts for over 1 percent of the world's fisheries production. The ISLME is located in the western Indo-Pacific marine biogeographical region, which is known for its exceptional species richness, including over 500 species of reef-building corals, 2 500 species of marine fish, 45 species of mangroves, and 13 species of seagrasses (Christie *et al.*, 2014).

In the early twenty-first century and era of climate change, there are various obstacles in the water sectors of ISLME, such as overfishing, marine pollution, illegal fishing, marine debris, anthropogenic pollution, and oil spills that decrease the health of the ocean (Ihsan *et al*., 2022). These issues need to be clearly outlined to guide management in both countries. Therefore, it requires effective and coordinated management to enable Indonesia and Timor-Leste to share concerns, restore and maintain marine fish stocks and biodiversity, and strengthen dependent livelihoods. Furthermore, the challenge of managing transboundary waters poses a significant threat to the economy and ecology, as these large international water systems cross political borders and face numerous challenges. Given the dynamics of the ocean, with an absence of clear boundaries, the sustainable management of waters and their resources requires joint efforts.

The Food and Agricultural Organization of the United Nations (FAO), with financial support from the Global Environment Facility (GEF), facilitates the project entitled "Enabling transboundary cooperation for sustainable management of the Indonesian Seas (ISLME)". The goal of this project (GCP/RAS/289/GFF) is to promote regional cooperation and support the effective and sustainable management of the ISLME region. The project's objective is to assist Indonesia and Timor-Leste to address transboundary concerns, restore, and sustain coastal and marine fish stocks and biodiversity, and dependent livelihoods (FAO, 2021). The project covers the waters of Indonesia and Timor-Leste and is implemented in close consultation with the respective governments and partner institutions, with the Ministry of Marine Affairs and Fisheries (MMAF) leading the project in Indonesia and the Ministry of Agriculture and Fisheries (MAF) leading in Timor-Leste (FAO, 2020a). The LME Approach provides a five-module strategy for assessing and monitoring LMEs and for taking remedial actions toward the recovery and sustainability of degraded goods and services in LMEs. The modules are focused on the application of suites of indicators for measuring LME socioeconomics, productivity, governance, pollution and ecosystem health, and fish and fisheries, which are incorporated into a multicountry LME strategic planning process through development of a

Transboundary Diagnostic Analysis (TDA) and a Strategic Action Programme (SAP) (GEF, 2020).

The ISLME Project comprises four essential main components (FAO, 2021), namely:

(i) identifying and mitigating the various factors that pose a threat to the marine environment, particularly unsustainable fishing practice series;
(ii) enhancing the capacity for regional and subregional cooperation in the management of marine resources;
(iii) coordinating with existing regional information networks, monitoring the impacts of the project, and disseminating and exchanging information with stakeholders; and
(iv) identifying and describing the existing status in transboundary cooperation, including socioeconomic, institutional drivers, and the impacts of climate change.

The ISLME Project has a distinctive organizational structure that enables it to effectively tackle global and transboundary environmental concerns. The governance framework comprises the Secretary General, Director, National Project Coordinator (NPC) of the Ministry of Marine Affairs and Fisheries (MMAF), Indonesia, and the Director General of Fisheries, Ministry of Agriculture and Fisheries (MAF), in Timor-Leste supported by a National Project Officer and a National Project Adviser both appointed by FAO. The Project is regionally coordinated by a Regional Project Coordinator appointed by FAO, and other essential staff support the team. They work together to implement project initiatives and activities on the ground. The implementation of these activities involves collaboration among national stakeholders and is coordinated by the MMAF Indonesia, MAF Timor-Leste, and FAO in both countries.

The structure of stakeholder consultation and technical review/inputs into the Transboundary Diagnostic Analysis was assisted and guided by the establishment of a National Scientific Advisory Group (NSAG), both in Indonesia and Timor-Leste, with the TDA-SAP overseen by a Regional TDA-SAP Technical Group (RTTG). Both Indonesia and Timor-Leste established a four-member NSAG, with the NSAGs of both countries (together) constituting the Regional TDA/SAP Technical Group (RTTG). Later, the NSAG Indonesia was expanded adding four more experts.

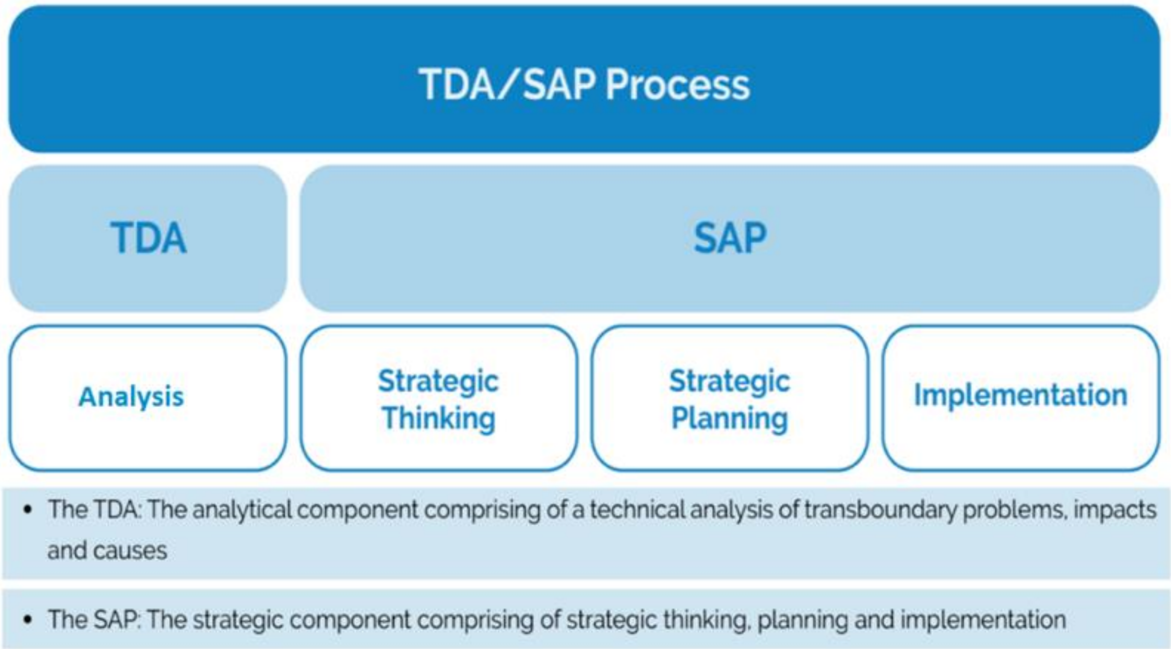
1.2 The Transboundary Diagnostic Analysis

This Indonesian Seas Large Marine Ecosystem (ISLME) project consists of a collaborative development of a Strategic Action Programme (SAP) based on a Transboundary Diagnostic Analysis (TDA), which will strengthen capacity in natural resources assessment, management, regional coordination, and information sharing. A TDA is considered to be an essential early step in the management of any large marine ecosystem (LME). The purpose of such a TDA is to identify, where possible quantify, and rank according to the severity of environmental and/or socioeconomic impacts, all water-related environmental and transboundary issues, and their proximate and root causes, including the socio-economic, institutional, legal, and administrative circumstances, and projected impact of climate change on the region. The generic process of preparing a TDA is guided by best practices and a specific methodology developed by the Global Environment Facility International Waters Programme (GEF, 2020) and consists of:

1) analysing causal chains to identify direct and indirect drivers that lead to the loss of ecosystem goods and services; and
2) analysing institutions, laws, policies, and projected investments.

The TDA is also an integral and linked component of the TDA-SAP process, providing the technical basis, evidence, and foundation for the more strategic planning process under the SAP (Figure 2).

Figure 2. Schematic outline of the Transboundary Diagnostic Analysis–-Strategic Action Plan process



Source: GEF. 2020. GEF Transboundary Diagnostic Analysis/Strategic Action Programme Manual: TDA/SAP Methodology. International Waters Learning Exchange and Resource Network. [Cited June 2023]. https://iwlearn.net/resolveuid/2cc6db95-cc24-46e6-8f18-8c894c156a27

The Transboundary Diagnostic Analysis (TDA) serves as the foundation for the development of a **Strategic Action Programme** (SAP) and **National Action Programmes** (NAPs) by providing a scientific and technical basis for a comprehensive and multisectoral assessment of the issues related to the status of and threats to habitats and resources within the ISLME. The SAP and NAP are designed to address the issues identified in the TDA and provide a reasoned, holistic approach to the sustainable management of these resources including linking with the Sustainable Development Goals (SDGs) and ecosystem restoration goals in 2030 (FAO, 2018a).

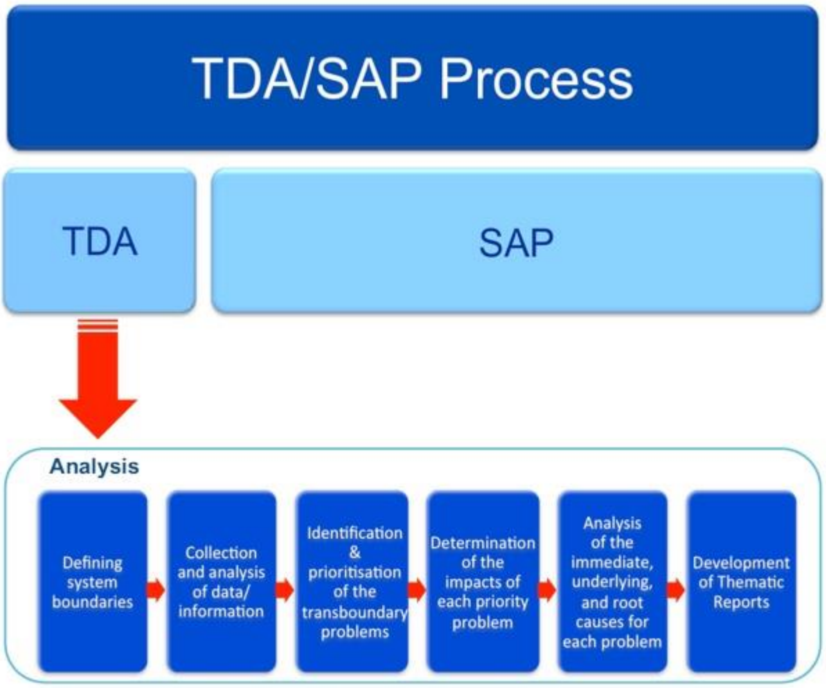
1.3 Indonesian Seas Large Marine Ecosystem Transboundary Diagnostic Analysis methodology

The TDA process is a collaborative and iterative process that involves a range of stakeholders, including government agencies, NGOs, and community members. The process is designed to identify and address complex environmental problems that cross national boundaries and require coordinated action among multiple stakeholders. The TDA process involves several key steps, which are outlined below:

(i) Establish the scope and objectives: this may involve identifying the geographic area of interest, the environmental problems to be addressed, and the stakeholders who will be involved in the analysis.
(ii) Conduct a situation analysis: this is done to gather information about the environmental problems and their causes. This may involve collecting and analysing data, conducting stakeholder interviews, and reviewing relevant literature.
(iii) Develop a conceptual model: based on the information gathered in the situation analysis, the next step is to develop a conceptual model of the environmental problems and their root causes. This involves identifying the key drivers of the problems and how they are interconnected.
(iv) Identify priority issues and solutions: using the conceptual model, the next step is to identify priority environmental issues and potential solutions. This may involve conducting a cost–benefit analysis to determine the most effective solutions.

The process for developing the TDA included the identification of priority environmental and transboundary issues, which started with a preliminary assessment, based on thematic assessments (national, regional), regional and national stakeholder consultations, followed by review and ratification of the selected issues by a combination of technical working groups and regional workshops. This is reflected in the workplan for the ISLME TDA. The implementation of this workplan had of course been negatively affected by COVID-19 between 2020 and 2022, which delayed some activities, whereas others had to be held using online, web-based consultation facilities for virtual meetings. Significantly, under the project document, there is also clear recognition of recent TDA-SAP's conducted for other LME projects in the region (including those adjacent to the ISLME) – the Bay of Bengal Large marine Ecosystem (BOBLME), Arafura and Timor Seas Ecosystem Action (ATSEA) project, and the Sulu Sulawesi Large Marine Ecosystem (SSLME) – which have provided important insights, learnings and also, major efficiencies in undertaking the TDA for the ISLME (Figure 3) (BOBLME, 2012a; BOBLME, 2012b; Ellet, 2021; SSMETC, 2014).

Figure 3. Schematic description of the Transboundary Diagnostic Analysis process



Source: GEF. 2020. GEF Transboundary Diagnostic Analysis/Strategic Action Programme Manual: TDA/SAP Methodology. International Waters Learning Exchange and Resource Network. [Cited June 2023]. https://iwlearn.net/documents/32987

1.3.1 Identification of the priority transboundary issues

Transboundary Diagnostic Analysis (TDA) plays a key role in identifying and quantifying the environmental issues and problems associated with international waters. A scientific and technical assessment approach of TDA is conducted to establish their immediate, intermediate, and fundamental (root) causes. The analysis involves an identification of the causes and impacts of environmental disturbances and/or threats and assesses the scale and distribution of impacts at national, regional, and global levels, predominantly in socioeconomic terms. Furthermore, the identification of causes specifies the practices, sources, locations, and human activity sectors from which environmental degradation happened. The TDA describes a list of main issues affecting an international waters area, their causes, and the origins of those causes. TDAs can be conducted by two or more countries depending on the need to identify transboundary effects and as impacting the international waterbody. The causes of transboundary issues should be identified in a hierarchical manner from technical perspectives, through management and socioeconomic perspectives to the policy level.

The term “root causes” refers to the most fundamental of causes. In the ISLME context, this sequential identification of the hierarchy of causes is conceptually known as a causal chain analysis (CCA) of environmental problems or to obviate environmental threats (Figure 4. Overview of the process for key stakeholder and technical inputs into the Indonesian Seas Large Marine Ecosystem ISLME Transboundary Diagnostic Analysis). The CCA continues with the identification of important leverage points (LP), potential areas of interventions, when relatively smaller initiatives have the potential of creating significant impact or change in the system. The most effective of these options for intervention then constitute the basis of the Strategic Action Programme (SAP) that can be formulated, officially endorsed, and applied in a coordinated manner by all riparian countries, in this case both Indonesia and Timor-Leste.

Figure 4. Overview of the process for key stakeholder and technical inputs into the Indonesian Seas Large Marine Ecosystem ISLME Transboundary Diagnostic Analysis

THEMATIC ASSESMENTS	• National Assessment (Timor-Leste, Indonesia) • Thematic Areas (4): environment/oceanography, fisheries & aquaculture, socio-economics • Regional (ISLME)-ecosystem services valuation
WORKING GROUPS FOR DATA INPUTS AND TECHNICAL REVIEW	• National Scientific Advisory Groups (NSAGs) • Regional TDA-SAP Technical Group (RTTG) • Input/review of Thematic Assessment, draft TDA
2 REGIONAL TDA TECHNICAL WORKSHOP	• First RTTG-identification of PECs; environmental and socio-economic impacts, format of draft TDA • Second RTTG-data integration, causal chain analysis, input/review of Thematic Assessment
COMPILATION AND APPROVAL OF TDA	• Compilation and writing of TDA (Lead TDA Writer) • National TDA validation/adoption workshop (2) • Approval of TDA by government of Indonesia, Timor-Leste
THEMATIC ASSESMENTS	• National Assessment (Timor-Leste, Indonesia) • Updating data and Adding section of CCA Analysis • Input/review of thematic assessment, draft TDA
WORKING GROUPS FOR DATA INPUTS AND TECHNICAL REVIEW	• National Scientific Advisory Groups (NSAGs) • Regional Technical Group (NSAG, FAO, MMAF, MAF) • Input/review of TDA document, draft TDA • CCA Analysis, Leverage Points, Recommendation
COMPILATION AND APPROVAL OF TDA	• Compilation and writing of TDA (Lead TDA Writer) • National and Regional TDA validation • Approval of TDA by government of Indonesia, Timor-Leste

Source: National Stakeholder Consultation Workshop Report (FAO, 2020a).

1.3.2 Thematic reports and development of the causal chains

Within the TDA-SAP process, the TDA is the technical analysis of environmental and priority transboundary problems, impacts and causes. As such, the TDA provides the factual basis for the strategic component of the TDA-SAP process (strategic thinking, planning and implementation of the SAP). There are several thematic reports commissioned, compiled, and included to enhance the TDA, among these also several technical reports as outputs of ISLME Project implementation activities.

Significantly, the TDA was also assisted by the preparation of detailed regional/national Thematic Assessments (FAO, 2020a; FAO, 2020c) to ensure that the following critical technical outputs required for the TDA ISLME were addressed:

a. Transboundary threats to marine resources and ecosystems and their root causes are identified.
b. Status of marine resources, ecosystem health, and ecological impacts on the ISLME marine resources and ecosystems are assessed.

c. Significant socioeconomic drivers and trends that create environmental pressure on ecosystem resources and services in the ISLME region are assessed.
d. The governance and institutional structures, including stakeholders who are relevant to the management of fisheries and the ISLME ecosystem, are identified and analysed.

Under the ISLME project, regional/national-level, reviews/assessments on specific thematic areas of environment, socioeconomics, governance, and ecosystem services valuation were carried out (with support from the NSAGs, RTTG, the TDA consultant and additional consultants), including consultations with relevant experts/key stakeholder, providing opportunities for technical inputs/review.

Developing causal chains is an important step in the TDA process as it provides a structured approach to identifying the root causes of priority transboundary environmental issues. By understanding the causal relationships between different factors, stakeholders can identify effective interventions to address the underlying drivers of these issues and work towards sustainable solutions. Data integration and the conducting of a CCA**,** are key steps in the TDA process. The principal aim of the CCA is to analyse causal chains to identify the direct and indirect drivers that lead to ecosystem degradation and the loss of ecosystem goods and services – for each identify the indirect and direct biophysical, socioeconomic, legal and political drivers of ecosystem degradation.

The CCA for the ISLME was undertaken at the Second Regional TDA Workshop based on data integration, workshop outputs and outputs from the TDA national/regional thematic assessments and reports. The TDA consultants and NSAG members also assisted the TDA specialist with any additional technical inputs/revisions related to the CCA in the TDA. In the finalization of the ISLME TDA report, the NSAGs also had the opportunity to provide any final technical review/inputs, prior to final technical review by the RTTG for the TDA-SAP.

The following steps were taken to develop causal chains for the priority transboundary issues:

1. Identify the priority transboundary issues: the first step is to identify the environmental issues that have a significant impact across national borders. This involved analysing data, conducting stakeholder in, and reviewing relevant literature to identify the most pressing issues.
2. Develop a conceptual model: the next step is to develop a conceptual model of the environmental issues and their root causes. This involves identifying the key drivers of the issues and how they are interconnected.
3. Develop a causal chain for each issue: based on the conceptual model, the next step is to develop a causal chain for each environmental issue. A causal chain is a sequence of events or factors that lead to a specific outcome. Each causal chain should identify the factors that contribute to the transboundary issue, and the relationship between these factors and the final outcome.
4. Validate the causal chains: once the causal chains have been developed, they should be reviewed and validated by stakeholders to ensure that they accurately represent the environmental issues and their root causes. This may involve conducting stakeholder workshops or focus groups to gather feedback and input.

5. Identify intervention points: using the causal chains, the final step is to identify intervention points where actions can be taken to address the root causes of the environmental issues. This may involve identifying policy changes, infrastructure improvements, or other actions that can be taken to address the factors identified in the causal chains.

CHAPTER 2

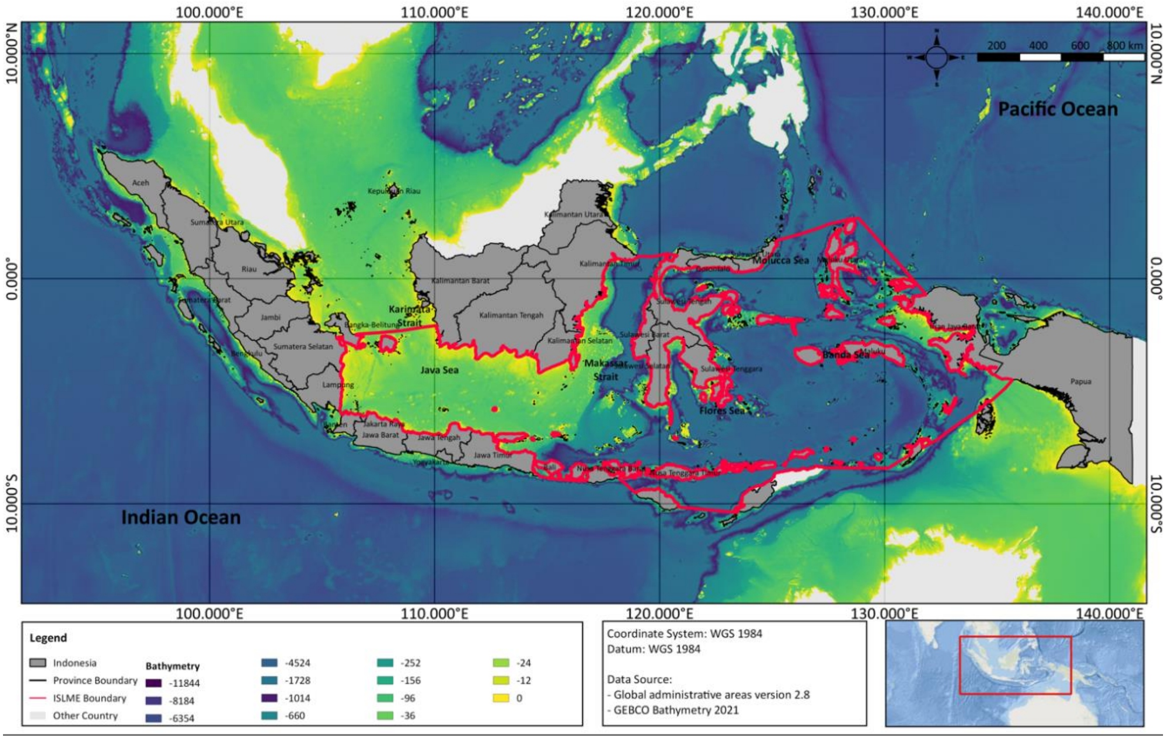
The Indonesian Seas Large Marine Ecosystem

2 Description of the Indonesian Seas Large Marine Ecosystem region

2.1 Biophysical characteristics

The Indonesian Seas Large Marine Ecosystem (ISLME) includes the world's largest archipelagic nation, Indonesia, with a coastline exceeding 54 716 km covering an area of 2.32 million km^2, of which 1.49 percent is protected, and contains almost 10 percent of the world's coral reefs (Sea Around Us, 2007). Approximately 232 million ha area of ISLME (98 percent) is within Indonesia's territorial waters, and nearly 2 percent is located within the territorial waters of Timor-Leste (Figure 5). Datasets associated with the delineation of ISLME boundaries can be accessed from an open repository (Purba, 2023).

Figure 5. Indonesian Seas Large Marine Ecosystem region shared between Indonesia and Timor-Leste



Note: The region is demarcated by the red line.
Sources: BPS. 2021; KKP. 2023; BIG. 2023, modified by UNPAD for ISLME project.

The ISLME boundaries enclose most of the inner seas and territory of the Republic of Indonesia, being bounded on its western and northern extent by the adjacent LME regions of the Bay of Bengal (LME 34), the South China Sea (LME 36), the Sulu-Celebes Sea (LME 37), the North Australian Shelf (LME 39). In the northeastern extent, it is bounded by the Pacific Islands (Pacific Warm Pool). For the purpose of fisheries management, Indonesian waters have been subdivided into 11 Fisheries Management Areas (FMA). The ISLME is comprised of a number of these areas: FMA 712, 713, 714, and 715 in their entirety and FMA 573 in part (Savu Sea only). More details related to the FMAs are found in the Indonesia capture fisheries section in this report.

According to the Critical Ecosystem Partnership Fund, a section of the ISLME overlaps the recognized Wallacea hotspot area identified by Myers *et al*. (2000) — the islands of the Indonesian Archipelago and Timor-Leste between the Sunda and Sahul continental shelves (CEPF, 2014). Three areas of the ISLME are included in this hotspot as biogeographic subregions:

1. the Maluku subregion, which includes the island groups of Halmahera, Bacan, Obi, Ceram, Buru, Tanimbar, Banda, and Kai, encompassing a total land area of 7 million hectares;
2. the Lesser Sunda Islands subregion includes the islands of Lombok, Sumbawa, Sumba, Flores, and Timor, totalling 8.1 million hectares; and
3. the Sulawesi subregion includes the largest land mass in the region, the island of Sulawesi; encompassing 18.6 million hectares, more than half of the total land area of the Wallacea hotspot.

The ISLME is characterized by its high levels of biodiversity, productivity, and hydrodynamic variability, which are driven by the unique interplay between physical and biological processes. Some of the biophysical characteristics of the ISLME include:

1. Hydrodynamics: the ISLME is affected by the ocean currents, winds, tides, monsoon patterns, including the Indonesian Throughflow (ITF), which influence the distribution and abundance of phytoplankton, zooplankton, nutrients, and other key components of the ecosystem.
2. Temperature: the ISLME is located in the tropics, with a surface temperature ranging from 25 °C to 30 °C, which supports a high level of primary productivity and a diverse array of marine species.
3. Productivity: the ISLME is considered one of the most productive marine ecosystems in the world, with high levels of phytoplankton and zooplankton as a result of high concentration of chlorophyll-a (Chl a) that supports a diverse food chain, including commercially important fish and invertebrates.
4. Biodiversity: the ISLME is home to a rich array of marine species, including over 2 500 species of fish, 569 species of coral, and hundreds of species of crustaceans and cephalopods (Hadi *et al*., 2018).

The high levels of biodiversity, are a result of its unique geography, hydrodynamic conditions, and its distinct historical and evolutionary processes. Some of the key components of the biodiversity in the ISLME include:

1. Coral reefs: the ISLME includes a large number of coral reefs that provide habitats and support for a wide variety of marine species, including fish, crustaceans, molluscs, and algae.
2. Seagrasses: the ISLME is also home to several species of seagrass that provide habitat and support to many species of marine life, including commercially important species of fish, crustaceans, and molluscs.
3. Mangrove: the ISLME includes a large number of mangroves, which are associated with many marine and coastal species, and they also protect the coastal area.
4. Fish species: the ISLME houses a diverse array of fish species, including commercially important species such as tuna, anchovy, sardines, and mackerel, as well as many other species of demersal fish, such as groupers and snappers.
5. Invertebrates: a large number of invertebrate species have their habitats in the ISMLE, including crustaceans such as shrimp and crabs, and cephalopods such as squids and cuttlefish.
6. Marine mammals: several species of marine mammals, including whales, dolphins, and porpoises can be found in the ISLME, and they play an important role in maintaining the balance of the ecosystem by serving as top predators and prey for other species, or as keystone species for certain habitats (e.g. the dugong).

2.1.1 Biogeography – including seascapes, regional patterns, ecological connectivity

The biogeography of the ISLME is characterized by a diverse range of seascapes and regional patterns. The ISLME includes several major seascapes, including the Java Sea, the small western part of the Arafura Sea, and the Banda Sea, which each have unique ecological and biogeographic features (Simanjorang *et al*., 2018). The high biodiversity is supported by ecological connectivity within the ISLME, which is facilitated by unique ocean currents and the migration patterns of marine species. These marine resources (fish and non-fish) are shared between the jurisdictions of Indonesia and Timor-Leste. The ecological connectivity also enables offshore demersal snapper fisheries for snapper (*Lutjanus spp.)*, and also supports migratory protected species such as dugongs, cetaceans, turtles, sawfishes, and elasmobranchs (Alongi, *et al*., 2011). The migratory protected species use the ISLME as a nursery ground and feeding habitat for fish and non-fish prey (Klain *et al*., 2007).

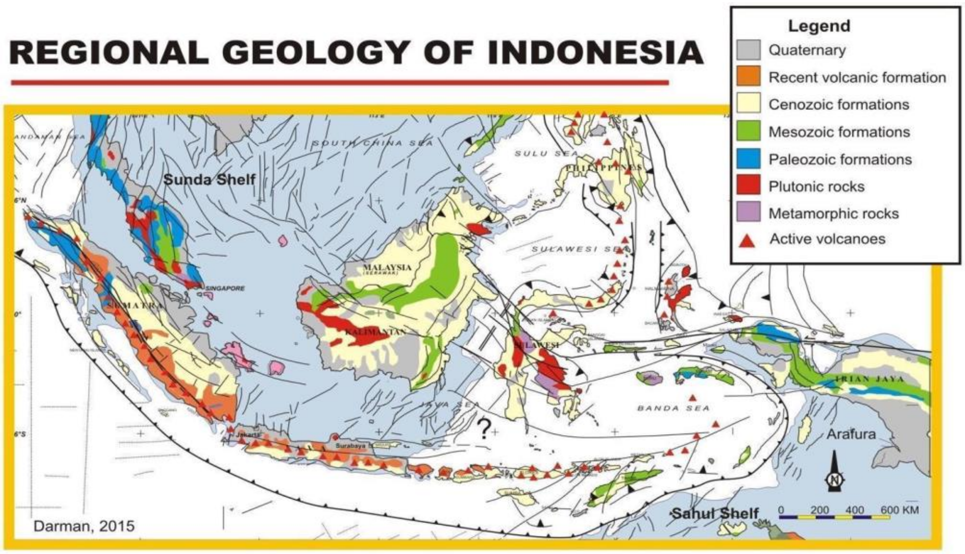
The ecological connectivity in the ISLME is facilitated by the ocean currents and winds, including the ITF which transports vital components such as coral larvae, mangrove propagules, and seagrass seeds and this establishes linkages between critical habitats. In the Java Sea, this connectivity is evident through the monsoon currents that connect the Kepulauan Seribu, Pulau Biawak, Karimun Jawa, and Bawean islands, as noted by Ramadhan *et al*. (2022). Moreover, in other regions such as the Makassar Strait, the connectivity is characterized by indications of currents flowing from north to south, a branch of the Indonesian Throughflow (Purba *et al*., 2021). In the Banda Sea and its surrounding areas, nutrient-rich eddies and the Indonesian Throughflow also provide vital nutrients to shallow waters, promoting the productivity of marine ecosystems.

Furthermore, the biophysical characteristics and biogeography of the ISLME cannot be considered in isolation and without regard to the physical setting of its marine environment. The ISLME is at the heart of one of the most geologically complex and tectonically active regions in the world, and this affects biophysical processes in the region (Tomascik *et al.,* 1997). Its evolutionary and geological histories, its unique archipelagic nature, and the interactions between its complex bathymetry, topography, oceanography, and ecology have resulted in the ISLME region having a diverse range of distinct coastal, shelf, and pelagic ecosystems and habitats. Islands of varying sizes partition marine waters into different seas connected by numerous channel passages and straits. The complex and rapid currents in the region are partly a result of interactions with the complex archipelagic topography and seafloor features of the area.

2.1.2 Physical setting – geology, bathymetry, coastal processes

The ISLME is situated at the confluence of the Pacific and Indian Oceans, is bordered by Indonesia and Timor-Leste, and covers a major part of the central and eastern archipelago. The ISLME region is one of the most complex oceanographic regions on Earth, with a complicated bathymetry and a wide diversity of seascapes. The Java Sea has shallow waters that are no deeper than 100 m. The ISLME is separated by deep seas in the east side, including the Banda Sea, Sulawesi Sea, and Maluku Sea in the north that connect to the Pacific Ocean, and by deep seas in the south, including the Bali Sea, the Flores Sea, the Ombai-Wetar Strait, and the Timor Sea that connect the region to the Indian Ocean. Furthermore, the Indonesian Seas region is situated within one of the most geologically complex and tectonically active regions on Earth. Geologically, the ISLME region lies at the confluence of three major tectonic plates: the Eurasian Plate, the Indo-Australian Plate, and the Pacific-Philippine Plate (Hall *et al*., 2009) (Figure 6).

Figure 6. Regional geology of the Indonesian Seas Large Marine Ecosystem area

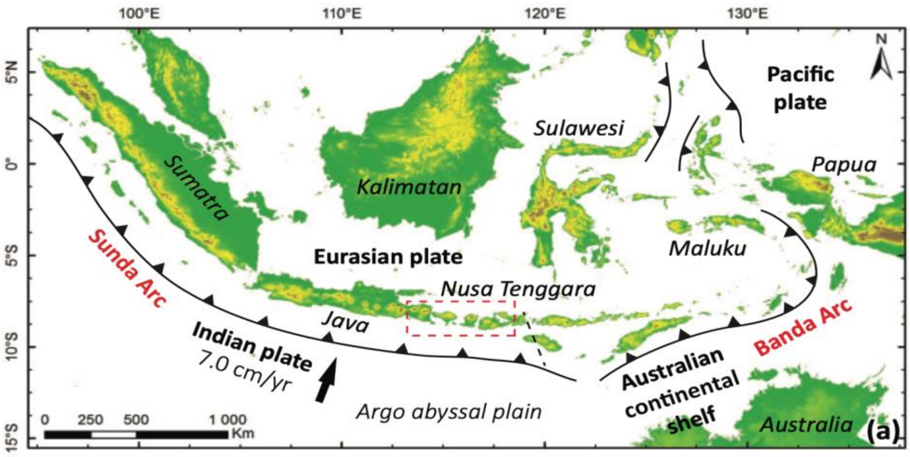


Source: Darman, H., Tampubolon, R. A., & Arisandy, M. 2018. Geological features observations in Eastern Indonesia based on selected P3GL seismic data: a report from FOSI-P3GL seminar, Cirebon, January 31, 2018. *Berita Sedimentologi*, 40(1): 55–64.

The Indonesian Archipelago is an "enclosed sea" comprising many smaller, marginal seas of diverse character. The complex bathymetry of the region, combined with the position of archipelago at the crossroads of the Pacific and Indian Oceans, not only drives the high ocean productivity of the region (fisheries and marine megafauna populations), making the region one of the primary drivers of the entire global ocean circulation system (Qu *et al*., 2005). Over geological time, these diverse seascapes (together with complex tectonic events and climate history) have also contributed to the evolution of the globally significant species richness of the region. The island of Kalimantan (Borneo), the third largest island on Earth, lies on the Asian continental (Sunda) shelf, is physically stable and was joined by a land bridge to the Asian mainland during Pleistocene and earlier periods of glaciation (Daws & Fujita, 1999). Similarly, Papua lies on the relatively geologically stable Sahul Shelf, and the larger Island of Irian (New Guinea) has been joined to Australia during glacial falls in sea level. Sumatra and Java lie on the southeastern edge of the Sunda Shelf, and many of Indonesia's islands are subject to tectonic instability and volcanic activity (with numerous active volcanoes and earthquake occurrences). In total, Indonesia has about 76 active volcanoes located in Indonesia, more than 80 percent are located in the ISLME. The island of Timor, shared by Indonesia and Timor-Leste, itself is non-volcanic (Santos *et al*., 2020).

In the western extent of the ISLME, the Sunda Trench is a subduction boundary between the Eurasian and Indo-Australian continental plate. The island of Sulawesi in Eastern Indonesia is located within the "triple junction" of the Australian, Philippine, and Sunda plates (Socquet *et al*., 2006). No less than four major volcanic arc-subduction zones have been described for Indonesia — Sunda, Sangihe, Halmahera, and Banda (Rachman *et al*., 2022). The Banda arc is the horseshoe-shaped feature within the ISLME that extends from Flores to Buru, including Timor and Seram, with islands forming both outer and inner non-volcanic and an inner volcanic arcs. The Banda arc is famous for its 180° curvature and is, in Timor, generally agreed to be the product of collision between a volcanic arc and the Australian continental margin. It is an unusual region of young extension that developed within the Australian continental plate and Sunda land shelf collision zone and was formed by the subduction of an oceanic embayment within the northward-moving Australian continental plate (Figure 7).

Figure 7. Map of the Indonesian volcanic arc system, showing the general tectonic setting



Source: Rachman, G., Santosa, B.J., Nugraha, A.D., Rohadi, S., Rosalia, S., Zulfakriza, Z., Sungkono, S., Sahara, D.P., Muttaqy, F. & Supendi, P. 2022. Seismic structure beneath the Molucca Sea collision zone from travel time tomography based on local and regional BMKG networks. *Appl. Sci.* 2022, 12(20): 10520. https://doi.org/10.3390/ app122010520

The Banda Sea occupies the main portion of the Banda Sea Plate. The southern margin of the sea consists of island arcs above subduction zones. To the east of the Sunda Trench is the Timor Trough which lies south of Timor, the Tanimbar Trough south of the Tanimbar Islands and the Aru Trough east of the Aru Islands. These trenches are the subduction zone of the Indo-Australian Plate beneath the Banda Sea Plate, where the Indo-Australian Plate moves northwards. Fore-arc sediments progressively carried northwards by the Indo-Australian Plate folded and faulted, leading to the eventual formation of the island of Timor. To the northeast lies Seram Island, which overlies the subduction of the Bird's Head Plate of West Papua.

A number of islands in the Banda Sea are active volcanoes, including Gunung Api and Gunung Manuk in the Banda Islands. In total, Indonesia has some 129 volcanoes, 15 of which are considered critical and likely to explode, with three to five eruptions annually. Thus, most of Indonesia’s seas fall within a geologically active region. Of the 76 active volcanoes identified by the Indonesian Geology agency, more than 80 percent are located in the ISLME region. As such, communities in the ISLME are particularly vulnerable to natural disasters, earthquakes, and tsunamis, which are known to have devastating impacts on those who live in coastal areas.

This diverse underwater topography, combined with the position of Indonesia and Timor-Leste at the crossroads of the Pacific and Indian Oceans, makes the region a crucial part of the global ocean circulation system (Qu *et al*., 2005). A detailed understanding of ISLME’s seafloor morphology is essential to comprehend the subduction processes that trigger earthquakes and tsunamis. Between the Eurasian and Australian continental plates lies an area of deep-sea basins, trenches, and submarine volcanoes. The shallow areas that border these deep underwater depressions (known as sill depths) play an important role in localized water circulation as cooler water from the depth is drawn to the surface.

The region has complex bathymetry, which includes the western area lying on the Sunda Shelf, the central area forming a transition zone composed in part by the deep basins of the Flores and Banda Seas and the eastern area lying on the Sahul Shelf (Table 1). The coastal waters of the Sunda Shelf, the Java Sea, and the Sahul Shelf are shallow (<200 m depth) and influenced by both marine and terrestrial inputs. By contrast, the Banda Sea has depths greater than 4 500 m, the Flores Sea is deeper than 5 000 m, the Java Trench exceeds 6 500 m in depth, and Timor Sea is deeper than 3 000 m. Most of these seas can be characterized as marginal seas, being enclosed by island landmasses, and with oceanic input from the Pacific and Indian Oceans into the Indonesian Seas.

Table 1. Main bathymetric features of the Indonesian Seas Large Marine Ecosystem*

ISLME Region	Description
Java Sea	The Java Sea is a component of the Sunda Shelf, which stretches from the Indochina Peninsula and terminates at the continental slope near the island of Madura. It comprises shallow waters with an average depth of approximately 50 m and is bordered by three primary islands: Sumatera to the west, Java to the south, and Kalimantan to the north. There are three potential links to other ecological regions: the waters of the Southern China Sea, Sulu and Sulawesi Seas in the north, and the waters of the eastern Indonesian archipelago in the east. To the northwest and northeast, it is connected to the Karimata Strait and Makassar Strait, respectively, and in the east, it directly opens into the Flores Sea (Sadhotomo and Atmadja, 2016).
Lesser Sunda Islands	The Lesser Sunda Islands are chain of islands separated by a number of straits that increase in depth to the east. The westernmost Bali Strait is approximately 60 m deep, the Lombok Strait reaches a depth of 300 m, the strait between Alor and Wetar reaches a depth of more than 1 200 m, and the deepest section of the islands is found further east with the Weber Deep at 4 300 m. The southern entrances of the Savu Sea are formed on both sides of Savu Island by sills approximately 1 150 m deep. Located to the south of the Timor Island is the 850 km Timor Trough which reaches a maximum depth of 3 200 m (*TDA for ATSEA Region, 2012*).
Makassar Strait	The Makassar Strait serves as a dividing line between Borneo and Sulawesi. These straits are situated within a geologically intricate region on the outskirts of the Eurasian plate. The northern section of the straits is the deepest, reaching water depths of nearly 2 500 m, and it leads northward into the Celebes Sea. On the other hand, the southern part of the straits is comparatively shallower, with water depths mostly less than 2 000 m, and it extends southward into the shallow shelf area of the East Java Sea (Hall *et al.*, 2009)

ISLME Region	Description
Masalembo Sea	Masalembo Sea located between Java Sea and Flores Sea. The depth in the west side is about 50 m and in the east side it is about 500 m (Wyrtki, 1961).
Molucca Basin (includes Molucca, Halmahera, Flores, and Ceram Seas)	Molucca Basin is closed by a ridge with a sill of 2 340 m, and its bottom is divided into five smaller basins which have maximum depths between 3 400 m and 4 800 m. The deepest threshold through this ridge is the Lifamatola Strait with a sill depth of 1 880 m (Wyrtki, 1961).
Banda Sea	The Banda Sea connects to the Halmahera Sea to the northeast with a sill depth of 580 m and the Flores Sea, which is separated from the southern Makassar Strait by the 680 m deep Dewakang Sill (west) (Zubaedah *et al.*, 2021), and with the Savu and Timor Seas through the Ombai Strait (1 450 m) and Timor Passage (1 200 m to 1 300 m) (south) (Gordon *et al*., 2008).
Savu Sea	The Savu Sea lies between Sumba Island, Savu Island, Rote Island, Timor Island, and Flores Island. The depth of the Savu Sea is 3 497 m. (Setiawan *et al*., 2021).

Sources: -Gordon, A. L., Susanto, R. D., Field, A., Huber, B. A., Pranowo, W. & Wirasantosa, S. 2008. Makassar Strait throughflow, 2004 to 2006. *Geophysical Research Letters,* 35, L24605. *https://doi.org/10.1029/2008GL036372*.

-Hall, R., Cloke, I. R., Nur'aini, S., Puspita, S. D., Calvert, S. J. & Elders, C. F. 2009. The North Makassar Straits: what lies beneath? *Petroleum Geoscience, 15: 147–158.*

Sadhotomo, B. & Atmadja, S. B. 2016. Sintesa kajian stok ikan pelagis kecil di Laut Jawa (Synthesis of the study of small pelagic fish stocks in the Java Sea). *Jurnal Penelitian Perikanan Indonesia, 18(4): 221–232.*

-Setiawan, J.H., Hidayat, H., Setiawan, A., Oktavitania, R. & Marjiyon, M. 2021. Potensi Penguatan Gelombang Gempabumi oleh Sedimen Permukaan: Studi Kasus Daerah Pantai Utara Kendal (The site amplification potency by surface sediment: case study north coast of Kendal regency). *Jurnal Geologi dan Sumberdaya Mineral, 22(1): 25–31. DOI:10.33332/jgsm.geologi.v22i1.570*

-Wyrtki, K. 1961. *Scientific results of marine investigations of the South China Sea and the Gulf of Thailand 1959-1961. Naga Report 2.*

-Zubaedah, S., Setiyono, H., Puspita, C. D., Gusmawati, N. F., & Pranowo, W. S. 2021. Schematic Model of Ocean Pacific Seawater Mass Circulation in Banda Sea. *In IOP Conference Series: Earth and Environmental Science (Vol. 750, No. 1, p. 012009).* IOP Publishing.

In general, the sills located in the ISLME are also crucial in their role of distributing nutrients to the surface. The primary deep sills between the Pacific Ocean and Indonesian Seas are formed within the northern Indonesian Seas and include three key features:

1. the Sangihe Ridge, which stretches from Sulawesi to Mindanao, which limits deep water access to the Sulawesi Sea and Makassar Strait;
2. the Halmahera Sea Sill, which controls the flow of South Pacific water to the Indonesian Seas;
3. the Lifamatola Strait which links the Maluku Sea to the Banda Sea; and

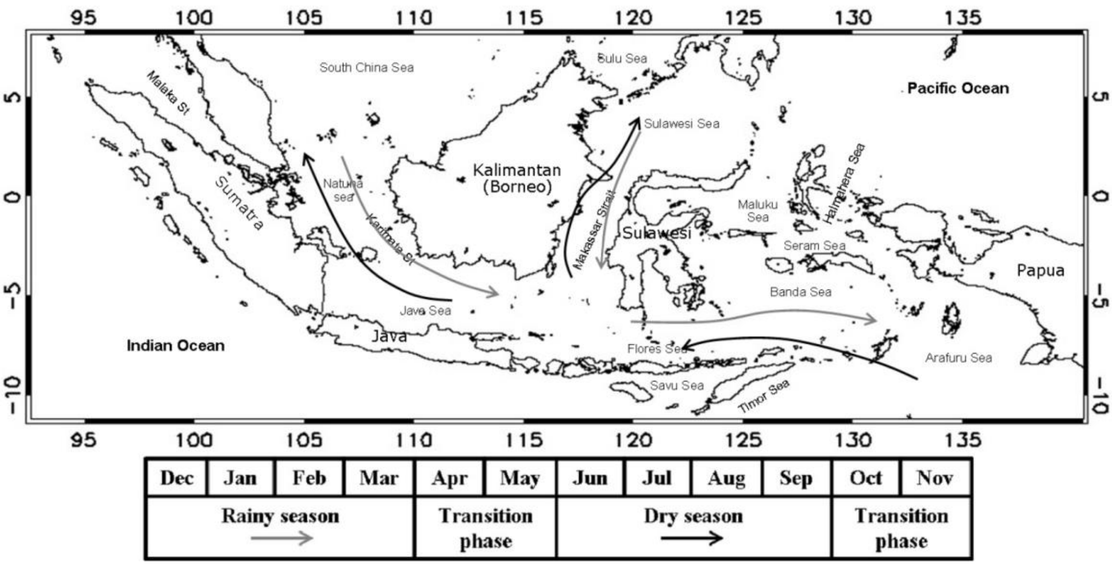
4. the sill between Alor Island and Ataúro Island in the transboundary area between Indonesia and Timor-Leste.

2.1.3 Climate and climate drivers

The ISLME, located in the tropics, is influenced by a range of climatic drivers, including the El Niño-Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), and the Pacific Decadal Oscillation (PDO). The ISLME plays a fundamental role in the coupled ocean and climate system, with the Indonesian Throughflow (ITF) providing the only tropical pathway connecting the Pacific and Indian Oceans. The warm waters of the ISLME act as a "heat engine" of global atmospheric circulation, with complex ocean-atmospheric dynamics. ENSO is a strong influence in which, every few years, moist trade winds from the equatorial Pacific are disabled and the Western Pacific experiences drought that profoundly affects farming and natural systems across the ISLME area and far beyond. Seasonal monsoons, during which ocean currents reverse directions, also exert a significant influence on the ISLME. The seas within this region have complex and rapid currents owing to strong tides over rough topography. Intraseasonal climate variability from the Madden-Julian Oscillation (MJO) also has a major impact on the ISLME region.

The wet season in the ISLME typically occurs between October and April, and it is characterized by high rainfall and strong winds from the northeast. During this season, the region experiences increased runoff and nutrient input, which can result in increased productivity in the marine ecosystems of the ISLME. The dry season in the ISLME typically occurs between May and September, and it is characterized by lower rainfall and calmer winds from the southeast. During this season, the region experiences decreased runoff and nutrient input, which can result in decreased productivity in the marine ecosystems of the ISLME (Figure 8).

Figure 8. Monsoon situation in Indonesian Seas Large Marine Ecosystem ISLME as a result of its position between Australia and Asia



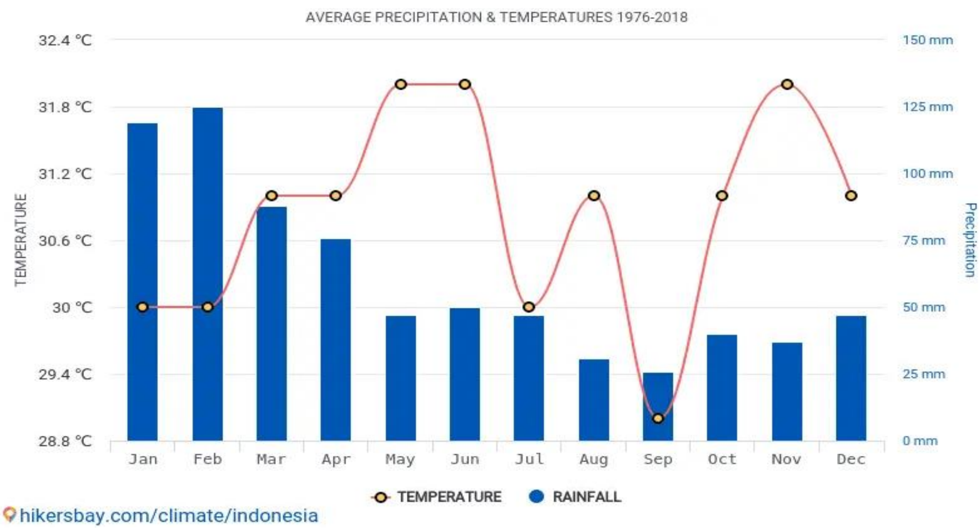
Source: Setiawan, R,Y. & Habibi, A. 2010.SST cooling in the Indonesian seas. *Journal Ilmu Kelautan*, 15(1): 42–46.

The typical impact of El Niño on Southeast Asia results in drier than average rainfall conditions, especially in June to August, and sometimes extends to October (Turkington, Timbal and Rahmat, 2018). Warmer temperatures typically follow this drier period. La Niña periods are typically wetter than average and are generally followed by cooler temperatures. Temperature data from 2020 indicate that average temperatures were 0.7 °C higher than the average air temperature from 1981 to 2010 (IPCC, 2019). Analysis conducted by the Meteorology, Climatology and Geophysical Agency or *Badan Meteorologi, Klimatologi, dan Geofisika (BMKG)* indicated that minimum, average, and maximum air temperatures in Indonesia increased annually by 0.03 °C. Temperatures in the Indonesian Seas region are expected to increase by 0.9 °C within 30 years.

The ISLME experiences high levels of rainfall and humidity, with annual rainfall totals ranging from 2 000 mm to 4 000 mm and average monthly relative humidity ranging from 75 percent to 85 percent. These high levels of rainfall and humidity are important for maintaining the productivity and biodiversity of the marine ecosystems in the ISLME, as they provide a source of nutrients and other essential resources for marine organisms. The Indonesian Archipelago stands between the Pacific and Indian Oceans and is heavily influenced by annual and inter-annual variations in surface temperature because of a reversing monsoonal system. The region lies within the subequatorial and equatorial zones (between latitudes 4°N to 10°S) and mostly falls under the influence of the seasonal monsoon winds.

Annual rainfall in excess of 1 000 mm occurs in many of the western and eastern areas, and annual minimum temperatures are usually more than 20 °C, except in the highlands, where it is usually cooler. Rainfall in the region is highest in the upland areas, notably in Central Kalimantan (Borneo), Central Sumatra, Java, and Papua. Some places receive more than 3 000 mm of rain annually. By contrast, parts of the lowlands, coastal areas, and other areas located in rain-shadows receive far less rain (less than 1 000 mm/year), and they may experience severe water shortages (Figure 9). Examples include some of the islands of Nusa Tenggara to the east of Bali and Lombok, including Timor-Leste (Barnett, Dessai and Jones, 2007). The temperature ranges from 21°C to 33°C, but at higher altitudes, the climate is cooler. Humidity is mostly between 60 percent and 80 percent.

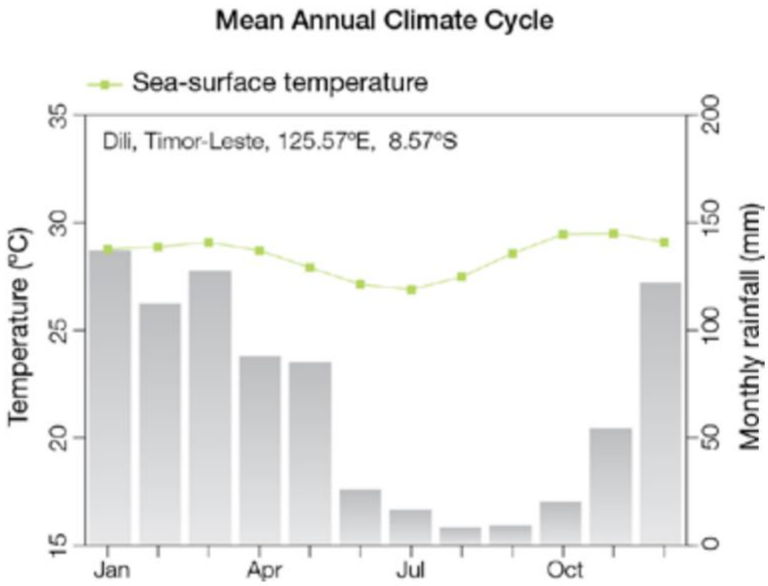
Figure 9. Indonesia average monthly rainfall from 1976 to 2018



Source: hikersbay.com. n.d. [Cited 23 September 2023]. [jakarta-average-monthly-rain.png (800×500) (hikb.at)]

In general, the winds over the Indonesian Archipelago and the position of the Inter Tropical Convergence Zone (ITCZ) are monsoonal. From July to September, wind blows toward continental Asia in the boreal summer (Gordon, 2005). In this period, the ITCZ is over the South China Sea as well as the Sunda Island Archipelago from July to September. The dry season corresponds to the southeast monsoon, as winds from the Australian continent transport drier and slightly warmer air. The resulting climate in northern Australia, southern New Guinea, the Lesser Sunda Islands, and Timor is characterized by a strong seasonal variance in rainfall (van der Kaars *et al*., 2000). Between January and March, the wind is directed toward Australia in the boreal winter (Gordon 2005) with the ITCZ dipping into northern Australia. The winds blow from continental Asia bringing wetter and slightly colder air masses — the northwest monsoon — causing heavy rain (Figure 10). The northwest monsoon is significantly stronger than the southeast monsoon, and the monsoonal changes are accompanied by an interannual variability caused by the El Niño or Southern Oscillation (Dsikowitzky *et al*., 2019). Interdecadal Pacific Oscillation (IPO) and Pacific Decadal Oscillation (PDO) affect climate variability at the decadal scale over the Pacific Ocean basin in a manner similar to the El Niño- Southern Oscillation (ENSO) phenomenon. This results in relatively abrupt shifts in the sea surface temperature anomaly patterns across the Pacific Ocean that can persist for two to three decades (Buckley *et al*., 2018).

Figure 10. Timor-Leste's average monthly temperature and rainfall from 1952 to –2009



Note: Data collected from a climate station in Dili.
Source: Australian Bureau of Meteorology. 2013. [Cited 2 October 2023].

In addition to monsoon-driven rainfall, the archipelago is subject to heavy precipitation caused by the Madden–Julian Oscillation (MJO), a tropical convection-coupled circulation that propagates eastward from the Indian to the Pacific Ocean. Riverine runoff from MJO-driven rainfall in the western archipelago significantly enhances phytoplankton biomass not only in the coastal regions but as far as the nutrient-poor Banda Sea, located 1 000 km downstream of the riverine source (Chang *et al*., 2019). Furthermore, observational data has estimated that the chlorophyll-a concentration in the Banda Sea increases by 20 percent over the winter average within an MJO life cycle. The enhancement of phytoplankton in the central Banda Sea is attributed to two coinciding MJO-triggered mechanisms: enhanced sediment loading and eastward advection of waters with high sediment and chlorophyll concentrations.

2.1.4 Ocean currents, processes, productivity and circulation

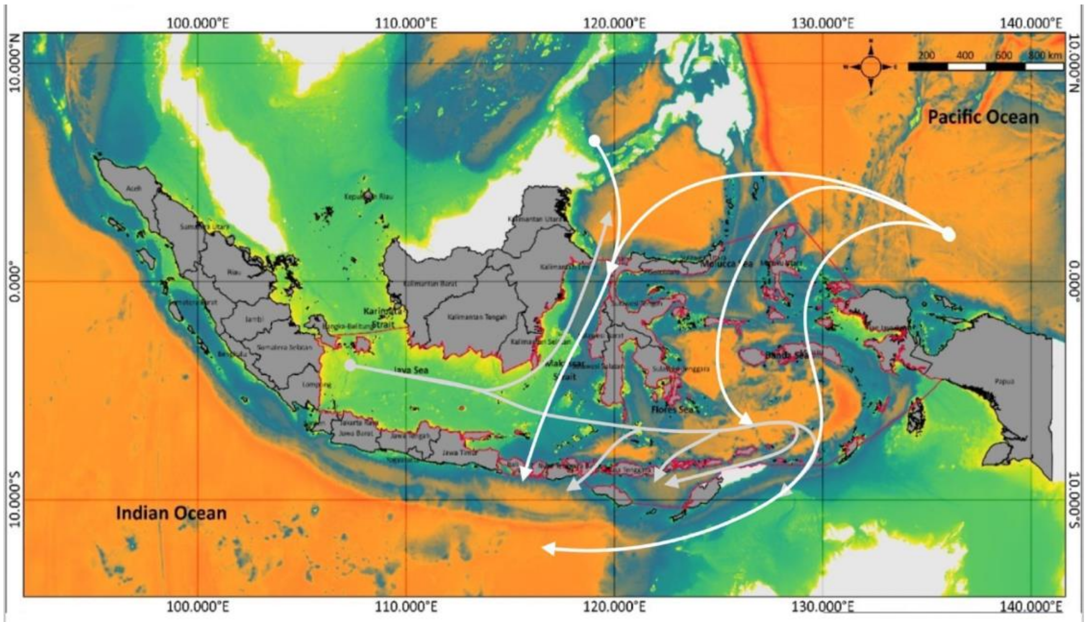
Seasonal monsoons, during which ocean currents reverse directions, exert a significant influence on the ISLME and beyond. The seas around Indonesia have complex and rapid currents owing to energetic tides over rough topography and the ITF. The Indonesian Seas play a fundamental role in the coupled ocean and climate system with the ITF, providing the only tropical pathway connecting the Pacific and Indian Oceans. The main path of the ITF consists of water entering from the North Pacific between the Philippines and New Guinea into the Sulawesi (Celebes) Sea and continuing through the Makassar Strait (SSMETC, 2013b). From there, the water can exit via Lombok Strait or circulate through the Banda and Flores Seas and can enter the Indian Ocean via Ombai Strait or Timor Passage. In addition, deeper South Pacific waters enter Lifamatola Passage and provide cooler, saltier water to ventilate the Banda Sea (van Aken, Punjanan and Saimima, 2009). Surface water also enters the Flores Sea from the South China Sea via Karimata Strait (Qu *et al*., 2005). The water flows to the

Banda and Flores Seas and circulates over the island boundaries. Furthermore, the water from the South Pacific flows to Lifamatola, which is characterized by high salinity, to the Banda Sea (van Aken, Punjanan and Saimima, 2009). Moreover, there is a pathway from the South China Sea entering the Banda Sea through the Java Sea and Flores Sea (Qu *et al.,* 2005). In the eastern part of the ISLME, from June to August, the surface waters in the Banda Sea flow west to the Flores Sea, Java Sea, and eventually the South China Sea. The current reverses during the northwest monsoon with surface waters from the Java Sea and Makassar Strait driven eastward through the Flores Sea and into the Banda Sea (Gordon *et al.,* 2008). West winds prevail over the Flores Sea from December to March and southeast winds in all other months (Wyrtki, 1961). During the passage of waters through the Indonesian Archipelago and associated seas, mixing of several water masses actively occurs. This is caused not only by monsoonal wind-induced upwelling, but also by very strong tidal forces (Pranowo, 2012; Mustikasari *et al*., 2015), especially along some of the narrow straits between several islands (Yasra *et al*., 2022a, 2022b).

The ITF is a major circulation feature of the ISLME and an integral part of global thermohaline circulation (Figure 11). Water masses flowing from the North Pacific Ocean enter into the Indonesian Seas around Sangihe Island and take a western or eastern route south. The western route passes the Sulawesi Sea into Makassar Strait, entering the Flores Sea through Dewakang Sill and flows eastward to the Banda Sea prior to exiting to the Indian Ocean. The eastern route passes through the Maluku Sea and the Lifamatola Strait to the Banda Sea (Yasra *et al.,* 2022a, 2022b). Through this eastern route, the water masses of the South Pacific Ocean also enter the Indonesian Seas. Thereafter, within the Banda Sea, these water masses are converted through a combination of tidally forced mixing, wind-driven upwelling, surface heat, and freshwater fluxes (Koswara, Setiyadi and Pranowo, 2017). This mixing of water forms a uniquely Indonesian tropical sea profile distinguished by a strong yet relatively isohaline thermocline. The ITF drives from the Banda Sea to exit into the East Indian Ocean along the Nusa Tenggara Island chain, which includes Ombai Strait, Lombok Strait, and Timor Passage. Currents in Ombai Strait are funnelled through a 1 250 m deep sill and 35 km wide passage, with speeds ranging between 0.12 metres per second (m/s) eastward and 0.16 m/s westward, averaging 0.11 m/s westward. The Lombok Strait has a 300 m deep sill, which is approximately 35 km wide and with currents averaging 0.25 m/s westward. The Timor Passage, which has a 1 890 m deep sill and approximately 160 km wide passage is the widest of the exit pathways and currents average 0.02 m/s.

In the Makassar Strait, the ITF consists mostly of North Pacific thermocline and intermediate water (Gordon *et al.,* 2008; Agustinus *et al.,* 2022). Secondary ITF portals permit water to enter through the Western Pacific marginal seas, such as through the Sibutu Passage connecting the Sulawesi Sea to the Sulu Sea or from the South China Sea via Karimata Strait. These relatively shallow portals provide a source of freshwater that influences the stratification of the ITF. Smaller contributions of North Pacific surface water may directly enter the Banda Sea via the channels to the north that serve as the eastern pathway of the ITF. Shallower waters from the South Pacific enter through the passages that line the Halmahera Sea. The contribution of South Pacific waters to the ITF via these northeastern passages is not well resolved and represents one of the largest uncertainties of ITF pathways. Because of the unique role that the ITF plays as the warm water pathway for global thermohaline circulation, there has always been a keen interest in knowing the total transport. Recent multiyear moorings in the major inflow and outflow passages suggest a total average ITF of nearly 15 Sievert (Sv) (1 Sv = 106 m^3/s) into the Indian Ocean. Of this, roughly 2.6 Sv exits via Lombok Strait, 4.9 Sv via Ombai Strait, and the remaining 7.5 Sv through the Timor Passage (Sprintall *et al.,* 2009). Approximately 13 Sv was measured in the Makassar Strait inflow, suggesting the remaining 2 Sv was contributed via the north-eastern passages, which were not particularly well resolved (Figure 11).

Figure 11. Major flows of the Indonesian Throughflow (white arrow) in the Indonesian Seas Large Marine Ecosystem ISLME region including Timor-Leste

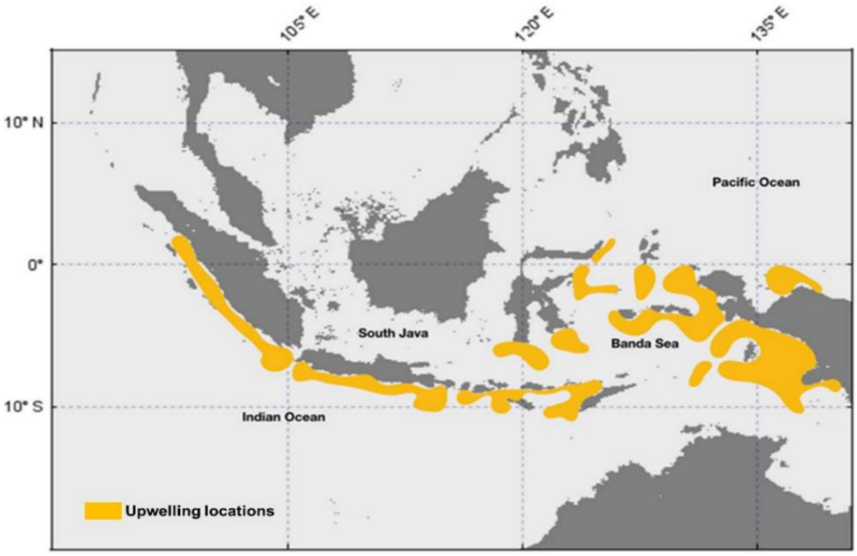


Note: Througflow indicated by white arrows.
Sources: Reproduced from Molcard *et al*., 1996
-Gordon, A. 2005. Oceanography of the Indonesian Seas and their throughflow. *Oceanography*, 18(4): 14–27.
-Purba, N. P. & Khan, A. M. A. 2019. Upwelling session in Indonesia waters. World News of Natural Sciences, 25: 72–83.

Besides its critical role in transferring mass, heat, and salt between the Pacific and Indian warm pools, the Indonesian Archipelago is also a region of strong water mass transformation (Ashafahani *et al.*, 2021; Supangat *et al.,* 2004). The enhanced and spatially heterogeneous internal tidal mixing in the Indonesian Seas not only alters the ITF water mass properties, but it also impacts the sea surface temperature (SST) distribution that in turn modulates air–sea interaction, atmospheric convection, and the monsoonal response. Within the Indonesian Seas, the four larger and deeper basins—the Sulu Sea, Sulawesi Sea, Maluku Sea, and Banda Sea—are the main eddy generating regions (Hao *et al*., 2021). More than 80 percent of eddies are short-lived with a lifetime that is under 30 days (Darmawan *et al.*, 2020). The properties of eddies exhibit high spatial inhomogeneity, with typical amplitudes and radiuses of 2 cm to 6 cm and 50 km to 160 km, respectively. Large eddy radius values have been observed in the Banda Sea, including a maximum value of 157 km in the central basin and a mode of more than 100 km. The most energetic eddies are observed in the Sulawesi and Seram Seas.

Because of their shallower depths (<200 m) and smaller basin scale, fewer eddies are detected in the other Indonesian Seas. Eddies in the Arafura Sea, Timor Sea, and Sawu Sea are caused by the confluence of ITF, which originates from the Banda Sea and which passes south of Papua through the Timor and the Arafura Seas (Ferdyan *et al*., 2022). In general, the SST fluctuation in the ISLME follows the monsoonal wind pattern. SST is generally warmer (28.5 °C–32 °C) during the northwest monsoon whereas during the southeast monsoon, it decreases by more than 2 °C on average (Heryati *et al.*, 2018; Siregar *et al.,* 2017). Upwelling occurs in this season in some parts of the ISLME, as indicated by a significant decrease of SST, and this trend is typically observed in areas of the southern Sulawesi Sea, the south-eastern Java and Bali Seas, the Savu Sea, the southern Ambon Sea, and the southern West Papua Sea (Figure 12). During these periods of upwelling, the SST has been recorded as being less than 25 °C because of the monsoon wind that drives the seawater south eastward causing the cooler seawater from the deeper sea to flow to the surface.

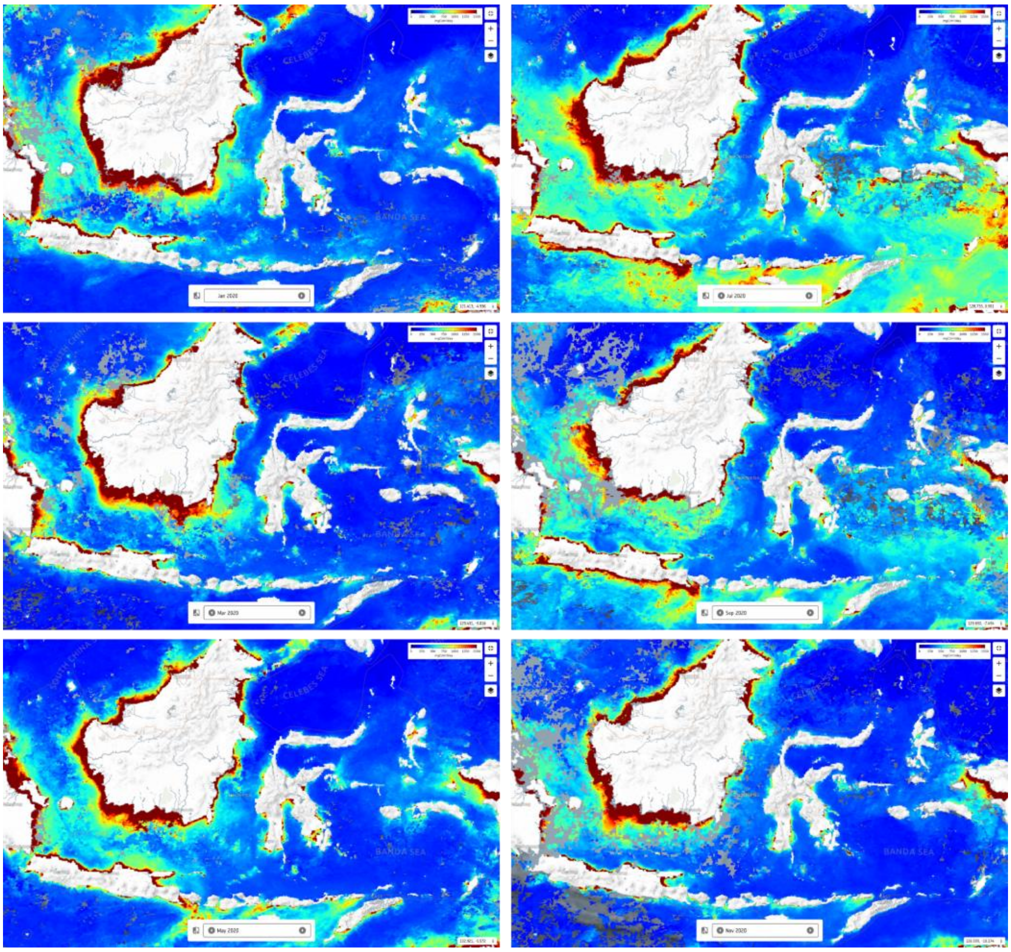
Figure 12. Location of major upwellings in the ISLME and adjacent areas



Sources: Purba, N.P., & Khan, A.M.A. 2019. Upwelling session in Indonesia waters. *World News of Natural Science*s, 25: 1-13.
Pranowo, W.S. 2012. Upwelling-down welling dynamics of Arafura and Timor Seas. *Widyariset*, 15(2): 415–424.

Whereas the average Chl-a concentration is 0.256 mg/m^3 for the Indonesian waters of the ISLME, a statistically significant decrease by 15.8 percent was observed between 2003 and 2013: annual Chl-a peaked at 0.369 mg/m^3 in August and was at its lowest value of 0.205 mg/m^3 in April (Figure 13). Maximum primary productivity (421 mg C/m^2) occurred during 1999 and minimum primary productivity in 2013 was 329 mg C/m^2. The average primary productivity of the ISLME is 380 mg C/m^2, which places the area in Group 4 of five categories (with 1 = lowest and 5 = highest) (UNESCO-IOC, 2015). This productivity ranking can explain the high secondary production, which is integral to fisheries production.

Figure 13. Chlorophyll-a concentration in the ISLME and surrounding seas



Source: Kulk, G., Platt, T., Dingle, J., Jackson, T., Jönsson, B.F., Bouman, H.A., Babin, M. *et al.* 2020. Primary production, an index of climate change in the ocean: satellite-based estimates over two decades. *Remote Sens*. 12: 826. https://doi.org/10.3390/rs12050826

The highest concentration of chlorophyll-a occurs in the west monsoon, and the lowest occurs in transitional season. In the Makassar Strait, the highest chlorophyll-a content is found on the surface of the waters. The primary productivity level of the Banda Sea during the La Nina event varied between 248.77 mg C/m^2 and 1 238 mg C/m^2 (Uneputty, Tubawalony and Noya, 2022).

2.1.5 Pelagic ecosystem

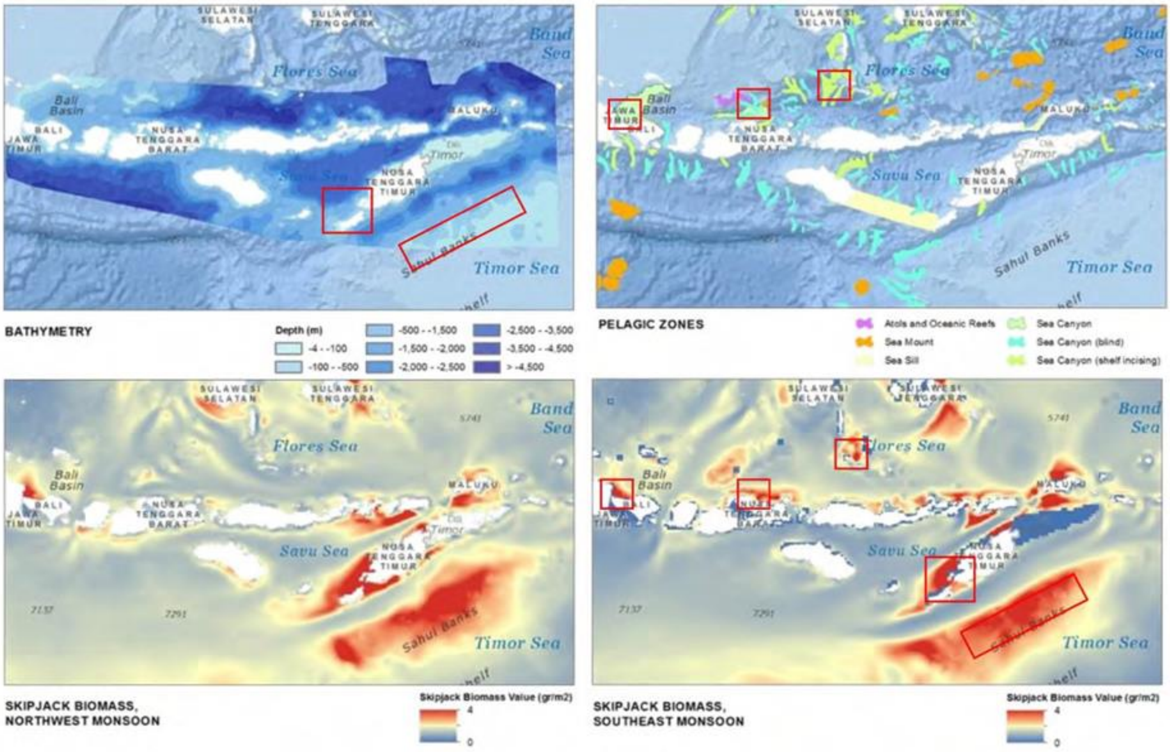
Persistent pelagic ecosystem

The vast and dynamic open ocean ecosystems, also known as pelagic waters, play a crucial role in shaping the marine environment both in the ISLME and globally. The strong currents, eddies, and upwelling fronts that are hallmark features of pelagic environments drive the movement of nutrients and debris, impacting the food and larval supply for marine organisms, thereby affecting the fishing industry, carbon sequestration, and migration patterns of whales and large fish. These large fishes are crucial to the structure and function of the food webs, and also to the recreation and tourism industries, and the cold-water upwelling from the ocean floor is vital in mitigating the negative effects of increasing sea surface temperatures caused by climate change.

In Indonesia, the management of the pelagic fishing industry has been successful, as evidenced by the decrease in overfishing activities in the 11 designated fishery management areas (FMAs) compared to areas outside of these management areas (Siaila & Rumerung, 2022). For example, the ISLME region boasts a significant fishing potential, particularly in the waters of Ambon, which has a potential catch of 484 000 tonnes per year. The pelagic ecosystem, characterized by high salinity, warm temperatures, abundant chlorophyll, and high oxygen solubility, is particularly beneficial for large pelagic fishery resources compared to small pelagic resources (Koswara, Setiyadi and Pranowo, 2017).

The pelagic ecosystem for large fish in Indonesia is particularly productive in the FMA 713 region, which is estimated to yield a maximum harvest value of 17 000 tonnes of large pelagic fish per year. This region is considered the best area for fishing activity in Indonesia thanks to its oceanographic conditions shaped by the ITF and monsoon patterns. The distribution of fish in this region is influenced significantly by the SST, sea surface chlorophyll, and the water depth, and important species such as yellowfin tuna, skipjack, and small tuna are key catches in this area (Safruddin *et al.,* 2019). This was confirmed in a 2016 report by Hatfield consultants on the pelagic ecosystem values in the Lesser Sunda Ecoregion (LSE) for The Nature Conservancy's Mapping Ocean Wealth (TNC-MOW) project, cited in the Thematic Study for the ISLME (FAO 2021), which also noted the potential influence of pelagic habitat features on tuna distribution. Using the Infrastructure Development for Space Oceanography (INDESO) (Bell *et al.*, 2018) model, Hatfield consultants found higher variability in skipjack productivity during the southeast monsoon, with skipjack being concentrated in the eastern part of the LSE, particularly around the Sahul Banks (Figure 14). The high productivity of skipjack in this region is associated with pelagic habitat features such as atolls, oceanic reefs, sea canyons, and sea sills. This highlights the strong connection between the complex bathymetry, atmospheric processes, ocean circulation, and marine organism distribution in the ISLME's highly productive pelagic ecosystems.

Figure 14. Pelagic habitat features and skipjack biomass of the Lesser Sunda Ecoregion of the Indonesian Seas Large Marine Ecosystem



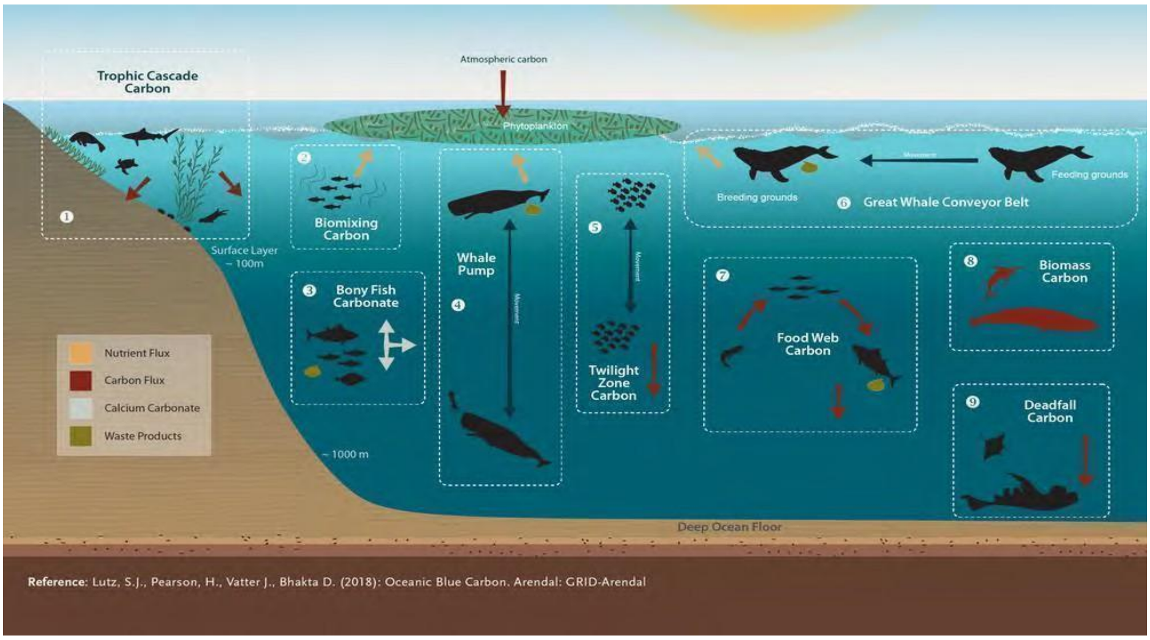
Source: Zainuddin, M., Farhum, A., Hasyim, S., Selamat, M.B., Sudirman, S., Nurdin, N., Syamsuddin, M., Ridwan, M. & Saitoh, S-I. 2017. Detection of pelagic habitat hotspots for skipjack tuna in the Gulf of Bone-Flores Sea, southwestern Coral Triangle tuna, Indonesia. *PLoS ONE* 12. e0185601. 10.1371/journal.pone.0185601. (http://geonode.grida.no)

Furthermore, one of the most productive areas for large pelagic fish in the ISLME is the Banda Sea, which is located between the islands of Seram, Ambon, and the Banda Islands. The Banda Sea is a unique and complex marine ecosystem, characterized by strong oceanic currents, seamounts, and underwater volcanoes, which provide important habitats and feeding grounds for large pelagic fish (Setianto, Sukoco and Pranawo, 2020). Additionally, the Banda Sea has a high level of primary productivity, which supports the food web and provides a steady supply of food for pelagic fish. As a result, the Banda Sea is a popular fishing ground for large pelagic fish and is also an important area for marine conservation and management.

Marine megafauna and oceanic processes

The ISLME region is closely connected to the oceanographic processes and marine megafauna populations in the area. Seasonal upwellings and areas of vertical mixing bring nutrient-rich waters from the ocean floor to the surface, creating hotspots of high ocean productivity and rich fishing grounds. Dethmers *et al.* (2009) reported that the deep-nearshore habitats of the Ombai-Wetar Strait and Timor Passage, adjacent to the north and south coast of Timor Island, respectively, and plankton-rich upwellings along the coast of the island provide critical feeding habitats for large resident and migratory marine megafauna such as whales, dolphins, dugongs, turtles, and manta rays. Furthermore, marine megafauna plays a significant role in shaping oceanographic processes in the region by bio-mixing carbon and redistributing nutrients, as highlighted by Lavery *et al.* (2010) and Roman *et al.* (2014) (Figure 15). These findings underscore the intricate relationship between the oceanographic processes and marine megafauna in the ISLME region.

Figure 15. Oceanic carbon process



Source: Lutz, S., Pearson, H., Vatter, J., & Bhakta, D. 2018. Oceanic blue carbon – How marine life can help to combat climate change. *Frontiers in Marine Science*, 5: 470. https://doi.org/10.3389/fmars.2018.00470

The "whale pump" is a term that refers to the vital contribution of whale excrement to the ocean's ecosystem as a source of iron and nitrogen, particularly for phytoplankton. A pre-whaling population of 120 000 sperm whales in the Southern Ocean was responsible for removing 2.2 million tonnes of carbon per year through their excrement (Lavery *et al*., 2010). A global pre-whaling population of approximately 2.5 million great whales was also responsible for removing 210 000 tonnes of carbon per year through their "deadfall carbon" (Pershing *et al.*, 2010). The gradual recovery of whale stocks has the potential to remove approximately 200 000 tonnes of carbon per year, equivalent to removing 110 000 hectares of forest. Cetaceans, including whales, are referred to as "marine ecosystem engineers" (Roman *et al.,* 2014) because of their impact on the ocean's ecosystem. The "great whale conveyor belt" describes the role of whales in redistributing nutrients from nutrient-rich polar waters to nutrient-poor tropical waters (Roman *et al.*, 2014). Furthermore, their swimming patterns contribute to "bio-mixing carbon" by mixing nutrients toward the surface of the ocean (Lavery *et al.,* 2010).

2.1.6 Coastal ecosystems, reefscapes and habitats

These include marine ecosystems such as estuarial beaches, mangroves, coral reefs, seagrass and algal beds, and small island ecosystems. Varying species diversity can be found in these different ecosystems, and relatively lower biodiversity exists in other coastal habitats such as sandy and muddy shores (Hutomo and Moosa, 2005). Using government provided spatial data, Hatfield consultants calculated that the ISLME encompasses over 756 153 km^2, with a total coastline of 19 748.52 km for the Indonesian provinces inside ISLME.

Table 2 summarizes the area of mangrove, coral reef, and seagrass ecosystems in the ISLME based on Hatfield's Geographic Information System (GIS) spatial analysis. FMA 714 constitutes the largest part of the ISLME (31 percent) and FMA 573 the smallest part (2.8 percent). FMA 715 hosts the most mangrove areas (31.8 percent), FMA 713 contains most of the coral reefs (38.9 percent), and FMA 715 hosts most of the seagrass (61.4 percent) in the Indonesian waters in the ISLME.

Table 2. Coverage of coral reefs, seagrass and mangrove per in each Indonesian Fishing Management Areas of the Indonesia waters in the Indonesian Seas Large Marine Ecosystem

FMA	Total area of FMA		Coral reef area		Mangrove area		Seagrass area	
	km^2	%	km^2	%	km^2	%	km^2	%
Part of FMA 573	103 171	4.8	481.39	2.8	*327.40	2.7	537.25	10.0
FMA 712	420 272	19.5	872.83	26.7	*3 148.27	9.7	25.75	0.5
FMA 713	484 281	22.5	4 378.97	10.5	*1 241.72	12.5	33.25	0.6
FMA 714	666 964	31.0	3 831.10	28.1	*3 316.51	39.0	1 408.75	27.1
FMA 715	477 871	22.2	1 693.90	31.8	*3 748.10	36.1	3 195.45	61.4
TOTAL	**2 152 559**	**100.0**	**11 258.19**	**100.0**	***11 782**	**100.0**	**5 200.45**	**100.0**

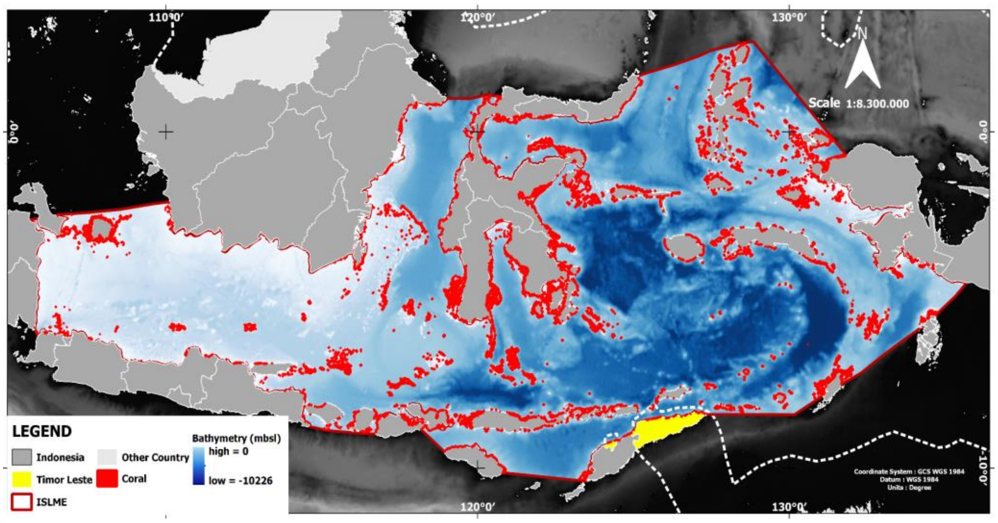
Source: Modified from UNEP. 2020

Corals

Indonesia has the largest area of coral reefs in Southeast Asia (Burke *et al*., 2002) comprising four types: (i) fringing reefs; (ii) barrier reef; (iii) atolls; and (iv) patch reefs. Indonesia's coral reefs are among the most biologically rich in the world and contain approximately 75 percent of global coral species (Hadi *et al.,* 2020). Another study by Hadi *et al.* (2018) identified 570 species of stony corals in Indonesian waters, and additional studies have documented at least 553 species of Scleractinia coral in Raja Ampat, which also has one of the world's richest coral reef fish fauna consisting of at least 1 320 species. It is the highest count in the world for an area of that size.

Figure 16 depicts the distribution of coral reefs in the Indonesian waters of the ISLME. Spatial analysis was used to determine that coral reefs within the ISLME region in 2021 covered 11 258.19 km^2 (Table 2). The largest coral reef coverage in the ISLME was 4 378.97 km^2 and was documented in FMA 713. Additionally, Allen Coral Atlas (ACA) provides coral reef data (i.e. geomorphology and benthic classes), based on the latest and detailed high-resolution images; however, this source has not been incorporated into this report and is provided as an additional reference (www.allencoralatlas.org).

Figure 16. Coral reef distribution in the Indonesian Seas Large Marine Ecosystem ISLME



Source: Giri, C., Ochieng, E., Tieszen, L. L., Zhu, Z., Singh, A., Loveland, T., Masek, J., & Duke, N. 2011. Status and distribution of mangrove forests of the world using earth observation satellite data (version 1.3, updated by UNEP-WCMC). *Global Ecology and Biogeography*, 20: 154–159. Doi: 10.1111/j.1466-8238.2010.00584.x

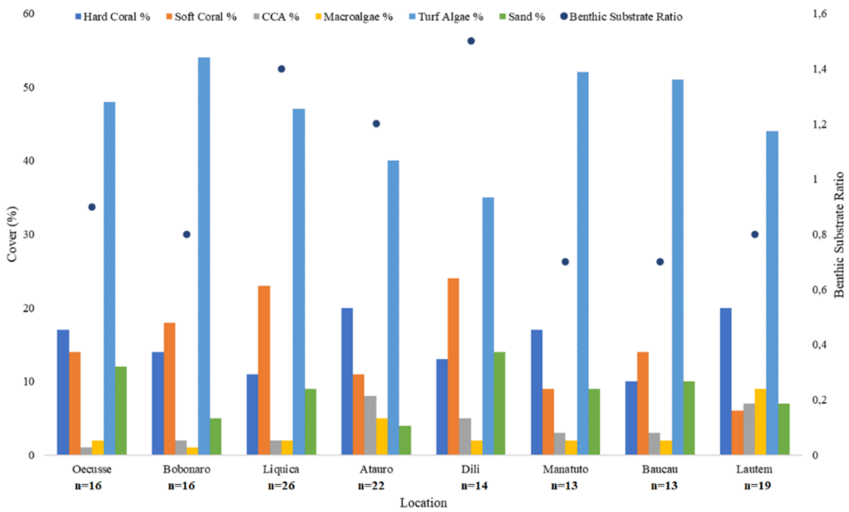
Around the island of Timor itself, a further reef habitat stratification identified four coral "reefscapes" (DeVantier, Turak and Allen., 2008), three of which occur in Timor-Leste and incorporate fringing reefs and associated seagrass and mangrove habitats: Atapupu, Fatu, and Timor East reefscapes (Figure 17). These reefs are strong and persistent under climate pressure and are mostly found in Behau close to the City of Dili and Liquiça (Tomascik *et al*., 1997). Tomascik *et al*. (1997) further confirmed that Timor-Leste's fringing reefs are highly comparable to those of Flores and Sulawesi Island. They are also characterized by karst geology and uplifted ancient coral reefs (Audley-Charles, 2004).

Figure 17. Coral 'reefscapes' of the island of Timor

Source: Turak, E. & Devantier, L. 2012. Reef-building corals in Timor-Leste. In M. V. Erdmann and C. Mohan, eds. *A rapid marine biological assessment of Timor-Leste,* pp. 85–149. RAP Bulletin of Biological Assessment 66, Coral Triangle Support Partnership, Conservation International Timor-Leste, Dili.
https://coraltriangleinitiative.org/sites/default/files/resources/04_Rapid%20Marine%20Assessment%20TL.pdf

A map produced by the Asian Development Bank (ADB, 2014) indicated that shallow coral reefs occupied nearly 3 000 ha located on the northern coast of Timor-Leste. ADB (2014) also provided a map of a potential coral habitats, which extended to more than 60 000 ha in deep waters on the northern coast. They noted that most of the coral reefs found tended to be encrusting, expanding their surface area to optimize exposure to sunlight. Different sponges and whip corals were also found in the deep sea. ADB (2014) confirmed that Acropora was the largest group of reef-crest hard corals in fringing reefs dominant on the northern coast. The main corals found included *Heliopora, Millepora, Briarium, and Xenia*. The list of different coral reefs in Timor-Leste is provided in Figure 18.

Figure 18. Coral reef composition in Timor-Leste



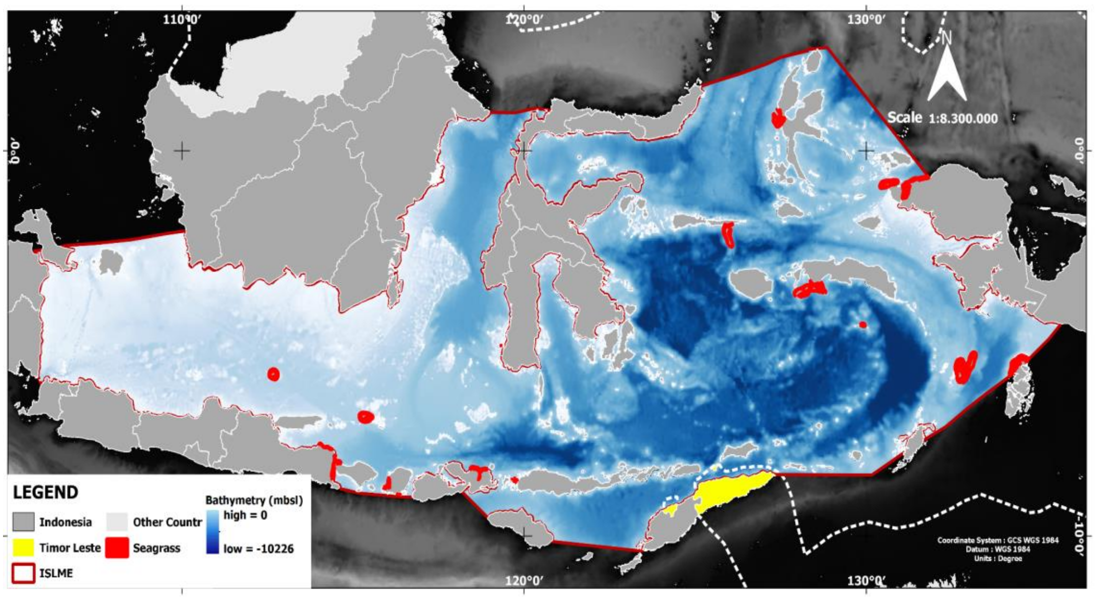
Source: Desrochers, A., Ehses, J., Huntington, B., McCoy, K., Moews, M., Oliver, T., Sudnovsky, M., Suka, R., Timmers, M., Vargas-Ángel, B., Brainard, R., & Kimball, J. 2017. Interdisciplinary baseline ecosystem assessment surveys to inform ecosystem-based management planning in Timor-Leste: final report. https://doi.org/10.7289/V5/SP-PIFSC-17-002

Surveys conducted by Conservation International (CI) in 2012 in Timor-Leste identified 393 coral species in the country (Turak and Devantier, 2012). Nearly 336 of them were recorded in Ataúro Island alone. It was concluded that three species had never been scientifically recorded: *Echinophyllia sp*., *Goniopora sp*., and *Montipora sp*. Each show significant morphological variation in skeletal and/or soft tissue characteristics from the closest known species in their genera: *Echinophyllia costata*, *Goniopora fruticosa,* and *Montipora porites,* respectively. Further taxonomic work is required to determine whether these are in fact new species or rather Timorese morphs of their closest congeners.

Seagrass meadows

Seagrasses occupy a variety of marine habitats. They are most often found in shallow- water back-reef environments (e.g. reef flats and moats) and lagoons (McKenzie *et al.,* 2021). However, in some locations they dominate the reef crest of barrier reefs and atolls. A few studies have suggested that seagrass covers a total area of approximately 30 000 km^2 throughout the Indonesian Archipelago (ADB, 2014). Indonesia has 15 species of seagrass (Sjafrie *et al*., 2018), of which *Enhalus acoroides* and *Thalassia hemprichii* are the most common in Indonesia waters (MMAF, 2018c). The total area of seagrass coverage within the ISLME region was calculated by extracting data from the United Nations Environment Programme (UNEP, 2018) and mapped in Figure 19.

Figure 19. Distribution of seagrass meadows in the Indonesian Seas Large Marine Ecosystem ISLME region



Source: Giri, C., Ochieng, E., Tieszen, L. L., Zhu, Z., Singh, A., Loveland, T., Masek, J., & Duke, N. 2011. Status and distribution of mangrove forests of the world using earth observation satellite data (version 1.3, updated by UNEP-WCMC). *Global Ecology and Biogeography*, 20: 154–159. Doi: 10.1111/j.1466-8238.2010.00584.x

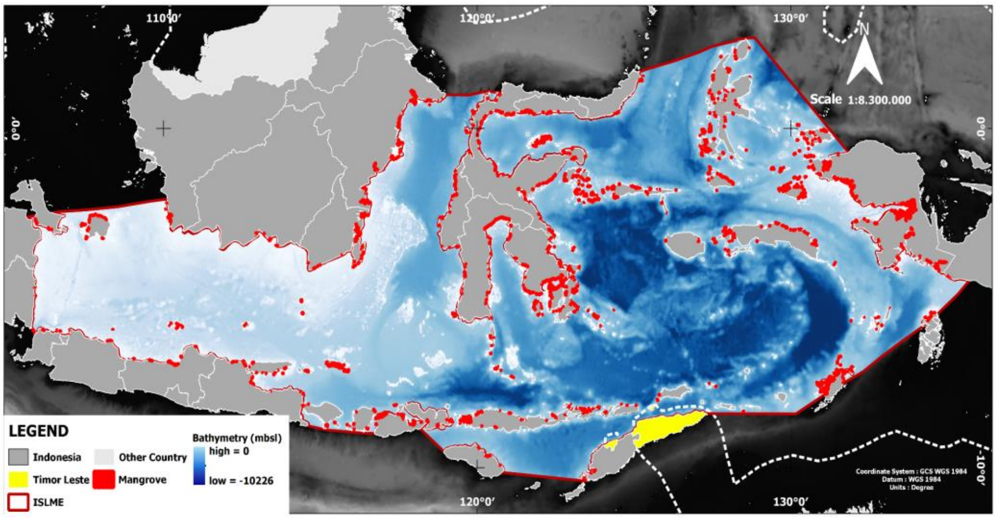
In Timor-Leste, seagrass is found in areas with a sandy substrate, including substrate that composes muddy bottoms to rocky shores. As documented by PIFSC (2017), seagrass generally grows in both the north and south coasts of the country, occupying approximately 2 200 ha on the narrow reef flats and shallow waters across the country. The following seven species of seagrass have been identified by McKenzie, Campbell and Roder (2001): *Halophila ovalis, Enhalus acoroides, Halodule uninervis, Syringodium isoetifolium, Thalassodendron cillatum, Thalassia hemprichii, and Halohila ovalis*. These seagrass species play vital roles in coastal areas, such as stabilizing coastlines and providing shelter to an array of economically important marine species.

