OCEAN ACCOUNTS OF INDONESIA

Pilot Study: Accounts of Gili Ayer, Gili Meno,
and Gili Trawangan (Gili Matra) Marine Protected Area

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PILOT STUDY: ACCOUNTS OF GILI AYER, GILI MENO, AND GILI TRAWANGAN (GILI MATRA) MARINE PROTECTED AREA

Citation:
This publication (and any material sourced from it) should be attributed as: Ministry of Marine Affairs and Fisheries (MMAF). 2022. Ocean Accounts of Indonesia - Pilot Study: Accounts of Gili Ayer, Gili Meno, and Gili Trawangan (Gili Matra) Marine Protected Area. Jakarta.

Kementerian PPN /

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Global Ocean Accounts Partnership

OCEAN ACCOUNTS INDONESIA
Ocean Account for Ocean Sustainability

OCEAN ACCOUNTS OF INDONESIA

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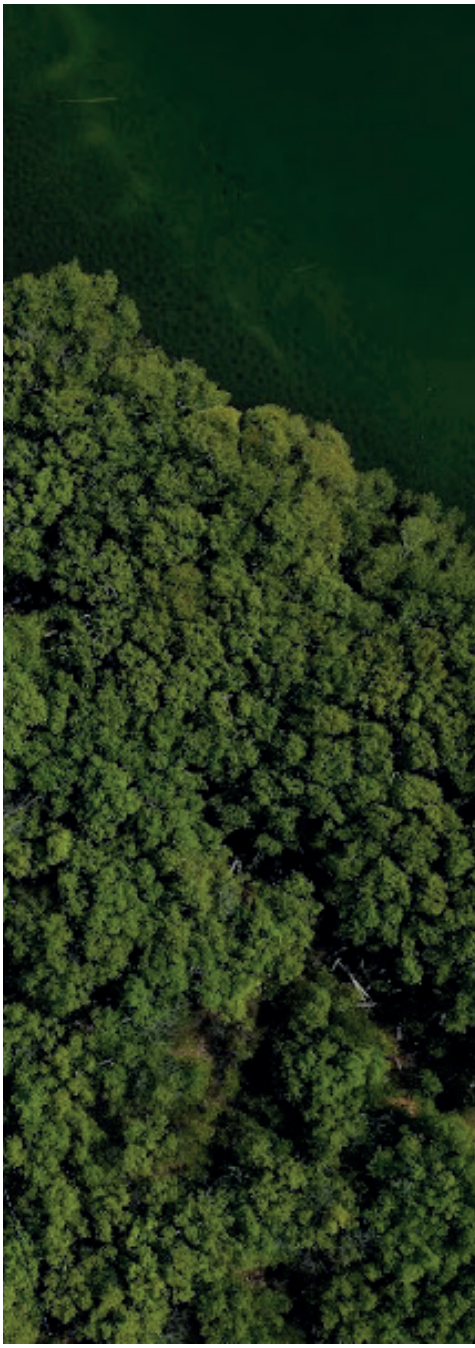

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SUMMARY

The Government of Indonesia commits to align economic growth with the sustainable development principles, hence the environmental health is fundamental for long-term economic development. The 2020-2024 National Mid-term Development Plan (RPJMN) has established agendas and priorities on the provision of data and information on biodiversity and ecosystems, which can be achieved through the completion of Natural Resources Accounts. In the global scheme, agenda related to the preparation of Natural Resources Accounts has become an agreement in the Convention on Biological Diversity (CBD Aichi Target 2), which target is to integrate the value of biodiversity into development strategies, particularly through the national accounting system. Ocean Accounts are structured set of information, in the form of maps, data, statistics, and indicators, regarding the marine and coastal environment status, including societal circumstances and other related activities. Information obtained from Ocean Accounts plays an important role in ocean management as indicators of the balance between economic growth and marine resources sustainability. For two decades, Indonesia has used the System of Environmental-Economic Accounting (SEEA) to quantify environmental assets, particularly in terrestrial areas, by compiling the Integrated System of Environmental - Economic Accounts of Indonesia (abbr. Sisnerling). It is a query and a task to see how the same initiative may be implemented in Indonesian marine waters. Several aspects, including the vastness of Indonesia's seas, human resource capacity, national budget, and the availability of policy and regulation, must be considered or even overcome.

Given the complexity of its preparation, the implementation of Ocean Accounts in Marine Protected Areas (MPA) as pilot site is considered a solid start, and among all established MPAs, Gili Matra has been selected as a pilot site for Ocean Accounts implementation in Indonesia. Four accounts have been prioritized to be developed, namely ecosystem assets, flows to the economy, flows to the environment, and ocean governance. Assessment involved desk studies, field surveys, interviews, and image processing and analysis to present the results through map.

Changes on ecosystem extent were identified by comparing the opening stock in 2015 with the closing stock in 2021 and its implication to the economic value. In 2015, total economic values for coral reefs, seagrass, and mangroves in Gili Matra was IDR 45.24 billion/year. Changes of coral reef, seagrass, and mangrove area, however, did not significantly affect the economic value as inflation and real interest rate in 2021 was higher compared to 2015. This led the increase of total economic value from coral reef, mangrove, and seagrass in 2021 to IDR 64.17 billion/year.

Assessment on flows to the economy was carried out in accordance with the role and functions of those ecosystems to identify the overall monetary value. Of the total monetary value IDR 33.05 billion/year, more than 90% came from tourism activities. This is far lower than the estimated monetary value before COVID-19 pandemic that estimated up to IDR 1.04 trillion/year.

Residual waste resulted from economic activity in the area was calculated to assess the flows to the environment accounts. In this assessment, both solid and liquid wastes were mainly sourced from tourism activities. Majority of solid waste 2,017 tonnes (70.4%) was disposed of in landfills, while 330,624 m^3 liquid waste was managed by waste companies.

For ocean governance accounts, we refer to the Management and Zoning Plan of Gili Matra MPA 2014 – 2034 to assess the current spatial use and arrangements, as well as taking the management measures that have been undertaken by a designated working unit (Satker). Alongside Satker, the management of Gili Matra MPA also involves the officials from Gili Indah Village, North Lombok Regency, and the West Nusa Tenggara Provincial government.

FOREWORD

The sustainable management of marine space is one of the strategic issues in current marine and fisheries development. Marine space and its resources provide goods and services for social and economic activities in the form of food, raw materials, cultural value and ecological functions. However, pressures from marine and coastal development and the impact of climate change have made the function and services of the oceans increasingly degraded. Waste and pollutants resulting from economic activities pose a threat to ecosystems integrity.

The Ministry of Marine Affairs and Fisheries undertakes key actions to response those issues. These include marine spatial planning, protection of biological diversity, improvement of ecosystems, and sustainable use of marine resources. Marine spatial planning ensures that all activities are in accordance with the space allocation and carrying capacity. Conservation preserve and maintains marine biodiversity at species and ecosystem level. Ecosystem restoration try to prevent, halt, and reverse the degradation of marine ecosystem.

Those policies and programs need instruments to measure and track its success. Ocean accounting provides a comprehensive instrument for purposes through its accounts. Ocean accounting generates temporal and spatial information about the extent, condition, and monetary value of marine resources. In addition, the value of the economic use of marine resources along with the flow of waste as a residue of economic activity are also presented in the accounts. In other words, the ocean accounting will strengthen science-based ocean policy where decisions are made from scientific data and information.

This report is a concrete effort undertaken by the Ministry of Marine Affairs and Fisheries with the Ministry of Finance, Statistics Indonesia (BPS), the Ministry of National Development Planning (BAPPENAS), and the Geospatial Information Agency (BIG) to develop ocean accounting in Indonesia. This ocean accounts were conducted as a pilot project for in the Gili Matra Marine Protected Area in West Nusa Tenggara Province. Beside involving Inter-Ministerial Team, this pilot project is also supported by the Global Ocean Account Partnership and Rekam Nusantara Foundation.

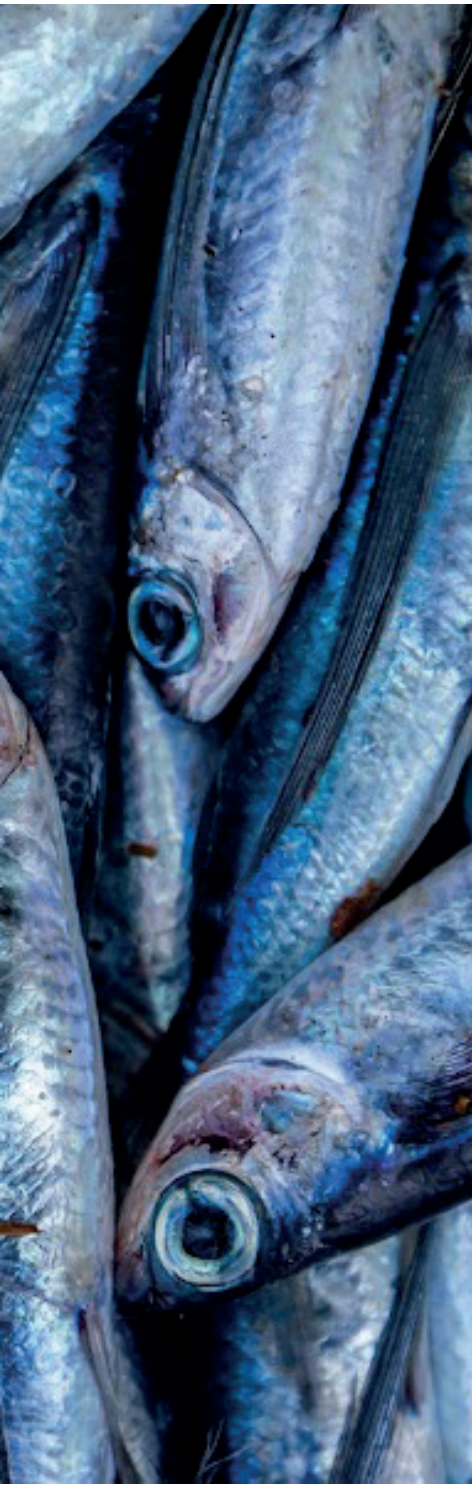
This document can be used as reference for national and provincial governments in developing ocean accounting for marine protected areas. The availability of ocean accounts will help improve the performance of conservation area management, especially in assessing the positive impacts to the ecosystem and socio-economic conditions of the community. In addition, the implementation of this pilot project provides valuable lesson in developing ocean accounting at the national scale.