Seagrass in the narrow reef flats is a suitable ecosystem feeding ground for green sea turtles (*Chelonia mydas*), dugong (*Dugong dugon*), and other diverse marine organisms. It is also home to sea cucumber, sea urchin, and sea snail. PIFSC (2017) confirmed that the seagrass ecosystem was relatively “intact”; however, future monitoring plans should be considered in relation to anthropogenic pressure, including the impact of climate change. Table 2 summarizes the area of mangrove, coral reef, and seagrass ecosystems in the ISLME based on Hatfield’s Geographic Information System (GIS) spatial analysis. FMA 714 constitutes the largest part of the ISLME (31 percent) and FMA 573 the smallest part (2.8 percent). FMA 715 hosts the most mangrove areas (31.8 percent%), FMA 713 contains most of the coral reefs (38.9 percent), and FMA 715 hosts most of the seagrass (61.4 percent) in the Indonesian waters in the ISLME. Table 2 earlier indicates that FMA 715 has the highest seagrass area coverage in the ISLME with approximately 3 195 km^2 or 61.45 percent of the total seagrass area in the ISLME, and FMA 712 has the lowest area of coverage with 25.75 km^2 or 0.50 percent of the total seagrass area in the ISLME region.

Mangrove forest

Mangroves are a key component of the rich biodiversity found in the marine ecosystems in Indonesia, and the country has one of the largest and most diverse mangrove forests in the world. Giri *et al.* (2011) noted that mangrove ecosystems in Indonesia encompassed 3 112 989 ha or 31 129 89 km^2, which equated to 22 percent of the total global mangrove area. Within the ISLME region, mangrove forests encompass 11 872 km^2. The proportion of this total ranges from FMA 715, which has the largest mangrove area covering 3 748 km^2 or 32 percent of the total area found within the ISLME to FMA 573, which has the smallest mangrove area covering 327.4 km^2 or 3 percent of the total mangrove area found within the ISLME (Figure 20).

Figure 20. Distribution of mangrove in the Indonesian Seas Large Marine Ecosystem ISLME



Source: Giri, C., Ochieng, E., Tieszen, L. L., Zhu, Z., Singh, A., Loveland, T., Masek, J., & Duke, N. 2011. Status and distribution of mangrove forests of the world using earth observation satellite data (version 1.3, updated by UNEP-WCMC). *Global Ecology and Biogeography*, 20: 154–159. Doi: 10.1111/j.1466- 8238.2010.00584.x

Mangrove (gross) deforestation in Indonesia for the 2009 to 2019 period totalled 182 091 ha. Within this period, the mangrove deforestation rate in Indonesia was estimated at 18,209 ha / yr (Arifanti, Novita and Tosiani, 2021). The decline of the mangrove ecosystems in Indonesia has been mainly a result of the land-use changes for settlements, tourism, industry, mining, agriculture, logging, aquaculture, and other uses. According to the Indonesia Biodiversity Strategy and Action Plan (IBSAP) 2015–2020 (BAPPENAS, 2016), Indonesian waters are home to 55 mangrove species and 75 mangrove-associated species. An earlier study by Kartawinata (2013) listed 88 mangrove species from 37 families in Indonesian waters and included epiphytes and associated vegetation in its assessment. *Rhizophoraceae* is represented by ten species belonging to four genera and *Sonneratiaceae* and *Verbenaceae* are each represented by three species. The flora and fauna of the mangrove forest facing the South China Sea is reported to include 42 mangrove species of 11 families. Additionally, 45 species of "true" mangrove species have been recorded in Indonesian waters (out of a world total of 73 species) (Spalding, 2010), 30 species of which were identified in Nusa Tenggara and Maluku, and 43 species in Papua (Kartikasari, Marshall and Beehler, 2012; Kusmana, 2014). Spatial analysis using UNEP primary data has indicated that the eastern part of the ISLME contains a higher mangrove species richness.

Beside coral reefs, wetlands and mangroves trees are also part of the coastal ecosystem in Timor-Leste. However, total mangrove areas have declined significantly from about 9 000 ha in 1940 to 4 000 ha in 1982 (Mackinnon, Beudels and Robinson, 1982). The main cause of mangrove forest degradation was illegal harvesting for cooking and heating, as well as being sold for cash and use for house construction. Some mangrove areas in Ulmera and Tibar (Liquiça) and Metinaro in Dili have been converted into salt processing and/or salt distillation operations, as well as into brackish water ponds (for milkfish and shrimp).
A total of 35 species including some back-mangroves and mangrove associates have been identified in the 2018 Mangroves Field Identification Manual of Timor-Leste through MAF-UNDP Coastal Resilience Building project (Ilman, 2017). Today, mangrove distribution species on the northern coast merely depends on the topographical condition of the coastal areas. A few species such as *Aegiceras corniculatum, Bruguiera sexangula, Bruguiera parviflora*, *Ceriops decandra, Pemphis acidula, and Rhizophora conjugata*, grow well on the northern coast in areas such as Maubara and Ulmera in Liquiça Municipality and Hera and Metinaro (Dili Municipality) as well as on Ataúro Island. Apart from that species, many species are also growing alongside the north coast, such as Avicennia marina which occupy stagnant water with high salinity, *Aegiceras corniculatum*, *Acanthus ilicifolius, Lumnitzera racemosa* including *Hertiera littoralis* (PEMSEA, 2019).

2.1.7 Marine resources

The Indonesian Archipelago has a total area of 4 986 325 km^2, with a land area of 1 904 569 km^2 and a water area of 3 081 756 km^2. However, the ISLME covers an area of 2.32 million km^2. The Geospatial Information Agency (BIG) reported that the water area of Indonesia, including the exclusive economic zone (EEZ), was 6 315 222 km^2 with a total coastline of 99 093 km. Thus, seas and coastal areas dominate the physiography of the Indonesian archipelago. Timor-Leste has a land area of 15 410 km^2, which encompasses the eastern part of the island of Timor, the enclave of Oe-Cusse Ambeno, as well as the islands of Jaco and Ataúro. Timor-Leste has a coastline that is approximately 700 km in length, and a potential exclusive economic zone (EEZ) of approximately 75 000 km^2. Marine resources in Indonesia and Timor-Leste include diverse ecosystems, fish and seafood supplies, oil and gas, minerals, sand and gravel, renewable energy resources, tourism potential, and biological diversity.

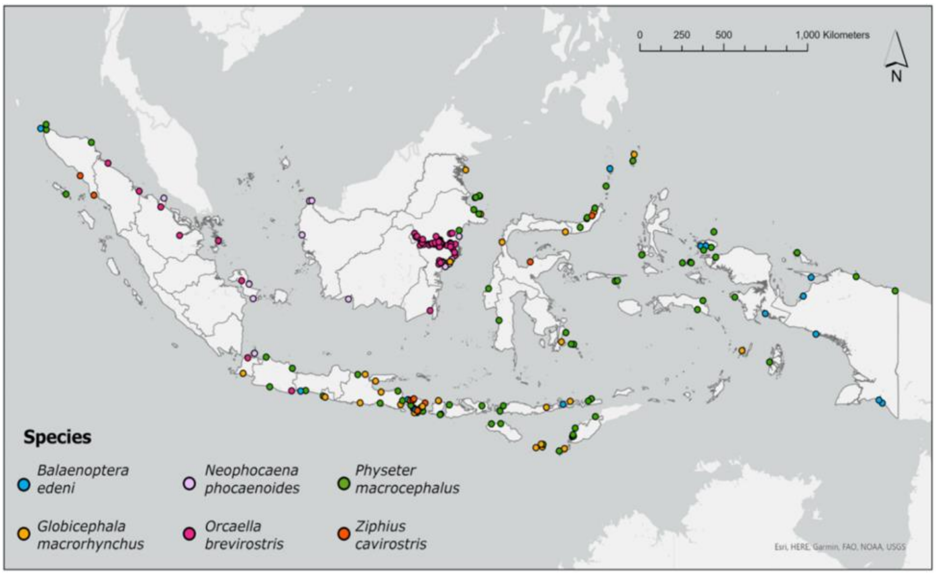
Marine biodiversity

The high species diversity and richness of the ISLME is a result of a number of factors, including aggregated geographic distribution of species because of ocean currents as during the larval phase, organisms are transported by ocean currents settling out in eddies and shallow flow-restricted areas.

As a global biodiversity hotspot, ISLME waters host 557 species of Echinodermata, 309 species of crustaceans, 569 species of corals (Hadi *et al.,* 2018), 3 476 species of marine fish, 15 species of seagrass (Sjafrie *et al.*, 2018), 981 species of algae, and 48 species of mangrove. Indonesia is also host to six of the seven marine turtle species: green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), olive ridley turtle (*Lepidochelys olivacea*), leatherback turtle (*Dermochelys coriacea*), flatback sea turtle (*Natator depressus*), and loggerhead sea turtle (*Caretta caretta*), and all have protected species status (MMAF, 2018b). The distribution of turtles across the country is influenced by the quality and availability of nesting beaches, migration routes, feeding grounds, and mating areas.

More than one third of all species of whales and dolphins on Earth are found in the seas of Indonesia, including the rare and endangered blue whale (*Balaenoptera musculus*). The Indonesian Ministry of Environment and Forestry (MoEF) Regulation No. 106/2018 on Protected plants and animals states that there are 35 species of marine mammals: 34 species of cetaceans (whales and dolphins) and one Sirenia (dugong) that are protected (MMAF, 2018b). Some cetaceans have been recorded from documented strandings (Figure 21). Additionally, 221 species of sharks and rays have been identified (Fahmi *et al.*, 2015).

Figure 21. Cetacean strandings of six species in Indonesia 1995–2021



Source: Mustika, P. L. K., High, K. K., Putra, M. I. H., Sahri, A., Ratha, I. M. J., Prinanda, M. O. & Kreb, D. 2022. When and where did they strand? The spatio-temporal hotspot patterns of cetacean stranding events in Indonesia. In *Oceans* (Vol. 3, No. 4: 509–526).

The waters of Timor-Leste are characterized by exceptional levels of marine biodiversity (corals, mangroves, fishes, invertebrates, and cetaceans), and have some of the highest levels of marine biodiversity ever recorded (Edyvane *et al*., 2009, Alongi *et al*., 2011, Turak and Devantier, 2012; Allen and Erdmann, 2012; ADB, 2014). Some new species have even been discovered: *Helcogramma Ataúroensis,* a new species of triplefin from Ataúro Island and *Eviota santanai*, a new dwarf goby from Timor-Leste (Telestoi: Gobiidae). Apart from these, some crustaceans of Ampithoidae and Maeridae Amphipods (Crustacea: Paracaridae) have been recorded by Hughes (2015). The newly described species include *Amphitoe Ataúro, Elasmopus tibarensis, Linguimaera christorei, and Quadrimaera metinaro*).

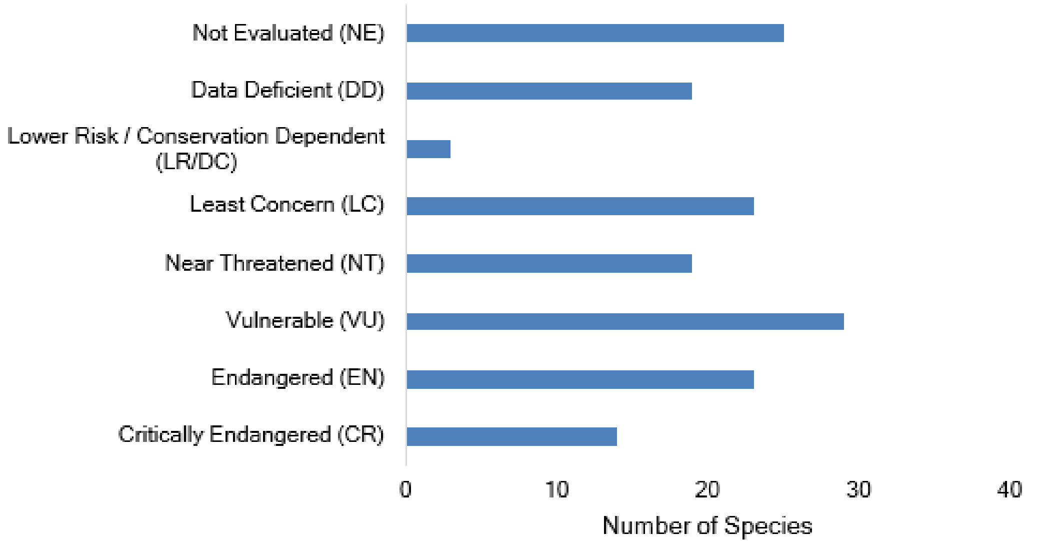
A total of 739 fish species within 234 genera within 61 families of reef fish have been recorded and documented in Timor-Leste. A marine rapid assessment (MRAP) conducted by Conservation International found that nearly 70 percent of five diving sites had high fish diversity (Conservation International, 2013). The assessment found 293 species around Ataúro Island, 249 species around Jaco Island, and roughly 773 species alongside Lautem, Com, which is located on the border of Tutuala. Allen and Erdmann (2012) recorded additional species on Ataúro Island. The reef fish diversity documented was 652 species with a total of 57 families and 210 genera. These species had not been previously documented. The overall total of reef fish in Timor-Leste is 894 species and overall, for the greater Timor region, it reaches 1 036 species. In addition, the researchers noted that this area was exceptionally rich in terms of reef-associated fauna, which constituted a total of 317 species from Berau Bay. It is believed that Ataúro Island has the third highest site diversity ever documented anywhere in the world.

Endangered, threatened and protected marine species

The ISLME is an important migratory area for many species including rare and/or endangered species. Although the diversity of marine mammal species has been recorded, there are few records of their distribution, especially for remote regions. Studies conducted by the World Wildlife Fund (WWF) in 2012 and Mustika *et al.* (2022) were combined with an earlier study by Beasley *et al.* (2016), and together they indicate that at least 35 species of cetaceans (whales and dolphins) exist in waters under the jurisdiction of Indonesia (see also Rudolph, Smeenk and Leatherwood, 1997). Each species has a particular habitat and ecological requirements, some of which may overlap with fisheries activities. The Directorate Marine Spatial Planning (MSP) at the MMAF through the IBSAP 2015–2020 identified five criteria for conservation measures to be applied to marine (fish) resources: (i) endangered; (ii) rare; (iii) endemic; (iv) decreasing numbers; and (v) low frequency.

MMAF (2020a) documented 146 marine species that should be prioritized for protection (Figure 22). Moreover, marine species in Indonesia are protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which covers sea turtles, sharks and manta rays, marine mammals (dugong, whales, and dolphins), and hump-head wrasse; all of these occur in the ISLME. In the case of Timor-Leste, the population status for the majority of globally threatened marine species is largely unknown because there is very little spatial data (Edyvane, 2020).

Figure 22. Number of marine species prioritized for protection in Indonesia



Source: MMAF. 2020a. TNP Laut Sawu: Home of the cetacean. KKP-Direktorat Jenderal Pengelolaan Ruang Laut, Kupang, NTT. [Cited 22 July 2023]. http://perpustakaan.kkp.go.id/knowledgerepository/index.php?p=show_detail&id=1073814

Sea turtles

The ISLME is home to several species of sea turtles, including the green sea turtle (*Chelonia mydas*), Olive Ridley Sea Turtle (*Lepidochelys olivacea*), leatherback sea turtle (*Dermochelys coriacea*), hawksbill sea turtle (*Eretmochelys imbricata*), loggerhead sea turtles (*Caretta caretta*) and flatback sea turtles (*Natator depressus*). These species are widely distributed throughout the ISLME, with nesting and foraging grounds present in various locations along the coasts of Indonesia and the surrounding region. Sandland *et al*. (2001) recorded all these species in Timor-Leste, except for the flatback sea turtles. The population of sea turtles in the ISLME has experienced significant declines in recent years as a result of a variety of factors, including over-harvesting of their eggs and meat, habitat degradation, entanglement in fishing gear, and marine pollution (ADB, 2014). Despite ongoing conservation efforts, many sea turtle populations in the ISLME remain at risk and face ongoing survival threats.

Although overall turtle numbers in Timor-Leste are considered low, the Nino Konis Santana Marine Park appears to be a major site for both turtle nesting and foraging (Edyvane *et al*., 2009). In a survey of marine megafauna in Timor-Leste (Dethmers *et al*., 2009), turtle nesting sites have been recorded along the north coast of Timor-Leste. Aerial surveys (conducted at an altitude of 1 000 m) indicate increased abundance of large turtles in nearshore waters during November, with the greatest density occurring around the far north-eastern tip of Timor-Leste in the Nino Konis Santana Marine Park region (offshore from the Lautem Municipality and southeast of Jaco Island) (Dethmers *et al*., 2009).

Sharks and rays

Sharks and rays are also widely distributed throughout the ISLME. Some of the species found include the scalloped hammerhead shark, whale shark, blacktip reef shark, and the manta ray. Some shark species in the ISLME are known to undertake large-scale migrations, moving between areas of higher and lower population density. For example, whale sharks (*Rhincodon typus*) are known to make long-distance migrations, often moving from their feeding grounds near the coast to their mating and pupping grounds in the open ocean. The Indonesian government has also established several marine protected areas, such as the Wakatobi Marine National Park, to conserve shark and ray species in Indonesian waters. The Indonesian government is also a party to the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which provide frameworks for the conservation of shark and ray species on regional and international scales. Indonesia has developed a National Plan of Action (NPOA) on sharks and rays, but this has not been implemented so far. Timor-Leste also ratified some international agreements and conventions related to the conservation and management of marine biodiversity, including the Convention on Biological Diversity (CBD) and the Convention on Migratory Species of Wild Animals (CMS), which could provide a framework for the conservation and management of shark and ray species in the country.

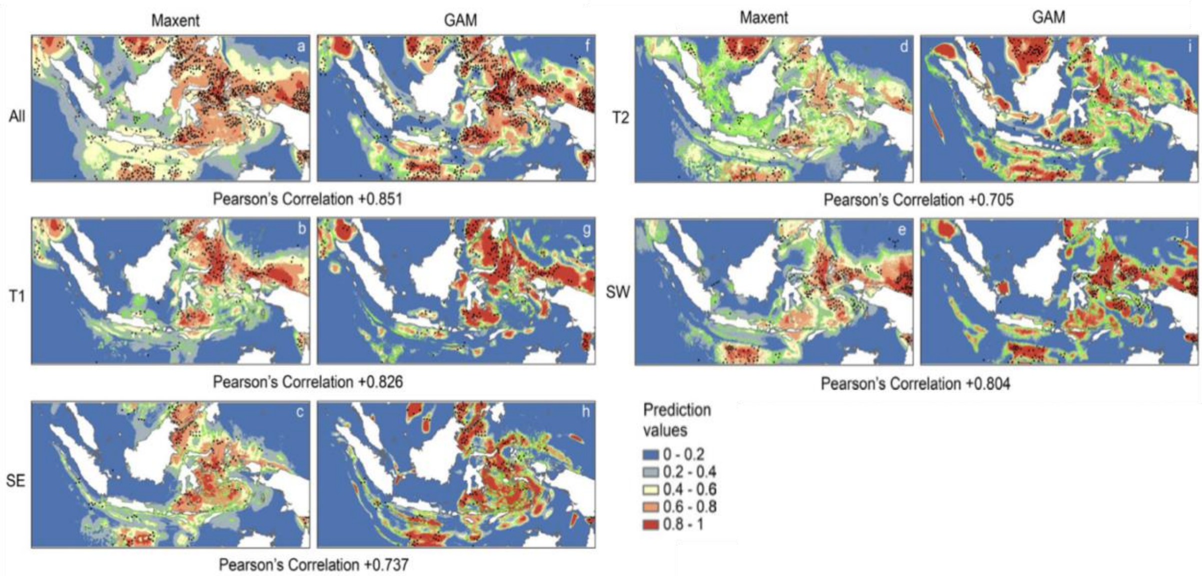
Marine mammals (whales, dolphins and dugongs)

Dugongs are found in the coastal waters of Indonesia, particularly where there are large tracts of seagrasses, mangroves, and coral reefs (reviewed in de Longh *et al.*, 2009). They obtain 90 percent of their food from seagrass beds, and the loss of this habitat is a major threat to the species. The distribution of dugongs is fairly widespread, from sheltered areas to wave-exposed coasts (e.g. South Bali); however, they mostly occur in low numbers as a result of hunting and by-catch (Cheung, 2002). The major dugong populations are found in western Cenderawasih Bay in Papua and Aru islands in the Arafura Sea (Husar, 1978).

Some of the most common species of whales in the ISLME include sperm whales, humpback whales, and blue whales; they have migration routes in ISLME waters. Many species of dolphins also live in these waters, including the spinner dolphin, the common dolphin, and the Indo-Pacific humpback dolphin. The distribution of these marine mammals varies depending on the species. Some species of whales are found throughout the ISLME. They have different migration patterns, depending on the species and their habitat requirements. Some species, such as the humpback whale, are known to migrate over long distances, whereas others, such as the spinner dolphin, have a more limited range. The migration patterns of marine mammals in the ISLME are influenced by various factors, including food availability, breeding opportunities, and changes in water temperature and other environmental conditions.

Figure 23 shows historical seasonal habitat suitability maps of sperm whales in Indonesia generated with the Maxent model and GAM model. Sperm whales are known to occur in the eastern region of the country, particularly in the Arafura Sea, Banda Sea, and Halmahera Sea. These areas are characterized by deep waters and steep underwater topography, which provide ideal habitats for the sperm whale and are located in the heart of the Coral Triangle, which is one of the world's most biodiverse marine regions, providing ample prey for the sperm whale to feed on. Sperm whales in Indonesia are known to feed primarily on squid, but they also consume fish and other deep seas organisms.

Figure 23. Habitat suitability of sperm whale in the Indonesian Seas Large Marine Ecosystem based on two models



Source: Sahri, A., Putra, M. I., Mustika, P. L., & Murk, A. J. 2020. A treasure from the past: former sperm whale distribution in Indonesian waters unveiled using distribution models and historical whaling data. *Journal of Biogeography*, *47*(10): 2102–2116.

Sperm whales are known to migrate seasonally, with their movements being influenced by food availability, reproductive behaviour, and environmental conditions. During the summer months, sperm whales are typically found in the northern part of the Indonesian Archipelago, where they feed in deep waters. As the seasons change and the water temperature cools, the sperm whales begin to migrate south towards the equator, where they mate and give birth to their young. During this time, they are often found in shallower waters closer to the coast, providing a unique opportunity for whale watching activities. Understanding the distribution and migration patterns of sperm whales in Indonesian waters is crucial for their conservation, as it can inform the development of effective management strategies to ensure the long-term survival of this iconic species.

The Ombai-Wetar Strait shared between the islands of Alor, Timor, and Wetar has been identified as a major Indo-Pacific transboundary migration corridor and critical habitat for cetaceans and other endangered, threatened, and protected marine megafauna species such as the sperm whale (*Physeter macrocephalus*), pygmy blue whale (*Balaenoptera musculus*), beaked whale (Ziphiidae), marine turtles (Cheloniidae), the whale shark (*Rhincodon typus*), and mantas (*Manta birostris*) (Kahn, 2017).

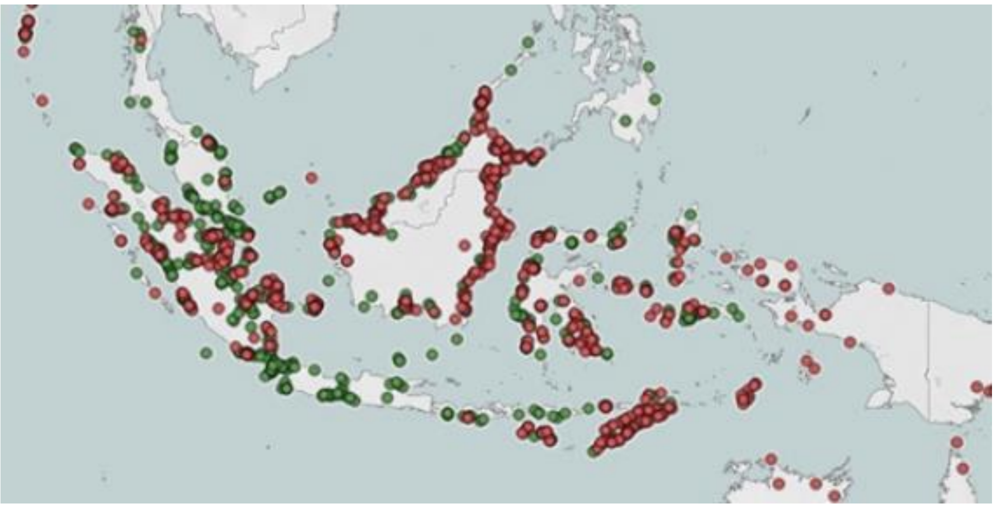
Humphead wrasse

The humphead wrasse (*Cheilinus undulatus*) is a species of marine fish that is widely distributed in the Indo-West Pacific region, including the ISLME. This species is known for its large size, a distinctive hump on its forehead, and bright colours. In terms of distribution, the humphead wrasse is commonly found in coral reefs and is known to live in a wide range of habitats, from shallow waters to depths of over 60 m. The species is also known to have a relatively large home range and to travel long distances in search of food. The humphead wrasse can grow up to 2 m in length and can weigh up to 200 kg. They are known for their striking appearance, with a distinctive hump on their forehead, large lips, and strong teeth. They are also capable of changing colour and can alter their appearance from blue-green to green to purple to yellow. Humphead wrasse are protogynous hermaphrodites, meaning that they change from female to male over time, and are considered to be slow-growing and long-lived, with a lifespan of nearly 30 years.

Crocodile

Four species of crocodile are found in Indonesia, among them saltwater (*Crocodylus porosus*) and freshwater (*Crocodylus novaeguineae*) species. Additionally, the smaller freshwater crocodile (*Crocodylus siamensis*) can also be found in some parts of Indonesia, especially in riverine habitats in the ISLME region. Geographical distribution of documented crocodile attacks is shown in Figure 24.

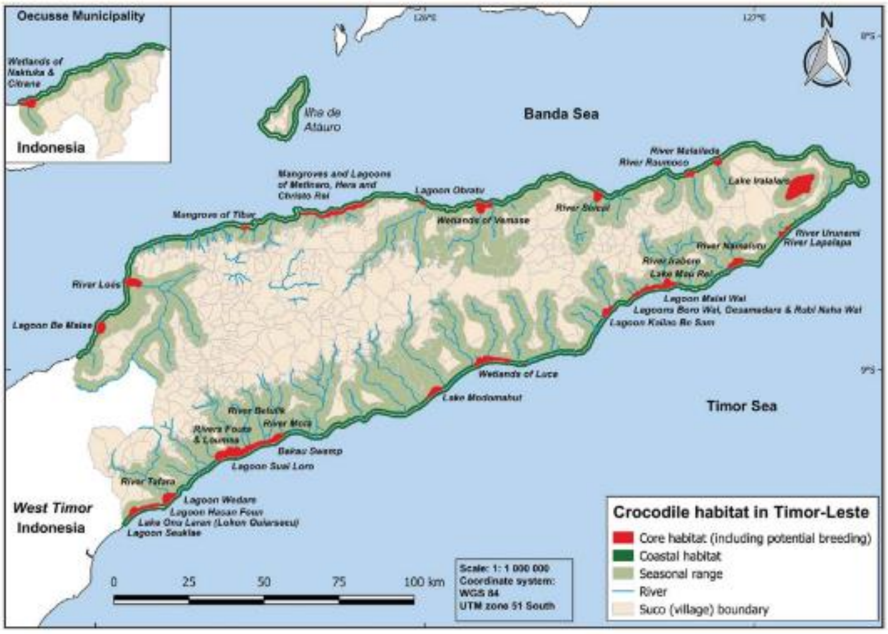
Figure 24. Saltwater crocodile attacks and notable records 2016–2021



Note: Attacks indicated by red circles and notable records indicated by green circles.
Source: CrocBITE database2

In Timor-Leste, the largest predator is the saltwater crocodile (Britton, Whitaker and Whitaker, 2012). They are also the most aggressive (Brien *et al.*, 2013) of all crocodilia in the world (Brackhane *et al.*, 2019). Although no population surveys have been undertaken in Timor-Leste, saltwater crocodiles can be found in coastal rivers and swamps, as well as the open sea and island shorelines, particularly along the southern coast (Kaiser *et al*. 2009; Sideleau, Edyvane and Britton, 2016). Their habitats are also scattered throughout different locations in the northern coast (Figure 25); however, the much drier climate with lower annual rainfall in the north creates less suitable habitats for the predator (Barnett, Dessai and Jones 2007).

Figure 25. Crocodile habitat in Timor-Leste



Source: Brackhane, S., Grahame, W., Flaminio, X., Josh, T., Marcal, G. & Peter, P. 2019. Crocodile management in Timor-Leste: drawing upon traditional ecological knowledge and cultural beliefs. *Human Dimensions of Wildlife,* 24(4): 314–331. DOI: 10.1080/10871209.2019.1614240

2.2 Socioeconomic characteristics

2.2.1 Indonesian Seas Large Marine Ecosystem region government administration

According to Badan Pusat Statistik (BPS)/Statistics Indonesia (BPS, 2019b), 21 provinces with 209 districts or municipalities were located along the Indonesian coastline of the ISLME in fisheries management areas: FMA 573, FMA 712, FMA 713, FMA 714, and FMA 715. Administratively, the provincial regions that have the authority and responsibility to manage fish resources in each FMA (Table 3). Based on the administrative region, provinces that form part of the ISLME are as follows: 1) Banten Province, 2) West Java Province, 3) Central Java Province, 4) East Java Province, 5) Bali Province, 6) East Nusa Tenggara Province, 7) Lampung Province, 8) DKI Jakarta Province, 9) Central Kalimantan Province, 10) South Kalimantan Province, 11) East Kalimantan Province, 12) West Nusa Tenggara Province, 13) East Nusa Tenggara Province, 14) South Sulawesi Province, 15) Central Sulawesi Province, 16) North Sulawesi, 17) West Sulawesi Province, 18) Southeast Sulawesi Province, 19) Maluku Province, 20) North Maluku Province, 21) North Sulawesi Province, 22) Gorontalo Province, 23) Maluku Province, and 24) West Papua Province.

Table 3. Coastal provinces in each Indonesian fisheries management area of the Indonesian Seas Large Marine Ecosystem

FMA	Province		FMA	Province	
573	West Nusa Tenggara	East Nusa Tenggara	714	East Nusa Tenggara	Maluku
712	Lampung	East Java	714	Southeast Sulawesi	North Maluku
712	Banten	Central Java	714	Central Sulawesi	West Papua
712	Jakarta	Central Kalimantan	715	North Sulawesi	Maluku
712	West Java	South Kalimantan	715	Gorontalo	North Sulawesi
713	East Kalimantan	East Nusa Tenggara	715	Central Sulawesi	West Papua
713	South Kalimantan	South Sulawesi			
713	East Java	Central Sulawesi			
713	Bali	North Sulawesi			
713	West Nusa Tenggara	West Sulawesi			

Source: BPS. 2019b. Statistik Sumber Daya Laut dan Pesisir 2019 [Marine and Coastal Resources Statistics 2019]. Jakarta and MMAF Regulation No. 18 of 2014 on Fisheries Management Areas (FMAs) in Indonesia to identify provinces in the FMAs within the ISLME region.

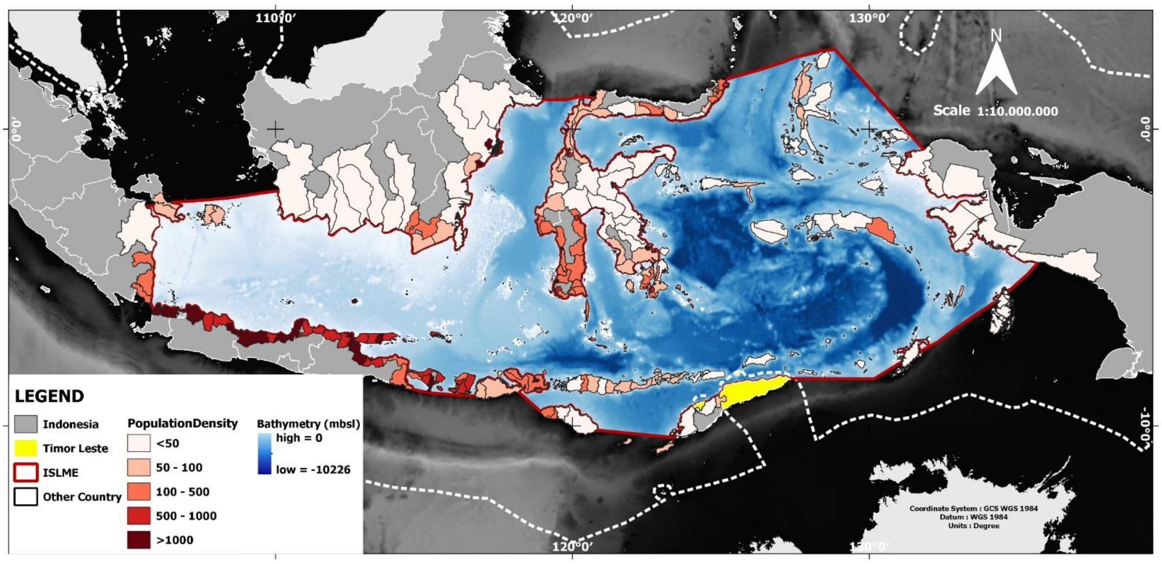
The north coast of Timor-Leste, which covers approximately 465.80 km of coastline from the east to the west side, has eight of Timor-Leste's 14 municipalities: Lautem, Baucau, Manatuto, Dili, Liquicia, Bobonaro, Oecussi, and Ataúro. Dili is also the capital city of the country. The municipalities are further subdivided into *posto administrativo*, then *sucos* (villages) and then *aldeias* (hamlets). Leadership posts such as the president of municipality authority, administrator, chief of *suco* and chief of *aldeia* are respectively assigned to the head of each administrative unit. At least *93 sucos* from the eight municipalities are located along this coast (Coral Triangle Centre, 2022). The municipalities in Timor-Leste that form part of ISLME include Bobonaro, Liquiça, Dili, and Ataúro Island on the northern coast.

From a geographical perspective, there are three maritime segments where Indonesia shares its maritime boundary with Timor-Leste: Timor Sea in the south and Ombai Strait and Wetar Strait in the north (Ramon and Adityo, 2018). Currently the maritime boundaries in these areas, including the one around the enclave of Oecussi, have not been settled between the two countries (Maritime Boundary Office, 2016). So far, Timor-Leste has only established a maritime boundary in the Timor Sea with Australia. After Timor-Leste's restoration of independence in 2002, both states prioritized demarcating their land boundaries with each other (Schofield and Arsana, 2007; Ramon and Adityo, 2018) in two sections, notably Noel Besi-Citrana and Bidjael Sunan-Oben (Kartini, Perdana and Kosandi, 2023). The Government of Timor-Leste will resume formal negotiations on maritime boundaries immediately after the final delimitation of land border.

2.2.2 Population and demography

In 2022, the total population in Indonesia was nearly 278 million people with a population growth rate of 1.17 percent (Badan Pusat Statistik, 2022a). According to the UNDESA (2022), population growth is likely to accelerate, with a total population of nearly 317 million predicted by 2050. The population living in rural areas is roughly 42.1 percent (BPS, 2022b). Indonesia, as an archipelagic country, has approximately 150 million people living in coastal areas (BPS, 2022b). Approximately 60 percent of Indonesia's population lives within a radius of 50 km from the coastline, which consists of various livelihoods including fishing. Indonesia's land area is 1.9 million km², with an average population density of 143 inhabitants per km² (BPS, 2022b). The population is unevenly distributed with nearly 60 percent living on the Island of Java, which has an average population density of over 800 inhabitants per km^2, among the highest population densities of any island on Earth. Another 20 percent of the population live on the Island of Sumatra, with a population density of 77 inhabitants per km^2. Kalimantan supports another 10 million, with a density of less than 17 inhabitants per km^2. By contrast, some of the smaller islands of Nusa Tenggara are sparsely populated, in part because of water shortages, and to the east, the comparatively large area of Papua supports less than 10 million people, almost entirely of Melanesian ancestry. Of the three subsystems, approximately 150 million live in Sunda, some 35 million in Wallacea, and less than 10 million in Sahul (Fogire 26).

Figure 26. Population density in the Indonesian Seas Large Marine Ecosystem ISLME region



Source: BPS. 2022a. Laju pertumbuhan penduduk (persen) 2020-2022 [Population growth rate (percent) 2020-2022]. Jakarta. [Cited 24 August 2023]. https://www.bps.go.id/indicator/12/1976/1/laju-pertumbuhan-penduduk.html.

The population is distributed in the larger urban settlements and throughout thousands of villages spread along the coast, across the lowlands, and into the highlands, usually concentrated on the water courses. The larger urban centres include Jakarta (>10 million), Surabaya, East Java (>4 million), Bandung, West Java (2.5 million), Semarang, Central Java (2 million), Makassar, Sulawesi (4 million), Denpasar, Bali (1 million), Mataram, Lombok (0.5

million), Palu, Sulawesi (300,000), Kupang, West-Timor (300 000), and Ambon City, Ambon (300 000). With very few exceptions, the major cities, towns, and villages are all developed on rivers, with concomitant water-related issues regarding use and pollution. The rivers passing through the major cities and adjacent coastal waters are in most cases badly polluted by sewage, heavy metals, and other industrial and agricultural waste products. Some areas also experience substantial immigration of the order of 4 percent annually through a transmigration project developed to ease population pressures in Java. The population of Java was approximately 156 million in 2020. It is projected to reach 174 million by 2030 and 184 million by 2040. Although the growth rate is expected to slow down in the coming decades, the population is still expected to increase steadily (UNDESA, 2022).

Badan Pusat Statistik (2020a) estimated that the number of people living in the ISLME region was 138 023 183 in 2019, an increase of nearly 21 million people or 17.9 percent compared with data from Badan Pusat Statistik in 2015. The province with the largest population in the ISLME region is East Java with 28 223 912 people in 2019, an 8 percent increase from 2015. The province with the lowest population in the ISLME area is West Papua, with 641 944 people in 2019, a 10.2 percent increase from 2015. In 2010, Badan Pusat Statistik used census data to project the growth rate in the ISLME area at 1.33 percent per annum through 2035.

The population in the ISLME area is concentrated on the island of Java followed by Sulawesi and West Nusa Tenggara/Nusa Tenggara Barat (NTB) and East Nusa Tenggara/Nusa Tenggara Timur (NTT) islands. Nationally, the highest population densities are on the islands of Java, Bali, and NTB, with an average population density of more than 250 people/km^2. This is reflected in socioeconomic development factors, such as increased infrastructure (e.g. roads), health facilities, and education facilities, as well as an increase in the level of economic productivity. Based on data from the Indonesian Ministry of Health (2018), public health facilities or *Puskesmas* (*Pusat Kesehatan Masyarakat*) in Indonesia included 9 825 health centres plus 2 776 general and specialist hospitals as of 2017. The results of the 2017 Indonesian Demographic and Health Survey (IDHS) indicate that the neonatal mortality rate (*Angka Kematian Neonatal*-AKN) was 15 per 1 000 live births, a marked decrease from 19 per 1 000 live births in 2012. Similarly, the infant mortality rate (*Angka Kematian Bayi*-AKB) dropped from 32 per 1 000 live births in 2012 to 24 per 1 000 live births in 2017. Moreover, the under-five (years of age) mortality rate (*Angka Kematian Balita*-AKABA) declined significantly from 40 per 1 000 live births in 2012 to 32 per 1 000 live births in 2017.

presents the population numbers for the municipalities on the northern coast that are part of ISLME.

Based on the census data from Timor-Leste in 2022, Timor-Leste's population is more than 1.3 million with a median age of 17.4 years. The population density is 89 per km^2. The majority of the population (74 percent) is under the age of 35 (Ministry of Finance, 2022a). The ratio between men and women is 50.54 and 49.46, respectively. Fertility in the country is high at nearly 4.1 children per woman. This trend has a direct impact on women's and children's health and forces women to perform unpaid work (Ministry of Finance, 2020).

Most of Timor-Leste's population (approximately 66 percent) live on the northern coast and are heavily dependent on marine and coastal resources. A proportion of this population on the northern coast is part of ISLME regionally; for example people who live in Bobonaro, Liquiça, and Dili Municipalities.

Table 4. Municipalities on the northern coast of Timor-Leste that form part of Indonesian Seas Large Marine Ecosystem

No	Municipalities	Posto-administration	Villages in coastal areas	Hamlets in coastal areas	Total households	Total population
1	**Bobonaro**	Balibo	Saniri	Caco; Palaca; Subaleco	3 994	17 600
			Batugede	Nu Badac; Batugede		
2	**Liquica**	Bazartete	Tibar	Libaulelo	5 608	33 517
			Ulmera	Nauner; Mane-Mori		
			Lauhata	Raukasa; Pissu craic		
			Maumeta	Nartutu		
			Mota Ulun	Mota Icun		
		Liquica	Dato	Camelehohoru; Camarelara; Leopa	4 823	26 397
		Maubara	Gugleur	Puquelete; Dair; Caicassa; Raenaba	4 355	23 775
			Vatuvou	Vatu-nau; Raime; Samanaro		
			Vatuboro	Vaupu; Sabulau; Tatamalobu		
			Vaviquinia	Morae; Delesuvati; Vila		
3	**Dili**	Cristo rei	Hera	Ailoc laran; Moris Foun; Hali Dolar	12 807	76 412
		Metinaro	Duyung	Manleu	1 251	7 180
			Sabuli	Ailoc-Laran; Acadiru-Laran		
Total					**32 838**	**184 881**

Source: Ministry of Finance. 2022b. General population and housing census. Preliminary results. Directorate General for Statistics. Timor-Leste. https://timor-leste.unfpa.org/sites/default/files/pub-pdf/censuspreliminaryresults2022_4.pdf

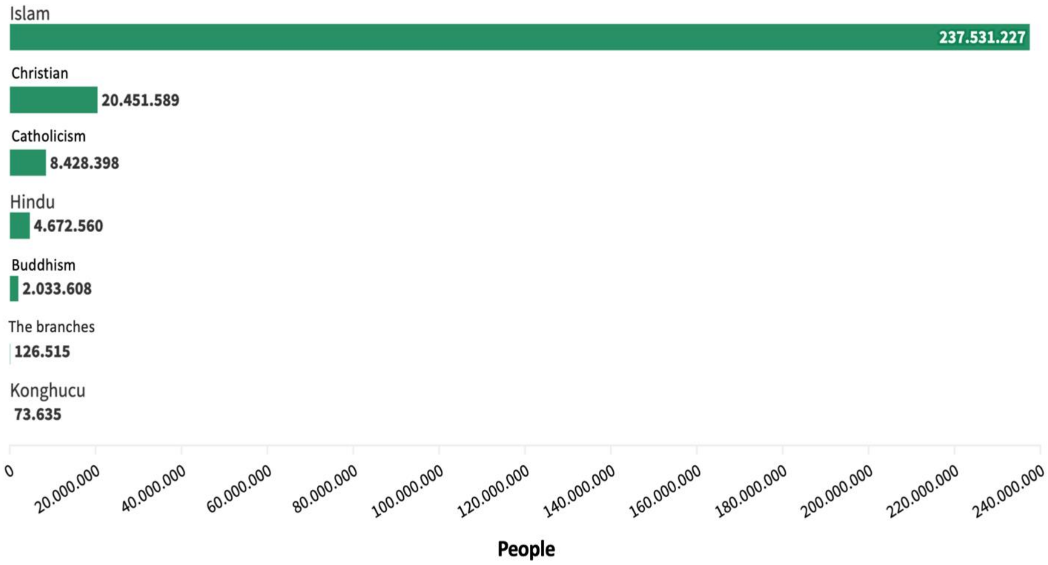
2.2.3 Language, religion, culture and social structure

Indonesia has a population of some 270 million people, comprising predominantly people of Indo-Malay and Melanesian origin (Irian). People of other ethnic origins are also present, some forming ancestral tribal groups, particularly in Kalimantan (Borneo), Sumatra, and adjacent islands (e.g. Nias and Mentawai Archipelago), and others have arrived more recently (e.g. Chinese and Indian traders). Within these broad ethnic groups, there are substantial cultural differences and various religious beliefs. The predominant religion is Islam, but in some regions there are people practising Christianity (notably Ambon, North Sulawesi and parts of Kalimantan), Hinduism (notably Bali), and Buddhism (parts of Java and Bali). There has been broad acceptance of different religious viewpoints in the past, and Indonesia's guiding principle is Bhinneka Tunggal Ika or unity in diversity.

There are seven formally acknowledged religions—Christianity, Catholicism, Islam, Hinduism, Buddhism, Kong Hu Chu (Confucianism), and traditional belief systems—practiced in all the provinces of Indonesia, including the ISLME area. Traditional belief systems are observed in all provinces and may have a more significant role in different provinces, regions, and villages as they are more associated with local culture. With the exceptions of Bali, North Sulawesi, East Nusa Tenggara, and West-Papua provinces, Islam is the predominant religion practiced in Indonesia. Bali is the only province where Hinduism is the most practiced religion. North Sulawesi and Papua have the largest Christian Protestant populations whereas Nusa Tenggara has a significant Christian Catholic population. Central and South Kalimantan provinces together with NTT Province are provinces where the majority of the populations adhere to traditional belief systems.

Figure 27 shows that the majority of people in Indonesia are Muslims. According to information from the Ministry of Home Affairs (2021), there were 237.53 million Muslims in Indonesia as of the end of 2021. This figure equates to 86.9 percent of the nation's total population of 273.32 million people. A total of 20.45 million individuals identifies as Christians, placing them in second place. There are 8.43 million Catholics in Indonesia. The number of Hindus and Buddhists in Indonesia is 4.67 million (1.71 percent) and 2.03 million (0.74 percent), respectively. There are 73 635 adherents of the Confucian faith.

Figure 27. Total Indonesian population based on religion



Source: Ministry of Home Affairs. 2021. Jumlah Penduduk Indonesia Berdasarkan Agama. [Indonesian population based on religions). https://dataindonesia.id/varia/detail/sebanyak-869-penduduk-indonesia-beragama-islam

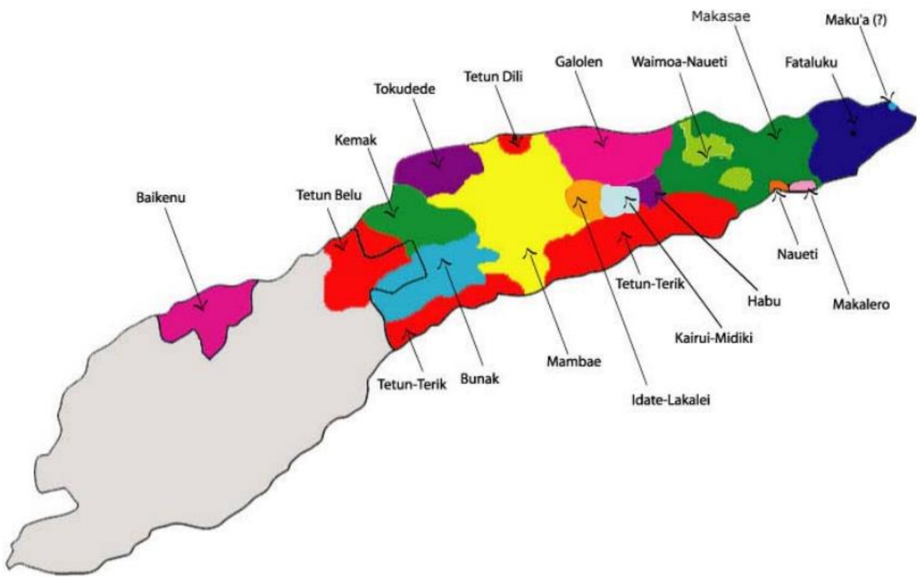
The ISLME is home to an estimated 300 distinct native ethnic groups, who speak over 700 unique languages and dialects, each with its own customs and culture (SEAMEO, 2009). Although the 2010 census found that 19.94 percent of the Indonesian population was five years and older and spoke Bahasa Indonesian in their daily life, most of the population speak local languages, most likely their mother tongue, at home. Nonetheless, Bahasa Indonesian is also a lingua franca that has been used for a long time, particularly in central and eastern Indonesia.

Although each ethnic group originates from a distinct geographic location to which they are indigenous, the 2010 census revealed that none of the provinces is exclusively populated by a single ethnic group. In fact, every province in Indonesia is populated by at least 20 ethnic groups (BPS, 2011), which indicates that the country is ethnically heterogeneous. One of the biggest ethnic groups in the ISLME area is *Orang Jawa*, who are present in all provinces, except for South Sulawesi Province. Moreover, the presence or even dominance of ethnic groups from southern Sulawesi such as Bugis, Makassar, and others in central and eastern Indonesia (Sulawesi, Nusa Tenggara Timur, Maluku, and Papua provinces) should also be noted. These ethnic groups are traditionally fishers who migrate for better fishing grounds, an important driver for their emigration from ancestral lands. Thus, they play a dominant role in fisheries and aquaculture in central and eastern Indonesia.

Some groups traditionally view coastal waters as being open access, adhering only to government regulations and disregarding often longstanding communal traditions to coastal management. For instance, the Bali and Lombok coastal waters are managed by local communities through a traditional practice called the *Awig-awig* (Satria and Adhuri, 2010). Although the communities do not claim ownership of the coastal waters in these two locations, they claim the right to manage the area adjacent to their villages (Satria and Adhuri, 2010). This claim enables the community to request that anyone fishing in waters managed by them to comply with all community regulations. The communities can bring those who breach their practices to the traditional court and punish those proven guilty. In Maluku and Papua provinces, the coastal waters are subject to communal tenure, referred to as *Petuanan Laut* (Sea Estate) in Maluku Province and *Wilayah Adat Laut* in Papua Province. This communal tenure provides these communities the right to exclude other people from accessing or exploiting their waters and has resulted in conflicts.

Most of the ethnic groups and spoken languages in Timor-Leste belong to the family of Austronesian (Malayo-Polynesian) and Papuan. The existence of different ethnic groups in the country have resulted in the use of diverse languages and dialects. Approximately 16 languages and 34 dialects are being used in different parts of the country (Figure 28). The formal and/or official languages are Portuguese and Tetun; however, Bahasa Indonesia and English are also used as business languages (Hattori *et al.*, 2005). Most of the population speak Tetun, Galole, Mambae, and Kemak for daily communication.

Figure 28. Language and dialect in Timor-Leste



Source: Williams-van Klinken, C. & Williams, R. 2015. Mapping the mother tongue in Timor-Leste: who spoke what where in 2010? Dili Institute of Technology, Timor Leste.

Almost all Timorese (99.53 percent) practice Catholicism, which was brought to the island during Portuguese colonization. Catholicism plays a role in shaping social norms, contributing to gender roles and shaping cultural values. Nearly 1.96 percent of the population are Protestants, and 0.24 percent are Muslim (see Table 5 below). Although most Timorese are Catholics, they continue to practice the religion in conjunction with traditional beliefs that are rooted in animist traditions and rituals. Their traditional beliefs play a significant role in dealing with natural resources management including humans relationship with nature. These beliefs are widely exercised in different villages and hamlets across the country.

Table 5. Religious affiliation in Timor-Leste

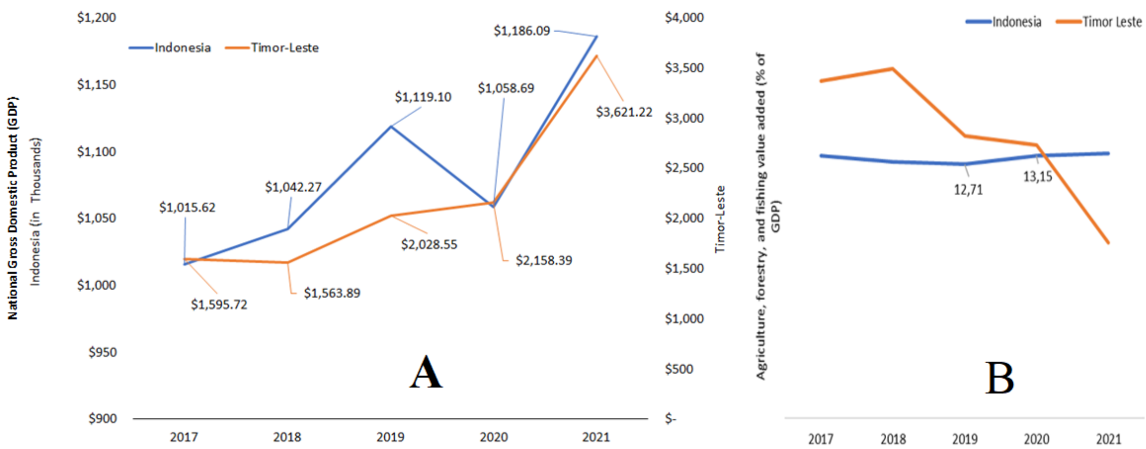
Gender	Total	Religion						
		Catholicism	Protestantism/ Evangelicalism	Islam	Buddhism	Hinduism	Traditional	Other
Total population	1 340 434	1 334 133	26 272	3 217	560	272	918	3 082
Male	678 087	678 087	12 132	1 103	336	141	483	2 000
Female	662 347	662 347	14 140	2 114	224	131	435	1 082

Source: Ministry of Finance. 2020. Timor-Leste demographics population, sex, age and trends. Directorate General for Statistics. Timor Leste.

2.2.4 Economics, social and economic indicators

Indonesia is the largest economy in Southeast Asia, the tenth largest economy in the world, and the only Southeast Asian country in the G20. The economy is largely commodity-driven and has been steadily growing since the Asian financial crisis in 1997 (World Bank, 2020a). Java dominates economic activity in the country as it comprises 59 percent of the national GDP, which is followed by Sumatra (21 percent), Kalimantan (8 percent), and Sulawesi (6 percent), and the remaining islands contribute 5 percent (BPS, 2020a). Generally, there was an increasing pattern of total GDP at current market prices from 2017 to 2021 for both Indonesia and Timor-Leste. In the section of agriculture, forestry, and fishing value added, Indonesia showed a stable pattern, whereas for Timor-Leste, the pattern exhibited a gradual decrease from 2017 to 2021 (Figure 29).

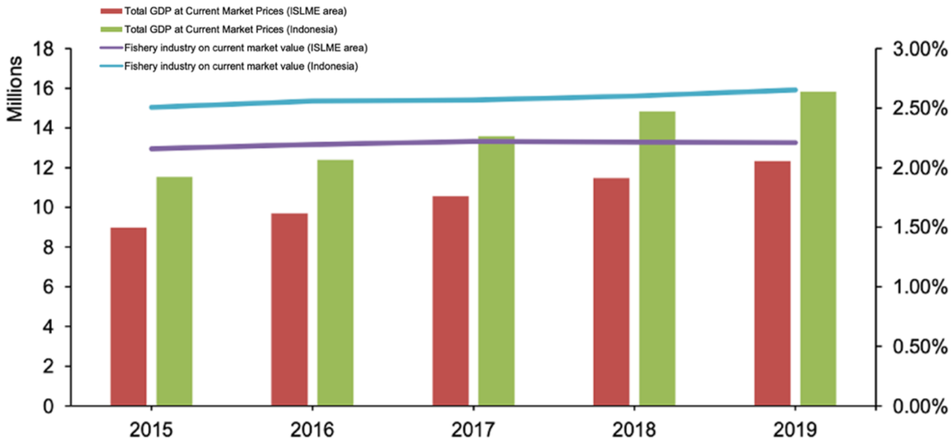
Figure 29. Indonesia's and Timor-Leste's gross domestic product



Note: A shows total gross domestic product (GDP) current market prices (million USD) in Indonesia (left axis) and Timor-Leste (right axis) and B shows percentage of value added from agriculture, forestry and fishing value to GDP Indonesia and Timor-Leste.
Source: worldbank.org [Agriculture, forestry, and fishing, value added (% of GDP) | Data (worldbank.org)]

The Indonesian economy is driven by 21 industrial sectors that are dominated by the manufacturing sector, which contributed 19.7 percent of the national GDP in 2019 (BPS, 2020a). Other notable sectors include the wholesale and retail trade and repair of motor vehicles and motorcycles, which collectively comprised 13 percent of GDP; agriculture, forestry, and fisheries, which collectively comprised 12.7 percent of the GDP; and construction, which comprises 10.8 percent of the national GDP () (BPS, 2020a). Indonesia's economic growth in 2019 was 5 percent, slightly down from 5.17 percent in 2018, according to Indonesia's National Income annual report (BPS, 2020a). Indonesia's gross domestic product (GDP) reached IDR 15.834 trillion (USD 1 053 billion) in 2019, of which Indonesia's fisheries industry generated IDR 420 trillion (~USD 27 billion) and comprised 2.6 percent of the national GDP (Figure 30).

Figure 30. Indonesian gross domestic product



Source: BPS. 2020a. Indonesian economic report. Jakarta. [Indonesian Economic Report, 2020 - BPS-Statistics Indonesia]

According to current MMAF data for 2022, the Fisheries GDP in Indonesia keeps rising yearly (Figure 31). Indonesia's fisheries GDP averaged IDR 212.9 trillion per year from 2011 to 2020, with the lowest value of IDR 154.5 trillion in 2011 and the highest value of IDR 268 trillion in 2021. Based on these records, it appears that the Indonesian fisheries sector has consistently increased from 2011 to 2021. The fisheries sector has played a leading role in shaping the understanding and assessment of the consequences of resource exploitation, with broader applicability to other ecosystem services (Antony and Mumby, 2021).

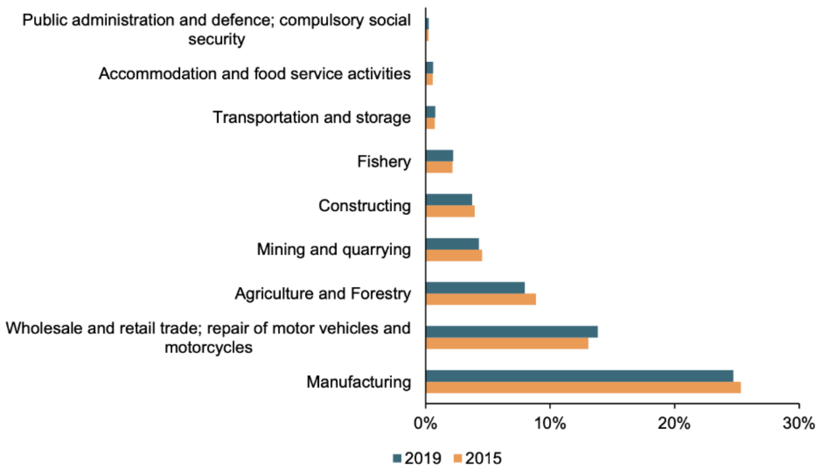
Figure 31. Annual fisheries gross domestic product in Indonesia, 2011–2020

Note: Calculated on the basis of constant prices development.
Source: Pusdatin. 2022b. Fisheries gross domestic product. [Cited 22 August 2023]. (statistik.kkp.go.id/home.php?m=pdb&i=415#panel-footer-kpda)

Economy of the ISLME

The economy of the Indonesia waters of the ISLME was assessed through the three key industries with the greatest contribution to their provincial gross regional domestic product (GRDP) and the fisheries industry of these provinces (MMAF, 2020c). The ISLME areas have experienced economic growth that mirrors the national GDP (BPS, 2020a). The top regional industrial sectors in the ISLME mirror those of the national industrial sector, namely, manufacturing, wholesale and retail trade. Repair of motor vehicles and motorcycles, agriculture and forestry, and fisheries each contribute more than 5 percent to the GRDP of the ISLME provinces (Figure 32).

Figure 32. Top regional industrial sectors in the Indonesian part of the Indonesian Seas Large Marine Ecosystem



Source: BPS. 2020a. Indonesian economic report. Jakarta. Indonesian Economic Report, 2020 - BPS-Statistics Indonesia

Ocean economy of the ISLME

Oceans are a critical part of Indonesia's immediate and long-term response to the COVID-19 crisis. Oceans are vital for Indonesia's economy and welfare, with more than 17 500 islands, almost 100 000 km of coastline, and three-quarters of its territory at sea, oceans are central to Indonesia's prosperity. Indonesia's oceans confer an unparalleled source of economic advantages that are estimated to support more than USD 180 billion worth of economic activity annually (PEMSEA, 2018a). Yet, the evidence presented in this report shows that Indonesia's oceans have more to offer when managed sustainably. Realizing this potential will deliver increased growth, jobs, food security, and reductions in the current account deficit. In addition, it can protect ecosystems for present and future generations and further Indonesia's ambition of becoming a global maritime nexus.

Indonesia has committed to a blue economy, requiring policy reform and investment

A blue economy strategy is a pathway toward these outcomes. A blue economy is a sustainable ocean economy that generates economic and social benefits while ensuring long-term environmental sustainability (the very source of these benefits) (World Bank and UNDESA, 2017). The latest 2020 World Bank systematic country diagnostic report is a good source for recent overviews and economic trends in the ocean economy and maritime sector, particularly for fisheries and marine tourism (World Bank, 2020b).

The key maritime industries in Indonesia that comprise the country's marine economy can be classified into nine sectors (PEMSEA, 2018b) Table 6 gives a clear idea of their economic value. According to the World Bank (2020a), Indonesia's marine economy generates more than USD 280 billion annually. The gross value added (GVA) — the measure of value of goods and services of a particular area, industry, or sector — of the country's ocean economy in 2019 was 26.18 percent of the country's GDP. However, this number does not represent the total contribution of the ocean economy to Indonesia's GDP because some industries or sectors contributing to the ocean economy's GVA, are not captured as a result of insufficient of data. For instance, ocean power generation, marine services, and seawater utilization. The GVA data used for this report were from 2013. Data regarding subsidies on products and taxes on products for every sector was not available.

Table 6. Gross value added of the ocean economy in Indonesia

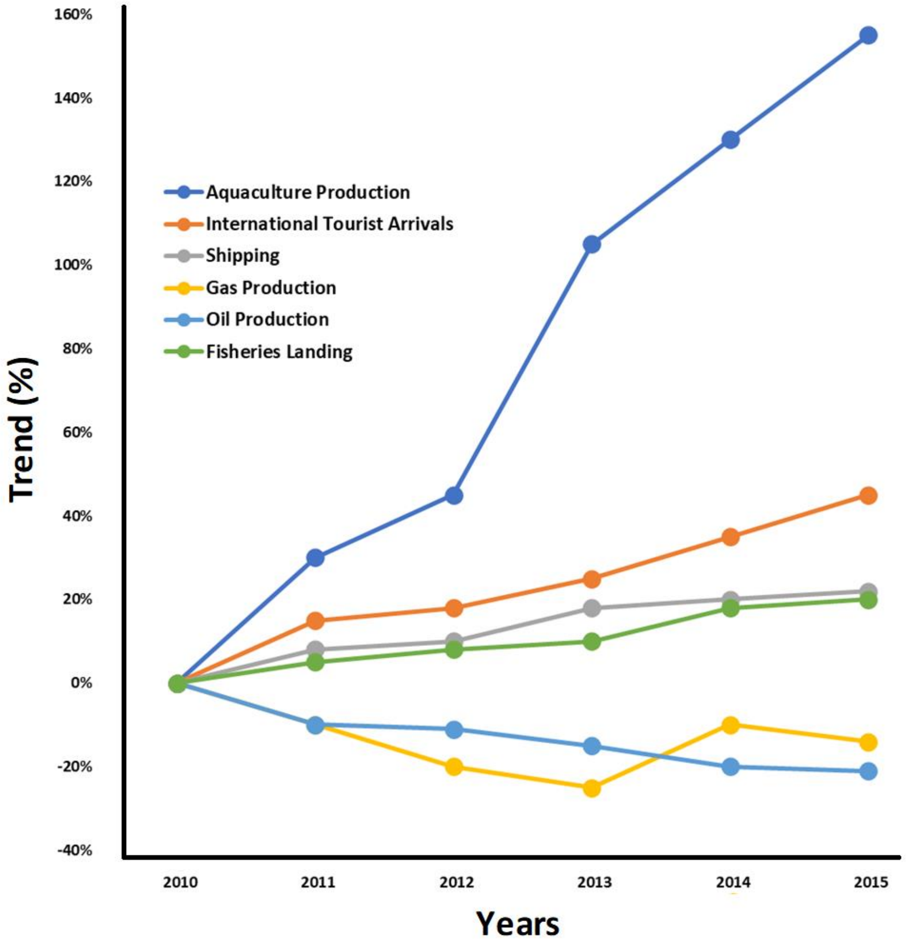
No.	Type of ocean economic activities	GVA 2013 in 2019 current price (million USD)	% of GVA sectoral to total GVA	% GVA sectoral contribution to GDP	GVA 2013 in 2015 current price (million USD)
1	Fisheries and aquaculture	33 343.07	11.37	2.98	29 179.91
2	Offshore oil and gas, Mining (minerals)	45 837.05	11.64	4.09	40 113.91
3	Ocean power generation (Ocean energy; offshore wind, renewables)	N/A	N/A	N/A	N/A
4	Seawater utilization (desalination)	N/A	N/A	N/A	N/A
5	Manufacturing	77 046.90	26.28	6.88	67 426.94
6	Marine construction	103 670.88	35.36	9.26	90 726.70
7	Shipping and ports	3 694.51	1.26	0.33	3 233.22
8	Marine tourism and recreation	28 391.49	9.69	2.54	24 846.57

No.	Type of ocean economic activities	GVA 2013 in 2019 current price (million USD)	% of GVA sectoral to total GVA	% GVA sectoral contribution to GDP	GVA 2013 in 2015 current price (million USD)
9	Defence/Government (navy, coast guard, etc.)	1 162.29	0.4	0.1	1 017.17
10	Marine research and education	N/A	N/A	N/A	N/A
11	Marine services (mapping, monitoring, consulting, maritime insurance)	N/A	N/A	N/A	N/A
Total GVA (in million USD)		**338 360.52**			**293 146.20**
GDP of Indonesia (in million USD)		**1 119 939.33**			
% GVA in GDP		**26.18**			

Source: The World Bank. 2019. *Indonesia Economic Quarterly: ocean of opportunity*. Jakarta.

Based on Figure 33, trends in maritime-related economic activities in Indonesia from 2010 to 2015, aquaculture production, international tourist arrivals, shipping, and fisheries landings all increased, whereas gas and oil production decreased. Aquaculture production increased sharply by 150 percent. This also occurred in the international tourist arrivals sector, which increased by 50 percent. The shipping and fisheries landings sectors both increased by 20 percent. By contrast, the gas and oil production sectors fell by 10 percent and 20 percent, respectively.

Figure 33. Trends in maritime-related economic activities in Indonesia (2010 to 2015)

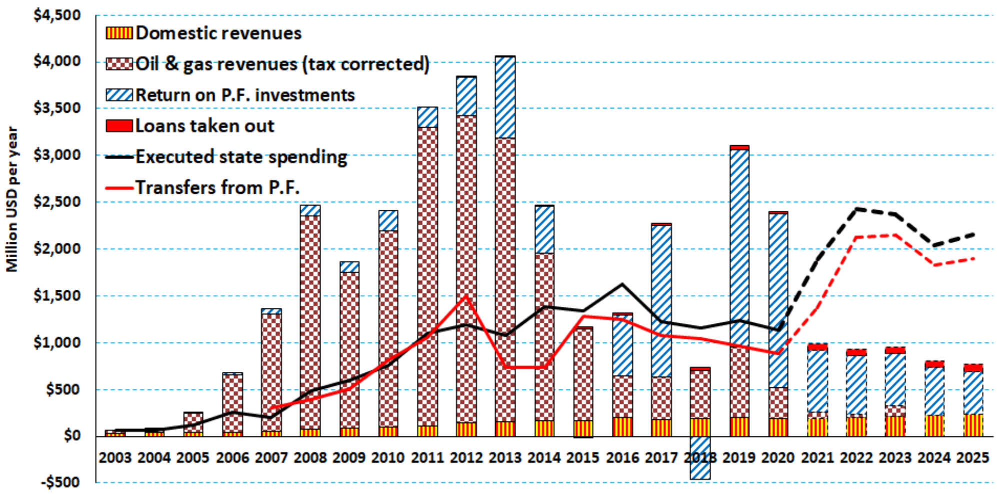


Source: MMAF. 2018a. Buku Pintar Kelautan 2018. Pusat Data Statistik dan Informasi 2018. Center for Statistical Data and Information. [Cited 22 June 2023]. http://sidatik.kkp.go.id/files/src/9b51341263445211c37f801ac8458a4c.pdf

Timor-Leste is a lower middle-income country with a GDP of USD 3 621 222.38 in 2021 (Neves, 2022). The petroleum sector accounts for approximately 70 percent of Timor's gross domestic product (GDP) and more than 90 percent of the total exports, as well as more than 80 percent of the state's annual revenue (Neves, 2022). A petroleum fund established by the Government of Timor-Leste in 2005 is the vehicle for managing Timor-Leste's receipts from the exploitation of its petroleum resources with the twin objectives of preserving intergenerational equity and maintaining fiscal responsibility. The oil and gas revenues are used by the government to build infrastructure such as schools, roads, and bridges, as well as to develop its human capital. The petroleum fund stood at USD 19 billion by the end of 2021. The government's expenditure is expected to increase in coming years as the population is projected to hit 1.85 million by 2050 (Ministry of Finance, 2020) and demands for more infrastructure and services in various sectors (i.e. health, education, clean water and sanitation, and electricity) increase.

Figure 34 presents data for the petroleum fund (PF) and other different income sources for the state and shows Timor-Leste's petroleum revenues rose rapidly since 2012. However, it has declined to one-tenth of its peak. The state has continued to receive 99 percent of the total revenue, and it is expected to continue receiving revenues from the nearly depleted Bayu-Undan gas reserves. Furthermore, Scheiner (2021) confirmed that the oil-gas outputs are expected to increase slightly in 2023. The additional wells to be drilled in Bayu-Undan are expected to generate much higher revenue for the state.

Figure 34. Petroleum fund and other different income sources for Timor-Leste



Note: In a few cases, collected revenues were returned to oil companies in subsequent years to repay over-assessed or over-estimated taxes.
Source: Hananto, A. 2021. Menjelang Habisnya Minyak Timor-Leste. [Timor-Leste's oil runs ahead]. [Cited 30 October 2023].
https://www.goodnewsfromindonesia.id/2021/10/25/menjelang-habisnya-minyak-timor-leste

The red-and-white checked segments show the oil and gas revenues that Timor-Leste has received each year and include royalties, profit, oil taxes, and corporate taxes. Approximately 93 percent of this has come from the still-active Bayu-Undan offshore oil and gas field, with most of the rest from the Kitan oil field, which produced from 2011 to 2015. Projections from 2021 onward are from state budget documents, based in turn on information provided by oil companies (Scheiner, 2021).

Apart from the oil and gas sector, Timor-Leste's non-petroleum sectors (i.e. agriculture, fisheries, tourism, and livestock) remain underdeveloped. The national state budget allocated to support agricultural and fisheries is quite small in comparison to that of other key ministries, such as education, social solidarity, and infrastructure (PEMSEA, 2019). Almost all people in rural areas rely on subsistence agriculture, livestock husbandry, and fisheries. The contribution of these sectors is small but quite significant for rural communities in terms of cash income and as a source of food for feeding families.

Apart from agricultural and fisheries products, the ecotourism sector is promising, especially on the northern coast. This is because nearly 67 percent of the total population lives on the north coast. Many of them reside close to coastal areas and are heavily dependent on coastal resources as their source of livelihoods (i.e. for cash and protein intake) (ADB, 2014). PEMSEA has facilitated coastal communities in Watubou (Liquiça) to provide roadside park food for income generation and job opportunities. The coastal communities provide various foods to visitors, such as *Ikan saboko* (fish baked with palm leaves), *Ketupa* (white rice covered by woven coconut leaves in a diamond shape), and white palm wine.

Timor-Leste's blue economy

The coastal economy typically relies on economic activities related to the tourism sector, fisheries, and aquaculture, including environmental services from marine and coastal ecosystems. Marine and coastal resources facilitate a wide range of marine and coastal assets that make the livelihoods of coastal people possible. In addition, the PEMSEA (2019) report has indicated that the coastal economy can be measured as the sum of:

(i) the economic activities that rely on marine and coastal resources;
(ii) natural assets, goods and services of marine and coastal ecosystems upon which people are dependent for income diversification, livelihoods, recreation, and food security; and
(iii) ports, shipping, and transportation for commercial and non-commercial trade.

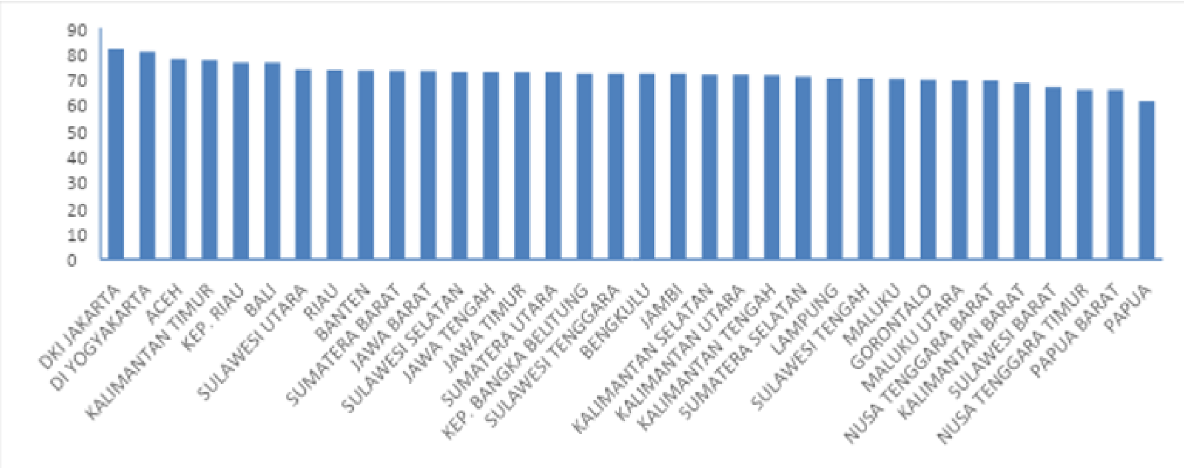
In addition to that, the PEMSEA (2018b) reported that the marine and coastal economy can be measured using a system of national accounts (SNA) that takes into account:

(i) *ocean-based activities*, such as fisheries, marine tourism, shipping, oil and gas, ocean energy; and
(ii) *ocean-related activities*: (a) those that use products from the ocean (e.g. seafood processing, marine biotechnology, salt); (b) produce products and services for ocean-based activities (e.g. ports, ship-building, communication, maritime insurance); (c) marine education and research and development; and (d) government agencies with direct maritime responsibilities (e.g. navy, coast guard, marine environmental protection.)

2.2.5 Education, employment, income and poverty

The Human Development Index (HDI) used by the United Nations Development Programme (UNDP) measures human development outcomes based on a number of basic components to assess quality of life measures: (i) long life and healthy life; (ii) knowledge; and (iii) a decent standard of living. These factors are determined by assessing life expectancy at birth, expected and average length of schooling, and per capita expenditure rates. The HDI is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable, and having a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions. The health dimension is assessed using life expectancy at birth, and the education dimension is measured by means of years of schooling for adults aged 25 years and more and expected years of schooling for children of school entering age. The standard of living dimension is measured by gross national income per capita. The HDI uses the logarithm of income to reflect the diminishing importance of income with increasing GNI. The scores for the three HDI dimension indices are then aggregated into a composite index using geometric mean. The UNDP HDI classification, which has been adopted by the Government of Indonesia through BPS are: (i) low status = HDI < 60; (ii) moderate status = 60 ≤ HDI < 70; and (iii) high status = 70 ≤ HDI < 80. Indonesia's HDI increased from 71.92 in 2019 to 72.91 in 2022 (1.4 percent increase), which moved the country to the high HDI status category, the third year that the country achieved this status. At the subnational level, the lowest 2022 HDI value of 60.06 was determined for Papua Province, although this value brought the province into moderate status. The highest HDI was achieved in DKI Jakarta Province at 80.47, and the province is the first and only one to achieve a “very high” human development status. Provinces within the ISLME area that achieved high HDI status are West Java, Central Java, D.I. Yogyakarta, East Java, Banten, Bali, Central Kalimantan, South Kalimantan, East Kalimantan, North Sulawesi, South Sulawesi, and Southeast Sulawesi. The ten provinces in the ISLME area that achieved moderate HDI status include South Sumatra, Lampung, West Nusa Tenggara, East Nusa Tenggara, Central Sulawesi, Gorontalo, West Sulawesi, Maluku, North Maluku, and West Papua (Figure 35).

Figure 35. The 2022 Human Development Index in provinces of Indonesia



Source: UNDP. 2022. Human development report 2021/22. United Nations Development Programme. New York.

Expenditure on health-related infrastructure and improved access to healthcare facilities has contributed to the increase in life expectancy across Indonesia. Similarly, investment in educational facilities and access has increased school enrolment and participation among children. BPS (2023) data indicate that Indonesia's mean years of schooling (MYS) in 2022 was 8.69 years, a 4.02 percent increase from 8.34 years in 2019. The Government of Indonesia has embarked on a new education strategy to increase MYS across the country to 12.91 years, which would enable children to attain a Diploma 1 level of education.

The standard of living, as measured by per capita expenditure, increased nationally from USD 676.15 in 2015 to USD 794 in 2021. In the ISLME area, the average per capita expenditure in 2018 was slightly lower at IDR 10.780 million, but had also increased from IDR 9.890 million in 2015. Timor-Leste saw a USD 1.080 per capita expenditure in 2021. It should be noted that there is a distinct disparity in HDI between provinces in western Indonesia and those in eastern Indonesia. Access to economic opportunities, health, and education are less available the further east one travels (Table 7).

Table 7. Human development index for Indonesia's Indonesian Seas Large Marine Ecosystem provinces

Region	District/Municipal	2010	2018
Western Indonesia	South Sumatra	64.44	69.39
	Lampung	63.71	69.02
	DKI Jakarta	76.31	80.47
	West Java	66.15	71.30
	Central Java	66.08	71.12
	DI Yogyakarta	75.37	79.53
	East Java	65.36	70.77
	Banten	67.54	71.95
Central Indonesia	Bali	70.10	74.77
	West Nusa Tenggara	61.16	67.30
	East Nusa Tenggara	59.21	64.39
	Central Kalimantan	65.96	70.42
	South Kalimantan	65.20	70.17
	East Kalimantan	71.31	75.83
	North Sulawesi	67.83	72.20
	Central Sulawesi	63.29	68.88
	South Sulawesi	66.00	70.90
	Southeast Sulawesi	65.99	70.61
	Gorontalo	62.65	67.71
	West Sulawesi	59.74	65.10
Eastern Indonesia	Maluku	64.27	68.87
	North Maluku	62.79	67.76
	West Papua	59.60	63.74
Indonesia		**66.53**	71.39
ISLME		**65.66**	68.74

Source: BPS. 2018a. Indeks Pembangunan Manusia [Human Development Index] Jakarta: BPS. ISSN: 2086-2369

Timor-Leste has an education system in place to facilitate both formal and non-formal education. The education system ranges from pre-school level education to tertiary level education. The government is also facilitating technical vocational education, with prominent examples, such as the Agriculture Senior High School, Fisheries Senior High School, and Veterinary High School. According to data provided by UNICEF (2020b), the education services have delivered a total of 1 426 public schools and 385 private schools, which are distributed in all villages, and *posto administrativo* and municipalities around the country.

The main barrier faced by the Government of Timor-Leste is education quality. Most teachers have insufficient formal teaching qualifications and relevant teaching skills. Nevertheless, the government has committed to improving the quality of teachers to ensure that all school age children (boys and girls) have an opportunity to attend school at all levels. The effort also aims to educate and equip Timorese people with skills that will enable them to compete in the job market. In addition, vocational training in tourism, fisheries, and small manufacturing ventures are needed.

The Government of Timor-Leste has acknowledged the negative effects of early undernutrition on learning ability and school performance. They have established feeding programmes at schools and health centres around the country to facilitate children’s access to healthy food in an effort to support their physical development in early development stages. Additionally, the country’s Strategic Development Plan (SDP) 2011–2030 underlines the importance of achieving gender equality in education. For that reason, the government has committed to focus on education and inclusion of children from lower economic backgrounds.

Economically, Timor-Leste has evolved from first depending on foreign aid to relying on oil and gas exports and eventually living off the returns from investing revenues received from extracting non-renewable resources (Scheiner, 2021). More than 80 percent of government expenditure come from Timor-Leste's petroleum fund. However, the country is still struggling to support job seekers entering the labour market. The existing jobs are dominated by the public sector because the private sector, characterized by small enterprises, self-financed, individually owned, and small kiosks is not large enough to generate enough jobs for the large number of young people entering the labour market.

Agriculture, livestock, and fisheries are the principal non-petroleum sectors that provide high employment opportunities in Timor-Leste. Almost 80 percent of the population rely on these sectors for cash and for food. Among them, coffee is the largest non-petroleum export. To engage more of the labour force in the agricultural sector, the Government of Timor-Leste plans to consider gender in adult education. This aims to improve knowledge and business skills training between men and women. As part of the National Employment Strategy (2017-2030), the government developed a national action plan (NAP) for gender and the private sector, which aims to improve labour market supply.

Enhancing the labour market is key to improving the competitiveness and suitability of Timor-Leste’s economy. However, Timor-Leste is less capital intensive and has lower labour and productivity levels. People have limited access to finance and limited workforce skills and education levels. The labour market is more related to education and skills as well as vocational training for men and women. Technical and vocational training has been organized between the Ministry of Education and the State Secretary for Youth and Labor. This collaboration has improved quality of skills and knowledge for both men and women. However, conditions should be in place to promote employment and enterprise creation for the youth of both genders, including cooperatives in limited rural areas. A lack of alternative livelihoods opportunities along with underemployment stands as a principal root cause of poverty and vulnerability around the country. Moreover, a lack of alternative livelihoods and labour shortages in rural areas has caused many youths to migrate to Dili to seek better job opportunities. The private sector has limited skills to identify business opportunities in rural areas, which further exacerbates the situation for farmers in rural areas. In addition, the limited state of rural roads and bridges affects the ability of people living in rural areas to run business operations. Transportation costs in rural areas are higher than in urban areas and impede economic growth and poverty reduction (ILO, 2022).

Apart from higher costs and poverty, social norms also contribute to issues in education/training and job opportunities. For example, patriarchal systems disproportionately prevent girls from completing their education and their involvement in technical and vocational training. This also affects their employment options, increasing the tendency for them to perform unpaid work (no cash income), such as preparing food for family members, taking care of children, cooking, and collecting water. The patriarchal system often forces girls to halt their education for marriage if the girl becomes pregnant (Secretary of State for Youth and Labor, 2017).

Increasing the capacity of both the male and female labour forces has been a principal priority of the Government of Timor-Leste. This is based on the premise that a highly knowledgeable and skilled labour force can diversify their sources of income and get better access to job markets. As part of that commitment, the government has invested in and standardized a technical and vocational education and training (TVET) system that aims to facilitate the labour force's access to job opportunities at both national and regional levels.

A large portion of Timor-Leste's population (more than 80 percent) living in remote areas are heavily dependent on the agriculture sector, which only provides very limited employment opportunities. In some municipalities, there is the potential to develop the fishery and ecotourism industries. In most cases, these sectors remain vital for economic production (income diversification and nutritional security) in the country.

Subsistence production refers to production meant for personal and family consumption and is not considered to be traditional employment. People engaged in subsistence production as their main source of income number 439 800. Among them, 273 400 are women and 166 400 are men. Youth (men and women) aged 15–24 years old total 179 200 with substance production as the principal work. This represents 66.1 percent of the total of their age group. By contrast, adults aged between 25 and 64 (47.7 percent of the total population) and elderly (>65 years) work in subsistence production (ILO, 2021). The report also further confirmed that people in rural areas are more engaged in subsistence production (61.2 percent) than those living in urban areas (43.9 percent).

A survey on labour force conducted by the Secretary of State for Training and Employment (SEFOPE) and International Labour Organization (ILO) in 2021 has confirmed that:

- The working-age population aged 15 years and above in Timor-Leste in 2021 was 809 300, with slightly more women (405 800) than men (403 600).
- The labour force, constituting women and men that were either employed or unemployed, totalled 247 000. The labour force participation rate was 30.5 percent overall, with a sharp disparity between women (24.2 percent) and men (36.9 percent).
- In terms of the distribution of the labour force based on educational attainment, 30.7 percent had no formal education or had not completed primary schooling. Conversely, 16.8 percent had at least some tertiary education.

- In total, 234 300 thousand people were employed, comprising 142 000 men and 923 000 women.
- Nearly half (48.5 percent) of all workers were classified as wage employees, whereas 50.3 percent were self-employed as either an own-account worker or a contributing family worker. Women compared to men were more likely to be self-employed and less likely to be in wage employment.
- Unemployed persons numbered 127 000, indicating a general unemployment rate of 5.1 percent. Unemployment among female jobseekers was higher (5.9 percent) relative to their male counterparts (4.6 percent). For young people aged 15–24 years, the unemployment rate was significantly higher at 9.6 percent.
- Out of 82 800 young people aged 15–24 years were not in employment, education, or training in 2021, representing 30.5 percent of young people of this age group. Young women were more likely to be in this situation than young men (31.3 percent compared to 29.8 percent, respectively).
- In terms of economic activity, 59.1 percent of total employment was based in the service sector, whereas agriculture and industry accounted for 26.9 percent and 13.5 percent, respectively (Ministry of Finance, 2022b).

A set of indicators was established for the labour force by SEFOPE and ILO in 2021. Table 8 presents labour force indicators (gender disaggregated) across the country.

Table 8. Selected indicators of the labour force, gender disaggregated, Timor-Leste, 2021

Descriptor	Male	Female	Total
Working-age population, aged 15+ years	403 600	405 800	809 300
Labour force	148 900	98 100	247 000
By education (% distribution)			
Less than primary or one	28.9	33.4	30.7
Completed primary	17.1	19.7	18.1
Completed secondary	36.9	30.3	34.3
Tertiary (first stage or completed)	17	16.5	16.8
Level not stated	0	0.1	0
Labour force participation rate (%)	36.9	24.2	30.5
Employment	142	92.3	234.3
By economic activity (% distribution)			
Agriculture, forestry and fishery	24.2	31	26.9
Industry	16.5	8.7	13.5
Services	59	59.3	59.1
Economic activity not classified	0.3	1	0.5
By status in employment (% distribution)			
Employees	59.2	31.5	48.3
Employers	1.4	0.7	1.1
Own-account workers	26.6	48	35.1

Descriptor	Male	Female	Total
Contributing family workers	12.7	19.2	15.3
Workers not classifiable by status	0.2	0.6	0.3
Share of informal employment (%)	75.3	80.4	77.3
Labour underutilization	48.9	46	94.9
Time-related underemployment	1.1	0.2	1.3
Unemployment	6.8	5.8	12.7
Potential labour force	40.9	40	80.8

Source: International Labour Organization (ILO). *2021.* Decent Work Country Programme Timor Leste 2022–2025. International Labour Organization.

Betuel (2020) confirmed that approximately 47 percent of the Timorese people live in poverty. However, a slight poverty rate reduction has been attained in the last two years. Table 9 shows the proportion of men and women in employment living below the poverty line in Timor-Leste. Poverty reduction falls under the 2030 Agenda, particularly in the case of SDG 1 End poverty in all its forms everywhere and SDG 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. The SDG goals have been adopted by the government of Timor-Leste. The SDG is a political instrument for improving living conditions and poverty reduction and protecting vulnerable people. These SDGs are also in line with the SDP 2011–2030. The SDP strongly underlines poverty reduction in all areas, including households and all aspects of political, socioeconomic, and cultural life. The SDP recognizes that poverty reduction strategies need to be gender sensitive and that women's empowerment is necessary for the balance between men and women to be improved in all sectors.

Table 9. Proportion of men and women in employment below the poverty line, Timor-Leste

Statistic	Year	Value (%)
Proportion of employed population below USD 1.90 PPP a day: female	2019	20.6
Proportion of employed population below USD 1.90 PPP a day: male	2019	22.8
Proportion of employed population below USD 1.90 PPP a day: total	2019	21.8

Source: ADB. 2020. *Basic 2020 statistics*. Manila, Asian Development Bank. Basic Statistics 2020 (adb.org)

2.2.6 Coastal communities – governance, livelihoods, vulnerability and gender analysis

Tanaya and Napitupulu (2021) estimated that women comprise at least 42 percent of the people engaged in fisheries in Indonesia, which includes aquaculture and wild capture. Anecdotal observations by Hatfield consultants while visiting and working with coastal communities in Indonesia make it clear that women and men participate in all steps of the fisheries industry, from preparing to fish (preparing the boat, gear and supporting facilities) to post-harvest processing and marketing, although the extent of their responsibilities differs across islands, ethnic groups, and even at the household level. The physical act of fishing is often a male-dominated activity; however, in many regions, including Demak, Central Jawa, women go fishing with their husbands or, as with the Bajau in central and eastern Indonesia, women often fish as part of their household activities. Fishing is a family activity in Asmat, Papua, with women and children joining men fishing in boats. This intergenerational approach enables parents to teach their children as was observed in Mayalibit Bay, Raja Ampat with mothers and children. Across Indonesia, from Aceh to Papua, women and children also fish in the intertidal zones and in mangrove forests. They glean for bivalve and small fish trapped in lagoons or hunt for crabs in mangrove areas, which provides an important source of household protein and food security (Figure 36).

Women also fill important support roles such as collecting fuel for boats, as was observed in Semarang, mending nets and fishing gear with men, or making bait to attract juvenile spiny lobsters in Lombok. Women also play a significant role in post-harvest and marketing activities. In many places, it is common to find that once fish are landed, the business switches from men to women. These land-based businesses manage the cleaning, cooking, and selling of the commodities. Although cleaning and cooking or processing are mostly small-scale activities completed in households, female fishmongers play a significant role. In *Tambak Lorok Tempat Pelelangan Ikan*/TPI (fish auctions) across Indonesia, women account for more than half of the buying and re-selling of landed fish both in terms of weight and monetary value (Izzaturrahim, 2019). In many places, including Probolinggo, West Java, Cempi, Waworada, and Sanggar on Sumbawa Island, the Hatfield team observing several female fish traders representing fishing operations.

Figure 36. Women involvement in fisheries activities across Indonesia

Source: Stacey, N., Gibson, E., Loneragan, N.R., Warren, C., Wiryawan, B., Adhuri, D., Fitriana, R. 2019. Enhancing coastal livelihoods in Indonesia: an evaluation of recent initiatives on gender, women and sustainable livelihoods in small-scale fisheries. doi.org/10.1007/s40152-019-00142-5

Unfortunately, the role of women in the fishing industry in Indonesia is often overlooked and underestimated as reflected in the national gender inequality status, which states this as being among the imbalances in human development in Indonesia. BPS (2018a) indicated that the HDI for men in Indonesia had reached 75.43 or had a “high” status, whereas the HDI for women reached 68.63 or had a "medium" status. This inequality is reflected in *Indeks Pembangunan Gender*—Indonesia's Gender Development Index (IPG), which only reached 90.99 in 2018. Firtiana and Stacey (2012), Alami and Raharjo (2017), and Loneragan *et al*. (2018) argued that the lack of accurate and comprehensive data on the many and varied roles of women might be the reason for this underestimation reported in the IPG.

The Government of Indonesia has started to address gender inequality through gender mainstreaming (*Pengarusutamakan Gender*, PUG) programmes in government ministries and other government institutions (*Kementerian/Lembaga* (K/L). These programmes aim to ensure that women participate in development, as supported by Presidential Regulation No. 18/2020 concerning the National Medium-Term Development Plan/*Rencana Pembangunan Jangka Menengah Nasional* (RPJMN) 2020–2024. This policy will be carried out by all sectors in accordance with Presidential Instruction No. 9/2000 regarding Gender mainstraming in national development and the Ministry of Finance Regulation No. 94/2017 regarding guidelines and assessments of work plans and K/L budgets. The MMAF has committed to implementing PUG gender mainstreaming through the publication of several regulatory policies as follows:

- the MMAF Regulation No. 4 of 2014 about guidelines for gender responsive planning and budgeting of the MMAF;
- MMAF Regulation No. 28 of 2016 about guidelines on the implementation of gender mainstreaming monitoring and evaluation at MMAF;
- MMAF Regulation No. 51 of 2016 about guidelines on gender mainstreaming mapping in marine and fisheries areas;
- MMAF Regulation No. 67 of 2016 about roadmap for mapping the implementation of gender mainstreaming in the MMAF environment;
- Memorandum of Agreement (MoA) between MMAF and Ministry of Women Empowerment and Child Protection (MoWECP) No. 07/MEN-KP/KB/VI/2017 and No. 21/KPP-PA/D.1/06/2017 about increasing the effectiveness of gender mainstreaming in the field of marine and fisheries; and
- Cooperation agreement between Directorate General for Capture Fisheries (DJPT) and Deputy for Gender Mainstreaming No. 6/MenPP- PA/DEP.I/04/2012 and No. 02/DJPT-KKP/PKS/IV/2012 regarding gender mainstreaming facilitation and guidance for diversification of fishing business for fisherwomen.

Most Timorese (approximately 650 000) live on the northern coast and are heavily dependent on marine and coastal ecosystems for their key livelihoods. These ecosystems services consist of providing water, shelter, and support food production, recreation, and tourism. These ecosystem services and their health are in turn dependent on human interventions and management measures. For this reason, proper management and governance is required to ensure that all marine and coastal resources are managed in an acceptable way. This means that coastal communities are not only users of the ecosystem services, but are also custodians of marine and coastal resources to ensure their long-term sustainability.

Many NGOs are working collectively with the Government of Timor-Leste to secure and promote livelihoods on the northern coast that are economically realistic and sustainable. At the same time, they are also working and addressing issues related to climate change impacts, which results in coastal erosion, inundation, and sea level rise. The coastal communities require tangible actions on climate change adaptation and mitigation. By addressing climate change impacts, sustainable livelihoods can be secured. This is also a way to enhance the resilience of marine and coastal resources to climate change impacts. Understanding the linkages between sustainable livelihoods and its challenges are extremely important to improve governance and livelihood opportunities associated with marine life and its ecosystems.

The heavy reliance of coastal communities on the northern coast on marine ecosystems calls for an innovative governance solution. Institutional arrangements and plans for diverse livelihoods should fit in with socioeconomic, local, and national contexts. Coastal communities need to be placed at the centre of the governance of marine and coastal resources. The governability of marine and coastal resources is closely related to institutional and demographic drivers. Fisheries governance and its development is an entry point for improving both marine ecosystem and human development outcomes as well as human well-being (Cinner and Bodin, 2010).

Cinner and Bodin (2010) have further affirmed that acknowledging the nature of the relationship between community livelihoods and coastal landscapes is an essential step for developing any interventions associated with marine coastal resources governance and other relevant management measures. However, development interventions related to livelihoods on coastal areas on the northern coast are limited. The local authorities have paid less attention to fisheries governance and its association with livelihood development. This is mainly because of limited skills and knowledge regarding marine resources and management measures. Additionally, coastal livelihood development is not part of the village development plans.

Therefore, understanding the nexus between livelihood, human development, income diversification, and nutritional security is essential and requires greater attention. The correlation between livelihoods and human prosperity is a complex issue. Indeed, it requires a comprehensive and integrated approach that engages many actors and different disciplines. As confirmed by Mills *et al*. (2017), fisheries governance and livelihoods should be prioritized at village development level.

Fisheries governance covers gender activities on coastal areas. So far, information related to the coastal economy and gender roles from the northern coast is limited. Nevertheless, it is fair to say that different gender roles exist in the coastal communities along this coast. Men normally engage in offshore fishing whereas women and girls tend the family doing household chores such as preparing meals and water to feed them on their arrival from offshore fishing. Women and girls also engage in additional tasks such as collecting/removing fish from gill nets, fish processing (often dried fish), and selling them on the beach (through an intermediary who may be male or female) or at local markets. In addition to that, they are involved in gleaning during low tide to collect small fish, octopus, oysters, and small shrimps for subsistence support, family consumption, and for cash.

The other roles played by women and girls particularly in Liquiça (Vatubow village) are related to added value for fish products. For instance, they produce "Ikan saboko" (fish baked with palm leaves) together with "Ketupa" (white rice covered by woven young coconut leaves in a diamond shape) for cash. This activity is basically done to supply food to the roadside park or for local visitors (from Dili to Liquiça/Bobonaro or vice-versa). These activities (gleaning and value addition) are relatively small but they play an important role at the household level especially for nutritional security and cash or income diversification. Indeed, women's involvement in fisheries activities is a form vital of livelihood support. Moreover, women and girls will actively engage in promoting the conservation of marine biodiversity-dependent livelihoods. It is also clear that women's participation in fisheries activities is paramount.

Men need to work closely with women both in decision making and in implementing fisheries conservation plans. By doing so, fisheries management measures, including aquaculture development can be developed to enhance biodiversity-based livelihoods. Through this activity, gender mainstreaming in fisheries will strengthen women's engagement in co-management through integration of best practices and lessons learned. The role of women should be considered in relation to marine and coastal resources management. This will ensure that marine and coastal resources are available to continue supporting coastal livelihoods for coastal communities.

According to López-Angarita *et al*. (2019), women and girls are always disproportionately disadvantaged in relation to fisheries resources compared to men. For example, women are likely to be affected by lack of food (protein intake) and are also more likely to suffer from nutritional deficiencies. To reduce the disadvantages faced by women, women's engagement in coastal management measures should be promoted. The principal reasons for women involvement in marine and coastal resources management, according to López-Angarita *et al*. (2019) is as follows:

1. to ensure that men and women are working together in managing marine and coastal resources for both conservation measures and the decision-making process;
2. to ensure that the potential roles of men and women in marine and coastal resources utilization are fully maximized to avoid or reduce the impacts of biodiversity-based livelihoods; and
3. to ensure that future fisheries development promote collaborative efforts between men and women including different stakeholders.

In summary, gender activities in fisheries, particularly for women, suffer from a lack of recognition or being ignored in national policy, programmes, and formal discussions. The government is committed to tackling gender issues and related challenges. It has established laws and regulations including policy development to address gender issues. Articles 6 and 17 of the Democratic Republic of Timor-Leste (RDTL) Constitution state that women and men "have the same rights and duties in all areas of political, family, economic, social, and cultural life," and a fundamental objective of the state is "to create, promote and guarantee the effective equality of opportunities between women and men". Timor-Leste has also signed and ratified the International Covenant on Civil and Political Rights and the International Covenant on Economic, Social and Cultural Rights. In 2010, the parliament passed Law No. 7/2010 Against Domestic Violence (LADV) and in 2017, the government launched the National Action Plan on Gender-Based Violence 2017–2021 (GBV NAP). In addition, Government of Timor-Leste committed to improving the socioeconomic empowerment of women by signing the first Maubisse Declaration (2015–2017). The second Maubisse Declaration, adopted in 2018, aimed at improving the lives of rural women by 2023. The government also encourages women's participation and empowerment in all sectors. This is actually part of Agenda 2030 on Sustainable Development, especially its SDG 5, which addresses the long-term existing structural barriers to gender equality through multiple interventions. The government's plan is to organize multiple sectors in a manner that reduces gender inequality and to realize this goal the government has provided a 20-year budget. Moreover, policymakers plan to focus on three areas: the implementation of social protection, legislation, and gender-responsive financing, as articulated by Trivedy and Satyam, (2022):

1. The implementation of laws is inadequate. If the state is able to ensure the implementation of relevant laws, this will ultimately improve the protection of women and girls, leading to women's rights being upheld;
2. A long-term social protection scheme will provide effective mechanisms to reduce the vulnerabilities of women and girls, leading to their empowerment and participation in all sectors.
3. Gender-responsive budgeting is a critical part of the public financial management agenda and will improve the social and economic situations of women and girls by ensuring a fair allocation of resources.