Finally, the highest appreciation is directed to the Inter-Ministerial Team and Rekam Nusantara Foundation for their dedication and support during the implementation of this pilot project. I do believe this effort is a substantial work toward the sustainable ocean development in Indonesia. And we are proud to be part of the process.

Director General for Marine Spatial Management
Ministry of Marine Affairs and Fisheries
Republic of Indonesia

LIST OF ACRONYMS

Amdal	Environmental Impact Assessment
BAPPENAS	National Development Planning Agency
BIG	*Badan Informasi Geospasial*; Geospatial Information Agency
BKKPN	*Balai Kawasan Konservasi Perairan Nasional*; Centre for National Marine Protected Area
BA	Basal Area
BOD	Biological Oxygen Demand
BPS	*Badan Pusat Statistik*; Statistics Indonesia
C	Circumference
CBD	Convention on Biological Diversity
COREMAP-CTI	Coral Reef Rehabilitation and Management Program – Coral Triangle Initiative
CPCe	Coral Point Count with Excel extensions
CTI-CFF	Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security
DO	Dissolved Oxygen
Evika	*Evaluasi Efektivitas Pengelolaan Kawasan Konservasi*; Evaluation of the Marine Protected Area Management Effectiveness
F	Frequency
FADs	Fish aggregating devices
GOAP	Global Ocean Accounts Partnership
GBO	Global Biodiversity Outlook
GT	Gross Tonnage
H'	Diversity Index
HLP-SOE	High Level Panel on Sustainable Ocean Economy
IELH	Economic Instrument of Environment
IUCN	The International Union for Conservation of Nature
ICCTF	Indonesia Climate Change Trust Fund
IVI	Importance Value Index
J'	Evenness Index
KEPMEN	*Keputusan Menteri*; Ministerial Decree
KKP	Kementerian Kelautan dan Perikanan; Ministry of Marine Affairs and Fisheries
KLHS	Kajian Lingkungan Hidup Strategis; Strategic Environment Analysis



KEMENKOMARVES	*Kementerian Koordinator Bidang Kemaritiman dan Investasi*; Coordinating Ministry for Maritime and Investment Affairs
MBSU	Marine Basic Spatial Unit
MMAF	Ministry of Marine Affairs and Fisheries
MoE	Ministry of Environment
MPA	Marine Protected Area
NGO	Non-Government Organization
OECM	Other Effective Area-Based Conservation Measures
PDB	*Pendapatan Domestik Bruto*; Gross Domestic Product
PERMEN	*Peraturan Menteri*; Ministerial Regulation
PNBP	*Penerimaan Negara Bukan Pajak*; Non-Tax State Revenue
RD	Relative Density
RDo	Relative Dominance
RF	Relative Frequency
RPJP	*Rencana Pembangunan Jangka Panjang*; Indonesia's National Long-Term Development Plan
RPJMN	*Rencana Pembangunan Jangka Menengah*; Indonesia's National Medium-Term Development Plan
RTRLN	*Rencana Tata Ruang Laut Nasional*; National Marine Spatial Plan
Satker	*Satuan Kerja*; Working Unit
SDGs	Sustainable Development Goals
SEEA	System of Environmental-Economics Accounting
Sisnerling	*Sistem Terintegrasi Neraca Ekonomi dan Lingkungan*; Integrated System of Environmental - Economic Accounts of Indonesia
SNI	*Standar Nasional Indonesia*; Indonesian National Standard
SST	Sea Surface Temperature
SUOP	*Satuan Unit Organisasi Pengelola*; Management Unit
SINASI	*Survei Neraca Terintegrasi*; Integrated Accounts Survey
TSS	Total Suspended Solid
UKL-UPL	Management Effort/Environmental Monitoring
UNGA	United Nations General Assembly
UNDP	United Nations Development Programme

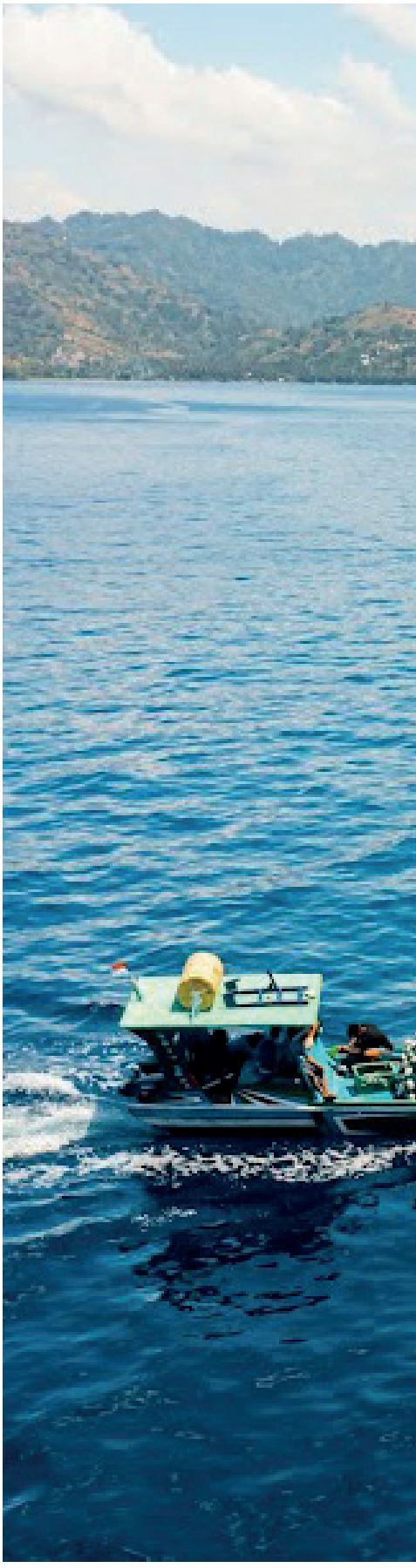
GLOBAL AGENDA FOR OCEAN ACCOUNTS 1

Globalization has driven a rapid growth of economy in many places. This encourages innovation and efficiency of the global value chains, which include research and development processes, production, and large-scale distribution of goods and services. In line with this, there have been significant changes to the environment condition such as land conversion, increasing level of pollutions of soil, water, and air, and human wildlife conflicts.

The Convention on Biological Diversity (CBD) is one of the global frameworks with the aim of ensuring the sustainable biodiversity to support the sustainability of life on earth. By prioritizing (1) biodiversity conservation, (2) sustainable use of biodiversity components, and (3) fair and equitable access and benefits of genetic resources, CBD has developed a strategic plan for the period of 2011-2020 by prioritizing five main strategies, of which, one emphasizes on the mainstreaming of biodiversity across government and society (Goal A). By 2020, biodiversity values are integrated into the planning systems of (1) development at national and regional levels, (2) poverty alleviation strategy, and (3) incorporated into the national accounting and reporting systems (Aichi Target 2).

Parallel to the mandate of CBD, equilibrium between economic growth and the environment was reiterated through the Sustainable Development Goals (SDGs) initiative or known as 'The 2030 Agenda for Sustainable Development Goals (SDGs)'. The 2030 SDGs Agenda was declared at the United Nations General Assembly (UNGA), which consists of 17 goals and 169 targets for 2015-2030 implementation. The 2030 SDGs Agenda focuses on direct contributions to humanity, development, and the environment, where biodiversity is one of key aspects to achieving those targets. As a system that has been adopted internationally and nationally, *Sisnerling* is developed to assist the government in measuring the progress of achieving the economic and environment linkages of the SDGs. There are 9 out of 17 goals of SDGs that are closely related with *Sisnerling*, namely resource assets (SDG 6, 13, 14, 15, 17), sustainable production and consumption (SDG 2, 12), economic growth (SDG 8), and green cities (SDG 11) (Pirmana et al., 2019). In terms of marine and fisheries sector, *Sisnerling* is related to the land asset accounts, material flow accounts, aquatic resource asset accounts, agriculture, forestry and fisheries accounts, environmental protection accounts, and environmental subsidy accounts.

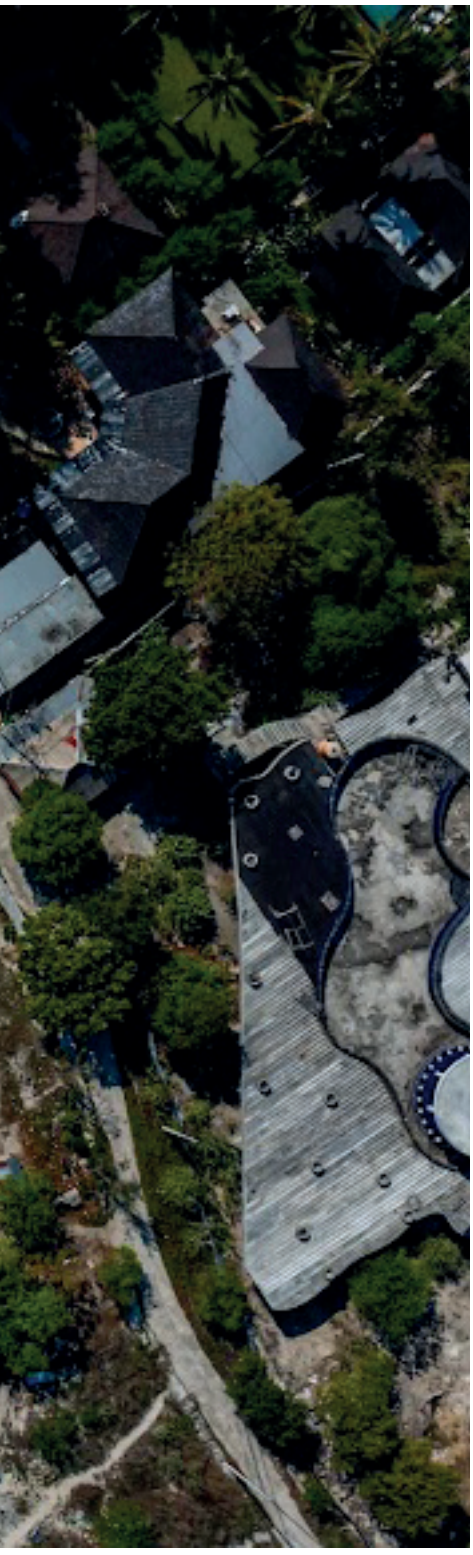
Responding to the increasing level of threats in maritime sector, the initiative to strengthen sustainable ocean economy emerged with the aim of aligning effective protection, sustainable production, and equitable distribution of welfare (Stuchtey et al., 2020). The High-Level Panel for a Sustainable Ocean Economy, a multilateral collaboration, was established in September 2018 by 14 Heads of State including Indonesia. This Panel aims at improving the relationships between the people and the ocean, bridging the health of the ocean and human welfare, embracing all stakeholders, harnessing the latest marine knowledge, and developing a transition agenda towards a sustainable ocean economy. In line with the spirit of achieving SDGs, this Panel is committed to managing 100% of the ocean area in a sustainable manner through five pillars: Ocean Wealth, Ocean Health, Ocean Equity, Ocean Knowledge, and Ocean Finance (IOC-UNESCO, 2021). Through the Ocean Wealth pillar, ocean management is directed towards sustainability, along with economic growth. Through Ocean Health, retention efforts are conducted to reduce the impact of climate change, to protect and restore marine and coastal ecosystems, and to reduce marine pollution. At the same time, through the Ocean Equity, Ocean Knowledge and Ocean Finance pillars, the equity in accessing the benefits of marine resources must go hand in hand with the knowledge of ecosystem services. Based on the records of the Global Biodiversity Outlook – GBO (Secretariat of CBD, 2020), nearly 100 countries have integrated the value of biodiversity into their accounting system, and Indonesia is one of the contributors through *Sisnerling*. Led by the Statistics Indonesia, Indonesia has started to integrate several natural resources components into the country assets accounts in 2014 (Statistics Indonesia, 2019).



Several challenges in SEEA implementation especially for developing countries are (1) data availability and quality, (2) inadequate financial support, and (3) limited knowledge and capacity in developing the SEEA (Pirmana et al., 2019). However, SEEA is currently the best approach to integrate natural resources utilization (Mahmud et al., 2013). The CBD are negotiating for the next biodiversity strategic plan after the 2011-2020 plan. The Post-2020 Global Biodiversity Frameworks brings opportunities to strengthen the SEEA, where according to the first draft of the frameworks for Goal B (CBD, 2020), contribution of nature to people should be accounted for and SEEA is applied as the monitoring tool for this.

Globally, the interrelations of people's welfare, nature sustainability, and economic growth is indisputable. Specifically related to the maritime sector, many of the benefits and opportunities from this sector are not explored or managed due to the suboptimal documentation system. Therefore, Ocean Accounts need to be developed as a benchmark of equilibrium between the economic growth and ocean sustainability (Ocean Panel, 2020). Responding to this need, the Global Ocean Account Partnership (GOAP) was established with the aim of facilitating the coordination and communication from various institutions to ensure that the value and benefits from maritime sector become one of the foundations in policy development (GOAP, 2019).

INDONESIA OCEAN MANAGEMENT 2



"Earth and water, and the natural resources contained therein are controlled by the State and used for the greatest prosperity of the people" is the commitment of the Government of Indonesia in managing natural resources as mandated in the 1945 Constitution, Article 33 (3). Furthermore, the use of natural resources for the welfare of the people also need to consider the aspect of justice for future generations. Therefore, in 1999, the implementation of this article was complemented by "The national economy is organized based on economic democracy, with the principles of togetherness, efficiency, justice, sustainability, environmentally friendly, independence, and by maintaining the balance of progress and national economic unity."

To ensure the use of natural resources for the maximum benefit of the people, the utilization of renewable natural resources must be conducted in a rational, optimal, and efficient manners, and must be maintained and improved in quality. As for nonrenewable natural resources, the utilization is conducted in balance with reclamation efforts and the search for alternative resources or substitute materials that are renewable and more environmentally friendly. In addition, its utilization is directed at (a) improvement of added value of natural resources products, (b) development of natural resourcesbased industries, (c) improvement of its efficiency and competitiveness in order to reduce the level of nonrenewable natural resources exploitation, (d) emphasis on environmentally friendly activities, (e) regional and local community development, (f) strengthening the support for young generations, and (f) firm and fair enforcement of environmental laws[1].

As the implementation of the above-mentioned commitment, the Government of Indonesia has developed the 2020-2024 National Medium-Term Development Plan (abbreviated as RPJMN in Indonesian). In line with the Law Number 32 of 2009, the government has formulated the foundation for environmental protection and management. Environmental protection and management are stated as systematic and integrated effort conducted to preserve environmental functions and prevent environmental pollution and/or damage which includes planning, utilization, control, maintenance, supervision, and law enforcement. This principle is one of the pillars of sustainable development in Indonesia. Therefore, mainstreaming of sustainability into development planning, including the 2020-2024 RPJMN, is conducted through the implementation of Strategic Environmental Analysis (abbreviated as KLHS in Indonesian) as one of the guidelines in developing the RPJMN as well

1 Law No. 17 of 2007 concerning 2005 – 2025 Long-Term Development Plan

as incorporating several SDGs indicators into the indicators of development achievement[2]. In 2020-2024 RPJMN, a specific development plan for marine and fisheries sector is part of the Development Agenda 1 "Strengthening economic resilience for quality and equitable growth" and Development Agenda 6 "Building the environment, improving disaster resilience, and climate change".

Indonesia is widely recognized as the largest archipelagic state in the world, has registered 16,671 out of an estimated of 17,504 islands in Indonesia to the United Nations, and has a water area of 6.4 million km^2 and a coastline of 108,000 km. As a maritime state, Indonesia also has a wealth of natural resources assets, including renewable resources such as fisheries, coral reefs, seagrass beds, and mangrove forests; nonrenewable resources such as oil, natural gas, and other mineral resources; marine energy such as tides, waves, and wind; as well as environmental services that support the people's livelihoods such as marine tourism, sea transportation, and germplasm. Although the potential benefits derived from natural resources are relatively high, problems especially in marine and fisheries sector are still a challenge as they are linked with other sectors, which also sensitive to interactions, particularly with environmental aspect. Issues in fisheries management as outlined in the 2020-2024 Strategic Plan of the Ministry of Marine Affairs and Fisheries include those related to the sustainability of fish resources and the environment, sustainability of community livelihoods in fisheries sector, food security, and economic growth derived from the use of marine and fisheries resources.

The development of marine and fisheries sector is conducted in reference to several regulations such as the Law No. 31 of 2004 in conjunction with the Law No. 45 of 2009 concerning Fisheries, Law No. 27 of 2007 in conjunction with the Law No. 1 of 2014 concerning Management of Coastal Areas and Small Islands, as well as the Law No. 32 of 2014 concerning Marine Affairs. Fisheries management, as mandated in the Law No. 31 of 2004, is conducted to achieve the optimal and sustainable benefits, and to ensure the sustainability of fish resources. Management of fish resources is conducted through a sustainable use approach as well as Fisheries Management Area-based resources

2 Presidential Regulation Number 18 of 2020 concerning 2020-2024 National Medium-Term Development Plan

governance. In addition, fisheries governance also further regulates Conservation of Fish Resources through the Government Regulation No. 60 of 2007, which explains the guidelines of conservation efforts that are based on the ecosystem, aquatic species, and genetic resources.

Similar with the management of coastal areas and small islands, resources management is conducted through the process of intersectoral planning, utilization, monitoring, and control between the Central and Regional Governments, between land and marine ecosystems, as well as between science and management to improve the people's welfare[3]. In a wider scope, as stated by the Maritime Law, marine management is stated as the implementation of activities, provision, exploitation, and utilization of marine resources as well as marine conservation.

Regional-based marine development planning is carried out through Marine Spatial Planning which includes Coastal Areas and Small Islands Zoning Plan, Inter-regional Zoning Plan, National Strategic Area Zoning Plan and/or Special National Strategic Area Zoning Plan[4]. In this area-based planning, the allocation of marine area is conducted to avoid the conflict of utilization. Marine sectors comprise sea transportation, energy and mineral resources, marine tourism, as well as maritime industries and marine services. In the regional planning system, these sectors are accommodated in the General Use Area. In addition, marine protected areas are dedicated for biodiversity conservation. However, it must be noted that marine protected areas are not the only way in protecting marine environment[5]. Prevention of pollution and/or damage to the ocean environment, which includes marine pollution control, marine disaster management, as well as prevention and management of pollution, damage, and disaster are also important.

3 Law No. 27 of 2007 concerning Coastal Areas and Small Islands
4 Government Regulation No. 32 of 2019 concerning Marine Spatial Plan
5 Law No. 32 of 2014 concerning Marine Affairs, Articles 50-57

FRAMEWORK OF OCEAN ACCOUNTS IN INDONESIA 3

Through the Vision and Direction of the 2005-2025 National Long-Term Development Plan (RPJP), the Government of Indonesia emphasizes the importance of natural resources development in the economy of Indonesia, in the past, present, and future. The natural resources contribute 30% to the national GDP in 2001, and 57% to employment rate. In marine sector, the annual potential of fish resources reaches 53.9 ton. However, it is recorded that approximately 40% of coral reefs are damaged and only around 30% of mangrove forests are in good condition[6]. Marine resources are highly valuable potential to support economic growth. Therefore, in the Direction of 2005-2025 RPJP, the utilization of marine resources must be supported by strong national policy, technology innovation, and human capacity. The suboptimal utilization of marine resources, among others, is due to the inadequate support of science and technology. The accurate, uptodate, consistent, and comprehensive data become important aspect in bridging the formulation of data or sciencebased policy.

Indonesia's marine and fisheries management policy has been outlined in the 2020-2024 RPJMN. The policy is also in line with SDG 14: Life Below Water, i.e., to support conservation of 10% of marine and coastal areas, to manage and protect marine and coastal ecosystems in a sustainable manner, as well as to improve the economic benefits from marine and fisheries sector. The policy direction to achieve these three objectives include strengthening the governance and synergy between institutions, sustainable use, and sustainable funding support.

Government of Indonesia initiated the Coral Reef Rehabilitation and Management Program – Coral Triangle Initiative (COREMAP-CTI) to preserve marine and coastal resources and improving the welfare of coastal communities. This strategic program produces innovation model of development, especially in the sustainable management of coastal and marine ecosystems in particular coral reef, and to support the management efforts of climate change impacts in marine and fisheries sector. The Government of Indonesia also committed to realizing the sustainable ocean economy through the Blue Economy approach. The scope of Blue Economy is not only related to ocean-based economy, but also harmonization between human and ecosystem, creating jobs and social capital, and innovation-based entrepreneurship (Adrianto, 2019 in KEMENKOMARVES, 2021). In early 2021, the President of Indonesia emphasized the importance of Blue Economy, as well as indicators or methods to measure marine resources potential in Indonesia.