The existing laws and regulations just mentioned will facilitate and promote gender equality agendas, which in turn will link to gender perspectives-based issues and challenges that are confronted by people in Timor-Leste. The principal objective relates to "leaving no women and girl behind."

2.3 Economic sectors

2.3.1 Capture fisheries

The fisheries sector is an important contributor to national food security and employment in Indonesia, and to a lesser degree in Timor-Leste. Nearly 7 million people are involved in fisheries-related jobs in Indonesia. A recent study ranked Indonesia as the eighth most fish-dependent nation in the world, measured by dependence on fish-derived animal protein. Much of the catch is produced in artisanal fisheries, and industrial fisheries contribute considerably more in terms of value because they target high-value shrimp and tuna stocks, major species caught in the ISLME, as well as a range of reef fishes. Reef fisheries are vital to subsistence fishers and their families in the region; moreover, they are crucial in supplying high value products to distribute to international, national, and local markets.

Indonesia marine capture fisheries

Indonesia's seafood industry exported nearly USD 6 billion in seafood value in 2021, and the goal of the government has been to continue to grow the fisheries and aquaculture industries, such that exports will reach USD 10 billion by 2024. However, because of the COVID-19 pandemic and other factors, the fisheries export value in 2022 only reached USD 5 billion. To further facilitate fisheries growth, the Government of Indonesia designated 20 remote islands as marine centres, that is islands strategically located closer to major export countries such as Thailand and the United States. With an overall investment of IDR 711 billion (USD 50 million), the marine centres are to be equipped with equipment to assist local fishers, including boats, fishing tools, cold storage, as well as fishing practice training.

In 2021, Indonesia's estimated per capita rate of fish consumption was 49.14 kg/year, according to the MMAF. National fish consumption continues to increase in every province in Indonesia, which may be partly attributable to the "Gemar Makan Ikan" ("Love to Eat Fish") national campaign. The campaign is designed to increase domestic consumption of fish as a source of protein to improve the health and nutrition of Indonesians, which is a priority in the government's vision, the *Nawacita* development agenda. The campaign continues to promote fish consumption, and the government aims to increase per capita consumption to 60 kg/year by 2024. As an implementing partner of the campaign, MMAF has established fish consumption promotion councils throughout the country at provincial, district, municipal, and subdistrict levels.

Fishery resources are vital for the economy of Indonesia, accounting for nearly 3 percent of GDP and more than 11 percent of the country's marine economy as of 2013. The production from the capture fisheries has been relatively consistent over the past decade, and aquaculture production has grown more strongly over the recent two years (Table 10).

Table 10. Indonesian fisheries production, 2016 – 2021

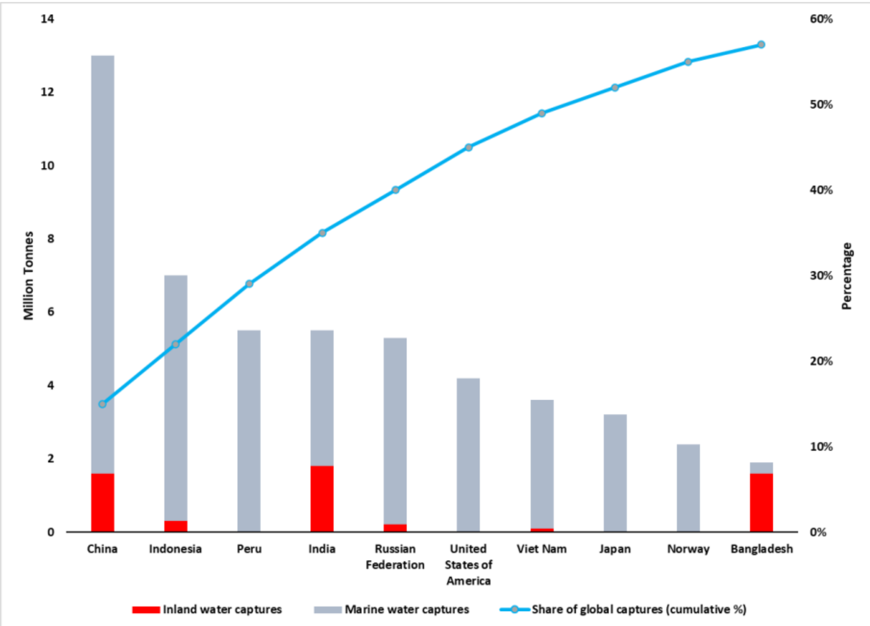
Category	Year					
	2016	2017	2018	2019	2020	2021*
Fisheries Production****	**22 582**	**23 186**	**23 049**	**22 761**	**21 834**	**21 873**
Capture Fisheries	6 580	7 071	7 361	7 335	6 989	7 225
- Marine	6 115	6 603	6 702	6 630	6 494	6 768
- Inland	465	468	659	705	495	457
Aquaculture Fisheries	**16 002**	**16 115**	**15 688**	**15 426**	**14 845**	**14 648**

Source: PUSDATIN. 2022b. Produksi perikanan (fish production). [Cited 22 August 2023]. Produksi Perikanan (kkp.go.id)

** Figures in 1 000 tonnes.

As the world's second largest fish producer, fisheries play a critical role in Indonesia's economy. Indonesia is second only to China as the world's largest fishing nation with an annual harvest of more than 6.1 million tonnes of marine fish (Figure 37). Marine capture fisheries and aquaculture together are a crucial source of employment, providing nearly 7 million jobs. Fish contribute 52 percent of all animal-based protein in the national diet, well above the global average of 16 percent. In 2018, the sector contributed over USD 26.9 billion to the national economy (about 2.6 percent of GDP), a larger proportion than that seen elsewhere in the region. In 2018, fisheries contributed export earnings worth over USD 4.8 billion, supplying 3 percent of the global market for exported seafood (BPS, 2019b). Moreover, Indonesia is ranked fourth in the world in terms of the production of aquaculture commodities, accounting for 8.53 percent of the world's aquaculture production (FAO, 2016). Production from aquaculture contributes more than two times as much as that from capture fisheries. Aquaculture contributes 67 percent of the nation's total fishing productivity and capture fisheries contributing 33 percent (MMAF, 2022a).

Figure 37. Global capture fisheries producers



Source: FAO. 2020b. The State of World Fisheries and Aquaculture 2020. [Cited 22 July 2023]. https://www.fao.org/documents/card/en/c/ca9229en

The fisheries of the ISLME are complex and diverse, reflecting the region's extraordinarily heterogeneous geography and species richness. Based on Indonesia's fishery reports from 2019, catches in the ISLME total nearly 3.5 million tonnes. Major species caught include tuna, sardines, anchovy, mackerel (Figure 38), as well as a wide range of reef fishes and other demersal fishes. Reef fisheries are vital to subsistence fishers and their families in the region but are also important in supplying high value products for distributing in international, national, and local markets. Small-scale artisanal fishing is prevalent throughout the ISLME region. Although the fisheries sector as a percentage of total GDP is relatively small, the fisheries sector contributes significantly to coastal communities and fishing families in both Indonesia and Timor-Leste, representing the primary source of income for many families in coastal communities and as an important element in diversifying income for other families (in most coastal areas within the ISLME, capture fisheries and aquaculture are among the few viable and sustainable options for livelihoods). In addition, the populations of many non-coastal communities in the ISLME are heavily reliant on fish as an affordable source of protein and income (in 2019, consumption of fish was nearly 44 kg per capita in Indonesia and 6.8 kg per capita in Timor-Leste).

Figure 38. Major species caught in the Indonesian Seas Large Marine Ecosystem

Source: (a) tuna. Wiki Images. 2012. Thunnus Tuna Fish Bigeye.
https://pixabay.com/photos/thunnus-tuna-fish-bigeye-tuna-69319/ [Accessed 24 March 2024]
(b) sardine. Katie, E. 2018. Sardines White Background Two Fish.
https://pixabay.com/photos/sardines-white-background-two-fish-3732726/ [Accessed 24 March 2024]
(c) anchovy. Chung, K. 2020. Clove fish at the wet market in Penghu Island, Taiwan.
https://pxhere.com/id/photo/1613554#google_vignette [Accessed 24 March 2024]
(d) mackerel. Tscharntke, T. 2016. Atlantic, mackerel, fish. https://pixnio.com/fauna-animals/fishes/atlantic-mackerel-fish [Accessed 24 March 2024]

Capture fisheries are dominated by tuna, skipjack tuna, and eastern little tuna, with a production volume of 608 300 tonnes. Coastal communities in Indonesia are involved in fisheries production, capture fisheries, collecting and trading, processing, and retailing. Small-scale collecting and trading involve fish collectors or microscale traders who are normally found at the village level. Historically, commercial fishing pressure has been most intense in western Indonesia, especially around Sumatra, Java, and Kalimantan. As the fisheries in these areas have been overexploited, the greatest pressure now has moved east of Sulawesi to Nusa Tenggara, Banda, Maluku, and Papua. In 2020, there were approximately 159 417 non-powered boats, 503 955 outboard motors, and 497 960 inboard motors used for marine fishing in Indonesia (MMAF, 2022a). Based on size, the boats are divided into eight categories (Table 11). The majority of fishing trips in Indonesia are made by small-scale fishermen going out and returning on a daily basis. There are also large-scale or industrial fishing vessels, which most frequently land their catch in the major fishing ports of Jakarta, Benoa Bali, Makassar, Kendari, Sorong, and Probolinggo.

Table 11. The number of Indonesian inboard engine fishing vessels by size (2015 – 2020)

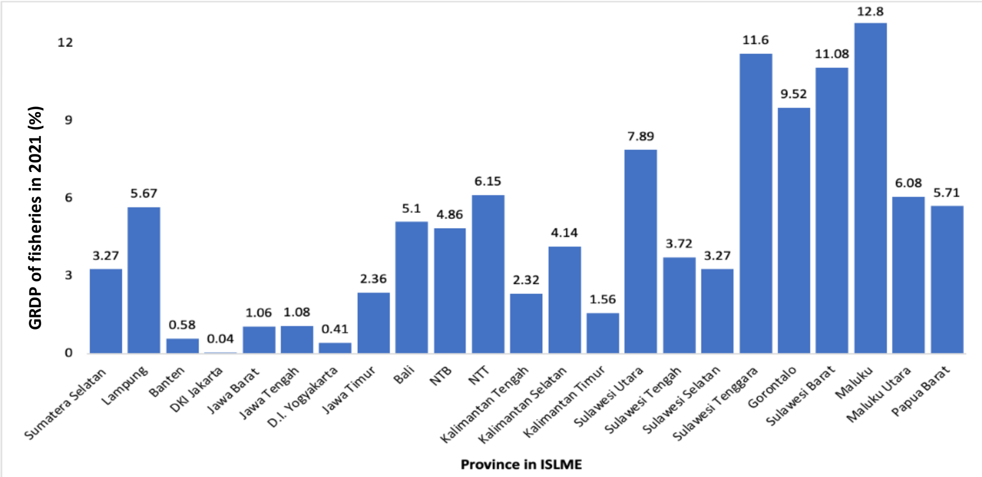
Size of Boat	Year					
	2015	2016	2017	2018	2019	2020
< 5 GT	117 848	115 814	116 604	184 035	201 924	388 618
5–10 GT	39 429	35 988	36 233	42 183	70 886	64 708
10–20 GT	10 515	9 790	9 857	11 900	22 200	21 589
20–30 GT	7 680	6 481	6 525	9 449	16 964	17 652
30–50 GT	825	805	810	1 061	1 130	975
50–100 GT	1 435	2 008	2 022	2 510	2 050	2 786
100 –200 GT	571	847	853	1 300	1 126	1 626
>200 GT	9	11	11	11	7	16

Source: PUSDATIN. 2020a. Jumlah Kapal (number of vessels). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=kapal&i=5

FAO's Division of Statistics and Information Department notes that Indonesian waters lie within Area 57 in the East Indian Ocean and Area 71 in the West Central Pacific Ocean in the Western Indo-Pacific region. The FMA numbering follows Area 71 with a consecutive local code from number 1 onwards, starting from west to east for regional Area 57 according to the international coordinate system. Area 71 starts from the South China Sea, Java Sea, Makassar Strait, Banda Sea, Seram Sea, Sulawesi Sea, Pacific Ocean, and Arafura Sea. The main fisheries in Area 57 are shad, catfish, pony fish, croakers, mullets, carangids, sardines, anchovies, tuna and tuna-like species, mackerel, sharks, prawns, prawns, lobsters, cockles, and cephalopods. Area 71 is dominated by regions with a wide continental shelf starting from Viet Nam and Thailand in the west and descending through Malaysia, Western Indonesia, and ultimately the Java Sea, and includes Eastern Indonesia, Papua New Guinea, and Australia. This area has many demersal resources, including high-value penaeid shrimp and small pelagic resources. The offshore waters host high-value tuna stocks. The most common fishing gear used is handline, followed by the gillnet.

Based on MMAF statistics with values for 2020, the ISLME area consisted of 209 districts (including municipalities) in 21 provinces and produced a total of 4 154 706 tonnes of seafood with an estimated value of IDR 123 252 507 million. The statistics show that 1 038 larger vessels (size >30 GT) operate in FMA 712, FMA 713, FMA 714, and FMA 715, and the government-issued fishing license or *Surat Izin Penangkapan Ikan* (SIPI) allows each fishing vessel to operate in two FMAs. Fisheries is a major local economic activity, especially in the central and eastern provinces of the ISLME contributing more than 10 percent to the GRDP in Southeast Sulawesi, West Sulawesi, and Maluku provinces. There are ten provinces in the ISLME region where the fisheries sector contributes more than 5 percent to GRDP in 2021: Lampung, Bali, NTT, North Sulawesi, Southeast Sulawesi, Gorontalo, West Sulawesi, Maluku, North Maluku, and West Papua (Figure 39).

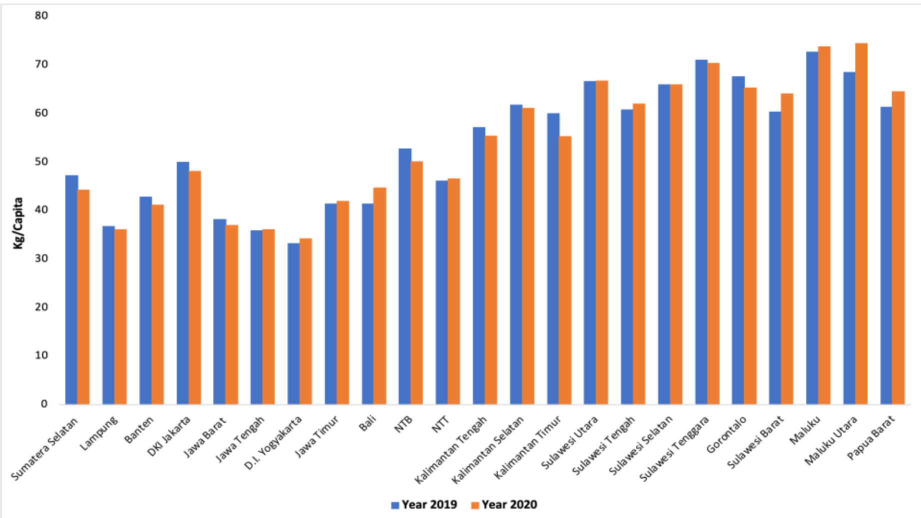
Figure 39. Fishery sector contribution to the gross regional domestic product for Indonesian provinces in the ISLME for 2021



Source: PUSDATIN. 2022d. Persentase Kontribusi PDRB Perikanan terhadap PDB Indonesia per provinsi (percentage of fisheries gross regional domestic product contribution to Indonesia GDP). [Cited 22 August 2023]. statistik.kkp.go.id/home.php?m=pdb&i=415#panel-footer-kpda

Fish consumption is also highest in the central and eastern provinces of the ISLME. In the ISLME area from 2019 to 2020, the average per capita fish consumption varied significantly from a low of 33.35 kg in D.I. Yogyakarta Province to a high in North Maluku of 77.49 kg (Figure 40). The government, through the MMAF, intends to set an annual target of target of 62.5 kg/capita for fish consumption in 2024. To meet the National Maternal Mortality Rate (MMR) target, the MMAF Directorate General for Increasing Competitiveness of Marine and Fishery Products/*Direktorat Jenderal Penguatan Daya Saing Produk Kelautan dan Perikanan* (PDSKP) continues to activate the *Gemar makan Ikan* campaign in 34 provinces, focusing on malnutrition and stunting-prone areas.

Figure 40. Average annual fish consumption per province in Indonesia of the ISLME region



Source: PUSDATIN. 2022e. Fish consumption [Cited 22 August 2023]. AKI - Angka Konsunsi Ikan (kkp.go.id)

There are noticeable differences between the fisheries in the FMAs. FMA 712 produced the highest total tonnage of catch contributing nearly 16 percent to the total national production; however, it is a relatively small FMA. FMA 712 also boasts the highest number of fishing ports, which may partially explain the high reported catches. The lowest production in the ISLME was observed in FMA 713 contributing 7.7 percent to the overall national fisheries production, even though this FMA reports the highest relative number of fishing gear.

Fisheries in FMA 573

According to MMAF Regulation No. 18 of 2014 on Fisheries Management Areas in Indonesia, FMA 573 is a small and large pelagic fishing area that covers the waters of the Indian Ocean from the south of Java to the south of Nusa Tenggara, Savu Sea, and the West Timor Sea, including eight provinces, namely Banten, West Java, Central Java, DI Yogyakarta, East Java, Bali, NTB and NTT, covering an area of 96 448 793 ha. The fisheries production in FMA 573 increased from 2017 (559 739 tonnes) to 2018 (653 051 tonnes). There are 707 853 fishermen and 90 fishing ports in FMA 573 (MMAF Decree No. 109 /2021). The estimated fish resource potential of FMA 573 is 1 338 442 tonnes/year. However, only a small part of FMA 573 is included in the ISLME area. The annual production trend in FMA 573 is shown in Table 12.

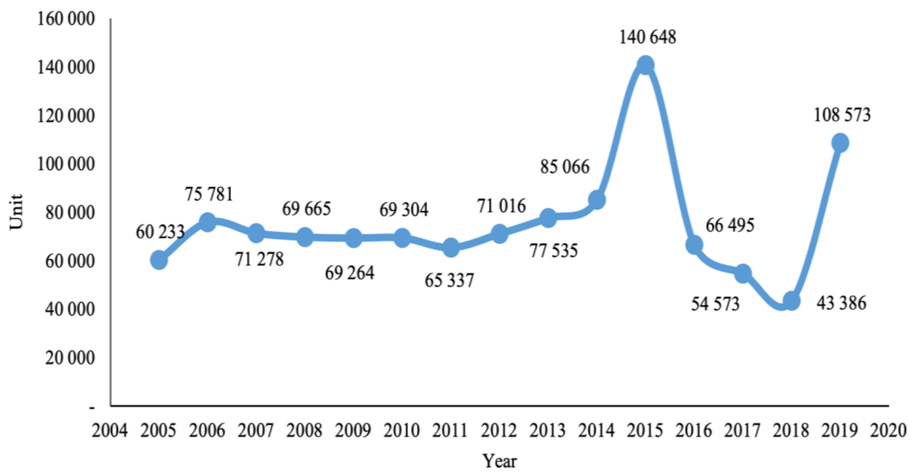
Table 12. Annual fish production in FMA 573

Year	Fish Production (tonnes)
2017	559 734
2018	653 051
2019	592 161
2020	538 551

Source: PUSDATIN. 2022b. Produksi Perikanan (Fish Production), recalculated for provinces in FMA 573. [Cited 22 August 2023]. [Produksi Perikanan (kkp.go.id)]

The catches of pelagic fish in FMA 573 include skipjack tuna (*Katsuwonus pelamis*), lemuru fish *(Sardinella lemuru*), *scad* (*Decapterus* spp.), yellowfin tuna (*Thunnus albacares*), and Eastern little tuna (*Euthynnus* sp.). According to data from the MoEF and MMAF, published on the MMAF Directorate of Conservation and Marine Biodiversity website, only 7.1 percent of the coral ecosystem area in FMA 573 has been protected in 2010. Moreover, the protected mangrove habitat in this area accounts for 17.8 percent of the total. According to data from the MMAF (Pusdatin, 2020a) the majority of fishing vessels in FMA 573 in 2019 were motorboats, making up 58.3 percent of the total. This was because many fishermen in the southern coastal areas of West Nusa Tenggara, East Nusa Tenggara, Bali, and Java use small boats with a gross tonnage of less than 5 GT to fish in the Indian Ocean south of Java, south of Nusa Tenggara, Savu Sea, and West Timor Sea. Figure 41 shows the overall number of fishing vessels that operate in the FMA 573.

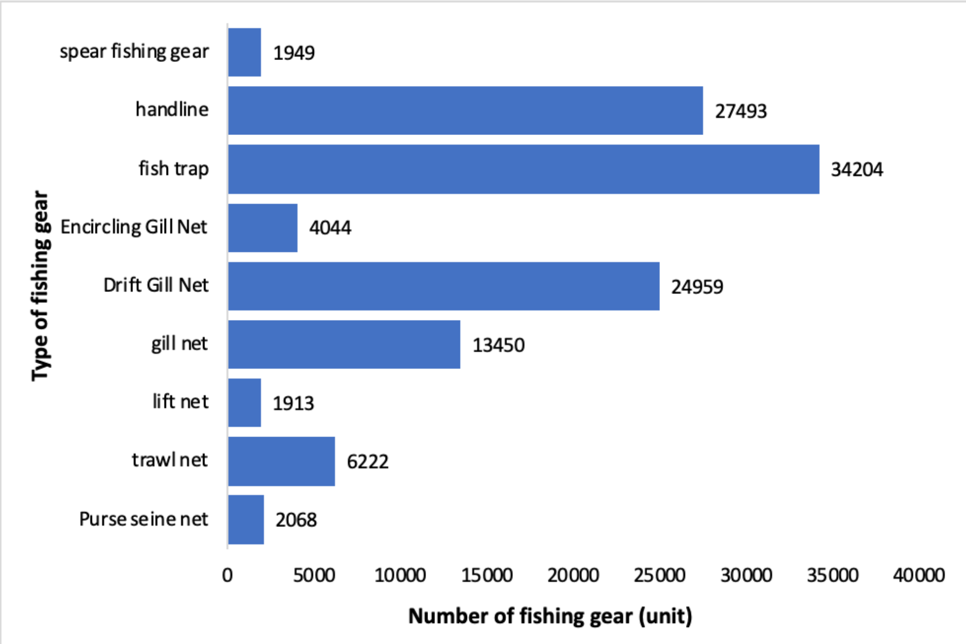
Figure 41. Total number of fishing vessels operating in FMA 573 (2005–2019)



Source: PUSDATIN (Pusat Data dan Teknologi Informasi). 2020a. Jumlah Kapal (Number of vessels). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=kapal&i=5#panel-footer-kpda

The MMAF Regulation No. 18 of 2021 outlines regulations related to fishing gear and fishing lanes in FMA 573. The regulation permits the use of certain types of fishing gear with specifications and prohibits others. The information on the breakdown of the types of fishing gear that are permitted in FMA 573, as per the regulation can be seen in Figure 42. Every fishing device used in FMA 573 must have a defined operational zone (*jalur*), according to Regulation No. 18 of 2021. Fishing routes IB, II, and III can be used with the majority of fishing equipment. Fishing zone IB covers waters that are up to four nautical miles from the shoreline out to open sea or island waters; fishing zone II covers waters that are up to 12 nautical miles outside of fishing route IB; and fishing zone III includes all other waters, including Indonesia's EEZ. Fish traps are the most common fishing gear in FMA 573 and can be utilized in fishing zones IA, IB, II, and III, except in open sea areas. Additionally, handline fishing equipment can be used in fishing zones II, III, and the open sea. The segmentation of fishing zones is done to make the fishing process more measurable while still considering the ecosystem of the fishing grounds.

Figure 42. Composition of fishing gear in FMA 573



Source: PUSDATIN. 2020b. Jumlah Kapal (Number of vessels). Retrieved from https://statistik.kkp.go.id/home.php?m=kapal&i=5#panel-footer-kpda

Fisheries in FMA 712

FMA 712 is an area that covers the waters of the Java Sea and measures 41 746 572 ha. It also includes seven provinces, namely Lampung, Banten, DKI Jakarta, West Java, Central of Java, East Java, Central Kalimantan, and South Kalimantan (MMAF, 2020c). FMA 712 has 184 fisheries ports with 89 311 fishers. The fisheries production in FMA 712 has decreased from 1 319 714 tonnes in 2016 to 1 086 135 tonnes in 2019. The decrease of fisheries production is likely because of the overfishing there. The estimated fish resources potential in FMA 712 is 1 034 485 tonnes/year. The annual fish production trend in FMA 712 is listed in Table 13.

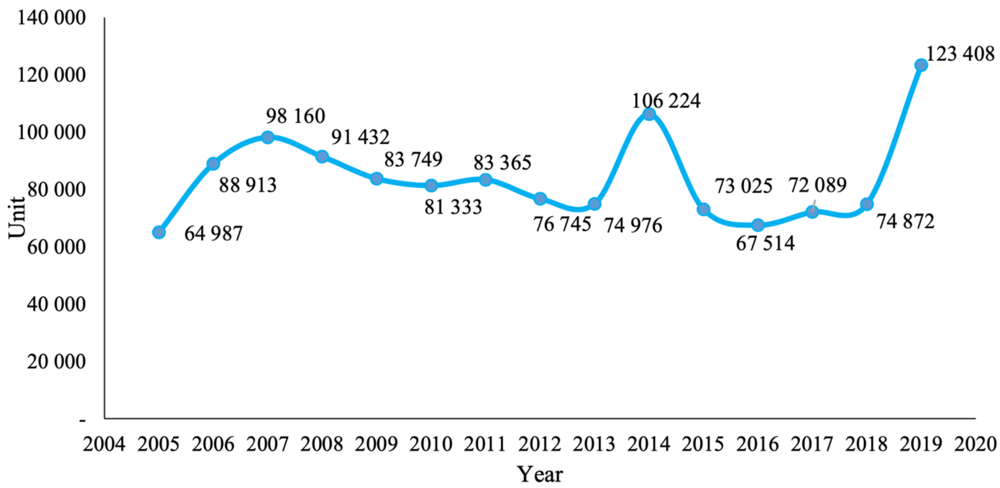
Table 13. Annual fish production in FMA 712

Year	Fish production (tonnes)
2017	1 024 985
2018	1 177 030
2019	1 086 135
2020	1 130 106

Source: PUSDATIN. 2022b. Produksi Perikanan (Fish Production), recalculated for provinces in FMA 712. [Cited 22 August 2023]. Produksi Perikanan (kkp.go.id)

The main catches of small pelagic fish in FMA 712 include sardine (*Sardinella)*, mackerel fish (*Rastrelliger* sp), and mackerel scad (*Decapterus* spp). Based on the data regarding the national capture fisheries of the MMAF, the number of fishing vessels in the Java Sea (FMA 712) in 2019 was dominated by motorboats (61.8 percent). This was because in conducting their fishing activities in the Java Sea, many fishers switched to using modified engines from land transports on boats below 5 GT. The overall number of fishing vessels operating in the FMA 712 is presented in Figure 43.

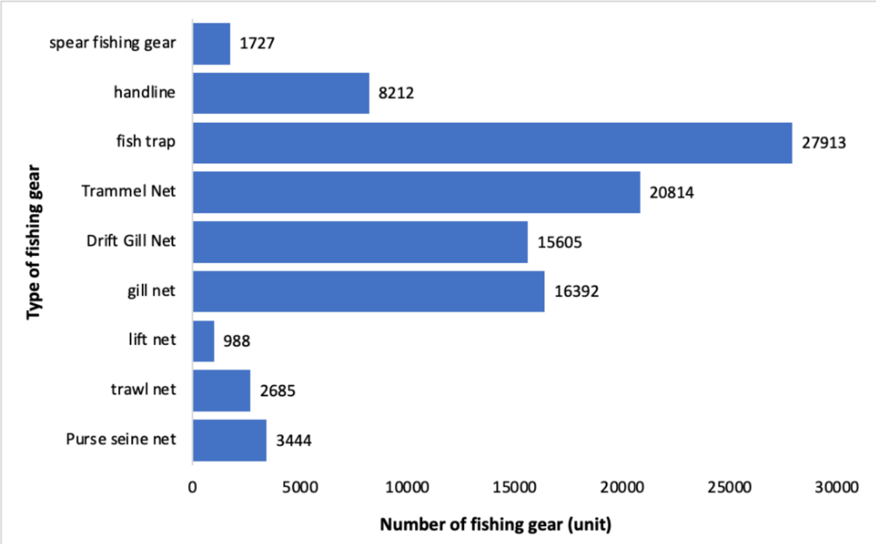
Figure 43. Total number of fishing vessels operating in FMA 712 (2005–2019)



Source: PUSDATIN. 2020a. Jumlah Kapal (number of vessels). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=kapal&i=5#panel-footer-kpda

Based on the MMAF Regulation No.18 of 2021 on the Fishing Lane and Fishing Gear in FMA 712 (MMAF, 2021a), there are several types of fishing gear that can be used with certain size specifications and there are some that are prohibited. The information on the composition of the types of fishing gear in the FMA 712 is as presented in Figure 44. FMA 712 fishing gear may normally be operated in fishing zones IB, II, and III. Gillnets, on the other hand, can only be used in fishing zone II, which includes waters up to 12 nautical miles beyond fishing zone IB. According to MMAF Regulation No.18 of 2021 (MMAF, 2021a), fish traps can only be used in fishing zones II and III. This segmentation of fishing zones is intended to make the fishing process more measurable and environmentally sustainable.

Figure 44. Composition of fishing gear in FMA 712



Source: PUSDATIN. 2020b. Jumlah Kapal (number of vessels). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=kapal&i=5#panel-footer-kpda

Fisheries in FMA 713

FMA 713 is an important fishing region in Indonesia that encompasses the Makassar Strait, Bone Bay, Flores Sea, and Bali Sea (MMAF, 2020b). The estimated potential of fish resources in this area is 1 073 147 tonnes per year, which is a significant amount. However, to ensure the sustainability of the fisheries businesses in the future, this high potential needs to be managed continuously in accordance with the principles of the ecosystem approach. The waters of FMA 713 cover a total area of 48 118 622 ha, and their fish resources are managed by ten provinces, namely East Java, Bali, South Kalimantan, East Kalimantan, West Nusa Tenggara, East Nusa Tenggara, West Sulawesi, South Sulawesi, Central Sulawesi, and Southeast Sulawesi. The primary sea products of that region include small pelagic fish, large pelagic fish (excluding skipjack tuna), demersal fish, reef fish, penaeid shrimp, lobster, crab, blue swimming crab, and squid. The annual fish production in FMA 713 is listed in Table 14.

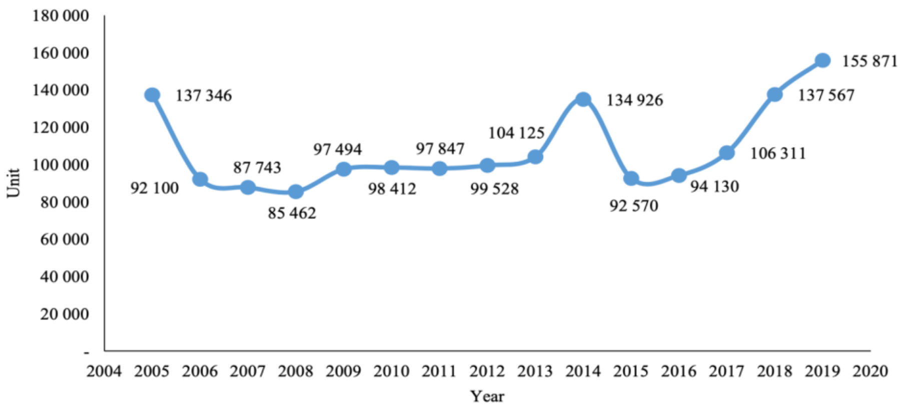
Table 14. Annual fish production in FMA 713

Year	Fish production (tonnes)
2017	500 775
2018	699 491
2019	808 007
2020	824 521

Source: PUSDATIN. 2022b. Produksi Perikanan (Fish Production), recalculated for provinces in FMA 713. [Cited 22 August 2023]. Produksi Perikanan (kkp.go.id)

The predominant catch of large pelagic fish in FMA 713 during 2019 consisted of skipjack tuna (*Katsuwonus pelamis*), tuna (*Thunnus tonggol, Euthynnus affinis, Auxis thazard, A. rochei, Thunnus albacares*), and Spanish mackerel (*Scomberomorus commersonii*). On the other hand, the small pelagic fish catch in FMA 713 during the same year was dominated by the species of gold stripe sardinella (*Sardinella gibbosa*), mackerels (*Rastrelliger* spp), scads (*Decapterus* spp), yellowstripe scads (*Selaroides leptolepis*), and anchovies (*Stolephorus* spp). According to the national statistics data from the MMAF, in 2019, outboard motorboats (45.3 percent) and motorboats (44.5 percent) were the most commonly used fishing vessels in FMA 713. Table 45 presents the overall number of fishing vessels that operate within FMA 713.

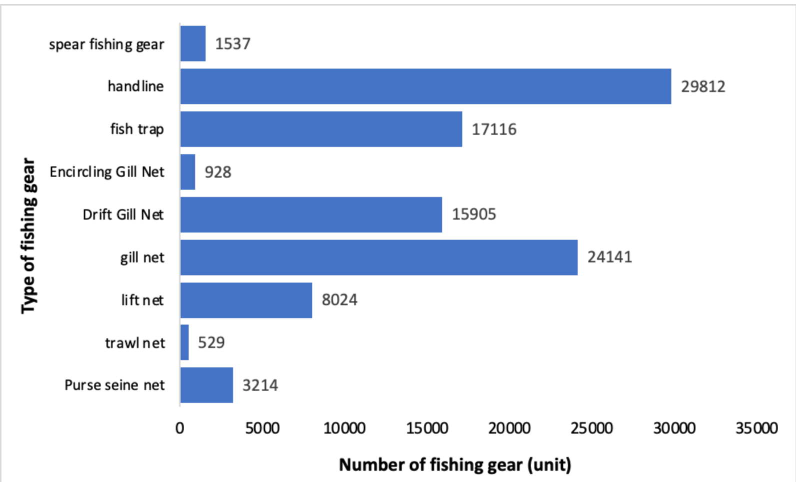
Figure 45. Total number of fishing vessels operating in FMA 713 (2005-2019)



Source: PUSDATIN. 2020a. Jumlah Kapal (number of vessels). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=kapal&i=5#panel-footer-kpda

The fishing lane and fishing gear regulations for FMA 713, as outlined in MMAF Regulation No. 18 of 2021, specify certain allowable and prohibited fishing gear with certain specifications. Table 46 provides information on the types of fishing gear present in FMA 713, with hooks and lines being the most dominant group at 147 102 units, followed by gillnets at 62 619 units. Fishing gear uses in FMA 713 also has specified operating zones, according to Government Regulation No. 18 of 2021 on the placement of fishing gear and fishing assistance tools in the FMAs and the arrangement of fishing grounds. This method is intended to support quota-based fisheries management while also preserving aquatic ecology. The majority of fishing gear in FMA 713 can be used in fishing zones II and III.

Figure 46. Composition of fishing gear in FMA 713



Source: PUSDATIN. 2020a. Jumlah Kapal (number of vessels). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=kapal&i=5#panel-footer-kpda

Fisheries in FMA 714

According to MMAF Regulation No. 81 of 2016 on Fisheries Management Plan for FMA 714, FMA 714 covers the waters of Tolo Bay and Banda Sea shared by five provinces, namely, East Nusa Tenggara, Southeast Sulawesi, Central Sulawesi, Maluku and North Maluku with an area of 66 248 430 ha. The potential stock of fish resources that can be utilized sustainably in FMA 714 is estimated to reach 1 033 979 tonnes/year (MMAF, 2022c). In 2019, approximately 631 782 tonnes or 80 percent of the potential has been utilized. Fish catches were dominated by large pelagic, small pelagic and reef fish groups. Ecologically, Banda Sea and Tolo Sea have a very high marine biodiversity and have a variety of unique fish resource habitats. Currently, there are about 25 marine protected areas in FMA 714 designed to support the supply of fish for consumption, including the protection for spawning and nursery habitats. The annual production of fish in FMA 714 is as listed in Table 15.

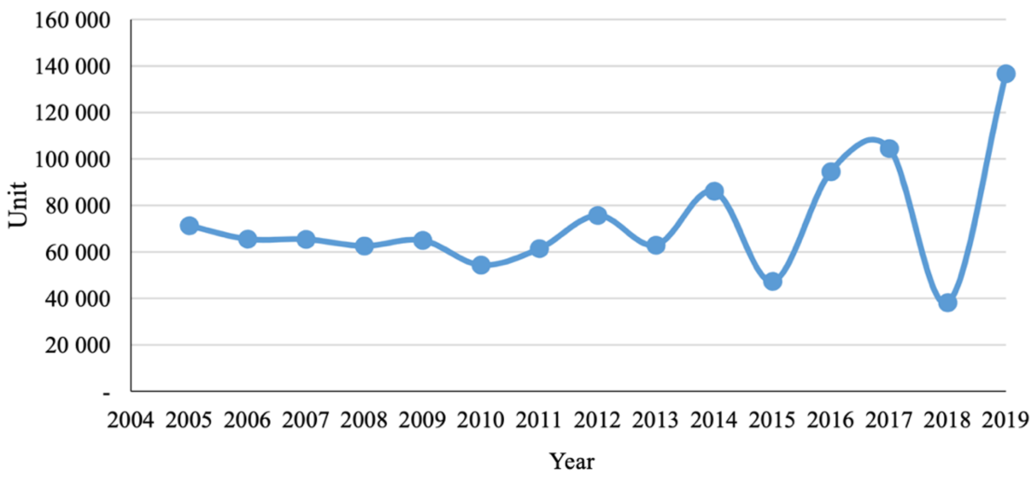
Table 15. Annual production of fish in FMA 714

Year	Fish production (tonnes)
2017	812 033
2018	764 021
2019	630 596
2020	569 819

Source: PUSDATIN. 2022b. Produksi Perikanan (Fish Production), recalculated for provinces in FMA 714. [Cited 22 August 2023]. [Produksi Perikanan (kkp.go.id)]

In 2019, the catch of large pelagic fish in FMA 714 was mainly skipjack tuna (*Katsuwonus pelamis*), tuna (*Thunnus tonggol, Euthynnus affinis, Auxis thazard, A. rochei, Thunnus albacares, Thunnus obesus*), and Spanish mackerel (*Scomberomorus commersonii*). Small pelagic fish, on the other hand, were dominated by scads (*Decapterus* spp.), mackerels (*Rastrelliger* spp.), goldstripe sardinella (*Sardinella gibbosa*), and anchovies (*Stolephorus* spp). In the reef fish group, rabbitfish (*Siganus* spp.), red snapper (*Lutjanus* spp.), browncross rockcod (*Cephalopholis boenak, C. argus*), leopard coral grouper (*Plectropomus leopardus*), and yellowtail fusilier (*Caesio cuning, C. teres*) were the most commonly caught species in FMA 714 in 2019. Based on the national statistics data from the MMAF, the number of fishing vessels in the FMA 714 in 2019 was dominated by non-motorized boats (36.6 percent) and outboard motorboats (35.2 percent). The overall number of fishing vessels operating in the FMA 714 is presented in Figure 47.

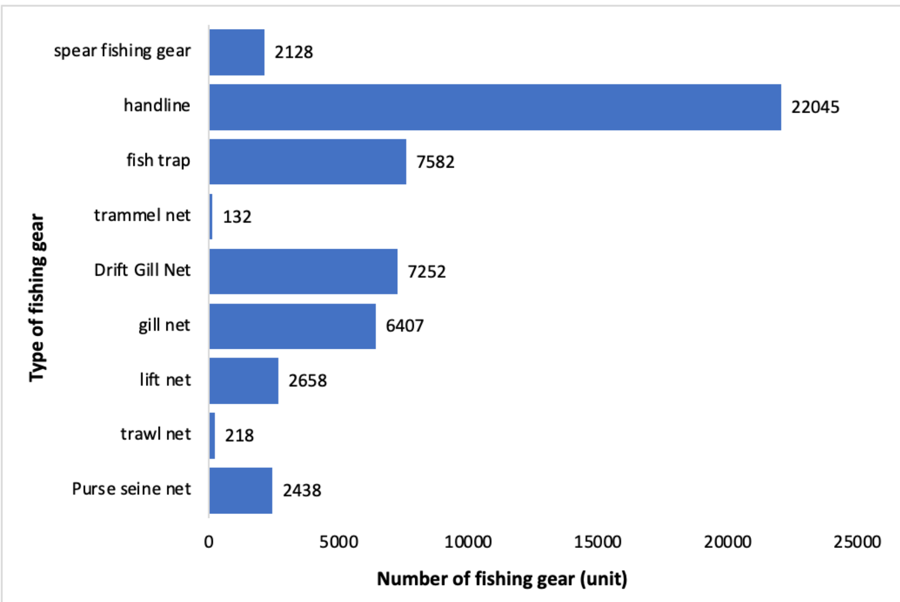
Figure 47. Total number of fishing vessels operating in FMA 714 (2005–2019)



Source: PUSDATIN. 2020a. Jumlah Kapal (number of vessels). [Cited 22 August 2023] https://statistik.kkp.go.id/home.php?m=kapal&i=5#panel-footer-kpda

The dominant groups of fishing gear in FMA 714 were handline, set gillnet, troll line, drift gillnet, and pot. FMA 714 is dominated by islands, therefore hooks and lines and gillnets are used predominantly. This type of fishing gear is typically used by small-scale fisheries that use fishing vessels with boats less than 1 GT and one to two people per boat. The information of the types of fishing gear in the FMA 714 is presented in Figure 48.

Figure 48. Composition of fishing gear in FMA 714



Source: PUSDATIN. 2020a. Jumlah Kapal (number of vessels). [Cited 22 August 2023] https://statistik.kkp.go.id/home.php?m=kapal&i=5#panel-footer-kpda

According to MMAF Regulation No. 18 of 2021, the majority of the fishing equipment used in FMA 714 should be handlines, which is employed in Fishing zones IA, IB, II, and III, with the exception of open sea areas. The small amount of trawl gear in use indicates how rigorously forbidden their use is in FMA 714. Meanwhile, most purse seine and gill net gear is used in fishing zone III. The purpose of this rule is to maintain sustainable and responsible fishing activities while protecting the marine ecology.

Fisheries in FMA 715

FMA 715, which covers Tomini Bay, the Maluku Sea, Halmahera Sea, Seram Sea, and Berau Bay, is one of the areas for catching reef fish, small pelagic fish, and providing bait fish for the main tuna fishery in Indonesia. The estimated potential fish resources in FMA 715 is 715 293 tonnes per year. Administratively, there are six provinces responsible for managing fish resources in FMA 715, namely North Sulawesi, Gorontalo, Central Sulawesi, Maluku, North Maluku, and West Papua. The waters of FMA 715 cover a total area of 47 468 479 ha. FMA 715 has 35 fisheries ports with 195 486 fishermen. The annual fisheries production in FMA 715 decreased from 870 160 tonnes in 2017 to 812 888 tonnes in 2019. The decrease in annual fisheries production is probably a result of the overfishing there. The annual production of fish in FMA 715 is as listed in Table 16.

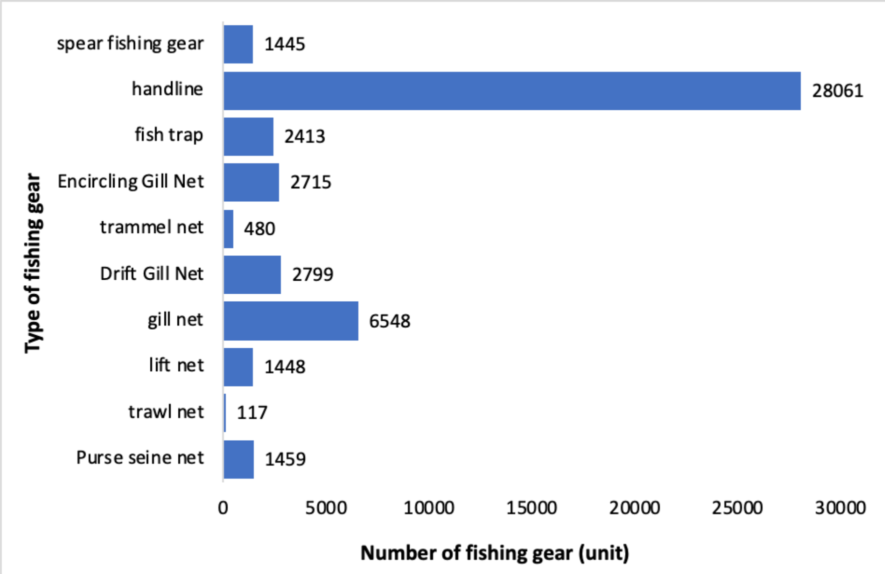
Table 16. Annual production of fish in FMA 715

Year	Fish production (tonnes)
2017	870 160
2018	792 353
2019	812 888
2020	782 279

Source: PUSDATIN. 2022b. Produksi Perikanan (Fish Production), recalculated for provinces in FMA 715. [Cited 22 August 2023]. Produksi Perikanan (kkp.go.id)

The dominant groups of fishing gear in FMA 715 were purse seine net, trawl net, lift net, gill net, fish trap, handline, and spear fishing gear (Figure 49). The priority-managed fish species include mackerel, skipjack tuna, anchovies, yellowfin tuna (*Thunnus albacares*) and mackerel scad. Handline is the dominant fishing gear in FMA 715 and it is commonly used in fishing zone III. Fishing zone III includes the waters outside of fishing zones I and II, as well as Indonesia's EEZ. Trawl gear with a mouth opening length of 2.5 m and a height of 0.5 m were permitted under MMAF Regulation No. 18 of 2021. Trawl gear is in use in fishing zones IB and II. No current data on fishing vessel numbers were available for this FMA.

Figure 49. Composition of fishing gear in FMA 715



Source: PUSDATIN. 2022b. Produksi Perikanan (Fish production). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=prod_ikan_prov&i=2

Generally, based on the MMAF Decree No. 19 of 2022 regarding Estimated fisheries resources, Total Allowable Catch and Level of Utilization in Indonesia FMAs of the ISLME region is presented in Table 17. Table 17 provides information on the maximum sustainable yield in tonnes, total allowable catch in tonnes, and utilization rate. The utilization rate is typically used to determine whether an area falls under the categories of underexploited, exploited, or fully exploited. Within the FMA ISLME region, the table shows that large pelagic fish, penaeid shrimp, lobster, and blue swimming crab have already reached the status of being fully exploited (0.5 < E < 1) and overexploited (E>=1), with reef fish seriously overexploited. Therefore, fishing efforts must be reduced in order to create sustainable fisheries resources.

Table 17. Estimation of selected fisheries resources potential in the fishery management areas of the Indonesian Seas Large Marine Ecosystem

Fisheries management area		Small pelagic	Large pelagic	Demersal fish	Reef fish	Penaeid shrimp	Lobster	Crab	Small crab	Squid
FMA 573*	MSY	624 366	354 215	299.60	23 725	8 524	1 563	585	3.75	22 124
	TAC	437 056	247 95	269.64	11 863	4 257	782	410	2 625	11 062
	Utilization rate	0.6	0.9	0.2	2.5	1.2	2.0	0.7	0.6	1.1
FMA 712	MSY	275 486	145 863	358 832	71 526	83 820	1 481	7 360	23 508	66 609
	TAC	247 937	72 932	179 416	57 221	58 674	1 037	5 152	16 456	46 626
	Utilization rate	0.4	1.3	1.1	0.8	0.8	0.5	0.9	0.7	0.9
FMA 713	MSY	284 302	162 506	374 500	167 403	56 835	765	6 213	9 253	11 370
	TAC	142 151	113 754	337 050	83 702	39 785	383	4 349	4 627	5 685
	Utilization rate	1.0	0.8	0.3	1.3	0.8	1.3	0.7	1.5	1.2
FMA 714	MSY	222 881	370 653	292	121 326	6 472	724	1 758	4 705	13 460
	TAC	156 017	259 457	204 400	60 663	3 236	362	879	3 294	9 422
	Utilization rate	0.7	0.7	0.7	1.1	1.0	1.7	1.4	0.6	0.5
FMA 715	MSY	443 944	74 908	80 226	105 336	5 295	1 217	336	157	3 874
	TAC	310 761	52 436	56 158	52 668	3 707	609	235	110	2 712
	Utilization rate	0.7	0.7	0.7	1.3	0.7	1.2	0.7	0.7	0.9

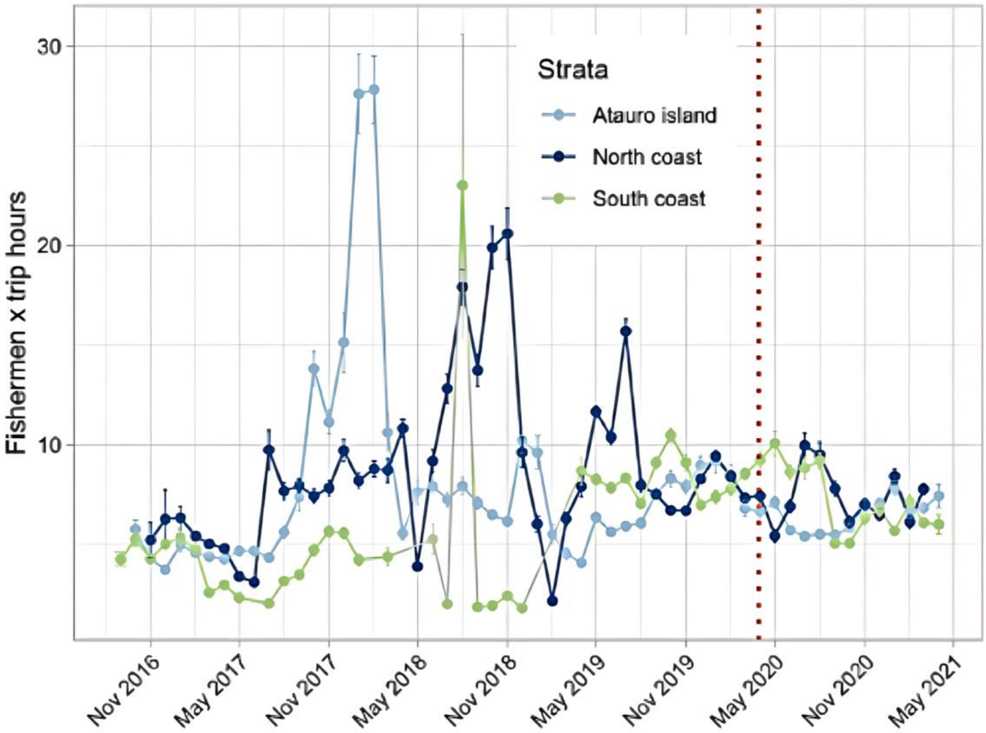
Note: *Complete data of FMA 573, but only a small part of FMA 573 contributes to ISLME.
Source: MMAF Decree No. 19 of 2022 on Estimated fisheries resources, Total Allowable Catch and Level of Utilization in Indonesia FMAs. Jakarta. 1670571648kepmen-kp-no.pdf (riau.go.id)

Timor-Leste marine capture fisheries

Fisheries in Timor-Leste is dominated and made up of subsistence and artisanal fisheries. The fish production is relatively low, ranging from 10 kg to 15 kg each trip. The fishing gear materials are limited to gill nets and hook and lines. Small canoes are the main fishing fleet and mostly non-motorized. The fishing activities are mostly done in shallow waters located approximately 2 km away from the coast. The fishing trip is varied, depending on monsoon and ocean conditions. However, the fishing efforts or fishing hours alongside Bobonaro, Liquiça, Dili, including Ataúro Island are relatively similar. Fishing effort observed during 2016 to 2021 by Veillat (2021) confirmed that trip effort on the northern and southern coasts mostly ranges from two to ten fisher-hours.

Fish catch in each municipality on the northern coast is sold in each fish landing centre. The number of fish trips on the north coast is higher than that of the south. The difference is caused primarily by a clear pattern of seasonality. The long dry season (approximately seven to nine months) and less rough seas in the north coast allows fishers to do more trips that than the fishers in the south coast.

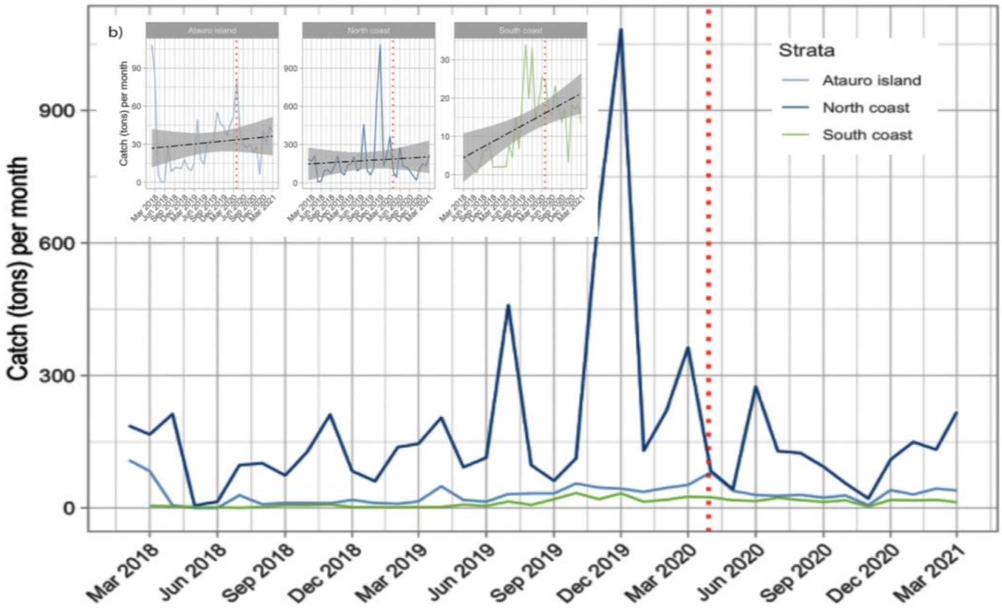
Figure 50. Fishing effort in the Ataúro, northern and southern coasts of Timor-Leste



Note: The fish trips on the northern coast are shown in dark blue, those for the south coast in green, and trip effort (fishermen × trip hours) in Ataúro Island are depicted in light blue.
Source: Veillat, J.S. 2021. *The small-scale fisheries of Timor-Leste and the impacts of the COVID-19 pandemic.* University of Bergen, Norway (master thesis). [Cited 23 October 2023]. https://hdl.handle.net/11250/2985128

Table 51 shows the mean effort (fishermen × trip hours) of various fishing trips in Timor-Leste for the period of September 2016 to March 2021.

Figure 51. Total monthly catch estimated in different locations: Ataúro Island, north and south coast of Timor-Leste

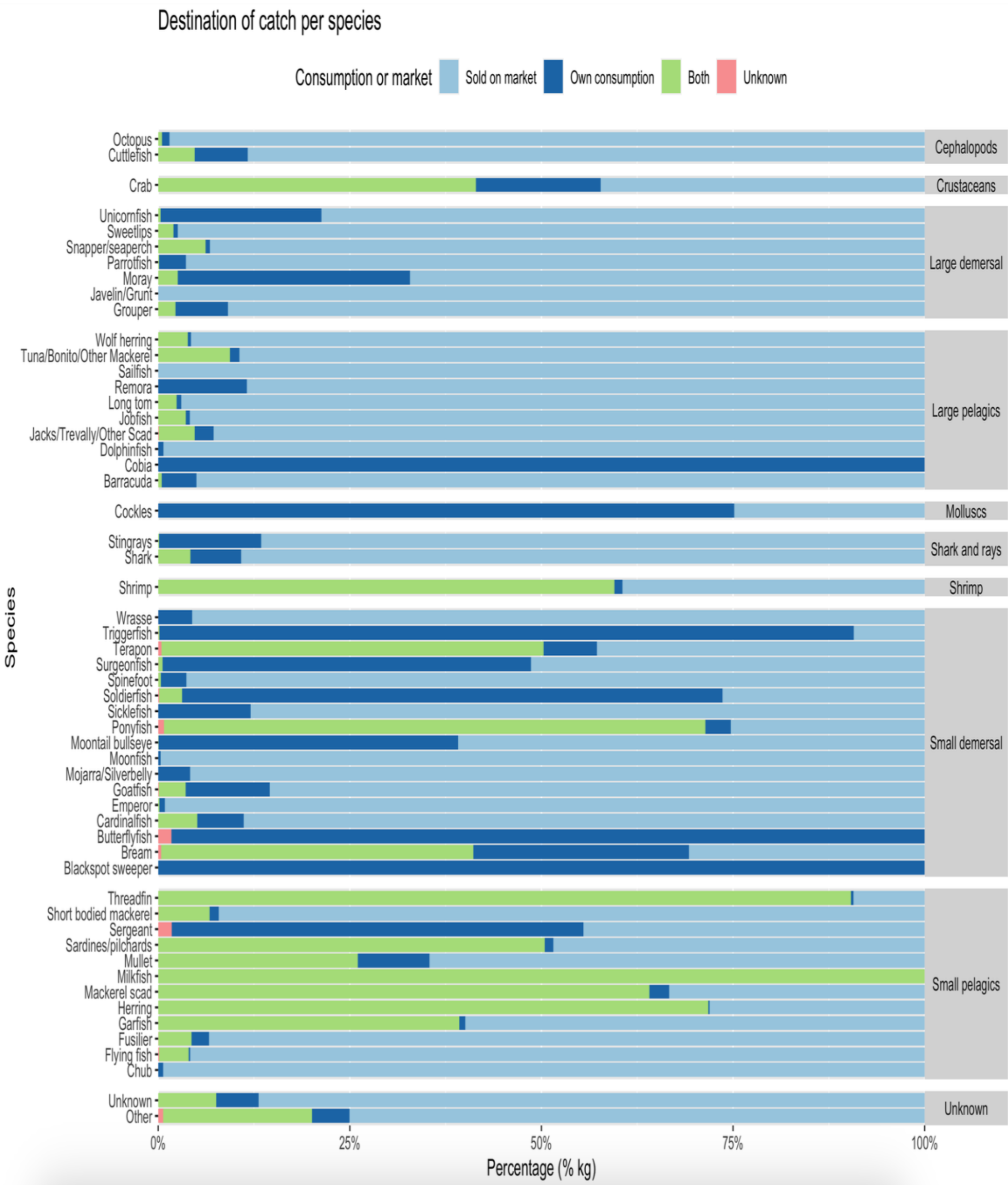


Notes: (a) Both sets of data are combined in a single plot, and (b) they are also presented separately. The dashed line represents the linear regression with 95 percent confidence intervals. Additionally, the dotted red line marks the commencement of the COVID-19 lockdown on 28 March 2020.

Source: Veillat, J.S. 2021. *The small-scale fisheries of Timor-Leste and the impacts of the COVID-19 pandemic.* University of Bergen, Norway (master thesis). [Cited 23 October 2023]. https://hdl.handle.net/11250/2985128

Most of the fish captured on the northern coast are sold at local markets and through intermediaries. This is because the fishermen are constrained by extra costs if they want to sell their fish in Dili, and there is also the problem of fish quality. For instance, the fishermen have limited ice to conserve their fish and to transport and sell to long distances. The fish product from each place differs depending on the type of equipment used and fishermen's skills and knowledge. Figure 52 shows different fish products sold and used for family consumption between 2016 and 2021. As the fish price is dependent on demand, abundant fish products with low demand will mean low prices. If for whatever reason, fishermen are unable to sell all their products, they will keep a small portion for domestic consumption.

Figure 52. The destination of catch per species in Timor-Leste



Source: Veillat, J.S. 2021. *The small-scale fisheries of Timor-Leste and the impacts of the COVID-19 pandemic.* University of Bergen, Norway (master thesis). [Cited 23 October 2023]. https://hdl.handle.net/11250/2985128

Fishermen primarily catch small pelagic fish species, alongside Batugade on the border of Atambua, Liquiça, Dili, and Ataúro. The small pelagic fish offer essential support to coastal communities in terms of cash income and nutritional security. This pelagic fishery is unregulated on the border between Indonesia and Timor-Leste. This can develop into a potential issue in the near future in terms of fish resource degradation and more importantly in relation to socioeconomic and security problems. As a result, proper fisheries management on the transboundary between Indonesia and Timor-Leste needs to be established. The small pelagic fisheries on the border require collective cooperation particularly on the Ombai Strait, Liran, and Wetar, which are situated close to Ataúro Island.

Cultural connectivity on the border between Indonesia and Timor-Leste needs to be considered. This is to facilitate not only fisheries management but also economic activities. People on the border (from both countries) have strong family relationships. Moreover, Indonesia and Timor-Leste have similar landscape characteristics, as well as similar socioeconomic conditions. Considering the similarities between people and socioeconomic conditions, transboundary fishing and trade policies need to be implemented collectively to manage marine and coastal resources to secure the sustainability of the fish industry while promoting ecosystem sustainability (Partelow *et al.*, 2020).

2.3.2 Small-scale and artisanal fisheries

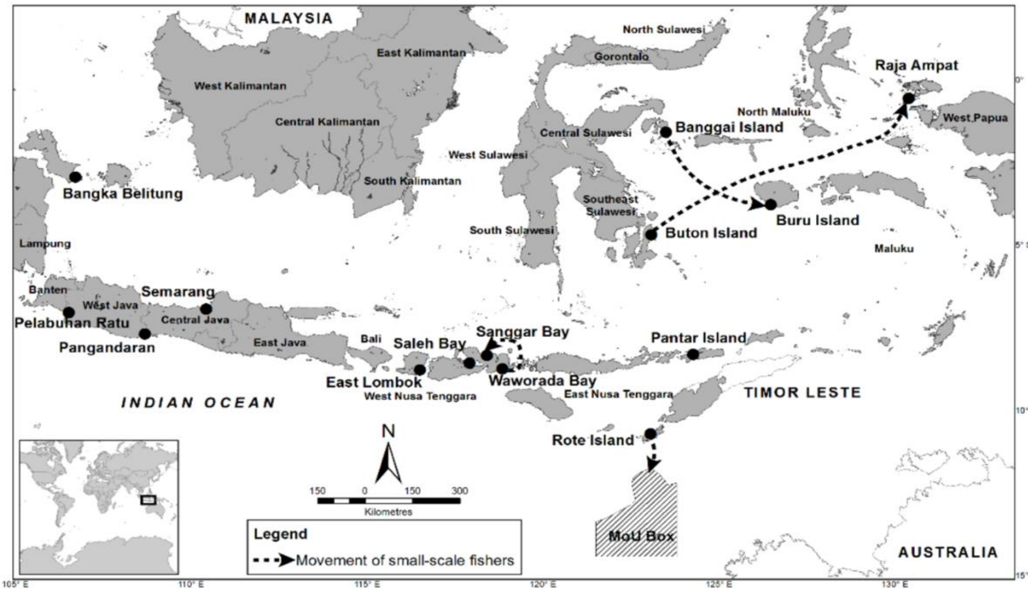
Indonesia's small-scale and artisanal fisheries

Small-scale fisheries are significantly important in Indonesia for livelihoods, protein supplementation in local diets, and contributing to Indonesia's seafood export market. Of the more than 2.2 million fishers in Indonesia, 95 percent are in the small-scale fisheries sector. The majority of these fishers are unlicensed and still use small boats (many without motors) and traditional equipment. Through direct and indirect employment, nearly 7 million people are involved in fisheries-related jobs in Indonesia. Law No. 7 of 2016 regarding the Protection and Empowerment of Fishermen, Fish Cultivators, and Salt Farmers defines small-scale fisheries as fishermen who engage in fishing to meet their daily needs, both those who do not use fishing vessels and those who use fishing vessels with a maximum size of 10 GT.

Detailed data on the number of fishers and fishing vessels as well as vessel sizes at the provincial and district levels are available from the Pusdatin (2020a) The number of registered fishing households (*Rumah Tangga Perikanan* [RTP]) and fishing companies (*Perusahaan Perikanan* [PP]) includes 2 890 394 people. Of this total number, 1 165 284 are full-time fishers, 772 887 are major part-time fishers, and 327 688 are minor part-time fishers. The same data indicate that the number of fishers in the ISLME area total 1 578 407 people. This number consists of 700 744 full-time fishers, 612 356 major part-time fishers, and 265 307 minor part-time fishers.

The numbers of fishers appear to vary between 2012 and 2016, although a small average reduction of 0.09 percent nationally appears to be the trend. The MMAF calculates the number of artisanal fishers by the total number of traditional and *jukung* or wooden plank-built boats and the number of small-scale fishers by the number of vessels that are 5 GT or less in size. In the ISLME region, small-scale artisanal fishers operate in West Java, East Java, West Nusa Tenggara, East Nusa Tenggara, South Sulawesi, Southeast Sulawesi, and Maluku Province (Figure 53).

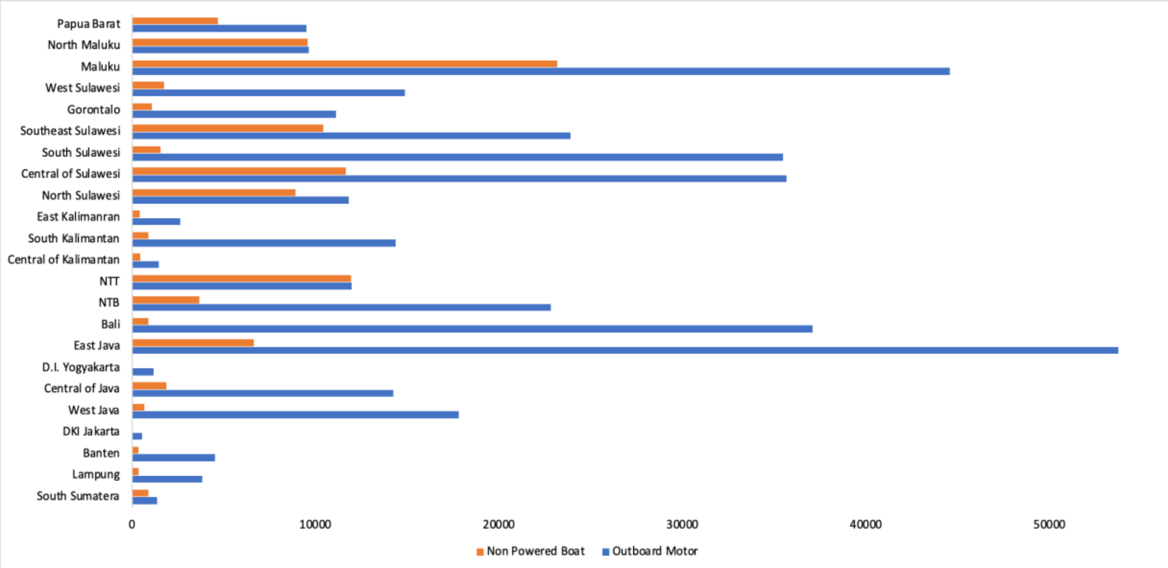
Figure 53. Centres of small-scale fishing operations and examples of their movement in the Indonesian waters of the Indonesian Seas Large Marine Ecosystem region



Source: Halim, A., Wiryawan, B., Loneragan, N. R., Hordyk, A., Sondita, M. F. A., White, A. T., & Yuni, C. 2019. Developing a functional definition of small-scale fisheries in support of marine capture fisheries management in Indonesia. *Marine Policy*, 100: 238–248.

Small-scale fisheries have diverse ecological, economic, and social attributes, and in Indonesia, one of them can be described by the types of boats or ships used for fishing. In small-scale fisheries, boats or ships used are usually divided into two types, namely motorized and non-motorized boats. Figure 54 presents the distribution of boat/ship types used by small-scale fisheries in the ISLME region.

Figure 54. Number of marine fishing boats by category and province in the Indonesian Seas Large Marine Ecosystem in 2021

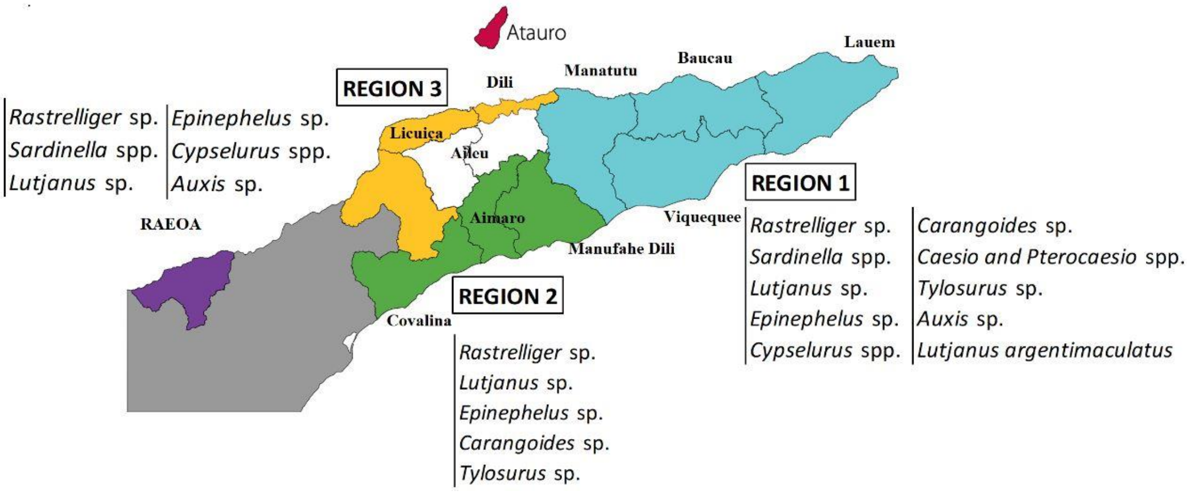


Source: PUSDATIN. 2022a. Jumlah Kapal (number of vessels). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=kapal&i=5#panel-footer-kpda

Timor-Leste's small-scale and artisanal fisheries

Most people in the coastal areas of Bobonaro, Liquiça, and Dili are involved in small-scale fisheries for cash and family consumption. Their fishing effort is limited because of having a small amount of capital, and they use small fishing vessels with low-powered engines. For that reason, their fishing results are often limited in terms of catch volume. Despite the low catches, the fishing activity there plays a vital role in cash income and nutritional security. The fishermen in the three municipalities are characterized by limited budget to invest in fishing activities, low skills, and knowledge levels. Indeed, they are unable to access the deeper seas for fishing. They use small canoes with different fishing gears, targeting small pelagic fish only. Moreover, fish products cannot be sold into Dili market because this requires extra budget for transport and cold storage. Therefore, they rely on intermediaries (Figure 55).

Figure 55. Geographical areas for important species caught in Timor-Leste



Source: López-Angarita, J., Hunnam, K., Pereira, M., Mills, D., Pant, J., & Teoh, S. 2019. Fisheries and aquaculture of Timor-Leste in 2019: current knowledge and opportunities. Penang-Malaysia, WorldFish.

According to Lópes-Angarita *et al*. (2019), most fishermen operate on the northern coasts (Oecusse, Bobonaro, Liquiça, Dili, Ataúro, Manatuto, Baucau, and Lospalos). Fishermen number nearly 5 000 for both sides (north and south coasts). The fisheries operating are clearly categorized as artisanal (small-scale). Even if small-scale, the industry contributes disproportionately to employment for men and women. For example, men can go offshore for fishing, and the girls and women engage actively in gleaning activities during low tide for cash and for family consumption. There are both full-time and part-time fishermen. The full-time fishermen are those who do fishing during most of the year. On the other hand, part-time fishermen are those who do other activities outside fishing, such as agriculture, animal husbandry, and small business.

Small-scale fisheries on the northern coast have limited access to modern technologies, as well as constrained access to capital and markets. However, small-scale fisheries are part of a livelihood strategy that combines different sources or ways of earning a living in a single household. These multi-livelihoods sources will help coastal communities minimize the insecurities of simply relying on fisheries and secure nutritional security and income diversification. Data provided by López-Angarita *et al*. (2019) reveal that total fish species caught by local fishermen and ranked in terms of price consisted of 25 species within 14 families. These are usually important species with high value for trading in both local and national markets.

The top species caught by fishermen are used primarily for cash and for family consumption. A rough estimation on fish production was made by PesKAAS in 2017. They estimated that total fish products were nearly 1 963 tonnes. The estimation was made using combined monthly catch per unit effort (CPUE) across 19 landing centres, mostly on the northern coast. The catch was estimated based on mean effort per trip; for example, motorboat-based operations are equal to 4.04 h per trip, whereas canoe-based operations are equal to 22 h per trip. Noting that the average trip for both types of vessels (small canoes and motorboats) is equal to 8.2 trips and 5.3 trips respectively. This fishing activity does not include gleaning activities.

2.3.3 Aquaculture

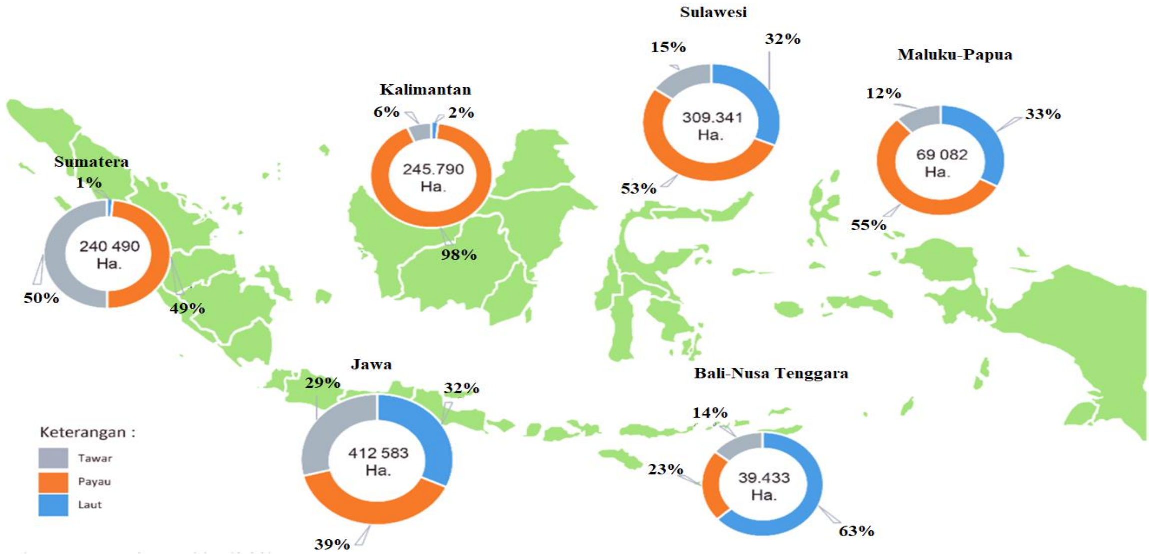
Indonesian aquaculture

Based on the typology of ecosystems, the potential area for aquaculture can be classified into three types: marine aquaculture, brackish water aquaculture, and freshwater aquaculture. The total potential area for aquaculture in Indonesia amounts to 17.92 million ha, consisting of 12.12 million ha for marine aquaculture, 2.96 million ha for brackish water aquaculture, and 2.84 million ha for freshwater aquaculture. However, their utilization rates up to now are only 11.3 percent for freshwater aquaculture, 22.7 percent for brackish water aquaculture, and 2.3 percent for marine aquaculture (Figure 56).

Indonesia's aquaculture sector is among the fastest growing in the world. Indonesia's aquaculture production increased from 2.4 million tonnes to 5.4 million tonnes between 2010 and 2019, with nearly 3.3 million people directly employed. Of the total aquaculture production, approximately 43 percent was from the rapidly growing marine aquaculture sector worth over USD 6 billion per year. The growth of Indonesia's seaweed cultivation was even more dramatic, increasing from less than 4 million tonnes in 2010 to 9.3 million in 2018 (≥130 percent), and accounting for nearly 30 percent of global production (FAO, 2020b).

Indonesia has been a major player in Asia's shrimp farming boom, which has seen remarkable economic successes, and marine fish farming in cages is currently expanding in locations such as Lombok and East Nusa Tenggara. MMAF operates 16 centres of aquaculture production, of which 11 are located within the ISLME. Seaweed farming is the most popular form of aquaculture for coastal communities in Indonesia, and the country produced nearly 9.7 million tonnes of seaweed in 2019, with the three biggest producing provinces being South Sulawesi, East Nusa Tenggara, and Central Sulawesi. Other important aquaculture production outputs include shrimp grown in coastal ponds and finfish in cages in North Bali and mud crab in East Kalimantan, north of Java and South Sulawesi. Aquaculture production in Indonesia has grown considerably over the past 20 years, averaging 33 percent growth over the past decade, and it provided nearly 1 million new jobs. Moreover, it currently contributes significantly more product by volume than capture fisheries and requires the management of an array of issues.

Figure 56. Indonesia's potential aquaculture areas in 2018 and their utilization rates



Source: MMAF. 2022a. *Analysis of main performance indicators in the marine and fisheries sector 2017–2021*. Pusat Data Statistik dan Informasi. [Daftar_Isi_Rev_2730522.cdr (kkp.go.id)]

In 2022, the total production of aquaculture was almost 4 million tonnes. The total production value contributed by aquaculture was IDR 58.6 billion. The most important aquaculture product is shrimp (Table 18). The fish commodity with the highest production in aquaculture is tilapia at 358 000 tonnes, followed by catfish at 343 000 tonnes with a growth rate of 0.14 percent (PUSDATIN, 2022b).

Table 18. Volume of aquaculture fisheries production (tonnes) based on fish species

Fisheries aquaculture	2021*	2022**
Shrimp	188 325	193 875
Grouper	3 291	2 995
Nile tilapia	361 968	358 094
Goldfish	177 734	170 245
Milkfish	241 170	243 187
Snapper fish	1 940	1 936
Silver catfish	141 182	161 114
Catfish	342 933	343 414
Carp	42 902	48 316
Others	260 043	248 089

Note: * very tentative figures ** estimated figures
Source: PUSDATIN. 2022b. Produksi Perikanan (Fish Production). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=prod_ikan_prov&i=2

According to MMAF statistics, the top five aquaculture commodities in Indonesia include seaweed, shrimp, grouper, snapper, and milkfish (MMAF 2018). These commodities correspond to aquaculture commodities found in ISLME provinces. In particular, seaweed, milkfish, and shrimp are vital commodities in the ISLME as 94.8 percent, 93.3 percent, and

88.1 percent of their national aquaculture production respectively, occurs in Indonesian waters of the ISLME (Table 19).

Table 19. Top five aquaculture commodities production (tonnes) in the Indonesian waters of the ISLME region

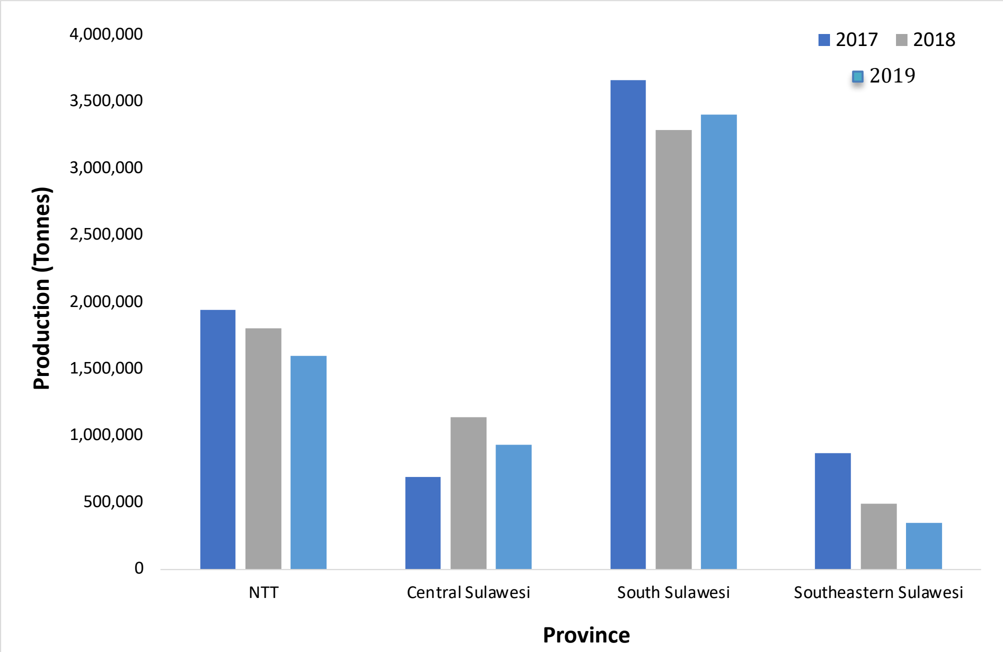
No.	Commodity	National production in 2019	Production in the ISLME in 2019	% of National production in 2019
1	Seaweed	9 746 946	9 240 254	94.8
2	Shrimp	861 336	759 080	88.1
3	Grouper	12 378	5 122	41.4
4	Snapper	7 231	5 157	71.3
5	Milkfish	822 380	767 283	93.3

Source: Adapted from BPS (2019b). *Statistik Sumber Daya Laut dan Pesisir 2019* [Marine and coastal resources statistics 2019]. Jakarta.

Seaweed

Indonesia ranks second in the world for seaweed production and first for red seaweed farming, with the latter experiencing significant growth over the last decade. Seaweed farming is also an important livelihood for many women, and rural and indigenous peoples. Seaweed in Indonesia is mainly used to produce carrageenan, which is widely used in the food and cosmetic industries as a natural gelling agent. Mariculture of the seaweed, namely carrageenophytes *Kappaphycus* and *Eucheuma*, generally occurs in shallow coastal areas, particularly sheltered bays. Dried *Kappaphycus* and *Eucheuma* are sold to intermediaries for processing either in Indonesia or offshore (Neish, 2013). Neish (2013) reported that women play an important role in seaweed farming, with some women being the main household earners. Seaweed farming therefore can promote gender equity, traditional communities, and indigenous rights. Seaweed production in Indonesian waters of the ISLME has increased from 2012 to 2017, and South Sulawesi Province is the leading province in terms of yield (Figure 57).

Figure 57. Seaweed production from Indonesian provinces in the Indonesian Seas Large Marine Ecosystem from 2017 to 2019



Source: Adapted from BPS (2019b). *Statistik Sumber Daya Laut dan Pesisir 2019* [Marine and coastal resources statistics 2019]. Jakarta.

According to the MMAF, the ISLME provinces with the highest production of seaweed, especially *Gracillaria*, are South Sulawesi, Central Sulawesi, and East Nusa Tenggara, which are located in FMA713 and FMA714. However, data indicate large variability in annual production in most provinces, a problem that needs to be managed to support sustainable livelihoods (Waters *et al*., 2019). The environmental impacts of seaweed farming are relatively low, although it has been observed that some seagrass ecosystems have been cleared and ponds excavated to expand seaweed mariculture activities. If seaweed farming expansion continues through these clearing activities, seagrass ecosystems could be at risk.

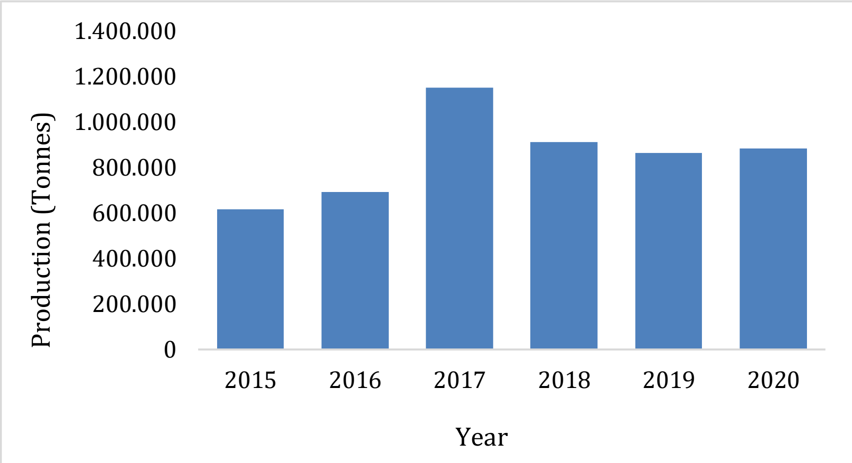
Shrimp

Two types of shrimps are farmed as aquaculture commodities in Indonesia: black tiger shrimp and vannamei shrimp. In the Indonesian waters of the ISLME area, black tiger shrimp are found in the waters surrounding East Kalimantan Province, whereas vannamei shrimp are found in the waters of West Nusa Tenggara, East Java, West Java, Lampung, and South Sulawesi provinces. Shrimp farming is thought to have the highest environmental impacts of any form of aquaculture in Indonesia, including the ISLME area. The impacts of shrimp farming include mangrove degradation, water pollution, and challenges related to the production of shrimp feeds.

Shrimp aquaculture is a prominent driver of economic growth within Indonesia's aquaculture sector, with shrimp being a dominant export commodity. Indonesia exports approximately 220 000 to 260 000 tons of shrimp annually, with about 60 percent going to the United States, 19 percent to Japan, and 5 percent to the European Union. (Napitupulu *et al.,* 2022).

Remarkably, Indonesia stands as the second-largest shrimp exporter to the United States, trailing only behind India. The total production of shrimp in Indonesia is shown in Figure 58.

Figure 58. Indonesia production of shrimp from 2015 to 2020



Source: MMAF. 2022a. Analysis of main performance indicators in the marine and fisheries sector 2017–2021. Kementerian Kelautan dan Perikanan Republik Indonesia.

Milkfish

In 2018, Indonesia's milkfish (*ikan bandeng*) production amounted to 0.8 million tonnes (Diatin, Effendi and Taufik, 2020). Milkfish farming is a good source of income for coastal fishermen and can improve the welfare of coastal communities. Milkfish is widely popular and has become an important brackish water aquaculture fish species (Prayitno, 2015). In 2015, the production of milkfish was 625 288 tonnes, which increased to 691 289 tonnes in 2016. In the following year, it decreased to 632 777 tonnes. However, it experienced another increase to 807 794 tonnes in 2018. Subsequently, there was a decrease to 747 869 tonnes in 2019 and to 742 055 tons in 2020. Milkfish contributed approximately 25% of the total brackish water aquaculture production in 2020 (PUSDATIN, 2022b).

Timor-Leste aquaculture

The development of the aquaculture sector has been included in the Timor-Leste-Strategic Development Plan 2011–2030. The document underlines the importance of aquaculture to combat malnutrition and to improve income diversification, including food security for rural and coastal communities. UN agencies, NGOs, and other development partners are working closely with government at both municipality and village levels to distribute fish fry to fish famers. Moreover, they provide training to household members regarding integrated farming systems to improve fish production and other livelihoods options in the face of climate change impacts.

Apart from fish farming, there is also seaweed farming that has prospered on the northern coast, such as operations in Liquiça (Ulmera), Dili (Hera) and on Ataúro Island. The production is limited to local markets. Products cannot be sold abroad because of insufficient volume to attract overseas buyers. However, limited amounts have been sold (Table 20). The seaweeds provide job opportunities typically for women and girls. Seaweed also provides a source of cash income for coastal communities in different municipalities. And now the seaweed has been introduced to other coastal communities particularly on the southern coast such as Lore in Lospalos, Suai, and Betano.

Table 20. Export of seaweed from 2015 to 2020

No	Species of seaweed	2015	2016	2017	2018	2019	2020	Total
1	*Eucheuma cottoni*	-	-	-	19.5	69.1	100	632
2	*Eucheuma spinosum*	52	156	148.7	25	46	-	484.9
3	mixed *E. cottoni* & *E. spinosum*	-	-	-	-	63	-	63
Total (tonnes)		52	156	148.7	44.5	178.1	100	1 180

Note: All figures in tonnes.
Source: Directorate General of Fisheries, Aquaculture and Marine Resources Management. 2022. Unpublished report on Seaweed production from 2015 to 2020. Dili. Timor-Leste.

Aquaculture development is progressing in Timor-Leste. Hatcheries are being developed, such as in Maubara, (Liquiça Municipality), Bobonaro, Hera in Dili, and other locations on the southern coast. These hatcheries aim to produce fingerlings, which can then be distributed to all fish farmers across the country. It aims to enhance overall nutritional status and food security, particularly in children and pregnant women. The most common freshwater species are tilapia (*Oreochromis niloticus*), carp (*Cyprinus carpio*), and catfish (*Clarias bathrachus* and *Clarias gariepinus*), whereas brackish water species are limited to milkfish (*Chanos-chanos*) and prawn (*Penaeus indicus/Lithopenaeus vannamei).* Marine aquaculture or mariculture is challenging. So far, there is one impounding net system in Dolok Oan near Dili City. The main species being farmed is grouper (*Ephinephelus summana*). However, the production is quite low because of the lack of supply of trash fish for feeds and insufficient funds to purchase it. As a result, mariculture has collapsed.

As stated, aquaculture development is vital in terms of supporting household income and nutritional security and it is crucial to improve existing facilities to support aquaculture activities, as well as to make available training and skills development. Training would be typically more related to hatchery management such as breeding, feeding, and broodstock management. Moreover, training could be used to promote agroecology-based fish cultivation methods. According to Guterres and Marques (2021), approximately 4 000 households are involved in aquaculture activities. Approximately 70 percent of the total households are on the northern coast. The results show positive impacts not only for cash but also for improvement of nutritional status of household members. As noted by López-Angarita *et al*. (2019), nearly 75 percent of households were aware of the benefits of consuming fish, particularly for children.

The Government of Timor-Leste has committed to enhance fish production annually by about 12 000 tonnes. In this way, it will contribute about 40 percent of the domestic fish consumption (MAF, 2019). To achieve this target, there is a need to provide significant aquaculture inputs such as skills improvement, brood-stock, improved quality of pellet and fingerlings. So far aquaculture input is very low and it results in low fish production. Table 21 presents total fish production from each municipality. In addition to fish production, all ponds need to fertilize, and local fish farmers need to use locally available ingredients that are affordable to produce pellet/feed. Development partners and UN agencies are encouraged to engage in aquaculture process and to subsidize feasible technologies and capacity building.

Table 21. Aquaculture production from each Timor-Leste municipality estimated from 2019 to 2023

No.	Municipality	2019	2020	2021	2022	2023 (estimated)
1	Aileu	3 211	1 734	1 769	1 804	1 840
2	Ainaro	3 904	7 719	7 873	8 031	8 191
3	Baucau	16 525	16 411	16 740	17 074	17 416
4	Bobonaro	11 293	16 591	16 923	17 261	17 607
5	Covalima	313	86	88	89	91
6	Díli	7 370	5 523	5 634	5 746	5 861
7	Ermera	49 626	30 790	31 406	32 034	32 675
8	Lautem	2 233	4 609	4 701	4 795	4 891
9	Liquiça	7 799	2 580	2 632	2 684	2 738
10	Manatuto	4 244	9 995	10 194	10 398	10 606
11	Manufahi	25 842	52 882	53 939	55 018	56 118
12	Oecusse	34	35	35	36	37
13	Viqueque	4 461	16 194	16 518	16 848	17 185
Total (kg)		136 854	165 148	168 451	171 820	175 257

Note: All figures in kilograms.
Source: Directorate General for Fisheries, Aquaculture and Marine Resources Management. 2023. Unpublished report on Aquaculture. Dili.

Aquaculture development involves a long transformation process and requires investment, particularly in pond construction and pellet or feed production. Many local fish farmers have no relevant expertise in aquaculture. There is a need to boost their technical skills to produce more aquaculture fish as part of their income diversification and protein intake strategy. So far, annual fish consumption from the aquaculture sector in each municipality is quite low (<1 kg per capita) (Table 22).

Table 22. Aquaculture contribution to annual fish consumption in each municipality

Municipality	Aquaculture fish productions consumed at municipality level per year				
	2019	2020	2021	2022	2023 (estimated)
Aileu	0.06	0.03	0.03	0.03	0.03
Ainaro	0.05	0.11	0.1	0.1	0.1
Baucau	0.12	0.11	0.11	0.11	0.11
Bobonaro	0.1	0.15	0.14	0.14	0.14
Covalima	0	0	0	0	0

Díli	0.02	0.02	0.02	0.02	0.02
Ermera	0.35	0.21	0.21	0.21	0.21
Lautem	0.03	0.06	0.06	0.06	0.06
Liquiça	0.1	0.03	0.03	0.03	0.03
Manatuto	0.08	0.18	0.18	0.18	0.18
Manufahi	0.43	0.85	0.84	0.83	0.83
Oecusse	0	0	0	0	0
Viqueque	0.05	0.18	0.18	0.18	0.18
National	0.1	0.12	0.12	0.12	0.12

Note: All figures in kg/person.
Source: Directorate General for Fisheries, Aquaculture and Marine Resources Management. 2023. Unpublished report on aquaculture. Dili.

2.3.4 Marine tourism

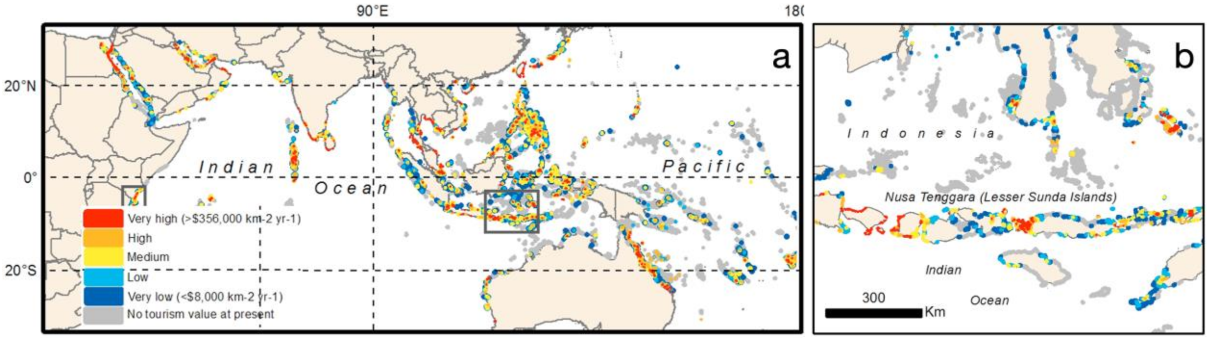
Indonesia's marine tourism

The development of marine tourism has been a high-profile priority sector for the government, as it is a non-extractive, service-oriented sector that brings foreign currency and can improve livelihoods through leisure and business travel. In 2016, the tourism industry accounted for 5.6 percent of total employment or 6 708 500 jobs (Ratman, 2016). This is expected to rise by 2.9 percent per year to 9 080 000 jobs in 2027 (6.2 percent of total).

Tourism in Indonesia had a slow start during the 1970s because of internal policy barriers, currency appreciation, and high costs hindering its early growth compared to neighbouring destinations. However, the market and tourist arrivals began to increase in the 1980s, with over 11 million overseas tourists arriving in 2016. Indonesia's tourism industry continued to grow in the years following 2017. In 2019, tourism accounted for 4.2 percent of Indonesia's GDP and provided employment for approximately 14 million people. This was prior to the COVID-19 pandemic. The pandemic had a significant impact on the tourism sector, with foreign tourist arrivals dropping by 75 percent in 2020. Indonesia's tourism industry is now large, rapidly growing, and segmented, ranking 17th in the world in terms of size and 12th in terms of global growth rate. This growth also makes it the largest and fastest growing among the six countries of the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF).

In 2020, tourism was the fourth most significant contributor to the government of Indonesia's revenue, after oil and gas, palm oil, and coal, with a value of USD 12.6 billion. Marine tourism, based on gross value added (GVA) in 2019, contributed USD 32.5 billion (2.78 percent) to GDP, with 10 percent of contribution to the marine economy in 2021 (Figure 59).

Figure 59. Expected value of reef tourism



Notes: a) Distribution coral reef in Indonesia and surroundings, b) Specific to East Nusa Tenggara and surroundings.
Source: Modified from Spalding, M., Burke, L., Wood, S. A., Ashpole, J., Hutchison, J., & zu Ermgassen, P. 2017. Mapping the global value and distribution of coral reef tourism. *Marine Polic*y, 82: 104–113.

A study by Spalding *et al.* (2017) estimated that 27 percent of Indonesia's tourism activities are in coastal, non-urban areas. Of the tourism in reef-coast areas, 23 percent is directly on-reef. Reef adjacent tourism was valued at USD 132.83million annually, whereas on-reef tourism was valued at USD 322.6 million annually, within the total estimated annual tourism value of USD 5 659.5 billion. Given its economic significance, the government is focused on growing the industry, and ten new tourism destinations have been identified for promotional attention, including four marine destinations and three within the ISLME.

Indonesia has set high growth targets to compete with neighbouring countries such as Malaysia, Thailand, and Singapore, who are currently ahead of Indonesia in attracting overseas visitors. Despite developing strategic tourism plans in recent years, the government faces a challenge with two conflicting objectives. On the one hand, there is a desire to expand the tourism sector in Indonesia to accelerate overall economic growth, whereas on the other hand, there is a growing realization that such growth puts pressure on the country's infrastructure, social sectors, and environmental resources. According to Tourism Indonesia, 35 percent of all visitors who came to Indonesia indicated a preference for nature destinations. Of this 35 percent, 45 percent prefer ecotourism destinations, 35 percent enjoy marine tourism, and 20 percent prefer adventure tourism. In 2017, foreign tourists that visited the coastal zone participated in the following activities: sun-bathing and sightseeing (60 percent); sailing, yachting, and cruising (25 percent); and diving and snorkelling (15 percent).