6 Annex of Law No. 17 of 2007 concerning 2005 – 2025 Long-Term Development Plan

The Government of Indonesia has set 2030 as the target for achieving the implementation of Sustainable Ocean Plan, which is a credible foundation for maintaining marine health and resilience in the longterm, attracting investments, as well as creating job opportunities for the benefit of coastal community and national economy. To be able to describe the linkages between economic development and sustainability of natural resources and the environment, the availability of accurate data and information becomes critical. Statistics Indonesia as the centre for the *Sisnerling* appoint relevant ministries/ institutions and/or Regional Governments to provide sectoral data and information. Similar mechanism was then applied in the development of Ocean Accounts. To date, Statistics Indonesia has conducted an indepth study on the preparation of Ocean Accounts, including organizing the discussion between institutions to identify data gaps. Based on the in-depth study, in addition to Statistics Indonesia, the key institutions for the development of Ocean Accounts include the MMAF, Geospatial Information Agency, and the Ministry of Finance. The Statistics Indonesia routinely conducts Integrated Accounts Survey (*Survei Neraca Terintegrasi*/SINASI) at provincial and district/city levels. In 2021, SINASI has incorporated the element of SEEA in-depth study to improve human capacity of Regional Governments in collecting data to develop the Ocean Accounts.

The development of ocean accounts is also one of key activities for the environmental management. Law No. 32 of 2009 regulate the environmental protection and preservation through prevention efforts. A number of regulated preventive instruments include strategic environment analysis (abbr. KLHS), spatial planning, environmental quality standard, standard criteria of environmental damage, environmental impact assessment (abbr. *Amdal*), management effort-environmental monitoring (abbr. UKL-UPL), permits, economic instrument of environment (abbr. IELH), environmental-based laws and regulations, environmentalbased funding, environmental risk analysis, environmental audit, as well as other instruments which continue to develop following the development of science and technology.

The economic instrument of environment is detailed in the Government Regulation No. 46 of 2017. This instrument includes development planning and economic activities, environmental funding, as well as the development of incentive and/or disincentive mechanisms. One of the components of the development planning and economic activities is the Natural Resources and Environmental Accounts, which are the responsibility of the Central and Regional Governments. The Natural Resources and Environmental Accounts as defined in Article 1 describe the assets and their changes. Implementation at regional level is conducted based on the Circular Letter of the Minister of Home Affairs and the Head of Geospatial Information Agency (BIG) Number 660/2367/S/83.KA/RT/6/2012.

Natural resources are the main capital in economic activities that are converted into various goods and services. Economic development is defined as the chain of efforts aimed to improve human welfare, employment opportunities, equitable income, and encouraging alternative sectors (Statistics Indonesia, 2012). To support the economic development, indicators such as Gross Domestic Product (GDP) need to be monitored. However, in many cases, economic activities have caused the environmental degradation. Hence, the measurement between economic achievement and environmental quality is needed.

According to the United Nations (2014), SEEA is a multipurpose conceptual framework that describes the interaction between economy and the environment, as well as the stock and changes in environmental assets. Indonesia *Sisnerling,* which was initiated in 1997, has provided important lessons learnt in the assessment of environmental assets. From its development, the needs for resource account continued to expand, including for marine assets. Not only knowing the existing assets, but the government is also required to be transparent regarding the value and condition of natural resources. Therefore, the success of *Sisnerling* must be replicated, and synergized with the country's financial system and decision making.

Marine landscape represents 70% of the earth's surface. This has placed the ocean as the centre of the world's economic activities. As an effort to measure the impact of economic, social, and environmental activities, Ocean Accounts need to be developed as part of *Sisnerling*. According to GOAP (2020), Ocean Accounts are defined as the compilation of structured information – consistent and comparable: maps, data, statistics, and indicators – regarding marine and coastal environment, including relevant social conditions and major activities. Ocean Accounts inform and enable public policy decisions on marine affairs, as well as relevant research and analysis. At the same time, Ocean Accounts provide coherent structure to standardize dispersed data and to produce reliable integrated indicators for policy purposes.

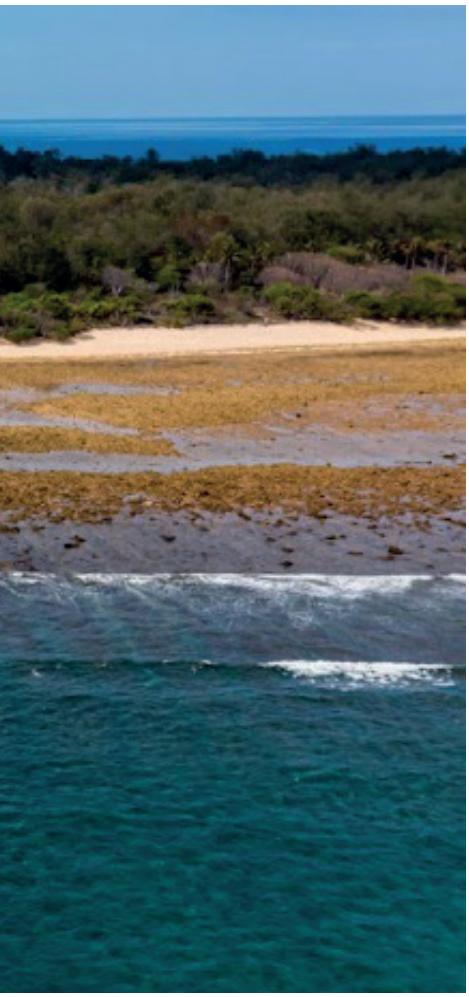
Referring to the Government Regulation No. 46 of 2017, natural resources accounts are applied for (a) natural resources management, (b) spatial planning, (c) conservation of natural resources, and (d) preservation of environmental functions. Ocean Accounts can be prioritized for those aspects; therefore, Marine Protected Area is selected as pilot for Ocean Accounts development in Indonesia as it accommodates the aspects. Marine Protected Area is a miniature of natural system, with defined clear boundaries, consist of natural resources (mangrove, coral reefs, etc.) as well as cultural sites, which is managed to achieve certain goals. In Indonesia, Marine Protected Area management is conducted through zoning system, which regulates the activities or utilization inside the area. This regulatory system is described in a management plan implemented by the Management Unit (*Satuan Unit Organisasi Pengelola*/SUOP). To ensure the compliance with the zoning system, permit is established to control activities in Marine Protected Area. The development of Ocean Accounts for Marine Protected Area provides information on the impact of economic activities. The results of this indicator can be used by SUOP for equitable and sustainable MPA management. Information provided by Ocean Accounts including (a) the ecosystem extent and condition, (2) impact of economic activities, and (3) residual waste to the environment. Based on that information, SUOP is expected to determine the appropriate measures for Marine Protected Area management, by ensuring the benefits of the natural resources for the communities.

Considering the development of ocean accounts is a complex and involve many different aspects of ocean, a road map as guidance is required. Ocean Accounts Roadmap for Indonesia has been consulted at the first National Stakeholder Workshop on September 23, 2021. The workshop involving stakeholders from government institutions, universities, NGOs, and civil society, resulted in several recommendations, including: 1) priority areas (MPA, fisheries, aquaculture, tourism, coastal industry area, marine mining area, and sea transportation), 2) institutional arrangement and mechanism (inter-agency team, data integration, integration with Marine Spatial Planning and conservation). General timeframe for Ocean Accounts development was proposed where in the first-year priority will be for institutional and governance strengthening; survey data analysis and accounts drafting, and presentation. In the second year, the main components include stakeholder consultation, developing guidelines, and standard for accounts data collection. And the next years are dedicated to accounts finalization, socialization, and knowledge management. General timetable for the implementation of Ocean Accounts development has been formulated as presented in Table 1.

Table 1. General Implementation Plan for Ocean Accounts Development in Indonesia

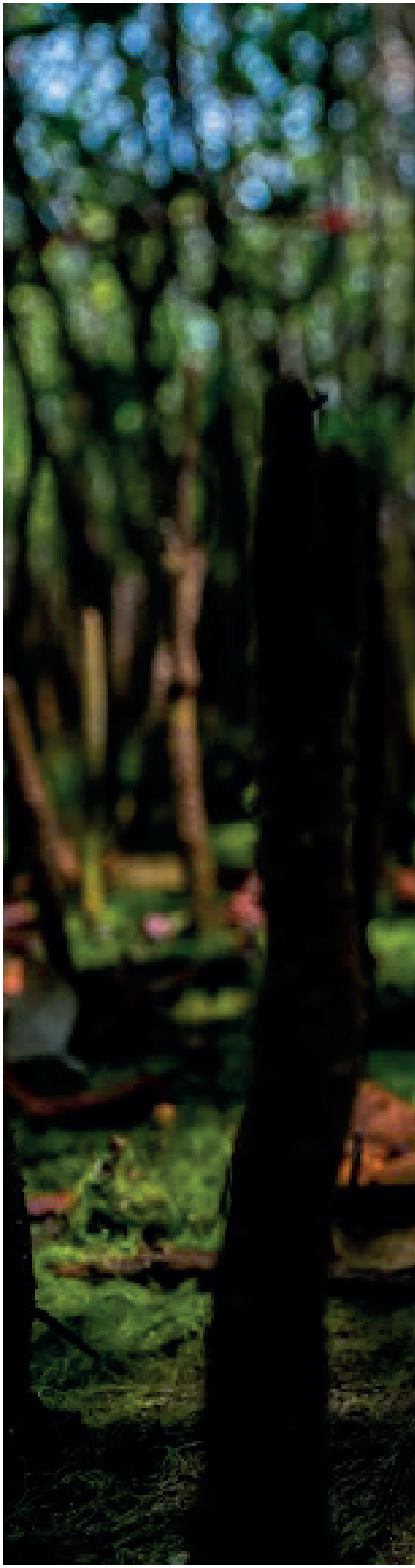
No.	Main Component/ Activity	Output	Year				
			1	2	3	4	5
1.	Institutional and governance strengthening: 1.1. Coordination and consolidation 1.2. Policy development and capacity building 1.3. Inter stakeholder collaboration	• Pilot site, accounts priority, data requirement, key actors, project management • New and/or improved policy to support operational level • National and local staff including key stakeholders are trained in Ocean Accounts conceptual approach and practice • Stakeholder forum					
2.	Survey, data analysis, and presentation	• Primary and secondary data for Ocean Accounts development • Scenario, trend, and changes analysis					
3.	Developing guideline and standard for data collection, analysis, and presentation	National guideline for Ocean Accounts and standard for data collection, analysis, and presentation.					
4.	Stakeholder consultation at national and local level	Input, comments, and recommendation to improve data, guideline, and relevant policy and programs.					
5.	Knowledge management	Awareness and education, best practices, data management					