To boost the economy of the tourism sector, Indonesia has established special economic zones (SEZs). These were developed through the preparation of areas with geo-economic and geostrategic advantages and they function to accommodate high-value economic activities such as industry, exports, imports, and other economic activities, including tourism with high international competitiveness. A special economic zone (SEZ) for tourism is a location for businesses engaged in the tourism industry to support the planning of events, such as entertainment and recreation, meetings, exhibitions, and other related activities. According to data from the Ministry of Tourism and Creative Economy (2021), the government has designated 15 SEZs, consisting of nine industrial SEZs and six tourism SEZs. There are several tourism SEZs located throughout Indonesia, such as Tanjung Kelayang SEZ in Bangka Belitung, Tanjung Lesung SEZ in Banten, Singhasari SEZ in East Java, Mandalika SEZ in NTB, Likupang SEZ in North Sulawesi, and Morotai SEZ in North Maluku. Currently, Tanjung Kelayang SEZ, Tanjung Lesung SEZ, Mandalika SEZ, and Morotai SEZ are already in operation, whereas the others remain in the preparation phase. The tourism SEZs located in the ISLME are Tanjung Kelayang SEZ in Bangka Belitung, Singhasari SEZ in East Java, Mandalika SEZ in West Nusa Tenggara, Likupang SEZ in North Sulawesi, and Morotai SEZ in North Maluku. Based on the SEZs, there are several locations that are highly suitable for marine tourism. The details can be seen in (Table 23).

The government has identified three marine areas as priorities for tourism development: (i) cruise tourism; (ii) yacht tourism; and (iii) dive tourism. The government has supported the cruise ship industry as vessels with foreign flags are granted approval for ship tours under the Ministry of Transportation Regulation No. 121/2015. Four out of five ports for the embarkation and disembarkation for cruise ships are in the ISLME: Makassar, Benoa, Tanjung Perak, and Tanjung Priok. The region boasts many world-class dive sites and one spot in the ISLME, the Tulamben shipwreck in Bali, is included in the top ten dive sites around the world. It is specially recognized for its high species diversity. The site is also recognized in the Ministry of Tourism Regulation No. 7/2016.

Table 23. Locations identified as highly suitable for marine tourism development in Indonesia

No.	FMA	Location	Marine tourism	Activity
1.	573	Bali	Tanjung Benoa	Beach activities, water sport
2.	573	Bali	Nusa Dua Beach	Surfing, diving, water sport
3.	712	DKI Jakarta	Kepulauan Seribu	Resort, water sport, snorkelling, diving
4.	712	Central of Java	Taman Laut Karimun Jawa	Snorkelling, diving, mangrove forest
7.	713	NTT	Taman Nasional Komodo	Diving, snorkelling, fishing, canoeing
8.	713	NTB	Gili Trawangan	Snorkelling, touring in a glass bottom boat, diving, water sport
9.	713	NTB	Gita Nada	Diving, snorkelling
9.	714	Southeast Sulawesi	Taman Nasional Wakatobi	MPA, snorkelling, diving
10.	714	Maluku	Taman Wisata Perairan Laut Banda	Fishing, diving, swimming
11.	715	Central Sulawesi	Taman Nasional Laut Kepulauan Togean	Scuba diving and snorkeling in *the heart of the coral triangle*
12.	715	Gorontalo	Cinta Island	Spot eco resort, snorkelling, swimming

Source: Based on Ministry of Tourism and Creative Economy (2021)

Prior to the COVID-19 pandemic, marine and coastal tourism was a rapidly developing component of the global ocean economy. According to the OECD, marine and coastal accounted for nearly 26 percent of global ocean-related value-added in 2016 (OECD, 2016). These tourism activities already account for a significant percentage of the entire tourism sector, with over 44 percent of international visitors engaging in at least some marine tourism activities during their visit (MoT, 2016).

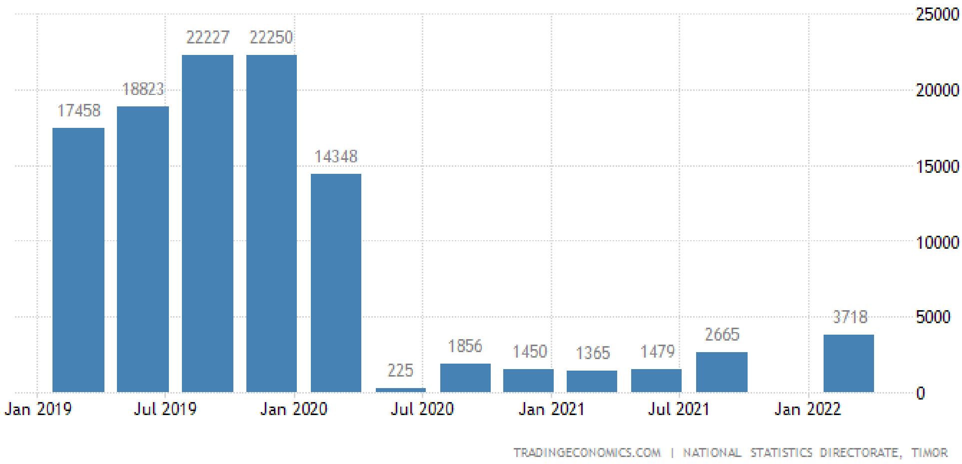
Following recovery from COVID-19, Indonesia will be well-positioned to capture a large share of this growth. With more than 17 000 islands, one of the world's longest coastlines, the world's highest coral diversity, and spectacular seascapes, Indonesia's marine and coastal tourism potential is promising. The natural assets that attract marine and coastal tourism, such as coral reefs, coastlines, and beaches, are at risk of degradation from intensifying weather and climate extremes, rising sea levels, and ocean acidification. The accumulation of marine debris is another acute threat.

Timor-Leste's marine tourism

Marine tourism development is vital, and it is one of the main pillars of economic growth in Timor-Leste. The tourism sector can provide job opportunities or job creation and income diversification. One of the famous tourism destinations with extensive natural beauty is Ataúro Island. The island has extensive recreational areas that attract local and foreign visitors to visit for relaxation and for adventuring, including snorkeling and scuba diving. The other is called Nino Konis Santana National Park (NKSNP) and is on the eastern point of the main Island of Timor-Leste. The NKSNP contains high levels of biodiversity in fish, coral reefs, and marine birds. This marine biodiversity attracts many foreigners and domestic tourists. It also provides many job and cash income opportunities for local people. The visitors come from a wide range of countries (da Silva, 2021).

Australia has been the main source of visitors since the last decade. However, during the COVID-19 pandemic, visitor numbers dropped significantly since July 2020 (Figure 60). Tourism facilities are much better and concentrated on the northern coast than on the southern coast. For example, there are many suitable accommodations on Ataúro Island, with clean water and power. Indeed, on this Island, the tourism sector is labour-intensive and has significant potential to generate local incomes and long-term employment for people on Ataúro Island. The local communities can benefit directly from work opportunities, such as tour guides, guesthouse management, and cultural performance, including sales of local handcrafts at local market.

Figure 60. Foreign visitors before, during and after COVID-19



Source: Tradingeconomics.com. 2022. *East Timor tourist arrivals*. East Timor Tourist Arrivals At Airport (tradingeconomics.com)

The tourism sector on the northern coast is quite attractive. It includes not only natural beauty but also much megafauna attractions (e.g. dugong, sharks, and crocodiles), associated biodiversity, and rich culture heritage. All these assets need to be managed in an integrated fashion. This means that tourism sector development should be part of an integrated coastal zone management system. This would include marine and coastal resources management, marine protected areas, local marine management areas, pollution control, the application of local wisdom, and climate change adaptation and mitigation measures to ensure long-term sustainability. Collaborative efforts and the sharing of both responsibility and benefits from all partaking stakeholders would be required to ensure success.

2.3.5 Oil and gas exploration and production

Indonesia oil and gas exploration and production

The oil and gas industry is a major contributor to the economies of Indonesia and Timor-Leste. In Indonesia, approximately 41.44 percent of oil production comes from the marine environment. More significantly, in Timor-Leste, oil production constitutes almost 80 percent of national GDP.

Oil and mining

Oil production, mostly offshore in the Java Sea, supplies the large domestic market and also provides export earnings. Indonesia is one of the world’s major oil producers, with 1.36 million barrels per day in 1997 from 8 535 wells and much of this is from Sunda (Hopley and Suharsono, 2000). Another major production area is off the coast of East Kalimantan, particularly the Mahakam Delta. Bontang Bay in South Kalimantan is a major producer of liquified natural gas. Mining for gold, copper, zinc, and other minerals, notably in Papua and Sulawesi, is another major export earner.

Indonesia's progress towards clean and renewable energy has improved markedly since such data began being recorded. According to the International Energy Agency, in 2021 renewable energy sources accounted for 11 percent of Indonesia's total primary energy supply, up from

8 percent in 2017. The government's target of increasing the share of renewable energy to 23 percent of installed capacity by 2025 is still in place, and the country has set a more ambitious target of achieving net-zero emissions by 2060. However, the challenge of transitioning to cleaner energy remains as fossil fuels still account for a significant portion of the country's energy production. Infrastructure challenges such as the high cost of grid extension and the need for financing are also slowing progress toward achieving renewable energy targets.

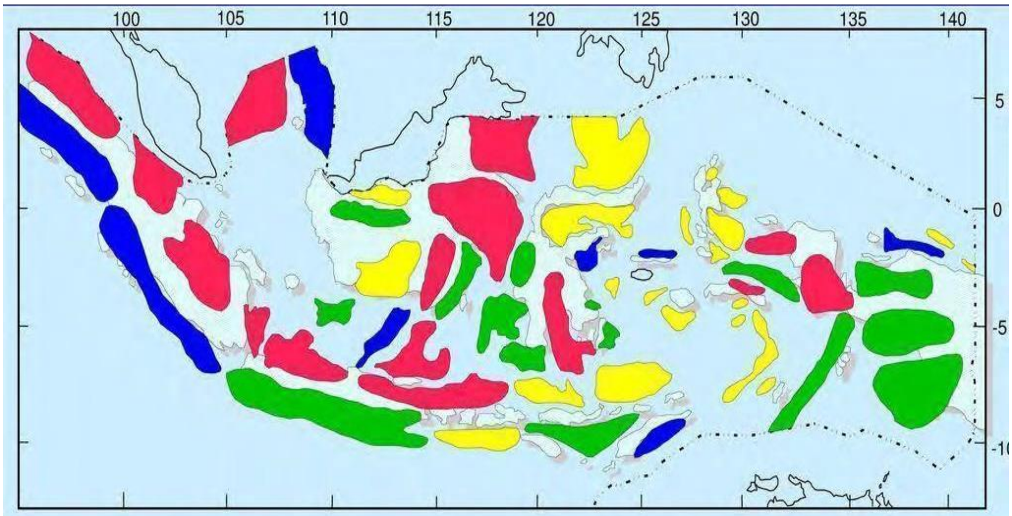
Indonesia's total primary energy needs, namely, 166 million tonnes of oil equivalents (MTOE), were primarily met by oil (46 percent) and gas supplies (23 percent). The national primary energy demand in 2025 is forecasted to be 412 MTOE, which will be predominantly met with oil and gas (25 percent and 22 percent, respectively). Domestically produced oil and gas are still the main source of income from energy sources, contributing USD 13.1 billion in state taxes to the Ministry of Energy and Mineral Resources (*Energi dan Sumber Daya Mineral* [ESDM]), which is 8 percent of the 2017 target of USD 12.2 billion to the state revenue. Based on the 2013 GVA expressed in 2019 current prices, offshore oil and gas, including mining, contributes USD 45 billion which equates to 4.09 percent of the GDP, of which 11.64 percent is allocated to the marine economy.

In the ISLME, the primary Indonesian marine or offshore oil and gas projects include the following:

- the 110 million metric standard cubic feet per day (MMSCFD) Indonesia Deepwater Development (IDD) in the Makassar Strait (Makassar Block) by Chevron Indonesia;
- the 1 200 MMSCFD Masela Block deep-water natural gas project by INPEX Ltd., also known as the Abadi field; and
- the 450 MMSCFD Jangkrik Complex operated by ENI Muara Baku near the Makassar Strait.

Prospects for additional reserves in Indonesia are now mostly located in the deep-sea, eastern regions, including in the ISLME, which will be technically more difficult and expensive to find and extract (Figure 61). In addition, oil and gas production facilities and equipment are aging: approximately 65 percent of pipelines, 57 percent of offshore platforms, 55 percent of tanks and vessels, 44 percent of rotating equipment, and 35 percent of the turbomachinery were built before 1980. This means that much of the infrastructure and equipment has higher operating costs to maintain the integrity of production equipment, and more effort is required to ensure fulfilment of *Kesehatan Keselamatan Kerja dan Lindung Lingkungan* (K3LL), that is, safety, health, and environmental protection requirements. The national downstream gas infrastructure is also inadequate to handle supply as excess liquid natural gas (LNG) cargoes are being sold in the spot market. In the short-term, gas production may need to be curtailed because of insufficient capacity of the midstream–downstream infrastructure. Because of the various conditions presented above, the main challenges facing the national upstream oil and gas sector are (i) the rate of decline in production; (ii) higher than average operating costs; (iii) reserve replacement ratio (RRR) smaller than one; and (iv) longer time required to develop new resources (Figure 61).

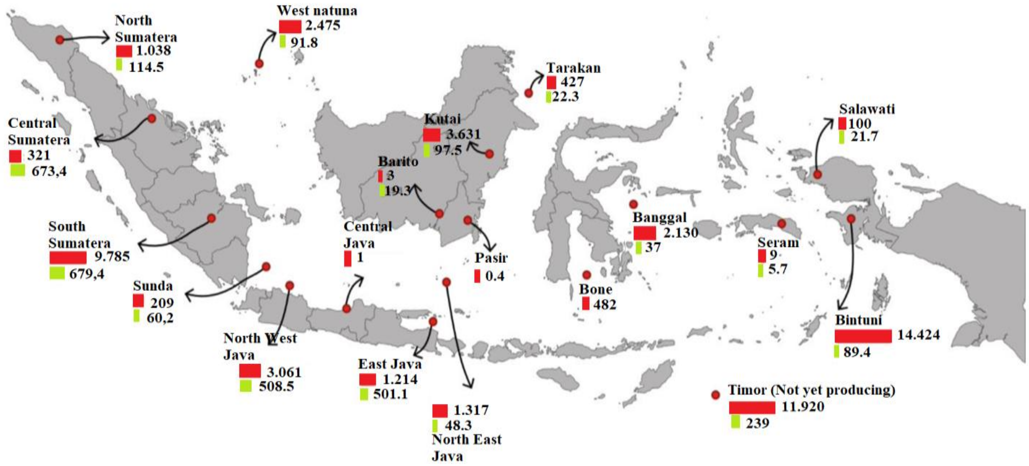
Figure 61. Major oil/gas sedimentary basins in the Indonesian Seas Large Marine Ecosystem and current development status



Note: Red colour represents producing basin, green colour represents drilled basin with no discovery yet, blue colour represents drilled and proven discovery, and yellow colour represents undrilled basin
Source: Directorate General for Oil and Gas. 2018. Oil and gas investment in indonesia. Department of Energy and Mineral Resources. Jakarta.

Therefore, incentives are required for investors to invest in exploration activities for new reserves. Meanwhile the government's emphasis on the oil and gas sector and the prospect of new investors have partially fueled the recent focus on improving infrastructure in eastern Indonesia and the Banda Sea in particular. The *Satuan Kerja Khusus Pelaksana Kegiatan Usaha Hulu Minyak dan Gas Bumi* (SKK MIGAS), that is, the Task Force for Upstream Oil and Gas Business Activities, continues to provide stakeholders with an understanding of the importance of exploration activities as new oil and gas reserves cannot be found without exploration and the marine spatial planning plans for large interregional areas such as the Banda Sea are probably influenced by this (Figure 62).

Figure 62. Distribution of oil and gas reserves in Indonesia



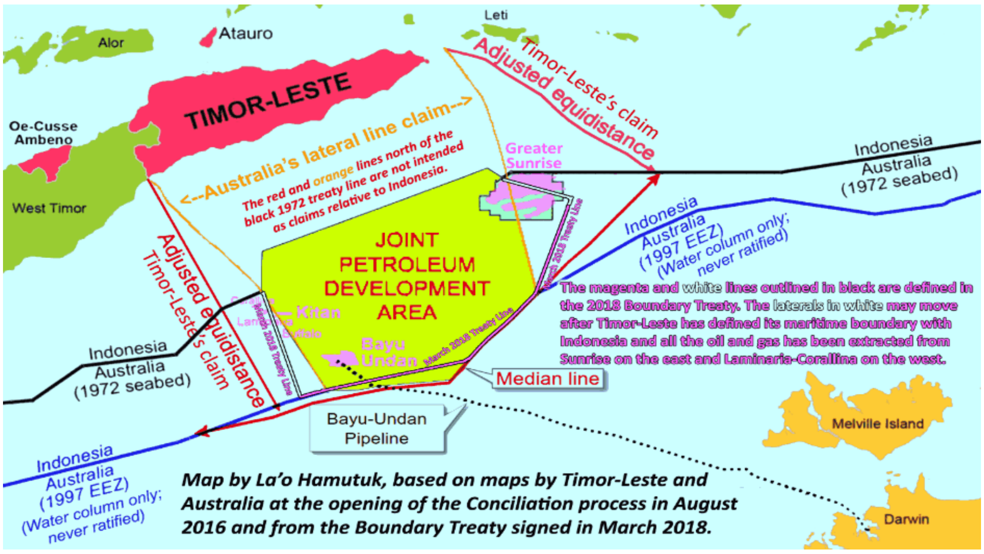
Note: Red rectangle represent gas asso+ non asso reserves (Bscf) and green rectangle represent oil+condensate reserves (MMstb)
Source: Ministry of Energy and Mineral Resources. 2017. Gas and oil statistics. https://migas.esdm.go.id/uploads/upload.s/Statistik-Migas-2019---spread.pdf

Timor-Leste's oil and gas exploration and production

The oil and gas exploitation in Timor-Leste started in 2002. The main area of exploitation covers Elang Kakatua, Kitan, and Bayu Undan called JPDA—Joint Petroleum Development Area—as depicted in Figure 63. The oil and gas exploitation activities started on different dates. For instance, the production of Bayu Undan started in 2004, whereas the Kitan operation started in 2011, and it was halted in 2015. Between 2005 and 2006, the first bidding round was executed for exploration blocks in JDPA and offshore exclusive areas. It has been estimated that the total volume of petroleum ranges between 12 billion barrels of oil and 17 billion barrels of oil. Timor-Gap is the state-owned company of Timor-Leste tasked to identify and develop the country's oil and gas resources. Based on Timor-Gap's estimations, the recoverable resources will be nearly 6.3 billion. As a comparison, the Bayu Undan reserves are nearly 1 billion, and the monetary value of these resources are estimated, at an average of USD 59 per barrel in the next 50 years, to be USD 372 billion (PEMSEA, 2019).

All exploitation areas are located in the Timor Sea south of Timor-Leste; there is no oil and gas exploitation on the northern coast. All oil and gas exploitations are off the southern coast. For example, the Suai supply base on the southern coast has a potential of USD 372 billion worth of resources tin the next 50 years that are yet to be monetized. If the government develops it in the proper manner, it will lead to approximately USD 31 billion if the project is fully exploited. These estimated benefits are based on projected tax revenues and profits from oil. However, the government needs to invest nearly USD 2.2 billion to achieve full exploration of oil and gas reserves. The government needs to fix Suai airport, including the highway to fully facilitate oil and gas exploitation and/or production. This will create many job opportunities, economic development, and will eventually sustain long-term GDP growth.

Figure 63. Oil and gas exploitation in Timor-Leste



Source: Laohamutuk. 2018. [Appendix 1. Oil and gas in and near Timor-Leste (laohamutuk.org)]

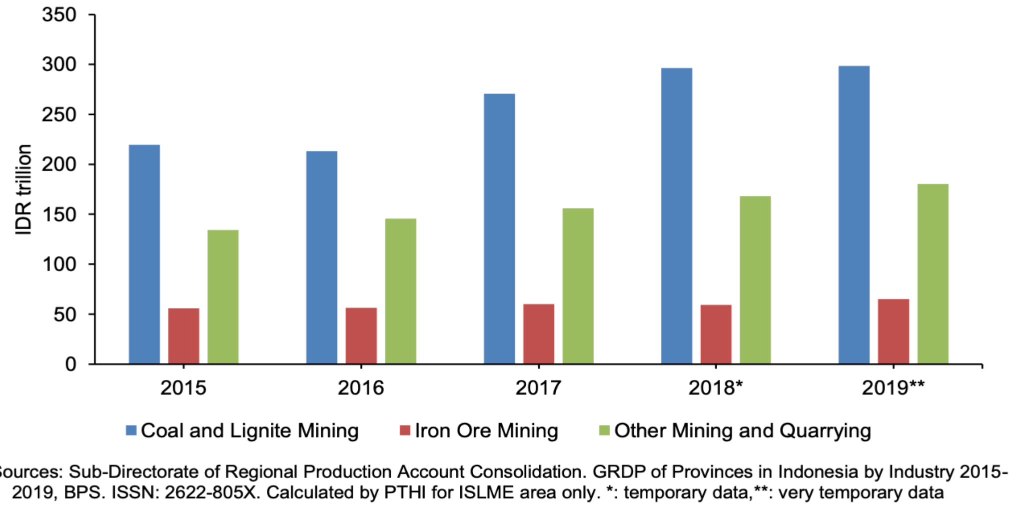
2.3.6 Mining

Indonesia's mining

The management of mineral resources in the ISLME is under the jurisdiction of the Ministry of Energy and Mineral Resources. Indonesia has abundant mineral resources, including petroleum, natural gas, coal, metal ore, and rocks found across most regions. As a result, micro-, small-, medium-, and large-scale mining and quarry operations and companies can be found in most provinces. Licenses for medium and large establishment (MLE) mining and quarry activities are often held by a combination of foreign companies, private companies, state-owned companies (Badan Usaha Milik Negara/BUMN), and locally owned companies, whereas licenses for micro and small establishments (MSE) are held by sole proprietors.

In 2020, the mining sector accounted for 9.1 percent of Indonesia's GDP, up from 8.5 percent in 2019. Coal, metal ores, and other commodities remain the major components of mining and quarrying in the country. Coal remains a major export for Indonesia, contributing significantly to the country's foreign exchange earnings. In 2021, the country's coal exports were estimated to be worth USD 38.2 billion, making up nearly 15 percent of total export value. East Kalimantan remains the province with the highest mining and quarrying contributions to Indonesia's GDP, followed by West Java and Central Java (Figure 64).

Figure 64 Contribution of the mining sector based on commodity prices in the Indonesian Seas Large Marine Ecosystem region



Source: FAO. 2021. *Thematic Assessment of the Indonesian Seas Large Marine Ecosystem (Indonesia)*. Food and Agriculture Organization. PT. Hatfield Indonesia.

Timor-Leste's mining

Timor-Leste is rich in natural resources such as chromite, sandstone, silver silica, in addition to offshore oil and gas. However, mining activities are generally non-existent in the country. Some local NGOs are exploiting marble in Metinaro, Dili Municipality. Furthermore, petroleum extraction began in Suai Loro, a coastal area south and east of th Indonesian border. It is believed that this activity will cause less pollution because it will be managed with pollution management protocols in place.

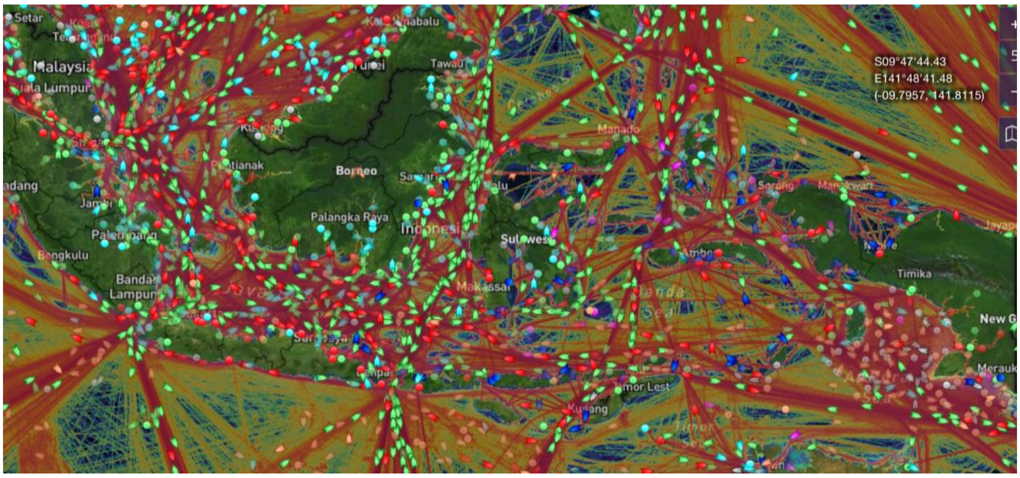
2.3.7 Shipping and ports

Indonesia's shipping and ports

Shipping is extremely important throughout the ISLME for inter-island freights, linking regions, and providing transport between islands. The northern Java Sea and Makassar Strait/Lombok Strait form part of the major oil tanker routes (the Main route and ULCC route, respectively) between Japan and the greater Pacific Ocean and the Indian Ocean and West Asia–Europe (Figure 65). Minor routes pass between Java and Sumatra and through the Java Sea to the east via the Arafura Sea.

Indonesian waters host some of the busiest shipping lane networks in the world. Sea lanes connect Asia's economies with bulk supplies of raw materials and the global markets with consumer products, and some of these lanes are through narrow inter-island straits. Based on GVA 2013 at 2019 prices, the shipping and port industry sector contributed USD 3 694.51 million (0.33 percent) to GDP, with 1.26 percent contribution to the marine economy only. Maritime piracy and securing sea borders were reported as one of the biggest problems in Southeast Asia in 2017. During the past few decades, armed robberies were considered an acceptable risk when sailing in these waters, especially the busy shipping lanes of the Malacca and Singapore Straits. At least 120 000 ships sail along these routes annually and account for one-third of the world's commercial ship traffic. The number of actual and attempted piracy attacks in Indonesian waters ranged from 15 to 108 annually between 2008 and 2021 (Statista, 2022).

Figure 65. Shipping routes in the Indonesian Seas Large Marine Ecosystem



Source: (Marinetraffic, 2023) MarineTraffic: Global Ship Tracking Intelligence | AIS Marine Traffic

For sea lanes and shipping density, Indonesia has a unique geographical position, as it includes both the Indian and Pacific Ocean shipping routes (Kahn and Vance-Borland, 2013). The north–south axis of the region is dominated by energy-related trade between Australia and Asia, and the majority of this traffic runs through the eastern waters of the archipelago. Hence, Indonesia is a prominent stakeholder of the region's marine transportation network, as its waters are extensively used by international ships in transit (i.e. "innocent passage"). A high proportion of the total area of the sea lanes in Indonesia (23.4 percent) overlaps with the country's Priority Conservation Areas (PCAs), including extensive overlap with specific areas, such as marine corridors and green turtle habitats.

Indonesia has more than 250 shipyard companies supported by approximately 1 700 formal and informal ports, including 111 commercial ports and 11 container ports (Global Business Guide, 2012). In an effort to stimulate national shipping capacity, the Ministry of Trade issued Decree No. 82 in 2017, which states the transportation of specified goods and products (i.e. coal, palm oil, rice, and government procurement goods) within Indonesian territory can only be done using Indonesian transport companies. This regulation was protested by many parties, and it risks damaging Indonesia's business climate and the confidence for foreign investors. The government has already deferred the implementation of the regulation because of the lack of national capacity in most of the transportation sectors covered by the regulation. In addition, the Port Development Master Plan calls for a significant investment in the development of port facilities which aims to improve shipment and transshipment capacity in Indonesia and capture a greater share of the international shipping market. Ship traffic is predicted to increase significantly through Indonesia and the ISLME, in particular, because of the resources boom in Australia (Western Australia and Queensland Resource

Routes) with the supply of gas, oil, coal, bauxite, precious metals, export goods, and livestock to Asia cutting through the ISLME on a south–north course. In addition, the growth of both national and ASEAN regional shipping will substantially increase the overall ship traffic density, including medium to small cargo vessels, passenger ferries, and fishing fleets.

The Indonesian government has established a sea toll (sea highway) programme to encourage successful maritime activities. The sea toll programme operates a distribution system based on huge ships that connect Indonesian ports. Its goal is to distribute commodities more equitably, consistently, and on time. Several ports in Indonesia are already connected under the sea toll programme. Tanjung Perak Port (Surabaya) is linked to Tanjung Priok Port (Jakarta), and Sorong Port (Papua) is linked to Tanjung Perak Port (Surabaya). The sea toll programme was initially introduced on 4 November 2015 at Jakarta's Tanjung Priok Port. The government intends to develop Indonesia as a marine country that is independent, advanced, strong, and based on national interests through the sea toll programme. To date, the sea toll programme has successfully acquired 32 ships, 33 routes, and transported 75 860 tonnes of cargo (Media Indonesia, 2022).

In accordance with the classification of fishing ports by MMAF Regulation No. 08/2012 concerning fisheries ports, there are four classes of fishing ports: (i) Oceanic Fishing Ports or *Pelabuhan Perikanan Samudra* (PPS); (ii) Archipelagic Fishing Ports or *Pelabuhan Perikanan Nusantara* (PPN); (iii) coastal fishing ports or *pelabuhan perikanan pantai* (PPP); and (iv) Fish Landing Centres or *Pangkalan Pendaratan Ikan* (PPI). Based on information from the Fishery Port Information Centre or *Pusat Informasi Pelabuhan Perikanan* (PIPP) of the Directorate General for Capture Fisheries (DJPT), there are 538 fishing ports in Indonesia. This number consists of seven PPS, 18 PPN, 40 PPP, 388 PPI, two private fishing ports, and 83 ports that do not have a category or class. In the ISLME, there is a total of 308 fisheries landing ports, or more than 50 percent of the total Indonesian fisheries landing ports, according to MMAF data on *Profil Pelabuhan Perikanan Indonesia* 2019-DJPT, consisting of three PPS (PPS Nizam Zachman [DKI Jakarta], PPS Kendari [Southeast Sulawesi], PPS Bitung [North Sulawesi], 11 PPN, 25 PPP, 216 PP, and 53 unclassified ports. The province in the ISLME with the largest number of fishing ports is East Java Province with 58 fisheries landing ports, followed by Central Java Province with 44 ports, and West Java Province with 35 fisheries landing ports. Bali Province is the province with the least number of fishing ports: only three fishing ports.

Timor-Leste's shipping and ports

One fish port is located on Ataúro Island, including a small shipping port. The shipping port facilitates a small quantity of cargo from Dili only on a daily basis. There is no fish port in Bobonaro and Liquiça. A medium fish port is located in Dili, but it was occupied by marine army/forces (Forsa Defesa Marinha). The major port and shipping is located in Tibar, the western part of Dili. This main port is to facilitate all goods and cargo, including construction materials loaded in this port.

The main port is under the Dili port authorities. This port is responsible for all goods imported from different countries, including Indonesia, China, India, Australia, Portugal, Brazil. The main port plays an important role because it serves national and international lines such as

Oecusse, Ataúro, Indonesia, Singapore, Australia, and Malaysia. The new Tibar port has just been completed (Figure 66). This port attends to all cargos and accommodates all deliveries or carriages from different countries at the same time.

Figure 66. Major port and shipping in Tibar – western part of Dili City

(Image by Julieta Oliveira, 2023)

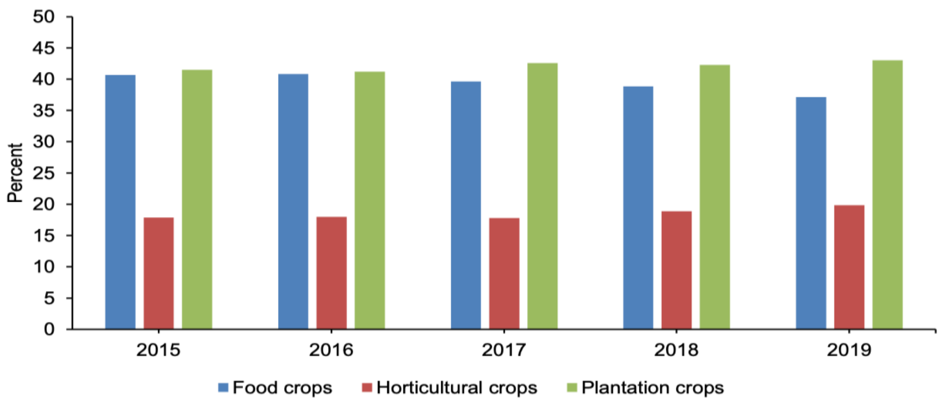
2.3.8 Agriculture

Indonesia's agriculture and forestry

The agriculture sector still provides employment for 49 percent of the population in Indonesia. According to the World Bank (2021), the total cultivated area is estimated to be nearly 646,000 km2, which is around 34 percent in 2021. Furthermore, about 14 million hectares were under permanent crops, such as rubber, coconut, coffee, cocoa, and palm oil. Annual crops, such as rice, maize, soybean, sugarcane, and tobacco, were grown on 19 million ha. Farm holdings in Indonesia are still relatively small: 33 percent are less than 0.25 ha, and a further 26 percent are between 0.25 ha and 0.5 ha. In 2020, the value added to GDP from agriculture in Indonesia was 13.65 percent.

Indonesia's economic planning follows a 20-year development plan from 2005 to 2025, which is segmented into five-year medium development plans (Rencana Pembangunan Jangka Menengah Nasional (RPJMN)). The Strategic Plan of the Ministry of Agriculture 2015–2019 has an overall objective to achieve food sovereignty and enhance the welfare of farmers. Through the presidential decree signed in December 2016, the Strategic Policy and Action Plan on Food and Nutrition was finalized. Based on BPS data, the total contribution of the agricultural sector in 2015 at the current market value to the national GDP was approximately 8.5 percent and totalled IDR 977.081 billion and IDR 1 203 208 billion in 2019. The contribution from the agricultural sector between 2015 and 2019 was mostly from food and plantation crops at 39 percent to 43 percent, followed by horticultural crops at 18 percent to 20 percent between 2015 and 2019 (Figure 67). Moreover, the sector's average annual income is the lowest of all sectors at IDR 743.399 /capita.

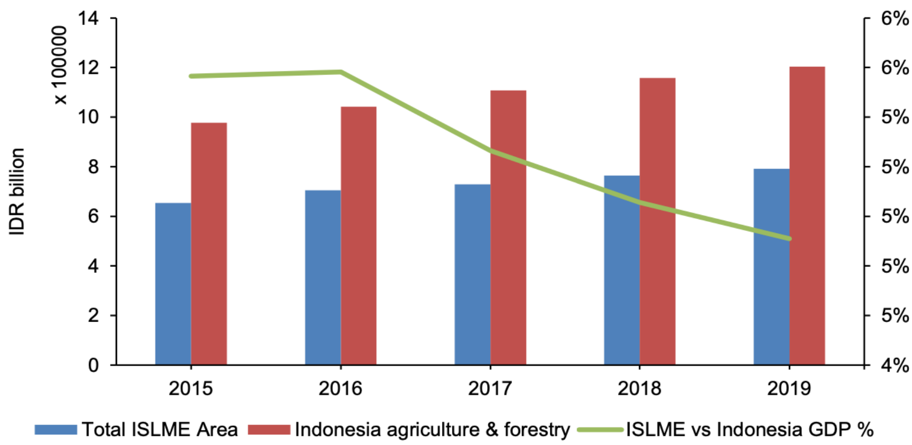
Figure 67. Percentage contribution of different types of agricultural industry



Source: BPS. 2019a. Pendapatan Nasional Indonesia 2015-2019 [Indonesia's National Income 2015–2019]. Jakarta. [Cited 22 August 2023]. https://www.bps.go.id/publication/2020/06/12/7fe8d749c43bad46b1601662/pendapatan-nasional-indonesia-2015-2019.html

Within the ISLME area, sectoral contributions in 2019 in 22 of the provinces contributed between 1.8 percent and 27.2 percent, whereas the DKI Jakarta Province had the lowest contribution at 0.05 percent. The highest agricultural contribution based on current market value was from East Java, which reached IDR 130.929 billion in 2015 and increased to IDR 141.705 billion in 2019, mostly from agricultural food crops. Agricultural land in Java consists of rice fields and is included in the category of food crops. Approximately 45 percent of rice fields in Indonesia are in Java. Indonesia's total rice field area (*Luas Lahan Baku Sawah* [LBS] is 7 463 948 ha. The high rate of conversion of technically irrigated agricultural food crops has threatened the role of Java and Bali as the national food barns, although rice remains the primary food in the country. The ISLME contributed more than 60 percent to Indonesia’s agricultural revenue between 2015 and 2019 at current market prices, and this area’s contribution reached 5 percent of the national GDP (Figure 68).

Figure 68. Agricultural revenue at current market value for the ISLME area



Source: BPS. 2019b. Statistik Sumber Daya Laut dan Pesisir 2019 [Marine and coastal resources statistics 2019]. Jakarta.

Forestry is a major industry, particularly in Kalimantan, Sumatra, and Papua, and less so in many other areas, where much of the harvestable forests have already been exploited. Much of the land area of the region was originally covered by diverse tropical forests. However, as noted above, substantial deforestation of dipterocarps and other commercial timber species has taken place since the colonial era, and continuing logging is further reducing the original forest cover. Fertile lowlands and hill areas have been extensively developed for rice production as paddy fields and upland terraces. Lowland areas and river flood plains also support mixed agriculture. Indonesia is a leading producer of palm oil and a major global producer of rubber, copra, cocoa, and coffee. The Global Food Security Index (GFSI) states that Indonesia's food security score has improved from 58.6 in 2015 to 60.9 in 2019.

BAPPENAS (2019) noted that the development of agricultural and forestry industries is focused on processing-derived commodities, including oil palm, coconut, rubber, wood, rattan, cocoa, coffee, medicinal plants, fruits, floriculture, and spices. This development could be strengthened by improving the certainty of sustainable jurisdiction between agricultural and agroforestry lands. The conversion of forested lands to agricultural and plantation areas and the occurrence of forest and wildland fires are the main triggers for the decline in forest cover. In many cases, this causes sediment runoff in coastal areas. The greatest damage or loss of forest cover on peatlands occurs on the islands of Kalimantan and Sumatra (Figure 69).

Figure 69. Distribution of Indonesia downstream agriculture centres

Source: Bappenas. 2019. Rencana Pembangunan Jangka Menengah Nasional (RPJMN) 2020–2024. [Cited 14 June 2023]. https://perpustakaan.bappenas.go.id/e-library/file_upload/koleksi/migrasi-data-publikasi/file/RP_RKP/Dokumen%20RPJMN%202020-2024/Lampiran%201.%20Narasi%20RPJMN%202020-2024.pdf

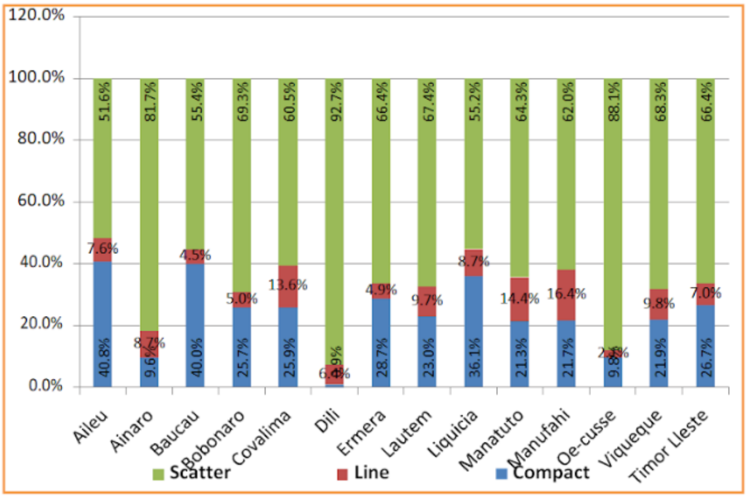
Timor-Leste's agriculture and forestry

The agriculture sector in the ISLME area (northern coast) is not quite favoured because of the long dry season (5 months to 9 months) compared to the southern coast. However, demand for food and raw agricultural materials as well as for cash income means that many coastal communities grow different crops to provide supplemental food. The predominantly agriculture-based area is in Bobonaro, Liquiça and is very low or limited in Dili. The coastal communities grow different crops, such as maize, potatoes, beans, cassava, and vegetables, and they also raise livestock and practice fishery. The combination of different crops or mixed farming in the ISLME area is mostly facilitated by both terrestrial and coastal environments. The coastal environments have tremendous potential and offer greater agricultural outputs in terms of food supply, job opportunities, and income generation.

Multicropping is vital to compensate for losses or adversity in the face of climate change. Multifarming is also essential to secure nutritional security for a growing human population. To facilitate multicropping systems, irrigation schemes and other water management measures need to be managed to improve the agricultural productivity of the existing agricultural systems, including the application of biotechnological approaches that have been developed. The irrigation scheme is mostly developed and applied in the Bobonaro area rather than in Liquiça and Dili. Indeed, rice dominates in Bobonaro compared to the other two municipalities.

Multicropping has greater beneficial effects for limited topsoil. The main cause of limited soil on the northern coast is shifting agricultural activities, soil erosion and land degradation, which hinder agricultural productivity. In addition, climate change impacts such as drought, inundation, and flash floods are the major threats to food security and those whose livelihoods rely on natural resources and/or ecosystem services. Food insecurity and malnutrition are linked to low agricultural productivity and production. This low production is also influenced by the method of planting, including cultivated areas (Figure 70). The graphs show three methods of sowing (scatter, mixed and compact planting) that are commonly practiced in Timor-Leste's 509 226 ha of gross area devoted for crops and plants. It shows that the scatter method is more common (66.4 percent) than the other two methods and the census report text explaining Figure 70 states that low agriculture productivity in the country is also influenced by the scatter cultivation method.

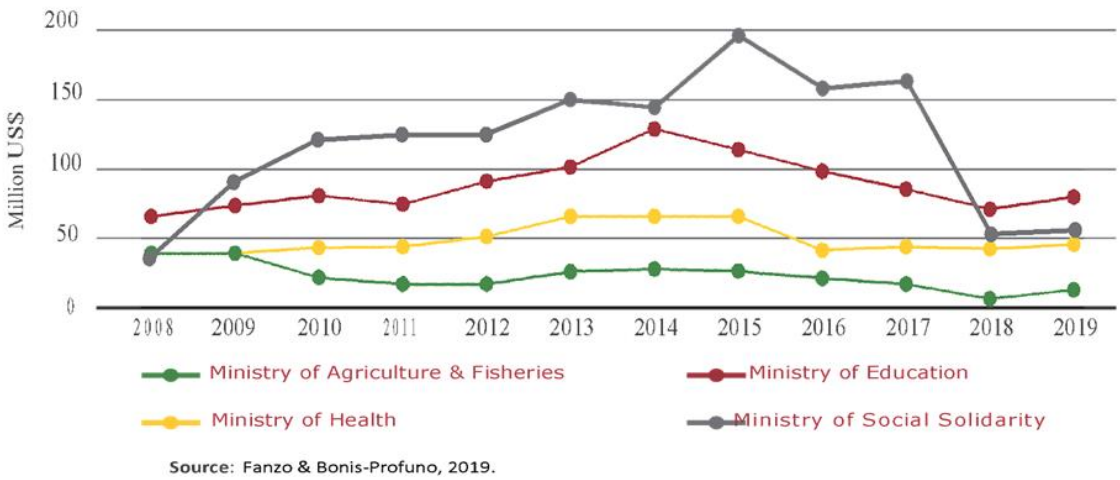
Figure 70. Cultivated area by method of planting



Source: Ministry of Agriculture and Fisheries. 2018. General Directorate of Statistics and Ministry of Agriculture and Fisheries. 2018 Timor Leste Agricultural Census: Instructions Manual for Field Staff. The Democratic Republic of Timor Leste

State budget allocation for the agricultural sector is relatively low (2.5 percent) compared to other main sectors, such as educatiKon, social solidarity and health sectors and the level of investment in the agriculture sector is relatively low; the investment is mostly in coffee plantations. This is the main barrier for the Ministry of Agriculture and Fisheries to deliver and meet the national demand for food and nutritional requirement (Figure 71).

Figure 71. Timor-Leste state budget allocated to key sectors between 2009 and 2019



Source: Fanzo, J. & Bonis-Profumo, G. 2019. [(PDF) Ravaged landscapes and climate vulnerability: The challenge in achieving food security and nutrition in post-conflict Timor-Leste (researchgate.net)]

The development of the agriculture sector is the key step in promoting economic growth and poverty reduction. Most of the population lives in rural areas and heavily depends on subsistence agriculture or agriculture-based livelihoods. In addition, coconut, orange trees, and ornamental crops are grown at high altitudes in addition to coffee plantations. Coffee is the main export product in Timor-Leste. Other agroforestry products include bamboo, mahoni (mahogany, *Swietenia macrophylla*), palms, sandalwood, and mangroves and are found across the country.

Low-lying agricultural land in Beacou (Bobonaro) is frequently subjected to severe drainage and soil salinity problems. This is mainly a result of the stagnation of rainwater and flash floods from rivers during heavy rain. This soil salinity problem will complicate its safe use for irrigation on paddy rice fields and for ornamental crops. Soil salinity also negatively affects land fertility, eventually leading to low productivity and ultimately negatively affecting agricultural production.

2.4 Legal, policy and institutional setting

Since the 1980s, Indonesia has ratified several ocean-related international conventions and is a member of various bilateral and multilateral collaborations with relevance to the management of marine and coastal resources. Indonesia demonstrated impressive leadership in the region by supporting the Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF) and building important partnerships that brought together domestic and foreign funding to promote the ocean conservation agenda. Since the election of President Joko Widodo (Jokowi) in 2014, policy and practice has focused more on domestic reform and strengthening the sovereign position of Indonesia with regards to its control over its coastal waters and marine resources and the prioritization of these resources for domestic needs. At the time of President Jokowi’s election, the government enacted Maritime Law No. 32/2014 to provide an effective legal framework for managing and developing natural resources. President Jokowi subsequently declared his vision to make Indonesia the “World’s Maritime Axis,” also known as the Global Maritime Fulcrum (GMF), and he outlined an ambitious maritime doctrine to boost economic growth by improving connectivity between the islands of the Indonesian Archipelago in Presidential Regulation No. 16/2017. A substantial government budget has been allocated to maritime infrastructure through the GFM initiative, with the objective of turning the country into a maritime-driven economy. Despite the significant potential for maritime growth, there is also a need to act cautiously because of intense competition and to ensure that ocean resources are utilized sustainably (i.e. the blue economy concept).

The blue economy concept is one of the MMAF agenda priority policies for 2021–2024 and has five main pillars. The first pillar aims to increase marine conservation areas to conserve marine life and protect the ocean (MMAF, 2022b). The second and third pillars focus on sustainable fisheries management and aquaculture practices to maintain fish resources and meet the protein needs of communities. The fourth pillar aims to manage coastal and small island areas to protect the environment and promote sustainable economic growth. Finally, the fifth pillar aims to tackle marine litter and pollution by cleaning up plastic waste in the ocean. The policy emphasizes promoting sustainable economic growth while protecting the marine environment, increasing marine conservation areas, implementing sustainable fisheries management practices, developing sustainable aquaculture practices, managing coastal and small island areas, and tackling marine litter and pollution.

Furthermore, it is anticipated that trade among the ASEAN economic community will continue to rise in the upcoming years, leading to an urgent need for investment in maritime infrastructure. The elimination of tariffs and trade barriers within the region is expected to cause an influx of goods to and from Indonesian ports, making it crucial for the country to invest in marine infrastructure to remain competitive with neighbouring nations. Moreover, the Jokowi administration has implemented various economic policies, including the Sea Toll Program (also known as the Sea Highway Program), to bolster Indonesia's maritime power in line with the Master Plan for Acceleration and Expansion of Indonesia's Economic Development (MP3EI, 2011–2025).

The Indonesian Ocean Policy (IOP) document states that it should be implemented by ministries and institutions according to their respective duties and functions. The implementation and monitoring of the Indonesian Maritime Policy is coordinated by the Coordinating Ministry for Maritime and Investments Affairs (CMMIA). The IOP Action Plan (2016 to 2019) is an elaboration of the seven pillars of the Indonesian policy, with its details described in five priority programme clusters: (i) maritime boundaries, ocean space, and maritime diplomacy; (ii) maritime industry and sea connectivity; (iii) services and industry of marine natural resources and marine environmental management; (iv) maritime defense and security; and (5) maritime culture.

The MMAF has interpreted the national policy to prioritize the development of the marine and fisheries sectors in MMAF Regulation No. 63/2017 on MMAF strategic plan 2015-2019 which states that the mission of the ministry builds on the three pillars of sovereignty, sustainability, and prosperity through seven goals:

(i) Enhance surveillance and management of marine fisheries resources.
(ii) Develop fish quarantine, quality control, fisheries security, and fish biosafety systems.
(iii) Optimize the management of sea space, conservation, and marine biodiversity.
(iv) Improve the sustainability of fisheries and aquaculture businesses.
(v) Improve the competitiveness of the logistics (shipping) system.
(vi) Develop human resource capacity and empowerment.
(vii)Develop marine and fisheries science and innovations in technology.

Although all these goals receive attention through budget allocations, the primary objective of the previous Minister of MMAF was to eradicate IUU fishing and turn the tide against economic, social, and food security losses from its oceans. Feeding the nation, especially children, with fish protein has become the driving force behind this initiative. The primary role of the CMMIA is to coordinate and synchronize the implementation of the national policy with four ministries: Transportation, Marine Affairs and Fisheries, Tourism, and Energy and Mineral Resources. While the Coordinating Ministry seeks to strengthen and accelerate effective performance of ocean-related policies through these four agencies, the Coordinating Ministry also has its own priorities, which focus on addressing ocean waste, accelerating development of Indonesia's renewable energy sector, and improving domestic connectivity for transport and trade between Indonesia's many islands. Various media articles since 2020 indicate that both the MMAF and the Coordinating Maritime Ministry share a growing interest in accelerating aquaculture development to increase domestic food security and seek to increase foreign currency earnings through the export of high-quality seafood to a growing global market. However, interagency decision-making on the offsets of choosing different economic growth scenarios does not yet appear to have effectively occurred.

An initial assessment of the policies governing the individual sectors leads to the conclusion that there are several overarching regulations—laws, government regulations and presidential regulations—that outline the general policy for conducting activities in the maritime environment. However, media coverage (March 2018) of the ministers' statements includes confirmation that the deep-water oil project at Masela Block will continue to be supported for exploitation purposes. Regulations provide direction on the policies and technical requirements governing each individual ministry's typical activities, such as operational requirements and licensing.

On the other hand, coastal communities are among the most vulnerable to poverty and economic inequality. The Blue Economy Development Framework for Indonesia's Economic Transformation offers potential solutions to combat poverty by leveraging the blue economy concept. The framework focuses on promoting sustainable economic development while protecting the marine environment. This approach aims to generate economic growth and job creation, particularly in sectors such as fisheries and aquaculture. This can be achieved through initiatives such as promoting sustainable fisheries practices, increasing access to finance and technology for small-scale fishers, and developing coastal tourism. Additionally, the framework highlights the importance of ensuring the equitable distribution of economic benefits and opportunities to reduce poverty and inequality.

2.4.1 International legal framework

Part VII of the 1982 United Nations Convention on the Law of the Sea (UNCLOS) in Article 118 outlines that states shall cooperate with each other in the conservation and management of living resources in the areas of the high seas. States whose nationals exploit identical living resources or different living resources in the same area shall enter into negotiations with a view to conservation of the living resources concerned and shall, as appropriate, cooperate to establish subregional or regional fisheries organizations. Articles 122 and 123 in Part IX of the Convention address the subject of “Enclosed and Semi-Enclosed Seas” and recognize special geographical situations where two or more bordering states should cooperate in exercising their rights and the performance of their duty to coordinate in the management of shared marine resources and environments.

Indonesia's regulatory framework governing shipping in Indonesia is based around its maritime law, which regulates the implementation of integrated Indonesian marine resources for national welfare. The implementation covers several aspects related to shipping, territorial seas, maritime development, marine management, protection of the marine environment, law enforcement, and sea safety. Indonesia has also ratified several international conventions on shipping, such as the International Maritime Organization Convention 1984, which maintains a comprehensive regulatory framework for shipping relating to safety, environmental concerns, legal matters, technical co-operation, maritime security, and the efficiency of shipping (UNCLOS 1982).

Indonesia has been implementing the International Plan of Action for the Management of Fishing Capacity (IPOA) and the Code of Conduct for Responsible Fisheries (CCRF) since their adoption by the FAO of the United Nations in 1999 and 1995, respectively. In 2018, Indonesia adopted a new fisheries law, Law No. 45/2018, which emphasizes sustainable fisheries management and the conservation of marine resources, including the management of fishing capacity, the protection of marine ecosystems, and the prevention of IUU fishing. To support the implementation of the IPOA and CCRF, Indonesia and FAO signed a new country programming framework (CPF) for 2021–2025. This CPF outlines areas of cooperation between Indonesia and FAO to promote sustainable fisheries management and the conservation of marine resources. Indonesia has also implemented initiatives, such as the establishment of FMAs and a national monitoring, control, and surveillance (MCS) system to prevent illegal fishing activities. These efforts demonstrate Indonesia's ongoing commitment to the sustainable management and conservation of its marine resources in accordance with the IPOA and CCRF.

The CCRF underscores principles and international standards of behaviour for responsible practices in terms of ensuring the effective management and conservation of marine and coastal resources. The Code covers all aspects of fisheries activities such as fishing, processing, trade including fisheries monitoring and surveillance, and it incorporates all principles introduced in Agenda 21, including the Rio Declaration. The principles consist of the conservation of marine and coastal ecosystems and their fauna and flora.

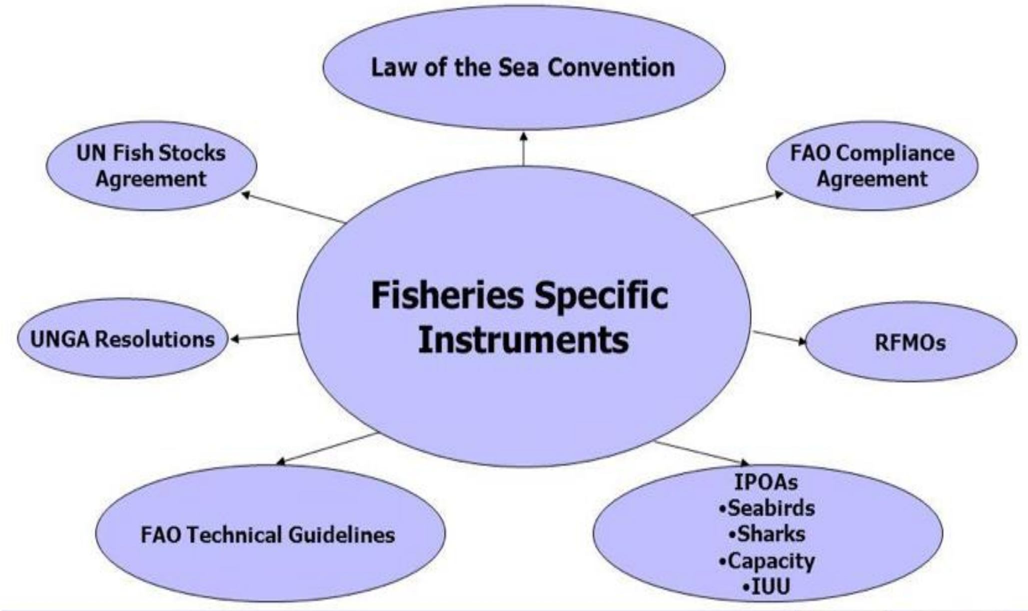
The international fisheries policy has been led by the FAO. FAO also plays an important role in fisheries management, fisheries governance, and combating IUU fishing. In addition, the FAO also deals with and implements the Code of Conduct for Responsible Fisheries and the Port State and Flag State Measures Agreements to prevent and/or monitor IUU fishing and related activities.

Apart from FAO, the United Nations Convention on the Law of the Sea (UNCLOS) adopted in 1982, plays an important role relating to the conservation and management of fish stocks and highly migratory fish stocks called the UN Fish Stocks Agreement. This agreement broadly incorporates a number of principles and rules that enable it to act widely in its application, which is relevant to the management and conservation, including utilization of marine and coastal resources. There are also several other UN bodies such as International Labour Organization, International Maritime Organization, World Customs Organization, World Trade Organization, World Bank, and United Nations Educational, Scientific and Cultural Organization that deal with measures on fisheries conservation, trade, monitoring, and surveillance, and enforcement of fishing operations. This collaboration is pivotal and should use existing scientific evidence to determine the area of fish distribution or fish stock. Transboundary issues are more complex than boundary issues within a single country. In this regard, cooperation is essential for fishery management and for the conservation of living resources in the coast and coastal and high seas. It should be possible for all nations to legally access the biodiversity resources provided along the high seas. The capture of fish along the high seas and its regulation are beyond the control of any one individual country.

To reduce illegal activities on the high seas, the United Nations Fish Stocks Agreement was developed. This agreement aims to manage measures of fish stocks and highly migratory fish stocks. This agreement should be ratified by each participating nation. This is because this UN agreement adopted obligations and fisheries management principles that support long-term conservation and sustainable use of marine resources and highly migratory fish stocks. The agreement encourages all countries to implement the agreement framework and engage in collective cooperation with each other to preserve and survey all fish stocks. The agreement also facilitates all member countries to inspect their fishing fleets on the high seas, and comply with regional and international management measures to properly manage international fisheries.

The principle of international law has been reinforced by the UN Fish Stocks Agreement. Therefore, all countries have to share flag state responsibility as a principle of international law. If there is any violation or infraction of rules, the flag state of the fleet concerned is responsible for undertaking investigation and appropriate enforcement action. This is a key component of an international legal and normative framework (Figure 72).

Figure 72. International legal and normative framework for managing fish stocks



Source: Tsamenyi, M. 2007. Fisheries management: the current legal and normative framework. University of Wollongong. Australia.

Fisheries-specific instruments are applicable in the regions (all nations) of their jurisdictions and under existing multilateral, bilateral, conventions, and agreements, including international protocols. Moreover, it needs proper cooperation among countries to exercise these instruments, particularly those that have enclosed or semi-enclosed sea. As stipulated in Article 123 of the UNCLOS regarding the cooperation of states bordering enclosed or semi-enclosed seas, "States bordering an enclosed or semi-enclosed sea should co-operate with each other in the exercise of their rights and in the performance of their duties under this

Convention. To this end they shall endeavour, directly or through an appropriate regional organization:

(i) to co-ordinate the management, conservation, exploration, and exploitation of the living resources of the sea;
(ii) to co-ordinate the implementation of their rights and duties with respect to the protection and prservation of the marine environment;
(iii) to co-ordinate their scientific research policies and undertake where appropriate joint programmes of scientific research in the area; and
(iv) to invite, as appropriate, other interested states or international organizations to co-operate with them in furtherance of the provisions of this article." (UNCLOS 1982)

International agreement about marine biodiversity

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement to regulate the international trade of endangered species and their products, including marine organisms, in order to ensure their conservation and sustainable use. The text was agreed on 3 March 1973 and came into force on 1 July 1975. Indonesia became a Contracting Party to the Convention on 28 December 1978 and plays a significant role in its implementation.

Indonesia is home to 118 species of sharks including ten shark species listed under Appendix II of CITES (CITES, 1975). These are *Cetorhinus maximus, Rhincodon typus, Carcharodon carcharias, Lamna nasus, Carcharhinus longimanus, Sphyrna lewini, Sphyrna mokarran, Sphyrna zygaena, Alopias spp, Carcharhinus falciformis*. The country aims to protect these species from overexploitation and ensure their long-term survival in Indonesian waters.

2.4.2 Regional policy framework

Indonesia and Timor-Leste participate in various regional policy initiatives, some of which are described here.

Indonesia

Coral Triangle Initiative for Coral Reefs, Fisheries and Food Security (CTI-CFF)

Recognizing the need to safeguard the region's marine and coastal resources, previous Indonesian President Yudhoyono inspired other leaders in the region to launch the CTI-CFF in 2009. The CTI-CFF is a multilateral partnership between the governments of Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste. At the Leader's Summit on 15 May, 2009 in Manado, North Sulawesi, Indonesia, these six governments agreed to adopt the ten-year CTI-CFF Regional Plan of Action (CTI RPOA) to safeguard the region's marine and coastal biological resources. Through the CTI-CFF, the Coral Triangle (CT) countries have agreed to support people-centered biodiversity conservation, sustainable development, poverty reduction, and equitable benefit sharing. The CTI-CFF seeks to address poverty reduction through economic development, food security, and sustainable livelihoods for coastal communities and biodiversity conservation through the protection of species, habitats, and ecosystems.

There are five goals of the CTI RPOA that were agreed upon by the six country leaders: (i) priority seascapes designated and effectively managed; (ii) the EAFM and other marine

resources fully applied; (iii) MPAs established and effectively managed; (iv) climate change adaptation measures achieved; and (v) improving the status of threatened species.
The CTI RPOA is a living and non-legally binding document intended to guide conservation and sustainable management of coastal and marine resources within the CT region in compliance with the laws and policies of each country. At the senior officials meeting in Port Moresby, Papua New Guinea in March 2009, it was agreed that the first CTI RPOA would be valid for a period of ten years. This RPOA is not only a guidance for each national plan of action (NPOA) of the CTI-CFF member countries, but it also includes programmes and activities that involve at least two member countries' authorities, responsibilities, and needs. The first RPOA was reviewed in 2019, and as a result, the next version of the RPOA was drafted in 2020 to build on learnings from the first version and to adapt to regional challenges that have evolved over the previous ten years. This RPOA 2.0 (2021_2030) has two goals and three objectives: on ecosystem health, on resilience and socioeconomic conditions, and on good governance.

Indian Ocean Tuna Commission (IOTC)

Indonesia has made progress regarding the management of its diverse fisheries, partially related to ensuring Indonesia's compliance with rules of the regional fisheries management organizations (RFMOs) and partially stimulated by import regulations and consumer trends in markets for higher-valued commodities (e.g. tuna) from Indonesia. Moreover, many of the systems that underpin responsible tuna fisheries management have been strengthened, thereby improving governance and management of other fisheries. Although the official fisheries statistics time–series data may be in question, the available data offer only country- and sector-wide time–series data to inform decision makers. More recently, the need to enhance traceability and transparency to serve the international market-driven demand for sustainable and socially responsible seafood has helped to improve fisheries data collection. Support from international institutions and NGOs has helped to improve Indonesia's capacity to collect catch and effort data, which in turn allows national scientists to improve their management advice to Indonesian authorities and decision-makers.

Government policy empowers tuna fisheries to comply continuously with RFMO rules, which obliged Indonesia to become a member of the IOTC, an intergovernmental organization responsible for the management of tuna and tuna-like species in the Indian Ocean. The IOTC works to achieve responsible management by promoting cooperation among its contracting parties (members) and Cooperating Non-Contracting Parties to ensure the conservation and appropriate utilization of fish stocks and to encourage the sustainable development of fisheries.

The IOTC has four key functions and responsibilities drawn from the UNCLOS, which enable the Commission to achieve its objectives: (i) to continuously review the conditions and trends of the stocks and to gather, analyse, and disseminate scientific information, catch and effort statistics, and other data relevant to the conservation and management of the stocks and based on the stocks to fisheries; (ii) to encourage, recommend, and coordinate research and development activities in respect to the stocks and fisheries covered by the IOTC, and such other activities as the Commission may decide appropriate, such as the transfer of technology, training and enhancement, having due regard to the need of equitable participation of commission members in the fisheries and the special interests and needs of members in developing countries; (iii) to adopt on the basis of scientific evidence conservation and management measures (CMM) to ensure the conservation of the stocks covered by the agreement and to promote the objective of their optimum utilization throughout the area; and (iv) to continuously review the economic and social aspects of the fisheries based on the stocks covered by the agreement bearing in mind, in particular, the interests of developing coastal states.

Commission for the Conservation of Southern Bluefin Tuna (CCSBT)

The CCSBT is an intergovernmental organization responsible for the management of southern bluefin tuna (*Thunnus maccoyii*) (SBT) throughout its distribution. The CCSBT's objective is to ensure, through appropriate management, the conservation and optimum utilization of southern bluefin tuna (SBT). The establishment of this organization was initiated by three governments concerned about the steady decline of the SBT because of intense fishing, which since the early 1960s has yielded an annual catch of 80 000 tonnes. In the mid-1980s, it became apparent that the SBT stock was at a level where management and conservation were required. The main nations fishing SBT at the time—Australia, Japan, and New Zealand—began to apply strict quotas to their fishing fleets from 1985 as a CMM to enable the SBT stocks to rebuild. On 20 May 1994, the existing voluntary management arrangement between these three countries was formalized when the Convention for the Conservation of Southern Bluefin Tuna, originally signed by the three countries in May 1993, came into force. The Convention created the CCSBT, which is headquartered in Canberra, Australia.

Indonesia joined the CCSBT as a full member in 2008 following the ratification of Presidential Regulation No. 109/2017 concerning the ratification of the CCSBT convention, and since then, Indonesian southern bluefin tuna products are considered legal and can be traded as such on the international market. Membership in the CCSBT currently includes Australia, Japan, New Zealand, Indonesia, Taiwan, South Korea, South Africa, and the European Union. The Philippines is a cooperating non-member.

Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)

PEMSEA was created with a clear mission: to foster and sustain healthy and resilient coasts and oceans, communities, and economies across the seas of East Asia through integrated management solutions and partnerships. PEMSEA also serves as an executing agency for the ATSEA Program, which focuses on combating illegal, unreported, and unregulated fishing in the region, promoting sustainable fisheries management, and protecting the marine environment in the seas of East Asia. In December 2003, participating governments and collaborative partners endorsed the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA), a document that outlines a shared vision, as well as collective strategies and approaches to achieve the goals of sustainable development for the region. The implementation of the SDS-SEA requires a long-term commitment, policy reforms, strategic management interventions, and significant financial resources. In June 2007, the Global Environment Facility (GEF) Council approved Phase I of a 10-year project (2007–2017) to implement the SDS-SEA, which facilitated PEMSEA's transformation into a self-sustaining regional operating mechanism. The GEF provided the necessary financial support to cover the incremental costs of addressing regional environmental issues that are of global significance through the implementation of the SDS-SEA.

PEMSEA serves as the executing agency for the Arafura and Timor Seas (ATSEA) programmes and has provided solutions to meet its mission (ATSEA, 2011b). As the regional coordinating mechanism for the SDS-SEA, a shared marine strategy among 14 countries in the region, PEMSEA works with national and local governments, companies, research and science institutions, communities, international agencies, regional programmes, investors, and donors toward implementation of the SDS-SEA. Crucial networks, such as learning centres, also contribute their expertise and coastal management skills to the shared goals of the SDS-SEA.

PEMSEA aims to proactively build effective intergovernmental and intersectoral partnerships and expand the capacities of countries and other stakeholders with innovative, cross-cutting policies, tools, and services for integrated coastal and ocean management. PEMSEA applies integrated coastal management as the primary approach for generating and sustaining healthy oceans, people, and economies. The member countries include Cambodia, China, the Democratic People's Republic of Korea, Indonesia, Japan, Lao People's Democratic Republic, Republic of Korea, Philippines, Singapore, Timor-Leste, and Viet Nam.

Southeast Asian Fisheries Development Centre (SEAFDEC)

SEAFDEC has a vision to promote sustainable management and development of fisheries and aquaculture to contribute to food security, poverty alleviation, and the livelihood of people in the Southeast Asian region. One of the measures of support from SEAFDEC includes collecting and presenting fisheries data and statistics for the FAO and providing capacity development. The aim of this organization is developing and managing the fisheries potential of the region by rational utilization of the resources to provide food security and safety and alleviate poverty through the transfer of new technologies, research, and information dissemination activities. Some departments of SEAFDEC include the Training Department, Marine Fisheries Research Department, Aquaculture Department, the Marine Fisheries Resources Development and Management Department, and the Inland Fishery Resources Development and Management Department (IFRDMD). IFRDMD was established in 2014 as a part of SEAFDEC and is located in Palembang, Indonesia. IFRDMD primarily carries out activities to support the sustainable development and management of inland capture fisheries in the ASEAN region. The activities include developing methodologies for data collection, monitoring, and assessment of inland fishery resources by using scientific-based methods to provide data.

Timor-Leste

The regional policy framework, such as the 2030 Agenda, is being adopted by the government of Timor-Leste, thus, cooperation is important for its successful implementation. Timor-Leste's responsibility under existing multilateral and bilateral arrangements should be extended and given more attention and priority, such as Goal 13, Goal 14 and Goal 17 of the 2030 Agenda and other multilateral commitments. This is necessary to manage marine and coastal resources, including transboundary fish stocks. Conservation and management measures of fish stocks, including transboundary stocks, need to be established and properly coordinated between/among countries.

The transboundary fish stocks and their issues at the regional level should be managed in accordance with respective competencies of relevant littoral countries (e.g. Australia, Indonesia, and Timor-Leste) through bilateral arrangements. Moreover, the management measures should be compatible with each nation's political circumstances. For the purpose of implementing these management measures, joint research, surveillance, and enforcement should be done together with all littoral countries.

Littoral countries at the regional level need to incorporate fisheries policy into regional economic blocs to facilitate and address crossborder fisheries management issues, such as the IUU fishing (Enderwick and Buckley, 2020). Currently, crossborder or transboundary fisheries have gained much attention from several countries as they involve marine environment and socioeconomic and political aspects. Most societies are concerned about the degradation of marine resources and the sustainability of the world's oceans. This is because the economic status of littoral countries is derived from fisheries (e.g. fishery industry and seafood trade). At the same time, the marine transboundary becomes a highly sensitive political issue when the delimitation of sea waters and geopolitical factors are involved, for example, the pending agreements regarding sea water delimitation between Indonesia and Timor-Leste. Most coastal communities rely on fisheries products (both Indonesia and Timor-Leste on the border) as part of their income generation and primary livelihood strategies, including nutritional security. For that reason, fisheries management requires regional cooperation and effective implementation of existing regional agreements (Li, 2022).

So far, fisheries management is often done by a single country, based on national ability, willingness, and implementation. FAO has provided many frameworks and regimes, including guidelines and principles to promote the conservation of living marine resources. However, because of certain circumstances, littoral countries are sometimes unable to implement these in an effective way. Regional fisheries bodies (RFB) and regional fisheries management organizations (RFMO) have been established. These organizations play an important role in facilitating and improving transboundary fisheries management. In addition, they are also dedicated to playing a special role in providing scientific data and advice, including decision-making based on scientific studies (Young, 2011).

Overall integration and demand for multilateral cooperation are the key steps in dealing with transboundary issues. Crossborder issues need to be regionalized to take into account the different technological, scientific, financial, and infrastructural development in the various littoral countries. This facilitates transboundary cooperation and/or coordination to explore better and more effective solutions (Sumaila, Bellmann and Tipping, 2016). IUU fishing can be the dominant issue in transboundary areas. Many treaties ratified by nations are actually legally binding forces. However, because of the high demand for seafood and economic performance, countries ignore these treaties, laws, and related regulations. A fundamental legal framework established under UNCLOS concerning marine issues, especially Articles 61–68, 116–120 and 197 of the Convention, underlines proper cooperation among countries to protect and preserve marine resources in a sustainable fashion.

Apart from UNCLOS, the FAO has provided more complete and practical regulations. The main function is to prepare a forum for the development of norms to gather, analyze, and share data. The FAO has created also legal instruments (legally binding treaties and non-legally binding or soft instruments) to support and facilitate fisheries management in crossborder marine waters. It plays an important role in providing technical and practical assistance for littoral countries on how to implement fisheries management measures (Henriksen, 2018).

2.4.3 National legislation, policies, institutions, administrative arrangements

National fisheries laws and policies in Indonesia

Indonesia has implemented a set of regulations (Table 24) that address the utilization and sustainable management of its fisheries resources, including the conservation, research, and development of fish resources and the environment.

Table 24. Laws and regulations related to marine and coastal resources management measures, Indonesia

Laws and regulations in Indonesia	Title
Law No. 45/2009	Fisheries
Law Number 11/2020	Job Creation
Law Number 27 Year 2007	Management of Coastal and Small Islands
Law No. 22/1999	Autonomy Law
Law No. 23/2014	Local Government
Government Regulation No. 27/2021	Marine Affairs and Fisheries
MMAF Regulation No. 18/2014	Fisheries Management Area and its boundaries.
MMAF Regulation No. 2/2023	Types and Tariffs of Non-Tax State Revenues in the Fisheries and Marine Sectors
MMAF Regulation No. 37/2023	Fisheries Data
MMAF Decree No. 33/2021	Logbook, Surveillance onboard Fishing Vessels and Fish Carrying Vessels, Inspection, Verification and Fishing Vessel Crew Management
MMAF Decree No. 19/2022	Estimated Fisheries Resources Potentials
MMAF Decree No. 87/2021	Fishing Vessel Productivity
MMAF Decree No. 22/2021	Formulation of Fisheries Management Plan and Fisheries Management Council/Institution
MMAF Decree No. 11/2023	Quota-Based Fisheries
MMAF Decree No. 48/2020	Organization and Mandate of MMAF
MMAF Decree No. 18/2021	Fishing Gears and Supporting Fishing Gears
MMAF Decree No. 10/2021	Business Activity Standard
MMAF Decree No. 79/2016	Fisheries Management Plan in 712
MMAF Decree No. 80/2016	Fisheries Management Plan in 713
MMAF Decree No. 81/2016	Fisheries Management Plan in 714
MMAF Decree No. 82/2016	Fisheries Management Plan in 715
MMAF Decree No. 77/2016	Fisheries Management Plan in 573

Source: FAO Stakeholder consultation. 2022.

These regulations are in line with Article 7, Paragraph (1) of Law No. 31/2004 concerning fisheries, which requires the establishment of fisheries management areas in the Republic of

Indonesia. The government of Indonesia, through the MMAF, has issued Regulation No. Per-18/MEN/2014, which outlines the FMAs and their boundaries. This regulation sets out the territory of the Republic of Indonesia that falls under the scope of fisheries management, with the aim of ensuring the sustainable use of fish resources and the environment.

Article 1, Paragraph (1) in Law (*Undang-undang*, UU) No. 31/2004 states that the Fisheries Management Territory of the Republic of Indonesia, which is hereinafter referred to as FMA-RI or FMA, is a fisheries management area for capture fishing, fish farming, conservation, research, and development, including inland waters, island waters, territorial sea, additional zones, and Indonesia's EEZ. FMAs in Indonesia, as described in Article 7, Paragraph (1) of Law No. 31/2004 concerning fisheries, are divided into 11 fisheries management areas, as listed below, with FMAs within the ISLME area in bold text:

- FMA 571 covers the waters of the Malacca Strait and the Sea Andaman;
- FMA 572 covers the waters of the West Indian Ocean Sumatra and the Sunda Strait;
- **FMA 573** covers the waters of the adjoining Indian Ocean South Java to the south of Nusa Tenggara, Sea Sawu, and the West Timor Sea;
- FMA 711 covers the waters of the Karimata Straits, Natuna Sea, and the South China Sea;
- **FMA 712** covers the waters of the Java Sea;
- **FMA 713** covers Makassar Straits Waters, Bone Bay, Flores Sea, and Bali Sea;
- **FMA 714** covers the waters of the Tolo Bay and the Banda Sea;
- **FMA 715** covers the waters of Tomini Bay, the Sea Maluku, Halmahera Sea, Seram Sea, and Berau Bay;
- FMA 716 covers the waters of the Sulawesi Sea and adjoining seas north of Halmahera Island;
- FMA 717 covers the waters of the Cenderawasih Bay and Pacific Ocean; and
- FMA 718 covers the waters of the Aru Sea, the Arafura Sea, and East Timor Sea.

Indonesia has introduced several updated policy initiatives in recent years aimed at addressing the legal aspects of fisheries capture. One such initiative is the quota-based fisheries management policy, which seeks to ensure that fish stocks are managed sustainably and that fisheries are operated in a responsible and ethical manner. The policy includes measures to establish sustainable fishing practices, such as limiting the size and number of fishing vessels, regulating fishing gear, and implementing a catch monitoring system. The policy also aims to promote the use of selective fishing gear and to encourage the adoption of environmentally friendly fishing methods.

Another significant policy development in Indonesia is the Omnibus Law, which was passed in 2020. This law includes provisions that are designed to support the sustainable development of the fisheries sector, including measures to improve the management of fish stocks, increase investment in the sector, and promote the use of advanced technologies in fisheries. The law also aims to streamline the licensing process for fishing activities and to establish a more transparent and accountable regulatory framework for the sector.

In addition, the Indonesian government launched the National Blue Agenda Action Plan, which was unveiled during the G20 Summit in 2020. This plan sets out a series of actions that are designed to support the sustainable development of the country's marine and fisheries sectors. The plan includes measures to increase investment in the sector, improve the management of fisheries resources, and promote the adoption of sustainable fishing practices. The plan also aims to strengthen the legal and regulatory framework for the sector and to promote greater collaboration between the government, industry, and civil society to achieve the objectives of the plan.

Moreover, in 2015, all United Nations Members adopted the sustainable development goals (SDGs) as a universal call to action aimed at eradicating poverty, preserving the environment, and ensuring peaceful and prosperous lives for all by 2030. The 17 SDGs are interrelated, recognizing that actions taken in one area will affect outcomes in others and that development must balance social, economic, and environmental sustainability (FAO, 2020a).

The government regulation of the Republic of Indonesia No. 85 of 2021 on Types and Tariffs of Non-Tax State Revenues in the Fisheries and Marine Sectors aims to optimize the potential of marine and fisheries resources in supporting economic development in these sectors. The regulation establishes tariffs for various types of non-tax state revenues in the fisheries and marine sectors and sets administrative requirements and payment procedures for stakeholders. Additionally, non-tax state revenues are obtained from various sources, such as fishery licensing, fish landing fees, fish auction fees, and others. The regulation also provides sanctions for stakeholders who violate the requirements or fail to pay non-tax state revenues. With the enactment of the regulation, the management of non-tax state revenues in the fisheries and marine sectors is expected to improve and provide optimal benefits for the development and sustainability of these sectors in Indonesia.

Institutional and fisheries management planning arrangements in Indonesia

Indonesia's current governance arrangements rely on a collaborative decentralized management approach, whereby provincial and district authorities are assigned certain fisheries management responsibilities through the Autonomy Law No. 22/1999, and Local Government Law, No. 23/2014. As a follow-up to Ministerial Decree No. 18/2014 concerning the FMAs of the Republic of Indonesia, the Director General of Capture Fisheries issued Decree No. 47/KEP- DJPT/2017 concerning the Fisheries Management Institution of the Indonesia Fisheries Management Areas. The Fisheries Management Institution is an independent, non-structural institution authorized to coordinate and recommend sustainable fisheries management in each FMA.

The FMA institution is structured into national and regional levels. The establishment of the FMA institution aims to improve the efficiency, optimization, and coordination of the implementation of fisheries management in FMAs using the ecosystem approach. The functions of the institution in accordance with the Decree of the Director General of Capture Fisheries No. 47/KEP-DJPT/2017 are to: (i) coordinate the implementation of the *Rencana Pengelolaan Perikanan (RPP)*, that is, the Fisheries Management Plan (RPP); (ii) evaluate the RPP; (iii) provide input for the preparation of the RPP; (iv) implement recommendations for sustainable fisheries management policies in FMAs; and (v) prepare reports on sustainable fisheries management in FMAs.

By carrying out the above functions, the FMA institution plays a role as a management authority that has complete control in managing each FMA, especially in the implementation and evaluation of the RPP. This includes solving fisheries management issues, as well as providing a forum for coordination and synergy in fisheries management in each of the 11 FMAs in the form of regional secretariat fisheries management institutions.

While awaiting definitive approval from the authorities, namely the Ministry of the State Civil Apparatus and Bureaucratic Reform on FMA institution, secretariats have been established in the four relevant ISLME FMAs and are hosted by the fishing port offices (PPS or PPN) as follows: FMA 573 at PPS Cilacap, FMA 712 at PPN Brondong, FMA 713 at PPN Untia, FMA 714 at PPS Kendari, and FMA 715 at PPS Bitung.

Fisheries management plans

To carry out the mandate of Article 7, Paragraph (1) in Law No. 31/2004 concerning fisheries, as amended by Law No. 45 of 2009, it is necessary to draw up a fisheries management plan for each Indonesian FMA. The MMAF has established Fisheries Management Plans for each of the five FMAs in the ISLME region.

1. Fisheries Management Plan of the FMA 573

The Fisheries Management Plan of the FMA 573 was established through MMAF Decree No. 77/ 2016 dated 29 December 2016. The purpose of this plan is to provide direction and guidance for the government and stakeholders in the implementation of the management of fish resources and the environment at the FMA 573. As noted in MMAF Regulation No. 18 /2014 concerning the Republic of Indonesia's FMA, FMA 573 covers territorial waters of the Indian Ocean south of Java to the south of Nusa Tenggara, the Savu Sea, and the West Timor Sea. The authority and responsibility to manage fish resources in FMA 573 rests with eight provincial governments: Banten, West Java, Central Java, the Special Region of Yogyakarta, East Java, Bali, West Nusa Tenggara, and East Nusa Tenggara provinces.

2. Fisheries Management Plan of the FMA 712

The Fisheries Management Plan of the FMA 712 was established through MMAF Decree No. 79/ 2016 on 29 December 2016. The purpose of this plan is to provide direction and guidance for the government and stakeholders in the implementation of management of fish resources and the environment at the FMA 712. As noted in MMAF Regulation No.18/ 2014 (MMAF, 2014), FMA 712 covers territorial waters of the Java Sea. The authority and responsibility to manage fish resources in the FMA 712 rests with eight provincial governments: Lampung, Banten, DKI Jakarta, West Java, Central Java, East Java, Central Kalimantan, and South Kalimantan provinces. FMA 712, which covers the waters of the Java Sea, is one of the strategic fishing areas in Indonesia. The estimated potential of fish resources in FMA 712 is 981 680 tonnes annually.

3. Fisheries Management Plan of the FMA 713

The fisheries management plan for FMA 713 was established through MMAF Decree No. 80/ 2016 on 29 December 2016. The purpose of this plan is to provide direction and guidance for the government and stakeholders in the implementation of management of fish resources and the environment at the FMA 713.

As noted in MMAF Regulation No. 18/ 2014, FMA 713 covers the territorial waters of the Makassar Strait, Bone Bay, the Flores Sea, and the Bali Sea. The authority and responsibility to manage fish resources in the FMA 713 rests with ten provinces: East Kalimantan, South Kalimantan, East Java, Bali, West Nusa Tenggara, East Nusa Tenggara, South Sulawesi, Central Sulawesi, North Sulawesi, and West Sulawesi provinces. FMA 713, which includes Makassar Strait waters, Bone Bay, Flores Sea, and the Bali Sea, is one of the strategic fishing areas in Indonesia. The estimated potential of fish resources in FMA 713 is 1 026 599 tonnes annually.

4. Fisheries Management Plan of the FMA 714

The fisheries management plan of FMA 714 was established through MMAF Decree No. 81/ 2016 on 29 December 2016. The purpose of this plan is to provide direction and guidance for the government and stakeholders in the management of fish resources and the environment in FMA 714. As noted in MMAF Regulation No. 18/2014, FMA 714, which covers the territorial waters of Tolo Bay and the Banda Sea, is one of the strategic fishing areas in Indonesia. The estimated potential of fish resources is 431 069 tonnes per year. The authority and responsibility to manage fish resources in FMA 714 rests with five provinces: East Nusa Tenggara, Southeast Sulawesi, Central Sulawesi, Maluku, and North Maluku provinces.

5. Fisheries Management Plan of the FMA 715

The Fisheries Management Plan of the FMA 715 was established through MMAF Decree No. 82/2016 on 29 December 2016. The purpose of this plan is to provide direction and guidance for the government and stakeholders in the implementation of the management of fish resources and the environment at the FMA 715. As noted in MMAF Regulation No. 18/ 2014, FMA 715 includes Tomini Bay, Maluku Sea, Halmahera Sea, Seram Sea, and Berau Bay, and it is one of the reef fishing areas that is a rich source of small pelagic fish and also provides bait fish in Indonesia. The estimated potential of fish resources in FMA 715 is 631 703 tonnes per year. The authority and responsibility to manage fish resources in the FMA 715 rests with six provinces: North Sulawesi, Gorontalo, Central Sulawesi, Maluku, North Maluku, and West Papua provinces.

Fish stock assessment

To support sustainable fisheries management policies in the FMAs, the MMAF through Decree No. 19/ 2022 has estimated the potential, the number of catches allowed, and the level of utilization of fish resources in each FMA, which are used as the main factors in determining the allocation of fish resources that will be evaluated annually based on study results from *Komisi Nasional Pengkajian Sumber Daya Ikan/*the National Commission on Fish Resources Assessment (*KOMNAS KAJISKAN*). If *KOMNAS KAJISKAN* did not specify a specific result, the potential, the number of catches allowed, and the level of utilization of fish resources in each FMA could still be declared until a new ministerial decree is ratified.

To protect spawning areas and grounds in FMA 714, the MMAF ratified Ministerial Regulation No. 26/ 2020 concerning the Prohibition of Fishing in the Fisheries Management Territory of the Republic of Indonesia 714. In Article 2, Paragraphs (1) and (2) of this regulation:

1. Everyone is prohibited from catching fish in a part of Management Area 714, which is a breeding and spawning ground; and

2. Breeding and spawning grounds, as referred to in Paragraph (1), with maps and coordination points are inseparable parts of this ministerial regulation.

It was determined that while the Coordinating Ministry of Maritime and Investment Affairs assists the other ministries in developing their own regulations regarding marine activities, the actual regulations issued by the Coordinating Ministry of Maritime and Investment Affairs address the internal organization and operation of the ministry itself or, in some cases, specific activities or projects (i.e. special economic zone development in Sorong). There are broad plans outlining how Indonesia will fulfil its vision of becoming a major player in the region (i.e. the Maritime Fulcrum Initiative). The responsibility to carry out this vision, including which ministry should develop detailed plans of how to achieve the vision, is assigned to the relevant ministries with the requirement that actions should be coordinated between each ministry.

National debris laws and policies in Indonesia

Indonesia aims to effectively manage debris in land, coastal, and marine environments, ensuring the protection of its ecosystems and promoting sustainable waste management practices by implementing waste management laws and policies. Indeed, there are several updated Indonesian policies related to waste management in coastal and marine areas.

Law No 18/2008 on Waste Management was enacted by the People's Representative Council and the Indonesian government to regulate waste management in Indonesia. This act, along with its derived laws, aims to regulate inland debris, such as household waste and household-like waste. For instance, Government Regulation No 81/2012, Presidential Regulation No 97/2017, MoEF Regulation No 13/2012, MoEF Regulation No P.10/2018, MoEF Regulation No P.75/2019, MoEF Regulation No 6/2022, and MoEF Regulation No 14/2021 provide further regulations and guidance on waste management practices.

In addition to inland debris laws, there are specific policies addressing debris in coastal and marine areas. Law No 18/2008 on Waste Management and its derived laws also encompass regulations on marine debris. Moreover, Government Regulation No 27/2020, Presidential Regulation No 83/2018, and Law No 17/2008 on Shipping were enacted by the People's Representative Council and the Indonesian government to regulate shipping activities, including pollution and waste management aboard ships. These acts are complemented by further regulations such as Government Regulation No 21/2010 and Presidential regulation No 29/2012.

National policies for shark conservation

Indonesia has implemented several policies to effectively manage and conserve its marine biodiversity. Indonesia is governed by Law No. 5 of 1990 concerning the conservation of biological resources and their ecosystems. It provides robust legal protection for plant and animal species that are classified as endangered or constitute rare populations.

The legal framework pertaining to marine and fisheries conservation includes Government Regulation No. 60 of 2007, which specifically addresses the conservation of fish resources. This regulation serves to strengthen the policy framework governing marine and fisheries management. Additionally, MMAF Regulation No. 5/2018 imposes a prohibition on the export of scalloped hammerhead (*Sphyrna* spp.) and oceanic whitetip sharks (*Carcharhinus longimanus*), along with their processed products, from Indonesian territory to other countries. The regulation explicitly addresses and regulates the export restrictions concerning these shark species. Moreover, the status of full protection has been designated for the whale shark (*Rhincodon typus*) through MMAF Decree No. 18 of 2013. This decree underscores the significance of preserving and protecting the population of whale sharks within Indonesian waters.

These policies and regulations exemplify Indonesia's commitment to the conservation and sustainable management of its marine biodiversity, with a specific emphasis on ensuring the survival and well-being of hammerhead and mako sharks. By implementing these measures, Indonesia strives to maintain the integrity of these species and their associated ecosystems within its territorial waters.

National fisheries laws and policies in Timor-Leste

Timor-Leste needs to develop appropriate institutional, policy, and legal frameworks to achieve marine and coastal resources management. The government has provided many facilities and promotes collective work with all entities, including research institutions, to support management and marine biodiversity conservation. All interested parties need to coordinate in an effective way in order to implement a fisheries management plan. The process should ensure that representatives of the various fisheries sectors, fishing communities, NGOs, and relevant parties are consulted in the decision-making process. Good fisheries management demands solid technological and financial support to gather data and analysis, conduct scientific research, and effectively enforce the existing laws (Henriksen, 2018).

The Government of Timor-Leste has clear policy and legal frameworks to manage and protect marine and coastal resources, such as fish, coral reefs, seagrass beds and mangroves. The main legal framework is Decree Law No. 5/2016 regarding the national system of protected areas, as well as Decree Law 6/2004 on the legal regime for the management and regulation of fisheries aquaculture. These legal frameworks aim to protect critical habitats for endemic and migratory species and implement an ecosystem approach to fisheries management to guarantee that marine and coastal resources continue to support the necessary services to support coastal livelihoods.

The Government of Timor-Leste has committed to implement and achieve the 2030 Agenda with its 17 Sustainable Development Goals, the Strategic Development Plan (SDP) 2011–2030 and the Aichi Biodiversity Targets to protect 10 percent of Timor-Leste’s critical marine biodiversity. This commitment has been manifested in different laws and regulations and programmes. The list of decree laws and regulations is presented in Table 25.

Table 25. Laws and regulations related to marine and coastal resources management measures, Timor-Leste

No	Laws and regulations	Title
1.	Decree Law No. 6/2020	Biodiversity Protection
2.	Decree Law No. 6/2004	Fisheries and Aquaculture
3.	Decree Law No. 19/2009	Penal Code
3.	Ministerial Diploma No.04/115/GM/IV/2005	The list of protected aquatic species
4.	Government Resolution No. 8/2007	Protection of marine and terrestrial areas
5.	Decree Law No. 5/2016	Creating the National System of Protected Areas
6.	Government Decree Law No. 21/2008	Implementation of Satellite System for Monitoring Fishing Vessels “SIMOCEP”
7.	Ministerial Order No. 01/03GM/I/2005	Definition of Fishing Zone
8.	Law 26/2012	Environmental Base Law
9.	Ministerial Order No. 05/116/GM/IV/2005	Minimum Size and Weight of Species to be Captured
10.	Ministerial Order No. 5/GM/I/2015	Aquatic Nature Reserve in Batugade Coastal Area in Balibó Sub District, Bobonaro District
11.	Ministerial Order No. 6/GM/I/2015	Aquatic Nature Reserve in Maumeta-Vila Coastal Area in Ataúro Sub District, Dili District
12.	Decree Law No. 4/2016	Council for Definitive Boundaries Delimiting of Maritime Area
13.	National Ocean Policy	Blue Economy and marine habitat conservation
14	Decree Law No. 36/2022	Environmental licence

Source: Journal da Republica, Dili Timor-Leste, 2020.

Apart from national laws and regulations, Timor-Leste has signed many other related UN Conventions, such as the United Nations Convention on Biological Diversity, United Nations Framework Convention on Climate Change (UNFCCC), United Nations Convention on the Law of the Sea, the Kyoto, and Montreal Protocols, and the Vienna Convention. More recently, the country ratified the Port State Measures Agreement (April 2023). These conventions and protocols are part of Timor-Leste’s commitment to preserve and manage marine and coastal resources and their habitats. To implement the conventions and obligations at the country level, the Government of Timor-Leste has set up the National Biodiversity Strategy and Action Plan (NBSAP) and National Adaptation Plan of Action (NAPA) under the UNFCCC. The NBSAP is a policy framework to guide government stakeholders, including other interested parties, with the specific objective of conserving and preserving the biological diversity of marine and coastal resources. NAPA focuses more on climate change impacts such as inundation/sea level raise, coastal erosion, and drought, including flash flooding. The implementation of the specific objective has faced some challenges because of a lack of coordination between government agencies and NGOs and community-based organizations (CBOs) on the ground. Limited funding access was also a major barrier in implementing the specific objectives. There is also a strategic approach to tackle the issues of insufficient coordination in managing marine and coastal biodiversity (Figure 73).

Figure 73. Five enablers for Timor-Leste's progress towards sustainable development

Source: ADB. 2019. Timor-Leste's roadmap for the implementation of the 2030 Agenda and the SDGs.

In terms of Implementing existing policy frameworks (i.e. laws, regulations, policies, and action plans) related to marine and coastal resources management, the principal agency responsible is the Ministry of Agriculture and Fisheries (MAAF). It is also in charge of national biodiversity conservation and recuperation under the State Secretary of Environment and is supported by relevant agencies and NGOs to smoothen the implementation of policy frameworks, particularly marine and coastal management measures. MAAF has established an integrated coordination and management mechanism through Ministerial Order No. 8/24/GM/X/2010. The principal aim of this ministerial order is to facilitate the implementation of regional and subregional projects, such as CTI-CFF and ATSEA, to be implemented in a collective way to attain common goals and objectives.

The ministerial order just mentioned is anchored in the Timor-Leste Strategic Development Plan (SDP) 2011–2030, which provides a framework for managing the fisheries sector. The ISLME programmes are congruent with SDP programmes' short-term and long-term visions of fisheries and their habitat conservation. The SDP is also focusing on some key sectors/areas that are related to the fisheries sector, such as ecotourism, the blue economy, and mangrove rehabilitation. These sectors/areas have potential and are essential for the sustainable development of Timor-Leste's fisheries and aquaculture and in job creation and income generation. The SDP outlines enablers toward sustainable development that also correspond with the objectives of the national ocean policy and blue economy roadmap.

2.4.4 The ecosystem approach to fisheries management and marine protected areas policy and programme analysis

Ecosystem-based management (EBM) is a holistic approach to managing human activities that affect ecosystems and is aimed at promoting the sustainable use and conservation of natural resources. EBM has been increasingly applied to fisheries and aquaculture management, leading to the development of the ecosystem approach to fisheries (EAF) and the ecosystem approach to aquaculture (EAA) planning and implementation tools. Fisheries management in Indonesia is an obligation mandated by Law No. 31/2004 which was improved in Law No.45/2009. In this law, fisheries management is noted as inseparable from three domains: (i) fisheries resource and its ecosystem; (ii) fisheries resource utilization within a social economy; and (iii) fisheries policies. Shortly after Law No. 45/2009 was enacted, the MMAF and some of its partners realized that fisheries management was not yet considering these three dimensions. Particularly at the time, the utilization of the fisheries for economic benefits was perceived as more important than the health of the ecosystem, which underpins productive fisheries. The MMAF decided that a more integrated approach that considered ecosystem aspects of fisheries management would become essential.

The ecosystem approach to fisheries (EAF) and ecosystem approach to aquaculture (EAA) planning and implementation tools are designed to help fisheries and aquaculture managers and practitioners develop and implement sustainable and socially responsible practices. The key principles of EAF and EAA include a focus on ecosystem-based management, the use of science and research to inform decision-making, stakeholder engagement and participation, and the promotion of economic and social benefits for all stakeholders (FAO, 2018b). These planning and implementation tools cover a wide range of topics, including site selection, species selection, feed and nutrition management, disease management, and monitoring and evaluation, and they are intended to be used by fisheries and aquaculture managers and practitioners at all levels, from local communities to national governments. By adopting an ecosystem-based approach to planning and management, fisheries and aquaculture operations can be developed and managed in a way that is environmentally sustainable, socially responsible, and economically viable.

The EAA policy in Indonesia is enshrined in the MMAF Regulation No. 56/2016. This regulation emphasizes the importance of ecosystem-based management in aquaculture development, and it promotes sustainable and responsible aquaculture practices that consider the needs of all stakeholders, including small-scale fishers and local communities. The regulation also calls for the use of scientific research and monitoring to inform decision-making, and it encourages the implementation of certification programmes and other mechanisms to ensure the environmental and social sustainability of aquaculture operations.

Additionally, Indonesia's National Long-Term Development Plan (RPJPN) for 2005–2025 includes a commitment to promoting sustainable and equitable development of the country's fisheries and aquaculture sector, and it emphasizes the importance of ecosystem-based management in achieving this goal. The RPJPN calls for the development of sustainable aquaculture practices that minimize negative impacts on the environment and promote the economic and social well-being of local communities. It also emphasizes the importance of stakeholder engagement and participation in the development and implementation of policies and programmes related to fisheries and aquaculture.

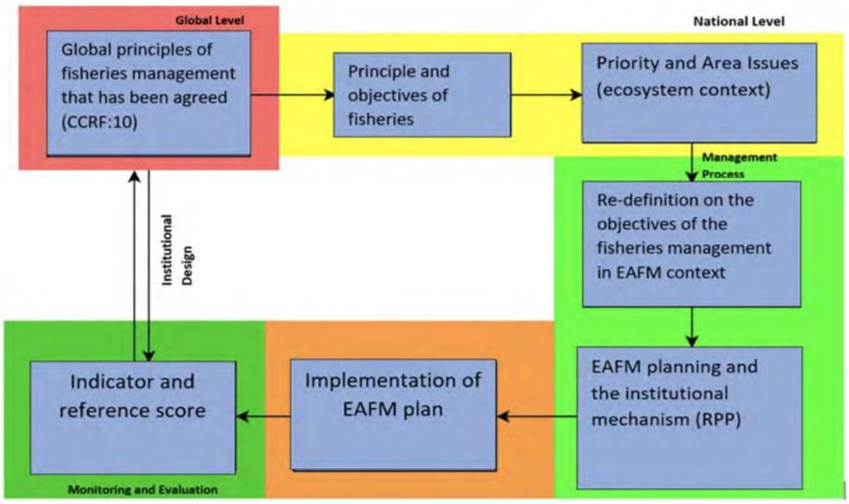
Ecosystem approach to fisheries management (EAFM)

Today, the legal basis for EAFM in Indonesia is summarized in Decree No. 18/2014 of the Directorate of Capture Fisheries and its attachment, as well as in MMAF Regulation No. 9/2015 regarding the standard competence of work to be implemented in EAFM. The attachment to Decree No. 18/2014 is inseparable from this decree and provides technical guidelines as reference for the national government, local government, and all stakeholders involved in developing, conducting, monitoring, and evaluating the status of EAFM in the 11 Indonesian FMAs. The decree refers to the ecosystem approach to fisheries (EAF) definition by the FAO (2003):

"An ecosystem approach to fisheries strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties about biotic, abiotic, and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries."

The implementation of the EAFM is critical to achieving sustainable fisheries management in Indonesia, as outlined in Decree No. 18/2014 of the Directorate General of Capture Fisheries and its attachment, along with the MMAF Regulation No. 9/2015, which provides technical guidelines for the development, monitoring, and evaluation of EAFM in the 11 Indonesian FMAs. The MMAF created a logic schematic describing how the two types of planning relate (Figure 74). Strategic planning involves the formulation of strategies to achieve the goals set in the policy plan at a certain time for all Indonesian fisheries or a certain sector within Indonesia's fisheries.

Figure 74. Process to plan and implement ecosystem approach to fisheries management (EAFM)

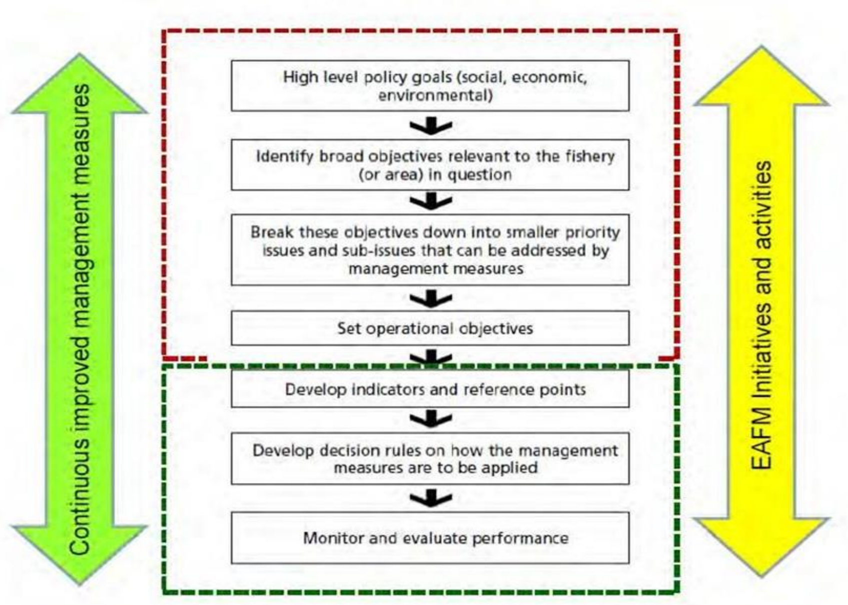


Source: adapted from MMAF Regulation No. 9/2015 on Standard competence for ecosysrem-based fisheries management
Muthmainnah, D., Rais, A. H., & Supriyadi, F. (2023). Evaluating the Application of EAFM in Inland Fisheries Management. In SEAFDEC Newsletter Vol. 45 No. 4 (pp. 12-13). Secretariat, Southeast Asian Fisheries Development Center.

The decree recognizes that EAFM implementation requires policy-related strategic planning and management planning to operationalize the strategy. Specific to supportive policy, it recognizes that statements of commitment from decision-makers at the national and regional levels related to the implementation of EAFM are of high importance. Moreover, it is necessary to state the basic and final objectives of EAFM implementation through the incorporation of socioeconomic goals, environmental considerations, and different aspects relevant to specific target fish resources. Specific to the relevance of operational or management planning, it recognizes that central and regional coordination mechanisms must be established through policy planning that specify pathways for intersectoral coordination and allow for clear and practical relationships between national and international regulations related to the comprehensive implementation of EAFM.

To operationalize the strategy, the management plan should describe activities that are required to affect stakeholder activities, as well as activities for control and enforcement of the rules set in the strategic plan. It must also describe how monitoring will be established to allow for the evaluation of stakeholder participation (Figure 75).

Figure 75. Process to monitor the implementation of ecosystem approach to fisheries management



Source: Muthmainnah, D., Rais, A. H., & Supriyadi, F. (2023). Evaluating the Application of EAFM in Inland Fisheries Management. In SEAFDEC Newsletter Vol. 45 No. 4 (pp. 12-13). Secretariat, Southeast Asian Fisheries Development Center.

The eventual strategy chosen within the EAFM may originate from international or national agreements and include: (i) the reduction of non-targeted fish and address bycatch practices; (ii) the prevention of water pollution; (iii) a risk reduction for certain fishers and certain fish resources; and (iv) the establishment of conservation areas or application of a fish refuge, among others. Referencing Cochrane (2002), the decree indicates that the strategic plan would contain "the rules of the game" and specify mechanisms for input management and output control based on a risk analysis of the sustainability of the fisheries system. In 2010 and 2011, the Directorate of Fish Resources and the Directorate General for Fisheries of the MMAF collaborated with the WWF-Indonesia, the Center for Coastal and Marine Resources Study (*Pusat Kajian Sumberdaya Pesisir dan Lautan [PKSPL*] - Bogor Agriculture Institute [IPB]), and Yayasan Konservasi Alam Nusantara (YKAN) to identify a first set of EAFM indicators. The attachment to Decree No. 18/2014 provides a range of fisheries, ecosystem, socioeconomic and governance indicators in six domains that must be considered when assessing the conditions for EAFM for a particular fishery in a certain area. The six EAFM domains are explained as follows:

1. Fisheries resources domain (with seven indicators)

The key indicators for the fisheries resources domain are:

- fish size, intended to assess the length frequency analysis, which could estimate the rate of exploitation of a stock unit;
- species composition, intended to assess the composition of the targeted and non-targeted species or bycatch;
- proportion of the juveniles intended to know the proportion of the juvenile fish that are being caught from the fishing gear;
- density/biomass for reef fish and invertebrates, intended to assess the density of the reef fish in the surrounding waters;
- endangered, threatened, and protected (ETP) species, intended to assess the impacts for the ETP species as a result of the fishing activity and specific fishing gear in an area;
- catch per unit effort (CPUE). CPUE has the highest importance percentage value at 40 percent. This is intended to determine the changing trends in fishery stock status from time to time; and
- range collapse for fisheries resources is intended to assess the impacts to the fisheries resources because of the increased fishing pressure.

2. Habitat and ecosystem domain (with seven indicators)

The key indicators for the habitat and ecosystem domain are:

- water quality is intended to evaluate and to determine the quality and health of the aquatic environment, as well as to determine the level of pollution in the waters;
- seagrass status is intended to determine the seagrass cover and density, as well as the presence of seagrass in a specific area;
- mangrove status is intended to determine the quality and productivity of ecosystems, to determine success recruitment, especially for important species whose life cycle resides in the mangrove ecosystems, and to determine the condition of the spawning areas and types of fish that are associated with the mangrove ecosystems;
- coral reef status is intended to determine the percentage of live coral and the diversity of the coral species. Coverage of the live coral reefs is related to the success of recruitment;
- estuary status and productivity, which is intended to determine the quality and productivity of the waters calculated from chlorophyll-a concentration; this indicator can explain the importance of an estuary as a nursery ground for several economically fisheries species;
- unique habitat (upwelling, spawning, nursery, and feeding ground), intended to provide a strong foundation for fisheries management that must be done either through open close area season, setting fishing gears, fishing ground determination, or regional development of water conservation; and

- climate change effects on the waters and habitat are intended to inform how climate change affects the waters and habitat.

3. Fishing techniques domain (with six indicators)

The key indicators for fishing techniques domain are:

- fishing techniques with destructive and illegal methods intended to identify fishing practices that are destructive or unsuitable with regulations and that can endanger the sustainability of fish resources and their ecosystems in an area;
- modification of fishing and supporting gear intended to identify the impact on unsuitable fishing gear that has been modified;
- fishing capacity and effort intended to determine the fishing intensity level and the impacts on the fisheries resource in the surrounding area;
- fishing selectivity intended to determine the percentage level of fishing gear, which is classified as non-selective gear, and to determine the impacts for the fisheries resource in the surrounding area;
- the suitability of the function and size of fishing vessels with legal documents intended to estimate the percentage of vessels with appropriate legal documents suited to the surrounding area; and
- certification of the vessel's crew according to the regulations intended to estimate the percentage of fishing vessels operated by the certified crew; this indicator can be used as a sensitive indicator to illustrate the impact of fishing activities on the sustainability of fish resources.

4. Economy domain (with three indicators)

The key indicators for the economy domain are:

- fishery household income with a weight of 30 percent intended to assess the dependence of households on fisheries resources and household dependence on family heads;
- saving ratio (SR) with a weight of 25 percent intended to determine the potential of fishing households in saving their excess income; SR is the percentage comparison between fisheries household income and expenditure with income; and
- asset ownership with a weight of 45 percent intended to determine the ability of fishing households to improve their economic businesses; asset ownership is a comparison between the number of productive assets currently owned by fisheries households to the previous year.

5. Social domain (with three indicators)

The key indicators of the social domain in EAFM are:

- participation of the stakeholders, which is intended to determine the activeness of stakeholders in all management activities; the level of activity from stakeholders is crucial for the success of a fisheries management activity;
- fisheries conflict, which is intended to determine the potential counter-productive and overlapping management that results in failure of implementation of fisheries resource management policies; fisheries conflict can also occur because of policy conflicts in the same area or other conflicting activities between sectors; and

- utilization of local knowledge in managing food resources, which is intended to determine the existence and the effectiveness of the application of local knowledge in fish resource management activities.

6. Institutional domain (with seven indicators)

The key indicators for the institutional domain are:

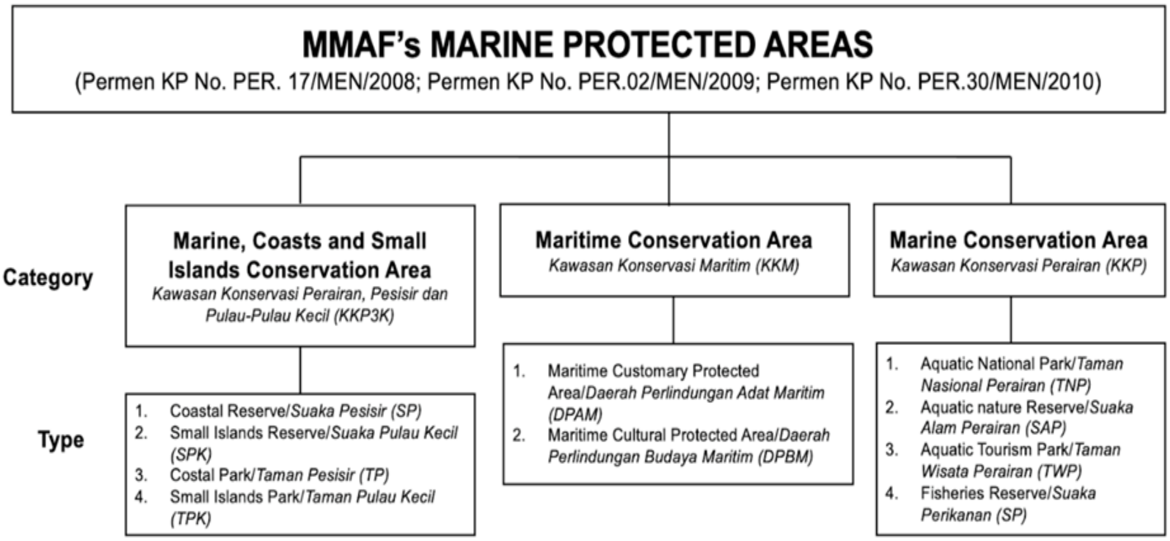
- obedience to the fisheries principles that are responsible in fisheries management that have been well established either formally or informally intended to determine the frequency of the violation of fisheries management in the specific FMA;
- full rules play in fisheries management is intended to determine the level of completeness of fisheries management primary rules and secondly to understand the enforcement of these rules;
- mechanism in decision-making intended to determine the level of effectiveness of decision-making in fisheries management. Institutional mechanisms ensure that all management systems are available;
- fisheries management plan intended to determine whether a fisheries management plan (RPP) exists or not;
- level of fisheries management policy synergy and institution; this indicator has two objectives: to determine the synergy level among fisheries management institutions and to determine policy synergy in fisheries management;
- capacity of the stakeholders intended to determine the efforts to improve stakeholder capacity within the EAF framework; some examples of efforts are training, seminars, and workshops to gain knowledge, short courses, and higher-level education; these efforts are steps to minimize errors in implementing fisheries management; and
- existence of a single management fisheries authority.

The decree contains further guidance that the assessment of the status of EAFM through the list of indicators results in a composite index that reflects the level of achievement of the management of certain fisheries in a certain area with EAFM principles. This index value can be calculated again after certain improvements have been made, or it can be compared with values from other fisheries in other areas. Hence, it provides opportunities to review the success of certain strategies and approaches and serves adaptive management and other learning purposes.

Marine protected areas (MPAs)

Marine protected areas (MPAs) are a strategy used in Indonesia to protect biodiversity, with the goal of benefiting coastal communities whose livelihoods rely heavily on coastal and marine resources (FAO, 2013). MPAs are regulated by the MMAF and the MoEF. MMAF uses the term “marine conservation areas” for formally recognized MPAs, with MMAF defined MPAs officially called “Marine, Coasts, and Small Islands Conservation Area” (Kawasan Konservasi Perairan, Pesisir, dan Pulau- Pulau Kecil/KKP3K). There are in total ten types of MPAs under these three MMAF MPA categories that have their own criteria and targets for conservation (Figure 76).

Figure 76. Categories and types of marine protected areas according to the Ministry of Marine Affairs Fisheries

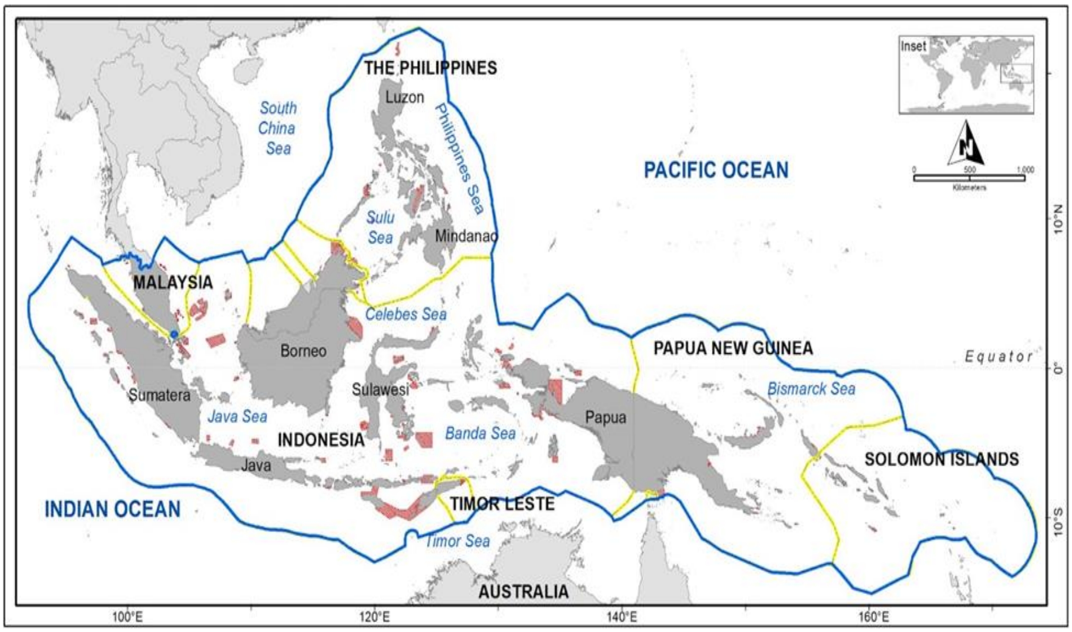


Note: All types of MPAs can be managed by national government (often named as National MPAs/Kawasan Perairan Nasional – KKPN) or provincial government (often named as Provincial MPAs/Kawasan Konservasi Perairan Daerah – KKPD)

Source: MMAF. 2020b. *Visi Kawasan Konservasi 2030 dan Peta Jalan Pengelolaan Kawasan Konservasi: Melindungi 10% wilayah laut bagi perlindungan keanekaragaman hayati dan pemanfaatan berkelanjutan di Indonesia* (Protected area vision 2030 and protected area management roadmap: protecting 10% of marine areas for biodiversity protection and sustainable use in Indonesia).

MMAF MPAs have four zone types: Core Zone (Zona Inti), Sustainable Fisheries Zone (*Zona Perikanan Berkelanjutan*), Use Zone (*Zona Pemanfaatan*), and Other Zone (*Zona Lainnya*) (Government Regulation No. 60/2007). The Core Zone is designated for absolute protection of fish habitats and populations, research, and education. The Sustainable Fisheries Zone/Subzone is intended for traditional fishing activities (to meet daily basic needs), and/or small- scale fisheries with a maximum size of fishing vessels not exceeding 10 GT. The Use Zone is intended for the protection and preservation of fish habitats and populations, tourism, and recreation (without extraction), research and development, and education. The Other Zone is a zone with a defined separate purpose (e.g. habitat rehabilitation) and may have variable protection levels. MPAs are quite important and can be found in many countries, including those located in the Coral Triangle Area of Indonesia. The six CTI countries and major marine protected areas (MPAs) are shown in Figure 77.

Figure 77. The six Coral Triangle Initiative countries and marine protected areas



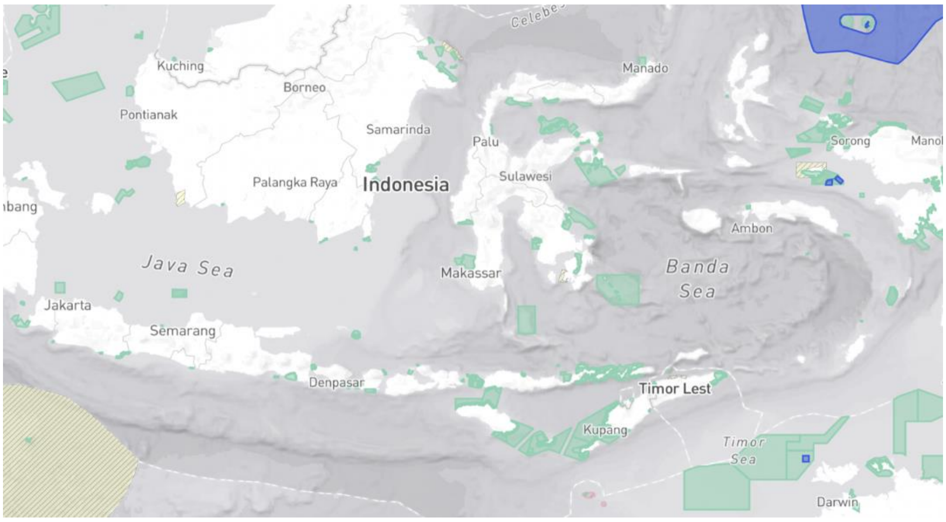
Notes: Areas in red are the marine protected areas; exclusive economic zones are indicated by the blue line; and sea country boundaries are indicated by a yellow line.
Source: Marine Conservation Institute. 2023. Marine protected atlas. [Cited 13 August 2023]. https://mpatlas.org/

The highest priority areas for enhanced protection (i.e. the top 10 percent highest priorities) were identified as: in Indonesia (the Halmahera Sea, the Banda Sea, the Sulawesi Sea, the Makassar Strait, Lesser Sunda, and the Bird's Head of Papua);in the Philippines (the Sulu Archipelago, the Bohol Sea, and the Visayan Sea); in Malaysia (Sabah, and Johor); in Papua New Guinea (the Bismarck Archipelago and Milne Bay), and in the Solomon Islands (Malaita and San Cristóbal Island). In addition, several MPAs should optimally be expanded to cover adjacent biodiversity features, including marine parks in Indonesia (Taka Bonerate National Park, Togean, Kepulauan Seribu, Bunaken, Komodo, and MPAs in the Birds Head Peninsula of Papua), in the Philippines (MPAs in the northwestern part of the Sibuyan Sea, the Visayan Sea, and the Bohol Sea), in Malaysia (MPAs in the northern and eastern part of Sabah), in Papua New Guinea (MPAs in Madang, and Milne Bay), and the Solomon Islands (MPAs in Santa Isabel Island).

The primary law regulating environmental protection is Law No. 32/2009 regarding Environmental Protection and Management, which is expanded upon at the ministerial level through various regulations, e.g. the designation of marine protected areas (MPA) by MMAF, and through specific regulations regarding the protection of the environment for certain activities (i.e. Ministry of Transportation Decree No. PM29/2014 regarding Mitigation of Marine Pollution, MoEF Regulation No. 05/2012 regarding the type of business or project requiring an environmental impact assessment). MPA establishment is one way of managing marine resources in the country, with the first MPA established in 1970 and 172 MPAs in existence in 2017. There are 110 MPAs in the ISLME region. The Indonesian government aimed to achieve 20 million hectares of MPA area in 2017, reaching 19.14 million hectares. Investments in MPAs have yielded remarkable results socially, ecologically, and economically.

The MMAF, in coordination with the Ministry of Environment and Forestry and local governments, is working to develop a nationwide system of MPAs to reach this target Figure 78 and Annex 1).

Figure 78. Indonesian marine protected areas distribution in the Indonesian Seas Large Marine Ecosystem and adjacent areas



Source: Marine Conservation Institute. 2023. Marine Protected Atlas. [Cited 13 August 2023]. https://mpatlas.org/

In Timor-Leste, MPAs, particularly no-take zones (NTZs), are also considered powerful tools to address local threats and enhance fisheries productivity, protect biodiversity, and increase ecosystem resilience to changes in climate and ocean chemistry (Green *et al*., 2014, 2019). They can also enhance food security and sustainable livelihoods for communities and other stakeholders. Timor-Leste has officially declared two MPAs with a total area of 163.44 ha located on the north coast of the country (Table 26). In addition, there exist eight Locally Managed Marine Areas (LMMAs) in Lautem and Ataúro Municipalities, with a total area of 2 747 ha. An LMMA differs from an MPA in that the former are characterized by local ownership, use and/or control, and in some areas, they follow the traditional tenure and management practices of the region, whereas the latter in the formal sense is typically designated via a top-down approach with little if any local input.

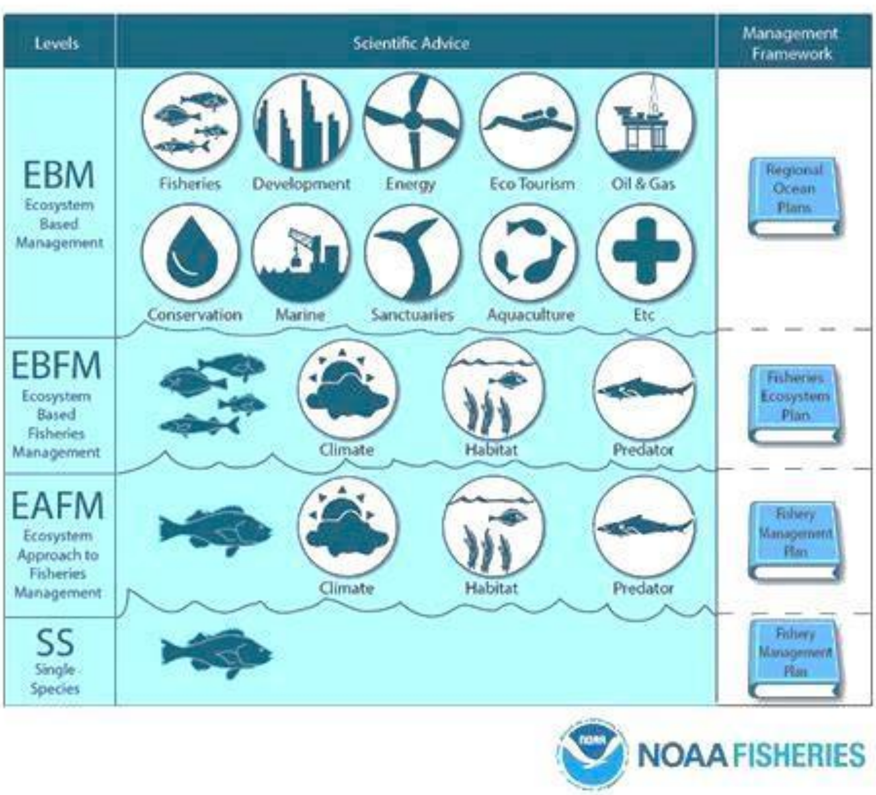
Table 26. Area and habitats of marine protected areas in Batugade (Bobonaro) and Vila (Ataúro), Timor-Leste

Type of ecosystem	MPA in Batugade (Bobonaro Municipality)	MPA in Villa (Ataúro Municipality)
Total area	112.59 ha	50.85 ha
Area of coral reef	18.95 ha	31.34 ha
Area of sea grass beds	3.39 ha	18.36 ha
Area of mangrove forest	0.60 ha	0.97 ha
Others (beach and deepwater)	89.55 ha	0.18 ha

Source: Government of Timor-Leste Ministerial Order No. 5/GM/I/2015 of creating the Natural Aquatic Reserve within the Coastal Area of Suco Batugadé; and Ministerial Order No. 6/GM/I/2015 of creating the Natural Aquatic Reserve within the Coastal Area of Suco Vila

Ideally, these MPA and LMMA are managed using ecosystem-based management (EBM) as an integrated approach for managing marine and coastal resources. The EBM aims to secure healthy and productive ecosystems and resilience toward climate change; in turn, they can provide ecosystem services for coastal communities. There are other fisheries management approaches that can be adopted also when managing marine and coastal resources such as the ecosystem approach to fisheries management (EAFM), the ecosystem approach to aquaculture (EAA), and single species management. The management frameworks are briefly illustrated in Figure 79. These frameworks and approaches provide a broader context for the management of marine and coastal resources to attain sustainable development with improved ecological well-being.

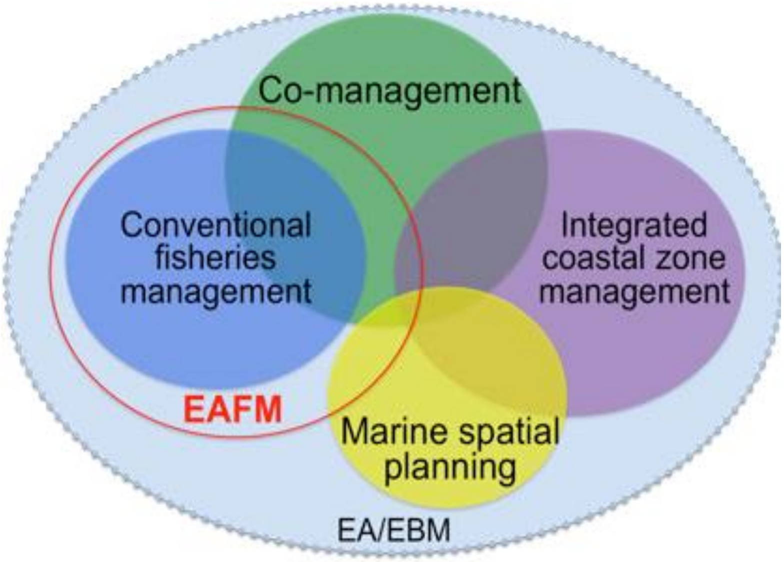
Figure 79. Management frameworks for marine and coastal resources management



Source: Dolan, T. E., Patrick, W. S., and Link, J. S. 2015. Delineating the continuum of marine ecosystem-based management: a US fisheries reference point perspective. *ICES Journal of Marine Science,* 73(4): 1042–1050. doi: 10.1093/icesjms/fsv242

All management frameworks recognize that management should deal with broad ecosystems, such as natural and human aspects and associated economic benefits including sociocultural. In addition, other management tools that need to be elaborated are marine spatial planning (MSP) to facilitate human distribution and activities in coastal areas, including marine protected areas as a management tool to be used in conjunction with other management actions. These management tools are strongly related to each other, with primary aims to address conservation of marine and coastal biodiversity concerns and issues. The interlinked management tools are illustrated in Figre 80.

Figure 80. Ecosystem approach to fisheries management and other management approaches for marine and coastal resources conservation



Source: Staples, D., Brainard, R., Capezzuoli, S., Funge-Smith, S., Grose, C., Heenan, A., Hermes, R., Maurin, P., Moews, M., O'Brien, C. & Pomeroy, R. 2014. Essential EAFM. Ecosystem Approach to Fisheries Management Training Course. Volume 1 – For Trainees. FAO Regional Office for Asia and the Pacific, Bangkok, RAP Publication 2014/13.

Greater cross-sector integration would help achieve more equitable sharing of costs and benefits of implementing management frameworks. Some management actions are outside the scope of the fisheries sector; thus, better cooperation between agencies and different stakeholders is needed, particularly during the planning stage. This is because implementing management frameworks requires consultative decision-making, information sources, and a wider scope for monitoring and evaluating process and impact. This is to acknowledge that EBFM/EAFM responds to wider societal needs, so the costs theoretically should be divided between people who are benefiting directly, for instance fishermen or coastal communities at large (Staples *et al*., 2014).

EAFM has been implemented on the southern coast of Timor-Leste under the ATSEA-2 project. The EAFM plan was focused on the red snapper resources. This is to ensure that the red snapper can be preserved and controlled more effectively and determine the best way to maintain the red snapper population/stocks. The benefits of the EAFM on the southern coast are as follows:

- maintaining ecosystem goods and services to deliver socioeconomic and cultural benefits for coastal communities;

- addressing cumulative impacts on marine and coastal resources;
- strengthening stakeholders' engagement in marine and coastal resources management;
- providing more information to support decision-making and be shared with other parties;
- forecasting pressures and impacts on both single and aggregated components of marine and coastal ecosystems; and
- providing a better understanding of how ecosystems and their components respond to multiple stressors.

The Directorate-General for Spatial Planning under the Ministry of Planning and Territory launched the National Spatial Planning programme in 2022. Spatial planning has been supported by a legal framework – Decree-Law No. 6/2017. This Decree Law will serve as a foundation to support national land use policy and at the same time can harmonize and incorporate all development sectors. Marine spatial planning (MSP) is a framework that facilitates all development processes in coastal areas. The principal aim is to harmonize human activities in coastal areas to attain ecological, socioeconomic, and cultural heritage. In addition, the MSP plays an important role in promoting interaction among different stakeholders in coastal areas to make balanced demands for development and safeguard marine and coastal environments and to deliver social and economic outcomes in a planned fashion.

Apart from MSP, integrated coastal management (ICM) is another instrument that deals with governance related to human activities affecting marine and coastal activities and/or goods and services generated by coastal ecosystems. ICM was implemented in three locations (Liquiça, Dili, and Manatuto) within the ISLME area of Timor-Leste. ICM facilitates coastal communities' understanding of biological diversity and its management measures. The management measures should be done in a collective way by engaging different and broad stakeholders to share responsibilities and share benefits. This is because ICM is actually an integration of ecological and socioeconomic concerns to secure the management strategies developed under ICM to encourage multiusers of coastal resources and its sustainability. Moreover, ICM is also promoting an interdisciplinary approach that engages many users and beneficiaries to address complex development in coastal areas. Through multidisciplinary approaches, conflict, and duplicated programmes/activities can be avoided and effective management measures can be attained or realized.

Marine Protected Areas (MPA) were initiated around two decades ago in Timor-Leste. An MPA was established for the first time in Batugade (Bobonaro) within the ISLME area, including Vila on Ataúro Island. The establishment of the MPA was supported by Ministerial Diploma No. 5/GM/I/2015. Currently, 19 MPAs and nearly six LMMAs have been proposed to be declared by the government. These MPAs and LMMAs are distributed mostly on the northern coast rather than the southern coast. MPAs/LMMAs aim to protect marine and coastal biodiversity, typically habitats and species that are under threat.

The LMMAs were established in accordance with local communities' agreements. The implementation of LMMAs and their management measures will be managed under a set of undocumented rules that have been verbally agreed upon by elders and local people. LMMA was first established and applied in the Lamsana Protected Area in Manatuto in 2012. This LMMA was supported by local wisdom (Tara-Bandu (TB)). Tara-Bandu is traditional knowledge that has been practiced for a long time by the area's ancestors to protect and conserve natural resources to ensure their sustainability for future generations. This TB has been adopted by the Government of Timor-Leste as part of a non-formal regulation to be implemented side-by-side with formal regulations and is also applied to support ICM implementation.

A list of MPAs and LMMAs is provided in Table 27 (for Timor-Leste) and also in Annex 1 (for Indonesia). Table 26 describes the type of aquatic natural reserves and LMMAs no-take zones in Timor-Leste. The list presents common constraints encountered by the government when it comes to implementation, budgeting, and planning.

Table 27. List of marine protected areas and local and locally managed marine areas of Timor-Leste

Name Municipality	TOTAL AREA (ha)	DATE OF DECLARATION	PARTNERS	PROGRESS
NATIONAL PARKS				
Parque Nacional Nino Konis Santana (marine) (Lautem)	55 600	1 August 2007	NSW Parks & Wildlife, BirdLife International, Charles Darwin University	Surveys, gazetted, management plan
AQUATIC NATURAL RESERVES				
Subtotal	**777**			
TOTAL AREA	**2 747**			
NO-TAKE ZONES (FISHERIES REGULATIONS)				
Nino Konis Santana – 7 NTZs (Lautem)	207 km^2	2 June 2013	USAID-CTSP (CI)	Fisheries regulations
PROPOSED MPAs and LMMAs				
Name Municipality	**TOTAL AREA (ha)**	**DATE OF DECLARATION**	**PARTNERS**	**PROGRESS**
Batugede-Atapupu (FMA 714) (Bobonaro)	-	-	FAO	Transboundary MPA (Indonesia-Timor-Leste) proposed under ISLME project (FAO)
Ilik-nami, Biqueli (Ataúro)	45		BV, Darwin Initiative	*Suco* regulations finalized, but not formalized
Kaitehu-Ulmera (Liquica)	-	-	CTC (TNC)	MPA being progressed by Timor-Leste CTI NCC
Ilmanu, Behau (Dili)	20	-	BV, KFF, Darwin Initiative	*Suco* regulations at consultation stage

Vila Reserva Natural Aquatica (Ataúro Island)	5 085	25 February 2015	ADB-ANZDEC	surveys, *tara bandu ceremony*, gazetted, management plan
Batugade Reserva Natural Aquatica (Bobonaro)	11 259	25 February 2015	ADB-ANZDEC	Surveys, *tara bandu ceremony*, gazetted, management plan
LOCALLY MANAGED MARINE AREAS				
Nino Konis Santana LMMAs (3)	1 600	2016	USAID-CTSP (CI)	*tara bandu ceremonies*, management plans (three), no gazettals
Tutula	270	2016		
Lore	100	2016		
Com				
Subtotal	**1 970**			
Ataúro Island LMMA network (5) -		15 December 2017	ADB-CI (LMMAs),	*tara bandu ceremonies*, four *Suco* regulations – Adara, Vila, Beloi, Bikeli (Uaro-ana, Akrema); no gazettals
Beloi (& 3 NTZs)		20 September 2017	Coral Triangle	
Uaro-ana	537	20 September 2017	Center (network),	
Akrema	32	15 December 2017	WorldFish, BV	
Adara	45	21 September 2017		
Vila	25			
	138			
Lamsanak or Ma'abat (Manatuto)^			BV, Oriental University, KFF, Lighthouse Foundation, PEMSEA	Mangrove restoration, *tara bandu* consultations
Betano-Clacuc (Manufahi)	90 000		PEMSEA	MPA proposed under ATSEA2

2.4.5 Co-management, traditional systems, and customary rights

Natural resources, such as fish resources, both in marine waters and inland waters, are often defined as common property resources. Therefore, many parties, especially communities, do not feel guilty when using or exploiting fish resources as much as they can without thinking about the impact on the sustainability of the fish resources. The management of natural property, which is common property, is not sufficiently regulated and is carried out only by the government. Especially in Indonesia, and more specifically in Eastern Indonesia, there are still many traditional or customary communities who claim to have customary territories and natural resources in them for generations, that is passed on by their ancestors. Experience shows that the management of natural resources that is dominated by government authorities in each stage of management, starting from planning, implementation, and supervision, results in more conflicts with other resource user groups, especially from local communities who live around these natural resources.

The customary communities of the ISLME region have developed their own traditional systems for managing marine resources. The Bugis-Mandar community in South Kalimantan believes that whale sharks are their friends and should be protected (Junaidi *et al*., 2018). Meanwhile, the Bajo community's local wisdom includes what is called *tuba dikatutuang*, which prohibits overfishing and the use of harmful fishing gear in their area, and *Parika* is a system that determines the time and location of fishing (Hasrawaty *et al.,* 2017). Additionally, the Lamakera community in East Nusa Tenggara has been practicing whale hunting for generations, which is regulated by a traditional system called *lawet.* The community views whales as sacred gifts from the gods; therefore, the hunt is carried out in a spiritual and ceremonial manner. The *lawet* system sets strict rules on the type of boats and weapons that can be used, as well as the number of whales that can be hunted each year. These traditional systems of resource management have been recognized by the government of Indonesia as part of the country's efforts to promote sustainable fishing practices and protect marine biodiversity.

Satria and Adhuri (2010) offer a robust description of the *Sasi* in the Maluku region. Importantly, *Petuanan Laut* and *Sasi Laut* are now being considered for improving small-scale fisheries (SSF) management in Indonesia through co-management and a foundation for implementing fisheries management rights (FMRs) and territorial use rights in fisheries (TURFs) for SSF. Also, Indonesia's Village Law (Law No. 6/2014) establishes a new institutional framework for community development in Indonesia's 74 091 rural villages. The law strengthens the legal status of villages, increases their authority and responsibility, and recognizes *adat* (traditional village governance arrangements).

It is true that the state has the power to regulate the management of these natural resources as mandated in Article 33, Paragraph (3) of the 1945 Constitution that the earth, water, and the natural resources contained therein are controlled by the state and used for the greatest prosperity of the people. However, in its operationalization, the state will not be able to work without assistance from other parties, especially the natural resource user community, including customary communities (user groups). For this reason, the government must open itself to collaborating with community groups that use natural resources, directly or indirectly, such as private companies, universities, non-governmental organizations, traditional communities, and others. Such cooperation has become known as collaborative management or co-management.

According to Rudianto (2014) this model is useful for the management of coastal and marine resources as it can unite relevant institutions and groups, especially the communities and government, and other stakeholders in each process of resource management, starting from planning, implementation, utilization, and supervision. The division of responsibilities and authority among stakeholders can occur in various patterns, depending on the ability and readiness of the human resources and institutions in each region. Over the long term, the implementation of co-management is believed to provide changes for the better:

- increased public awareness of the importance of coastal and marine resources in supporting life;
- improved ability of the community so that they can participate in every stage of management in an integrated manner; and
- increased community income through other forms of sustainable and environmentally friendly use.

The success of applying co-management is strongly influenced by the willingness of the government to decentralize management responsibilities and authority with fishers and other stakeholders. Therefore, co-management needs legal and financial support, such as policy formulation that allows fishers and coastal communities to manage and restructure the roles of fisheries management actors. Crawford (2008) suggest a number of reasons why fisheries need co-management:

- it is considered by most leading experts to be a more effective approach compared with conventional top-down command and control approaches;
- fishers have significant input in what should be managed and how it should be managed; and
- it results in greater legitimacy of rules and therefore more voluntary compliance and self-enforcement among peers.

The prospect of collaborative management in the management of marine conservation areas is very open and is clearly regulated in Article 18 of Government Regulation No. 60/2007, which states that the government, in accordance with their authority in managing marine conservation areas, can involve the community through partnerships between management organizational units and community groups and/or indigenous peoples, non-governmental organizations, corporations, research institutions, or universities. The pattern of partnership in the management of conservation areas is also stated in one of the eight principles of fish resource conservation (Article 2 Paragraph (1) Letter c, Government Regulation No. 60/2007). The eight principles of conservation of fish resources, as mentioned in Article 2, Paragraph (1), are: (i) benefits; (ii) fairness; (ii) partnership; (iv) equitability; (v) integration; (vi) openness; (vii) efficiency; and (viii) sustainable sustainability. The principle of partnership seeks to ensure that the implementation of conservation of fish resources is carried out based on work agreements between stakeholders relating to the conservation of fish resources.

Under Timor-Leste's regulatory framework, there are provisions for co-management of natural resources between local communities, municipalities, and national governments (Pereira *et al*., 2013). This has provided room for a bottom-up approach in the management of MPAs, where all measures and directions are regulated under the customary law, *tara bandu*. The word *tara* means hang, and *bandu* means prohibition. Punishment for breaking the rules is also imposed by *tara bandu*. This age-old tradition is rooted in the animistic beliefs of Timorese people. Considered local wisdom, *tara bandu* directs and encourages all communities to actively manage their marine and coastal resources collectively and in a sustainable way. It is a form of traditional law that has been proven to be an effective institutional tool in the protection of the forest, wild animals, water sources, sacred places, and property rights of the people (Cardinoza, 2005). *Tara bandu* has been used by different ethnic groups across the country, including coastal communities in Bobonaro, Liquiça, and Dili Municipality.

2.4.6 Decentralized coastal governance

In Article 1, Paragraph (7) of Law No. 32/2004 concerning regional government, decentralization is defined as the transfer of governmental authority by the government to autonomous regions to regulate and administer government affairs in the unitary state of the Republic of Indonesia. Article 18, Paragraph 1 states that regions that have sea areas are given the authority to manage resources in the sea area; and Paragraph 3 regional authority to manage resources in the sea area, as referred to in paragraph 1 includes the following:

a. exploration, exploitation, conservation, and management of marine resources; administrative arrangements;
b. spatial planning;
c. law enforcement of regulations issued by regions or those delegated by the government;
d. participation in security maintenance; and
e. participation in the defense of national sovereignty.

Article 12, Paragraph (3) of Law No. 32/2004 states that the choice of government affairs referred to in Article 11 Paragraph (1) includes: (i) marine and fisheries; (ii) tourism; (iii) agriculture; (iv) forestry; (v) energy and mineral resources; (vi) trade; (vii) industry; and (viii) transmigration.

Article 13, Paragraph 2 of Law No.32/2004 states that based on the principles referred to in Paragraph 1, the criteria for government affairs, which are the authority of the central government, are as follows:

a. affairs whose location is across provincial or cross-border regions;
b. affairs whose users cross provincial or cross-country regions;
c. affairs whose benefits or negative impacts cross provincial or cross-country regions;
d. affairs whose use of resources is more efficient if carried out by the central government; and
e. government affairs whose role is strategic for the national interest.

Article 13 in Paragraph 3 is based on the principles referred to in Paragraph 1 criteria for government affairs that become the authority of the provincial region:

a. affairs whose location crosses regency/city region;
b. affairs whose users cross regency/city region;

c. affairs whose benefits or negative impacts cross district/city regions; and
d. affairs whose use of resources is more efficient if carried out by the provincial region.

2.4.7 Community participation, civil society, and public awareness

Integrated coastal and marine management (ICMM) is of paramount importance in an archipelagic nation such as Indonesia, where more than 75 percent of the national area is sea and the remainder is land fragmented among more than 17 000 islands. The almost 100 000 km shoreline is the world's second longest (after Canada) and the most accessible. Coastal and marine industries such as oil and gas production, transportation, fisheries, and tourism account for a quarter of the GDP and employ more than 15 percent of Indonesia's workforce. Indonesia is quite advanced in preparing marine spatial plans that can accommodate various interests. The regulation of marine space is based on statutory regulations, some of which are listed here:

1. the determination of Fisheries Management Area is based on MMAF Regulation No. 18/2014 concerning the Fisheries Management Area of the Republic of Indonesia;
2. Law No.27/2007 concerning the Management of Coastal Areas and Small Islands (which was amended by Law No. 1/2014). In this law, it is mandated that all provincial governments in Indonesia prepare the Zoning and Small Islands Zoning Plan or *Rencana Zonasi Wilayah Pesisir dan Pulau-Pulau Kecil* (RZWP3K) and a mandate for the establishment of MPAs;
3. Law No. 5/1990 concerning the Conservation of Living Natural Resources and their Ecosystems, which mandates the designation of conservation areas including the protection of ecosystems and important habitats both on land and in waters; and
4. Law No. 5/1983 that established Indonesia's EEZ as "... a water area outside and bordering the Indonesian territorial sea as stipulated by law which applies to Indonesian waters covering the seabed, the land underneath and water above it with an outer limit of 200 (two hundred) nautical miles measured from the baseline of the sea in Indonesian territory".

Indonesia has made significant progress in improving the participation of communities and resource owners in marine spatial planning such that by May 2020, the status of the development of provincial plans was as follows:

- plans for 27 provinces have been formalized through local decrees in North Sulawesi, West Sulawesi, West Nusa Tenggara, East Nusa Tenggara, Central Sulawesi, East Java, Lampung, West Sumatra, Maluku, North Maluku, North Kalimantan, DI Yogyakarta, South Kalimantan, Gorontalo, Central Java, West Kalimantan, Kalimantan Central, West Java, North Sumatra, Southeast Sulawesi, South Sulawesi, Bengkulu, Jambi, West Papua, South Sumatra, Bangka Belitung Islands, and Aceh provinces;
- plans for three provinces are being evaluated by the Ministry of Home Affairs (MoHA) and respective local parliaments in Banten, Riau, and East Kalimantan provinces;
- plans for three provinces await suggestions for final document revision for DKI Jakarta, Bali, which is part of the Bali Sea region, and Riau Islands provinces; and
- the plan for Papua Province is at the stage where intermediate documents are being prepared.

Arriving at this status has taken significant time and resources. As lessons were learned, the MMAF made improvements in their support to provincial governments to complete several provincial spatial plans and to gain understanding of the relevance of marine spatial planning at different administrative levels. Moreover, the private sector has started to improve participation and support for marine spatial planning processes. What remains is making progress in those areas where national priorities overlap with prior claims or are not aligned with ambitions of local governments as well as where *adat* interests and needs have not been fully considered in regional plans. Building on the lessons learned will be particularly relevant for completing the complex task of facilitating marine spatial planning for large interregional areas such as the Banda Sea—an important part of the ISLME.

Within the context of MSP and ICM, the implementation of EAFM is critical to achieving sustainable fisheries management in Indonesia, as outlined in Decree No. 18/2014 of the Directorate of Capture Fisheries and its attachment, along with the MMAF Regulation No. 9/2015, which provides technical guidelines for the development, monitoring, and evaluation of EAFM in the 11 Indonesian FMAs.

CHAPTER 3

Status of the Indonesian Seas Large Marine Ecosystem

3 Assessment of marine living resources and the environment

3.1 Status of fisheries and marine living resources

3.1.1 Current production and value

Indonesia is a prominent fish producer in Southeast Asia with marine, brackish, and freshwater capture fisheries and aquaculture. In the third quarter of 2021, the fisheries industry contributed IDR 102.98 trillion (about USD 7.2 billion) to the country's GDP, reflecting a 3.44 percent growth from the same period in 2020. The per capita fish availability for annual consumption was 60.85 kg/capita, and national fish consumption has steadily increased year over year. The 2021 fish consumption per capita was 55.37 kg, a 1.47 percent rise from 2020 of 54.56 kg. Indonesia ranked second in total production from capture fisheries and fourth in total aquaculture production worldwide in 2020. According to data from the Central Bureau of Statistics (BPS, 2023b), Indonesia's fisheries production in 2022 reached 22.18 million tonnes, which was a 0.88 percent increase compared to the previous year. Based on fisheries activity, in 2021 capture fisheries production increased 15.72 percent, whereas aquaculture production increased by 10.42 percent.

The amount of capture fisheries production in an ISLME province is largely determined by its potential for marine capture fisheries. The volume of capture fisheries production by ISLME provinces during 2017–2020 is presented in Table 28. The fisheries values of both capture fisheries and aquaculture presented are based on provincial data for regions that fall under the ISLME. Overall, Maluku had the highest value for the capture fisheries, followed by East Java, whereas the lowest value in the ISLME was in the DI Yogyakarta Province.

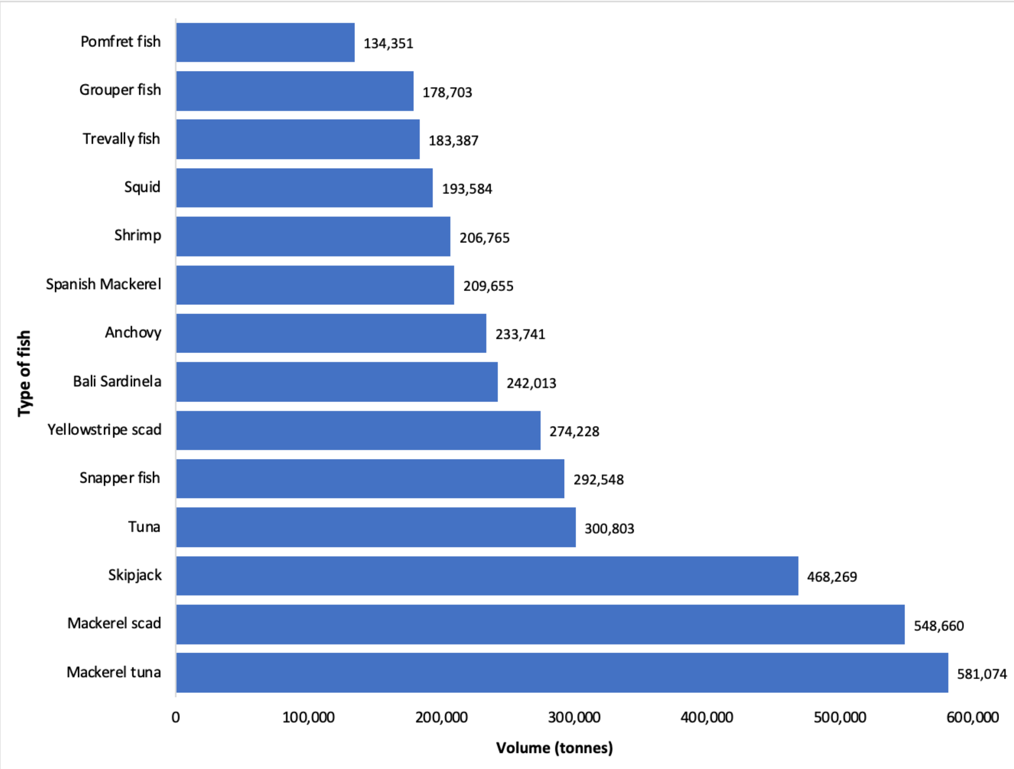
Table 28. Capture fisheries production in the Indonesian Seas Large Marine Ecosystem provinces of Indonesia (in tonnes)

Province	Year			
	2017	2018	2019	2020
South Sumatra	127 492	196 962	197 534	125 348
Lampung	178 104	142 969	161 656	141 992
Banten	109 552	101 663	168 184	75 651
DKI Jakarta	135 619	103 681	100 086	107 841
West Java	274 466	263 847	269 865	250 543
Central Java	275 469	446 277	313 259	390 886
DI Yogyakarta	6 824	6 501	6 370	6 592
East Java	564 398	487 332	489 613	424 251
Bali	112 628	110 174	95 842	95 973
NTB	182 995	207 971	224 763	226 981
NTT	72 226	157 691	137 094	182 35
Central Kalimantan	113 823	133 367	150 438	154 287
South Kalimantan	188 774	325 830	229 135	207 834
East Kalimantan	41 104	162 078	176 049	166 377
North Sulawesi	394 697	382 005	316 273	330 224
Central Sulawesi	178 438	171 115	154 197	152 668
South Sulawesi	362 038	366 541	392 304	387 177
Southeast Sulawesi	232 861	240 339	254 029	255 178
Gorontalo	136 156	147 399	145 938	117 873
West Sulawesi	56 100	65 328	67 149	64 182
Maluku	602 97	603	489 659	445 577
North Maluku	96 528	286 629	288 187	319 925
West Papua	422 509	204 504	155 084	121 742

Source: Adapted from PUSDATIN. 2022b. Produksi Perikanan (kkp.go.id)

Tuna (*Thunnus albacares*), Mackerel tuna (*Euthynnus affinis*), and Skipjack (*Katsuwonus pelamis*) remain a top commodity group with high production volume in marine capture fisheries in 2020. Among them, mackerel tuna had the highest production volume of 581 000 tonnes, followed by skipjack with a production volume of 468 000 tonnes, and tuna with 300 000 tonnes. Figure 81 presents various marine capture commodities with the highest production volumes.

Figure 81. Marine capture fisheries commodities in the Indonesian Seas Large Marine Ecosystem area of Indonesia in 2020 (in tonnes)



Source: Adapted from MMAF Centre for Data, Statistics and Information. 2022c.

Capture fisheries contribute significantly to the local economy and food security. Capture fisheries in the ISLME face various challenges, such as overfishing, illegal fishing, and destructive fishing practices. In some areas, these factors have resulted in declining fish stocks and lower catch per unit effort (CPUE). Furthermore, the COVID-19 pandemic has had an impact on the fishing industry, causing supply chain disruptions and decreasing demand for fish products. To address these issues, the Government of Indonesia has implemented various measures, such as improving fisheries management, strengthening law enforcement, promoting sustainable fishing practices, and providing support for small-scale fishers.

According to the PUSDATIN (2020c), the total aquaculture fisheries production in Indonesia reached 17.5 million tonnes, a 5.75 percent increase compared to the previous year. Currently, Indonesia is ranked as the second-largest aquaculture producer in the world and has a potential of nearly 100 million tonnes of annual aquaculture production, but currently only about 16 percent of it is being utilized. The aquaculture-related production volume of a region is largely determined by the environment and the availability of land for fish farming, in contrast to capture fisheries. South Sulawesi and East Nusa Tenggara Provinces are two provinces that have sufficiently large seaweed cultivation areas, making them key candidates for highest aquaculture production volumes compared to other provinces. Information regarding aquaculture fisheries production based on provinces in the ISLME is presented in Table 29.

Table 29. Aquaculture fisheries production in the Indonesian Seas Large Marine Ecosystem provinces of Indonesia (in tonnes)

Province	Year			
	2017	2018	2019	2020
South Sumatra	538 282	439 059	460 512	357 138
Lampung	156 132	160 583	181 128	182 259
Banten	142 861	121 262	117 317	129 184
DKI Jakarta	5 565	3 814	2 048	1 822
West Java	1 160 748	1 174 357	1 268 510	1 184 916
Central Java	485 690	510 324	513 365	509 944
D.I. Yogyakarta	88 550	95 247	109 548	93 846
East Java	1 189 443	1 226 560	1 243 767	1 264 159
Bali	17 536	25 665	16 411	31 862
West Nusa Tenggara	1 024 084	1 089 317	1 140 552	907 017
East Nusa Tenggara	1 953 261	1 814 056	1 600 421	2 162 046
Central Kalimantan	94 346	98 152	101 857	116 729
South Kalimantan	164 715	177 852	129 822	139 079
East Kalimantan	107 206	140 038	143 512	160 244
North Sulawesi	459 514	488 247	556 005	370 451
Central Sulawesi	971 924	1 270 551	966 953	960 117
South Sulawesi	3 902 808	3 551 150	3 660 689	3 713 191
Southeast Sulawesi	1 016 382	631 232	453 382	381 690
Gorontalo	94 850	57 561	52 825	47 802
West Sulawesi	104 321	102 501	105 554	133 569
Maluku	817 332	670 000	620 843	200 815
North Maluku	74 632	105 856	82 600	82 599
West Papua	56 546	56 632	22 906	10 160

Source: PUSDATIN. 2022b. Produksi Perikanan (Fish Production). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=prod_ikan_prov&i=2

South Sulawesi has the highest aquaculture production, followed by East Nusa Tenggara and DKI Jakarta reported the lowest value in the Indonesian waters of the ISLME. Marine aquaculture makes the largest contribution to aquaculture production each year. This high contribution is related to the large production of seaweed, which is one of the main products of aquaculture. Despite providing a significant contribution to aquaculture production, seaweed production experienced only a slight decrease 0.18 percent in 2021 compared to 2020. The details of aquaculture fisheries production can be seen in Table 30.

Table 30. Aquaculture production in tonnes by main commodities, 2016–2021

Fish Species	2017	2018	2019	2020	2021
Milkfish	701 427	875 592	824 239	811 883	780 763
Carp	234 084	173 345	190 389	152 669	149 170
Other fish	590 945	358 249	343 368	311 331	326 070
Snapper	8 432	9 583	7 228	5 418	8 464
Grouper	70 294	16 414	13 829	9 478	13 423
Catfish	1 125 526	944 779	1 088 945	993 768	1 041 422
Goldfish	316 649	534 215	620 831	560 669	651 238
Nile tilapia	1 280 126	1 171 236	1 317 561	1 172 633	1 300 529
Pangas catfish	319 967	373 262	380 130	327 146	332 023
Seaweed	10 547 552	10 320 202	9 775 986	9 618 421	9 092 031
Shrimp	919 988	911 857	863 119	881 599	953 177
Total	**16 114 991**	**15 688 734**	**15 425 625**	**14 845 015**	**14 648 310**

Source: PUSDATIN. 2022b. Produksi Perikanan (Fish Production). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=prod_ikan_prov&i=2

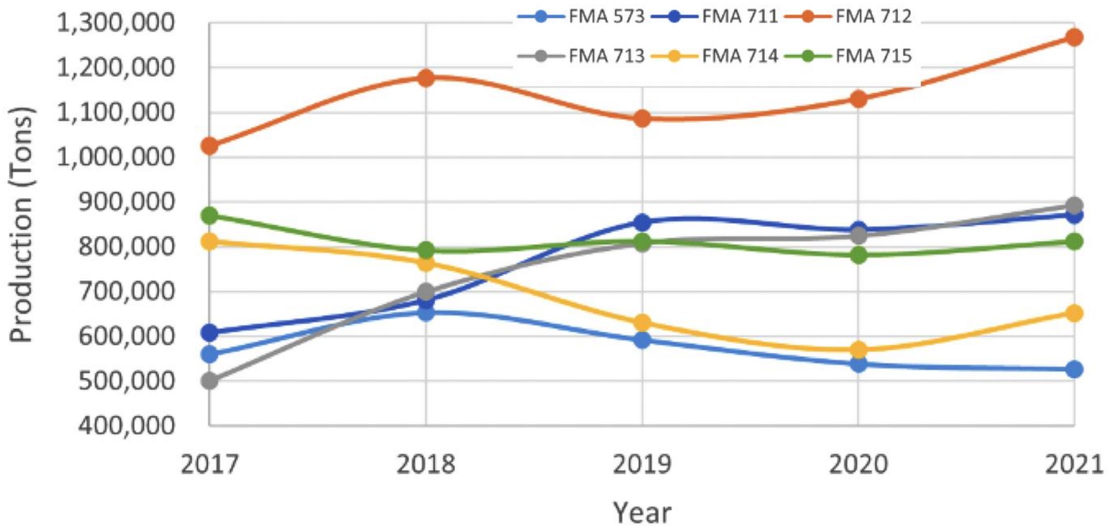
The Directorate General for Aquaculture (DJPB) of the MMAF set up two programmes in early 2022 to enhance the productivity of Indonesia's aquaculture sector. The main objective of these programmes is to meet export targets, primarily for aquaculture commodities. The first programme aims to develop export-oriented aquaculture with superior commodities that have high demand in global markets. The second programme focuses on the establishment of aquaculture villages based on local wisdom.

Despite this, the aquaculture sector in Indonesia still faces various challenges, such as a lack of infrastructure, limited access to finance, and issues related to water quality and disease outbreaks. Efforts have been made to address these challenges, including the establishment of aquaculture zones, increased investment in infrastructure, and the introduction of sustainable aquaculture practices.

3.1.2 Fisheries characteristics – catch, fleet, methods/gear, fishing grounds and socioeconomics

Fisheries characteristics are the natural and human-related factors that influence fisheries resources. The highest capture fisheries production is in FMA 712 (Java Sea), with the highest production in 2021, namely 1 268 583 tonnes. Meanwhile, the lowest production of 500 775 tonnes in 2017 was in FMA 713, which includes Makassar Sea, Bone Bay, Flores Sea, and Bali Sea. FMA 714 (Tolo Bay and Banda Sea) and FMA 573 (Indian Ocean of Southern Java, South Nusa Tenggara, Sawu Sea, and Western Timor Sea) tend to decrease eve ry year because of differences in the number of fishing gear, the number of vessels, and the number of fishing trips carried out in each FMA (Figure 82).

Figure 82. Fisheries production in Indonesian Seas Large Marine Ecosystem area of Indonesia from 2017 to 2021



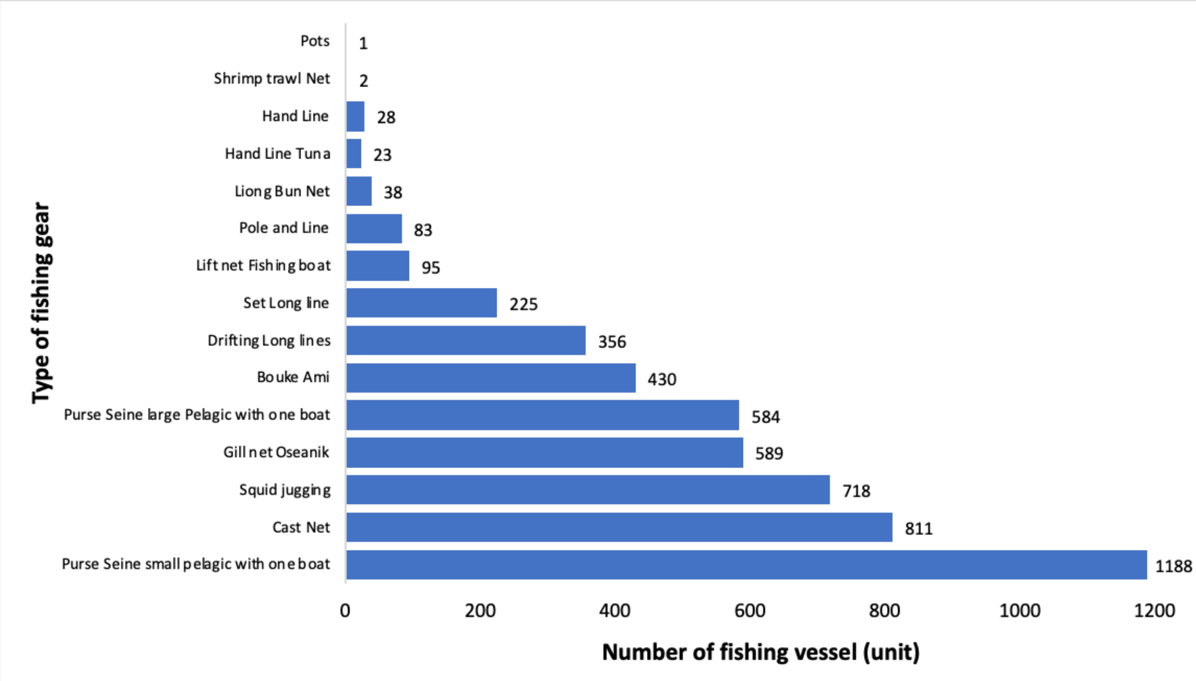
Source: Adapted from PUSDATIN. 2022b. Produksi Perikanan (Fish Production). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=prod_ikan_prov&i=2

However, despite its immense potential, the Indonesian fisheries sector faces numerous challenges. Overfishing, destructive fishing practices, habitat destruction, and pollution are some of the major issues that are currently affecting the sector's sustainability. The Indonesian government has implemented various policies and regulations aimed at promoting sustainable fisheries practices, including banning destructive fishing practices, implementing fishing quotas, and promoting responsible aquaculture practices. Another issue that has arisen is the limited adoption of e-logbooks among small-scale fisheries (Suhufan, Aifuddin and Giu, 2022). This problem stems from inadequate infrastructure, including limited internet access and a lack of trained personnel at fishing ports (Suhufan, Aifuddin and Giu, 2022).

Fishing gear and fishing vessel characteristics

Fishing gear used in Indonesia varies depending on the type of fishing and the target species. Some of the most commonly used fishing gears include nets, traps, hooks, and lines, and traditional gear, such as harpoons. In some instances, one type of fishing gear may be used to catch multiple species; however, there are also fishing gear that can only be used to catch specific target species. The MMAF reports on fishing gear used based on three fishing vessel categories: non-powered boats, boats with an outboard motor, and boats with an inboard motor. The inboard motor vessels are further divided over different size classes, depending on their size (GT). MMAF Data, Statistics and Information Centre (PUSDATIN, 2022c) reported that there are 5 554 fishing vessels that are registered and have a license for fishing gear. The details can be seen in Figure 83.

Figure 83. Number of fishing vessels' licences by fishing gear in 2020 in Indonesia

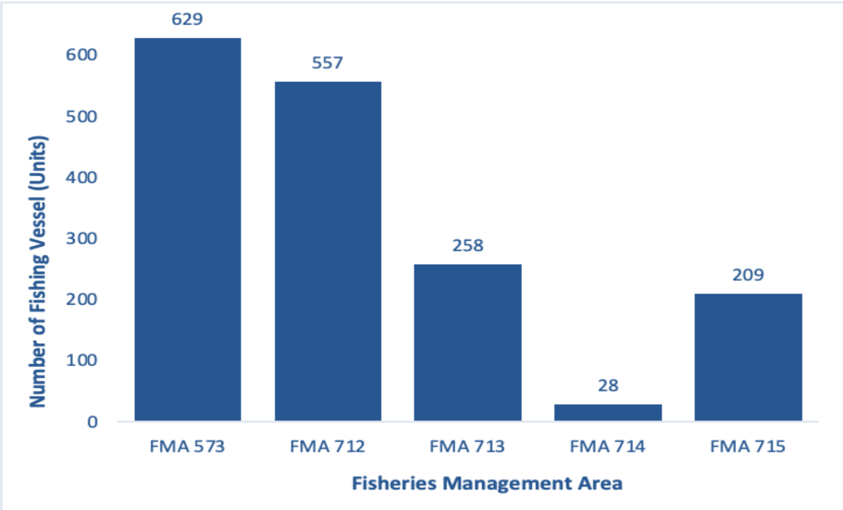


Source: PUSDATIN. 2022c. Kelautan dan Perikanan dalam Angka KKP [Marine and Fisheries in Numbers MMAF 2022]. Daftar_isi_rev_270522.cdr (kkp.go.id)

Within the Indonesian waters of the ISLME, 1 681 fishing vessels are registered with the central permitting authority (PUSDATIN, 2020) (Figure 84). As previously indicated, gear type usage varies according to the vessel size, the target fish species, and habitat, and this applies to the ISLME as well. For example, the seas around southern Java, part of FMA 573 and directly adjacent to the Indian Ocean, are mainly fished using surrounding nets, gillnets, and hook and line gears, as these gears work best in open waters, whereas shallower waters in the ISLME are often trawled to mainly catch pelagic fish species and shrimp. Medium-scale and large-scale vessels tend to use surrounding nets and gillnets, whereas small-scale fishing vessels mostly use hooks and lines and small trawls targeting pelagic fish, demersal fish, reef fish, squid, and blue swimming crab.

As a further example of gear variety in the waters of East Sumatra, part of FMA 712, the use of gillnets and hook and line gears dominate in catching small pelagic fish, demersal fish, and squid. Off North Java, also part of FMA 712, surrounding nets, seine nets, and gillnets are primarily used to catch the target fish species in the waters off East Sumatra.

Figure 84 Number of fishing vessels registered to operate in fisheries management areas in 2020



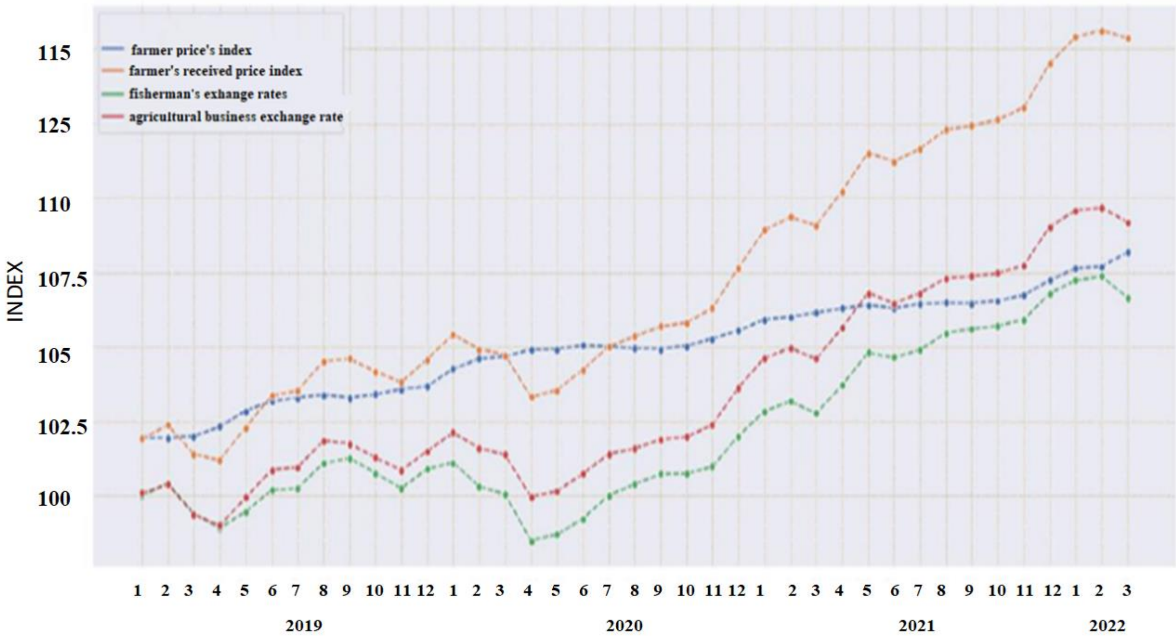
Source: PUSDATIN. 2022c. Kelautan dan Perikanan dalam Angka KKP [Marine and Fisheries in Numbers MMAF 2022]. Daftar_isi_rev_270522.cdr (kkp.go.id)

Understandably, different fishing gear can have different and potentially significant ecological impacts, including the bycatch of sharks, turtles, and other vulnerable marine species. The effects of abandoned nets or ghost fishing can also cause negative ecological consequences. For example, although tuna fishing affects tuna stocks through the unintentional catch of juvenile tuna, it can also affect other unintended bycatch species, including sharks, turtles, and other marine species. There is a growing effort to raise awareness of the significant ecological impacts of Indonesia's tuna fisheries with the intention and hope that fishers will prioritize and implement sustainable fisheries management practices. Nonetheless, although some purse seine, pole and line, and long line fisheries have been successfully certified as sustainable in other countries, a national management framework is currently still being developed in Indonesia (MMAF, 2022a).

Indonesia's management of its domestic fleet remains immensely challenging. Indonesia's fleet comprises over 600 000 vessels, with small vessels (less than 10 gross tonnes), accounting for more than 90 percent of the fleet and about half the total catch. The gears used and the species caught vary widely. Fish stocks and vessels cross jurisdictions, and different classes of vessels fall under the responsibility of different levels of government. Small vessels are exempt from licensing and often go unregistered and unmonitored. Improving the management of the domestic fleet would help lock in the benefits of Indonesia's eviction of foreign fishing vessels from their waters.

The development of the fisherman exchange rate (NTN), a measure of economic feasibility or profitability of fisheries, from January 2019 until March 2022 has fluctuated. Since April 2020, the exchange rate for fishermen has changed, rising from 98.49 to 107.50 and then falling to 106.65 in March 2022 (Figure 85). The decrease in the exchange rate for fishermen is thought to be the result of a decline in the price index received by fishermen, particularly for sea fishing. As shown in Figure 86, the exchange rate for fishermen and the price index received also show significant fluctuations. The exchange rate for fishermen increased to 0.5 in February 2019 from 0 in January 2019, then sharply declined to -1 in March 2019, and then increased once again to 0.75 in June 2019. The exchange rate for fishermen experienced the smallest decline in April 2020, when it was -1.4, but it continued to rise afterwards, reaching 0.75 in July 2020, and finally decreasing to -0.3 in March 2022. Fishermen's monthly exchange rates have a reasonably good association with income. This can be understood to mean that the price of fish at the producer level has a substantial impact on the fisherman's exchange rate.

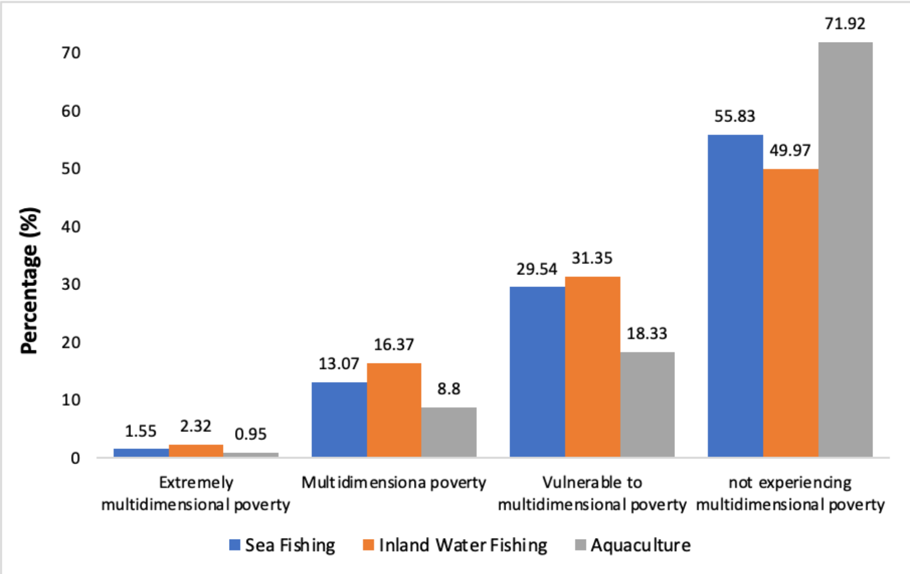
Figure 85. Fluctuations of fisherman exchange rate, January 2019 to March 2022



Source: MMAF. 2022a. Analysis of main performance indicators in the marine and fisheries sector 2017–2021. Pusat Data Statistik dan Informasi. [Daftar_Isi_Rev_2730522.cdr (kkp.go.id)]

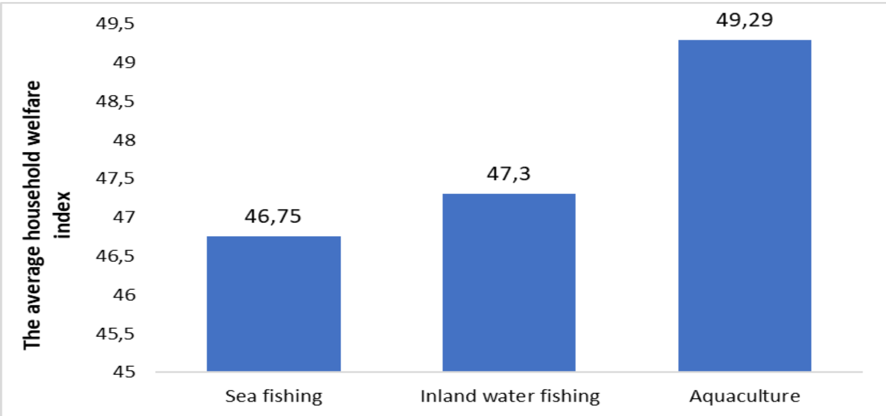
Figure 86 shows that the majority of fishing company households in 2014 fell into the moderate welfare category. The statistics from the three groups show that aquaculture households are relatively more prosperous than other types of fisheries. According to Figure 87, the average fishing household welfare index in 2014 was 49.29, with aquaculture households having the highest average. The lowest was 46.75 for sea fishing households, followed by inland water fishing households at 47.3. The high levels of welfare in aquaculture households can be explained by the high demand, low investment costs and numerous inland resources that provide ideal conditions for aquaculture.

Figure 86. Percentage of fisheries households based on household welfare category and type of fisheries business in 2014



Source: BPS. 2015. Nilai Tukar Nelayan [Fisherman exchange rates]. Jakarta. [Cited 2 July 2023]. https://www.bps.go.id/indicator/22/20/5/ntn-nilai-tukar-nelayan-menurut-subsektor.html

Figure 87. Average fisheries household welfare index by type of business in 2014



Source: BPS. 2015. Nilai Tukar Nelayan [Fisherman exchange rates]. Jakarta. [Cited 4 July 2023]. https://www.bps.go.id/indicator/22/20/5/ntn-nilai-tukar-nelayan-menurut-subsektor.html

3.1.3 Status of coastal resources

Indonesia has a vast and diverse range of coastal resources within its area of the ISLME. In this part, the coastal resources refer to the various living marine and fisheries resources found in the coastal areas, including fish, crustaceans, molluscs, and other aquatic plants and animals. These resources are important for the livelihoods of millions of people in coastal communities who rely on them as a primary source of food and income. Based on the MMAF data, the priority fisheries and marine living resources are lobster, mud crab, snapper, and grouper (Table 31).

Table 31. Status of selected marine resources in the ISLME Area of Indonesia

FMA		Coral fish	Penaeid shrimp	Lobster	Crab	Blue swimming crab
FMA 573	Estimated potential	23 725	8 514	1 563	585	3 750
	Allowable catch	11 863	4 257	782	410	2 625
	Utilization level	2.5	1.2	2	0.7	0.6
FMA 712	Estimated potential	71 526	83 820	1 481	7 360	23 508
	Allowable catch	57 221	58 674	1 037	5 152	16 456
	Utilization level	0.8	0.8	0.5	0.9	0.7
FMA 713	Estimated potential	167 403	56 835	765	6 213	9 253
	Allowable catch	83 702	39 785	383	4 349	4 627
	Utilization level	1.3	0.8	1.3	0.7	1.5
FMA 714	Estimated potential	121 326	6 472	724	1 758	4 705
	Allowable catch	60 663	3 236	362	879	3 294
	Utilization level	1.1	1	1.7	1.4	0.6
FMA 715	Estimated potential)	105 336	5 295	1 217	336	157
	Allowable catch	52 668	307	609	235	110
	Utilization level	1.3	0.7	1.2	0.7	0.7

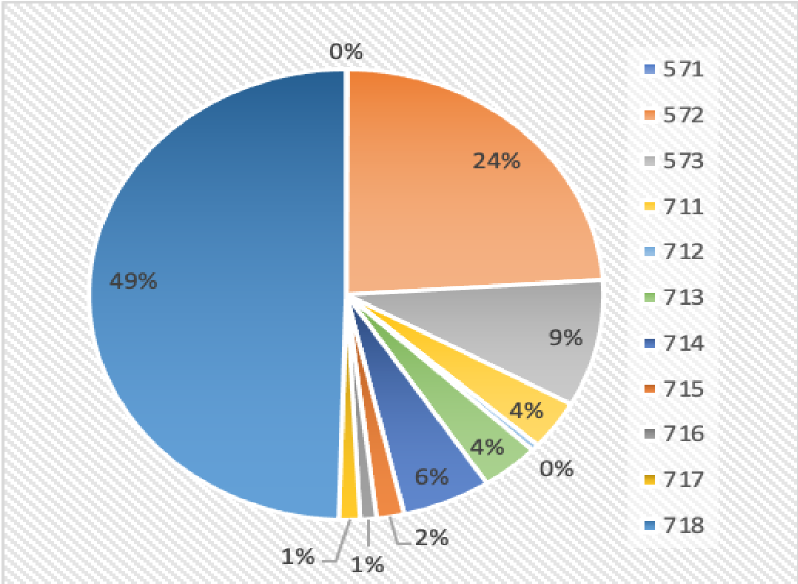
Notes: Estimated potential catch and allowable catch in tonnes.
A level of utilization below 0.5 means the resource is moderately exploited, between 0.5 to 1 means fully exploited, greater than 1 means overexploited.
Source: MMAF Decree No. 19/ 2022 on Estimated fisheries resources, Total Allowable Catch and Level of Utilization in Indonesia FMAs. Jakarta. 1670571648kepmen-kp-no.pdf (riau.go.id)

Status of lobster in fisheries management

Lobster resources are classified as an important economic aquatic resource because of high market demand in Asia, Europe, and the United States. This causes the potential for overfishing (Witomo and Nurlaili, 2015). Lobster fishing activities have not been done sustainably; thus, several problems have occurred. One common problem is catching lobster juveniles for grow-out, also called seeds (Witomo and Nurlaili, 2015). Indonesia saw its lobster export value increased sharply to USD 76.11 million in 2020. However, it fell to USD 28.62 million in 2021 and further dropped to USD 25.7 million in 2022 (Statista, 2024). In 2021, key lobster producing provinces in Indonesia were among others Maluku, Bengkulu, Southeast Sulawesi, East Java and Banten (MMAF, 2022b). The province with the highest lobster production was West Nusa Tenggara Province, with 68.01 tonnes (FAO, 2022b).

Based on the FAO 2021 report, Indonesia is the world's sixth largest country for lobster catch production. Lobster production data for 2020 based on FMA show that the highest catches came from the four dominant FMAs: namely, FMA 718 contributed 5 040 tonnes (49.54 percent), FMA 572 contributed 2 431 tonnes (23.89 percent), FMA 573 contributed 929 tonnes (9.13 percent), and FMA 714 contributed 568 tonnes (5.58 percent) (Figure 88).

Figure 88. Percentage production of lobster by Indonesian FMAs in 2020



Source: PUSDATIN. 2020c. Produksi Perikanan (Fish Production). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=prod_ikan_prov&i=2

In Indonesia, seven species of spiny lobster have been recorded (Tewfik, Mills and Adhuri, 2009; Phillips, 2006; Chan, Ma and Chu, 2013; Wardiatno *et al*., 2016), or 7.2 percent of the total spiny lobster worldwide (Williams *et al*., 2005; Chan, 1998). Six of these species are included in the tropical spiny lobster group from the Palinuridae family, the genus Panulirus, namely *Panulirus homarus* (lobster pasir), *P. ornatus* (lobster mutiara), *P. longipes* (lobster batik), *P. versicolor* (lobster bambu), *P. polyphagus* (lobster Pakisten/lumpur), and *P. penicillatus* (lobster batu), and one species of the deep-sea spiny lobster group of the genus Puerulus, namely *Puerulus mesodontus* (Wardiatno *et al*., 2016). The status of lobster species according to the International Union for the Conservation of Nature (IUCN) is "least concern" for all species of lobster (FAO, 2022a).

The types of fishing gear used to catch lobsters throughout the FMAs are grouped into fishing lines (basic longlines and handlines), gill nets (trammel nets, fixed gill nets, layered gill nets, and drifting gill nets), dragged nets (shrimp trawl), and traps (FAO, 2022a). Based on MMAF Regulation No. 18/2021, lobster fishing gear is included as permissible fishing gear; however, it can only be used according to particular selectivity measures and fishing gear capacity specified in the regulation. The dominant fishing gear used to catch lobsters were as follows: the bottom longline (23 percent of total lobster catch), trammel net (20 percent), traps (17 percent), and fixed gill net (10 percent). The level of lobster utilization is based on the total allowable catches (TAC) compared to fish production in the current year. The utilization level is classified into three levels:

(i) moderate – the value is ≤0.5;
(ii) fully exploited – the value is >0.5 to 1.0; and
(iii) overfishing – the value is >1.0 (Suman, 2016).

Based on the ISLME areas defined by FMAs 573, 713, 714, and 715, the utilization of lobster has exceeded the optimum utilization rate, which means that in this condition, the effort to catch lobster must be reduced or limited to maintain the stability of the lobster resource stock in the sea. However, the level of lobster utilization remains in a healthy or moderate condition in FMA 712, which means that efforts to catch lobster in FMA 712 can still be increased.

Status of mud crab in fisheries management

The mud crab or mangrove crab fishery is one of the high potential and priority fisheries in Indonesia and is generally managed through the Fisheries Management Plan or RPP for Fisheries Management Area (FMA) 712 and 713. The government issued MMAF Regulation No. 1/2015 and No. 56/2016 to maintain natural stocks by setting the minimum allowable catch size for lobster, mud crab, and blue swimming crab. However, trends in the status of mud crab fisheries are declining, and in some areas, the status of the stocks and habitats must be improved (Aisyah *et al*., 2016).

East Kalimantan is Indonesia's second-largest contributor province to mud crab production after North Sumatra province. Based on data grouping by the Marine and Fisheries Services of the Kutai Kartanegara Regency in 2019 (Syahdan *et al.*, 2021), mud crab production is not only obtained from catch activity but also supported by aquaculture. Kutai Kartanegara is one of the ISLME's pilot sites. The respondents stated that fishing was an effort to obtain mud crabs by catching them in their main habitat, namely the mangrove area. As for aquaculture activities, in local contexts this means catching juvenile mud crabs and placing them in artificial or man-made conditions, such as fish farm ponds.

In general, the production of mangrove crab has decreased. Production obtained in 2015 could not be surpassed in 2016, 2017, and 2018 (Table 32). However, in the last three years, the development of production has shown fluctuations, which indicates mangrove crab availability is heading toward moderate levels. There are good prospects that moderate levels be achieved, supported by mangrove forests in the delta of the Mahakam River, which has high mangrove cover and density. Syahdan *et al.* (2021) indicated that the most dominant ecosystem or land cover in Kutai Kartanegara Regency was mangrove (54 percent), ponds (22 percent), dryland forest (14 percent), and the remainder were open land, settlements, and shrubs.

Table 32. Production of mangrove crabs in Kutai Kartanegara regency from five main districts, 2015 – 2018

Year	Catch production		Aquaculture production		Total	
	Weight (ton)	Production Value (1 000)	Weight (tonne)	Production value (1 000)	Weight (tonne)	Production value (1 000)
2015	2 011.7	40 233 600	1 873.38	56 201 400	3 885.06	96 435 000
2016	1 745.9	51 898 500	1 297.44	38 923 200	3 043.34	90 821 700
2017	1 980.1	47 705 877	1 375.08	41 252 400	3 355.18	88 958 277

2018	1 776.7	108 720 700	1 448.28	43 448 400	3 224.98	152 169 100

Source: Syahdan, M., Rosadi, E., Dewi, I. P., & Anshary, A. F. 2021. Management status of mud crab fisheries in selected areas of FMA 713, East Kalimantan, Indonesia using the Indonesian Ecosystem Approach to Fisheries Management (EAFM) Assessment Methodology. In *IOP Conference Series: Earth and Environmental Science.* Vol. 763, No. 1, p. 012046. IOP Publishing

Status of snapper and grouper fisheries management

Snapper and grouper are key reef fish species in Indonesia because of their significant economic value. In 2018, snappers alone contributed around IDR 201 billion to the Indonesian economy. As the largest global exporter of snapper fish, Indonesia accounts for 45 percent of the total global trade, which amounted to 519,074 tonnes in 2018 (FAO, 2018b). Snapper species in Indonesian waters are generally found in the Aru, Arafura, and Timor Seas (ATSEA, 2011c). According to FAO data, Indonesia is the world's second-largest producing country for grouper (FAO, 2018b). Based on Badan Pusat Statistik data, the export value for grouper from Indonesia reached IDR 571 billion in 2018, with production volume reaching approximately 16 700 tonnes. High market demand has resulted in high exploitation rates of grouper stocks, exceeding maximum sustainable yields. The most common groupers in Indonesia are *Epinephelus fuscoguttatus, Epinephelus lanceolatus,* and *Cromileptes altivelis*.

The Indonesian waters of the ISLME, particularly in FMA 713, are vital for snapper and grouper, as the majority of the national catch for these species is from this area. As a result, FMA 713 is already being overexploited because of the increased market demand for snappers and groupers (MMAF, 2018b). Most of the primary snapper species are at high risk because of the overexploitation of juveniles (with a mean rate of nearly 50 percent). For the majority of species, including the top five in terms of volume landed, the trend is declining. However, the mangrove red snapper or mangrove jack *Lutjanus argentimaculatus* (known as *kakap merah bakau* or *kakap bakau'* in Indonesian) is an exception. This could be attributed to different age groups' habitat usage, as the data are based on fisheries in relatively deep water using a limited range of gears. Based on the number of fishing vessels operating and the level of exploitation of the total potential fish stock available, it is evident that FMA 713 requires a harvest strategy for grouper fish to prevent further stock depletion.

3.1.4 Status of offshore resources

In the FMAs that are part of the ISLME in Indonesia (FMA 573, FMA 712, FMA 713, FMA 714, and FMA 715) offshore fishery resources consist mainly of small pelagic fish, large pelagic fish, squid, and demersal fish, and their potential values are as shown in Table 33. The National Committee on Fish Stock Assessment (KOMNASKAJISKAN) includes *lemuru* and sardines as part of the small pelagic fish group in their research scheme for estimating fish resource stocks. This is in accordance with MMAF Decree No. 19 /2022, which deals with the estimation of potential, total allowable catch (TAC), and the level of fish resource utilization and presents the potential, as well as the TAC, and resource utilization level of small pelagic fish in each FMA. Based on the estimated proportion of *lemuru* in the small pelagic fish group from 2015 to 2019, which is 2.6 percent, the estimated potential value of *lemuru* fish nationally would be approximately 81 100 tonnes per year to 141 736 tonnes per year.

Table 33. Status of offshore resources commodities in the Indonesian Seas Large Marine Ecosystem area of Indonesia

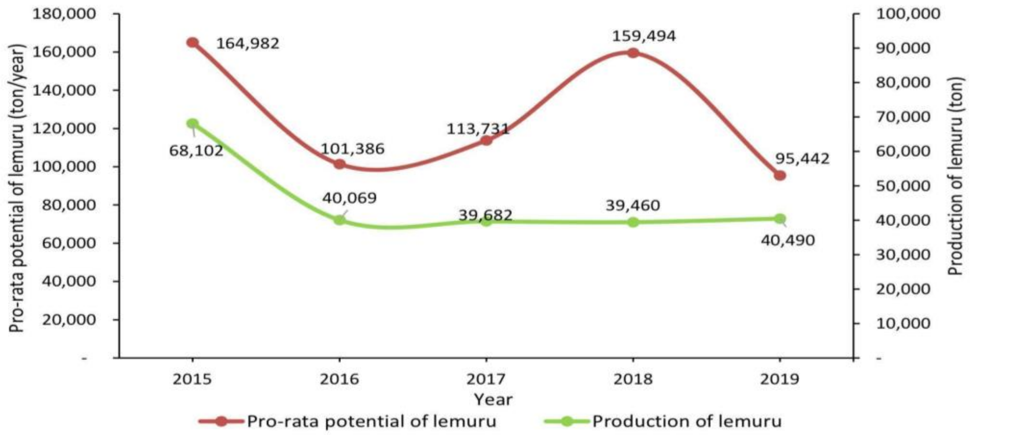
Fisheries management area		**Small pelagic fish**	**Large pelagic fish**	**Squid**	**Demersal fish**
FMA 573	Estimated potential	624 366	354 215	22 124	299 600
	Allowable catch	437 056	247 950	11 060	269 640
	Utilization level	0.6	0.9	1.1	0.2
FMA 712	Estimated potential	275 486	145 863	66 609	358 832
	Allowable catch	247 937	72 932	46 626	179 416
	Utilization level	0.4	1.3	0.9	1.1
FMA 713	Estimated potential	284 302	162 506	11 370	374 500
	Allowable catch	142 151	113 754	5 685	337 050
	Utilization level	1	0.8	1.2	0.3
FMA 714	Estimated potential	222 881	370 653	13 460	292 000
	Allowable catch	156 017	259 457	9 422	204 400
	Utilization level	0.7	0.7	0.5	0.7
FMA 715	Estimated potential	443 944	74 908	3 874	80 226
	Allowable catch	310 761	52 436	2 712	56 158
	Utilization level	0.7	0.7	0.9	0.7

Notes: Estimated potential and total allowable catch in tonnes.
A level of utilization below 0.5 means the resource is moderately exploited, between 0.5 to 1 means fully exploited, greater than 1 means overexploited.
Source: MMAF Decree No. 19/ 2022 on Estimated fisheries resources, Total Allowable Catch and Level of Utilization in Indonesia FMAs. Jakarta. [1670571648kepmen-kp-no.pdf (riau.go.id)]

Since there has been no specific estimation conducted for the potential of *lemuru* fish species in Indonesia, the available data and research results are used to make estimations. This implies that the estimations for the potential, utilization rate, and TAC of *lemuru* are based on the approach used for the small pelagic group (Figure 89).

To estimate the potential of the lemuru species, the Catch MSY (cMSY+) and Bayesian Schaefer Model (BSM) were used (Froese *et al.,* 2017). The cMSY+ is a Monte-Carlo method that estimates fishery reference points, such as maximum sustainable yield (MSY), fishing mortality (Fmsy), and biomass (Bmsy), as well as the relative stock size (B/Bmsy) and exploitation rate (F/Fmsy) from catch data (ct), level of productivity or resilience, and the ratio of biomass (B) to carrying capacity (k) over a certain time series. In estimating the potential of *lemuru* fish, the data used include the catch data of *lemuru* fish (ct) in Indonesia from the MMAF in 2021, the relative abundance of *lemuru* fish in Bali Strait based on the research of Sari, Koeshendrajana and Nababan (2009), Zulbainarni *et al*. (2011), and statistics data of Banyuwangi and Pengambengan Ports (bt) from 1980 to 2019 (yr) (Figure 90).

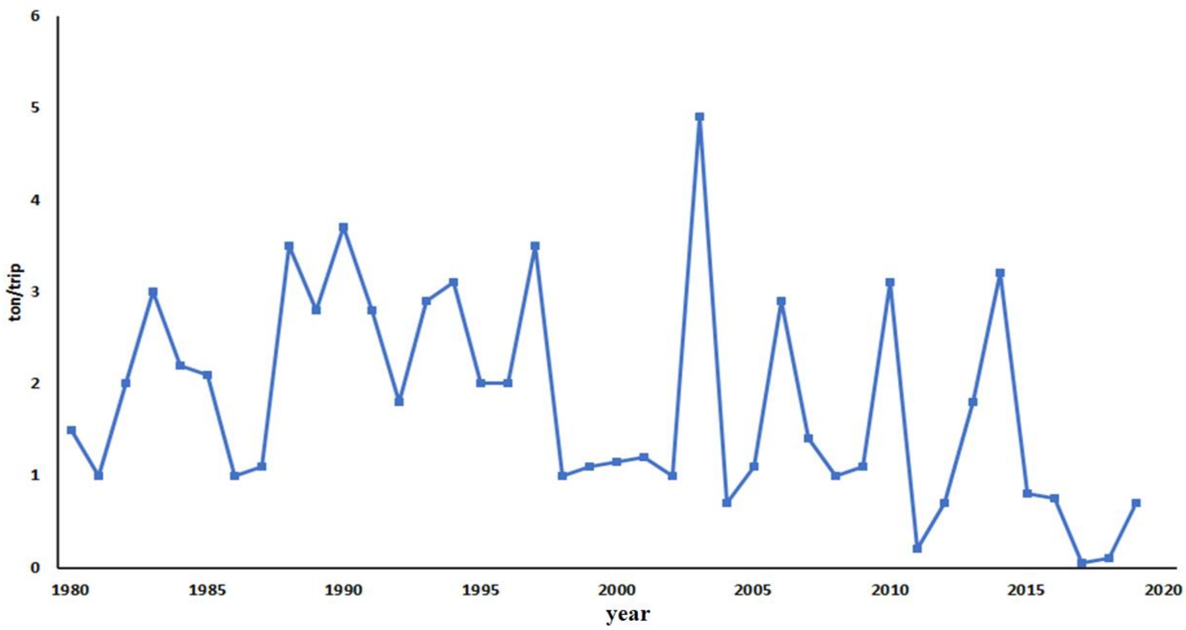
Figure 89. Pro-rata potential of lemuru based on the production proportion



Source: FAO. 2022a. Review of fisheries management plan of small pelagic lemuru fishery (Sardinella lemuru). Lemuru Fisheries Management Plan. Yayasan Padmi Yasa Mandiri. Jakarta.

The exploitation rate of *lemuru* fish (Figure 90) is primarily above 1.0, and there was a tendency for a significant increase in the exploitation rate in 2019. This suggests that the exploitation rate of *lemuru* fish has surpassed its optimal level. The fit model results demonstrate a significant decrease in the production development and relative abundance as measured by catch per unit effort (CPUE) of *lemuru* fish until 2019. Table 34 summarizes priority issues of *lemuru* fishery management.

Figure 90. Catch per unit effort of lemuru fish in the waters of Bali Strait in 1980–2019



Source: FAO. 2022a. Review of fisheries management plan of small pelagic lemuru fishery (Sardinella lemuru). Lemuru Fisheries Management Plan. Yayasan Padmi Yasa Mandiri. Jakarta

Table 34. Priority issues of lemuru fishery management

Issue	
A. Fish resource	
1.	*Lemuru* of all sizes are being caught, and the population is dominated by young fish (juveniles), with more than 50 percent of the fish caught being juveniles.
2.	The *lemuru* fish stocks have degraded, reaching the level of overfishing (indicated by CPUE proxy) and overfished conditions (when the natural biomass is lower than the ability to recover the fish resource).
B. Fish resources environment	
1.	Comprehensive information about the critical habitats and life cycle of the *lemuru* fish resource is not yet available, so it has not been used as a basis for management.
2.	Materials related to climate change mitigation have not been included in the formulation of *lemuru* fishery management.
C. Social economy	
1.	Very limited alternative livelihoods for fishermen and *lemuru* fish processing workers, especially during the low fishing season.
2.	There is a conflict between temporary (andon) fishermen from the north coast of Java (FMA 712) and local fishermen in Pengambengan regarding *lemuru* fishing, including the utilization of catch quota for *lemuru* fishing in the Bali Strait.
3.	There is a insufficiency of mechanisms and strategies to anticipate the shortage of raw materials for fish processing units (UPI) during the low season.
D. Governance	
1.	There has not been any implementation of harmonious joint management of *lemuru* fishery between the provinces in the Bali Strait (East Java and Bali).
2.	There is an insufficiency of compliance among fishermen with the applicable laws and regulations, and there is an insufficiency of law enforcement, especially related to licensing.
3.	There is a low level of stakeholder participation, particularly among fishermen, business actors, and local communities, in the management of *lemuru* fishery.

Source: FAO. 2022a. Review of fisheries management plan of small pelagic lemuru fishery (Sardinella lemuru). Lemuru Fisheries Management Plan. Yayasan Padmi Yasa Mandiri. Jakarta

3.1.5 Fisheries management – overcapacity, illegal, unreported, and unregulated fishing, compliance, ecosystem approach to fisheries management

Illegal, unreported, and unregulated (IUU) fishing practices are widespread in the LME and are a serious threat to fishery resources in the ISLME. MMAF has estimated losses from IUU fishing in Indonesian waters at USD 20 billion per year. These losses from IUU fishing in Indonesia are estimated to cost the Government of Indonesia several billion dollars annually in lost tax revenues, because of the IUU activities of some 5 000 unlicensed foreign vessels. This number does not include the impacts of ecological destruction from IUU fishing activities (FAO, 2019a).