MARINE PROTECTED AREA SYSTEM AND MANAGEMENT 4



Referring to Law Number 31 of 2004 jo. Law Number 45 of 2009 concerning Fisheries, the development of MPAs is part of fish resources management. Similar with Law Number 27 of 2007 on the Management of Coastal Areas and Small Islands, and Law Number 32 of 2014 on Marine Affairs, management of marine protected areas is part of the efforts to ensure the existence, availability, and sustainability of natural resources. MMAF has set two main targets for the management of MPA: (1) more than 20 million hectares of existing MPAs will be managed effectively by 2024; and (2) to expand MPAs to 32.5 hectares (10% of Indonesia's territorial waters) by 2030, and all of them are managed effectively. These main targets are set out into seven Areas of Work: (1) integrated planning and funding for central and regional programs; (2) human resources, competence, and capacity; (3) legal and regulatory framework; (4) sustainable use in MPA; (5) sustainable financing; (6) Other Effective Area-Based Conservation Measures (OECM); and (7) communication and outreach platforms (MMAF, 2020).

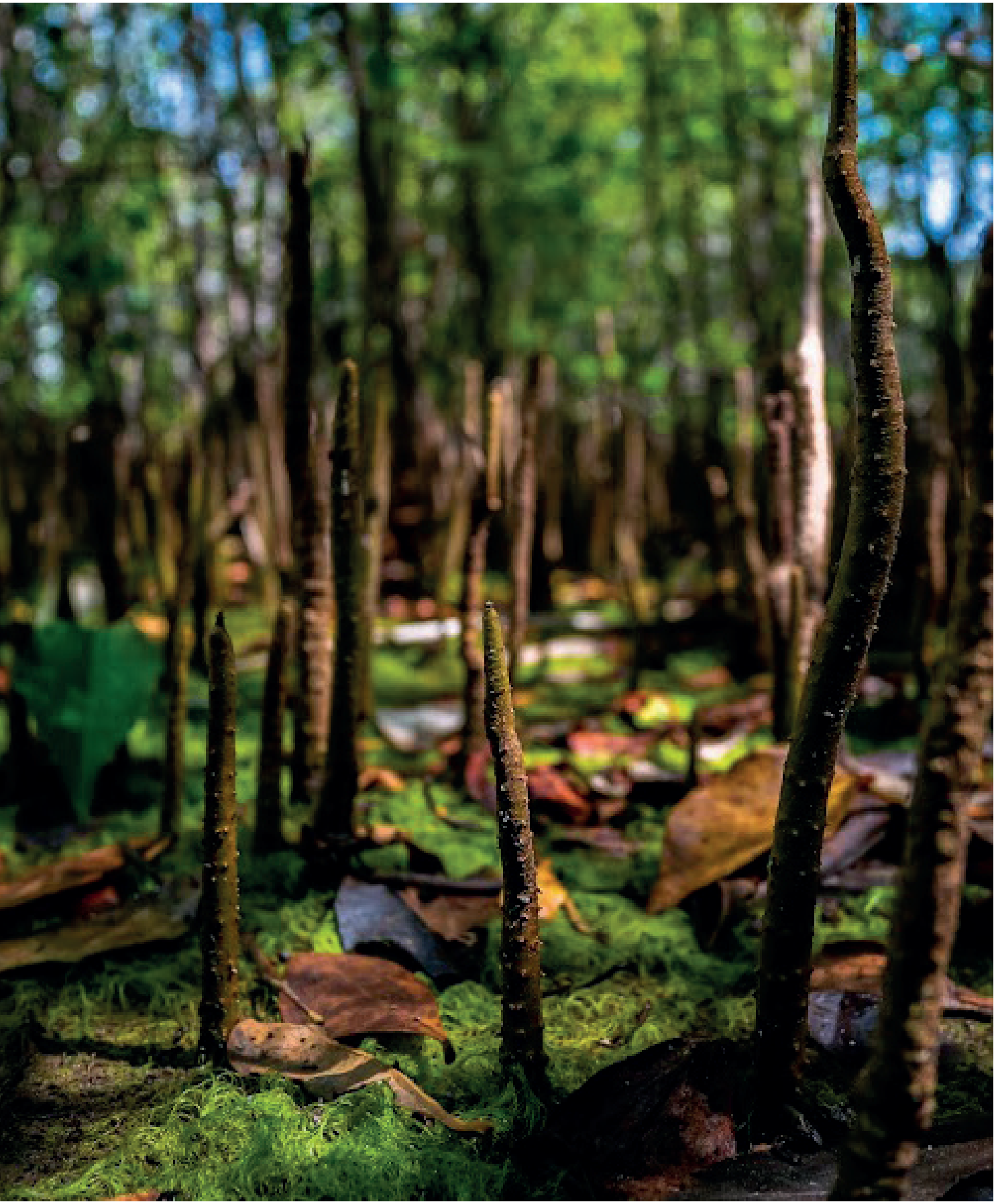
The main target related to the expansion of MPAs is one of the realizations of Development Agenda 6 of the 2020-2024 RPJMN. In 2020, Indonesia has allocated 24.11 million hectares or 7.4% of its territorial waters for MPA (MMAF, 2021). Statistically, Indonesia has reserved 411 MPAs, of which there are 10 MPAs managed by Central Government (National Marine Protected Areas or *Kawasan Konservasi Nasional*), 371 MPAs managed by Provincial Government (Regional Marine Protected Areas or *Kawasan Konservasi Daerah*), and 30 MPAs under the Ministry of Environment and Forestry. The MMAF targeted the effective management of at least 10 million hectares of MPAs, and as of the fourth quarter of 2020, the area of effectively managed MPAs in Indonesia has reached 10.1 million hectares.



The technical development and management of MPAs refers to the Regulation of MMAF No. 31 of 2020, which regulates the planning, determination, utilization, monitoring, management evaluation, and funding of MPAs. Specifically related to utilization, the Regulation of MMAF No. 47 of 2016 stated that all parties utilize the MPAs must comply with the zoning system. Utilization in this regulation include (1) research and education, (2) fishing, (3) fish farming, (4) recreational boat, (5) marine tourism, (6) tourism infrastructures, (7) marine structures, (8) marine installation, (9) alternative energy, (10) commercial filming, and (11) seaplane landing and taxi.

To ensure the MPA achievements, a monitoring tool has been developed by the Directorate General of Marine Spatial Management through Decree No. 28 of 2020 on the Evaluation of the MPA Management Effectiveness (abbr. *Evika*). *Evika* measures the input, process, output, and outcome of MPA management. *Evika* becomes part of adaptive management cycle which is expected to improve decisions, management policies, and practices.

The existence of Ocean Accounts, among others, plays a role in determining the baseline for monitoring and evaluation of MPAs, as the basis for benefit and cost analysis, as well as performance indicators. Ocean Accounts are also important in calculating the cost of utilization, financial incentives, and impact of utilization. Therefore, Ocean Accounts can be used as pillar for MPA management effectiveness. Given the relatively complex aspects of its preparation, initiative in MPA is a good start for a pilot site of Indonesia's Ocean Accounts.



GILI MATRA MARINE PROTECTED AREA 5

Of the many MPAs that have been established, there is Gili Ayer, Gili Meno and Gili Trawangan (Gili Matra) MPA that have been chosen as pilot site. Gili Matra MPA is located within the administrative area of Pemenang Sub District of North Lombok District, West Nusa Tenggara Province. The area of Gili Matra has several special features, such as being one of the 50 National Tourism Destinations. This area is also located within the Lesser Sunda Seascape, which is one of the priority seascapes of CTI-CFF. More importantly, Gili Matra is the habitat of various species of coral reef, mangrove, and seagrass.

Apart from the ecological and economic potential, Gili Matra MPA face various threats. The decline in the ecosystem value of Gili Matra was caused by human activities and climate change impacts in particular coral bleaching (Setiawan et al., 2017). Despite the various efforts to restore the ecosystem, habitat function has not yet been fully recovered. Therefore, it is important to assess the ecosystem assets accounts of Gili Matra.

Gili Matra MPA has long history in its development. The designation was beginning with Marine Tourism Park (Decree of the Minister of Forestry Number 85/Kpts-II/1993). In 2001, the status of Gili Matra changed into MPA managed by the Ministry of Forestry (Decree of the Minister of Forestry No. 99/Kpts-II/2001). After eight years, the management was transferred to the MMAF (Handover Notes: BA.01/Menhut-IV/2009-BA.108/MEN.KP/III/2009 KEP.67/MEN/2009), and later the management was handed to the Centre for National Marine Protected Area (abbr. BKKPN) located in Kupang, East Nusa Tenggara.

According to the Decree of the MMAF No. 67 of 2009, the extent of Gili Matra MPA was 2,954 hectares. The government established the 2014-2034 Management and Zoning Plan of Gili Matra MPA (Decree of the Minister of Marine Affairs and Fisheries Number 57 of 2014), with total area of 2,273.56 hectares (Figure 1). The Management and Zoning Plan document reviews the existing potentials in Gili Matra MPA, including the ecological, economic, social, and cultural potentials. In addition, the document presents various management issues, such as habitat degradation, governance, and law enforcement. According to the zoning plan, Gili Matra MPA was divided into four zones: (1) core zone, (2) sustainable fisheries zone with one sub-zone for sustainable reef fisheries, (3) utilization zone, and (4) other zones consisting of protection zone, rehabilitation zone, and port zone (Figure 1). As for the management plan devided into long- and medium-term plans, to be achieved within the period of 2014-2034. In 2021, the *Evika* Assessment Team (according to Decree of the Director General of Marine Spatial Management Number 36 of 2021) conducted assessment for Gili Matra MPA. The assessment score was 64.19, meaning that the Gili Matra MPA was optimally managed.