Earlier estimates of IUU catches by foreign vessels in the Arafura and Timor Seas, Banda Sea, and Savu Sea (which comprise a significant proportion of the ISLME) and contiguous areas are between 399 658 to 429 658 tonnes, with an estimated value of USD 524 million to 906 million (Wagey *et al*., 2009). A study carried out in the neighbouring Arafura Sea shows that reported catches are between 0.9 percent and about 20 percent of the estimated catches. In Timor-Leste, it is estimated that over USD 40 million worth of marine resources are being stolen from Timor-Leste by foreign vessels every year (National Plan of Action on IUU). Other types of IUU fishing include blast and cyanide fishing, mostly conducted by small-scale fishermen and related to the international market for live reef fish.

The socioeconomic impacts of overexploitation of fisheries and IUU fishing include reduced economic returns and tax revenues, loss of employment of fisher families, conflicts between user groups, and loss of food sources for humans and animals (including farmed fish). The reefs of Indonesia provided annual economic benefits of USD 1.6 billion per year in 2002, based on their value in food security, employment, tourism, pharmaceutical research, and shoreline protection, but over the next 20 years, human impacts, notably overfishing, destructive fishing, and sedimentation, would cost Indonesia some USD 2.6 billion.

Transboundary threats of IUU fishing within the region, particularly from fishing operators flagged in neighbouring countries, are persistent and have a well-documented impact on the fisheries of the ISLME. Much of the IUU catch of the neighbouring Arafura and Timor Seas is transshipped or transported through the ISLME area (ATSEA, 2011d). The permeability of the region to fishing vessels from throughout East Asia and Southeast Asia means this area sits at the heart of uncontrolled fishing activity by vessels which, though nominally flagged to the ISLME countries, have beneficial ownership outside the region and engage in substantial illegal transshipping and other IUU-related fishing activity. The use of fish poisons to catch aquarium and food fish for the live reef fish trade is a serious issue in Indonesia, and the use of explosives is also of grave concern. There is widespread habitat destruction of coral reefs from blast and poison fishing, including extensive damage to soft-bottom communities from trawling. The impacts of destructive fishing have major transboundary implications, both in terms of target species population dynamics and in terms of international market demand (i.e. overfishing, loss of biodiversity, and negative market perceptions).

Behaviour of Indonesia as a flag state and port state in relation to fishing in international waters

The five types of IUU fishing violation issues in FMAs 712, 713, 714, and 573 include: (i) fishing without legal documents; (ii) illegal fishing in territorial waters; (iii) the use of fishing gear that is prohibited, especially seine net; (iv) smuggling juvenile/seed lobsters; and (v) the use of explosives/anaesthesia (FAO, 2019a). In 2015, Indonesia had a fleet of 31 patrol vessels, including large patrol vessels between 17 m and 32 m and 109 speedboats between 6.5 m and 16 m. Large patrol vessels had a total of 354 crew members in 2015 (MMAF, 2017a).

The government's efforts are implemented by accommodating international principles and standards, reforming regulations and strengthening marine patrol forces by developing special task units and using monitoring technology such as vessel monitoring system (VMS), which is required to catch fish of with vessels more than 30 GT operating in Indonesian waters, as stipulated in the MMAF Regulation No 42/2015. In fact, in the last five years, the government has taken severe action against IUU fishing actors by sinking several ships caught carrying out IUU fishing activities (FAO, 2019b).

The Indonesian government audit in 2015, as reported by Chapsos and Hamilton (2018), found that 1 132 vessels had committed regulatory violations, such as deactivating the VMS (73 percent), using foreign seamen and captains (67 percent), fishing outside designated fishing grounds (47 percent), transporting goods to and from the territory of Indonesia without going through customs authorities (37 percent), transshipment (37 percent), failing to land the catch in a fishing port (29 percent), not owning or partnering with a fish processing unit (24 percent), using illegal fuel (23 percent), forgery of fishing logbooks (17 percent), trafficking in persons and forced labour (10 percent), and using prohibited fishing gear (2 percent).

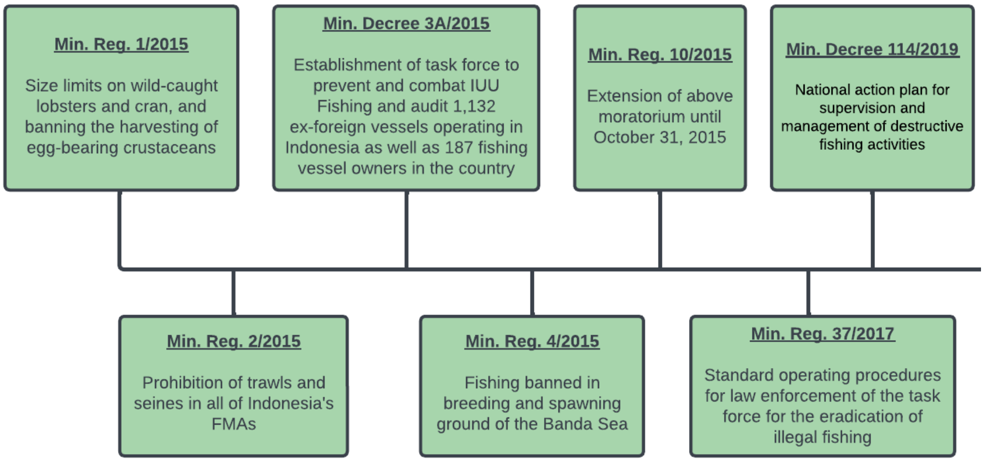
Government action to eradicate IUU fishing

The MMAF has developed a five-year action plan to address IUU fishing from foreign and domestic vessels. In this action plan, a special task force (Satuan Tugas – SATGAS 115 Task Force for the Eradication of Illegal Fishing) was established to synergize cooperation on illegal fishing with representation from authorities on maritime sovereignty, security, and sustainability. The task force also has the mandate to address transnational crimes, including smuggling.

The MMAF strategic plan includes a review of the relevant gaps and opportunities related to improving the effectiveness of existing legislation. Significantly, MMAF has passed a range of regulations since 2014 to eradicate IUU fishing and improve enforcement and compliance with RFMO agreements, including a series of ministerial decrees aimed at reducing fishing with certain types of gear deemed destructive for certain types of seafood and in certain fisheries management areas, on reducing foreign fleets inside Indonesian waters, and temporarily ending the practice of transshipments (MMAF Regulation No. 58/2014 on temporary suspension (moratorium) of transshipment) (Figure 91). To a large degree, the eradication of IUU fishing aims at increasing fish quantities to support domestic economic interests, as well as to support nutrition targets that include increased consumption of fish protein for all Indonesian citizens.

In popular media, the initial ban on transshipment at sea was judged to be harmful to many smaller-scale fisheries (KKP News, 2016). Indonesian Vice-President Jusuf Kalla visited affected areas and observed that there were empty cold storages and hundreds of inactive vessels. The vice general manager of *PT. Delta Pacific Indotuna* reported that their processing capacity is only 30 percent utilized because of the lack of supply and that fish had to be imported to meet demand (Simbolon, 2016). The head of the Indonesia Fisheries Cannery Association in North Sulawesi, Mr Basmi Said, estimated that the fishing industry in North Sulawesi has lost IDR 8.7 billion (approximately USD 633 million) worth of income and 10 502 workers since 2014 (Prasetyadi, 2019). The MMAF Regulation No. 58/2014 was later rescinded with the issuance of MMAF Regulation 11/2020 on revoking the temporary suspension (moratorium) of transshipment. Accordingly, transshipment can now be conducted by authorized fishing vessels and/or in compliance with applicable rules and regulations to curb illegal transshipment, but whether this has improved the lot of smaller-scale fisheries needs to be investigated.

Figure 91. Ministerial decrees or regulations issued by the Ministry of Marine Affairs and Fisheries to address illegal, unreported and unregulated fishing



Source: Modified from MMAF. 2016b. *NPOA: National Plan Of Action To Prevent And To Combat Illegal, Unreported, and Unregulated Fishing 2012-2016*. Jakarta.

The Indonesian Maritime Information Centre (IMIC), launched on July 22, 2020, helps detect foreign vessels entering Indonesian waters by pooling high-quality surveillance data from several government bodies, according to Demo Putra from the Indonesian Coast Guard (*Badan Keamanan Laut* or *Bakamla*), which oversees this initiative. During the ISLME TDA National Stakeholders Consultation, participants mentioned that challenges still exist, particularly on domestic IUU, in some areas of the ISLME. Participants mentioned that unsustainable fishing and aquaculture practices are still growing in some areas in FMA 712; the fishers also still used *cantrang*, a modified trawl.

Destructive fishing practices are common in tropical waters with coral reefs such as those of Indonesia where they can be found primarily in FMA 712 (North Java Sea Area). Destructive fishing practices include using of fishing gear that is not categorized as ecofriendly. Destructive fishing can disrupt the ecological balance, in which the food chain in the sea is disrupted and destroy coral reefs, which serve as critical habitats for the marine ecosystem. According to the Indonesian Institute of Sciences/*Lembaga Ilmu Pengetahuan Indonesia* (LIPI) research and monitoring of coral reefs at 1 067 sites throughout Indonesia showed that as many as 386 sites of coral reefs were in the "bad status" category (36.18 percent), as many as 366 sites (34.3 percent) in the "moderate category", and as many as 245 sites (22.96 percent) in the "good category" and 70 sites (6.56 percent) in the "very good" category. High economic pressure within fisher communities triggers the decision to engage in destructive fishing. This is chosen by fishers to increase their catches to make a short-term profit. This is inseparable from the condition of fishers in Indonesia, the majority of whom live in poverty.

IUU fishing remains a big challenge not only for coastal communities but also for the government. The Government of Timor-Leste has limited capacity to control all its waters.

Given the enhanced capacity to do monitoring and surveillance operations, a lot of IUU fishing still happens on the northern and southern coast of the country. This IUU fishing was monitored through Global Fishing Watch (GFW) from 2018 to 2022. The results showed that much of the IUU fishing happened inside Timor-Leste's EEZ. As detected by GFW many boats that do IUU fishing activities are coming from Indonesia. For example, from December 2020 to January 2021, about 15 Indonesian boats were operating illegally in Timor-Leste's waters, starting from northern coast near Oecusse and Bobonaro to Suai, Betano and Viqueque on the southern coast.

Recently, the IUU fishing has caused the loss on average of USD 84 million per year as estimated by the Directorate General of Fisheries, Aquaculture and Marine Resources Management (DFAMRM) of Timor-Leste (
). The DFAMRM has monitored this IUU fishing since 2018. This monitoring effort was made in close collaboration with Australia and Indonesia

Table 35. Estimated economic loss in Timor-Leste from illegal, unreported and unregulated fishing

Year	Tonnes/Day	Fishing trip	No. of vessels	Total catch (tonnes)	Average (GT)	Fish p rice/kg (USD)	Total money loss (USD)
2021	5	12	42	2 520	53	2	53 424 000
2020	5	12	48	2 880	53	2	61 056 000
2019	5	12	69	4 140	53	2	87 768 000
2018	5	12	107	6 420	53	2	136 104 000
Total							338 352 000

Source: Directorate General of Fisheries, Aquaculture and Marine Resources Management. 2022. Unpublished report on Estimated economic loss in Timor-Leste from Illegal, Unreported and Unregulated fishing. Dili. Timor-Leste.

IUU fishing also poses a significant threat to species under threat such as sharks, dugongs, and turtles. The Government of Timor-Leste is committed to reduce IUU fishing in close cooperation with littoral countries e.g. Australia, Indonesia, and Papua New Guinea. The commitment is part of the country's implementation of the 2030 Agenda, especially SDG 14.4, which states that all littoral countries will be able to "effectively regulate harvesting and end overfishing, IUU fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics".

GFW has identified that many Indonesian boats regularly operate around Timor-Leste's waters. Normally they use small vessels (approximately 5m to 6m long) equipped with handlines targeting coral fish. The vessels are regularly coming from Atambua (Indonesia) near Batugade, Bobonaro Municipality toward the west part of the island. They are also using fishing activities as an opportunity to sell basic necessities such as noodles, soap, sandals and fuel to coastal communities of Batugade. In addition, many fishers from Ataúro Island are also doing illegal fishing near Liran and Wetar Islands and vice versa. This activity has been practiced for the last two decades and cannot be halted easily because these fishermen have cultural connectivity. Historically, many people in Atambua or Kupang including Wetar and Liran Islands have strong family interconnections although they were separated during the civil war that took place during the referendum in Timor-Leste in 1999. Therefore, Timor-Leste and Indonesia need to use diplomatic channels to enable the two countries to work more closely to control and manage all marine and coastal resources.

Again, to address these IUU fishing activities, close cooperation between Indonesia and Timor-Leste is strongly required. Monitoring the IUU fishing and evaluating the magnitude of its impacts is necessary for both countries. In addition, each country needs to identify the main hotspots of IUU around the border area. Each country needs to prepare proper risk assessment instruments which can facilitate IUU fishing monitoring and evaluation. Wilcox *et al*. (2021) have observed Timor-Leste's hotspots and have outline the type of IUU fishing activity in its EEZ including species caught. The type of IUU fishing activity is trawlers and gillnetters fishing illegally in the Timor-Leste EEZ.

3.1.6 Status of coastal aquaculture and management

Although coastal aquaculture is an important sector for Indonesia's economy, providing livelihoods for millions of people and contributing to the country's food security, the rapid expansion of coastal aquaculture has also led to environmental and social challenges that need to be addressed. Mariculture is a cultivation activity that contributes to the largest aquaculture production annually. According to the most recent statistics, the top five aquaculture commodities in Indonesia were seaweed, shrimp, grouper, snapper, and milkfish (MMAF, 2018a). Based on data from the MMAF Directorate General for Aquaculture (2017–2021), the contribution of aquaculture production in 2017–2021 is shown in Table 36. With a total production volume of 49.86 million tonnes and a contribution of 85 percent, seaweed is by far the most produced aquaculture commodity, followed by shrimp (4.46 million tonnes and 7.61 percent), then milkfish (4.17 million tonnes and 7.12 percent), then grouper (124 000 tonnes and 0.21 percent), and lastly snapper (39 000 tonnes and 0.07 percent).

Table 36. Aquaculture production in Indonesia according to main commodities, 2017 – 2021

Commodities	2017	2018	2019	2020	2021*	Total
Milkfish	701 427	875 592	824 239	811 883	960 733	4 173 874
Snapper	8 432	9 583	7 228	5 418	9 034	39 695
Grouper	70 294	16 414	13 829	9 478	14 069	124 084
Seaweed	10 547 552	10 320 202	9 775 986	9 618 421	9 601 435	49 863 596
Shrimp	919 988	911 857	863 119	881 599	884 939	4 461 502
Total/year	**12 247 693**	**12 133 648**	**11 484 401**	**11 326 799**	**11 470 210**	**58 662 751**

Note: *provisional numbers. In tonnes.
Source: PUSDATIN. 2022b. Produksi Perikanan (Fish Production). [Cited 22 August 2023]. https://statistik.kkp.go.id/home.php?m=prod_ikan_prov&i=2

The common problems faced by the Directorate of Production and Aquaculture Business in increasing the production of aquaculture include: (i) the continuous availability of high-quality seeds in cultivation centres; (ii) disparity between potential production centre locations (such as remote areas, eastern regions, and border areas) and infrastructure centres that provide fish feed, cultivation equipment, and machinery; (iii) floods and natural disasters in cultivation centres that result in harvest failures and damage to cultivation infrastructure; (iv) the emergence of new diseases and attacks on main cultivated commodities that increase production costs or harvest failures; (v) the incapacity of entrepreneurs to adapt to changes in cultivation practices (e.g. climate change, technological developments, increased market requirements, and business competition).

The challenges in sustainable aquaculture development today include: (i) declining consumer purchasing power, so cultivation activities must be efficient and produce affordable fish; (ii) environmental damage issues resulting from cultivation activities, so cultivation activities must consider environmental sustainability; (iii) technological developments and demographic changes that require adjustments in cultivation activities and marketing of their results; (iv) export competition as a result of the faster growth of aquaculture production in some other countries with competitive prices; and (v) increasing negative impacts of climate change on cultivation activities.

3.2 Condition and status of coastal and marine habitats

Indonesia has extensive natural marine and coastal assets—mangroves, coral reefs, and seagrasses, among other critical ecosystems—that underpin its ocean economy. The country has 240 mangrove species, which include 48 true and 192 associated mangroves and consists of trees, palms, shrubs, herbs, lianas, epiphytes, ferns and parasite species (Rahman *et al.*, 2024), supporting a wide diversity of marine fauna. Indonesia's reefs span a combined area of over 2.4 million ha and, being the home to over 2 100 fish species and 590 coral species, showcase the greatest reef biodiversity globally (Hutomo and Moosa, 2005). Although scientific understanding of seagrasses is limited, these ecosystems are considered the most species-rich and extensive examples of their kind worldwide (Unsworth *et al*., 2018).

In addition to reducing the value of coastal ecosystem services for fisheries and tourism, degradation hinders another crucial economic function: community protection. Reefs and mangroves lessen the devastation from storm surges and tsunamis. Less dramatically but more frequently, they moderate wind waves and swells, reducing chronic shoreline erosion (Guannel *et al*., 2016). Recent studies indicate that Indonesia's coral reefs protect coastal areas from flood damage to the value of at least USD 639 million annually (Beck *et al*., 2018). These values are especially high for reefs near major cities, such as Jakarta and Surabaya, which are particularly vulnerable. This value is likely to grow as coastal areas become more developed and as climate change becomes more severe. By 2050, rising sea levels and resulting coastal flooding are expected to affect 23 million Indonesians annually (Kulp and Strauss, 2019).

There is significant and ongoing degradation and loss of coastal and marine ecosystems in the ISLME region, including important areas of biodiversity, habitat and fisheries productivity such as mangrove forests, seagrass beds and coral reefs. Coastal development processes, including expanding urbanization, port development, industries, aquaculture, tourism facilities, and other infrastructure in the coastal zone either remove or impact natural ecosystems and reduce the ecosystem services they produce.

Clearance of coastal areas and coastal habitats for timber and fuelwood, conversion to aquaculture and other forms of coastal development, heavy siltation, and pollution have caused major fragmentation and loss in mangrove ecosystems. More than 28 percent of Indonesia's mangrove cover has been lost in the past 30 years.

Modification of coastal habitats (i.e. mangrove, coastal fringe, seagrass, and coral reefs) has resulted in major changes in fisheries, their population structure as well as functional group composition, notably in coral reefs, and massive changes in the ecosystem services of coral reefs and mangroves. Mangrove areas used for shrimp aquaculture are important nursery grounds for marine coastal resources, the sustainability of which may be severely impacted by the establishment of aquaculture operations. The crucial role of mangroves and seagrass beds as nursery and feeding grounds for fish and marine mammals have been compromised or entirely lost over extensive areas.

In the past 50 years, the proportion of degraded reefs in the ISLME has increased from 10 percent to 50 percent (Johan *et al*., 2015). Damage to coral reefs from the use of explosives and poisons is significant; on regularly blasted reefs, coral mortality can range from 50 percent to 80 percent. The effects of cyanide fishing on coral reefs are also major, as the reefs are frequently broken to retrieve stunned fish, and they are also severely bleached by the cyanide. Mining and quarrying coral is another significant threat to the ISLME's coral reefs and is widespread at both subsistence and commercial levels.

Habitat degradation has significant transboundary implications in terms of reduced fish recruitment and impacts on migratory species, as well as on biodiversity throughout the region. This degradation and loss of coastal and marine habitats is one of the major threats to sustainable marine ecosystems, fisheries, and their dependent livelihoods in the ISLME region, and it also increases the vulnerability of coastal communities to climate change impacts.

Marine ecosystems in the ISLME region are currently experiencing significant threats caused by climate change, plastic waste pollution, oil pollution, and intentional and non-intentional damage to ecosystems, including coral reefs, seagrass beds, and mangroves. Uncontrolled development on land and on coastal regions is increasing in intensity (Pramudianto *et al*., 2018). Infrastructure developments and increasing land-use changes have also affected coastal and marine habitats across the ISLME area.

Increases in human settlements, industrial establishments, tourism facilities, and aquaculture conversions have all impacted marine and coastal habitats (MMAF-USAID, 2018). These impacts can be direct through the loss or conversion of habitat and indirect through pollution and sedimentation. Activities such as dredging, land filling, and mining can also directly alter the physical environment through the removal of habitats, while the by-products of mining released into the marine environment can be toxic to marine ecosystems (Solihin, Batungbacal and Nasution, 2013). Structures built in water (e.g. jetties or barriers) can affect coastal areas by altering wave and water flow patterns. Coastal developments can also alter sedimentation processes in coastal areas, which is of concern as sediment can smother and kill corals and seagrass beds.

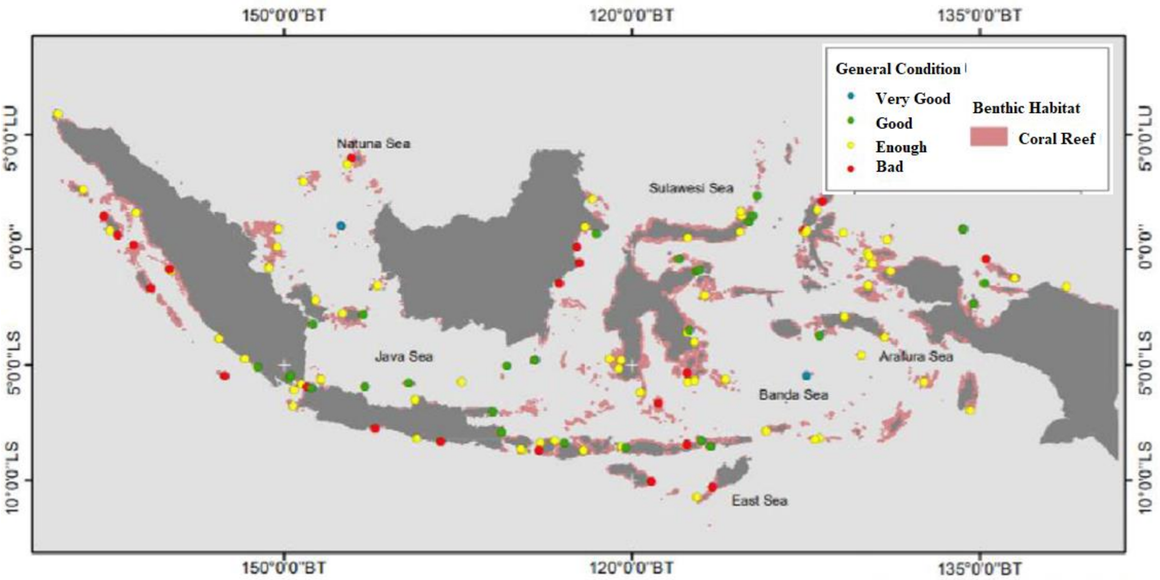
According to the initial design narrative of the National Medium-Term Development Plan (RPJMN) 2020–2024 (BAPPENAS, 2019), there are two main activities that contribute to the destruction of the ecosystem: IUU fishing and the disposal of garbage or waste into the sea. IUU fishing activities often lead to overfishing and include the use of prohibited tools such as trawls, bombs, or poisons. Disposal of waste into the sea often occurs in areas that have dense rates of shipping traffic and processing plants. Both of these actions damage the ecosystem, which, in the long run, can reduce the health of marine ecosystems and, in turn, reduce the productivity of marine resources.

3.2.1 Coral reefs

Heavy reliance on marine resources across Indonesia has led to marine resources and habitats being overexploited and degraded, particularly those near major population centres (ADB, 2014). For example, nearly 95 percent of Indonesia's coral reefs are threatened by local human activities, with more than 35 percent at high or very high risk from overfishing, destructive fishing, marine and watershed-based pollution, and coastal development (Burke *et al*., 2012). The impacts of climate stressors and changes in land-use, such as deforestation for food production and human settlement, have affected multiple species and trophic levels in both terrestrial and marine systems. These changes cause a significant loss of biodiversity, especially in tropical regions. Deforestation can have indirect consequences on the ability of tropical forests and reef biota to withstand additional climate disturbances. This is because deforestation can result in unfavourable landscapes and ocean conditions that make it difficult for species to adjust and move toward areas with more suitable climate conditions (Newbold *et al*., 2019; Eigenbrod *et al*., 2015).

Indonesian Institute of Sciences or LIPI (2020), on the basis of 2019 data, assessed the health of 1 153 coral reefs in Indonesian waters and found that 33.82 percent of reefs were in poor condition, 37.38 percent were in fair condition, 22.38 percent were in good condition, and 6.42 percent were categorized as being in excellent condition (Figure 92). Reefs that were considered in poor or fair conditions had less than 50 percent coral coverage and represented 69.16 percent of all reefs analysed, whereas reefs having more than 50 percent coral coverage were considered in good or excellent condition and represented 30.85 percent of the reefs in the studies (LIPI, 2020).

Figure 92. Current status of coral reefs in the Indonesian area of the Indonesian Seas Large Marine Ecosystem



Source: LIPI. 2020. Kondisi Terkini Tingkat Keterancaman Spesies Akuatik (Current conditions threat level of aquatic species). Presented on the National WEBINAR Fish Species Management Roadmap Threatened with Extinction Priority, Pusat Penelitian Biologi LIPI.

In Western Indonesia (the surrounding area of FMA 712), coral reef conditions appear to be better. This may be related to the change of natural resource exploitation in the area, as fisheries in the western seas of Indonesia were overexploited and fishers moved east. Thus, corals in Western Indonesia have had time to regrow. Furthermore, awareness of coral reef destruction has increased over time. Initiatives under the Coral Reef Rehabilitation and Management Program (COREMAP) Phase II have encouraged law enforcement to combat destructive fishing practices, and it has also instituted community-based management, which involved local communities actively managing the coastal ecosystems in eight locations in Western Indonesia.

The health of coral reefs in the areas surrounding FMA 713, FMA 715, and some areas of FMA 573 were improving until 2015 when a widespread bleaching event occurred. The areas that experienced the most bleaching during this period were those adjacent to the Indian Ocean, mainly the Lesser Sunda Islands. However, the impact was recorded across the region: in Bali, the coral cover declined from 60.3 percent (2015) to 29.6 percent (2016); in West Lombok, the coral cover declined from 36.09 percent (2015) to 18.23 percent (2016); and in the marine conservation area of Gili Matra coral cover declined from 23.43 percent (2015) to 18.48 percent (2016). It is typical that during El Nino events, the warm phase of the ENSO, the Indian Ocean is warmer, and this affects the reefs in the western and southern parts of Indonesia. In addition, human factors, such as coastal development, land-based pollution, blast fishing, mining activities, and tourism, also contribute to the decline of coral cover.

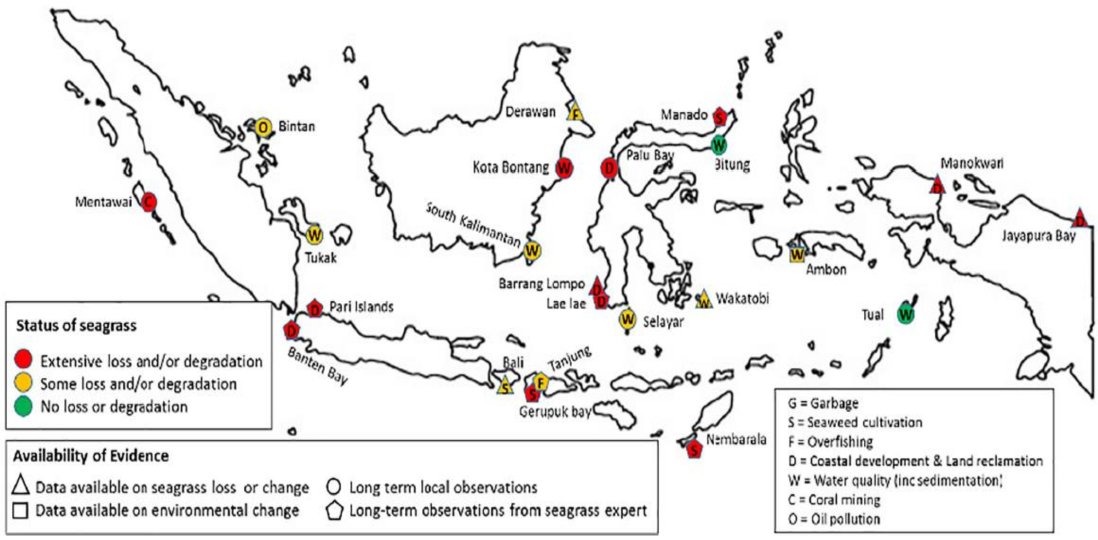
The trend of declining coral reef conditions has also been observed in eastern parts of Indonesia. This is likely related to the shift in fisheries exploitation referred to above, as overfishing of western regions of Indonesia forced fishers east. Other key issues harming coral reefs in Eastern Indonesia include a lack of community awareness and law enforcement. The remote nature of the area results in the need for improved surveillance as the reefs are exposed to destructive fishing practices and exploitation.

Since the bleaching event in 2015, recovery of coral reefs in the eastern areas of Indonesia has been progressing. In Ternate and surrounding waters, coral cover increased from 29.26 percent in 2015 to 32.83 percent in 2016. Likewise, in the marine conservation area of Padaido, coral cover has also increased from 29.92 percent in 2015 to 35.25 percent in 2019. A similar result has also been observed in the marine conservation area of Raja Ampat (Waigeo), with an increase in coral cover from 32.24 percent in 2015 to 37.84 percent in 2019. This recovery may be a result of the eastern part of the country being more resilient to bleaching events as a result of thermal refugia from the ITF and vertical mixing of localized upwellings and internal tides within the region (Storlazzi *et al*., 2020; Sprintall *et al*., 2014).

3.2.2 Seagrass

Indonesian coastal waters are populated by thirteen species of seagrasses: *Cymodocea rotundata, C. serrulata, Enhalus acoroides, Halodule decipiens, H. finifolia, H. minor, H. ovalis, Halophila spinulosa, H. uninervis, Syringodium isoetifolium, Thalassia hemprichii, Thalassodendron ciliatum, and Ruppia maritima*. The fourteenth species, *Halophila beccarii,* is thought to exist in Indonesian waters, but a confirmed observation of its presence has not been recorded. Of the thirteen species, *R. maritima* and *Thalassodendron ciliatum* have limited distribution to Eastern Indonesia, whereas *Halophila spinulosa* and *Halodule decipiens* have been recorded in limited locations across the archipelagic waters (Figure 93). Status information is only available from selected sites within the ISLME, with areas off the north coast of Java and Makassar Strait in degraded status.

Figure 93. Status of seagrass in Indonesia in 2018



Source: Unsworth, R. K., Ambo-Rappe, R., Jones, B. L., La Nafie, Y. A., Irawan, A., Hernawan, U. E., & Cullen-Unsworth, L. C. 2018. Indonesia's globally significant seagrass meadows are under widespread threat. *Science of the Total Environment*, 634: 279–286.

Seagrass meadows support fisheries productivity by providing nursery and foraging grounds for commercially important fish and invertebrate species (Unsworth *et al*., 2014), feeding grounds for dugongs and turtles, and habitats for gastropods, bivalves, fish, sea cucumbers, and echinoderms. They provide trophic subsidies to adjacent fisheries (Heck *et al*., 2008) and act as direct fishery habitats (Nordlund *et al*., 2017). Seagrass meadows also support the health of adjacent coral reef fisheries by limiting the release of coral disease-causing pathogens through water filtration (Lamb *et al*., 2017). The MoEF Decision No. 200/2004 states that seagrasses in Indonesia cover an area of 1 507 km^2, and 5 percent are classified as healthy, 80 percent less healthy, and 15 percent not healthy. However, the estimated seagrass area in Indonesia was revised to 2 935 km^2 in 2018 based on the GIS techniques used by Sjafrie *et al*. (2018). There has been an alarming loss of this important marine ecosystem in recent decades. McKenzie and Yoshida (2015) and Duarte *et al*. (2008) previously stated that the rate of seagrass loss amounts to approximately 2 percent to 5 percent annually. The declining seagrass health is caused by coastal development, land reclamation, and deforestation, as well as seaweed farming, overfishing, and garbage dumping. Declining health will reduce seagrass resilience to climate change and could result in a loss of their high ecosystem service value.

Although details of seagrass degradation in Indonesian water require more documentation, the Indonesian Seagrass Committee (2003) stated that the degradation is mainly a result of human activities (Table 37). Threats to seagrass appear to change from west to east across the country. In the west, coastal development and sedimentation were present and important threats were noted in most areas; however, water quality is considered a bigger threat in central and eastern areas. In the central region, sand mining and seaweed farming were key threats, and in the west, oil pollution and overfishing were also thought to be a problem. These spatial differences may reflect the variable levels of population, development, and industry across what is a vast archipelago. The ability for policy and management to reverse these growing threats requires making longer-term decisions for the sake of food security for a growing population.

Table 37. Type of activities/threats that affect the seagrass ecosystem in Indonesia

Activities/Threats	Effect
Coastal development and reclamation	Destruction of seagrass caused by dredging, sedimentation, and pollution.
Destructive fishing gear	One of the fishing gears that damage the bottom of the water is the trawl. This tool sweeps the biota in the bottom waters and will affect the growth of seagrass.
Aquaculture	Remnants of excessive feed will interfere with seagrass growth and cause disease for organisms in seagrass.
Waste	Will cause algae blooming associated with eutrophication and cause conditions of insufficiency of light and oxygen.

Activities/Threats	Effect
Runoff	Derived from deforestation, mining, and agriculture. Increasing the load of pollutants and sedimentation harmful to seagrass life.
Lack of community awareness	Awareness about seagrasses is low at the community level, managers, government officials, so it is difficult to make new rules and obey the old rules
insufficiency of tools and information	Managers and decision-makers need tools and information to carry out conservation

Source: FAO. 2021. Thematic Assessment of The Indonesian Seas large Marine Ecosystem (Indonesia). Food and Agriculture Organization. PT. Hatfield Indonesia.

There is growing empirical global evidence that sea level rise and increasing temperatures will have a negative impact on seagrass (Saunders *et al*., 2013; Saunders *et al*., 2014; Short & Neckles, 1999). Without addressing these immediate smaller-scale threats, it is unlikely that seagrasses will remain sufficiently resilient to cope with the consequences of a changing climate (Unsworth *et al*., 2015). Seagrass meadows form complex socioecological systems that require consideration in conservation management (Unsworth *et al*., 2014).

Provisions in international and national law have sought to protect this ecosystem, including the marine animals in it (Pramudianto *et al*., 2018). The types of plants in this ecosystem are partly protected through UNCLOS 1982, UNCBD 1992, the UNEP's Regional Seas Conventions, CITES 1973, and several other international agreements.

Community-supported management initiatives provide a mechanism for seagrass protection. In Southeast Sulawesi, a community-led incentive scheme is being used to protect seagrass by providing landowners with economically valuable plants to incentivize them to plant and maintain riparian vegetation in hot spots of surface runoff. Additionally, a small community-led initiative in the *Tolitoli* and *Baru Baru* MPAs is focused on protecting the dugong (the flagship species) (e.g. Bintan), which can indirectly protect seagrass ecosystems.

Although these seagrass conservation programmes exist within the ISLME region, a significant barrier to conservation actions in Indonesia includes the low level of knowledge and recognition—including economic importance—of the value of protecting seagrass ecosystems. Continued coastal development threatens their potential success, but without a long-term, large-scale monitoring effort, the continual decline and recovery of this vital ecosystem will remain a challenge to overcome.

3.2.3 Mangroves

From the 1980s to the 2000s, when world shrimp prices and market demand were skyrocketing, vast mangrove areas were converted into shrimp ponds, especially on the northern coast of Java and the southern coast of Sulawesi. The conversion eventually resulted in environmental problems that reduced the productivity of the coastal areas. However, this conversion of mangrove forests to shrimp farming or other uses appears to be declining.

Mangrove ecosystems in Indonesia were reported in the 1980s to encompass 4.2 million ha, although they were mapped across 3 489 140.65 ha (Tabel 38). In 2016, the area was down to 2 703 410 ha (Table 38). Of this area, 220 370 ha (8.2 percent of this area) have been lost, and 41 901 ha (1.5 percent of this area) have been degraded. The deforestation rate was estimated at 1.24 percent per year, one of the highest in the world (Murdiyarso *et al*., 2015). According to MoEF (2021), just under 93 percent of the total mangrove area in Indonesia is still considered high density and just over 7 percent is still considered medium to low density.

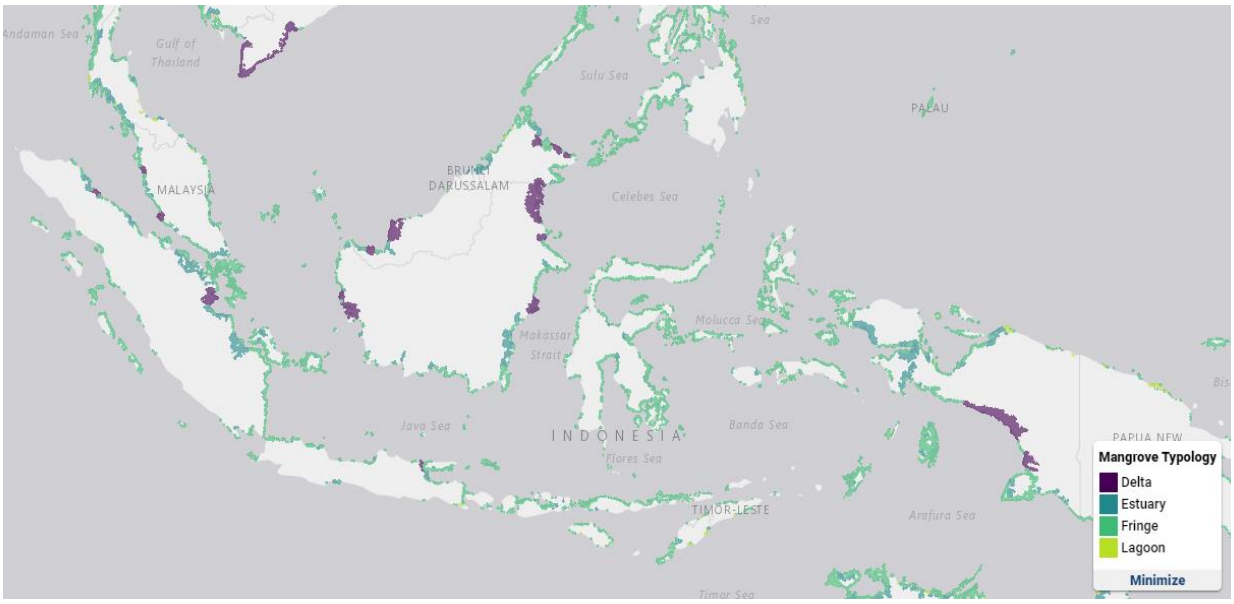
Table 38. Status of mangrove ecosystems in Indonesia in 2021

Mangrove status	**Area (ha)**	**% of total mangrove area**
High density	3 121 240	92.78
Medium density	188 366	5.60
Low density	54 474	1.62

Source: MoEF (Ministry of Environment and Forestry**)**. 2021. Peta Mangrove Nasional Tahun 2021 (2021 National Mangrove Map). Ditjen PDASRH, Jakarta.

More recently, scientific studies have confirmed that mangrove forests are highly effective carbon-storing ecosystems, even higher than rain forests, and they therefore help mitigate global climate change (Murdiyarso *et al*., 2015; Donato, 2011). A study done by Conservation International (CI) in Kaimana, West Papua, in 2016 found that with sound interventions to protect it and halt further conversions, Indonesia mangrove area can reduce 30 million tonnes of emissions, which is the largest mitigation potential annually (Howard, 2016). It is estimated that one hectare of mangrove could offset the total carbon emissions of 20 (luxury) cars operating for 25 years (Nikijuluw, 2016). Compounding this function of carbon storage to the traditional uses and benefits of mangrove forests, the apparent value of this ecosystem is becoming increasingly multifold. Hence, the remaining mangrove areas in Indonesia—approximately 25 percent of the global mangrove ecosystem coverage—should be conserved as a global natural capital and a national source of sustainable growth. The mangrove distribution according to its typology can be seen in Figure 94.

Figure 94. Distribution of mangrove ecosystems in Indonesia as of 2016



Source: Mangrove Restoration | (coastalresilience.org)

Referring to the Ministerial Decree of the CMMIA No. 2/2018 on the National Action Plan of the CTI-CFF Indonesia 2018–2020, BAPPENAS (2020), and the report from Indonesia Blue Carbon Strategy Framework (IBCSF), the Government of Indonesia targets mangrove rehabilitation to achieve a total of 31 000 km^2 across Indonesia. However, in 2019 the Director of Environment and Disaster Management of the CMMIA, Sahat M. Panggabean, stated that Indonesia's mangrove forest cover had already grown to 35 600 km^2 (Haryati, Dahlan and Togibasa, 2019).

Coastal erosion, sea level rise, and the impacts of rapid economic development in coastal areas—unsustainable forest practices, conversion/reclamation of land for agriculture, aquaculture, mining, port expansion, urbanization, tourism, and infrastructure development, and coastal pollution from oil spills and domestic and industrial wastes—have severely reduced the extent and health of mangrove forests. Initiatives for mangrove rehabilitation have been implemented throughout Indonesia, including an earlier effort made by fishers in Sinjai, Sulawesi (Setyawan, Winarno and Purnama, 2004). The MoEF has a routine programme for mangrove rehabilitation and has implemented Forest and Land Rehabilitation (*Gerakan Rehabilitasi Hutan dan Lahan* or GERHAN), which has included mangrove forests since 2003. According to MoEF (2021), 5 653 ha of mangrove forests were rehabilitated under the GERHAN between 2005 and 2009. Around the same period, the MOEF reported that 175 525 ha of mangrove forests were rehabilitated under its routine programme, which included the planting of 780 000 seedlings.

Different figures on Timor-Leste's mangrove areas have been reported from 1982 up to 2017 in Timor-Leste's Sixth Report to the Convention on Biological Diversity (Directorate General for Environment, 2019). According to 2021 data from the Coastal Resilience Building (CRB) Project implemented by the Ministry of Agriculture and Forestry (MAF) and UNDP Timor-Leste, the total remaining mangrove area is 4 831 ha. Nearly 21 percent (1 041 ha) is distributed along the northern coast. The project has restored and protected more than 2 300 ha of the total area.

Mangrove forests play an important role in marine habitats along coastal areas. These mangrove species have a clear pattern of zonation in almost all coastal areas in Timor-Leste (ADB, 2014). They also provide valuable ecological services and serve as habitats for fish and non-fish marine resources, as well as support coastal livelihoods (ADB, 2014). For that reason, mangroves alongside the northern coast need immediate protection not only from animal destruction but also from illegal harvesting. In addition, laws and regulation enforcement that incorporate local wisdom, are essential as management measures to protect all mangrove areas. Table 39 shows species abundance data, relevant location, and management recommendations.

Table 39. Species of mangroves in Timor-Leste and their management measures

Species	Geographical distribution	National status	Management recommendation
Acanthus ilicifolius	All locations	Abundant	Regular monitoring
Acrostichum speciosum	Hera and Metinaro	Very rare, threatened	Strict protection of the mother trees, nursery and replanting to maintain the population
Aegiceras floridium	Hera	Very rare	Strict protection of the habitat in Hera
Avicennia marina	All locations in north coast	Abundant, vulnerable	Regular monitoring
Bruguiera parviflora	North coast	Rare	Regular monitoring
Bruguiera sexangular	Hera and Metinaro	Very rare, endangered (IUCN Red List)	Strict protection of its habitat in Metinaro
Ceriops tagal	All locations	Abundant	Regular monitoring
Dolichandrone spathacea	Hera	Very rare	Strict protection of its habitat in Hera
Exoecaria agallocha	All locations	Abundant	Regular monitoring
Lumnitzera racemose	North coast	Rare	Regular monitoring, strict prohibition for cutting
Rhizophora apiculate	All locations	Abundant	Regular monitoring
Rhizophora mucronate	North coast	Rare	Strict protection, nursery, replanting
Sonneratia alba	All locations	Abundant	Regular monitoring
Pemphis acidula	North coast	Very rare	Regular monitoring
Xylocarpus	South coast	Rare	Regular monitoring
Nypa	South coast	Rare	Regular monitoring

Source: UNDP, MAF, the GEF. 2018. Building shoreline identification in Timor-Leste to protect local communities and their livelihood. In: *UNDP.org*. Dili. Mangroves Field Identification Manual of Timor Leste (undp.org)

3.3 Water quality, marine and land-based pollution

Anthropogenic activities, such as agriculture, aquaculture, fossil fuel usage, discharging wastewater, and other wastes, contribute to nutrient pollution. If present in a marine environment, this pollution can affect the health of aquatic ecosystems. When there are more nutrient inputs from industrial, urban, and agricultural activities to the environment, the quality of seawater can be impacted, which can accelerate the toxicity of the water or trigger the excessive growth of harmful algal species. Furthermore, information shared by the participants of the ISLME TDA National Stakeholders Consultation on September 3-4, 2020 confirmed that pollution issues are significant in some areas in the ISLME.

3.3.1 Harmful algal blooms, nutrients

Algae and aquatic plants rely on nutrients, such as nitrogen and phosphorus, for their growth. However, increasing pollution can dramatically alter food webs in coastal ecosystems and promote harmful algal blooms (HAB). Several HAB events were identified by LIPI between 1991 and 2015 and for 2020 and 2021 in the Indonesian waters of the ISLME area (Table 40).

Table 40. harmful algal bloom events in the Indonesian waters of the Indonesian Seas Large Marine Ecosystem from 1991 to 2021

Year	Causative species	Groups	Type of habitat	Location	Impacts
1991	*Trichodesmium erythraeum*	Cyanobacteria	Red tide	Java Sea	N/A
1992	*Gymnodinium sp./ Gonyaulax sp.*	Dinoflagellates	Red tide	Manokwar, Papua	N/A
1992	*Gonyaulax sp.*	Dinoflagellates	Red tide	Jakarta Bay	N/A
1993	*Noctiluca scintillans*	Dinoflagellates	N/A	Jakarta Bay	N/A
1993	*Pyrodinium bahamense* var. *compressum*	Dinoflagellates	N/A	Kao Bay, Halmahera	N/A
1994	*Pyrodinium bahamense var. compressum*	Dinoflagellates	N/A	Ambon Bay	N/A
1995	*Noctiluca scintillans*	Dinoflagellates	N/A	Ambon Bay	N/A
1995	*Trichodesmium sp.*	Cyanobacteria	N/A	Ambon Bay	N/A
1996	*Chaetoceros sp.*	Diatoms	N/A	Ambon Bay	N/A
1997	*Alexandrium affine*	Dinoflagellates	N/A	Ambon Bay	N/A

Year	Causative species	Groups	Type of habitat	Location	Impacts
1997	*Gonyaulax spinifera*	Dinoflagellates	N/A	West Sumatra	N/A
1997	*Trichodesmium thiebautti*	Cyanobacteria	N/A	Jakarta Bay	N/A
1998	*Chaetoceros spp.*	Diatoms	N/A	Ambon Bay	N/A
1999	*Pyrodinium bahamense var. compressum*	Dinoflagellates	N/A	Lampung Bay	N/A
2012	*Pyrodinium bahamense var. compressum*	Dinoflagellates	Toxin production	Ambon Bay	Health problem
2012	*Chaetoceros spp.*	Diatoms	Bloom	Ambon Bay	Oxygen depletion, fish kills
2012	*Nitzschia spp.*	Diatoms	Bloom	Ambon Bay	Oxygen depletion, fish kills
2012	*Other diatoms*	Diatoms	Bloom	Ambon Bay	Oxygen depletion, fish kills
2012	*Cochlodinium polykrikoides*	Dinoflagellates	N/A	Lampung Bay	N/A
2012	*Cochlodinium polykrikoides*	Dinoflagellates	N/A	Lampung Bay	N/A
2015	*Unknown*	Unknown	Red tide	Ai Island, Banda	N/A
2015	*Coscinodiscus spp.*	Diatoms	Bloom	Jakarta Bay	Oxygen depletion, fish kills
2015	*Alexandrium spp.*	Dinoflagellates	Bloom	Jakarta Bay	Oxygen depletion, fish kills

Year	Causative species	Groups	Type of habitat	Location	Impacts
2020	*Pseudonitzschia, Nitzschia, Skeletonema, Thalassiosira, Chaetoceros, Ceratium, Dinophysis, Protoperidinium and Peridinium*	Dinoflagellates	Bloom	Bedono	N/A
2021	*Trichodesmium*	Dinoflagellates	Bloom	Seribu Islands	N/A

Note: Information was selected for the areas in ISLME only.
Sources:
-Gurning, L. F. P., Nuraini, R. A. T., & Suryono, S. 2020. Kelimpahan Fitoplankton Penyebab Harmful Algal Bloom di Perairan Desa Bedono, Demak (Phytoplankton abundance causes harmful algal bloom in Bedono village waters, Demak). *Journal of Marine Research*, 9(3): 251–260;
-Cokrowati, N., Risjani, Y., Firdaus, M., & Andayani, S. 2021. Accelerated growth of Kappaphycus alvarezii using Sargassum aquifolium extract and its anatomical characteristics. *Biodiversitas Journal of Biological Diversity*, 22(11) : 5195–5202.

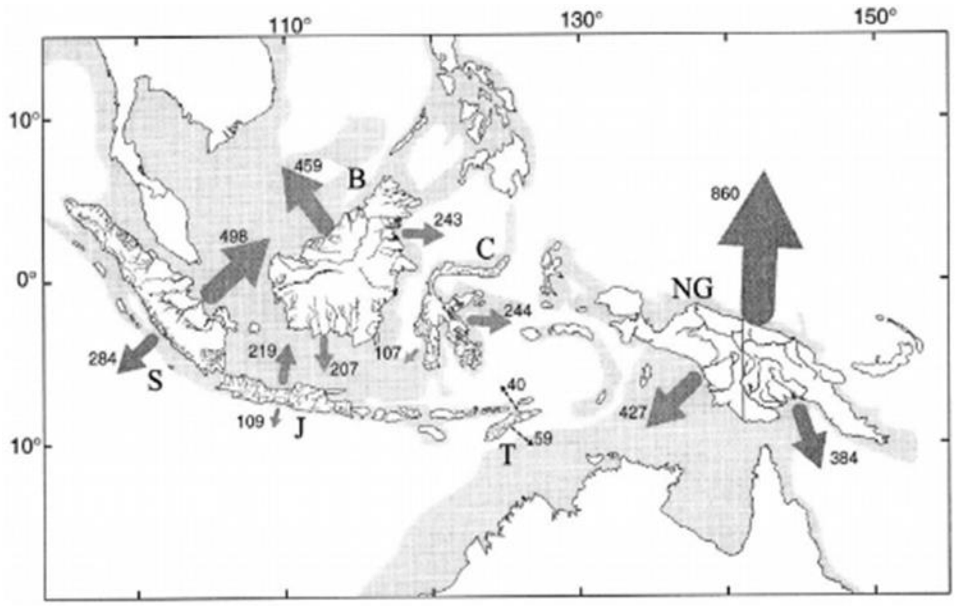
In May 2020, Hatfield consultants completed an environmental baseline study in areas around the Molucca Sea. The results showed that the most abundant phytoplankton species was *Trichodesmium* sp. from Class Cyanophyceae, a common nitrogen-fixing plankton characterized by a slow growth rate, which has been hypothesized as an adaptation to survival in the high energy but low nutrient conditions of oligotrophic waters where growth is limited by iron and phosphate concentrations (Bergman *et al*., 2013). Phytoplankton community indices in the Molucca Sea were lower during the wet season than in the dry season, but overall comparable to communities in the Celebes Sea (SSMETC, 2013a). Seasonal differences are likely related to changes in water temperature and available sunlight, which can affect reproductive rates. Zooplankton in the Molucca Sea area also showed a similar seasonal effect to phytoplankton, with higher abundance during the dry season, which is likely affected by water temperature but also likely related to seasonal abundance of phytoplankton in the area.

3.3.2 Sedimentation

Sedimentation in the ISLME water region varies greatly because of several factors, such as wind, ocean currents, and beach conditions. Sedimentation in the northern coast of Java is mostly caused by currents that move parallel to the coastline. In this area, sedimentation is accompanied by accretion. In this case, erosion occurs in one place, but sedimentation occurs in another. Changes in sedimentation can be seen in changes in the coastline from year to year. Sedimentation is a common occurrence in various areas within the ISLME region, including the coastal regions of Northern Java, Sulawesi, and Maluku. Several coastal areas in Northern Java, such as the Serang region (Prihantono *et al*., 2018), Brebes (Gemilang *et al*., 2018), Cirebon (Setyadi and Aryanto, 2008), and Kendal (Setiawan *et al*., 2021), have been identified in relation to sedimentation. In Sulawesi, sedimentation has been observed in the coastal areas of Takalar Regency, South Sulawesi (Inaku, Nurdin and Satari, 2021), Makassar City (Usman and Irbani, 2019), and Batu Gong Coast (Jaya, 2021). Additionally, sedimentation is also prevalent in the coastal areas of Maluku, including Ternate (Edward and Triandiza, 2020), Ambon (Limmon and Marasabessy, 2019; Rahmawan *et al*., 2019), and the Aru Islands (Kalay *et al*., 2017).

Between 2019 and 2020, Hatfield Consultants carried out an environmental monitoring study along the Northern Java Patimban coast. The findings revealed that mud is the primary sediment in deep sea environments and may be affected by human-made materials. Coastal areas, on the other hand, are mainly affected by river sediment. The sediment discharge from islands to the Arafura and Timor Seas region and adjacent regions is shown in Figure 95.

Figure 95. Sediment discharge from islands to the Arafura and Timor Seas, the Indonesian Seas Large Marine Ecosystem and adjacent areas



Source: ATSEA. 2012. Transboundary Diagnostic Analysis for the Arafura and Timor Seas Region. Arafura and Timor Seas Ecosystem Action Program, Jakarta.

3.3.3 Heavy metals, plastic debris, and persistent organic pollutants

The rise in marine debris is primarily caused by human activity. Sources of waste related to human activities and natural causes include inadequate waste management and disposal facilities, lack of public awareness, lack of legal regulations, industry, marine tourism, and fishing operations, as well as garbage from shipping vessels and foreign waste flows. These sources of waste have also contributed to the increase in waste in Indonesian waters. Moreover, ghost fishing in the ocean can also contribute to the accumulation of plastic debris, as it has been estimated that at least 46 percent of the Great Pacific Garbage Patch is composed of discarded or lost fishing gear. Globally, abandoned fishing gear accounts for at least 10 percent of marine litter, which means that between 500 000 and 1 million tonnes of fishing gear are left in the ocean each year, as estimated by WWF (2020).

The MoEF (2017) conducted marine debris monitoring results in 18 regencies and cities in Indonesia. The results provided insight into coastal waste profiles based on the Litter Classification System (LCS) classification and distinguished between meso-sized marine debris (0.5 cm–2.5 cm) and macro-sized marine debris (>2.5 cm). The Coordinating Ministry for Maritime and Investments Affairs (CMMIA, 2017) has identified areas across the country that account for 80 percent of marine debris, which indicates that most districts on Java Island along with Balikpapan, Makassar, Manado, and Bitung contribute to this 80 percent (Figure 96).

Figure 96. Districts that contribute 80 percent of marine debris to Indonesia waters

Source: Coordinating Ministry for Maritime and Investments Affairs. 2018. Combating marine plastic debris in Indonesia. [Cited 23 March 2023]. [PowerPoint Presentation (unesco.or.id)]

Waste management in Indonesia and in the ISLME faces several challenges (MoEF, 2020):

1. Ineffective legal basis. Law No.18/2008 concerning Waste Management has not yet brought meaningful changes, even though Indonesia's waste services in 2017 claimed to have reached 72 percent. During this time, the central government assumed a key role in developing waste facilities in all regions, as many local governments did not prioritize waste management. Operational and maintenance funds for waste management are still far below 1 percent of the *Pendapatan Asli Daerah* (PAD) or local government revenue, achieve poor results, and perpetuate a business-as-usual approach to waste management.

2. Insufficient waste management. Not all onshore waste can be managed, according to data from the MOEF National Waste Management Information System (SPSN), and the amount of unmanaged waste in 2018 reached almost 4 million tonnes. Waste entering a river that drains into the sea is potentially the biggest contributor nationally to marine debris. Garbage that accumulates in the sea or on a beach has environmental and social consequences, as it can damage ecosystems, wildlife habitats, and biota.

3. Inadequate waste disposal facilities. According to data from the *Kementerian Pekerjaan Umum dan Perumahan Rakyat Republik Indonesia* (ithe Ministry of Public Works and Housing [PUPR], only 10 percent of the total investment in solid waste facilities operates as expected.

4. Inadequacy of community awareness. Littering is a frequently observed habit of some people in Indonesia. According to BPS (2018), 10.5 percent of households still throw garbage into rivers or gutters, and 9.2 percent of households do not use waste containers.

5. Industrial-based activities. As small and traditional trade is replaced by large industrial factories, industrialization has resulted in and benefited from rapid technological development. These factories generate an enormous amount of waste and it is a great challenge to ensure it is disposed of in a way that does not adversely affect the environment and ecosystems.

6. Marine tourism. The increase in visitors traveling in the coastal areas is one factor increasing marine debris or marine trash. Visitors leave litter, such as food, bottles, plastic, cans, and cigarette butts, either through lack of awareness or concerns or because of an absence of waste containers and waste collection. Waste left on the beach can be carried by waves and can increase the volume of marine waste. Of most concern is inorganic or toxic waste, which requires significant time to decompose.

7. Fisheries-based activities. Based on MMAF data, there were 2 265 859 fishers in Indonesia in 2016. Although they are integral to the national economy and livelihoods, fishers' activity is also one of the factors increasing marine waste as inorganic waste and materials, including discarded fishing gear, are dumped overboard.

8. Water-based public transportation and overseas waste. Vessel or ship transportation is one of the main means of transportation in Indonesia to reach islands separated by the sea. Basically, each port is required to provide facilities that enable the temporary collection of garbage from ships or from activities at the port, and every vessel must dispose of its garbage at the harbour facility.

In addition, based on the discussion from the TDA ISLME National Stakeholders Consultation, marine debris significantly affects marine species and is causing environmental destruction in several areas in the ISLME, which are coupled with socioeconomic effects. For example, in East Nusa Tenggara, marine debris causes seaweed and pearl farmers to change jobs because of polluted waters that prevent farming. In FMA 715, marine debris from tourism activities and suboptimal waste handling from the fishing fleet is frequently reported, and this is exacerbated because there is no waste management available in this area.

Toxic effects from arsenic on marine biota occur at concentrations as low as 0.013 mg/L to 0.02 mg/L for some species of microalgae, whereas other algae species (e.g. *Champia parvula*) survive concentrations of up to 10 mg/L (Neff, 2002). The toxicity and relative impact of arsenic on marine organisms is species specific and also subject to specific environmental conditions that affect the bioavailability of arsenic to organisms. Arsenic found in the environment primarily comes from the breakdown of rocks that contain arsenic, volcanic activity, and specific biological processes (Nordstorm, 2002). Additionally, the use of herbicides, pesticides, and wood preservatives containing arsenic over an extended period (i.e. decades or longer) is a significant source of this element. Arsenic is a metalloid that cannot be broken down or eliminated from the environment (Wang *et al*., 2022). The release of large quantities of dissolved arsenic in water into the ocean also has the potential for contamination of sediments through deposition of arsenic and adsorption to sediment particles. International guidelines set by the Canadian Council of Ministers of the Environment (CCME) for marine sediment arsenic concentrations set probable effect levels (PEL) at 41.6 mg/kg, and define interim protective guidelines for marine sediments at 7.24 mg/kg (CCME, 2001).

In May 2020, in some coastal areas in Molucca Sea, Hatfield Consultants also did a simulation of the fate of heavy metal consisting of two characters, dissolved arsenic and adsorbed arsenic in the sediment. The study found that the direction of arsenic dilution in dry and wet seasons spreads primarily along the coast that, in the study area, extended to the southeast and northwest. In the wet season, the concentration of dissolved arsenic $\geq$ 0.012 mg/l was observed as reaching as far as 1 400 m to the southeast, up to 500 m to the northwest, and up to 230 m directly perpendicular to the coast from the source. In the dry season, the concentration of dissolved arsenic $\geq$ 0.012 mg/L was also predicted to reach up to 1 400 m to the southeast, up to 2 400 m to the northwest, and up to 237 m directly perpendicular to the coast from the source. Similar patterns for the dispersion of arsenic to sediment were observed, with larger areas affected during the dry season than during the wet season. The greatest increases in arsenic to sediment concentrations predicted by the model during the wet season was 0.016 g/m^2, compared with 0.012 g/m^2 during the dry season (FAO, 2020a). The relative impact to marine biota depends on bio-availability, which in turn relies on the total concentration, but can also be modified by conditions in certain areas that affect the proportional speciation of arsenic compounds, the types of organisms present that potentially uptake arsenic, and the ability of the environment to reduce arsenic compounds from toxic to non-toxic forms (Neff, 2002).

Notable levels of lead (Pb), cadmium (Cd), and chromium (Cr) in suspended particulate matter (SPM), sediments, and green mussels collected from Cilincing and Kamal Muara in Jakarta Bay have been reported by Puspitasari *et al*. (2023). The study also aimed to assess the potential human health risks associated with these levels. The findings of the study revealed that the metal concentrations in SPM samples collected from Cilincing ranged from 0.81 mg/kg to 1.69 mg/kg for Pb and 2.14 mg/kg to 5.31 mg/kg for Cr. Moreover, the samples collected from Kamal Muara showed levels ranging from 0.70 mg/kg to 3.82 mg/kg for Pb and 1.88 mg/kg to 4.78 mg/kg dry weight for Cr. In sediments, the levels of Pb, Cd, and Cr in Cilincing ranged from 16.53 mg/kg to 32.51 mg/kg, 0.91 mg/kg to 2.52 mg/kg, and 0.62 mg/kg to 1.0 mg/kg, respectively. In Kamal Muara, the levels ranged from 8.74 mg/kg to 8.81 mg/kg, 0.51 mg/kg to 1.79 mg/kg, and 0.27 mg/kg to 0.31 mg/kg dry weight, respectively. Regarding the green mussels, Cd and Cr levels in Cilincing ranged from 0.014 mg/kg to 0.75 mg/kg and 0.003 mg/kg to 0.11 mg/kg, respectively, whereas in Kamal Muara, they ranged from 0.015 mg/kg to 0.073 mg/kg and 0.01 mg/kg to 0.04 mg/kg wet weight, respectively. However, Pb was not detected in any of the green mussel samples. Finally, the study found that all the Pb, Cd, and Cr levels in green mussels were within the permissible limits established by international standards (Puspitasari *et al*., 2023).

In Timor-Leste, marine and land-based pollution also have great impacts on marine and coastal biodiversity. According to da Cruz (2015) the major solid pollution was generated from big towns in Timor-Leste's north coast in the municipalities of Liquiça, Dili and Manatuto. Conversely, the south coast has been highly contaminated with marine-based pollution (da Fonseca and Spiller, 2021a & 2021b). According to da Cruz (2015) the major rivers close to Dili bring millions of tonnes of solid waste including sediments into marine environments around Dili and Ataúro Island. The common solid waste consists of plastic accounting for 70 percent to 80 percent. As observed, most of solid wastes are generated from the sea particularly from ships (also through IUU fishing) and also from neighbouring countries via strong current, winds, and inundation.

The solid waste pollution in the north coast of Timor-Leste is not well treated in a proper way. This is mainly because of insufficient waste treatment facilities and lack of people's awareness. This unmanaged solid waste is believed to deteriorate marine biodiversity which in the end undermines the economic development of the nation. The Government of Timor-Leste is committed to managing marine biodiversity from any form of pollution. The government has enacted some laws and regulations to act upon regional and global demand for protection and management of marine and coastal ecosystems. For example, the 2030 Agenda SDG 14 aims for conservation and sustainable use of seas and marine ecosystems. Additionally, SDG 14.1 aims to prevent and significantly reduce marine pollution of all kinds. The Government of Timor-Leste is committed implement the 2030 Agenda in close partnership with development partners and NGOs through a national comprehensive policy for the management and conservation measures of the marine and coastal environment and/or ecosystems.

To date, there is no private entity investing in pollution control. The government has approved the National Ocean Policy (NOP) including the Port State Measures Agreement (PSMA) to detect and prevent IUU fishing. The PSMA also contributes to the long-term conservation and sustainable use of marine and coastal biodiversity and its ecosystems. The government has taken some legal measures through Decree Law No. 26/2012 – Basic Law on the Environment which covers management of pollution for both solid and liquid forms. The law also protects marine and coastal environment from land-based pollution. However, because of the lack of urban planning, inadequate waste management as well as population growth, the level of pollution is increasing. The solid waste is washed by rainwater into drains and canals and goes through river systems and ends-up in the ocean as seen in the case of the urban area of Dili during the rainy season.

The source of waste needs to be managed through collective action engaging all entities to ensure that all actors engaged understand the evidence and root causes of the problem. The collective action can also facilitate equitable solutions to the diverse and complex issues of waste pollution. This type of collaboration can be done through both formal and non-formal arrangement during the formulation of the problem and programme including its implementation. This is very important to capture all aspirations from different entities/organizations related to marine and coastal environment management measures (Partelow *et al*., 2020).

3.3.4 Oil spills

One of the most notable oil spills in the ISLME occurred in 2018, when an undersea pipeline belonging to the state-owned oil and gas company *Pertamina* leaked crude oil into Balikpapan Bay in East Kalimantan. The oil spill covered an area of approximately 130 km^2 and killed marine life, including dolphins, turtles, and fish. The spill also affected the livelihoods of local fishermen and caused health problems for nearby residents. Abimanyu *et al*. (2021) showed that leakage from oil platforms could harm coastal ecosystems. The oil spill components were discovered at a considerable distance from the initial point of leakage. The movement of the spill was primarily influenced by the direction of the wind and the movement of the ocean. The oil spill that originated from the rig predominantly spread in the west to northwest direction and affected the coastal regions. However, oil platforms are not the only source of oil spills; other sources include ship collisions and similar accidents. These have been documented for the ISLME, which is also an international shipping route named ALKI (*Alur Laut Kepulauan Indonesia*).

Indonesia ranks among the top 25 oil-producing countries worldwide and is the fifth-largest oil producer in Pacific Asia (IEA, 2021). Gade *et al*. (2017) conducted a study of oil pollution in Indonesian waters using satellite imagery to calculate the normalized spill number and the normalized mean polluted area. They found that the sources of marine oil pollution differed across the country. Ship traffic appears to be the main source in the Java Sea, whereas the oil production industry causes the highest pollution rates in the Strait of Makassar. Hotspots of marine oil pollution were found in the open sea, and the largest numbers of oil spills in the Java Sea occurred between March and May and between September and December, that is, during the transition from the northwest monsoon to the southeast monsoon, and vice versa.

3.4 Condition and status of marine biodiversity and key marine species

3.4.1 Marine biodiversity

According to the Status of Priority Aquatic Biota Biodiversity (MMAF, 2017a), there are four main anthropogenic causes of marine biodiversity loss in Indonesia:

- Overexploitation: Fishing activities that exceed the sustainable threshold have caused several types of fish resources to experience a drastic population decline. Characteristics of a population decline include a decrease in the size of the fish caught, a decrease in the catch per unit effort, and the location of fishing that is getting further away.
- Habitat degradation: Three main ecosystems occur in coastal areas, namely mangrove, seagrass beds, and coral reefs. From 1999 to 2005, the mangrove area decreased by 5.58 million ha (64 percent). Approximately 25 percent of the coral reefs are in good condition; the rest are in bad condition and heavily damaged. Damage to the three ecosystems affects the population of fish species because they are generally nursery

grounds or feeding grounds for a large number of juvenile fish. Based on the discussions held during the National Stakeholders Consultation Workshop on 3-4 September 2020, environmental impacts from degradation and loss of coastal and marine habitats in the ISLME cause a decline of coral reefs and other potential areas for marine species nesting grounds. The status of some species may be threatened because of the loss of their habitat. Abrasion and sedimentation into benthic habitats is also an impact of this degradation. The socioeconomic impacts from degradation and loss of coastal and marine habitats will reduce the population and range of attractive species, such as the dugongs, sea turtles, and sharks, with a commensurate adverse impact on marine tourism. In addition to the impacts on attractive species, marine tourism destinations, including diving and fishing spots, may also be affected, and this may affect livelihoods in communities dependent on marine tourism.

- Pollution: Pollution can have an adverse impact on water quality and the associated ecosystems to the point that the environment no longer supports aquatic biota. Based on the discussions during the National Stakeholders Consultation Workshop on 3-4 September 2020, pollution from marine and land activities is causing mortality among marine species and environmental destruction, as seen from oil rig exploitation in Montara, East Nusa Tenggara. Pollution at this location will affect the health of the environment, which can lead to decreasing health in the local community and a reduction in the water quality, which adversely impacts pearl and seaweed farmers who would need to change jobs as their farms would no longer be viable.
- Destructive fishing activities: Unsustainable fishing practices, the use of explosives and cyanide in fishing activities were raised during the discussions at the National Stakeholders Consultation Workshop on 3-4 September 2020. Other destructive fishing practices are happening in the ISLME, including reef gleaning for infrastructure purposes, as communities use reefs because they are easy to harvest and their structures are stronger compared to other materials such as bricks. Other reef gleaning practices that were discussed are that fishers hunt octopus by lifting or fragmenting coral reefs. This practice occurs particularly in Wakatobi.

There are several key challenges leading to marine biodiversity degradation and further to economic loss, food insecurity, and malnutrition. Most of the evidence of marine environmental degradation on the south coast is less well documented than on the north coast. Other activities that have been documented are gleaning which is are done by women and children during low tide. This activity is part of nutritional security and cash income for households. However, the activity leads destruction of coral reefs as fish habitats. As a consequence of the biodiversity degradation, many fishermen on the north coast (on Ataúro Island in particular) have increased their operational costs to do fishing activities on offshore with small canoes equipped with gill nets and traditional equipment operating beyond Timor-Leste waters (e.g. in Liran and Leti Islands of Indonesia).

There is a need to improve monitoring and surveillance systems between Indonesia and Timor-Leste. A joint collaboration between the two countries is believed to reduce IUU fishing and its impact on economic loss. Both countries should identify the root causes of the marine environmental degradation on the border of two sides including marine pollution and unsustainable fishing practices. Management measures to preserve and protect marine and coastal ecosystems need to be in place. At the same time, the measure can also promote sustainable fishing practices to secure fisheries productivity to support coastal livelihoods. This is very important provided that most of the people on the coastal areas rely on marine and coastal resources as their main source of livelihood.

3.4.2 Endangered, threatened and protected marine species

Based on a report that assessed threatened species in the CTI region published by MMAF (KKP, 2018b), threats to marine species in Indonesia include: (i) bycatch; (ii) pollution; (iii) climate change; (iv) marine debris; (v) unsustainable tourism; (vi) illegal trade; (vii) poaching; (viii) trade and utilization; (ix) habitat degradation; (x) IUU fishing; (xi) habitat conversion; and (xii) overlapping/conflicting national policies and regulation. Information on the condition of key protected species in Indonesia is summarized below.

Sea turtles

Six of the world's seven species of sea turtles occur in Indonesia (reviewed in Huffard, Erdmann and Gunawan, 2009) and are considered endangered (green), critically endangered (hawksbill), vulnerable (leatherback, loggerhead, and olive ridley) and data deficient (flatback). Sandlund *et al*. (2001) recorded all five species in Timor-Leste, except for flatback sea turtles. Despite being protected species, they are still threatened in Indonesia by illegal trade and consumption for food and curios, habitat destruction and alteration from coastal tourism and industrial development, pollution, disease, climate change, and fisheries bycatch from trawlers, longlines, and gillnets (ADB, 2014).

Several factors threaten turtles: illegal trade and direct consumption (e.g. their meat, eggs, shell, leather, and curios), bycatch (trawlers, longlines, and gill nets), habitat destruction and alteration (coastal tourism and industrial development), pollution, disease, and climate change (WWF, 2012). In 2012, the WWF estimated that every year, as many as 7 700 turtles in Indonesia’s waters were killed accidentally from shrimp trawls and tuna longlines. More than 140 turtle nesting sites are known (Salm and Halim, 1984; Soehartono, 1993), although the degree of usage by large nesting populations remains unclear, and it is thought to be declining because of widespread habitat destruction, targeted and accidental capture, and other disturbances (Cheung, 2002).

In Indonesia, all species of sea turtles are protected by Government Regulation No. 7 of1999 and the Bali Governor Decree No. 243 of1999, which cancels the permit to take green turtles for religious festivals. Act No. 5/1990 concerning conservation of living resources and their ecosystems also prohibits and punishes the direct harvesting of protected species. In Timor-Leste, Joint Ministerial Order No. 18/MAP/MCIA/II/2017 lists all species of sea turtles as protected.

Sharks and rays

Many shark and ray species in the ISLME are threatened by overfishing as well as by the demand for their fins and gill plates. Many shark species have slow growth rates and late maturity, making them particularly vulnerable to overfishing. Conservation and management measures are needed to protect these species and their habitats, particularly in the face of increasing pressure from human activities, such as overfishing and habitat destruction.

In Indonesia, regulation regarding shark and ray conservation includes Law No. 7 of 1999 on the Management and Conservation of Living Resources and their Ecosystems, and the MMAF Regulation No. 12 of 2017 on the Management of Fisheries Resources of Species with Elongated Body Shape. Several versions of an NPOA for Sharks and Rays have been drafted, but there has been no formal adoption (Sadili *et al*., 2015, Fahmi *et al*., 2015).

The shark trade in Indonesia has a wide market share, not only in international trade but also in the domestic market, where it is consumed by Indonesian communities. The domestic market for shark trade is mainly found in major cities, such as Jakarta, Bogor, Surabaya, Bali, Balikpapan, Pontianak, Makassar, and in Nusa Tenggara. The shark trade from Tanjung Luar, Lombok (Nusa Tenggara Barat) is destined for Surabaya, Jakarta, and Bali as part of the domestic marketing network, although China has the largest global market (Nurlaili, 2018). Balikpapan City is included as one of the shark collectors' cities from Kalimantan. In 2016–2017, the live shark trade trend in Balikpapan experienced a significant increase in marine aquarium needs (Efendi *et al*., 2018).

The number of shark fins exported from South Sulawesi shows an increasing trend from year to year. Hong Kong, Thailand, and South Korea are the main export destinations for sharks raised in South Sulawesi (Zamrud *et al.*, 2018). At the Benoa Port in Bali, the most caught shark species, reaching 80 percent of the bycatch composition, is the blue shark *Prionace glauca,* which mainly comes from the southern part of the Java Indian Ocean (Jatmiko, Rochman and Wujidi, 2018). The shark trade is commonly found in the Nusa Tenggara Barat and Nusa Tenggara Timur regions, where sharks are a targeted fish and a primary source of income for fishermen from Tanjung Luar, East Lombok (West Nusa Tenggara) (Suryawati & Triyanti, 2015). Several protected shark species, including *Sphyrna lewini, Sphyrna mokarran, Carcharhinus longimanus, Alopias pelagicus,* and *Alopias superciliosus,* have been landed at the Tanjung Luar Fish Landing Site (PPI) according to reports (Damayanti *et al*., 2018). In Makassar, 11 out of 17 shark species exported from South Sulawesi belong to the near threatened group. One shark species is classified as vulnerable, four as endangered, and one other species as data deficient (Zamrud *et al*., 2018). Other shark species found in the region include those that can be traded, such as hammerheads and bull sharks. In Balikpapan, based on the total weight of the shark species landed at PPI Sungai Kakap, the highest number of sharks was *Carcharhinus brevipinna* (Hidayat *et al*., 2018).

Marine mammals (whales, dolphins, and dugongs)

The impact of human activities, such as pollution from the discharge of untreated waste and accidental capture by fishing gears, threatens ten dolphin and whale species in Indonesia's waters. These are listed in CITES (Appendices II and I). Dugongs are protected by the Minister of the Department of Agriculture Decree No. 327/Kpts/Um/1972. However, dugongs obtain 90 percent of their food from seagrass beds, which are not protected, and the loss of seagrass beds is a major threat to the dugongs. They are also hunted extensively as food and for other body parts, including their teeth and skeleton. They are accidentally caught in fishing activities and are killed or injured by boat propellers. The population of dugong in Indonesia was estimated at approximately 10 000 in the 1970s, but by 1994, their population was down to approximately 1 000 (de Longh, 1996). The latest reports on dugong distribution and their status in Indonesia are those of de Longh *et al*. (2009) and van Katwijk *et al.* (2011). No reliable estimates of dugong populations are available for Indonesia, although important dugong populations are believed to still occur in North Sulawesi, West Papua, Maluku, and East Nusa Tenggara. Very limited scientific information is available on the abundance, distribution, and behaviourof dugongs in ISLME, but they have been observed throughout Indonesia, including in the coastal waters of Sumatra, Java, Kalimantan, Sulawesi, Bali, Nusa Tenggara Timur, Maluku, and Papua Barat. The GEF Dugong and Seagrass Conservation Project in Indonesia based in the Bintan, Alor, Maluku Tenggara, and Kotawaringin Barat districts and focused both on supporting the enforcement of existing national legislation, raising awareness among communities of the threats to dugongs and their seagrass habitat, and providing incentives to local communities for dugong and seagrass conservation (DSCP, 2018).This was a significant effort to protect and preserve threatened species and their habitats. The project comprised two initiatives, ID1 and ID2, which aimed to promote dugong and seagrass conservation by addressing policy barriers, enhancing community awareness, and improving research and monitoring capacity. ID1 focused on tackling policy barriers and facilitating the implementation of existing government regulations, whereas ID2 aims to enhance community awareness, improve research and monitoring capacity, and address various threats posed to dugongs and their habitats (MMAF, 2018d). The population status of cetaceans is largely unknown in Indonesian waters. Although all cetaceans are protected, they face increasing threats and stressors from ship strikes, entanglement in fishing nets, loss of coastal habitats and plastic pollution, undersea mining, and seismic testing (Mangubhai *et al*., 2012). Commercial whaling was banned in 1986, but indigenous harvesting of whales and other megafauna (manta rays and whale sharks) continues in Lamalera and Lamakera Villages in East Nusa Tenggara (Dewar, 2002a & 2002b).

Humphead wrasse (Cheilinus undulates)

Humphead wrasse is classified as vulnerable by the International Union for Conservation of Nature (IUCN) because of overfishing, habitat destruction, and collection for the aquarium trade. The species is also known to be particularly susceptible to overfishing because of its slow growth, late maturity, and the high demand for its meat and live specimens in the aquarium trade. The species is also affected by habitat degradation, particularly coral reefs. Together with Malaysia and the Philippines, Indonesia is the main exporter of this species globally. Dirhamsyah (2005) has critically reviewed the status of this species, highlighting the issues of the trade and recommending actions by relevant authorities. This species is listed in CITES Appendix II. Populations of large vulnerable reef fishes, particularly species targeted by the live reef food fish trade, including Humphead wrasse (ADB, 2014).

Saltwater crocodile (Crocodylus porosus)

The saltwater crocodile (*Crocodylus porosus*) is the largest predator in Timor-Leste and also occurs in Indonesia. Despite its predatory nature and enormous cultural significance (as an ancestor figure in the creation myth), no population surveys of the saltwater crocodile (*Crocodylus porosus*) have ever been undertaken in Timor-Leste. As such, there are no population estimates for the country or, critically, information on known nesting sites. *Crocodylus porosus* is currently protected and listed as an endangered species under national legislation (Joint Ministerial Order No.18/MAP/MCIA/II/2017). There is currently no plan of management for crocodiles in Timor-Leste.

Impacts of fishing activities on cetaceans

For decades, scientists have known that cetaceans – whales, dolphins, and porpoises – are incidentally killed in fisheries throughout the world. Incidental catch in fisheries is now considered by many to be the biggest threat to marine mammals worldwide. As fishing fleets continue to operate across all areas in the worlds' oceans, cetacean populations and species continue to face this threat. In many nations and regions around the world, cetaceans are protected with legislation, through international agreements, and through designated sanctuaries; however, lack of detailed information on the interaction of cetaceans with national fishing fleet hampers the effective implementation of measures.

From a conservation and management perspective, migratory species such as cetaceans are exposed to an array of threats because they do not confine themselves to one location. The level of protection given to cetaceans fluctuates according to their geographical location. To address and mitigate bycatch impacts, there is a need to document the extent and specifics of this threat and to develop measures to mitigate impacts related to the specifics of deployment of different fishing gears and fishing practices.

A rapid assessment was conducted in 2017 by Hatfield Consultants to investigate interactions between cetaceans and tuna fisheries in the ISLME. The study areas were selected based on their proximity to known cetacean habitats and anecdotal evidence that suggested primary gear used by tuna fishermen caused mammal bycatch or entanglement. The study found that cetaceans, such as pilot whales, interacted with tuna fisheries in Indonesian waters mainly because they feed on the tuna. Although some fishers feel disturbed by their presence, they do not want to kill or harm these marine mammals, as they believe that dolphins and marine mammals bring luck by identifying the location of their target: tuna.

The highest number of bycatch incidents was reported in the area of Bitung, North Sulawesi, whereas no bycatch incidents were reported in Morotai and Ternate. The study identified 20 species of cetaceans, including three species of baleen whales and 17 species of toothed whales, but it is likely that the interactions of cetaceans with tuna fisheries are underestimated in the study results. Overall, Hatfield Consultant's rapid assessment provides insights into the interactions between cetaceans and tuna fisheries in the ISLME. Although the study identifies some potential risks to cetaceans from tuna fishing, it also highlights that many fishers in the region do not want to harm or kill these marine mammals because of cultural beliefs. Nonetheless, the study suggests that bycatch does occur in Indonesian waters, and there is a need for further research to better understand the nature and extent of these interactions, with the goal to reduce bycatch.

Furthermore, a study by Mustika (2019) revealed that the two types of fishing gears that are responsible for the majority of incidental entanglement in Paloh and Adonara are gillnets and purse seines, respectively. In Paloh, all cetacean bycatch events were caused by gillnets, which is consistent with the observation that gillnets have the highest bycatch rates among small-scale fisheries. Otherwise, 75 percent of bycatch events in Adonara were associated with purse seines.

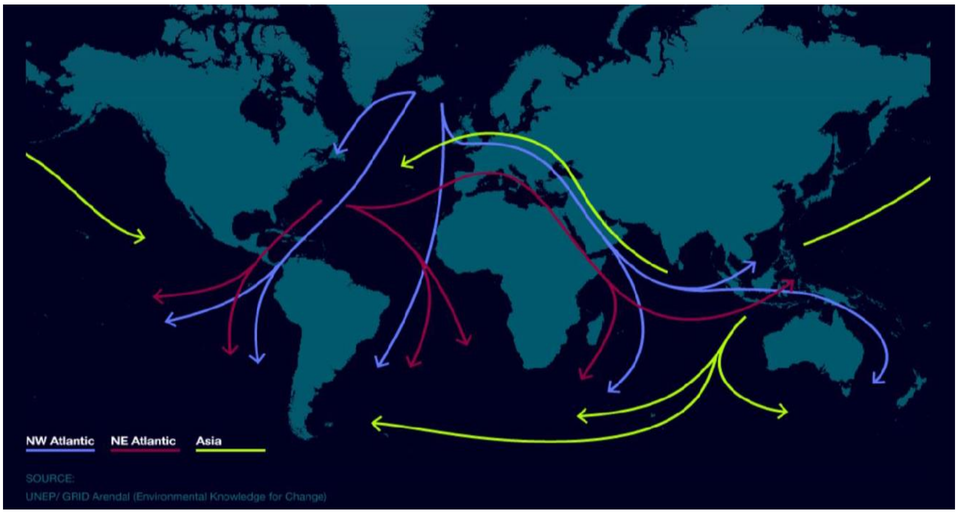
The Savu Sea, located within the ISLME region, is an important marine conservation area for cetaceans. Taman Nasional Perairan (TNP) Laut Sawu is a national marine conservation area managed by the MMAF. The Savu Sea is a migration route not only for protected marine mammals, but also for sea turtles, whale sharks, and manta rays. It is also a source of biodiversity for coral reefs, seagrass beds, and mangroves. Throughout the year, whales can be observed in the Savu Sea, where a variety of small fish serve as their main source of food. According to a survey, 54 larvae of commercially important fish species were found in the Sumba and Timor regions of the Savu Sea. The Savu Sea is home to four species of large whales, including the Bryde's whale, blue whale, humpback whale, and sperm whale. There are also several species of smaller cetaceans, including short-finned pilot whales, spinner dolphins, spotted dolphins, melon-headed whales, Risso's dolphins, Fraser's dolphins, pygmy killer whales, killer whales, and various species of bottlenose dolphins. The Savu Sea also hosts short-finned pilot whales, false killer whales, rough-toothed dolphins, and Cuvier's beaked whales. It is a vital area for the conservation of cetaceans and their ecosystems in Indonesia (MMAF, 2020a).

3.4.3 Invasive species

There is only limited information on the status of invasive marine species in Indonesia, although the threat of invasive species continues to grow as global trade, travel, and tourism allow species to be transported over increased distances to areas that were not previously accessible to them. Areas subjected to the worst pollution, intensive fisheries and/or bottom trawling, and major shipping routes are likely to be the most seriously impacted by the invasion of non-native species.

Approximately 3 billion tonnes to 12 billion tonnes of ballast water are transported and discharged throughout the world each year by large ships. Ballast water can contain thousands of species and is believed to be the main vector for the spread of invasive aquatic species. Large numbers of invasive species are also transported as "hitchhikers attached to the hulls of ships, on floating objects such as marine waste, and accompanying marine plants or animals brought in for mariculture. Figure 97 shows that invasive species in Indonesia may have arrived from the Northwest Atlantic and Northeast Atlantic.

Figure 97. Origin and pathways of invasive species



Source: Reprocessed from UNEP/Arendal, 2023: https://www.grida.no/resources/7191

Many non-native and invasive species (NIS) spread to new environments by chance, whereas humans intentionally introduce some other species to new habitats in a variety of ways. Hulme *et al.* (2008) simplified a framework for categorizing introduction pathways into six categories based on the amount of human assistance, which are as follows: (i) release – whereby an organism is intentionally introduced as a commodity for release; (ii) escape – whereby an organism is intentionally introduced as a commodity but escapes unintentionally; (iii) contaminant – whereby an organism is introduced unintentionally alongside a specific commodity; (iv) stowaway – whereby an organism is unintentionally introduced attached to or within a transport vector; (v) corridor – whereby an organism is unintentionally introduced through infrastructures that connected previously unconnected areas; and (vi) unaided – whereby an organism is unintentionally introduced without human interference or as a result of non-native species' natural dispersal across regions.

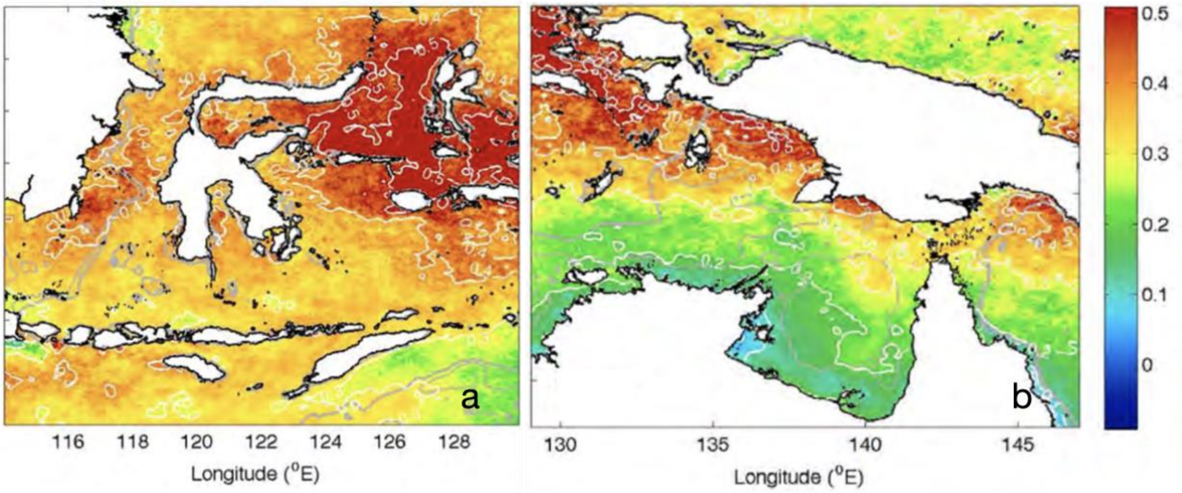
3.5 Impacts of climate change

3.5.1 Global and regional climate change trends

As the environmental and economic impacts of climate change are being felt globally, the ISLME also experiences them. During the National Stakeholders Consultation Workshop on 3-4 September 2020, participants reported that environmental impacts from climate change in the ISLME included flooding in all FMAs as well as changes to the coastline and an increase in wave height that affects ship routes. Effects are also being reported on ecosystem health, coral reefs (bleaching), and organisms, such as larval and adult fish migration. Climate change is changing upwelling intensity and period, which, in turn, affects primary production. Additionally, dry seasons last longer than wet seasons.

Over the past 33 years (1982–2014), the sea surface temperature (SST) in the ISLME has experienced a warming trend on average of 0.19 ± 0.04 decade−1, which is larger than the global SST warming trend (Iskandar *et al*., 2020) (Figure 98). The warming trend indicates seasonal variations, in which the maximum trend occurs during boreal summer season. The seasonal dependence in the warming trend, highest during the boreal summer, was significantly related to the Indo-Pacific climate modes, namely the negative Indian Ocean Dipole (IOD) and La Niña events (Dunstan *et al.*, 2020).

Figure 98. Long-term sea surface temperature trends (1992–2017)



Note: On the left (a) is the Indonesian Seas and on the right (b) is the Gulf of Carpentaria and north Irian/Papuan coastline

Source: Iskandar, I., Mardiansyah, W., Lestari, D. & Masumoto, Y. 2020. What did determine the warming trend in the Indonesian sea? *Progress in Earth and Planetary Science*. 7, 20. DOI https://doi.org/ 10.1186/s40645-020-00334-2.

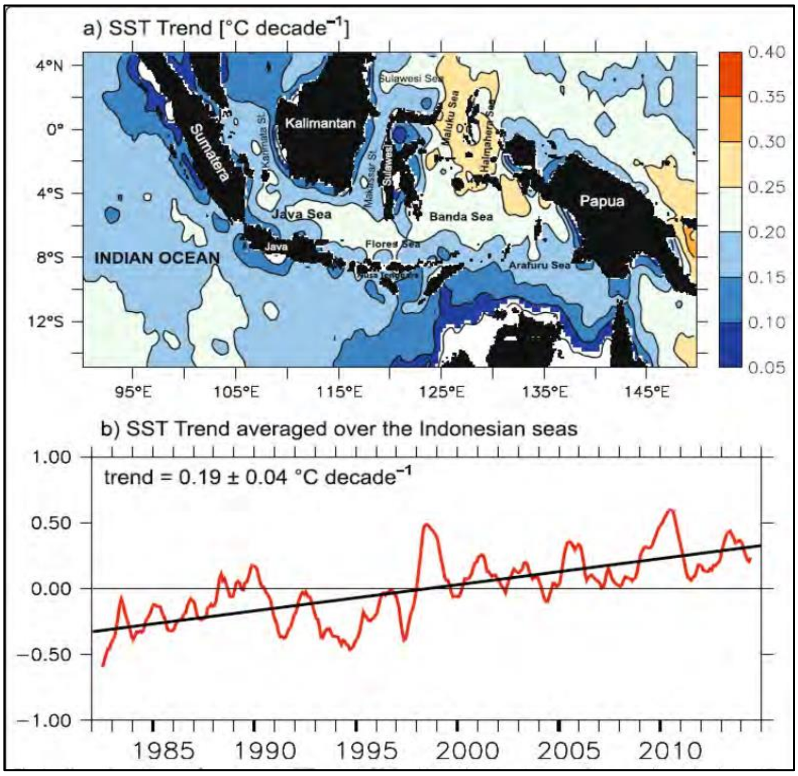
The higher warming trend observed in the south of Makassar Strait and in the eastern Indonesian Seas, in the vicinity of the Maluku Sea and the northeastern part of the Banda Sea, was significantly associated with the La Niña event. Meanwhile, a strong warming trend observed in the Karimata Strait and Java Sea, and in the Flores Sea south of Sulawesi Island seems to be enhanced by the negative IOD event.

Climate projections for Indonesia suggest that the country will experience significant changes in temperature, precipitation patterns, and sea level rise over the coming decades. These changes are largely driven by global warming caused by human activities, such as burning fossil fuels and deforestation. According to the Indonesian MoEF, the average temperature in Indonesia is projected to increase by 0.5 °C to 1.5 °C by 2030, and by 1.0 °C to 3.0 °C by 2070. This increase in temperature is expected to lead to more frequent and severe heat waves, which can have a significant impact on public health and agriculture (MoEF, 2018).

A close examination of the SST trend (figure 99) within the Indonesian sea reveals that the highest warming trend (> 0.2 °C/decade) was observed in the eastern parts. This warming trend was highest in the vicinity of the Molucca Sea and in the northern part of the Banda Sea as well as in the Flores Sea and the southern part of Makassar Strait. The area-averaged trend within the Indonesian Seas shows a ubiquitous warming trend at a rate of about 0.19 °C ± 0.04 °C/decade, though there was a short relaxation in the early 1990s.

Superposed on this secular trend is a shorter time scale time variation. It was found that there were two robust events of warming tendency occurring during 1998/1999 and 2010/2011 (Figure 99). These robust warming events are considered to be associated with the La Niña events that increased precipitation over the Indonesian region (Iskandar *et al*., 2020).

Figure 99. Observed trend in sea surface temperature over the Indonesian seas and surrounding region during 1982– 2014.



Source: Iskandar, I., Mardiansyah, W., Lestari, D. & Masumoto, y. 2020. What did determine the warming trend in the Indonesian sea? *Progress in Earth and Planetary Science*. 7. DOI: 10.1186/s40645-020-00334-2.

Sea-surface temperatures in the ISLME has shown a significant increasing trend over the last few decades. The warmest waters were found in the Maluku waters, while the coldest were found around the Flores Sea and Tomini Bay in North Sulawesi. It has become a significant concern for ecosystem health, especially coral reefs. Increasing temperature causes coral reef bleaching. This increase in SST has the potential to cause coral bleaching, reduce the abundance of fish stocks, and alter the distribution of marine species. These impacts could have significant consequences for the livelihoods of local communities and the overall health of the marine ecosystem in the ISLME Region. In terms of precipitation patterns, Indonesia is projected to experience more extreme weather events, such as heavy rainfall and droughts. The intensity and frequency of extreme weather events are expected to increase, which could lead to flooding, landslides, and other natural disasters. The Indonesian government has identified the need to improve its disaster risk reduction and management systems to better respond to these events. Sea level rise is also a significant concern for Indonesia, as the country has over 17 000 islands and a long coastline. According to the Intergovernmental

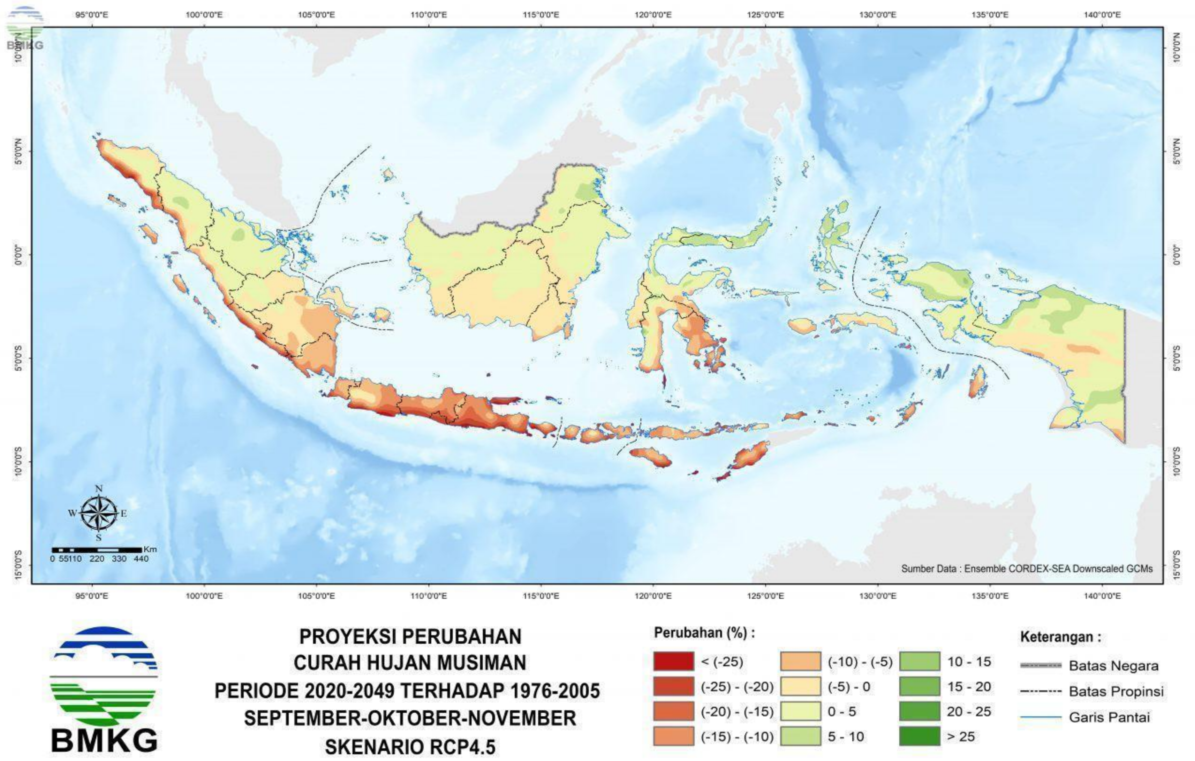
Panel on Climate Change (IPCC), sea levels could rise by as much as 0.98 m by the end of the century, which could lead to significant coastal flooding and erosion. This could have major impacts on the country's infrastructure, economy, and population (IPCC, 2019). Sporadic meteorological data make establishing accurate historical trends for Timor-Leste difficult, but the data that does exist suggests that average temperatures in the country have been increasing annually by 0.016°C since 1950. The temperature is projected to increase by 0.4°C–1.0°C by 2030. By 2050, the increase in temperatures is expected to reach 1.25°C–1.75°C, with an increase in heat waves (Secretary of State Environment, 2021).