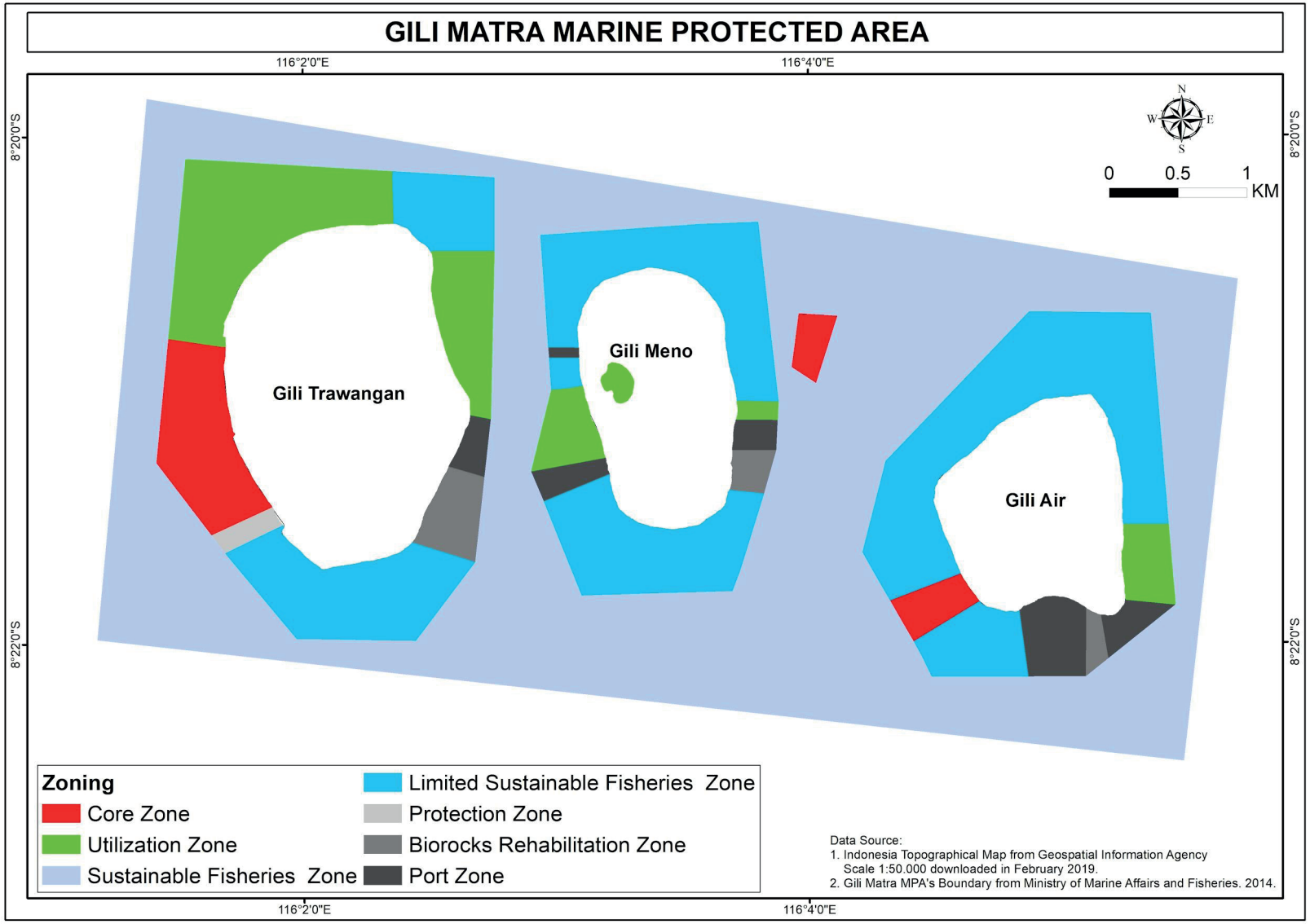


Figure 1. Gili Matra MPA and its zoning plan according to Decree of the Minister of Marine Affairs and Fisheries Number 57 of 2014

METHODOLOGY 6

The Ocean Accounts framework are composed of the following structures: (1) environmental assets; (2) flows to the economy; (3) flows to the environment; (4) ocean economy; (5) ocean governance; (6) combined presentation; and (7) ocean wealth (GOAP, 2020). The structures are generally arranged in tiers and are interconnected. The preparation of the ocean accounts at Gili Matra MPA will focus on the ecosystem assets, flows to the economy, flows to the environment and ocean governance.

A. Data Collection

The data used in the preparation of the ocean accounts are sourced from survey results and official government data which also has information to be analysed and displayed spatially. In addition to surveys and official government data, several data on water conditions are obtained through data analysis from global data portals. The use of global data sources is recommended with caution, due to the possibility of generalizations and interpretations that are not suitable to local conditions.

In preparing the ecosystem assets in Gili Matra MPA, the supporting data consist of (1) ecosystem extent and condition of coral reefs, seagrass, and mangroves; and (2) biophysical features which include sea surface temperature (SST), chlorophyll-a, total suspended solids (TSS), acidity (pH) and dissolved oxygen (DO). The data represents the 2015 and 2021 observation periods. Data were obtained through field surveys, sampling, analysis of image data, and data that were obtained from the Geospatial Information Agency, scientific articles, and technical reports. Data collection and analysis was carried out from September to October 2021. The summary of the data collection and method at Gili Matra MPA is shown in Table 2.

The ecosystem assets survey was conducted in Gili Matra MPA and surrounding areas. Survey for ecosystem extent was carried out at 194 points (Figure 2), where the sampling location was represented by a grid measuring 100 x 100 meters, which was then used to verify and update the spatial data of ecosystems produced by Geospatial Information Agency. Survey for ecosystem condition was conducted at 30 stations (covering coral reef, seagrass, and mangrove; Figure 3), while biophysical survey was conducted at 40 sampling locations (Figure 4).

Table 2. Parameters observed for ecosystem assets in Gili Matra MPA

Agenda	Parameter Observed	Methods
Ecosystem extent and condition		
Survey of coral reef extent and condition	Coral reef extent (validation)	Rapid survey, Coral Point Count with Excel extensions (CPCe)
	Diversity	Underwater photo transects
	Coral reef condition	Recruitment
	Reef fishes	Underwater visual census, timed swim, habitat complexity
Survey of seagrass extent and condition	Seagrass extent (validation)	Rapid survey
	Diversity	Quadratics transect
	Seagrass condition	Diversity analysis
Survey of mangrove extent and condition	Mangrove extent (validation)	Rapid survey
	Diversity	Quadratics transect
	Seagrass condition	Diversity analysis
Biophysical/Water quality		
Analysis and survey of biophysics condition	Sea surface temperature	Landsat 8 satellite imagery
	Chlorophyll-a	Landsat 8 satellite imagery
	Total suspended solids (TSS)	Landsat 8 satellite imagery
	Acidity (pH)	Water quality instrument
	Dissolved oxygen (DO)	DO Meter
	Biological oxygen demand (BOD)	Laboratory analysis