3.5.2 Extreme weather events

Extreme weather events, such as tropical cyclones and heavy rainfall, pose significant threats to the marine ecosystem and communities in the ISLME region. These changes could have significant implications for the marine ecosystem, including changes in water temperature and nutrient levels, which could impact the distribution and abundance of marine species.

It is important to monitor rainfall pattern change associated with climate change and to develop strategies to mitigate the potential impacts on the marine ecosystem and local communities in the ISLME region. The Meteorology, Climatology, and Geophysics Agency (BMKG) of Indonesia has projected annual rainfall for the period of 2020 to 2049 based on data from 1976 to 2005. As shown in the rainfall projection map (Figure 100), Java Island is expected to experience significant changes in rainfall patterns, with some parts of other islands following suit, particularly in the Nusa Tenggara and Southeast Sulawesi regions. These changes could have serious consequences for the marine ecosystem, such as altered water quality and increased nutrient and sediment runoff, as well as for local communities who rely on fishing and other marine resources for their livelihoods. It is crucial to take these projections into account and implement appropriate measures to mitigate the potential impacts of these extreme weather events on the marine ecosystem and local communities in the ISLME region.

Figure 100. Projection of annual rainfall 2020–2049



Source: BMKG (Badan Meteorologi, Klimatologi, and Geofisika). 2014. Proyeksi Perubahan Iklim. [Climate change projection]. [Cited 10 August 2023]. https://www.bmkg.go.id/iklim/?p=proyeksi-perubahan-curah-hujan

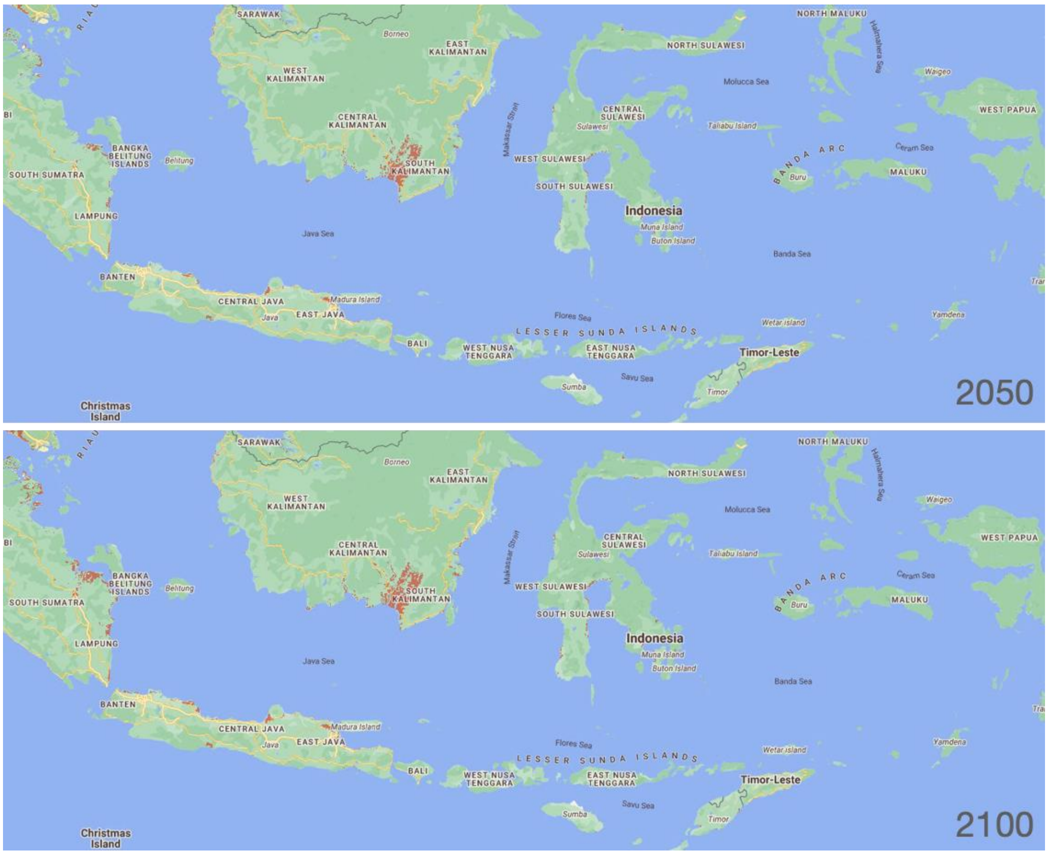
Air temperature is projected to change in terms of annual averages for Indonesia and Timor-Leste. This indicates increases of up to 3.6 °C to 3.80 °C by 2070 (Johnson *et al*., 2021). The air temperature will increase (>40 °C) in all small archipelagic islands (Indonesia and Timor-Leste) by 2070, for all emissions scenarios. Based on this scenario, there will be implications across the ISLME region. This does not only have implications for marine biodiversity but also for terrestrial runoff, including freshwater inputs, nutrients, and sedimentation into marine ecosystems, typically from islands with larger rivers and land mass. This will also affect coastal structures that ultimately impact coastal biodiversity, including sea turtle nesting places (ATSEA-2, 2023).

3.5.3 Sea-level rise and coastal inundation

Sea-level rise is currently increasing at 1 mm/year to 3 mm/year in the coastal areas of Asia, and it is projected to accelerate to a rate of approximately 5 mm/year over the next century (Cruz, 2007). Sea level rise and coastal inundation are significant challenges that are expected to have serious impacts on the ISLME. According to the Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report, global mean sea level is expected to continue to rise throughout the twenty-first century, with a likely range of 28 cm–58 cm by 2100 compared to 2000 levels, under an intermediate emission scenario. The report notes that this could lead to an increased frequency and severity of coastal flooding, exacerbating the risks faced by communities in the region. A study by Hauer *et al*. (2020) estimated that under a high-end scenario of sea-level rise of 2 m by 2100, which is considered unlikely but plausible, up to 300 million people globally could be at risk of being displaced as a result of coastal flooding, with Asia being the most affected region.

Furthermore, Tran (2005) noted that the rise in sea level, reduced freshwater flows, and saltwater intrusion will pose a threat to Indonesia's coastal mangroves, which provide critical habitats for a variety of marine species. This threat is compounded by existing stresses primarily caused by human activities (Figure 101). The impacts of sea level rise and coastal inundation are also expected to affect the biodiversity and ecosystem services of the region. Cruz (2007) reported that up to 50 percent of Asia's total biodiversity is at risk, and Wilkinson (2004) noted that there would be an 88 percent loss of coral reefs in Asia in the next 30 years as a result of warming sea-surface temperatures, sea level rise, and other added stresses. This massive coral bleaching, leading to widespread loss of coral reefs and biodiversity, will have significant implications for the fish that many Indonesians rely on for food and livelihoods.

Figure 101. Prediction of coastal inundation in the Indonesian Seas Large Marine Ecosystem affected by sea level rise



Note: Red colour indicates areas affected.
Source: Climate central. 2022. A global screening tool by Climate Central. Sea level rise and coastal flood risk maps (2050 and 2100) [Cited 23 June 2023]. https://coastal.climatecentral.org/map/5/117.8888/-2.4739/?theme=sea_level_rise&map_type=coastal_dem_comparison&basemap=roadmap&contiguous=true&elevation_model=best_available&forecast_year=2050&pathway=ssp3rcp70&percentile=p

50&refresh=true&return_level=return_level_1&rl_model=gtsr&slr_model=ipcc_2021_med [for year 2050] [Cited 23 June 2023]. https://coastal.climatecentral.org/map/5/117.8888/-2.4739/?theme=sea_level_rise&map_type=coastal_dem_comparison&basemap=roadmap&contiguous=true&elevation_model=best_available&forecast_year=2100&pathway=ssp3rcp70&percentile=p50&refresh=true&return_level=return_level_1&rl_model=gtsr&slr_model=ipcc_2021_med [for year 2100]

In addition, rising sea levels, extreme weather events, warming temperatures, and changes in ocean circulation and salinity patterns will impact Indonesia's marine turtle populations (WWF, 2007). Changes in species distribution, reproduction timing, and phenology of plants are also expected to occur because of climate change (Cruz, 2005). Sea level rise and coastal inundation are significant challenges that are expected to have serious impacts on the ISLME. The impacts on human livelihoods, biodiversity, and ecosystem services are expected to be substantial. Effective measures to address these challenges are urgently needed to safeguard the sustainability of the region's marine ecosystem and the people who depend on it.

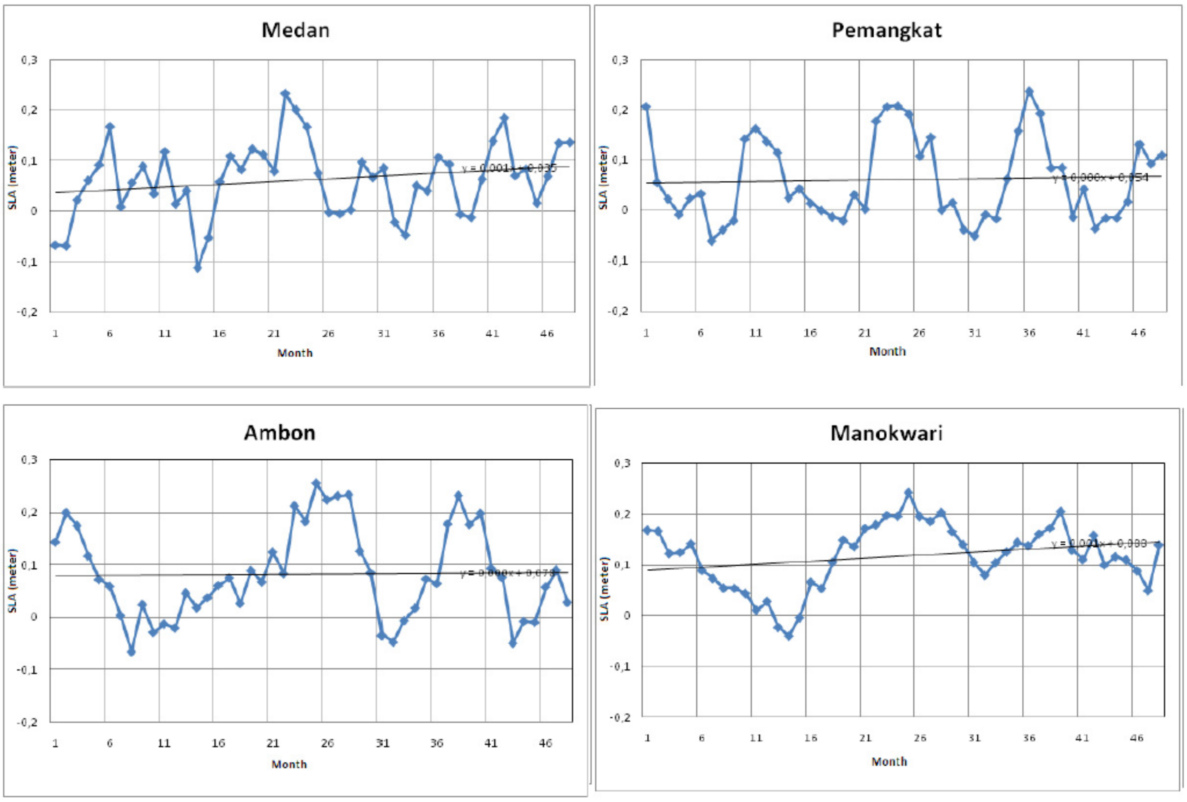
The increase of air temperature will support sea level rise across the ISLME region at an average rate of 2.1mm/year over 1966–2009 and 3.1mm/year over 1993–2009 (ATSEA-2, 2023). This is consistent with the global temperature average rise. A study done by Johnson *et al*. (2021) shows that the Indonesian Archipelago and Timor-Leste will experience increases at approximately 0.4 m (under high emissions scenario). In addition, a vulnerability assessment of habitats in the ATS region to climate change impacts was conducted by Johnson *et al*. (2021). The results showed that coral reefs in shallow waters were highly vulnerable to climate change on the northern and southern coasts of Timor-Leste, including the eastern part of Indonesia. Johnson *et al*. (2021) reported that climate change would also largely impact mangroves, seagrass meadows, and wetland habitats both in Indonesia and Timor-Leste.

3.5.4 Coastal vulnerability and adaptation in the Indonesian Seas Large Marine Ecosystem

Global warming as a result of the effects of greenhouse gases has an impact on the rise in sea levels. Recently, several remote sensing technologies have been developed that can monitor the condition of the oceans continuously. Satellite altimeter technology is one technique used to monitor sea level change. During the past two decades, observations from satellite altimeters have demonstrated dramatic descriptions of sea level variability with higher spatial resolution than traditional tide gauges (Din *et al*., 2012).

This study used altimeter data from Jason-2 over the Indonesian Seas region from 2009 until 2012. The process and analysis of sea level data were carried out using Basic Radar Altimetry Toolbox 3.1.0 (BRAT) (Din *et al*., 2012). Figure 102 presents the findings for several regions within Indonesia.

Figure 102. Trend of sea level rise in several regions

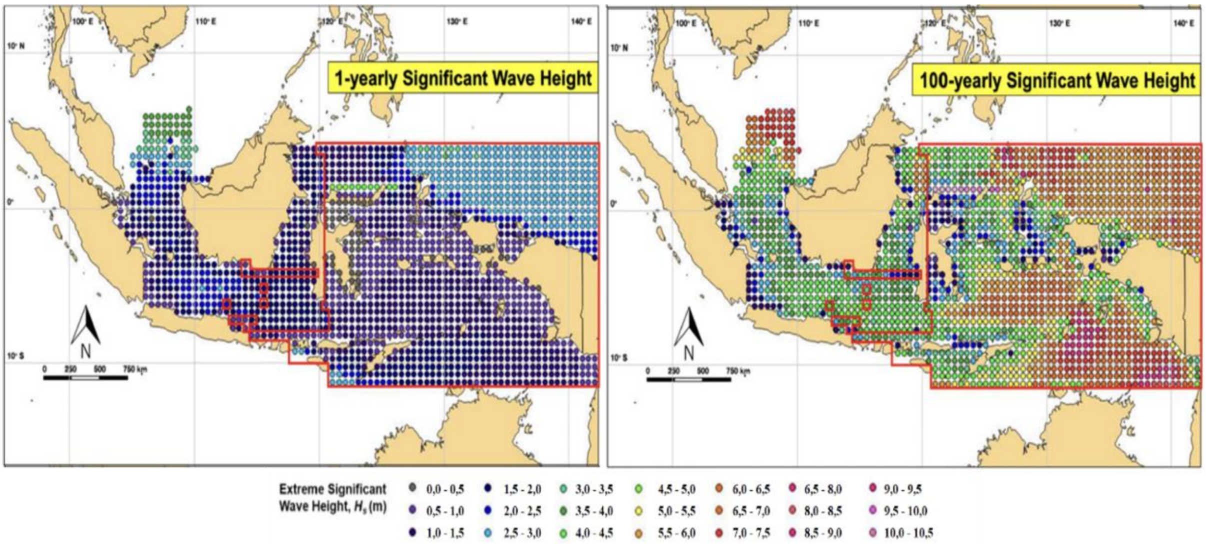


Source: Din, A. H., Omar, K. M., Naeije, M. C., & Ses, S. 2012. Long-term sea level change in the Malaysian seas from multi-mission altimetry data. *International Journal of the Physical Science*s, 7(10): 1694–1712.

The global ocean wave climate has long been of interest to the ocean engineering community because of the need for accurate operational wave data for applications such as vessel design, design of offshore and coastal structures, or naval operations. Recently, there has been a major interest in wave climate change as a result of global warming. Results of studies on wave height values projected in 1 year and 100 years are shown in Figure 103.

In ISLME waters, the status of extreme wave height information is an important aspect to consider in relation to climate change impacts. A recent study by Wurjanto, Mukhti and Wirasti (2021) provided a comprehensive map of extreme significant wave heights in Indonesia based on the SEASMOS-South Fine Grid Hincast (SEAFINE) and ERA5 database analysis. Figure 103 revealing a significant rise in significant wave height (Hs) by 8 m to 10 m from 1-yearly and 100-yearly Hs map. This crucial information, based on 2.0x factored ERA5 results represented as dots within red boxes. The study provides crucial information on the extreme wave heights that could occur in ISLME waters, particularly in the Flores and Banda Seas where significant impacts from extreme wave heights are projected.

Figure 103. 1-yearly and 100-yearly Hs map based on combined SEAFINE and ERA5 databases



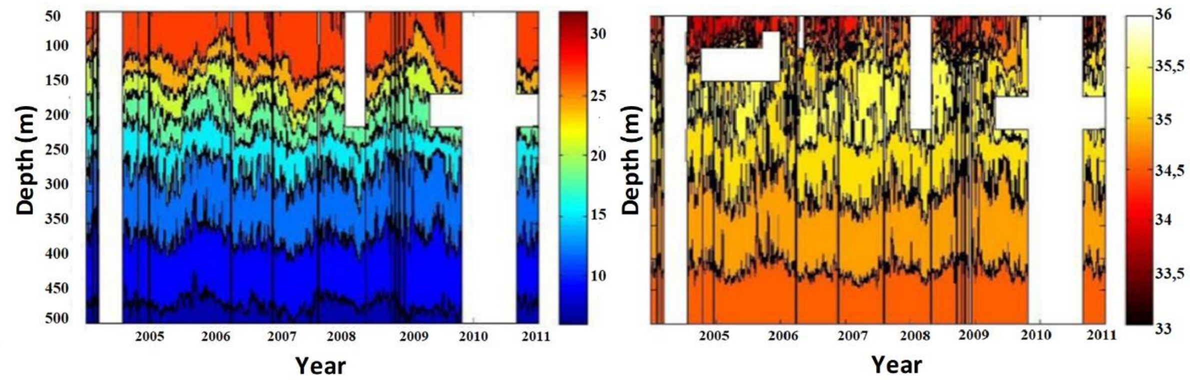
Note: Regions based on 2.0x factored ERA5 results are shown as dots within red boxes.
Source: Wurjanto, A., Mukhti, J. A., & Wirasti, H. D. 2021. Extreme significant wave height map of Indonesia based on SEAFINE and ERA5 database. *Journal of Engineering and Technological Sciences*, 53(1): 210110.

Climate change has led to the warming of coastal waters in the ISLME region, which is expected to continue in the. Twenty-first century (IPPC, 2007b). This warming trend can result in changes in oceanic circulation patterns and salinity levels, which may have significant impacts on the species that inhabit these areas. Additionally, the intensity of El Niño and La Niña events increases along with the process of global warming (Timmermann *et al*., 1999). The El Niño event of 1997/1998 caused coral bleaching in Indonesia as a result of the long dry season, whereas the La Niña event in 1999 led to a rise in sea level of 20 cm to 30 cm, causing flooding in most coastal areas of Indonesia (Sari *et al*., 2007).

It is essential to have accurate and up-to-date information on extreme wave heights in ISLME waters to understand the potential impacts of climate change on coastal communities, infrastructure, and ecosystems. The study by Wurjanto, Mukhti and Wirasti (2021) made a valuable contribution to this field by providing a comprehensive map of extreme significant wave heights in Indonesia. Nonetheless, further research is needed to understand the full extent of the impacts of extreme wave heights on the ISLME region and to develop effective mitigation and adaptation strategies to address these impacts.

Figure 104 specifically shows the pattern of temperature and salinity changes in the Pacific Ocean caused by El Niño and La Niña based on a study by Hasita and Zikra (2013). This study used temperature and salinity data from TRITON (Triangle Trans-Ocean Buoy Network) buoy located at precisely 0° N 138° E on the southwest side of the Pacific Ocean for a five-year period (2005–2010). The rapid increase in coastal populations and the effects of climate change pose a threat to both humans and infrastructure in coastal areas. To address this issue, global communities must take two actions: climate change adaptation and mitigation. The world needs to rapidly shift away from carbon-intensive fuels to mitigate the impact of climate change. Indonesia's unique role in climate change issues affects precipitation patterns, resulting in a wetter climate in Sumatra and Kalimantan, but drier seasons in Java, Bali, and Nusa Tenggara. This imbalance in rainfall can increase the risk of drought during critical periods and flooding during already wet times. Climate change will also lead to stronger and more frequent La Niña events, exacerbating drying and flooding trends and potentially causing decreased food production and increased hunger (Nature Conservancy, 2020).

Figure 104. Pattern change caused by El Niño and La Niña, 2005–2011



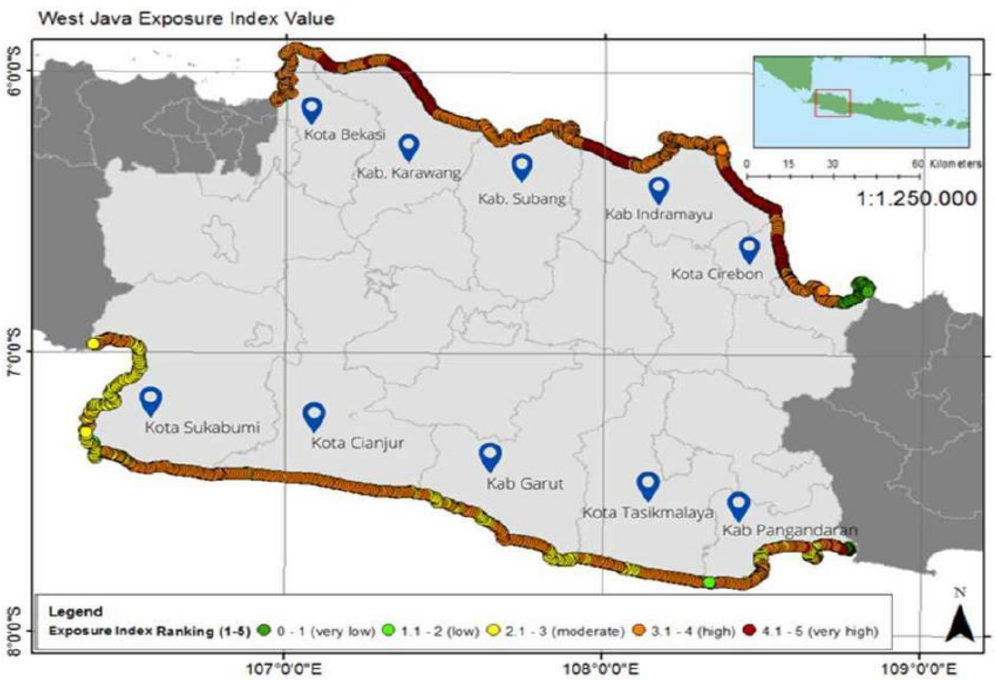
Note: Figure on the left shows temperature and figure on the right shows salinity.
Source: Anwar, S. K., & Purba, N.P. 2020. Coastal vulnerability based on oceanographic and ecosystem parameters on the north and south coast of West Java. In 2020 IEEE Asia-Pacific Conference on Geoscience, Electronics and Remote Sensing Technology (AGERS) (pp 184–190) IEEE. DOI:10.1109/AGERS51788.2020.9452761

The coastal areas of the ISLME are facing an increasing risk of flooding and seawater intrusion as a result of global warming, resulting in a rise in sea levels at a rate of 3 mm to 5 mm per year. This puts more people in harm's way. Additionally, Indonesia's rich biodiversity and ecosystem services are under threat, with 50 percent of its total biodiversity and 80 percent of its coral reefs at risk as a result of warming sea-surface temperatures, sea level rise, and other factors. Declining numbers in fish larvae and changes in fish habitats, such as is the case with the skipjack tuna, as a result of climate change are also concerning. The widespread loss of coral reefs and biodiversity because of massive coral bleaching further affects the fish that many Indonesians rely on for their food and livelihoods. On land, forest fires are becoming more frequent, which is having a severe impact on wildlife habitats and biodiversity, resulting in economic and domestic as well as transboundary pollution consequences. Human health is also at risk, with more frequent and severe heat waves, floods, extreme weather events, and prolonged droughts leading to increased illness, injury, and death. There is also an increase in the frequency and spread of infectious diseases, such as malaria, dengue fever, diarrhea, and severe respiratory problems, following an increase in wildfires (Nature Conservancy, 2020).

More than half of the population in Indonesia lives in the coastal area. A unique coastal characteristic can be found in the West Java Region (WJR). WJR consists of two different coasts: the north side faces the Java Sea, and the south has a boundary with the Indian Ocean

(Figure 105). The vulnerability index is mostly 3.1–4, suggesting a high level of vulnerability indicated by orange dots, especially in the coastal areas of Bekasi City and Subang Regency, which are along the coast and have the same high level of vulnerability. There is a slight difference in the areas of Karawang Regency, Indramayu Regency, and the western part of Cirebon City; half of these areas have an index value of 4.1–5 marked by a red dot, which means that the level of vulnerability is very high. Besides that, there is a significant difference in the east of Cirebon City, which show a few areas with dark green dots, which mean that the index value in the area is 0–1, indicating the level of vulnerability is quite low. The vulnerability index value on the south coast of West Java shows a vulnerability value of 3.1–4 or (high), as indicated by orange dots, especially on the coast of Cianjur City, which has the same high level of vulnerability. There is a slight difference in the western area of Sukabumi City as well as several points in Garut Regency, Tasikmalaya City, and Pangandaran Regency: namely, there is a yellow dot, which means the index value on the coast is 2.1–3 and is at moderate levels (Anwar and Purba, 2020).

Figure 105. Vulnerability index for the coast of West Java



Source: Nature Conservancy. 2023. How we're protecting our ocean. https://www.nature.org/en-us/what-we-do/our-priorities/protect-water-and-land/land-and-water-stories/protecting-our-ocean/?vu=r.v_marine

Indonesia has placed strong emphasis on adaptation measures to address challenges related to rising sea levels, extreme weather events, and threats to biodiversity and ecosystems. To promote more sustainable management practices, integrated agro-ecosystems are being encouraged both on land and at sea. Integrated coastal zone management (ICZM) programmes are being implemented in coastal areas, with the participation of local governments. To preserve and conserve their 75 000 km^2 of coral reef resources from the effects of climate change, as well as to strengthen their food security, Indonesia and five other countries launched the CTI in 2009, using an ecosystem approach to manage fisheries resources. Indonesia and FAO have also implemented programmes to promote inland water fisheries biodiversity and the transboundary management of the large marine ecosystem of the Indonesian Seas under the GEF Cycle-5 Program. Climate mitigation programmes are also underway, including the construction of solar cell power plants, an increase in the percentage of biofuels in gasoline consumption, and the promotion of geothermal energy for power plants (Soesilo, 2014).

The Resilient Coastal Cities project aimed at building social-ecological community resilience in the face of natural disasters (Nature Conservancy, 2021). To assist in this effort, the Nature Conservancy has teamed up with the Global Disaster Preparedness Centre of the American Red Cross to identify ways in which nature can play a role in disaster preparedness, response, and recovery. Leveraging its expertise in nature conservation and habitat restoration as well as innovative geospatial technology, The Nature Conservatory is also helping to guide city-level planners and community members in making informed decisions about nature-based adaptation solutions (Figure 106). By providing city-specific ecosystem data, natural infrastructure can be incorporated as a critical component of disaster risk reduction (Soesilo, 2014).

Figure 106. Coalition-building process

Source: Nature Conservancy. 2021. Resilient coastal cities in Indonesia. https://coastalresilience.org/project/indonesia/

The collaboration between GDPC and TNC aims to enhance existing approaches to disaster risk reduction through community assessments, problem solving, and outreach to households and small businesses. The focus is on exploring the potential of nature and natural defenses to reduce risks. To demonstrate the value of natural systems in protecting social and economic community assets, it is essential to gain the support and participation of key stakeholders and governments. This can be achieved by integrating valuable ecosystems within cities and improving their management, including reefs, mangrove forests, fisheries, and flood-prone areas (Soesilo, 2014).

3.6 Current status of ecosystem approach to fisheries management and ecosystem approach to aquaculture within the Indonesian Seas Large Marine Ecosystem region

3.6.1 Status of ecosystem approach to fisheries management and ecosystem approach to aquaculture, gaps and priorities

Indonesia has implemented both ecosystem approach to fisheries management (EAFM) and ecosystem approach to aquaculture (EAA) in its fisheries management policies and practices and has been recognized as a global leader in implementing these approaches. EAFM in Indonesia was started in 2009 through cooperation between WWF Indonesia and the Directorate of Fisheries Resources (MMAF), and it has received technical support from various organizations such as universities, non-government organizations (NGOs), and other experts. EAFM was then officially endorsed in 2014 through the Director General of Capture Fisheries' decree. One of the important results from the pilot test of EAFM implementation is a recommendation to establish a working group (*kelompok kerja/pokja*) across sectors, both at provincial and district levels.

The implementation of EAFM in ISLME has made significant progress in Indonesia and Timor-Leste. The activities involve providing training to MMAF extension officers through the training of trainers (ToT) sessions, which included additional modules on EAFM. In Timor-Leste, comprehensive EAFM training and ToT sessions on EAFM have been conducted, which are now being followed up through pilot EAFM plans for their respective pilot areas. The ISLME project has now developed an EAFM performance index-based assessment for lobster, mud crab, snappers/groupers, and blue swimming crabs through cooperation with the EAFM Learning Center (LC) in four universities: LC-EAFM Mataram University, LC-EAFM Lambung Mangkurat University, LC-EAFM Hasanuddin University, and LC-EAFM IPB University. Moreover, earlier FAO-supported projects, such as BOBLME and REBYC II CTI, also played significant roles, particularly in EAFM capacity development.

For fisheries status, targets and its management planning, we should refer to the Fisheries Management Planning for every fisheries management area (RPP-FMA). MMAF now has established 11 FMA councils, but there is some concern around the operation of these councils to support fisheries management governance at every FMA. There is a need to build partnerships between districts, provinces, and FMAs.

There is also a need to build synergies between marine and fisheries programme policy and implementation, between national-province-district and local (village/desa) government levels, and between Indonesia and Timor-Leste. The United States Agency for International Development through the SEA Project has been working with the local government to establish local community groups for marine-protected areas surveillance and monitoring

(POKMASWAS) for 14 marine protected areas (MPAs) in FMA 715. It is one good example of how the government builds partnership with the community.

Since 2007, the Regional Plan of Action (RPOA) for IUU fishing has been developed for 11 member countries. There is a subregional office that covers four countries (Indonesia, Timor-Leste, Papua New Guinea, and Australia). The secretariat for this subregional office is at the Directorate General for Marine and Fisheries Resource Surveillance (MMAF), Indonesia. Marine and fisheries governance between Indonesia and Timor-Leste is also a relevant topic under the CTI-CFF. One bilateral cooperation that has been agreed upon between Indonesia and Timor-Leste under CTI-CFF is on developing Lesser Sunda Seascapes, which is relevant for the ISLME. Under the ISLME project, a bilateral meeting between Indonesia and Timor-Leste is planned.

An aquaculture programme developed by the Directorate General for Aquaculture (MMAF) located in the ISLME region concerns the integrated multitrophic aquaculture for lobster-seaweed-bivalves in West Nusa Tenggara. Another pilot project on the EAA on seaweed aquaculture has also been implemented in West Nusa Tenggara.

Since 2010, Indonesia has been working to implement the EAFM and the EAA as part of its commitment to sustainable fisheries and marine resource management. In terms of management planning for fisheries per species, Indonesia has developed several EAFM plans, such as the Blue Swimming Crab EAFM Plan in Lampung, the Lobster EAFM Plan in Lombok, and the Tuna EAFM Plan in North Sulawesi. These plans aim to promote the sustainable management of specific fisheries by considering the ecosystem and social considerations, and by involving stakeholders in the decision-making process. The plans also incorporate elements of monitoring, control, and surveillance (MCS) to ensure compliance with regulations and reduce illegal fishing activities.

Key data priorities and gaps

- Fisheries – number of fishers/vessels, catch/production (tonnes, value), key species (by districts).
- Coastal aquaculture – production (tonnes, value), key species, methods (by location).
- Maritime shipping – number of vessels, size, shipping lanes.
- Human population – coastal districts (Indonesia), sucos (Timor-Leste).

Key issues EAFM and EAA

There are still several challenges to the full implementation of EAFM and EAA in ISLME. Some of the key issues are as follows:

- Insufficient information: one of the main challenges to implementing EAFM and EAA is an insufficiency of comprehensive data and information about the state of fish stocks and ecosystems. This can make it difficult to make informed decisions about sustainable fishing practices and habitat conservation.
- Illegal, unreported, and unregulated (IUU) fishing: IUU fishing undermines efforts to manage fisheries sustainably, as it can lead to overfishing and damage to marine ecosystems. Although Indonesia has made significant progress in combating IUU fishing, it remains a major challenge for the country.

- Monitoring, control, and surveillance (MCS): several important findings related to the effectiveness of fisheries management in the region. MCS includes various components, such as vessel monitoring systems (VMS), port state measures, observer programmes, and enforcement and prosecution measures, and inadequate integration between the various MCS activities, resulting in inefficiencies in monitoring and enforcement efforts (with a focus so far on "during fishing").
- Challenged enforcement: despite improvements in enforcement efforts, there are still challenges in enforcing fisheries regulations and combating IUU fishing. This can lead to unsustainable fishing practices and the degradation of marine ecosystems.
- Limited institutional and community capacity: EAFM and EAA require effective communication and collaboration between various stakeholders in the fisheries sector, including government agencies, industry, and local communities. However, limited institutional and community capacity can hinder these efforts.
- Climate change: cimate change poses a significant threat to Indonesia's fisheries and marine ecosystems, and can complicate efforts to manage fisheries sustainably using EAFM and EAA approaches.

Overall, although progress has been made in implementing EAFM and EAA in Indonesia, there are still challenges that need to be addressed to fully realize the potential benefits of these approaches. Efforts to address these challenges will require continued collaboration and cooperation between government agencies, industry, and local communities.

3.6.2 Status of integrated coastal management, gaps and priorities

Since the implementation of integrated coastal management (ICM) in Indonesia, several efforts have been made to apply this approach in various regions. The MMAF has designated several areas as pilot projects for ICM implementation, including Bintuni Bay in West Papua, Wakatobi in Southeast Sulawesi, and Morotai Island in North Maluku. Several guidelines and protocols have been developed to support the implementation of ICM in Indonesia. MMAF has published a handbook on ICM that provides practical guidance on the planning and implementation of ICM at the local level. The Coordinating Ministry for Maritime and Investments Affairs has also issued a regulation on ICM that sets out a policy framework for ICM implementation in the country. In addition, the government has collaborated with international partners, such as the UNDP and ADB, to develop ICM guidelines tailored to the Indonesian context.

Various activities have been carried out to implement ICM in Indonesia, including the development of coastal zone management plans, the establishment of coastal zone management institutions, capacity development programmes for local communities, and awareness-raising campaigns. In addition, several guidelines and protocols for ICM planning and implementation have been developed, such as the Guidelines for Coastal Zone Management Planning in Indonesia, the National Action Plan for Coral Reef Management, and the Coastal Area Management Program for Integrated Development.

ICM involves the integration of various sectors and stakeholders in the planning and management of coastal areas. ICM in Indonesia has been implemented through various projects and initiatives to improve coordination among stakeholders, increase awareness of the importance of coastal resources, and establish MPAs. However, challenges remain in terms of the effective enforcement of regulations and the sustainability of ICM initiatives.
These initiatives aim to address the challenges of climate change and sustainable resource management in coastal areas. The implementation of the ICM in transboundary areas between Indonesia and Timor-Leste faces several challenging issues related to climate change, overfishing, and marine pollution.

- Climate change: climate change poses a significant threat to the coastal areas of Indonesia and Timor-Leste, with rising sea levels, increased intensity of storms, and ocean acidification all affecting the health and resilience of coastal ecosystems. The challenge for ICM is to integrate climate change adaptation and mitigation strategies into coastal management plans to ensure that coastal zones remain resilient in the face of climate change impacts.
- Overfishing: overfishing is a major issue in both Indonesia and Timor-Leste, with many fish stocks being exploited beyond their sustainable limits. ICM approaches must address this challenge by promoting sustainable fishing practices, improving governance and management of fisheries, and creating alternative livelihoods for fishing communities that rely on overfished resources.
- Marine pollution: marine pollution is a growing problem in both Indonesia and Timor-Leste, with plastic pollution, oil spills, and other forms of pollution affecting the health of coastal ecosystems and the communities that depend on them. ICM must address this challenge by implementing policies and practices that reduce pollution, promote sustainable waste management, and improve the monitoring and enforcement of regulations.

In addition to these challenges, the transboundary nature of coastal management in Indonesia and Timor-Leste requires effective coordination and cooperation between different government agencies, NGOs, and stakeholders to ensure that ICM approaches are truly integrated and effective in addressing the complex challenges facing these coastal areas.

Priority issues

Current priorities that need to be addressed to improve ICM in ISLME waters:

- Strengthening institutional capacity

A major challenge facing ICM implementation in Indonesia and Timor-Leste is to enhance institutional capacity. The need of resources, expertise, and coordination among government agencies, NGOs, and communities often results in the ineffective implementation of ICM approaches. Therefore, one of the priorities for ICM is to strengthen institutional capacity through capacity development, training, and better coordination between stakeholders.

- Improving governance and enforcement

Effective governance and enforcement are critical to the success of ICM. However, inadequate governance frameworks, regulations, and limited enforcement capacity undermine ICM efforts. Therefore, improving governance and the enforcement of regulations is a priority for ICM in Indonesia and Timor-Leste.

- Promoting sustainable livelihoods

Many coastal communities in Indonesia and Timor-Leste rely on coastal resources for their livelihoods. However, the unsustainable exploitation of resources, climate change, and other factors threaten these livelihoods. Therefore, a priority for ICM is to promote sustainable livelihoods through alternative livelihoods, such as ecotourism, sustainable fisheries, and aquaculture.

- Addressing climate change

Climate change is a major threat to coastal ecosystems and communities in Indonesia and Timor-Leste. Therefore, addressing climate change is a priority for the ICM. This includes integrating climate change adaptation and mitigation strategies into ICM plans, promoting the use of renewable energy, and reducing greenhouse gas emissions.

- Improving data and information

Effective ICM requires accurate and up-to-date data and information on coastal ecosystems, resources, and socioeconomic conditions. However, there are often data gaps and limitations in these areas. Therefore, improving data and information is a priority for ICM in Indonesia and Timor-Leste.

Overall, addressing these priorities will require the engagement of various stakeholders, including government agencies, NGOs, communities, and the private sector. It will also require a long-term commitment to ICM and sustained investment in capacity development and research.

ICM with information management

Integrated coastal management (ICM) involves the coordinated management of land, water, and resources in coastal areas to achieve sustainable development. Effective data and information management is an essential component of ICM since it enables decision-makers to monitor, evaluate, and adjust management practices based on the best available information.

There are several challenges associated with data management in ICM, including the following:

- Insufficient data: obtaining comprehensive, reliable, and up-to-date information is a significant challenge in many coastal areas. This can be a result of various factors, including inadequate monitoring systems, data-sharing mechanisms, and limited resources.
- Data fragmentation: data related to coastal management are often dispersed across various sectors and institutions, making it challenging to integrate and analyse them cohesively. This can lead to gaps in knowledge and challenged decision-making.
- Data quality: inaccurate or incomplete data can lead to ineffective or inappropriate management decisions, wasting resources, and exacerbating environmental problems.
- Data analysis: processing and analysing large volumes of data can be challenging, particularly for coastal management agencies with limited resources and technical capacities.

  Various efforts have been made to enhance monitoring systems and improve data quality for ICM in Indonesia.

- Integrated Coastal Zone Management (ICZM) Monitoring System: the MMAF has developed an ICZM monitoring system to monitor the implementation of ICZM in Indonesia. The system includes a database that stores information on coastal zones, coastal hazards, ecosystem services, and socioeconomic data. The system allows for the monitoring of progress in the implementation of ICZM and can help identify areas where improvements are needed.

- Enhancing Data Quality: the MMAF has also been working to enhance data quality for coastal management in Indonesia. This has involved the development of standard operating procedures for data collection, management, and reporting. Additionally, the MMAF has established a network of monitoring stations across Indonesia to collect data on water quality, marine biodiversity, and other parameters.
- Community-based monitoring: another approach to enhancing monitoring and data quality has been through community-based monitoring programmes. These programmes involve local communities in collecting data on coastal and marine resources, which can help fill data gaps and provide important information for decision-making.

To improve data management in ICM, stakeholders need to prioritize the following:

- Develop integrated data management systems: integrated data management systems can help overcome data fragmentation and ensure that data are accessible, relevant, and reliable.
- Develop capacity: capacity development efforts should focus on strengthening technical skills and institutional capacity to collect, analyse, and disseminate data.
- Improve data sharing mechanisms: improved data-sharing mechanisms are essential to facilitate the exchange of information between institutions and stakeholders.
- Invest in monitoring systems: improved monitoring systems can provide a more comprehensive understanding of the coastal environment and support the development of evidence-based management policies.
- Enhance data quality: efforts should be made to improve the quality of data through standardized collection and validation procedures.

In summary, effective data and information management is essential to support the implementation of ICM in Indonesia and Timor-Leste. To improve data management, stakeholders need to focus on developing integrated data management systems and capacity, improve data-sharing mechanisms, invest in monitoring systems, and enhance data quality.

3.6.3 Status of marine protected areas, gaps and priorities

Marine protected areas (MPAs) are areas of the ocean and coastal zones that are managed for the conservation and sustainable use of marine and coastal resources. In Indonesia, several MPAs have been established in the ISLME and also around the transboundary waters with Timor-Leste.

The MMAF has a programme aimed at expanding coverage and improving the management of MPAs in Indonesia. The target is to achieve a total area of 32.5 million ha by 2030. As of 2021, the existing conservation areas in Indonesian waters have reached 28.4 million ha, which accounts for 8.7 percent of the country’s total water area (MMAF, 2022a). The ISLME region has a total of 110 MPAs, but only one of them, Raja Ampat on Papua, has a highly protected status (see Annex 1). This means that extractive activities are strongly restricted in Misool, minimizing impacts on the marine environment. The other 109 MPAs in the region have lightly protected status, allowing moderate to extensive extraction and associated impacts. These MPAs are distributed widely across the region, such as Java Sea (14 MPAs), Kalimantan (10 MPAs), Sulawesi (28 MPAs), Nusa Tenggara (30 MPAs), Maluku (14 MPAs), and Papua (14 MPAs). A number of MPAs have been established to protect coral reefs, seagrass beds, mangroves, and other important habitats. These include Wakatobi National Park in Sulawesi, Bunaken National Marine Park in North Sulawesi, and Cenderawasih Bay National Park in Papua. These MPAs are managed by the Indonesian government and have regulations in place to limit fishing, tourism activities, and other human impacts that could damage marine and coastal ecosystems. The MPA list including information on size of area of each site is provided in Annex 1.

There are also several MPAs established around the transboundary waters between Indonesia and Timor-Leste. These include the Nino Konis Santana National Park in Timor-Leste, which is managed by the Government of Timor-Leste, and the Wetar Strait Conservation Area in the waters between Timor-Leste and Indonesia, which is managed by the two countries in cooperation.

The primary regulation in Indonesia that governs MPAs is Law No. 32 of 2004 on Regional Government, which provides the legal framework for the establishment and management of MPAs by local governments. The law empowers regional governments to establish MPAs to protect marine and coastal resources and to regulate the use of these areas for fishing, tourism, and other activities.

In addition to this law, there are several other regulations and policies in Indonesia that specifically address the establishment and management of MPAs. These include:

- MMAF Regulation No. 56 of 2014 on the Procedures for the Establishment of Marine Protected Areas. This regulation provides the procedures and requirements for establishing MPAs in Indonesia, including the criteria for selecting MPA sites, the stakeholder consultation process, and the management plan development process.
- Presidential Regulation No. 83 of 2018 on Indonesian Ocean Policy. This regulation provides a national framework for the sustainable management of marine and coastal resources, including the establishment of MPAs as key conservation and management tools.
- MMAF Decree No. 4 of 2019 on the Guidelines for the Management of Marine Protected Areas. This decree provides guidance on the planning, implementation, and monitoring of MPA management activities, including the roles and responsibilities of government agencies, stakeholders, and local communities.

These regulations and policies are aimed at providing a legal and policy framework to support the establishment and management of MPAs in Indonesia. However, there are still many challenges to effectively managing and enforcing MPAs in Indonesia, including insufficient resources, capacity, and funding, as well as ongoing threats from illegal fishing, climate change, and other human activities.

KKP has developed a tool to monitor and evaluate the effectiveness of MPA management named EVIKA (Evaluasi Indeks Keberlanjutan Areal Konservasi). It is a monitoring tool developed by the Ministry of Marine Affairs and Fisheries in Indonesia to assess the

effectiveness of conservation area management (MMAF, 2020d). EVIKA aims to provide a new approach for evaluating the sustainability of conservation areas in the country. The tool employs a holistic approach, considering factors such as biodiversity conservation, habitat quality, community involvement, and management practices. By collecting and analysing relevant data, EVIKA calculates a sustainability index, offering a quantitative measure of the conservation areas' health and management performance. EVIKA enables continuous monitoring and facilitates data-based decision-making for adaptive management strategies.
Many stakeholders are involved in efforts to increase MPAs in the ISLME, including NGOs, government agencies, and local communities. In the last ten years, there have been significant efforts to establish new MPAs and to expand the coverage of existing MPAs in Indonesia’s waters, although the rate of increase varies from region to region.

At the national level, the Indonesian government has also made efforts to increase the coverage of MPAs in the country’s waters. In 2018, the government announced a target to establish 20 million ha of MPAs by 2020 as part of the country's commitments to the sustainable development goals and the Aichi biodiversity targets. Although this target has not been fully achieved, several new MPAs have been established in recent years, including the Togean Islands National Park in Central Sulawesi and the Sabang Marine Protected Area in Aceh.

Local stakeholders, including communities and traditional resource users, have also been involved in MPA establishment and management efforts in Indonesia. In some cases, community-managed MPAs have been established with the support of NGOs or government agencies, providing an opportunity for local communities to take a leading role in protecting and managing their marine resources.

Although the rate of increase in MPA coverage in Indonesia's waters has been significant in some areas, there is still much work to be done to effectively manage and enforce MPAs, and to address ongoing threats to marine and coastal ecosystems. This includes addressing issues such as illegal fishing, climate change, and marine pollution, which continue to impact the health and productivity of Indonesia’s marine resources.

Marine debris constitute potential pollution sources for MPAs. Purba *et al*. (2020) reported debris floating around the MPAs that have the potential to reach beaches inside the MPAs and that display various patterns between the monsoons. Furthermore, in MPAs in the North Java Sea (FMA 712), which are designated as National Parks, the debris managed to land in the most crucial zones, the core zone and buffer zone.

Timor-Leste started its MPAs establishment in 2005 through close cooperation between the FAO and the MAF. The first step was the introduction of a community-based marine sanctuary in 11 coastal municipalities across the country. This was then followed by the establishment of two MPAs in Batugade (bordering Indonesia) and on Ataúro Island, which covers 0.57 percent of the country’s marine area (UNCBD, 2018).

The Government of Timor-Leste enacted Ministerial Diploma No. 5/GM/I/2015 to support the establishment of the Aquatic Natural Reserve in Batugade (Bobonaro Municipality) and

Ministerial Diploma No. 6/GM/I /2015 to support the establishment of another MPA in Villa (Ataúro Municipality). Apart from MPAs, Timor-Leste also established the first locally managed marine areas (LMMAs) in 2013 in the Lamsana Protected Area of Manatuto Municipality. The LMMA occupies an area of approximately 8 ha. The LMMA is an area that is managed by local communities who are in charge of protecting and preserving it. In 2013, Timor-Leste launched the nation's first no take zones (NTZs) (seven in total) within 207 km^2 of the Nino Koni Santana National Park, the country's only national park, located on the northeast part. The zones encompass important coral reefs which help maximize climate resilience, serve as reef fish spawning sites, enable fisheries replenishment, and protect key dive and snorkel sites for tourism purposes.

3.6.4 Status of climate change adaptation, gaps and priorities

Climate change adaptation is the process of adapting to the impacts of climate change by developing strategies and measures that can reduce the vulnerability of individuals, communities, and ecosystems to its effects. There are several types of climate change adaptation measures that can be implemented in Indonesia, including:

- Coastal zone management: Indonesia is one of the world's most extensive archipelagos, and it is imperative to develop and implement effective coastal zone management policies to reduce the impacts of sea-level rise, storm surges, and coastal erosion. These measures can include building protective structures, such as sea walls, mangrove restoration, and wetland conservation.
- Agriculture: agriculture is an essential sector in Indonesia, and changes in precipitation patterns and temperatures can significantly impact food production. Climate change adaptation measures in the agriculture sector may include the development and promotion of drought-resistant crop varieties, water management strategies, and land-use changes to protect against soil erosion.
- Water management: climate change may impact the availability and quality of water resources in Indonesia. Climate change adaptation measures in water management could involve developing water conservation strategies, improving the efficiency of irrigation systems, and implementing policies that encourage sustainable water use practices.
- Disaster risk reduction: Indonesia is prone to natural disasters, such as floods, landslides, and earthquakes, which are likely to be exacerbated by climate change. Climate change adaptation measures in disaster risk reduction may involve the development of early warning systems, improving emergency response capabilities, and enhancing disaster preparedness and resilience.
- Biodiversity conservation: Indonesia has some of the world's richest and most diverse marine ecosystems, which are threatened by climate change. Climate change adaptation measures in biodiversity conservation could include the establishment of protected areas, conservation of endangered species, and reforestation efforts.

These are just a few examples of the types of climate change adaptation measures that can be implemented in the ISLME region to adapt to the impacts of climate change. The most effective climate change adaptation strategies will depend on the specific circumstances and needs of each region and community.

ISLME waters are particularly vulnerable to the impacts of sea-level rise, which is a significant concern for climate change adaptation. Some of the priority areas and gaps for climate change adaptation related to sea-level rise in these regions include the following:

Priority areas

- Infrastructure: the development of infrastructure, such as ports, airports, and roads, must take into account the impacts of sea-level rise to prevent damage and disruption to critical systems and services.
- Coastal communities: many coastal communities in the ISLME are at risk of sea-level rise, including increased flooding and coastal erosion. Priority areas for climate change adaptation in these communities include developing early warning systems, improving evacuation routes, and enhancing community resilience.
- Biodiversity conservation: sea-level rises can have significant impacts on coastal ecosystems, such as mangroves and coral reefs. Priority areas for climate change adaptation in biodiversity conservation include protecting and restoring coastal habitats, improving monitoring and research, and enhancing adaptive management strategies.

Gaps

- Insufficient information: there is still a significant insufficiency of data on sea-level rise impacts in the ISLME, which makes it challenging to develop effective climate change adaptation strategies.
- Limited financial resources: many communities and governments in the region have limited financial resources to implement climate change adaptation measures, which can hinder their ability to adapt effectively.
- Limited institutional capacity: many governments and institutions in the region lack the capacity and expertise to develop and implement effective climate change adaptation measures, which can also hinder their ability to adapt.
- Inadequate policy frameworks: there is a need for more comprehensive and coordinated policy frameworks to guide climate change adaptation efforts related to sea-level rise in ISLME and Indonesia's waters.

Addressing these priority areas and gaps will be essential for effective climate change adaptation related to sea-level rise in the ISLME. It will require cooperation and collaboration between governments, communities, and other stakeholders, as well as investments in research, capacity development, and infrastructure development.

3.6.5 Current status of ecosystem approach to fisheries management, ecosystem approach to aquaculture, ecosystem-based management information and data systems

Biophysical knowledge, information gaps and priorities

Understanding of the physical and biological processes that drive ecosystem dynamics is important. It includes knowledge of the physical and chemical properties of the environment as well as the biological interactions and processes that occur within the ecosystem. Examples of priority problems in biophysical knowledge might include understanding the impacts of climate change on ecosystem dynamics, identifying critical habitat areas for key species, and characterizing the physical and chemical properties of the water column and sediment.

EAFM : there is a need to identify the distribution and abundance of key fish species and their life history traits, such as spawning areas and migration patterns, to inform management strategies.
EAA : it would help to improve understanding of the ecological relationships between aquaculture species and their environment, including the potential impacts of feed and waste on water quality and benthic habitats.
EBM : there is a need to develop and implement monitoring programmes to track changes in ecosystem structure and function over time, including the health of keystone species and the effects of climate change.

Knowledge of ecosystem impacts

The effects of human activities on the ecosystem, including impacts on species, habitats, and ecosystem processes. Examples of priority problems in ecosystem impacts might include reducing bycatch in fisheries, minimizing the impacts of aquaculture on wild populations, and reducing the impacts of coastal development on critical habitats.
EAFM : there is a need to assess the impacts of fishing gear and practices on non-target species, such as bycatch and discards, and implement measures to reduce their impact; also to gain a better understanding the impacts from other sectors on the fisheries.
EAA : it would help to evaluate the environmental and social implications of different aquaculture systems and production methods, such as closed or open systems and use of antibiotics, to ensure sustainable practices.
EBM : there is a need to identify and address the impacts of anthropogenic activities, such as pollution and coastal development, on ecosystem health and function.

Socioeconomic knowledge, information gaps/priorities

Recent studies have examined the social and economic status of these communities and the challenges they face. Bachtiar, Wiryawan and Nurrochmat (2022) found that social capital plays an important role in the adaptation strategies of small-scale fishermen in the Spermonde Archipelago, which is part of the ISLME. Aulia *et al*. (2021) used spatial modelling to assess the social and economic characteristics of fishing communities in the Bintuni Bay area and found that these communities have low levels of income and education and are highly dependent on marine resources. Cahyono, Fithria and Aswandi (2020) investigated the factors affecting the livelihoods of small-scale fishers in the Muara Angke coastal area, and identified declining fish stocks, infrastructure, and limited access to credit and markets as significant challenges. These studies underscore the need for targeted policies and programs to support sustainable fisheries management, through EAFM, and improve the economic and social well-being of coastal communities in the ISLME.

FAO (2020c) based on EAFM mud crab fisheries assessment in FMA 713 showed some of the indicators that indicate the low level of stakeholder participation is a result of the absence of a forum/institution as a means to educate and coordinate between stakeholders of mud crab fisheries both at the provincial and district levels, so that in the field there are still different perceptions among stakeholders regarding the implementation of regulations, lack of socialization, lack of joint control/agreement on crab market prices between fishermen, collectors, and distributors. According to FAO’s (2020d) assessment of snapper and grouper populations in FMA 713, the main economic challenges for most fishing households were managing household finances and small business planning and management.

EBM : one of the gaps and priorities is the need to balance conservation and economic development goals. This can be particularly challenging in areas where there is significant economic pressure to exploit marine resources, such as large-scale industrial fishing operations or tourism development. Additionally, there may be socioeconomic inequalities among coastal communities that need to be addressed to ensure that the benefits and costs of marine resource use are distributed fairly.

EAFM : one of the gaps and priorities in terms of socioeconomic context is the lack of economic alternatives for fishers and coastal communities who depend on fishing as their primary livelihood. This can lead to overfishing and unsustainable fishing practices. Additionally, there may be a lack of awareness or understanding among fishers and communities about the benefits of EAFM, and how it can help to improve their economic situation in the long run.

EAA : there may be a lack of data and information about the economic value of ecosystem services and the contribution of aquaculture. This can make it difficult for decision-makers to prioritize conservation and management measures that may be beneficial in the long term but may have short-term economic costs in aquaculture.

Current status of marine spatial data and data management (including data-sharing, geographic information system decision support systems, ecosystem models)

The implementation and priority gaps of marine spatial data and data management in the ISLME waters territory are as follows:

- **Insufficient consistent and standardized data**: one of the main gaps in marine spatial data and data management in ISLME waters is inadequate consistent and standardized data. There is often inconsistency in the way that data is collected, stored, and analyzed. This can make it difficult to compare data across different regions and time periods, hindering effective decision-making.
- **Insufficient data coverage**: another gap is the insufficient data coverage. Many areas of ISLME waters do not have adequate data coverage, particularly in remote or hard-to-access regions. This can limit the ability of managers to make informed decisions about conservation and management.
- **Limited capacity for data analysis**: there is often limited capacity for data analysis in ISLME waters. This can be a result of a lack of technical expertise, equipment, or funding. Without the ability to analyse data effectively, it can be difficult to identify trends and make informed decisions.
- **Insufficient integration of traditional knowledge**: traditional knowledge is often not integrated into marine spatial data and data management. This can be a significant gap, as traditional knowledge can provide valuable insights into ecosystem dynamics and help identify key areas for conservation and management.
- **Inadequate data sharing**: in some cases, data sharing may be limited because of concerns about data ownership or privacy. However, this can be a significant disadvantage, as it limits the ability of managers to make informed decisions based on comprehensive data.

To address these gaps, priorities for marine spatial data and data management in ISLME waters include the following:

- **Developing standardized data collection protocols**: developing standardized data collection protocols can help to ensure that data is collected consistently across different regions and time periods.
- **Increasing data coverage**: increasing data coverage in remote or hard-to-access regions can help fill gaps in knowledge and support effective decision-making.
- **Developing technical capacity for data analysis**: improved technical capacity for data analysis can help ensure that data are analysed effectively, leading to more informed decisions.
- **Integrating traditional knowledge**: integrating traditional knowledge into marine spatial data and data management can provide valuable insights and support more effective conservation and management.
- **Encouraging data sharing**: encouraging data sharing can help to ensure that decision making is based on comprehensive and up-to-date information.

MMAF in Indonesia and MAF in Timor-Leste have been working to improve the management of marine spatial data and data in ISLME waters through various initiatives. One of the initiatives is the development and implementation of a Marine Spatial Plan (RZWP3K), which aims to integrate various marine-related activities and interests within a defined area. This plan includes the identification of marine and coastal zones as well as the identification of priority areas for conservation and sustainable use. EBM, EAFM and EAA not only require the filling of information gaps and improved knowledge management. Good governance as the ability to achieve ecological and social well-being, based on the principles of the ecosystem approach, is of key importance. This also needs to be supported by additional capacity development and institutional strengthening.

CHAPTER 4

Causal chain analysis of transboundary problems

4. 1 Driving forces impacting the Indonesian Seas Large Marine Ecosystem

The ISLME is facing multiple factors that result in five priority environmental concerns (PECs), namely: (i) unsustainable fishing and aquaculture practices and decline of living coastal and marine resources; (ii) degradation and loss of marine habitats; (iii) marine and land-based pollution; (iv) decline of biodiversity and key marine species; and (v) impacts of climate change. The unsustainable fishing and aquaculture practices primarily occur in FMA 712 (Java Sea), but also elsewhere. These factors pose various limitations and obstacles to any efforts aimed at resolving these issues and can be classified into: (i) socioeconomic drivers; (ii) institutional, legal, and administrative drivers; and (iii) climate change.

4.1.1 Socioeconomic drivers

Socioeconomic drivers are the factors that influence social and economic conditions in a region, affecting the natural environment and the ecosystem services it provides. These drivers can include population growth, urbanization, poverty, and industrialization (Table 41). The socioeconomic drivers of ISLME are varied and complex and can have significant impacts on the environment and ecosystem services.

Table 41. Societal and economic factors influencing the Indonesian Seas Large Marine Ecosystem region

Societal influences	Economic influences
Local coastal communities are experiencing increased poverty, food insecurity, and malnutrition.	There is a rise in demand for fish, and invertebrates leading to increased foreign earnings and improved access to global markets.
There is a trend of emigration from rural and coastal communities, particularly among males and youth.	Economic development and revenue maximization in seafood production are given more priority than sustainability.
The region is experiencing population growth, which is creating pressure for food, employment and housing.	Coastal resources such as food, income, and livelihoods are heavily relied upon.

Societal influences	Economic influences
There is a loss of access to distribution and transportation infrastructure, including ports, shipping channels, and roads.	National energy security is being prioritized with a focus on developing the energy sector, particularly in coal, offshore oil and gas.
There is an insufficiency of alternative livelihoods for people living in coastal and rural areas.	Coastal subsistence communities are prevalent, resulting in a high dependency on coastal resources such as food, income and livelihoods.

The main driver for key issues in the ISLME region is probably population density. The human population in the region continues to grow, having already reached a significant base of approximately 269 million in 2019 (BPS, 2019b). It is projected that this number will surpass 300 million by 2030. Moreover, there has been a noticeable trend of emigration from rural and coastal communities in recent years, particularly among males and youth. It was reported that the coastal population currently stands at 187.2 million in 2019 (BPS, 2019b). This shift in population distribution has led to a number of concerns, including economic impacts and social changes. The reasons for this trend are varied and complex, but some contributing factors include limited economic opportunities in rural and coastal areas, a desire for higher education and career prospects, and the allure of urban living. Although emigration can provide opportunities for individuals and families, it also poses challenges for the communities left behind, including a shrinking labour force and the potential loss of cultural traditions.

The fisheries sector is an important contributor to national food security and employment in Indonesia: nearly seven million people are involved in fisheries-related jobs in Indonesia. The global demand for fish, and other living marine resources has been on the rise, resulting in increased foreign earnings and better access to global markets. The demand for these resources is driven by various factors, including population growth, changing diets, and increasing awareness of the nutritional benefits of seafood. This demand has opened up new opportunities for seafood producers and exporters, particularly those from developing countries with abundant marine resources. As a result, the seafood industry has become a significant source of income and employment for many coastal communities. However, the increasing demand for seafood also poses challenges for sustainable resource management, as overfishing and habitat destruction could threaten the long-term availability of these resources.

National energy security has become a top priority for Indonesia, leading to a focus on developing the energy sector, especially in coal, offshore oil, and gas. The development of the energy sector has significant economic benefits, such as job creation, increased revenue, and improved infrastructure. It was reported that the gross value added (GVA) of a particular area, industry, or sector of the Indonesian ocean economy in 2019 was 26.18 percent of the country’s GDP. The energy sector contributed 11 percent of the total GVA value for the whole GVA value of Indonesia’s ocean economy in 2019. However, it poses environmental and social challenges, such as pollution, habitat destruction, and the displacement of communities.

4.1.2 Institutional, legal and administrative drivers

Successful management of natural resources and ecosystems requires a collaborative approach that involves multiple stakeholders from the community and several levels of administration: local, subnational, national, and regional. However, in many cases, community-based planning and management are limited and inadequate, leading to unsustainable outcomes. To address this, there is a growing emphasis on participatory planning and adaptive management approaches. These approaches aim to engage communities and other stakeholders in decision-making processes and to adapt management strategies to changing circumstances. By involving multiple stakeholders and adopting a flexible approach, participatory planning and adaptive management can lead to more sustainable outcomes and greater resilience in the face of environmental challenges. However, the primary institutional factor that hinders a country's capacity to implement changes at the regional level is the absence of a suitable platform for multinational consultations, planning, monitoring, and reporting on sustainable development progress.

Recognizing that the root causes and solutions to priority issues transcend national political boundaries, ISLME Indonesia and Timor-Leste should come to terms with the idea that addressing these issues through coordinated regional action is beneficial. By establishing an institutional and legal framework that encourages intersectoral and transboundary planning and management, both nations can benefit greatly from addressing these issues together.

The core issues or priority concerns discussed in Section 4.2 in this report are rooted in the difficulties of implementing efforts to generate compliance with the many existing laws, regulations, and policies at the national level. To be more precise, some of the areas where compliance is not met include the following:

- an ineffective long-term monitoring system could potentially benefit from further improvements in consistency, regularity, and standardization, as its current challenges with inconsistencies, irregularities, and insufficient standardization may lead to insufficient data, assessments, and information for effective evidence-based decision-making and management;
- inadequate awareness in the practice of monitoring, regulation and management of small-scale polluting activities, destructive fishing practices;
- legal and institutional frameworks at all levels experience implementation constraints because of overlapping of existing frameworks and limited compliance, monitoring, and enforcement;
- community-based and multistakeholder participatory planning and adaptive management are also limited and inadequate;
- uncoordinated and inadequate intersectoral planning at all levels;
- ineffective translation of political will into implementation, low priority to environment and habitat conservation; and
- insufficient standardized monitoring and information sharing.

The absence of effective governance is a complex issue because different levels of government, namely national, state, and local, are responsible and accountable for specific sectors that are divided among various governmental bodies. The assignment of responsibility and accountability is not always evident, and the legislation, derived from multiple sources and based on its sectoral nature, sometimes overlaps or clashes, which results in additional ambiguity regarding responsibility and accountability.

To ensure effective conservation and management of the marine environment in the ISLME, it is necessary to implement initiatives and activities in a coordinated manner, using harmonized laws and policies, and with the support of strong national and regional institutions with the necessary financial resources and jurisdictional mandates. Given the transboundary nature of the challenges facing the ISLME, it is also essential to strengthen institutional capacity and improve integration and coordination between local and national governments to address these challenges collaboratively, using ecosystem-based management or adopting and ecosystem approach.

4.1.3 Climate change

The ISLME has experienced ocean warming because of the impacts of global anthropogenic climate change. The crucial condition was discussed at the workshop held on 3-4 September 2020 known as the National Stakeholders Consultation. Attendees stated that the ISLME region is experiencing environmental effects of climate change, such as flooding in many locations, modifications to the coastline, and higher wave heights, which cause disruption to ship routes. It is anticipated that the ISLME region will experience the following impacts because of global climate change: (i) rising sea surface temperatures; (ii) increased extreme events including cyclones and heavy rainfall; (iii) sea-level rise; and (iv) coastal vulnerability. The negative impacts of global climate change have affected many critical habitats. Coral bleaching is linked to sea temperature warming, and rising sea levels can lead to insufficient light at deeper levels and increased risks of flooding. Coastal and marine ecosystems in the ISLME region are experiencing ongoing degradation and loss, including the destruction of important areas of biodiversity, habitat, and fisheries productivity, such as mangrove forests, seagrass beds, and coral reefs. Recent studies have shown that Indonesia's coral reefs provide crucial protection against flood damage, with an estimated annual value of at least USD 639 million (Beck *et al*., 2018). This value is likely to increase as coastal areas continue to develop and climate change worsens. The rising sea surface temperatures and other global stressors have had a significant impact on Indonesia's coral reefs, with coral bleaching events alone causing considerable mortality over the past decade.

Climate change in the ISLME, acting both as a driver and a cause, is likely to have an impact on its ecology and biodiversity. Although there have been predictions of various global scenarios, such as sea level rise, extreme storms, and heavy rainfall, these changes should be considered when planning for future interventions and management, specifically for implementing adaptation measures. For instance, non-climate-related factors are expected to have a more significant impact on the fisheries industry in the short term, but the region's ability to handle these issues will also determine the long-term effects of climate change. Insufficient management of fisheries systems can weaken their resilience, making them more vulnerable to climate change impacts.

The rise in relative sea level is considered a major threat to mangroves in ISLME (Tran, 2005), particularly in areas where the sediment surface of mangroves is not keeping up with the rise in sea level, and there is limited space for them to move inland. However, further research is necessary to determine where this problem is happening in the ISLME, such as in the Java Seas, Makassar Straits, and Flores Sea, where sea level changes are caused primarily by subsidence and partly by climate change. In these areas, it may be possible to evaluate the effectiveness of mangrove management frameworks and provide support for the management of coastal activities that have unsustainable impacts on mangroves and other coastal habitats, as well as to increase resilience to the effects of climate change. There may also be opportunities to plan for mangrove migration inland in response to rising sea levels, but the competition for available land will pose a significant challenge. Indonesia and Timor-Leste must collaborate and take decisive action on the pressing issues and root causes identified. The effectiveness of current management practices will determine the potential consequences of future climate change.

4.2 Priority environmental concerns and their causes

4.2.1 Unsustainable fishing and aquaculture practices

<table>
<tr><th colspan="2">PEC 1: Declining productivity and sustainability of ISLME fishery and aquaculture</th></tr>
<tr><td colspan="2">SECTORS – artisanal and small-scale fisheries, industrial fisheries, aquaculture at all scales.</td></tr>
<tr><td colspan="2">CATEGORIES – coral reef fisheries, reef gleaning, offshore fisheries, IUU fishing, seaweed farms, offshore caged culture, coastal pond culture.</td></tr>
<tr><th colspan="2">IMPACTS</th></tr>
<tr><td>ENVIRONMENT
• Decline in pelagic, invertebrate, reef fish, and other local fish stocks, also non-target species.
• Decline in reef biodiversity, ecosystem health and water quality.
• Reduced fisheries production and smaller-sized fish.
• Change in fish population structure.
• Degradation and loss of marine habitats, particularly benthic habitats from impacts of fishing gears and fishing activities.
• Loss of coastal habitat and nutrient pollution from coastal land and water-based aquaculture
• Shading effects on seagrasses from poorly managed seaweed culture.
• Spread of diseases, introduced feral species and threats to local species from introduced cultured species.</td><td>SOCIOECONOMIC
• Lower catches, and declining profitability of fishing, and high operational costs to fish further offshore.
• IUU-associated organized criminal activities.
• Reduced production, increased losses, and higher operating costs for aquaculture.
• Pristine coastal scenery and its economic values are negatively affected.
• Negative impacts on coastal subsistence communities, traditional harvesting, reef gleaning, and culture/customary practices.
• Reduction in livelihoods/family income, decline in national and seafood revenue.
• Increased household poverty, food insecurity, malnutrition.
• Diverging perspectives and potential conflicts among local fishers, reef users, and other coastal-marine users.
• Emigration from rural and coastal communities.</td></tr>
<tr><th colspan="2">IMMEDIATE CAUSES</th></tr>
<tr><td colspan="2">• Inefficient management of domestic fisheries.
• Overcapacity and overfishing; high fishing pressure in most fishing grounds including commercial and SSF.
• IUU fishing and destructive fishing practices, capture of juvenile and immature fishes.
• High level of fisheries bycatch and discards.
• High demand for marine fish as feeds and fishmeal by for aquaculture.
• Poor on-farm aquaculture practices.
• Insufficient regulation of aquaculture and inadequate attention to environment, ecology and other conflicts.</td></tr>
</table>

UNDERLYING CAUSES	
GOVERNANCE	**SOCIOECONOMIC**
• Insufficient regulatory capacity for aquaculture and capture fisheries at all levels. • Limited effectiveness of improvement in compliance, enforcement, monitoring, surveillance, and reporting. • Future aquaculture production growth targets not aligned with sustainable development principles. • IUU fishing by domestic commercial and SSF vessels. • IUU activity of foreign vessels and vessels operating under foreign beneficial ownership. • The prevalence and fragmentation of rights and the decentralized governance systems, leads to gaps or overlaps in the regulatory and management regimes for coastal and marine resources, especially fisheries. • The approach to management of the fisheries and aquaculture sub-sectors is inadequately framed in environmental, governance and socio-economic terms.	• Limited development of fisheries value chains, financial and human resources. • Harmful incentives and poorly targeted fuel subsidies. • Inadequate incorporation of fishery management plans. • Significant numbers and widespread distribution of artisanal, subsistence, and small-scale fishers. • Aquaculture that conflicts with other users of water / land areas and local versus external investor conflicts.
ROOT CAUSES	
GOVERNANCE	**SOCIOECONOMIC**
• Archipelagic geography challenges of huge coastline and fragmentation of systems. • Overlapping legal and institutional frameworks at all levels. • Unclear property rights, land and marine tenure. • Inadequate decentralized and intersectoral planning at all levels. • Insufficient political will for stronger regulation of the sector. • Low priority of sustainable fisheries in national and marine policy-making, including blue economy. • Cultural and traditional practices in support of sustainable fisheries and aquaculture management not well analysed and recognized.	• Population growth, pressure for food, employment and housing. • High proportion of the population living in the coastal zone dependent on coastal resources for livelihoods. • National food security, high levels of domestic seafood demand (Indonesia) for national food security. • Limited availability of alternative coastal and rural livelihoods options. • High levels of poverty, low levels of education/literacy. • Limited environmental awareness and environmental responsibility. • Economic development and revenue maximization (seafood production) prioritized over sustainability. • Foreign earnings – high demand for seafood export, access to global markets (Indonesia).

Description of the problem and transboundary issue

IUU fishing (overfishing, destructive fishing) and catching of immature fish

Nearly half of Indonesia's wild fish stocks are overfished as the country struggles to meet its own fisheries targets, whereas some essential marine ecosystems are still left out of the expanding marine protected areas (MPAs). Most Indonesian boats draw their catch from areas that are already overfished and overcrowded with boats. Many of Indonesia's fish stocks are already depleted or exploited because of fishing. A fish stock can become overfished by taking too many immature or juvenile fish (also smaller-sized fish and spawning fish).

Destructive fishing practices are common in waters with coral reefs primarily in FMA 712 (North Java Sea Area), often caused by not using ecofriendly fishing gear. Furthermore, the use of destructive fishing gear is triggered by high economic pressure on fisher communities. This is chosen by fishers to get higher catches in order to make short-term profit. This is inseparable from the condition of fishers in Indonesia, the majority of whom live in poverty. Destructive fishing is also a big challenge for the government of Timor-Leste, because of limited capacity to control all its waters. Given inadequate capacity to monitor and conduct surveillance operations, much IUU fishing happens on both northern and southern coast of the country. This IUU fishing was monitored through the assistance of Global Fishing Watch (GFW) from 2018 to 2022. The results showed that many IUU fishing happening inside Timor-Leste's EEZ. As detected by GFW, many boats that do IUU fishing activities come from Indonesia. For example, from December 2020 to January 2021 about 15 Indonesian boats were operating illegally in Timor-Leste's waters, starting from the northern coast near Oecusse and Bobonaro to Suai, Betano and Viqueque on the southern coast.

Very high numbers of artisanal, subsistence and small-scale fishers

Small-scale fisheries (SSF) provide crucial contributions to livelihoods, food and nutrition security, and the well-being of coastal communities worldwide. In Indonesia, 2.5 million households are involved in SSF production; however, these households are characterized by high poverty rates and vulnerability because of declining ecosystem health and climate changes. Small-scale artisanal fisheries are striking examples because open access to resources is typical, and the remoteness of small fishing communities contribute to high and often prohibitive transaction costs in the labour and product markets. The combination of these economic forces largely determines the biological status of the resource base and profoundly affects human well-being.

High feed demand for fish farms and suboptimal aquaculture practices

The increasing demand for food because of population growth has resulted in many aquaculture practices neglecting the welfare of fish, which can cause environmental and health problems. Expanding aquaculture of carnivorous fish leads to increasing demand for fish (catch) based aquaculture feeds.

High level of fisheries bycatch and discards

Bycatch has an impact on ecosystems and humans. Because of bycatch, the results of the catch will affect the fish community structure in the sea. In addition, bycatch also affects the fishermen's economy. Discarded bycatch, i.e. the practice of high-grading in the face of limited fish storage capacity, usually has economic value to other fishers, and when the catch is discarded and dies, the opportunity to catch that fish is affected. Bycatch of threatened, endangered, and vulnerable species causes serious biodiversity losses.

Impacts on ecosystem services and human well-being

The issue of fisheries has significant impacts that can be divided into two categories: environmental impacts and socioeconomic impacts. Environmental impacts include a decrease in water quality, declining fish and marine wildlife populations, coral reef damage, and loss of biodiversity. The loss of ecosystem functions, such as the critical habitat abilities of mangroves, seagrasses, and coral reefs to act as carbon sinks and provide ecosystem services like feeding zones, breeding grounds, and nursery grounds, directly affects the sustainability of marine biota. Anthropogenic activities, such as overfishing, changes in land use, the use of destructive fishing technology, and pollution, worsen the situation. The use of hazardous substances, such as cyanide and explosives, to catch fish illegally also affects the health of fishermen.

These environmental impacts have implications for socioeconomic impacts, such as an increased difficulty in meeting the basic needs of communities, including food and daily necessities that rely on natural resources. A decrease in environmental quality also leads to a loss of potential in the tourism and related job sectors, making it increasingly difficult for local communities to find employment. Inadequate policies, or inadequate translation of policies into action, in natural resources management can threaten the livelihood of coastal communities, leading to conflicts. Increased poverty, food crises, and malnutrition are also some of the other socioeconomic impacts that arise from unsustainable fishing and aquaculture practices. The environmental and socioeconomic impacts also have implications for many coastal communities that are forced to emigrate from their hometowns to seek employment in big cities. This will cause losses in terms of social and cultural richness because of the loss of cultural identity and traditions that are inherent to coastal communities. In addition, conflicts between communities because of inappropriate natural resource management policies can also cause disruptions in security and social stability. Therefore, it is important to carry out sustainable natural resource management in order to minimize environmental and socioeconomic impacts.

In Timor-Leste, IUU fishing greatly affects marine and coastal ecosystem diversity including degradation of wild stock of fish and other marine living resources as well as habitat degradation, which results in socioeconomic impacts. Existing laws and regulations for fisheries in Timor-Leste are not well aligned with economic circumstances. Most coastal communities are heavily dependent on marine and coastal resources as a key source of livelihood. A lack of livelihood options tends to lead to conflicts among coastal communities because of overexploitation and unsustainable fishing practices. Eventually, it will increase poverty rate, food insecurity, and malnutrition. The marine environment and socioeconomic conditions of coastal communities are also interlinked. Thus, the conflicts between communities occur as a result of inappropriate marine and coastal resources management which cause social instability and could lead to famine.

Causal chain analysis of direct and indirect drivers

Factors underlying unsustainable fishing practices and the decline of living coastal and marine resources can be categorized based on the sector where the problem arises, namely the government sector and the socioeconomic sector. From the government sector, inefficient management of domestic fisheries, institutional arrangements, policies, and legal frameworks for fisheries that have not been fully implemented, minimum coordination, collaboration, harmonization, and cross-jurisdictional management, and inadequate information lead to unsustainable fishing and aquaculture practices and decline of living coastal and marine resources. From a socioeconomic perspective, minimum quantity of infrastructure, finance, and human resources as well as lack of effective compliance, law enforcement and limited monitoring and supervision in managing the area make fisheries unsustainable. Adverse incentives and harmful subsidies can trigger excess capacity and excessive fishing, especially for large-scale fleets, and it can decrease living coastal and marine resources.

Key priorities, gaps, potential indicators

In addressing unsustainable fishing and aquaculture practices and the decline of living coastal and marine resources issues, the key priorities are effective and non-overlapping legal and institutional frameworks at all levels and community-based and

multistakeholder participatory planning. Moreover, the government must be strong with effective decentralization, and environmental awareness and responsibility need to be increased. The development model must be based on sustained and consistent effort and should be both environmentally and economically sustainable.
The gaps in unsustainable fishing and aquaculture practices include a lack of enforcement and incentives for improving fishery-based socioeconomic and environmental performance, inadequate integration of coastal and marine spatial planning, and a lack of appreciation and valuation of ecosystem services (in decision-making).

Moreover, potential indicators are measures that can be used to track progress toward achieving desired outcomes or goals and may include species-specific data (example CPUE), stock assessments, and information for evidence-based and ecosystem-based fisheries management.

4.2.2 Degradation and loss of coastal and marine habitats

<table>
<tr><th colspan="2">PEC 2: Degradation and loss of marine habitats)</th></tr>
<tr><td colspan="2">SECTORS – coastal development, agriculture, aquaculture, fisheries, industry, mining, marine tourism.</td></tr>
<tr><td colspan="2">HABITATS – coral reefs, seagrasses, mangroves, soft sediments and beaches, seamounts, pelagic and demersal.</td></tr>
<tr><th colspan="2">IMPACTS</th></tr>
<tr><td>ENVIRONMENT
• Coastal habitat degradation: loss of critical habitat.
• Decline of ecosystem health and reduction of ecosystem services, marine biodiversity decline.
• Decline of marine living resources and key species including ETP species dependent on these habitats.</td><td>SOCIOECONOMIC
• Reduced fulfilment of food and livelihoods needs.
• Loss of coastal resources (including coastal protection offered by healthy habitats).
• Emigration because of negative effects on livelihoods dependent on marine resources.
• Reduced tourist attraction (loss of potential marine wildlife tourism).</td></tr>
<tr><th colspan="2">IMMEDIATE CAUSES</th></tr>
<tr><td colspan="2">• Progressive development within coastal area (housing, tourism, fuelwood, building materials, urban, industry) disregarding ecosystem sustainability.
• Unregulated coastal habitat and resource use activities such as destructive fishing practices and overfishing predominantly by small-scale fishers.
• Changing land use (aquaculture, palm oil, agriculture, grazing livestock, salt production, mining).
• Increasing shipping and maritime transport (ports, shipping lanes, building materials, road construction).
• Destructive fishing practices.</td></tr>
<tr><th colspan="2">UNDERLYING CAUSES</th></tr>
<tr><td>GOVERNANCE
• Predominantly production-based approach ignoring ecosystem-based management (including MPA, mangrove management).
• Weak regulatory and enforcement capacity.
• Insufficient capacity to use and implement coastal spatial management.
• Limited regulatory capacity at local level to conserve or protect critical habitats.
• Policy focuses on restoration rather than conservation.
• Insufficient environmental impact assessment capacity and implementation for larger-scale development.
• Limited local government capacity in marine habitat management.</td><td>SOCIOECONOMIC
• Insufficient financial support for coastal management effort by local communities.
• Insufficient education effort in environment public awareness.
• Inadequate capacity development effort for conservation skills of coastal community.</td></tr>
<tr><th colspan="2">ROOT CAUSES</th></tr>
</table>

GOVERNANCE	SOCIOECONOMIC
• Short term development policy does not require incorporation of long-term considerations for environmental sustainability and maintenance of integrity of ecosystem services. • Policy and responsibility overlap between institutions. • Divergence in planning and executing of adaptive management at all levels (e.g. conservation zoning and fisheries zoning not synchronized). • Legal uncertainty over resource use, development, and protection. • Insufficient government understanding of ecosystem services.	• Short-term demand for livelihoods and services of natural resource exploitation. • High dependency on coastal resources for national food security and livelihoods. • High coastal population and anthropogenic stressors.

Description of the problem and transboundary issues

The primary issues causing the degradation and loss of marine habitats are the high level of development in coastal areas, the ongoing practice of IUU fishing, the introduction and spread of alien and invasive species, and the worsening phenomenon of climate change. Uncontrolled development in coastal areas is one of the causes of habitat destruction, such as mangroves, coral reefs, and seagrass. The need for land for activities such as housing development, aquaculture, mining, agriculture, and livestock farming is one of the drivers of habitat conversion in coastal areas that have already experienced degradation. Land-use conversion also underlies the increasing demand for materials and resources taken from natural areas around the coast, such as the harvesting of wood from mangroves and limestones from coral reefs. The high level of anthropogenic activity required to meet the demand for food and building materials has resulted in a decline in fish populations and other marine biota. In an effort to meet these needs, IUU fishing activities still occur, directly impacting the decline of economically valuable fish and the degradation of water quality and coral reef habitats, which is further worsened by climate change.

Impacts on ecosystem services and human well-being

The problems that occur can be categorized into two parts: problems that impact the environment and problems that impact the socioeconomic conditions of the surrounding communities. From an environmental perspective, it can be summarized that the degradation of habitats and biodiversity is caused by both anthropogenic and natural factors. The increasing degradation of critical habitats, such as mangroves, seagrass, and coral reefs, leads to a decline, even to the loss of ecosystem services that have been provided by these critical habitats. This problem is like a domino effect that brings up other issues to the surface, with the loss of functions such as the ability of these habitats to act as carbon pools and services that directly impact the sustainability of marine biota, such as feeding zones and breeding and nursery grounds.

Anthropogenic activities have become drivers that further exacerbate the situation, where efforts to meet economic needs through development activities and overfishing are not properly managed. Land-use conversion eliminates the coastal area’s ability to retain sediment and nutrient inputs, which further triggers a decline in environmental quality. These environmental problems underlie the socioeconomic problems that occur. These include the increasing difficulty in fulfilling the basic needs of the community, including food and daily necessities, which depend on natural resources. Ecosystem degradation leads to the loss of tourism potential and other related job sectors, making it harder for the local community to find employment.

Causal chain analysis of direct and indirect drivers

In simpler terms, the indirect factors underlying the emergence of the primary issue can be categorized based on the sector where the problem arises, namely the government sector and the socioeconomic sector. Uncontrolled development of infrastructure and economy in coastal areas, as well as the lack of ecosystem-based management and other integrated management or holistic principles, led to preventive and mitigation efforts against the introduction of alien species and the negative impact of climate change. From the socioeconomic sector, minimum financial support for the local community's efforts to manage their area and the inadequate education and awareness-raising efforts on environmental issues have led to the continued exploitation of coastal resources, threatening sustainability.

Key priorities, gaps, potential indicators

The fundamental issue that needs to be addressed regarding degradation and loss of marine habitats is the very strong anthropogenic pressure caused by the high level of dependence on coastal resources for food, housing, and infrastructure needs. Environmental damage that occurs alongside the worsening impacts of climate change requires adaptive management that determines how to mitigate and adapt to ongoing problems, with the clear target to reduce these. Legal certainty is needed to improve the current situation, as overlapping policies between institutions will only worsen the situation and provide a guarantee of failure long before any management project can be implemented. Increasing the capacity of stakeholders related to understanding ecosystem services is needed to create integrated ecosystem-based management that is increasingly efficient and effective.

4.2.3 Marine and land-based pollution

<table>
<tr><th colspan="2">PEC 3: Marine and land-based pollution</th></tr>
<tr><td colspan="2">SECTORS – industries, maritime transport, agriculture and forestry, mining, tourism, and recreation, offshore energy, fisheries and aquaculture, urbanization.</td></tr>
<tr><td colspan="2">CATEGORIES – marine debris and plastics, sediments, sewage, and nutrients, heavy metals and contaminants, oil spills, invasive marine species.</td></tr>
<tr><td colspan="2">IMPACTS</td></tr>
<tr><td>ENVIRONMENT</td><td>SOCIOECONOMIC</td></tr>
<tr><td>● Decline in water quality.
● Decline in environmental quality driven by land-based nutrient sources (e.g. harmful algal blooms (HAB), high coastal turbidity).
● Increased marine contaminant impacts on marine life: acute (toxicity) and chronic (e.g. growth, reproductive health).
● Increased bioaccumulation in the food chain (toxicants, plastics).
● Increased marine debris from multiple sources (land based and marine-based activity) endanger marine life: e.g. ingestion, entanglements in discarded fishing gear.</td><td>● Contaminated seafood, threats to human health.
● Cost of treating illnesses.
● Aesthetic impacts reduced visual amenities, and economic value of coastal areas.
● Reduced marine tourism potential for coastal communities (diving, sport and game fishing, marine wildlife tourism).
● Loss of foreign exchange earnings.
● Cost of environmental clean-up, wildlife rescue.
● Increased monitoring, surveillance, and enforcement costs.</td></tr>
</table>

IMMEDIATE CAUSES	
• Point and non-point land-based sources of nutrients and pollutants (industrial, mining, and urban waste). • Increased flooding (freshwater, pollutants, etc.) and domestic waste, debris, plastics entering the ocean (riverine inputs), sediment loads from soil erosion. • Atmospheric deposition (e.g. greenhouse gases, sulphur dioxide or acid rain, lead, organic chemicals). • Use of antibiotics and chemicals in fishing and aquaculture practices, chemical fertilizers, and pesticides (agricultural runoff). • Marine debris – solid waste from shipping and fishing industries including discarded fishing gears. • Marine fouling, unauthorized discharges, and accidental spillages (marine pests, ballast water, fuel/oil, sewage).	
UNDERLYING CAUSES	
GOVERNANCE	**SOCIOECONOMIC**
• Inadequate waste and wastewater treatment, control, disposal, and management of coastal urban developments. • Inadequate monitoring, regulation, and management of small-scale polluting activities (e.g. artisanal mining, aquaculture, recreation). • Inadequate marine pollution monitoring. • Deficiency in environmental impact assessments. • Insufficient ICM, poor planning and coordination in coastal development. • Criteria for development approvals not well defined including that of licensing potentially polluting activities. • Lack of watershed management.	• Insufficient investment, policies, programs to implement best practices for reducing excess nutrients (from all sources). • Growing and intensive seafood demand (fisheries, aquaculture), maritime transport sectors and growing oil/gas sector. • Insufficient biosecurity and quarantine facilities at ports, and waste disposal facilities (solid waste, including fishing debris). • Limited financial and human resources (particularly at local district, province level). • Improper land use, poor catchment, and agricultural practices.
ROOT CAUSES	
GOVERNANCE	**SOCIOECONOMIC**
• Inadequate, decentralized and intersectoral planning at all levels. • Ineffective translation of political will into implementation. • Low priority given to environment and habitat conservation. • Insufficient appreciation and valuation of ecosystem services (in decision-making). • Low environmental awareness and responsibility; poor application of precautionary principle, unsustainable development models.	• High proportion of population living in the coastal zone, making it vulnerable to anthropogenic impacts. • Major dependence on maritime shipping, infrastructure and transport, and coastal industries. • National energy security –rapidly growing energy sector, particularly coal, offshore oil/gas. • Generation of export income from production of industrial products that have poorly controlled pollution impacts. • Suboptimal nature of habitual behaviour in waste reduction and disposal.

Description of the problem and transboundary issue

The ISLME region is considered to have one of the worst marine debris problems in the world, with huge volumes of garbage, including plastics, entering the ISLME from both land and sea-based sources on a continuous basis. The decline in water quality and its impact on coastal and marine ecosystems is primarily caused by various human activities that contribute to the release of pollutants into the environment. One of the leading causes of this is inadequate waste and wastewater treatment, control, disposal, and management. Improper land use, minimum catchment, and agricultural practices such as slash-and-burn and deforestation, and lack of watershed management also contribute to this problem. Small-scale polluting activities, such as artisanal mining, aquaculture, and recreation, are not adequately monitored, regulated, or managed. Inadequate implementation of IMO guidelines and rules for ballast water management has resulted in the introduction of marine species and underwater noise. Insufficient compliance, enforcement, monitoring, and surveillance, particularly at the local, district, and province levels, also contribute to this issue. Environmental impact assessments are often inadequate, and adherence to environmental quality standards, such as water quality and habitat degradation, is insufficient. Inadequate marine pollution monitoring, including inadequate assessments, and information for evidence-based management, is another major contributor to the decline in water quality. There is also a lack of standardized and harmonized methodologies and intersectoral and regional data-sharing arrangements. Inadequate implementation of zoning plans under the Zonation Plan for Coastal Provinces, including Small Islands and largely unregulated coastal urban and tourism development, also contribute to the problem.

Very limited quantity of investment, policies, and programmes to implement best practices for reducing excess nutrients from all sources is a significant contributing factor to the decline in water quality. These best practices include capturing and treating wastewater, controlling agricultural runoff, and implementing smart and sustainable development practices. The growing and intensive seafood industries, including fisheries and aquaculture, as well as the maritime transport and oil and gas sectors, also contribute to this issue. The growth of these industries increases the demand for resources and energy and generates significant waste and pollution. Harmful subsidies, particularly in the fisheries, oil and gas, and agriculture sectors, also contribute to the decline in water quality. Inadequate incentives for improving socioeconomic and environmental performance further exacerbate this issue.

The lack of biosecurity and quarantine facilities at ports and inadequate waste disposal facilities, including waste and fishing debris, also contribute to the problem. The limited financial and human resources, particularly at the local district and province levels, further exacerbate the issue. To address these issues, there is a need for increased investment, policies, and programmes that promote best practices for reducing excess nutrients and improving sustainable practices of waste reduction in all sectors. There is also a need to promote sustainable growth in the seafood, maritime transport, and oil and gas sectors while reducing pollution from these sectors.

Collaborative action should be led by the government to make it more interactive. It is expected that it will capture all conceptual frameworks of how the government agencies are engaged in the operational parts of the marine-based pollution issues and how the government considers this marine pollution become part of its plan and efforts (Viana, 2021). According to Viana (2021) “the government plan is part of an instrument which links these ideas to the action on the ground, and can also assist the implementation of policies, regulations and financial.” Therefore, there needs to be a holistic approach to ensure the interactive governance to reduce marine and land-based pollution. This is basically to ensure the coastal environmental integrity and socio-economic viability is harmonized and exercised (Viana, 2021). However, coastal people have low awareness to manage their own pollution at household level. Insufficient education and knowledge also largely contribute to poor waste management. This is part of the key challenge impeding the implementation of the laws and regulations in Timor-Leste and also in Indonesia.

Impacts on ecosystem services and human well-being

The impact of environmental degradation through pollution on coastal communities has been well documented. The effects can be seen in increased poverty, food insecurity, and malnutrition, particularly in local coastal communities. This is a direct result of the negative impacts on subsistence coastal communities, reef gleaning (especially by women and children), traditional harvesting, and culture/customary practices. With the loss of livelihood and cash income, particularly for small-scale fishers, local fishers, aquaculture farmers, and marine tour operators, the community is also experiencing increased operational costs to fish further offshore. In addition, the loss of fishing grounds because of local fish stocks moving or declining has resulted in a loss of foreign exchange earnings and a reduced value of seafood products. This is compounded by the threat of contaminated seafood, which poses a significant risk to human health. The reduced potential for marine tourism, including diving, sport and game fishing, and marine wildlife tourism, also had a profound impact on coastal communities.

As a result, there has been emigration from rural coastal communities, particularly among males and youth. The cost of environmental cleanup and wildlife rescue, as well as treating illnesses, has also placed a significant burden on these communities. The increased monitoring, surveillance, and enforcement costs have further exacerbated the issue, and the aesthetic impacts have resulted in a reduced visual amenity and economic value of coastal areas. Therefore, the impact of environmental degradation on coastal communities cannot be overstated. The effects are far-reaching and profound, and they are likely to continue unless urgent action is taken. This includes a concerted effort to address the root causes of environmental degradation, including unsustainable fishing practices, pollution, and climate change, as well as providing support to affected communities to help them rebuild their livelihoods and protect their natural resources.

The decline in water quality also has a significant impact on coastal and marine ecosystems. This decline has resulted in a decrease in environmental quality, including harmful algal blooms, where the water contains little to no oxygen, making it uninhabitable for most marine life. Additionally, increased marine debris has a significant impact on marine life, with ingestion of and entanglement in discarded fishing gear causing harm to many species. The increased presence of marine contaminants also has a severe impact on marine life. These contaminants can cause acute toxicity and chronic issues, such as growth and reproductive health problems. These contaminants can also accumulate in the food chain, posing a risk to human health. The degradation and loss of coastal and marine habitats, including coral reefs, seagrasses, mangroves, and soft sediments, have further exacerbated the issue.

The introduction and spread of marine species and diseases have also impacted the marine ecosystem, posing a threat to biodiversity and fisheries productivity. The decline in marine biodiversity, populations, and species diversity, including ETP species, has further added to the issue. Reduced fisheries productivity has also resulted from the decline in water quality, with overfishing and habitat destruction causing many species to become endangered or extinct. The effects of this can be seen in the declining fish catch, which has a severe impact on the livelihood of people who depend on fishing for their income.

Urgent action is needed to address the root causes of this decline, especially with the focus on pollution. This includes measures to protect and restore coastal and marine habitats, reduce the impact of marine debris and contaminants, and promote sustainable fishing practices to ensure that fisheries remain productive and that the communities that depend on them can thrive.

In Timor-Leste, marine and land-based pollution is another issue that can reduce water quality, together with destructive fishing including hazardous substance that greatly impacts marine biodiversity. These activities have huge implications for society and the economy and human well-being because of the fact that pollution also contributes to fish stock degradation and loss of potential in ecotourism which is strongly related to job opportunities and income generation as well as nutritional security.

Causal chain analysis of direct and indirect drivers

Urban expansion and industrialization have resulted in coastal pollution from domestic, mining, and other industrial wastes in the ISLME. Various forms of land-based runoff and discharges, including untreated sewage and huge amounts of garbage, are generated from ever-expanding urban centres, tourism areas, and coastal industries. Microbiological pollution and eutrophication because of inadequate sewage disposal and treatment are severe around urban centres throughout the ISLME region. Solid waste is a severe problem locally, particularly in the Java Sea and around the cities, towns, and villages where waste management is inadequate.

Inadequate waste collection and treatment infrastructure at the local level leads to higher rates of waterways leakage and have negative impacts on health and competitiveness. More than half of 65 million tonnes of domestic solid waste in Indonesia remain uncollected per year, being burned, dumped, or entering waterways and the ocean. More than 70 percent of local disposal cells and treatment facilities experience operational challenges within a few years of being handed over to the government. Currently, recycling is still a largely informal sector capturing only 7.5 percent of national waste, and the level of private sector investments in the recycling industry is low. The government's commitment to reduce marine debris (a major detractor for tourism) by 70 percent by 2025 might face challenges from insufficient investment in solid waste management collection (this requires about USD 5 billion) in addition to the lack of enabling legal frameworks and policies such as producer responsibility schemes. Successful solid waste management offers the potential for greenhouse gas mitigation and energy generation.

Key priorities, gaps, potential indicators

Effective waste management in the ISLME region is essential and must be addressed as a priority to support government goals in 2025 which include 70 percent reduced of leak waste to the ocean. With increasing population and urbanization, the proper handling and disposal of waste become crucial to prevent environmental pollution, safeguard public health, and ensure sustainable development in the ISLME region. Key priorities should start with addressing the insufficient or ineffective legal bases, or generating better compliance with existing laws. Furthermore, there is a need to provide more or sufficient funding for waste management, increasing significantly the amount of waste properly managed or disposed of, and this will mean investments in increasing the capacity or number of waste disposal facilities. Aside from these policies, legal, and investment interventions, increasing community or consumer awareness is another necessity.

Industry sectors are also key targets for interventions, but also marine tourism, marine transport or shipping, and the fisheries sector.

In addition, based on the discussion from the TDA ISLME National Stakeholders Consultation, marine debris significantly affects marine species and is causing environmental destruction in several areas in the ISLME, which are coupled with socioeconomic effects. For example, in East Nusa Tenggara, marine debris has caused seaweed and pearl farmers to change jobs because of polluted waters that prevent farming. In FMA 715, marine debris from tourism activities and ineffective waste handling from the fishing fleet (e.g. ferry and transportation vessels) is frequently reported, and this is exacerbated because there is no waste management available in this area.

4.2.4 Decline and loss of biodiversity and key marine species

PEC 4: Decline of biodiversity and key species

SECTORS – fisheries, marine tourism, maritime transport.

CATEGORIES – coral reefs, sharks and rays, sea turtles, whales and dolphins, dugongs, crocodiles.

IMPACTS

ENVIRONMENT

- Decline in marine biodiversity and species diversity, including high-value fish, invertebrates, sharks and rays, pelagic fish, coral species, marine mammals, and marine reptiles.
- Decline and loss of critical habitat of key marine species.
- Human and vessel disturbance to marine wildlife, affecting behaviour, feeding, nursing, and reproduction.
- Negative impacts on the health and function of marine ecosystems because of the loss of higher-order predators and the spread of introduced marine species (displacing native species).
- Introduction and spread of marine pests, diseases [shipping ballast water, aquaculture introductions and escapes].
- Contamination of seafood by various industrial, agriculture, and aquaculture pollutants.