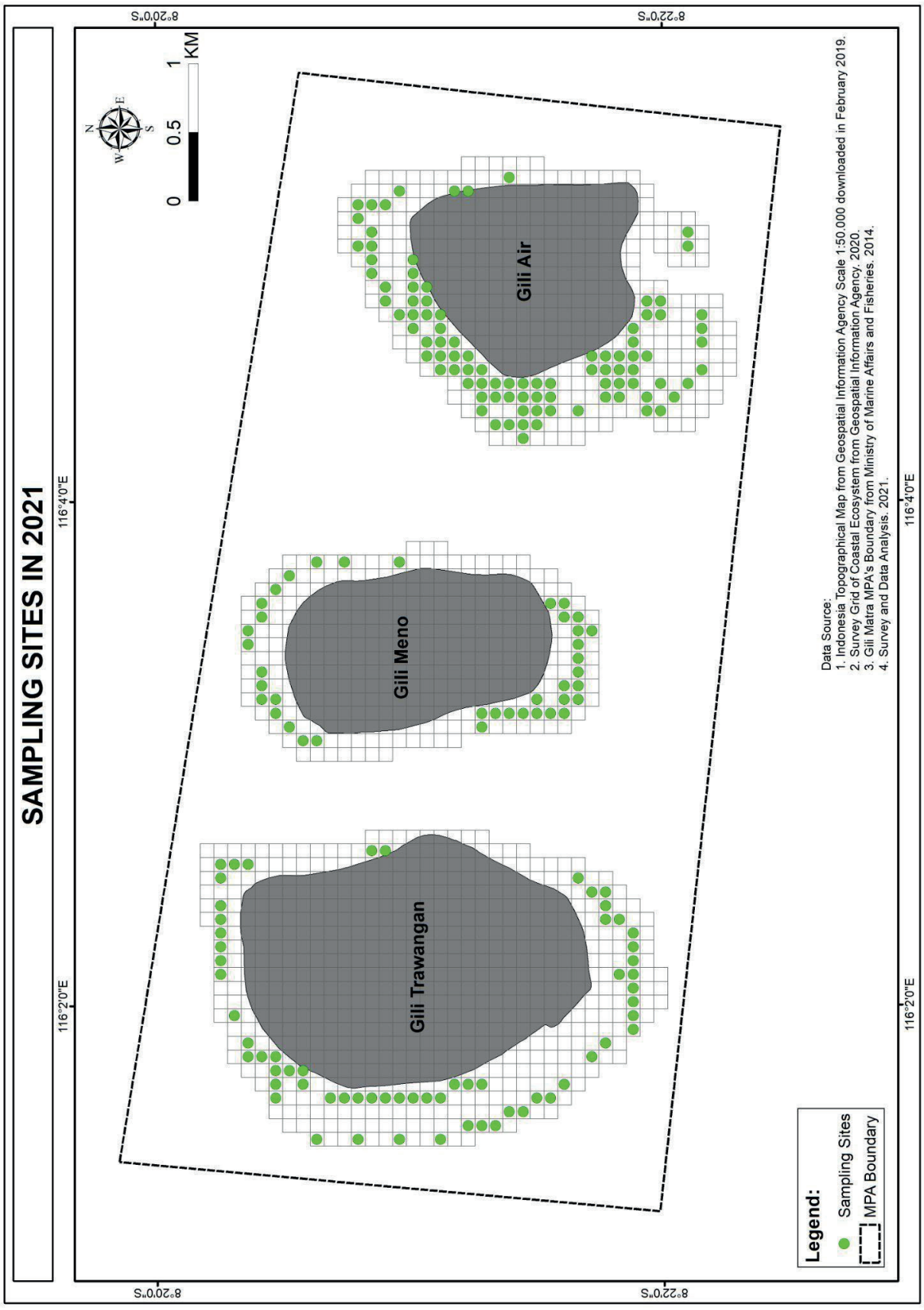
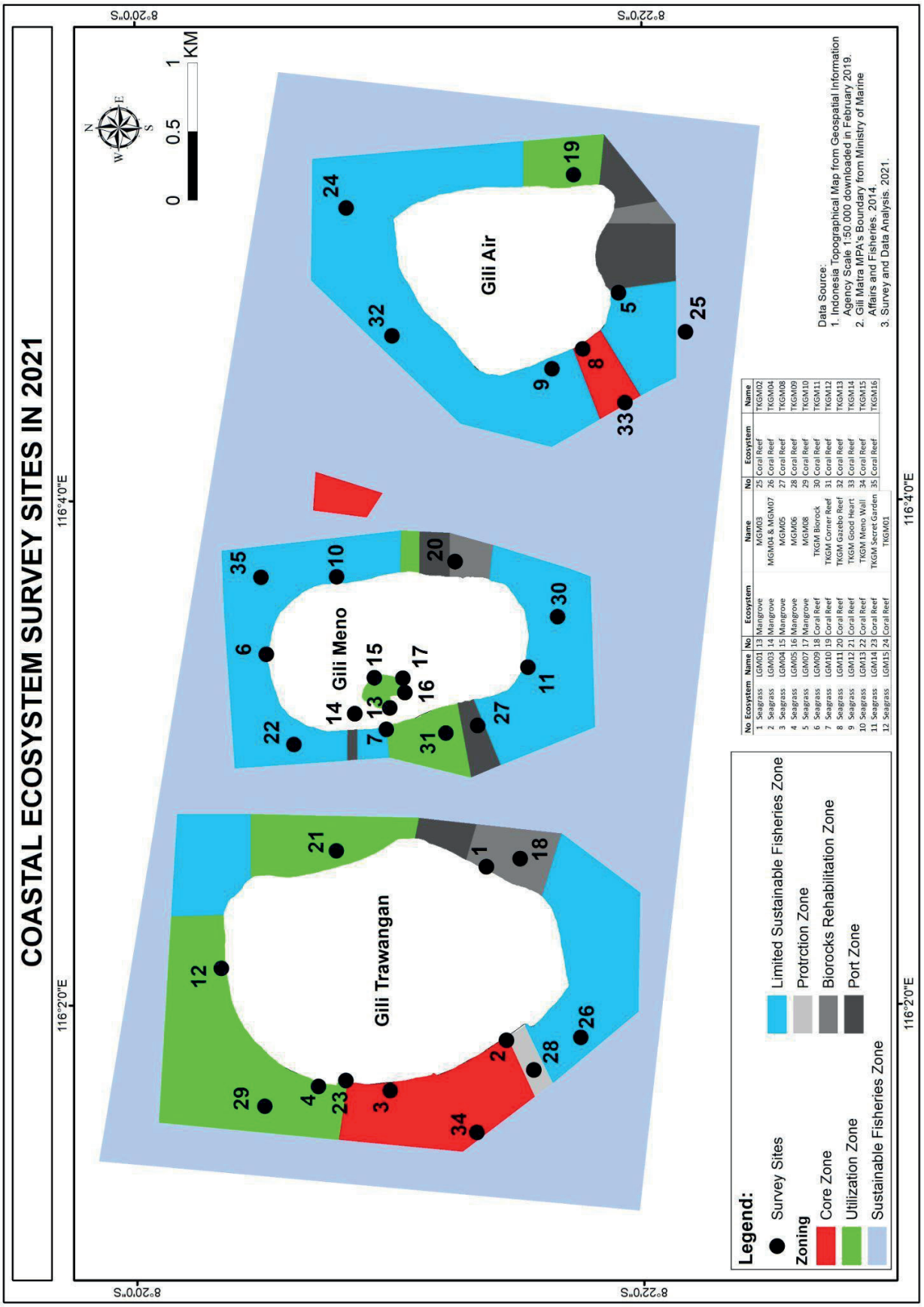


Figure 2. Map of ecosystem extent survey in Gili Matra MPA



No	Ecosystem	Name	No	Ecosystem	Name	No	Ecosystem	Name
1	Seagrass	LGM01	13	Mangrove	MGM03	25	Coral Reef	TKGM02
2	Seagrass	LGM03	14	Mangrove	MGM04 & MGM07	26	Coral Reef	TKGM04
3	Seagrass	LGM04	15	Mangrove	MGM05	27	Coral Reef	TKGM08
4	Seagrass	LGM05	16	Mangrove	MGM06	28	Coral Reef	TKGM09
5	Seagrass	LGM07	17	Mangrove	MGM08	29	Coral Reef	TKGM10
6	Seagrass	LGM09	18	Coral Reef	TKGM Biorock	30	Coral Reef	TKGM11
7	Seagrass	LGM10	19	Coral Reef	TKGM Corner Reef	31	Coral Reef	TKGM12
8	Seagrass	LGM11	20	Coral Reef	TKGM Gazebo Reef	32	Coral Reef	TKGM13
9	Seagrass	LGM12	21	Coral Reef	TKGM Good Heart	33	Coral Reef	TKGM14
10	Seagrass	LGM13	22	Coral Reef	TKGM Meno Wall	34	Coral Reef	TKGM15
11	Seagrass	LGM14	23	Coral Reef	TKGM Secret Garden	35	Coral Reef	TKGM16
12	Seagrass	LGM15	24	Coral Reef	TKGM01			

Figure 3. Map of ecosystem condition survey in Gili Matra MPA

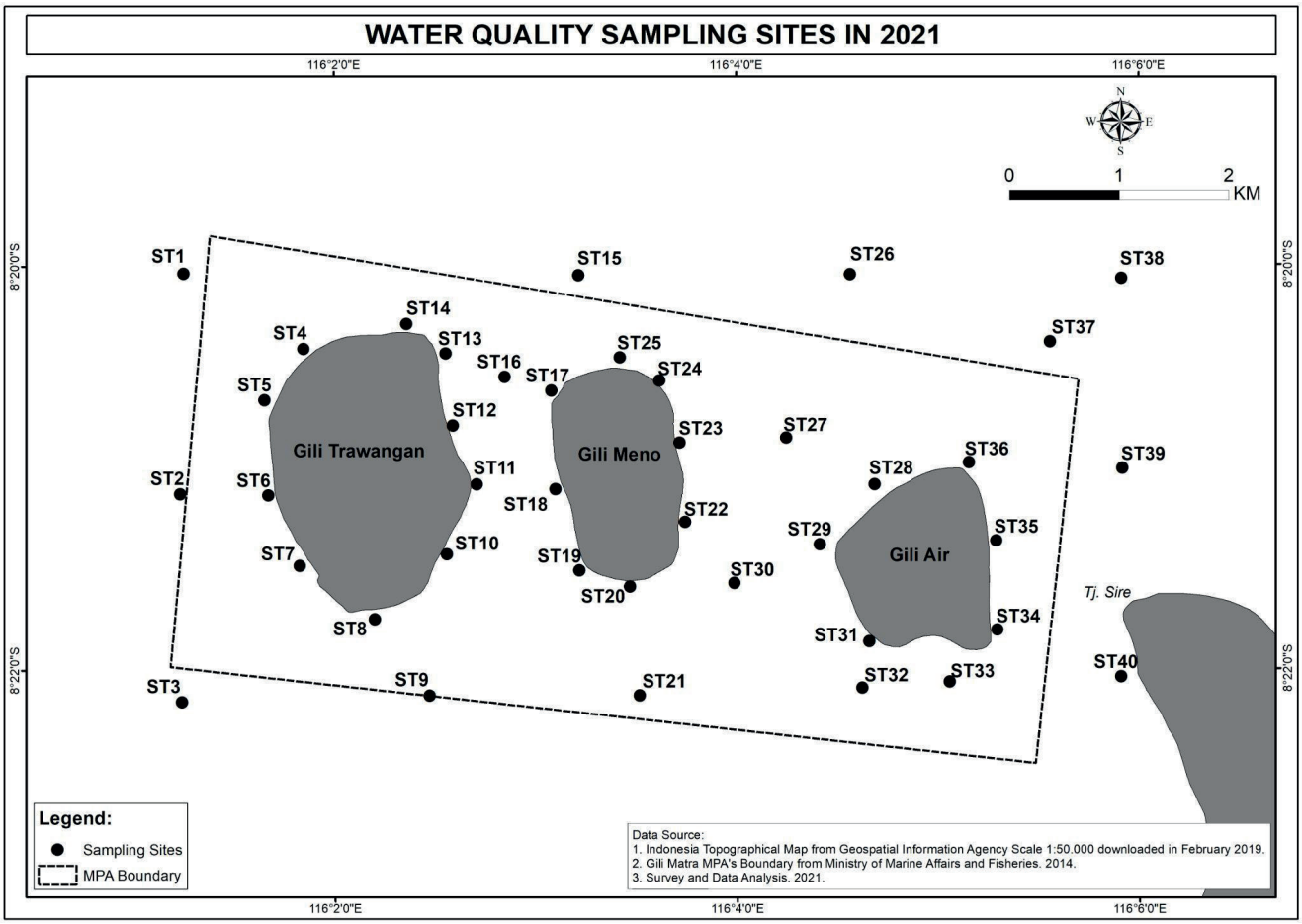
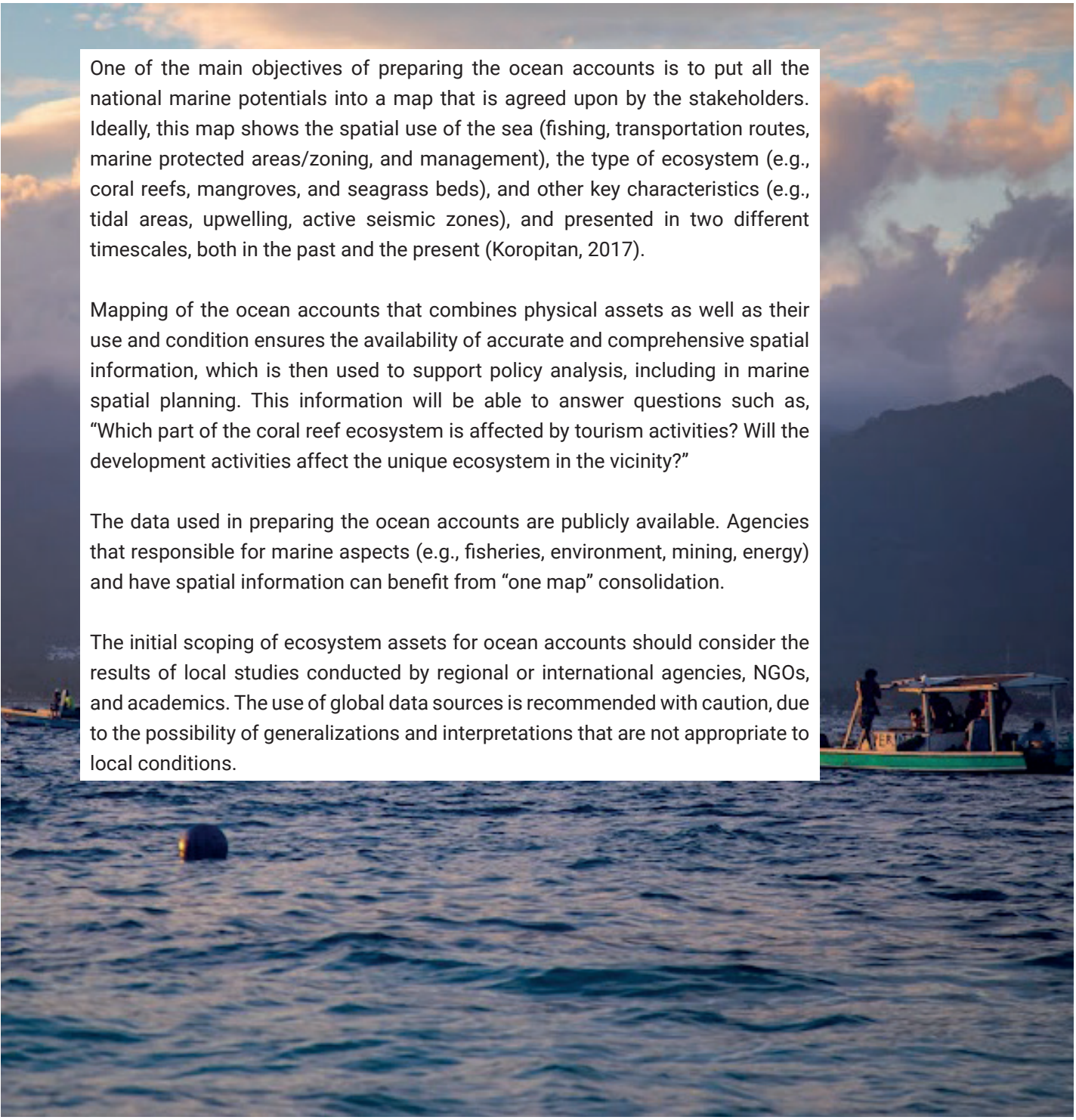