SOCIOECONOMIC

- Negative impacts on local coastal communities including increased poverty, food insecurity, displacement of fishermen, loss of livelihoods and employment, and decline in economic status.
- Loss of cultural totems and traditions (turtles in Bali, crocodiles in TL), including traditional harvesting and hunting, and the decline and loss of existing and potential marine ecotourism assets and value.
- Illegal activities, including transboundary fishing and illegal wildlife trade (shark fin, turtles shell, manta ray gills, dugong tusks).
- Impacts on human health (eating contaminated seafood).
- Human-crocodile conflicts in certain areas (Timor-Leste).

IMMEDIATE CAUSES

- Unsustainable and destructive fisheries practices (overfishing, bycatch, and IUU fishing).
- Removal of keystone ecosystems species, leading to proliferation of other species.
- Legal and illegal trade of live reef fish, marine aquarium species, and traditional medicines.
- Declining water quality and increasing marine pollution, affecting especially coral ecosystem health.
- Inadequate management of critical habitats and key marine species.

UNDERLYING CAUSES

GOVERNANCE

- Weak regulatory capacity and law enforcement of marine species protection and conservation.
- Limited site-based conservation, critical habitat protection, and waste management.
- Insufficient information about critical habitats.
- Insufficient standardized monitoring, information generation and sharing (e.g. on ITF).
- Difficulties in regulating trade in CITES-listed ETP species.

SOCIOECONOMIC

- Inadequate support for community-based conservation efforts (e.g. LMMA).
- Limited resources and inadequate public awareness of impact of demand and trade in ETP species products.
- High local cultural demand for ETP species resources (e.g. shark fins and turtle eggs).

ROOT CAUSES	
GOVERNANCE	**SOCIOECONOMIC**
• High vulnerability and risk to the coastal zone and marine environment. • Ineffective governance and legal frameworks and weak political will to address biodiversity issues. • Inadequate environmental awareness and unsustainable development. • Archipelagic geography and high population in coastal areas. • Insufficient understanding of the relation between Indonesian Throughflow (ITF) and marine biodiversity.	• High dependency on coastal resources, prevalence of coastal subsistence communities. • Lack of alternative coastal and rural livelihoods. • Pressure for food, employment, and housing in the coastal zone. • High levels of poverty and low levels of education/literacy.

Description of the problem and transboundary issue

The ISLME is one of the most biodiverse regions in the world, home to a rich array of marine species and supporting vital ecosystem services, such as fisheries, tourism, and carbon sequestration. However, the region is facing a growing crisis of declining biodiversity, especially endangered, threatened and protected marine animals. This problem is caused by a combination of factors, including unsustainable and destructive fisheries practices, the legal and illegal trade of marine species, declining water quality, increasing marine pollution, and the degradation and loss of critical habitats of key marine species.

One of the primary drivers of the decline in biodiversity in the ISLME region is unsustainable and destructive fisheries practices. Overfishing, bycatch, and illegal, unreported, and unregulated fishing are putting significant pressure on the region's marine ecosystems and the species that depend on them primarily in FMA 712. This leads to declining fish stocks, a loss of biodiversity, and a decline in the quality of marine ecosystems.

Another factor contributing to this problem is the legal and illegal trade of live reef food, marine aquarium species, and traditional medicines. The extraction and trade of these species are often unsustainable and unregulated, leading to the overexploitation and depletion of these marine resources. This threatens the biodiversity of the region, especially marine animals categorized as endangered, threatened and protected.

Declining water quality and increasing marine pollution also pose a significant threat to the health of the ISLME. Pollution from land-based sources, such as agricultural runoff and urban development, leads to nutrient enrichment, algal blooms, and other harmful effects on marine ecosystems. This, in turn, affects the species that depend on these ecosystems and contributes to a decline in biodiversity.

The degradation and loss of critical habitats of key marine species, such as coral reefs, seagrass beds, and mangroves, are also contributing to the decline in biodiversity. Human activities such as coastal development, pollution, and climate change are putting these habitats at risk, and this is affecting the species that depend on them. This loss of biodiversity has transboundary implications, as many of these species are migratory, and the ecosystems are shared with neighbouring countries.

Impacts on ecosystem services and human well-being

The decline in biodiversity and key marine species in the ISLME have significant environmental and socioeconomic impacts. The decline in marine biodiversity and species diversity, including high-value fish, invertebrates, sharks and rays, pelagic fish, coral species, marine mammals, and marine reptiles, has a significant impact on the ecosystem's health and function. The loss of these key species can lead to the decline of ecosystem structure, and this, in turn, has consequences for ecosystem services, such as fisheries, carbon sequestration, and nutrient cycling. The decline and loss of critical habitats of key marine species further exacerbate this problem, as many of these habitats are essential for breeding, feeding, and other critical life cycle stages. Moreover, human and vessel disturbance to marine wildlife negatively affects the behaviour, feeding, nursing, and reproduction of marine species, leading to a further decline in their populations. The loss of higher-order predators, such as sharks and rays, also has negative impacts on the health and function of marine ecosystems.

Local coastal communities are often the most affected, with increased poverty, food insecurity, displacement of fishermen, loss of livelihoods and employment, and decline in economic status. The loss of these marine resources affects the income and food security of these communities who rely on fisheries and related activities for their subsistence and livelihoods. Moreover, the decline and loss of existing and potential marine ecotourism assets and value affect not only the economic status of coastal communities, but also the overall economy of the region. The loss of cultural totems and traditions, such as the turtles in Bali and crocodiles in Timor-Leste, also affects the identity and heritage of these communities. Furthermore, illegal activities, including transboundary fishing and illegal wildlife trade, threaten the sustainability of marine ecosystems and further exacerbate the decline in biodiversity and endangered, threatened, and protected species. These activities can also have transboundary implications, affecting the sustainability of marine resources and the well-being of communities in neighbouring countries.

Causal chain analysis of direct and indirect drivers

One of the major challenges facing marine ecosystems is ineffective governance and management of marine species protection and conservation. This includes inadequate engagement between local and national agencies, inadequate registration and licensing of small-scale fishers, and inadequate management of marine protected areas. This inadequate coordination and oversight can lead to unsustainable fishing practices and the overexploitation of marine resources, resulting in the loss of biodiversity and key species. Insufficient site-based conservation, critical habitat protection, and waste management pose significant threats to marine ecosystems. Ineffective marine pollution control, coastal development challenges, and destructive fishing practices can cause habitat degradation, leading to the loss of important ecological functions and services. Without proper waste management, marine debris and pollution can harm marine wildlife, leading to further declines in biodiversity. Furthermore, the inadequate implementation of ecosystem-based approaches to fisheries and aquaculture, the lack of regular and standardized monitoring, and inadequate environmental impact assessments exacerbate the impact of human activities on marine ecosystems. These factors can contribute to overfishing and the degradation of marine habitats, leading to a loss of biodiversity and key species.

Unsustainable marine tourism, non-transparent development approvals, and insufficient adherence to environmental quality standards also threaten marine ecosystems. Uncontrolled tourism activities can damage marine habitats and impact marine wildlife, leading to further declines in biodiversity and the loss of important ecological services.

Several factors contribute as key drivers of decline and loss of biodiversity and key marine species, both directly and indirectly. These include insufficient support for community-based conservation efforts and inadequate public awareness and education about the importance of biodiversity conservation. Despite the efforts of local communities to protect their natural resources, their initiatives are often hindered by limited resources and inadequate public awareness. Community-based conservation efforts have been recognized as effective tools for biodiversity conservation, as they allow for the active participation of local communities in the management of their natural resources. Public awareness campaigns and educational initiatives are essential to raising awareness about the critical need to conserve biodiversity and the benefits that can be derived from sustainable resource management practices.

Key priorities, gaps, potential indicators

Governance

Biodiversity and key marine species face significant challenges because of a range of anthropogenic activities and climate change. Several key governance points need to be addressed to prevent loss of biodiversity and key marine species:

1. High vulnerability and risk to the coastal zone and marine environment are crucial issues. The coastal zone and marine environment are highly vulnerable to the impact of human activities and climate change. The coastal zone is characterized by high population densities and rapid urbanization, which has led to significant land-use changes and pollution. The marine environment is also facing significant challenges because of overfishing, destructive fishing practices, and pollution. These activities have contributed to the decline and loss of biodiversity and key marine species, which have important ecological and economic impacts.
2. Deficient governance and ineffective legal frameworks are major challenges that need to be addressed to prevent further degradation of the coastal zone and marine environment. Ineffective governance has led to a range of issues, such as illegal fishing primarily in FMA 712, insufficient enforcement of environmental regulations, and inadequate coastal zone management. This has contributed to the decline and loss of biodiversity and key marine species. Therefore, effective governance and legal frameworks need to be established to address these challenges. This includes strengthening regulations and enforcement mechanisms, establishing effective coastal zone management, and promoting sustainable development practices.
3. Low environmental awareness and unsustainable development are also major challenges that need to be addressed to prevent further degradation of the coastal zone and marine environment. Low environmental awareness has contributed to insufficient action on the part of the public, private sector, and government agencies to address environmental issues. Unsustainable development practices, such as rapid urbanization, overfishing, and pollution, have also contributed to the decline and loss of biodiversity and key marine species. Therefore, efforts need to

be made to raise environmental awareness and promote sustainable development practice.

4. The archipelagic geography and large population in coastal areas present unique challenges that need to be addressed to prevent further degradation of the coastal zone and marine environment. The archipelagic geography of the region presents challenges, such as limited access to the ocean, which can lead to overfishing and destructive fishing practices. The large population in coastal areas has led to significant land-use changes and pollution, which have contributed to the decline and loss of biodiversity and key marine species. Therefore, efforts need to be made to address these challenges by promoting sustainable coastal zone management practices, establishing effective regulations and enforcement mechanisms, and promoting sustainable development practices, ideally through adherence to the principles of the ecosystem approach.

Socioeconomic

Coastal communities rely heavily on marine resources for food, income, and employment. This high dependency on coastal resources has contributed to the decline of key marine species. It is essential to promote sustainable practices to ensure the long-term availability of these resources. Several socioeconomic issues must be tackled to stop the continued decline of biodiversity and important marine species.

1. Coastal subsistence communities are particularly vulnerable to the impact of climate change and environmental degradation. These communities often have insufficient access to basic services, such as education, healthcare, and clean water. They also rely on traditional knowledge and practices to exploit natural resources, which may not always be sustainable. Therefore, it is important to involve these communities in conservation efforts and promote alternative livelihoods that are less dependent on natural resources.
2. The increasing demand for food, employment, and housing in coastal zones has put additional pressure on natural resources. This has led to the expansion of human activities into sensitive coastal habitats, such as mangroves, wetlands, and coral reefs, resulting in habitat destruction and loss of biodiversity. Therefore, it is important to balance the needs of human development with the conservation of natural resources to ensure the sustainability of coastal ecosystems.
3. High levels of poverty and low levels of education and literacy often result in unsustainable practices and the overexploitation of natural resources. This is particularly true for coastal communities where poverty and inadequate education can lead to overfishing, destructive fishing practices, and pollution. It is essential to promote education and awareness-raising activities that encourage sustainable practices and conservation efforts.

Biodiversity and key marine species face significant challenges that need to be addressed to prevent further degradation and loss. The key governance and socioeconomic points identified include high vulnerability and risk to the coastal zone and marine environment, governance in need of improvement, and ineffective legal frameworks, low environmental awareness and unsustainable development, archipelagic geography, and large population in coastal areas. Addressing these challenges will require a coordinated effort from all stakeholders, including government agencies, the private sector, and the public. Therefore, it is essential to establish effective governance and legal frameworks, raise environmental awareness, promote sustainable development practices, and ensure the sustainable management of the coastal zone and marine environment.

4.2.5 Impacts of climate change

PEC 5: Climate change impacts	
SECTORS – Energy, agriculture, mining, industry, maritime transport, aquaculture, fisheries, marine tourism.	
CATEGORIES - sea level rise, ocean warming, ocean acidification, oceanographic change, seasonal variability, storms, and storm surges.	
IMPACTS	
ENVIRONMENT	**SOCIOECONOMIC**
● Coastal degradation and islands sinking: loss of habitats, wetlands, beaches, and coral reefs, leading to impacts on biodiversity, fisheries, and critical habitats. ● Increased riverine flooding and landslides because of deforestation and poor catchment area practices. ● Reduced freshwater resources: increased saltwater intrusion, salinization, and flooding leading to loss of freshwater resources. ● Climate-driven temperature changes: altered marine fauna and flora distribution, temperature-dependent sex determination (altered sex ratio fish and reptile), and reduced ocean productivity (algal blooms). ● Ocean warming related shifts in distribution of fish populations and on growth and productivity of fish; also, acute events of coral bleaching. ● Impacts on shellfish populations: decline and loss because of ocean acidification.	● Economic impacts: Loss of foreign exchange and domestic earnings from seafood and tourism because of effect on fish resources and key marine habitats. ● Increased operational costs for fishing in increasingly distant fishing grounds. ● Impacts on local coastal communities: increased poverty, food insecurity, malnutrition, loss of livelihoods, employment, emigration, and cash income. ● Negative impacts on traditional practices and culture. ● Inundation and flooding leading to damage and loss of infrastructure and access: affecting coastal settlements, roads, agricultural land, and transportation infrastructure. ● Impacts on coastal agricultural and aquaculture production. ● Increased risks and dangers for fishermen: decreased fishing time, unpredictable weather, and sea safety concerns leading to increased maritime accidents. ● Increased water and food insecurity: loss of freshwater resources and increased reliance on fishing during drought, as well as increased costs for accessing food and water on remote, small islands.
IMMEDIATE CAUSES	
● Insufficient implementation of climate-smart, low-carbon, and climate-resilient approaches as well as EAFM. ● Climate variability (increased temperature and temperature variability, greater heat stress, prolonged droughts). ● Changes in precipitation patterns (more intense rainfall events, riverine flooding, and droughts). ● Extreme weather events (increased frequency and intensity of extreme weather events; strong winds, storms, storm surges, and cyclones). ● Changes in ocean conditions (ocean warming; increase SST, hypoxia, change in oceanographic processes). ● Ocean acidification and sea level rise (increasing coastal inundation, saltwater intrusion, reduced calcification.	

UNDERLYING CAUSES	
GOVERNANCE	**SOCIOECONOMIC**

● Inadequate protection and governance of marine habitats. ● Inadequate climate risk monitoring, predictive modelling, and adaptation planning. ● Insufficient integration of climate change in fisheries and habitat management planning. ● Loss of seagrass, mangroves and other forests leading to decline in natural carbon storage. ● Inadequate research and dissemination of information on greenhouse gases and other climate related issues.	● High coastal population density, with high vulnerability and limited adaptive capacity to cope with climate change impacts. ● Reduced climate change resilience of coastal ecosystems. ● Harmful incentives and poorly targeted subsidies encourage development that is vulnerable to climate variability. ● Insufficient support for nature-based climate solutions and incentives (e.g. mangrove/seagrass conservation and restoration). ● Limited investment, market instruments, and incentives for renewable energy. ● Limited financial and human resources available
ROOT CAUSES	
GOVERNANCE	**SOCIOECONOMIC**
● Archipelagic geography challenges (e.g. insufficient mangrove conservation and general habitat management). ● Ineffective governance and legal frameworks. ● Insufficient implementation of coordinated inter-sectoral planning (e.g. One Stop Services). ● Modest environmental awareness, appreciation, and responsibility. ● Global threat of increased carbon emission which is not controlled.	● High dependency on coastal resources. ● Economic development and revenue maximization prioritized over sustainability. ● Population growth and pressure for resources. ● Limited infrastructure and economic diversification. ● Global and national phenomena (e.g. increase of greenhouse gases emissions and deforestation).

Description of the problem and transboundary issue

Climate variability (rise of temperature, greater heat stress, prolonged droughts)

Climate variability has become increasingly significant in the ISLME in recent times. The region has been affected by rising temperatures and extended droughts that have impacted agriculture, water resources, and human health. Heat stress also leads to reduced productivity and work capacity, which can cause personal financial hardship and have large-scale economic consequences. A report by the Indonesian MoEF showed that the Indonesia average temperature has risen by 0.3 °C to 0.6 °C over the last century and is expected to increase by 1.0 °C to 2.5 °C by the end of the century. In Timor-Leste, increase in temperature is projected to be in the range of 0.5 °C–1.1 °C. Meanwhile, sea level has risen near Timor-Leste by about 9 mm per year since 1993 larger than the global average of 2.8 mm to 3.6 mm per year (PACCSAP, 2015). Climate variability also poses a threat to the ISLME's biodiversity and ecosystem services, with 50 percent of total biodiversity at risk and 80 percent of its coral reefs in a critical condition because of warming sea surface temperatures. Coral reefs were reported to have been lost primarily because of coral bleaching in response to high sea surface temperatures. Based on Gusviga *et al*. (2021), there are several regions influenced by global warming including East Nusa Tenggara, West Sumatera, and Java Seas.

Several phenomena will occur in the future for both countries including: annual mean temperatures and extremely high daily temperatures will continue to rise, increase in average temperatures will also result in a rise in the number of hot days and warm nights, and a decline in cooler weather. There is a range of projections of average annual rainfall, from a decrease to increase, but with more extreme rain, ocean acidification is expected to continue and the risk of coral bleaching is expected to increase. Timor-Leste is expected to experience a continuous increase in mean sea levels during the twenty-first century. According to the CMIP5 models, by the year 2030, all RCP emission pathways indicate comparable rises, with projected elevations ranging from 80 mm to 180 mm. Meanwhile, Timor-Leste may experience two main types of droughts: meteorological drought, which is typically linked to a shortage of precipitation, and hydrological drought, which arises from a deficit in surface and subsurface water flow, often stemming from the broader river basins in the region. Although there are limited records of documented drought events prior to Timor-Leste's independence, it is widely regarded anecdotally as a recurring phenomenon in the area. In Indonesia, the prospect of more frequent and severe droughts looms large as the association between accentuated drought and El Niño events becomes increasingly evident. Moreover, the exacerbating impacts of global warming are projected to intensify both the frequency and strength of these El Niño occurrences. Indonesia, being an archipelagic nation with diverse ecosystems, is particularly vulnerable to the adverse effects of changing climate patterns and extreme weather events. At present, Indonesia faces an annual median probability of severe meteorological drought of about 4 percent, as defined by a standardized precipitation evaporation index (SPEI) of less than −2.

Droughts, which can encompass both meteorological and hydrological aspects, pose significant challenges to the country's agriculture, water resources, ecosystems, and overall socioeconomic well-being. The link between El Niño events and heightened drought conditions in Indonesia has been well-documented. El Niño, characterized by the periodic warming of sea surface temperatures in the central and eastern equatorial Pacific Ocean, has historically disrupted weather patterns globally. In Indonesia, it often leads to reduced rainfall, prolonged dry spells, and water scarcity, escalating the risk of drought impacts. (Nauman *et al*., 2018).

Change in precipitation pattern (more intense rainfall events, riverine flooding, and droughts)

Changes in precipitation patterns brought about by climate change have led to more frequent and heavy rainfall events, riverine flooding, and droughts. These changes have had significant impacts on agriculture, water resources, and human health. Meanwhile, the region’s weather and seasonal changes are marked by an increase in rainfall. Rainfall has a significant impact on human quality of life, such as the availability of water resources for consumption and agricultural needs.

The majority of disasters in Indonesia during 2016 were hydrometeorological in nature, with floods, landslides, and tornadoes (*puting beliung*) being the main causes. These disasters are often the result of increased rainfall, which is one of the impacts of climate change. The IPCC (2007a) has also noted that changes in rainfall patterns are a global phenomenon with far-reaching effects. Indonesia has experienced a rise in precipitation intensity, particularly in the central and western parts of the country, over the past few decades. This has resulted in more frequent and severe flooding, which has caused significant harm to infrastructure, agriculture, and communities.

The changing rainfall pattern has also led to droughts in certain regions, particularly in the eastern part of Indonesia. According to Oktari *et al.* (2022), the incidence and severity of droughts have notably increased in recent years, especially in the eastern region. This has resulted in crop failures, water scarcities, forest fires, and heightened tensions over water resources. The Indonesian MoEF has reported that rainfall pattern changes have brought wetter weather to Sumatra and Kalimantan while producing drier seasons in Java, Bali, and Nusa Tenggara. In East Nusa Tenggara, a study by Trenberth (2011) discovered that climate change has affected precipitation patterns, resulting in more recurrent and severe droughts. This has led to a reduction in agricultural productivity and an increase in forest fires, which have considerable ecological and economic impacts. Similar effects can be expected in Timor-Leste.

Changes in rainfall patterns because of climate change can increase the risk of droughts and floods in Indonesia. The study projected that high-emission scenarios could result in up to a 200 percent increase in riverine flooding events by the end of the century. This emphasizes the importance of taking urgent measures to reduce greenhouse gas emissions and implementing adaptation measures to address the impacts of climate change, especially in vulnerable coastal areas. The decrease in rainfall during critical times can heighten the risk of drought, and increased rainfall during already wet periods may cause flooding. Thus, it is crucial to address climate change to reduce the occurrence and magnitude of hydrometeorological disasters.

Extreme weather events (strong winds, storms, storm surges, and cyclones)

The ISLME is considered one of the regions that are highly vulnerable to natural disasters, particularly extreme weather events including strong winds, storms, storm surges, and cyclones. These occurrences have caused immense destruction to various structures, such as infrastructure, homes, and crops, as well as resulted in the loss of many lives. Among these extreme weather events, cyclones are regarded as one of the most severe in Indonesia, though not so common in the ISLME area. Cyclones usually occur at sea and bring about heavy rainfall, strong winds, high waves, and ocean surges, causing extensive damage and casualties.

There is an increase in frequency and intensity of cyclones in the ISLME in recent decades, particularly in the eastern part of the country. There are compounded impacts of cyclones because of factors such as high population density, poverty, and inadequate preparedness. Indonesia is usually affected by strong winds and heavy rainfall because of the movement of tropical cyclones in the southeastern Indian Ocean between January and April and the Eastern Pacific between May and December. The increasing intensity of storms and cyclones will have detrimental effects on shallow tropical waters, particularly intertidal organisms, and lead to scouring of many biota from hard substrates.

Another extreme weather event that has caused significant damage in the ISLME region are storm surges. According to a study conducted by Vitousek *et al*. (2017), the frequency and severity of storm surges are increasing in the coastal areas because of the combined effects of sea-level rise and extreme weather events. The study highlights that inadequate protective measures and early warning systems makes these areas highly vulnerable to storm surges. Furthermore, Indonesia is also prone to cold surges, which are an enhancement of cold air mass moving from Siberia to Asia via the Asian monsoon wind. This phenomenon usually occurs from November to January, resulting in cold temperatures and strong winds in some parts of the ISLME.

Change in ocean conditions (change in oceanographic processes)

Climate change has a significant impact on the ocean conditions and oceanographic processes, which affect the marine ecosystem and the livelihoods of millions of people.

Studies have shown that oceanographic processes, such as upwelling, stratification, and circulation patterns in the Indonesian Seas, have been altered because of climate change, resulting in changes in ocean temperature, salinity, and pH. These changes are affecting the growth and distribution of marine organisms, altering marine biodiversity, bleaching coral reefs, and leading to a decline in coral diversity.

Furthermore, the changes in ocean conditions have led to alterations in the monsoon patterns, which are having a significant impact on the oceanographic processes in the ISLME (Nurrohman *et al*., 2022). The El Niño Southern Oscillation (ENSO) is one of the phenomena affecting the oceanographic conditions, causing more frequent droughts and flooding trends that could lead to decreased food production and increased hunger.
The ISLME's oceanographic conditions are also influenced by monsoon winds, which cause monsoon currents and the ITF, and the mass of water transported by the ITF is affected by ENSO events consisting of normal conditions, El Niño, and La Nina (Anugrah, Samad and Berlianty, 2020).

Ocean acidification and sea level rise

Climate change has a significant impact on the marine ecosystem in the ISLME through ocean acidification and sea level rise. Ocean acidification is defined by the IPCC Workshop on Impacts of Ocean Acidification on Marine Biology and Ecosystems as a long-term reduction in ocean pH caused primarily by the uptake of carbon dioxide from the atmosphere (Tilbrook *et al.*, 2019). This absorption of CO_2 from the atmosphere will increase because of the high concentration of atmospheric CO_2, leading to alterations in the seawater carbonate system and decreased ocean pH. As a result, marine organisms such as coral reefs and shellfish are experiencing negative impacts on their growth and reproduction. The IPCC (2019) report explains that the level of ocean acidification caused by CO_2 associated with global warming of 1.5 °C is expected to exacerbate the harmful effects of warming, which could impact the growth, development, calcification, survival, and abundance of a broad range of species, including algae and fish.

The greenhouse gases that contribute to global warming also have an effect on sea level rise. According to the IPCC (2007a), sea levels are increasing by an average of 2.5 mm annually A study by Barbier (2015) showed that sea level rise was already causing coastal flooding, erosion, and saltwater intrusion in low-lying areas, which endangers the livelihoods of millions of people who depend on coastal resources. Furthermore, sea level rise is worsening the impacts of natural disasters, such as storms and tsunamis, leading to more frequent and severe disasters. Global sea-level rise is currently increasing at nearly 2 mm per year, but in coastal areas of Asia, it is rising at a rate of 1 mm to 3 mm/year (Cruz, 2007). This level of change is expected to lead to significant losses of coastline and marine resources, and put the aquaculture industry and infrastructure, including human habitation, in the region at risk.

Impacts on ecosystem services and human well-being

Climate change has numerous impacts, and its negative effects have a detrimental impact on coastal communities and ecosystems. These impacts encompass the following:

1. Coastal degradation, including the loss of important habitats, such as wetlands, beaches, and coral reefs, has significant impacts on the marine environment. This degradation can lead to changes in the behaviour and biology of marine fauna,

affecting fisheries production and the availability of food for local communities. Furthermore, it has significant effects on marine biodiversity and critical habitats.
2. Climate change also contributes to environmental stresses and can lead to reductions in freshwater resources because of saltwater intrusion and flooding as well as declining shellfish. Additionally, poor watershed management practices and deforestation can increase riverine flooding and landslides, further damaging coastal ecosystems.
3. These impacts have numerous downstream effects on coastal communities, including increased poverty, food insecurity, malnutrition, loss of livelihoods, employment, and emigration, as well as negative impacts on traditional practices and culture. There are also losses of infrastructure and access, including damage to food production, houses, and buildings, as well as transportation infrastructure, such as ports, shipping channels, and roads, and decreased aquaculture production.
4. The economic impacts are also significant, including loss of foreign exchange earnings from seafood and tourism, and increased operational costs for fishing. Lastly, there are increased risks and dangers for fishermen, including decreased fishing time, unpredictable weather, and sea safety concerns leading to increased maritime accidents, as well as increased water and food insecurity because of the loss of freshwater resources and increased reliance on fishing during droughts.

Causal chain analysis of direct and indirect drivers

Climate change has a special position as a priority environmental concern, as it can also be defined as a driver, and at the same time as the underlying cause of a range of negative impacts. It was therefore dealt with in some detail under Section 3.5 and will be addressed again in Section 4.1.3.

Key priorities, gaps, potential indicators

Key priorities represent areas that require attention or action to achieve a desired outcome or goal. Regarding climate change impacts, the key priorities may include reducing greenhouse gas (GHG) emissions, understanding of geographical challenges in the ISLME region (how large coastal and marine areas are to be managed and high levels of human activity), promoting sustainable land-use practices, building resilience to the impacts of climate change, promoting sustainable (and renewable) energy practices, addressing the impacts of climate change on human health, supporting the transition to a low-carbon economy, economic development, where revenue maximization is not prioritized over sustainability.

The gaps may refer to missing or incomplete information or knowledge about specific aspects of climate change and its impacts on the country. The gaps in climate change issues include insufficient data on the impacts of climate change on vulnerable populations, inadequate governance and legal framework, low environmental awareness, appreciation, and responsibility (in decision-making), and limited knowledge of the social and economic impacts of climate change.

Moreover, potential indicators are measures or metrics that can be used to track progress toward achieving desired outcomes or goals. Potential indicators may include measures of greenhouse gas emissions, renewable energy production, the effectiveness of adaptation programmes in reducing vulnerability to climate change, and rate of deforestation.

4.3 Commonalities among root causes

Introduction of commonalities among root causes

Root causes are linked to the underlying social and economic causes and sectoral pressures, but they are often related to fundamental aspects of the macro-economy, demography, consumption patterns, environmental values and access to information and democratic processes. It is important to document them for two reasons:

1. some proposed solutions might be unworkable if the root causes of the problem are overwhelming; and
2. actions taken nearer to the root causes are likelier to have a lasting impact on the problem.

Root causes are often the most difficult to assess – and address. Within each of the above categories, the underlying causes or pressures will link to numerous governance and socioeconomic causes, at scales and levels that may vary significantly from region to region.

The process of determining commonalities in root causes

Table 42 and Table 43 are helpful resources that provide a list of the most common root causes for transboundary issues in the ISLME. They outline the various components and problems they are associated with, along with their frequency of occurrence. By using these tables, it becomes easier to identify the most common reasons for intervention and to develop effective solutions accordingly.

Despite slight differences in wording resulting from the independent development of each causal chain in each of the priority environmental concerns (PEC), there is a considerable overlap among the root causes beyond what the tables show. This means that there may be underlying factors that are not explicitly listed, but still contribute to technical issues in the project. Therefore, it is crucial not to rely solely on the tables and to conduct further research and analysis to fully understand the root causes of transboundary problems in the ISLME.

Prioritization in commonalities among root causes

Root causes can be divided into two categories: governance and socioeconomics. The governance sector’s top five root causes include “Low environmental awareness and responsibility," which underlies the five PECs identified in the ISLME. The second most common root cause is "Ineffective and overlapping legal and institutional frameworks at all levels." In third place is “Uncoordinated and inadequate intersectoral planning at all levels," which is the underlying cause of four PECs. "Archipelagic Geography” comes in fourth place, with similarities in three PECs. Finally, "High anthropogenic stressor'' is the last root cause on the list and its ranking (Table 42 & Table 43). On the other hand, the socioeconomics sector's most frequent root causes include "High proportion of population living in the coastal zone and dependency on coastal resources," which is present in three PECs. The second most common root cause is "Population growth, pressure for food, employment, and housing," and in third place is "High dependency on coastal resources for national food security and livelihoods." The last root cause listed is

"Economic development and revenue maximization (seafood production) prioritized over sustainability."

It is important to note that understanding the root causes of a problem is crucial to developing effective solutions. By identifying the underlying factors and their interrelationships, targeted interventions can be implemented to address the issue at the source. However, identifying root causes can be a complex and challenging task that requires a thorough analysis of various factors and perspectives. Therefore, it is essential to approach the issue holistically and engage with diverse stakeholders to develop sustainable and effective solutions.

Table 42. Commonalities among root causes analysis

No	Governance	PEC					Score
		1	2	3	4	5	
1	Low environmental awareness and responsibility	√	√	√	√	√	5
2	Ineffective and overlapping legal and institutional frameworks at all levels	√	√		√	√	4
3	Disorganized and inadequate intersectoral planning at all levels	√	√	√		√	4
4	Archipelagic geography	√			√	√	3
5	High anthropogenic stressor		√	√	√		3
6	Deficient governance and ineffective decentralization	√					1
7	Unclear property rights, land and maritime tenure	√					1
8	Inadequate political will, low priority for fisheries, cultural practices and traditional preferences	√					1
9	Legal uncertainty		√				1
10	Inadequate political will, low priority to environment and habitat conservation			√			1
Socioeconomics							
1	High proportion of population living in the coastal zone and high dependency on coastal resources	√		√	√		3
2	Population growth, pressure for food, employment, and housing	√			√	√	3
3	High dependency on coastal resources for national food security and livelihoods		√		√	√	3
4	Economics development and revenue maximization prioritized over sustainability	√				√	2
5	Insufficient alternatives for coastal and rural livelihoods	√					1
6	High levels of poverty, low level of education/literacy	√					1
7	National food security, high levels of domestic seafood consumption	√					1
8	Foreign earnings – high demand for seafood export, access to global markets			√			1
9	Fragile nation with limited infrastructure and economic diversification					√	1

Table 43. Ranking among root causes in each sector

Score	Governance
5	Low environmental awareness and responsibility
4	Ineffective and overlapping legal and institutional frameworks at all levels
4	Disorganized and inadequate intersectoral planning at all levels
3	Archipelagic geography
3	High anthropogenic stressor
1	Deficient governance and ineffective decentralization
1	Unclear property rights, land and maritime tenure
1	Inadequate political will, low priority for fisheries, cultural practices and traditional preferences
1	Inadequate uncertainty
1	Inadequate political will, low priority to environment and habitat conservation
Socioeconomics	
3	High proportion of population living in the coastal zone and dependency on coastal resources
3	Population growth, pressure for food, employment, and housing
3	High dependency on coastal resources for national food security and livelihoods
2	Economics development and revenue maximization prioritized over sustainability
1	Insufficient alternatives for coastal and rural livelihoods
1	High levels of poverty, low level of education/literacy
1	National food security, hight levels of domestic seafood consumption
1	Foreign earnings – high demand for seafood export, access to global markets
1	Fragile nation with limited infrastructure and economic diversification

The common root causes that most often in each issue

Table 44 shows a list of the most frequent root causes, along with their associated problems. In the governance sector, there are three root causes that occur in more than three PECs. The root cause of "Low environmental awareness and responsibility" is associated with all PECs in ISLME and is the root causes for several problems that arise in each PEC, including the decline in marine biota and non-target species, deteriorating water and ecosystem quality, the impact on human health, destruction of coastal infrastructure, increasing marine debris, marine pollutant accumulation, invasive species spread, and the loss of critical habitats such as coral habitats.

The root causes of “Ineffective and overlapping legal and institutional frameworks at all levels” are associated with four out of five PEC in ISLME, except for PEC 3, which is marine and land-based pollution. This root cause is the root cause that leads to the decline of marine habitats, including coral habitats, and the loss of critical habitats, which leads to habitat degradation and a decline in highly valuable marine species. This, in turn, results in a loss of coastal revenue and livelihoods, including declines in endangered and key species. Moreover, the contamination of seafood, illegal trade of wildlife species, and changes in marine biota distribution are also observed. The situation is further aggravated by the reduction in primary and secondary marine production, changes in marine fauna behaviour, and increases in riverine flooding.

The final root cause, "Uncoordinated and inadequate inter-sectoral planning at all levels," is present in four PEC except excluding PEC 4 of Decline of biodiversity and key species. This particular root cause is responsible for decreasing fish stocks, worsening water quality, the spread of invasive species, and the degradation of marine habitats. These problems have resulted in the loss of marine biodiversity and ecosystem health, as well as the loss of critical habitats. Additionally, other contributing factors include changes in marine biota distribution, reductions in primary and secondary marine production, changes in marine fauna behaviour and an increase in riverine flooding, which all exacerbate the situation.

Table 44. Most frequent root causes

Root causes	Associated problem	PEC
Low environmental awareness and responsibility	Decline of marine biota, non-target species, in water quality	1
	Decline in ecosystem quality and health status	2
	Human health impact and destruction of coastal infrastructure	2
	Increasing marine debris and marine pollutant accumulation	3
	Decline in ecosystem health	3
	Decline in coral habitat and invasive species spreading	4
	Loss of critical habitats	5
Ineffective and overlapping legal and institutional frameworks at all levels	Declining of marine biota and loss of coastal revenue	1
	Habitat degradation and loss of livelihoods	2
	Decline in coral habitat and in highly economic valuable marine species	4
	Decline in endangered, key species, and loss of critical habitats	4
	Contamination of seafood and illegal trade of wildlife species	4
	Change in marine biota distribution and in marine fauna behaviour	5
	Reduction in primary and secondary marine production	5
	Increases of riverine flooding	5
Disorganized and inadequate intersectoral planning at all levels	Decline in fish stock and in water quality and invasive species spreading	1
	Decline in ecosystem quality and health status	2
	Loss of marine biodiversity	2
	Water quality decline and marine habitat degradation	3
	Marine pollutant accumulation	3
	Decline marine biodiversity and in ecosystem health	3
	Loss of critical habitats and change in marine biota distribution	5
	Reduction in primary and secondary marine production	5
	Change in marine fauna behaviour and increases of riverine flooding	5

4.4 Leverage points to address impacts and causes

As a critical linking step between the TDA and the SAP, a number of leverage points have been identified during TDA development. A leverage point is described as a place within a complex system (such as the ISLME), where a small shift at one point can produce large changes elsewhere. Identifying leverage points identifies where changes can be made in the water system (GEF, 2020).

The TDA development team, and other key stakeholders have reviewed the transboundary problems, and related governance mechanisms, their impacts, and the causal chains for the PEC (GEF, 2020). This work had been started during a regional workshop in September 2021, when for all five PECs, options for interventions that appeared to have a large potential of a broad positive influence on the status of the ISLME, were discussed and listed.

These leverage points were further validated in April 2023 during two national stakeholder workshops as part of the final stage of the TDA development process. The majority of these leverage points can be categorized as potential interventions in the area of management (e.g. supporting or strengthening management activities), whereas others are concerning policy and legal reform or aiming at improving governance. Only relatively few are considered knowledge management interventions that either generate or disseminate information to improve awareness or develop capacity. A smaller number still refers to direct investments, often in combination with other intervention types, such as management measures. This underlines the strong assumption that there is a felt need for improved management (of resources, habitats, and human activities). Improvements in governance (or legal/policy change) are also seen as having a high chance of positive changes in the status of the ISLME. The SAP action planning will need to show if knowledge management and capacity development will also play an important role in changing attitudes and practices (e.g. in resource and habitat use) to bring about improvements in the ecosystem status of the ISLME, noting that low environmental awareness had been identified as an important root cause. This obviously entails that governments need to be ready to inject finance into or provide budget to leverage point-related actions. A listing of the identified leverage points for each PEC is provided in Table 45 to Table 49.

Table 45 addresses the leverage points identified for PEC 1. In order to address unsustainable fishing and aquaculture practices, there is a focus on small-scale fisheries, but also covering commercial fisheries for Indonesia. Strengthening management measures, as well as legal and policy reform, are considered relevant. Capacity development is proposed only in the context of stock assessment (for Timor-Leste) and addressing IUU fishing (as an important regional concern). Knowledge management-related interventions are mainly cited for improving knowledge on rules and regulations, but also for improving the information base for management. Investment-related leverage points are seen as relevant, in particular for improving aquaculture activities.

Table 45. Leverage points identified for priority environmental concern 1

1. Unsustainable fishing and aquaculture practices
Fisheries

1. Support effectiveness and operationalization of fisheries management institutions in FMAs – education and training, integrated data systems (including funding for operationalization) – *Indonesia.*
2. Improve monitoring and legal definition of SSF, traditional harvesting/hunting – see FAO legislative guidance for SSF (2020), USAID Sustainable Ecosystems Advanced (SEA) Project (Raja Ampat) – *Indonesia.*
3. Improve management of SSF – licensing/registration reform, explore and expand rights-based fisheries management (e.g. quota, managed access, territorial-based FMRs) (e.g. Maluku, West Papua) (Halim *et al*. 2019) – *Indonesia.*
4. Strengthen coordination at national and local levels to support co-management of SSF, including local customary management such as *tara bandu* (see Tilley *et al*., 2019) – *Timor-Leste.*
5. Support increased seafood value, value chains and markets, particularly for artisanal fishing and SSF (gear type, fish handling/processing, cold storage).
6. Support implementation of fisheries harvest and control rules in fisheries plans (fishing effort controls, vessel numbers, gear restrictions and modifications and spatiotemporal closures) (e.g. shark fisheries).
7. Improve management of coral reef fisheries and trade, particularly ETP and CITES-listed species (e.g. groupers, wrasses, snappers) – fisheries rules and monitoring, implement overseas export limits (including volume, size of fish), coral reef fisheries management plans, protection of spawning aggregations, electronic catch, documentation and traceability systems (e-CDTs), certification (MSC) (Khasanah *et al*., 2020).
8. Strengthen the implementation of EAFM and integration with MPAs, MSP and law enforcement (see FMA 715, MMAF-USAID, 2018).
9. Reform fisheries licensing and complete registration of all vessels, including SSF sector
10. Improve catch-effort monitoring, species-specific data, stock assessments (e.g. demersal fish, big pelagics).
11. Expand and improve decentralized data collection and data integration – e-log book system (Indonesia) and PeskAAS – Timor-Leste.
12. Develop capacity in fisheries stock assessment, catch monitoring and reporting – *Timor-Leste.*
13. Remove harmful subsidies for fisheries (optional formulation: improve the design and implementation of government support targeting SSF).
14. Promote livelihood enhancements and diversification along the fisheries value chain and alternative livelihoods outside the fisheries value chain for fishers (with emphasis on women to reduce pressure on fishing), particularly in fishing communities and adjacent no-take protected areas (CoastFish).
15. Improve and strengthen socialization and dissemination of new fisheries laws and regulations, particularly to local communities.
16. Harmonize and coordinate Indonesia–Timor-Leste fisheries rules, arrangements in border regions (i.e. Ataúro Island, Batugade, Oecusse, Covalima).
17. Improve and expand catch–effort monitoring and management of SSF – e.g. insights and lessons from PeskAAS (Timor-Leste).
18. Coordinate and improve species-specific data (e.g. CPUE), stock assessments and information for transboundary small and big pelagics and demersal fisheries.
19. Harmonize and finalize fisheries management plans for Timor-Leste–Indonesia border regions including coordinated plans to combat IUU fishing.
20. Strengthen bilateral and regional IUU fishing, surveillance and monitoring and capacity-development under RPOA-IUU (i.e. VMS, Ministry of Marine Affairs and Fisheries-Commonwealth Scientific and Industrial Research Organization (MMAF-CSIRO), Global Fishing Watch, PSMA).

Aquaculture

21. Recognize the distinction between ranching, hatchery-based aquaculture (HBA) and wild capture fisheries (including CBA) in terms of differing objectives and management (i.e. operational, regulatory and administrative), including recognizing juvenile capture as a wild capture fishery – Timor-Leste to focus on lobster catch regulation.
22. Strengthen environmental assessments and develop environmental quality standards for small aquaculture farms (less than 50 ha).
23. Promote integrated multitrophic aquaculture (IMTA), aquaculture of indigenous species (marine, brackishwater).
24. Promote restorative aquaculture (shellfish, seaweed) and silvofisheries.
25. Support for broodstock hatcheries and production of fish-free aquaculture feed – to reduce reliance and impacts on local fish stocks.
26. Strengthen the implementation of EAA and align / harmonize spatial zoning plans for aquaculture with MPAs, MSP (particularly in FMA 573) – *Indonesia.*
27. Improve and strengthen socialization and dissemination of new aquaculture laws and regulations, particularly to local communities.

For PEC 2, there appears to be a balance between leverage points relating to direct management interventions and to legal and policy reform. Additional capacity development is nominated mainly in relation to improved MPA management and increased management effectiveness (Table 46). Some leverage points, e.g. relating to coastal development and protection, or EAFM are likely to require actions that will result in combinations of different task categories, such as knowledge management, capacity development, and investment.

Table 46. Leverage points identified for priority environmental concern 2

2. Degradation and loss of marine habitats

1. Strengthen coordination at national and local levels to support co-management of marine habitats, including protected areas (LMMAs) and local management practices such as *tara bandu* (see Tilley *et al*., 2019) – *Timor-Leste.*
2. Support MPA and LMMA education, planning, establishment and management (at the local and municipality level), particularly for conservation and fisheries management (fisheries replenishment, protection of critical habitat, nursery, feeding, spawning, breeding areas).
3. Improve MPA effectiveness, including monitoring and evaluation and exploring potential entrance fees for MPAs to help support MPA management – *Focus on co-management.*
4. Improve regulations, control rules and enforcement to minimize trawling impacts on benthic ecosystems and marine biota (e.g. gear design, trawl operation, spatial controls, impact quotas and effort controls) (McConnaughey *et al*., 2019).
5. Improve mangrove protection, restoration, monitoring and assessment, including national/provincial/municipality-level and cross-sectoral coordination.
6. Integrate marine spatial planning (MSP) – Pilot study for FMA (e.g. Maluku) (see MMAF-USAID, 2018: evaluated) – *Indonesia.*
7. Improve and demonstrate the benefits of ICM – Develop and implement coastal regulations for zoning plans under RZWP3K, namely *Indonesia Integrated RTRW, Kawasan Strategis Nasional Tertentu (KSNT), Rencana Zonasi Kawasan Antar Wilayah (RZKAW), Rencana Zonasi Kawasan Strategis Nasional Tertentu Pulau Pulau Kecil Terluar (RZKSNTPPKT.)*
8. Standardize marine and coastal cadastre (i.e. land register – extent, value, ownership) to assist planning, enforcement – in relation to submergence or sea level rise – *focus on enforcement.*

9. Strengthen the implementation of EAFM and EAA and harmonization and integration with MPAs, MSP and law enforcement
10. Strengthen policy for coastal development, protecting the natural beauty and marine environmental health – Timor-Leste

Only a single knowledge management related leverage point (to improve adherence to rules and regulations) for PEC 3 has been nominated, others show a balance between direct management interventions and legal or policy reform (Table 47). It is not surprising that investment-related leverage points are also seen as relevant to address problems of marine and land-based pollution, in the context of improving onshore waste management.

Table 47. Leverage points identified for priority environmental concern 3

3. Marine and land-based pollution
1. Improve water quality and environmental quality monitoring, assessment and reporting (particularly at local and LPP level) and implementation of pollution control measures – r*efers to all kind of wastewater/*effluents (standard exist, but limited M&E).
2. Strengthen coordination at national and local levels to support co-management of pollution impacts and monitoring, including harmonized water quality standards, standardized monitoring, data-sharing arrangements, national marine pollution inventory.
3. Support wastewater management – particularly promotion of nature-based solutions (e.g. artificial wetlands).
4. Improve compliance, monitoring and reduce local discharges from fuel and petrol stations and storage facilities, particularly in coastal and rural regions.
5. Promote and improve ICM, coastal development, watershed/catchment area management.
6. Support implementation of IMO rules – establish ballast water and biosecurity and quarantine facilities at major ports, improved monitoring of ballast water and introduced species, acoustic noise, shipping discharges.
7. Promote waste disposal facilities at ports, debris traps (stormwater drains), ban on single-use plastics, promote recycling and biodegradable options.
8. Remove harmful subsidies (e.g. for fertilizers).
9. Ratify OPRC 90, greater safeguards by petroleum industry to avoid spills – GISEA, oil spill response training, environmental sensitivity mapping.
10. Support regional marine debris and ghost net monitoring.
11. Support measures to address the issues of mine tailing from reaching the oceans (e.g nickel mine in Halmahera, Obi Island, Raja Ampat) – *Indonesia.*
12. Support Large Cities Community Waste Water Treatment Facilities – *Indonesia.*

Important potential Leverage Points for PEC 4 are seen in the area of direct management interventions aimed at improving conservation of ETP species, with fewer leverage points seen in the area of legal and policy reform (Table 48). There is one particular area, where a combination of knowledge management (awareness raising) and capacity development (education) are considered relevant to improve adherence to rules and regulations. Tourism and other enterprise development in support of the same objectives can be categorized as investment-related.

Table 48. Leverage points identified for priority environmental concern 4

4. Decline of biodiversity and key species
1. Improve national and local coordination, support for community-based marine species conservation efforts – LMMAs, co-managed MPAs, marine conservation ecotourism, local tenure and property rights, support and incentives for marine protected species conservation and flagship species by local communities.
2. Establish legal definition, rules around traditional harvesting and traditional hunting of ETPs and also, mandatory population and harvest monitoring (i.e. sea turtles, dugongs, whales) (e.g. Kei Islands, Aru Islands, Lamalera/Lamakera) – *Indonesia.*
3. Introduction of turtle excluding devices (TED) on all trawling activities and mandatory reporting of ETP bycatch (fisheries observer programme) – *Indonesia.*
4. Implement national regulations on ETP species (turtles, sharks/ray) – NPOA (Indonesia) for sharks/ray is currently voluntary (no legal basis).
5. Improve local and community-based monitoring/reporting and assessment of ETP species, including cross-sectoral regional data-sharing arrangements (regional database).
6. Pursue and support full membership of CMS and IWC to access international support/assistance for ETP species.
7. Strengthen education and awareness of marine biodiversity conservation and ETP species, for fisher/coastal communities and fisheries officers, including relevant rules and regulations.
8. Promote transboundary cooperation for conservation of ETPs (turtles, dugongs, whales & dolphins) – ETPs also include crocodiles in Timor-Leste.
9. Develop crocodile ecotourism and strengthen crocodile monitoring and management – *Timor-Leste, Indonesia (West Timor).*
10. Develop sustainable marine wildlife ecotourism guidelines and community-based enterprise-development (turtles, dugongs).

Nominated leverage points for PEC 5 (Table 49) cover a balance of both adaptation and mitigation actions, and these can be considered mainly as management related. One leverage point concerns knowledge management-related (improving warning systems) or capacity development-related (community-based climate change education) issues. Investment-related leverage points are likewise proposed, such as for implementation of blue carbon strategies and nature-based solutions.

Table 49. Leverage points identified for priority environmental concern 5

5. Impacts of climate change
1. Expand community-based climate change education and participatory, coastal vulnerability and risk assessments, mitigation and adaptation planning.
2. Strengthen coordination at national and local levels to support climate action, including coastal vulnerability assessment and adaptation planning, including integration with marine spatial planning laws (RZWP3K, RTRW).
3. Support nature-based climate solutions and incentives for blue carbon conservation, reforestation and ecosystem restoration (payment for ecosystem services (PES), Reducing Emissions from Deforestation and Forest Degradation (REDD+)) by local communities – for e.g. low carbon development plans (LCDPs, LCDI/Low Carbon Development Initiative).
4. Incorporate flood risk mapping and SLR projections into coastal development planning and approvals.
5. Improve coastal protection, particularly nature-based solutions, e.g. dunes, intertidal wetlands, reefs (coral and shellfish) and nature-based mitigation of inland flooding (Timor-Leste) (UNFCCC, Green Climate Fund).
6. Strengthen cyclone, tsunami and flood warnings systems in priority areas.

7. Promote protection of freshwater resources (from groundwater salinization).
8. Support blue carbon strategy – e.g. climate-smart, low carbon and climate resilient approaches to shipping, fisheries and aquaculture, tourism sectors (IMO 2018, FAO 2018b)
9. Strengthen regional and local-scale monitoring (climate risks, impacts) and predictive climate risk modelling – sea level rise, ocean acidification and coral bleaching monitoring
10. Develop strategies, incentives, pathways and GHG emission reduction and renewable energy targets for low-carbon, blue economy development, including removal of harmful subsidies and greater investment in renewable energy

CHAPTER 5

Stakeholder analysis

5.1 Introduction to stakeholder analysis

During drafting of the TDA document between 2020 and 2023, a series of consultations with major stakeholders at the local, provincial, national, and regional levels were held from 2020 to 2023 as part of the activities carried out to develop a preliminary framework for the TDA. During these meetings and workshops, stakeholders showed great interest and enthusiasm in participating in the TDA-SAP drafting of the ISLME. Since the initiation of creating a TDA for the ISLME in August 2020, a number of workshops have been organized to generate information for the TDA document. During the process of finalizing the content of the TDA document (socioeconomic, fisheries and biophysical reports) the involvement of stakeholders at regional, national, and provincial levels has been extremely beneficial.

The implementation of the ISLME Project required extensive stakeholder consultation and technical review. The process was aided by the establishment of a National Scientific Advisory Group (NSAG) in both Indonesia and Timor-Leste, which together formed the Regional TDA/SAP Technical Group (RTTG). The primary role of the RTTG and NSAGs was to provide technical input and guide the development of the TDA, National Action Plans (NAP), and SAP as key outputs to be generated by the ISLME project. The NSAGs, comprised of experts in oceanography and marine environmental sciences, fisheries management and governance, aquaculture, and socioeconomics, also provided inputs to the National Project Steering Committees and National Project Coordination Units on planning for the TDA and SAP at the national level. This chapter will further explore the stakeholder engagement process and the roles played by these groups in the successful development of the TDA for the ISLME project5.2 Stakeholder consultations prior to and during development of the transboundary diagnostic analysis.

The partnership has established an efficient mechanism for involving relevant stakeholders in the ISLME TDA document development. Since its establishment, over 60 organizations from Indonesia and Timor-Leste have participated in this programme, including government (MMAF and MAF), environmental non-governmental organizations (NGOs), universities, and community organizations. Additionally, the Government of Timor-Leste has been a strong advocate for this project and there has been increasing representation from local communities and engagement from NGOs as the capacity of Timor-Leste grows.

Several discussions were held with key stakeholders at different levels (provincial, national, and regional levels) regarding priority environmental concerns (PEC), drivers, and impacts as part of the preliminary framework for the TDA document. Stakeholders demonstrated their strong interest and desire to be involved in the ISLME and TDA development.

5.2 Stakeholder consultations prior to and during development of the transboundary diagnostic analysis

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5.3 Indonesian Seas Large Marine Ecosystem project stakeholders

Stakeholders who have been involved in the preparation of the ISLME TDA document, and who will have a role in implementing the future SAP, have been identified from both countries at national, subnational and local levels. In addition, there are also important stakeholders at regional and international levels.

The primary categories of stakeholders participating in this project are:

- Governments of Indonesia and Timor-Leste
- Universities and scientific research institutions
- Environmental and other CSOs (private sectors and civil society organization)
- Local communities, resource users and their representatives.

5.3.1 International stakeholders

International organizations with links to the TDA of the ISLME include funding partners, implementing agency (IA) and executing agency (EA) at international level (Table 50).

Table 50. International organizations engaged in the Indonesian Seas Large Marine Ecosystem

Stakeholders	Roles
Funding	
Global Environment Facility (GEF)	The GEF providing financial support and planning programme for environmental projects and facilitating partnerships among stakeholders to promote sustainable development and conservation in ISLME.
Implementing agency (IA)	
Food and Agriculture Organization of the United Nations (FAO)	1. Collaborating with the Indonesian government, local communities, and other stakeholders to

Stakeholders	Roles
	promote integrated ecosystem approaches that balance marine ecosystem conservation, sustainable fisheries management, and the well-being of coastal communities in Indonesia. 2. Capacity development of human resources in ISLME
Multilateral / Role in project	
Asian Development Bank (ADB), World Bank, IMO (International Maritime Organization), UNDP (United Nation Development Programme), UNOPS (United Nation Office for Project Services), UNIDO (United Nations Industrial Development Organization), UNEP (United Nation Environment Programme), UNESCO-IOC (United Nations Decade of Ocean Science for Sustainable Development - Intergovernmental Oceanographic Commission) and the IOC sub-Commission for the Western Pacific (IOC-WESTPAC).	Developing international collaboration and collaborating with the Indonesian government, local communities, research institutions, and various stakeholders to address a wide range of issues, including marine conservation, sustainable fisheries, coastal resilience, pollution reduction, and the overall well-being of coastal communities.
Bilateral agencies active in the ISLME region	
Australian Centre for International Agricultural Research (ACIAR), Australian Agency for international Development (AUSAID), Commonwealth Scientific and Industrial Research Organisation CSIRO), United States Agency for International Development (USAID), Japan International Cooperation Agency (JICA), Agence Française de Développement (AFD), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Kreditanstalt für Wiederaufbau (KfW), Norwegian Agency for Development Cooperation (NORAD), Norsk Institutt for Vanforskning (NIVA), International Development Research Centre (IDRC), New Zealand Aid, The Korea International Cooperation Agency (KOICA), and related stakeholders	They play a crucial role by supporting marine research, coastal resource management, and funding projects focused on marine conservation, sustainable fisheries, and ecosystem restoration, thereby contributing to the preservation of marine ecosystems and the sustainable development of its coastal areas.
International NGOs	

Stakeholders	Roles
Sustainable Fisheries Partnership (SFP), Marine Stewardship Council (MSC), Environmental Defence Fund (EDF), RARE, Worldwide Fund for Nature (WWF), World Research Institute (WRI), The Nature Conservancy (TNC), Wildlife Conservation Society (WCS), Conservation International (CI), Mercy Corps.	Contributing the implementation of marine conservation projects, sustainable fisheries management, community engagement, and the protection of marine ecosystems in the ISLME region. They collaborate with local communities, governments, and other stakeholders to achieve their conservation and development goals.

5.3.2 Regional stakeholders

Several stakeholders exist at the regional level that are relevant to the ISLME Project, including various multilateral programmes and projects such as:

- the Regional Plan of Action for Promoting Responsible Fishing Practices and Combating Illegal, Unreported, and Unregulated Fishing in Southeast Asia (RPOA-IUU);
- the Subregional Arafura and Timor Seas MCS Network of the RPOA;
- the Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF), which involves participating countries, donor agencies, and NGOs;
- the Southeast Asian Fisheries Development Center (SEAFDEC), with its Secretariat, Training Department and several research departments;
- Partnerships for the Environmental Management of the Seas of East Asia (PEMSEA) and the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA); and
- the Association of Southeast Asian Nations (ASEAN).

These regional stakeholders represent opportunities for collaboration, coordination, and synergies with the ISLME Project and will be important participants in the stakeholder involvement plan to be established (Table 51).

Table 51. Regional stakeholders engaged in Indonesian Seas Large Marine Ecosystem

Stakeholders	Roles
RPOA– IUU; PEMSEA; SEAFDEC's Marine Fishery Resources Development and Management Department (MFRDMD); CTI; Asia Pacific Economic Cooperation (APEC); ASEAN; CGIAR WorldFish Centre; and other Asian fisheries research organizations and universities such as Indian Ocean Tuna Commission (IOTC); Commission for the Conservation of Southern Bluefin Tuna (CCSBT); Coral Triangle Center (CTC), Blue Ventures, Mission Blue	Regional stakeholders in the ISLME region play a crucial role in promoting collaboration, implementing integrated coastal management, conducting research, providing technical assistance, and fostering sustainable development to strengthen fisheries management, combat IUU fishing, and contribute to marine conservation efforts in countries partnership level. Collaborative initiative between Indonesia and Timor-Leste in related issues capture fisheries, marine biodiversity, and marine debris and also developing programme in marine protected areas in the ISLME.

Other regional stakeholders include the scientific and research community, which provides crucial baseline information and analysis for informed policy and management of the ISLME, the fisheries and aquaculture industries, the coastal and marine tourism industry, and the shipping and ports industries.

5.3.3 National stakeholders

At the national level, the primary participants are the national governments and the various branches of these governments that deal with relevant sectors, such as fisheries, environment, climate change, pollution, biodiversity, and forestry (mangroves), and also actors such as Public Works, Health, Education and Communication. Essential to the project's success are also national-level stakeholders from the private sector, the scientific community, NGOs, and coastal and customary communities.

Indonesia

Ministry of Marine Affairs and Fisheries (MMAF) and the Ministry of Environment and Forestry (MoEF or KLHK) are the main stakeholders, and other ministries such as Ministry of National Development Planning (BAPPENAS); Environmental Impact Management Agency (BAPEDAL); Ministry of Public Affairs, Ministry of Home Affairs, Ministry of Energy and Mineral Resources (which deals with mining and offshore oil and gas), and the Ministry of Transportation (shipping and ports) also have responsibilities in the marine environment. Detailed national and subnational stakeholders are shown in Table 52.

Indonesia is home to several institutions that conduct research on marine science and fisheries, including the National Research and Innovation Agency (BRIN), the Agency for Assessment and Implementing Technology, as well as several universities. Some universities, such as Universitas Padjadjaran in Bandung, IPB University in Bogor, Universitas Hasanuddin in Makassar, and Universitas Mataram in Nusa Tenggara Barat, have played a direct important role in ISLME Project implementation.

Table 52. Indonesian and Timor-Leste national agencies engaged in Indonesian Seas Large Marine Ecosystem, national and subnational levels and their roles

INDONESIA	ROLES
BAPPENAS (Indonesian Ministry of National Development Planning)	Responsible for national development planning and resource management in ISLME and long-term goals planning.
Coordinating Ministry of Maritime Affairs and Investment	Oversees and coordinates maritime affairs, investment, and development to ensure sustainable and integrated maritime development in Indonesia.
Ministry of Marine Affairs and Fisheries	Manages and regulates fisheries and aquatic resources, promotes sustainable marine conservation, and supports the livelihoods of fishing communities in Indonesia.
Ministry of Environment and Forestry	Formulates and implements national environmental policies and conservation strategies, ensuring the protection and sustainable management of Indonesia's natural resources.
BRIN (National Research and Innovation Agency)	Facilitates research and innovation activities to drive scientific advancements and technological development in Indonesia and supporting data and policy to government.

Ministry of Public Affairs	Coordinates political and diplomatic affairs, executing national foreign policies and fostering cooperation with international partners.
Ministry of Home Affairs	Supports decentralization and administrative management of local authorities, promotes urban hygiene, and contributes to coastal and marine resource management at the local level.
Ministry of Energy and Mineral Resources	Manages and oversees the exploration, development, and sustainable utilization of energy and mineral resources in Indonesia.
Ministry of Transportation	Promotes and coordinates scientific research and technological development in land, air, and maritime civil transportation sectors.
Ministry of Foreign Affairs	Coordinates political and diplomatic affairs, executes national foreign policies, and engages in multilateral and regional cooperation.
Ministry of Tourism	Implements tourism policies, provides technical advice for sector development, and fosters a conducive institutional setting for competitiveness and innovation in the tourism industry.
BIG (Badan Informasi dan Geospasial)	Responsible for geospatial information management and dissemination, providing accurate and reliable geospatial data for various sectors in Indonesia
BAKAMLA (Badan Keamanan Laut)	Ensures maritime security and safety, conducting surveillance and enforcement activities in Indonesian waters.
AL (Angkatan Laut)	Indonesian Navy, responsible for safeguarding national sovereignty, protecting territorial waters, and enforcing maritime laws.
TIMOR-LESTE	**ROLES**
Directorate General for Fisheries, Aquaculture and Marine Resources, Ministry of Agriculture and Fisheries (MAF)	The main mission is to ensure the general orientation and integrated coordination of all MAF services that carry out tasks related to fisheries and aquatic resources, following the government programme, MAF policies and programmes and guideline. They have existing technical capacities in fishery, aquaculture and natural resources management and have established partnerships with development partners, INGOs, and fisher communities.
Directorate General for Multilateral and Regional Affairs, Ministry of Foreign Affairs and Cooperation (MNEC).	The office responsible for ensuring the coordination of political and diplomatic affairs and the execution of national foreign policy related to multilateral and regional cooperation. The National Directorates of Regional Organizations will play an important role in the ISLME region. They have diplomatic experience with multilateral and regional organizations and can have significant contributions to political and diplomatic discussion at the regional level.

Secretary of State for Environment (SSE).	SSE is responsible for the design, execution, coordination, and evaluation of national environmental policies. They have existing knowledge on environmental conventions and technical capacity and have established partnership with development partners, NGOs (local and international), and local communities.
Naval Component of F-FDTL (Falintil Forças de Defesa de Timor Leste), Ministry of Defence (MoD)	Its main mission is to guarantee national independence, integrity of the territory and the freedom and security of Timorese people against any external aggression or threat. It is also responsible for implementing the mission of Autoridade Maritima Nacional which is to affirm the national sovereignty and project State Authority in the waters under the State's jurisdiction.
Polícia Nacional de Timor-Leste (PNTL) Unidade Marítima, Ministry of Interior (MoI)	The specialized unit of PNTL responsible for integrating Maritime Authority System and is specially dedicated to the surveillance of the coastal and public-domain areas. Together with F-FDTL Naval Component, they provide surveillance and enforcing rules and regulation in territorial sea.
National Maritime Authority (NMA)	The central government body for civil–military coordination and responsible for the development and sustainability of an efficient, safe and environmentally-friendly maritime domain. This would include an effective regulatory framework for the development of the maritime industry, maritime infrastructure, fisheries and aquaculture, ports, coastal areas, shipping, and environmental and safety regulation.
Directorate General for Administrative Decentralization, Ministry of State Administration (MSA)	The office is responsible for supporting decentralization and administrative management of municipal authorities as well as promoting urban hygiene and organization. They provide necessary support for local authorities and leaders which are the main actors coastal and marine resource managements at the lowest administrative level.
Minister of Transport and Communications (MTC)	The responsible ministry for promoting and coordinating scientific research and technological development in the fields of land, air and maritime civil transportation.
Autoridade Portuáriu Timor-Leste (APORTIL)	An autonomous government Institution responsible for managing the sea port.
Directorate General for Tourism, Ministry of Tourism, Commerce and Industry (MTCI)	The office responsible for implementing and guiding tourism policies as well as providing relevant technical advice to MTCI to promote the development of an institutional setting favourable for competitiveness and business innovation in the sector. They can support the development of the tourism sector in the south coast which provides a sustainable financial mechanism for community-based natural resource management.

Ministry of Petroleum and Mineral Resources (MPMR) The National Petroleum Authority (Autoridade Nacional do Petróleo – ANP)	The responsible authority for the establishment and supervision of compliance with the enacted rules and regulations covering the onshore and offshore exploration, development, production, transportation and distribution of petroleum, natural gas resources and minerals. They can enhance environmental compliance and local content of private sectors who operate in Timor-Leste's coasts and seas.
Directorate General for Management and Mobilization of External Resources, Ministry of Finance (MoF)	The responsible authority for managing the effectiveness and mobilization of external aid, public-private partnerships, public debt management and technical assistance in Public Administration. They can extend their services to support the operation of ISLME's national implementing committee and facilitate ISLME stakeholder partnership forums
Ministry of Planning and Territory.	The government department responsible for the design, coordination and evaluation of the policy, defined and approved by the Council of Ministers, for the areas of promotion of economic and social development of the country, through strategic and integrated planning and rationalization of available financial resources, assuming specific responsibilities on the implementation of the Strategic Development Plan, especially with regard to infrastructure and urban planning, petroleum and minerals, planning and territory
SUBNATIONAL, INDONESIA	**ROLES**
Provincial government in ISLME region District government in ISLME region, including Dinas Lingkungan Hidup (DLH), Balai Konservasi Sumber Daya Alam (BKSDA), and related institutions.	-Formulating and implementing provincial environmental policies and regulations. -Conducting environmental impact assessments and monitoring environmentally quality -Managing and conserving natural resources within the province -Collaborating with other government agencies, local communities, and stakeholders to promote sustainable environmental practices.
West Papua (Dinas Kelautan dan Perikanan (DKP)) in each region/district	1. formulating and implementing district environmental policies and regulations; 2. conducting environmental impact assessments and monitoring environmentally quality; 3. managing and conserving natural resources within the district; and 4. collaborating with other government agencies, local communities, and stakeholders to promote sustainable environmental practices in district government level.
North Maluku (DKP in each region/district)	
West Nusa Tenggara (DKP in each region/district)	
East Nusa Tenggara (DKP in each region/district, Dinas ketahanan pangan dan perikanan Kabupaten Manggarai Barat)	
West Sulawesi (DKP in each region/district)	
South Sulawesi (DKP in each region/district)	

North Sulawesi (DKP in each region/district)	
Central Sulawesi (DKP in each region/district)	
Bali (DKP in each region/district)	
SUBNATIONAL, TIMOR-LESTE	**ROLES**
NGOs in Timor-Leste	Marine environment conservation at municipality level will be exercised in close cooperation with local authorities (head of village and head of hamlet including CBOs) as well as coastal communities. So far, marine and coastal resources conservation within the ISLME area is also supported by different NGOs Blue Ventures, MercyCorps, and by WorldFish PEMSEA and FAO.
Municipality Administration/Authorities	Municipality administration/authority aims to ensure the implementation of the administrative functions of the State through the execution of policies and of programmes in various areas (including environment, agriculture and tourism) at municipality and post administrative level. They promote and guide economic and social development and through provision of public goods and services at subnational level. This function is performed under the supervision of the Ministry of State Administration.
Community authorities	Community authorities, composed of Chief of Sucos (village) and members of the Suco Council, must carry out their duties and exercise their competence with respect to the national constitution and the laws on the property of the state, namely on natural, renewable and non-renewable resources.
Universities	
INDONESIA	
Universitas Padjadjaran (West Java), IPB University (West Java), Universitas Udayana (Bali), Universitas Mataram (West Nusa Tenggara), Universitas Pattimura (Maluku), Universitas Hasanuddin (North Sulawesi), Universitas Halu Oleo (Southeast Sulawesi), Universitas Sam Ratulangi (North Sulawesi), Universitas Papua (West Papua), Universitas Nusa Cendana (East Nusa Tenggara), Universitas Mulawarman (East Kalimantan), Universitas Brawijaya (East Java), Universitas Diponegoro (Central Java), Politeknik Ahli Usaha Perikanan (Jakarta), Politeknik Kelautan dan Perikanan Bitung (North Sulawesi), Politeknik Kelautan dan Perikanan Sorong (West Papua), Politeknik Kelautan dan Perikanan Karawang (West Java), Politeknik Kelautan dan Perikanan Bone (South Sulawesi), Politeknik Kelautan dan Perikanan Kupang (East Nusa Tenggara), Politeknik Kelautan dan Perikanan Jembrana (Bali), Akademi Komunitas Kelautan dan Perikanan Wakatobi (Southeast Sulawesi), Politeknik Kelautan dan Perikanan Sidoarjo (East Java).	
Roles Research and scientific studies, capacity development and education, policy development and advocacy, collaboration and partnerships, data collection and monitoring, innovation, and technology development.	
TIMOR-LESTE	

Universidade Nacional Timor Lorosa'e (UNTL): an accredited national academic institution with research skills in marine and coastal ecosystem; it has a Department of Fisheries and Marine Science and a Center for Climate Change and Biodiversity. UNTL also has its representative in the NSAG for ISLME project. Universidade Oriental Timor Lorosa'e (UNITAL): An accredited private higher education which is also a member of ISLME project's NSAG.
Roles Research and scientific studies, capacity development and education, policy development and advocacy, collaboration and partnerships, data collection and monitoring, innovation and technology development

5.3.4 Civil society organizations and private sector stakeholders

Apart from its governmental stakeholder, various other ISLME stakeholders can be grouped as civil society organizations (CSOs), including non-government organizations (NGOs) and community elements/groups; and private sector. Table 53 shows some of (but not limited to) the CSOs in the ISLME. Coastal and traditional or customary communities in these areas will be the main beneficiaries of the project and therefore an important stakeholder group. Considerations must be given to gender issues such as promoting women's empowerment and engagement for sustainable fisheries and coastal resources management and to support women's livelihoods. There is also a need to address the vulnerabilities of other stakeholder groups who are highly dependent on ISLME resources, such as landless and migratory fisher populations and those displaced from fishing activities in the ISLME region. These considerations will need to be incorporated in the design, implementation, and monitoring of the SAP and NAP.

Table 53. Civil society organizations in Indonesian Seas Large Marine Ecosystem region

Stakeholder	Roles
NGOs in Indonesia: KEHATI (Yayasan Keanekaragaman Hayati), YKAN (Yayasan Konservasi Alam Nusantara), YKCI (Yayasan Konservasi Cakrawala Indonesia), WALHI (Wahana Lingkungan Hidup Indonesia), MDPI (Yayasan Masyarakat dan Perikanan Indonesia), Pandu Laut, Rekam Nusantara Foundation	Contributing to the implementation of marine conservation projects, sustainable fisheries management, community engagement, and the protection of marine ecosystems in the ISLME region. They collaborate with local communities, governments, and other stakeholders to achieve conservation and development goals.
NGOs in Timor-Leste: KFF (Konservasaun Flora no Fauna), Timor Verde, FCOTI (Fundação Carbon Offset Timor), PERMATIL (Permaculture Timor-Lorosa'e).	Contributing to various initiatives aimed at coastal conservation and sustainable development; Engaged in managing and promoting projects such as mangrove learning, sea grass monitoring, reforestation in both upland and coastal areas, and the development of coastal ecotourism. Additionally, involved in promoting carbon credit accreditation and are keen on expanding their operations to include blue carbon credits specifically related to mangroves.

Stakeholder	Roles
Indigenous/customary communities [Masyarakat Adat]: Maluku (Suku Pulau Selaru, Suku Tidore, Suku Ternate, Suku Togutil, Suku Kei, Suku Tobelo), Sulawesi (Suku Bajo, Suku Bugis, Suku Makassar, Suku Mandar, Suku Buton, Suku Talaud, Suku Gorontalo, Suku Konjo Pesisir/Kijang, Suku Kaili, Suku Banggai), NTB (Suku Sasak, Suku Samawa / Sumbawa, Suku Mbojo), NTT (Suku Alor, Suku Rote, Suku Ende, Suku Kedang), Papua Barat (Suku Asmat, Suku Muyu).	Conserving and inspiring marine conservation understanding to coastal community
Community groups in Timor-Leste: Movimento Tasi Mos, Laudato Si' Movement Timor-Leste	A group of volunteers which frequently organize beach clean ups around the City of Dili.
Fishers groups [Kelompok Nelayan] in Indonesia: KUBE Waihaong, BUMNEG Huseka, Erto, Nametek Permai, Tunas Jaya, Kaunin, Benteng Amsterdam, Waemele, Putilessy, Talaga Bisa (Maluku), Putri Baudale (NTT), Himpunan Nelayan Seluruh Indonesia (HNSI)	Coastal community

The participation of stakeholders in the SAP development and implementation must assure a greater involvement of international and bilateral stakeholders to enhance the sustainable management of the ISLME within international governance frameworks. A significant challenge in sustainable marine and coastal management is the need to improve cross-sectoral coordination and eliminate redundancies between national, provincial, and local levels. Therefore, the engagement of all relevant ministries and sectors through interagency committees is essential throughout the lifespan of ISLME management. Emphasis must be placed on stronger engagement with the private sector, particularly in the fisheries, transportation, energy, and mining industries, because of the relationship of these sectors with the drivers of environmental degradation in the ISLME region.

There have been concrete Corporate Social Responsibility (CSR) programmes related to marine and fisheries, conducted by multinational, national and local companies from within and outside of the marine and fisheries sector. The focus of the CSR ranges from strengthening marine conservation; protecting ISLME biodiversity and ecosystems; to fostering inclusive, sustainable livelihood and economic growth. Often carried out in collaboration with NGOs working in environmental protection, these CSR activities include raising awareness on ecosystems and biodiversity, mangrove and coral reef planting, capacity building to boost SSF production (good practice aquaculture, responsible fishing practice), post-harvest processing (skills to produce various seafood-based products, food safety, proper packaging), online marketing, beach clean-up and support for marine waste management, among many others. Some of these CSR initiatives were specifically designed as women's empowerment in coastal areas. Community and women's empowerment programme is a useful opportunity to raise public awareness on ISLME sustainability, mobilize their active roles and gather their ideas and aspirations to shape policies. Similarly in Timor-Leste, private sector companies, especially those in food and beverage and tourism industries are engaged in various activities to protect its north coast waters. Continuous effort to foster consistent, more coordinated and impactful CSR initiatives, especially by direct ISLME resource users (such as tourism, shipping, fishing industries just to name a few), is needed for improved ISLME protection in the long-term.

Because of the diversity of the demographic, social, and cultural characteristics of stakeholders, it will be necessary for ISLME management to adopt suitable methods for stakeholder engagement and communication to cater to diverse audiences at all levels through a range of communication tools and methods, such as local language translations, public relations materials, media, and visual aids. The partnership with local NGOs with grassroot engagement experience will be highly advisable and crucial in this process.

CHAPTER 6

Conclusions and possible options

6 Overall conclusions and possible options for priority actions

6.1 Conclusions

The ISLME is a regional dynamic water area that includes part of Indonesia and Timor-Leste. Both partners have similar characteristics and issues, but at some point, they face different conditions. This region not only has great ecological importance with a high value of diversity in each ecosystem, but also will face several threats in the years to come. Anthropogenic activities, including illegal fishing practices, land-based pollution, and coastal development are challenges that will become even more difficult to handle. Both governments must prioritize sustainable management and conservation efforts to ensure the long-term viability of the ISLME's natural resources. To help in achieving their common interests, the TDA has been developed with cooperation between both countries to transform scientific study and information into policy, strategic action, and eventually, implementation. The drafting of the TDA followed established rules and guidance such as in the GEF (2020) and was aligned with several SDG goals, especially SDG 14 (Life below water), which is also related to SDG 1 (No Poverty) and SDG 13 (Climate action).

Through the drafting process, the TDA document has successfully identified and analysed the status of the ISLME and the primary factors responsible for environmental degradation, thus linking them to their respective causes. Capture fisheries are influenced by both policy decisions and oceanographic factors, such as catch quota or design of the Indonesian Archipelagic Sea Lanes (ALKI), and the Indonesian Throughflow (ITF), as well as coastal ecosystem conditions. In general, there has been degradation in the quality of natural resources in coastal ecosystems, for example, the area of mangroves, seagrass, and coral reefs. Coastal ecosystem degradation has an impact on fish populations and on several species that migrate across water areas within the ISLME. In addition to ecosystem degradation, there is a link between the impact of climate change on oceanographic factors, capture fisheries and other wild marine species, and, ultimately, on the socioeconomic conditions of coastal communities and related sectors.

In terms of unsustainable fishing and aquaculture practices, essential components of various factors that pose a threat to the marine environment were identified. Additionally, the ISLME Project and TDA development enhanced the capacity for regional and subregional cooperation in the management of marine resources, coordinated with existing regional information networks, monitored the impacts of the project, and disseminated and exchanged information with stakeholders. Furthermore, the Project identified and described the existing status of transboundary cooperation, including socioeconomic and institutional drivers and the impacts of climate change. Overall, the ISLME project's efforts have contributed significantly to the protection and conservation of the marine environment in the ISLME region, promoting sustainable development and ensuring the well-being of both present and future generations.

The TDA has identified five priority environmental concerns in ISLME as follows:
1. unsustainable fishing and aquaculture practices result in a decline in living coastal and marine resources;
2. degradation and loss of coastal and marine habitats;
3. marine and land-based pollution;
4. decline and loss of biodiversity and key marine species; and
5. impacts of climate change.

The causal chain analysis of issues in ISLME describes the underlying direct and indirect drivers and causes leading to ecosystem degradation and thus the loss of ecosystem goods and services.

The TDA also identified the main root causes of these issues, and they can be attributed to a combination of governance, environmental, and socioeconomic factors.
- Governance-related factors that are a root cause of the priority environmental concerns (PEC) include inadequate enforcement of laws and regulations, ineffective management and governance frameworks, insufficient stakeholder involvement and participation, and limited financial resources for conservation and management efforts. These factors can lead to overfishing, illegal fishing practices, and inadequate protection of marine and coastal habitats.
- Environmental factors that are also a root cause of PEC include climate change, ocean acidification, and natural disasters such as typhoons and tsunamis. These factors can contribute to the degradation and loss of coastal and marine habitats, decline of key marine species, and the overall decline of living coastal and marine resources; and
- Socioeconomic factors that have been identified as a root cause of PEC include poverty, insufficiency of alternative livelihood options, and population growth. These factors can drive the overexploitation of natural resources, land-use changes, and increased pollution because of inadequate waste management practices.

Overall, addressing these complex issues and problems in the ISLME will require integrated approaches that involve the participation of multiple stakeholders, ranging from the private sector to international stakeholders. A comprehensive approach that combines effective governance, environmental conservation, and socioeconomic development is needed to achieve sustainable management and conservation of marine and coastal resources in the ISLME region.

The transboundary waters issues in the ISLME region between Indonesia and Timor-Leste are a significant challenge that requires effective management and cooperation between the two countries. Priority regional issues include illegal fishing, oil spills, fish migration, and marine debris. These issues are complex and require a comprehensive approach that addresses the root causes of these problems. Sustainable management of the ISLME region requires the collaboration of all stakeholders, including governments, NGOs, and local communities, to ensure the long-term health and productivity of this important marine ecosystem.

Unsustainable fisheries, IUU fishing, and biodiversity degradation are still common problems in the ISLME. Although many laws and regulations have been established, they are not always compatible with economic circumstances, and compliance is insufficient. It is important that the governments apply some tangible actions to minimize unsustainable fisheries and habitat degradation through the following measures:

1. strengthening existing laws and regulations and in joint implementation with traditional wisdom;
2. implementing more joint research between or among academic institutions and NGOs to share information and data among them;
3. scaling-up the ecosystem approach to fisheries management at different sites;
4. implementing ICM and its monitoring and evaluation using Management Effectiveness Tracking Tool (METT) instruments to assess management effectiveness and secure sustainability;
5. declaring all MPA candidates and their operationalization to ensure that all management measures are implemented and coordinated in a synergistic manner;
6. improving local fishermens' (subsistence fisheries) skills and knowledge to improve their fishing activities with proper fishing equipment;
7. improving fisheries harvest both fishing and gleaning activities as part of nutritional security and protein intake as well as livelihoods diversification;
8. applying strict regulations on hunting and consumption of threatened and protected marine species such as dugongs and turtles (eggs and meal) for cash and protein intake; and
9. promoting proper cooperation with neighbouring countries to control all marine resources in the transboundary areas to reduce IUU fishing including joint research to share data and information.

6.2 Possible options for priority actions for the Strategic Action Programme

The TDA highlights the critical need to promote the conservation and sustainable use of the oceans, seas, and marine resources in the ISLME region. This is closely aligned with SDG 14 (Life below water), which aims to conserve and sustainably use the oceans and coastal and marine resources for sustainable development. The TDA identifies various factors responsible for environmental degradation, including unsustainable fishing practices, habitat loss, marine and land-based pollution, biodiversity loss, and the impacts of climate change. To address these issues, it is essential to develop and implement effective management plans and strategic actions and initiatives that promote sustainable fishing practices, protect key marine species and their habitats, and promote the restoration of degraded habitats. Additionally, strengthening the monitoring and enforcement of regulations, and generating improved compliance, promoting sustainable production and consumption practices, and supporting the development of climate-resilient infrastructure can help to address marine and land-based pollution and the impacts of climate change. By addressing these challenges and promoting sustainable development, the ISLME region can contribute to achieving SDG 14, while contributing to other SDGs such as SDG 1 (No poverty) and SDG 13 (Climate action).

The TDA document references the need for the governments of Indonesia and Timor-Leste to develop a SAP document as the next step to addressing the priority regional issues identified in the ISLME region. The outlines give possible options for priority actions in order to achieve integrated environmental management emphasizing sustainable fisheries. It should be noted that the proposed priority actions presented below act as a bridge from TDA to SAP and require further evaluation, analysis, and discussion during the SAP development process. SAP development will not be limited to the proposed priority actions and will still be open for other options, which are in line with current and future conditions, including location-specific interventions. These considerations lead to several points of possible options to address priority environmental concerns in the ISLME as follows:

- In order to implement and enforce sustainable fisheries practices, it is necessary to encourage the implementation of sustainable fishing gear and methods, quota-based management, and the establishment of effectively managed marine protected areas.
- To promote sustainable fisheries practices, restoring and conserving marine ecosystems such as mangroves, seagrass beds, and coral reefs need to be encouraged to improve habitat for many marine species. This can be addressed either to law enforcement or community awareness related to this subject.
- To address marine and land-based pollution, it is necessary to encourage better waste management practices in fisheries, including fisheries practice onboard, landing centres, and post-harvest stages, reducing nutrient runoff, enforcing stricter regulations on industrial discharges and sewage treatment, and fisheries-related pollution (e.g. marine debris and ghost fishing).
- To promote marine biodiversity conservation, it is necessary to improve management effectiveness in existing protected areas for endangered species, implement habitat restoration programmes, and enforce regulations on the illegal wildlife trade.
- To improve governance and management, it is important to increase coordination among stakeholders, improve registration and licensing of small-scale fishers, and improve management of marine protected areas. Standardized monitoring and data sharing should be implemented to enhance effective governance and management of marine resources.
- It is important to enforce effective regulations and monitoring by prioritizing sustainable development and regulating small-scale pollution activities, as well as promoting effective regulations and monitoring for activities such as artisanal mining, aquaculture, and tourism. This could include increasing enforcement capacity at the local district and provincial levels.
- It is also important to encourage research and provide accessible information for the public to develop a better understanding of the status of fish populations and ecosystems, as well as engage with stakeholders to ensure that management strategies are socially and economically feasible.
- To raise awareness of climate resilience in coastal communities, it is necessary to improve knowledge management on adaptation to the impacts of climate change, such as promoting sustainable lifestyle by adopting energy efficiency and implementing plastic

reduction habits, contributing to ecosystem conservation to reduce the impacts of sea level rise, and improving coastal infrastructure from extreme weather events as well.

Some urgent plans should include measures to strengthen law enforcement and reduce illegal, unreported, and unregulated fishing; improve emergency response plans and preparedness to mitigate the impacts of oil spills; implement sustainable infrastructure development that considers the impacts on fish migration patterns; and develop a comprehensive strategy to address marine debris in the region. In addition, both countries will work together to develop a shared vision for the sustainable management of the ISLME region and establish a joint management framework to ensure effective collaboration and coordination. This will require the commitment of all stakeholders and the allocation of sufficient resources to implement the necessary actions to ensure the long-term health and productivity of the ISLME region.

Multistakeholder coordination

Addressing identified issues will require a multisectoral approach involving government, civil society, and the private sector, as well as engagement with local communities and traditional knowledge holders. It will also require collaboration and coordination across different levels of governance, from local to national and international stakeholders.

Effective collaboration and coordination across different levels of governance are crucial to address the complex challenges facing the ISLME region. At the local level, collaboration between communities, civil society organizations, and local government agencies is essential for promoting sustainable practices and addressing local environmental concerns. This includes initiatives such as community-based fisheries management, marine conservation areas, and sustainable tourism development.

At the national level, coordination between government agencies, academia, and the private sector is necessary for the development and implementation of policies and regulations that promote the sustainable development, conservation, and management of coastal and marine resources. This includes initiatives such as integrated coastal zone management, marine protected area networks, and sustainable fisheries management following EAFM principles.
International stakeholders can also play a vital role in supporting sustainable development in the ISLME region, particularly through providing technical and financial assistance, promoting international cooperation, and facilitating knowledge sharing and capacity development. This includes initiatives such as international partnerships and agreements, funding mechanisms for conservation and sustainable development, and capacity development programmes for stakeholders.

Overall, regional collaboration and coordination between Indonesia and Timor-Leste can help address shared environmental challenges and promote sustainable development across the region. This includes initiatives such as regional forums for cooperation and dialogue, joint monitoring and research programmes, and regional strategies for sustainable development and conservation.

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Annex 1. List of MPAs, coverages, and recent status

No.	MPA name and province	MPA type	Cover area (ha)	Status*
1	Alas Purwo, East Java	National park	41 408.5	Lightly protected
2	Ayau-Asia Island	District marine conservation area	101 229.1	Lightly protected
3	Bali Barat, Bali	Marine national park	86 402.7	Lightly protected
4	Baluran, East Java	National park	20 306.0	Lightly protected
5	Bangkiriang, Central Sulawesi	Wildlife reserve	12 666.5	Lightly protected
6	Bangko-bangko, West Nusa Tenggara	Nature recreational park	2 451.6	Lightly protected
7	Bawean, East Java	Nature reserve	19 638.1	Lightly protected
8	Bonto Bahari, South Sulawesi	Grand forest park	4 684.3	Lightly protected
9	Bukit Soeharto, East Kalimantan	Grand forest park	63 215.2	Lightly protected
10	Buton Utara, Southeast Sulawesi	Wildlife reserve	103 341.8	Lightly protected
11	Derawan (Berau), East Kalimantan	District marine conservation area	1 237 808.1	Lightly protected
12	Desa Olele, Gorontalo	District marine conservation area	13.8	Lightly protected
13	Gili Banta, West Nusa Tenggara	District marine conservation area	40 500	Lightly protected
14	Gili Meno, Gili Anyer (Air), Gili Trawangan, West Nusa Tenggara	District marine conservation area	2 954	Lightly protected
15	Gili Tangkong, Gili Nanggu , Gili Sundak, West Nusa Tenggara	District marine conservation area	21 332.0	Lightly protected
16	Gili Sulat, Gili Lawang, West Nusa Tenggara	District marine conservation area	10 000	Lightly protected
17	Gugus Pulau Teluk Maumere, East Nusa Tenggara	Marine nature recreation park	52 500.8	Lightly protected
18	Gunung Api, Maluku	Wildlife reserve	119.1	Lightly protected
19	Gunung Api Banda, Maluku	Nature tourism park	739.0	Lightly protected
20	Gunung Dua Sudara, North Sulawesi	Nature reserve	12 075.1	Lightly protected
21	Kai Besar, Maluku	District marine conservation area	29 417.1	Lightly protected
22	Kaimana, West Papua	District marine conservation area	543 380.8	Lightly protected

No.	MPA name and province	MPA type	Cover area (ha)	Status*
23	Karimun Jawa, Central Java	Marine national park	180 918.5	Lightly protected
24	Kawe/Kep. Wayag Sayang/Kep. Panjang, West Irian Jaya	Marine wildlife reserve	154 564.2	Lightly protected
25	Kepulauan Kapoposang, South Sulawesi	Marine tourism park	21 884.3	Lightly protected
26	Kepulauan Padamarang, Southeast Sulawesi	Marine tourism park	3 710.1	Lightly protected
27	Kepulauan Raja Empat, West Irian Jaya	Marine conservation area	35 685.8	Fully protected
28	Kepulauan Seribu, DKI Jakarta	Marine national park	114 414.5	Lightly protected
29	Kepulauan Togean, Central Sulawesi	Marine national park	398 923.0	Lightly protected
30	Kepulauan Wakatobi, Southeast Sulawesi	Marine national park	1 281 156.2	Lightly protected
31	Kofiau and Boo Islands, West Irian Jaya	District marine conservation area	157 908.2	Lightly protected
32	Komodo, East Nusa Tenggara	National park	180 630.4	Lightly protected
33	Kutai, East Kalimantan	National park	224 362.6	Lightly protected
34	Lampoko Mampie, West Sulawesi	Wildlife reserve	3 328.7	Lightly protected
35	Lewotobi, East Nusa Tenggara	District marine conservation area	8 119.8	Lightly protected
36	Manupeu -Tanah Daru, East Nusa Tenggara	National park	58 584.9	Lightly protected
37	Manusela, Maluku	National park	15 7580.5	Lightly protected
38	Morowali, Central Sulawesi	Nature reserve	224 194.5	Lightly protected
39	Muara Angke, DKI Jakarta	Wildlife reserve	3 339.4	Lightly protected
40	Napabalano, Southeast Sulawesi	Nature reserve	1 389.4	Lightly protected
41	Ngurah Rai, Bali	Grand forest park	2 039.6	Lightly protected
42	Pangi Binanga, Central Sulawesi	Nature reserve	6 000.5	Lightly protected
43	Panua, Gorontalo	Nature reserve	49 606.5	Lightly protected
44	Pati Pati, Central Sulawesi	Wildlife reserve	74.5	Lightly protected
45	Perhatu, East Nusa Tenggara	Wildlife reserve	67.6	Lightly protected
46	Pulau Batanta Barat, West Irian Jaya	Nature reserve	17 165.2	Lightly protected
47	Pulau Besar, Central Sulawesi	District marine conservation area	6 972.6	Lightly protected
48	Pulau Biawak, West Java	Marine nature recreation	123 432.6	Lightly

No.	MPA name and province	MPA type	Cover area (ha)	Status*
		park		protected
49	Pulau Bokor, Jakarta	Nature reserve	19.5	Lightly protected
50	Pulau Dua, Banten	Nature reserve	4.3	Lightly protected
51	Pulau Kassa, Maluku	Marine nature recreation park	74.1	Lightly protected
52	Pulau Kayu Adi / Kab Selayar, South Sulawesi	District marine conservation area	1 033.2	Lightly protected
53	Pulau Kofiau, West Irian Jaya	Nature reserve	12 846.0	Lightly protected
54	Pulau Lapang, East Nusa Tenggara	Nature recreational park	243.0	Lightly protected
55	Pulau Larat, Maluku	Nature reserve	3 747.7	Lightly protected
56	Pulau Manuk, Maluku	Wildlife reserve	101.0	Lightly protected
57	Pulau Manuk Woha, Maluku	Wildlife reserve	1 598.5	Lightly protected
58	Pulau Marsegu, Maluku	Marine nature recreation park	10 164.7	Lightly protected
59	Pulau Misool, West Irian Jaya	Nature reserve	111 234.9	Lightly protected
60	Pulau Moyo, West Nusa Tenggara	Marine nature recreation park	6 000	Lightly protected
61	Pulau Noko-Nusa, East Java	Nature reserve	6.6	Lightly protected
62	Pulau Nustaram, Maluku	Nature reserve	66 197.2	Lightly protected
63	Pulau Nuswotar, Maluku	Nature reserve	3 565.6	Lightly protected
64	Pulau Panjang, West Nusa Tenggara	Nature reserve	13 135.1	Lightly protected
65	Pulau Pombo, Maluku	Marine nature recreation park	1 718.9	Lightly protected
66	Pulau Rambut, DKI Jakarta	wildlife reserve	18.2	Lightly protected
67	Pulau Rambut dan Perairan, DKI Jakarta	Marine wildlife reserve	88.9	Lightly protected
68	Pulau Rusa, East Nusa Tenggara	Marine conservation area	1 208.4	Lightly protected
69	P. Sabuda dan P. Tataruga, West Irian Jaya	Marine wildlife reserve	16 652.4	Lightly protected
70	Pulau Salawati Utara, West Irian Jaya	Nature reserve	67 549.2	Lightly protected
71	Pulau Sangiang, Banten	Marine nature recreation park	751.7	Lightly protected
72	Pulau Saobi (Kangean), East Java	Nature reserve	1 204.3	Lightly protected
73	Pulau Satonda, West Nusa Tenggara	Marine nature recreation park	2 600	Lightly protected

No.	MPA name and province	MPA type	Cover area (ha)	Status*
74	Pulau Seho, North Maluku	Nature reserve	1 963.3	Lightly protected
75	Pulau Selayar, Kab Selayar, South Sulawesi	District marine conservation area	1 684.7	Lightly protected
76	Pulau Waigeo, West Irian Jaya	Nature reserve	131 236.3	Lightly protected
77	Raja Ampat, West Irian Jaya	Marine conservation area	166 178.6	Fully protected
78	Rawa Aopa Watumohai, Southeast Sulawesi	National park	103 730.7	Lightly protected
79	Riung, East Nusa Tenggara	Nature reserve	429.3	Lightly protected
80	Sabuda Tataruga, West Irian Jaya	Wildlife reserve	1 161.4	Lightly protected
81	Sumbawa Island, West Nusa Tenggara	District marine conservation area	32 867.8	Lightly protected
82	Selat Dampier, West Irian Jaya	District marine conservation area	300 048.2	Lightly protected
83	Selat Pantar / Alor, East Nusa Tenggara	District marine conservation area	407 502.3	Lightly protected
84	Selat Tiworo, Southeast Sulawesi	Marine nature recreation park	29 617.1	Lightly protected
85	Sepanjang, East Java	District marine conservation area	34 427.2	Lightly protected
86	Southeast Misool, West Irian Jaya	District marine conservation area	332 860.0	Fully protected
87	Sumba Strait Marine Area, East Nusa Tenggara	National marine park	567 165.6	Lightly protected
88	Sungai Bulan dan Sungai Lulan, South Kalimantan	Nature reserve	2 370.3	Lightly protected
89	Tafermaar, Maluku	Nature reserve	3 046.1	Less protected
90	Taka Bonerate, South Sulawesi	Marine national park	542 192.6	Lightly protected
91	Kawasan Konservasi Laut Pangandaraan	Marine nature tourism Park	44 932	Lightly protected
92	Taman Laut Banda, Maluku	Marine nature tourism park	2 672.4	Lightly protected
93	Tanah Pedauh, West Nusa Tenggara	Nature reserve	557.6	Lightly protected
94	Tangkoko Batu Angus, North Sulawesi	Nature reserve	3 198.0	Lightly protected
95	Tanjung Amolengo, Southeast Sulawesi	Wildlife reserve	49.4	Lightly protected
96	Tanjung Api, Central Sulawesi	Nature reserve	242.3	Lightly protected
97	Tanjung Batikolo, Southeast Sulawesi	Wildlife reserve	83.6	Lightly protected
98	Tanjung Panjang, Gorontalo	Nature reserve	7 300.8	Lightly protected
99	Tanjung Peropa, Southeast Sulawesi	Wildlife reserve	30 573.5	Lightly

No.	MPA name and province	MPA type	Cover area (ha)	Status*
				protected
100	Tanjung Santigi, Central Sulawesi	Wildlife reserve	1 591.2	Lightly protected
101	Teluk Adang, East Kalimantan	Nature reserve	57 307.4	Lightly protected
102	Teluk Apar, East Kalimantan	Nature reserve	46 319.9	Lightly protected
103	Teluk Bintuni, West Irian Jaya	Nature reserve	94 290.6	Lightly protected
104	Teluk Kelumpang; Selat Laut; Selat Sebuku, South Kalimantan	Nature reserve	61 138.5	Lightly protected
105	Teluk Kupang, East Nusa Tenggara	Marine nature recreation park	60 616.9	Lightly protected
106	Teluk Lasolo-Teluk Dalam, Southeast Sulawesi	Marine nature tourism park	144 359.9	Lightly protected
107	Teluk Mayalibit	District marine conservation area	48 976.8	Lightly protected
108	Teluk Pamukan, South Kalimantan	Nature reserve	20 825.4	Lightly protected
109	Tirosa Batek Marine Area, East Nusa Tenggara	National marine park	2 953 964.4	Lightly protected
110	Toffo Kota Lambu, West Nusa Tenggara	Nature reserve	4 067.1	Lightly protected
111	Tujuh Belas Pulau Riung, East Nusa Tenggara	Marine nature recreation park	8 531.6	Lightly protected
112	Tuti Adagae, East Nusa Tenggara	Nature recreational park	5 697.8	Lightly protected
113	Wae Wuul/ Mburak, East Nusa Tenggara	Nature reserve	1 367.1	Lightly protected
114	Batugade, Timor-Leste	Marine natural reserve	100	Lightly protected
115	Lagoa Tasitolu, Timor-Leste	Protected area	100	Lightly protected
116	Behau, Timor-Leste	Protected area	24 300	Lightly protected
117	Lamsanak, Timor-Leste	Protected area	12400	Proposed
118	Nino Konis Santana, Timor-Leste	National park	56 200	Lightly protected

*Source: Marine Conservation Institute. 2023. Marine Protection Atlas. [Cited 30 June 2023]. www.mpaatlas.org

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