Figure 4. Map of biophysical (water quality) survey in Gili Matra MPA

Data and information for the flow to the economy accounts, flow to the environment accounts and governance accounts were collected through desk studies, field surveys, and interviews. Desk studies aimed to identify the forms of economic activity and zoning system in the pilot study area. A set of questionnaires on the zoning system and economic activity in Gili Matra MPA was prepared and distributed among key figures in the study site. The questionnaires referred to the survey questionnaire of integrated accounts (SINASI) undertaken by Statistics Indonesia. Data collection was carried out in February 2022, involving a total number of 107 respondents (36 from Gili Meno, 36 from Gili Ayer, and 35 from Gili Trawangan). Data and information obtained from the field were analyzed to estimate (1) the monetary value of economic activity in the region, (2) the spatial distribution of economic activity, and (3) the residues into the environment.

B. Assess the Ecosystem Extent and Condition



One of the main objectives of preparing the ocean accounts is to put all the national marine potentials into a map that is agreed upon by the stakeholders. Ideally, this map shows the spatial use of the sea (fishing, transportation routes, marine protected areas/zoning, and management), the type of ecosystem (e.g., coral reefs, mangroves, and seagrass beds), and other key characteristics (e.g., tidal areas, upwelling, active seismic zones), and presented in two different timescales, both in the past and the present (Koropitan, 2017).

Mapping of the ocean accounts that combines physical assets as well as their use and condition ensures the availability of accurate and comprehensive spatial information, which is then used to support policy analysis, including in marine spatial planning. This information will be able to answer questions such as, "Which part of the coral reef ecosystem is affected by tourism activities? Will the development activities affect the unique ecosystem in the vicinity?"

The data used in preparing the ocean accounts are publicly available. Agencies that responsible for marine aspects (e.g., fisheries, environment, mining, energy) and have spatial information can benefit from "one map" consolidation.

The initial scoping of ecosystem assets for ocean accounts should consider the results of local studies conducted by regional or international agencies, NGOs, and academics. The use of global data sources is recommended with caution, due to the possibility of generalizations and interpretations that are not appropriate to local conditions.

The validation of the ecosystem extent is carried out by Rapid Survey or quick observations by taking photos at each sampling location. The results are then registered based on the type of object encountered. Data analysis for coral reef was carried out using Coral Point Count with Excel extensions/CPCe (Figure 5).

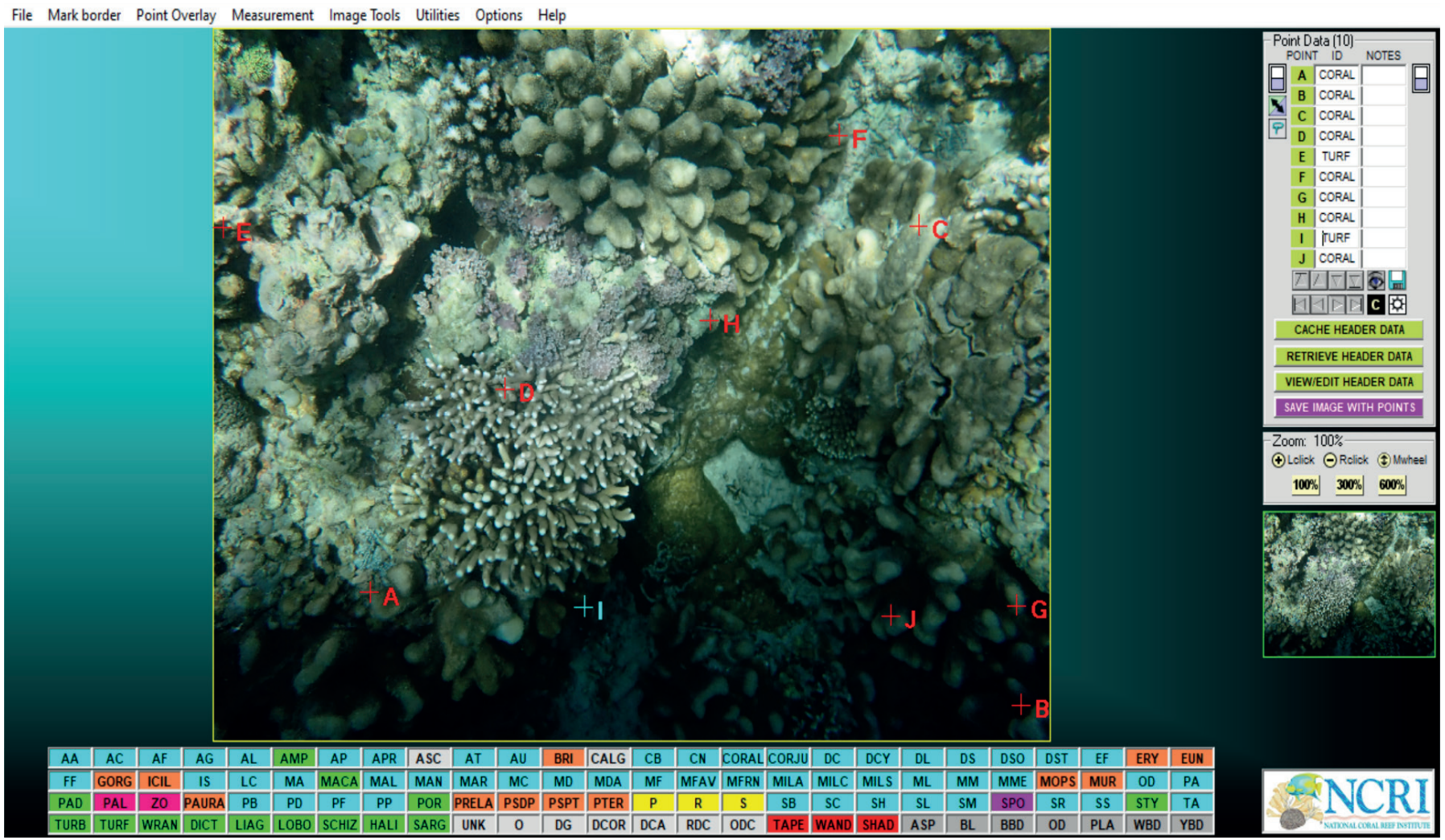


Figure 5. Coral reef data analysis with CPCe

The sampling results are then used to update data on coral reef, seagrass, and mangrove ecosystems that have been issued by Geospatial Information Agency in 2020. Data of 2015 from Geospatial Information Agency was overlaid with Marine Basic Spatial Unit (MBSU). Referring to the Technical Guidelines for Ocean Accounts (GOAP, 2020), BSU is defined as unit that represents the smallest resolution/pixel of a satellite image, while MBSU is the smallest resolution that can be applied to the marine environment. In the context of preparing the ecosystem assets at Gili Matra MPA, one MBSU size is 25 x 25 m, resulting in 48,211 grids. By using MBSU, the extent of each ecosystem has changed, because each grid is categorized as one ecosystem according to the selected dominant ecosystem. Grid that overlaps with coastline is defined as island, so it can either increase the extent of the island or reduce the ecosystem bordering the island (Figure 6).

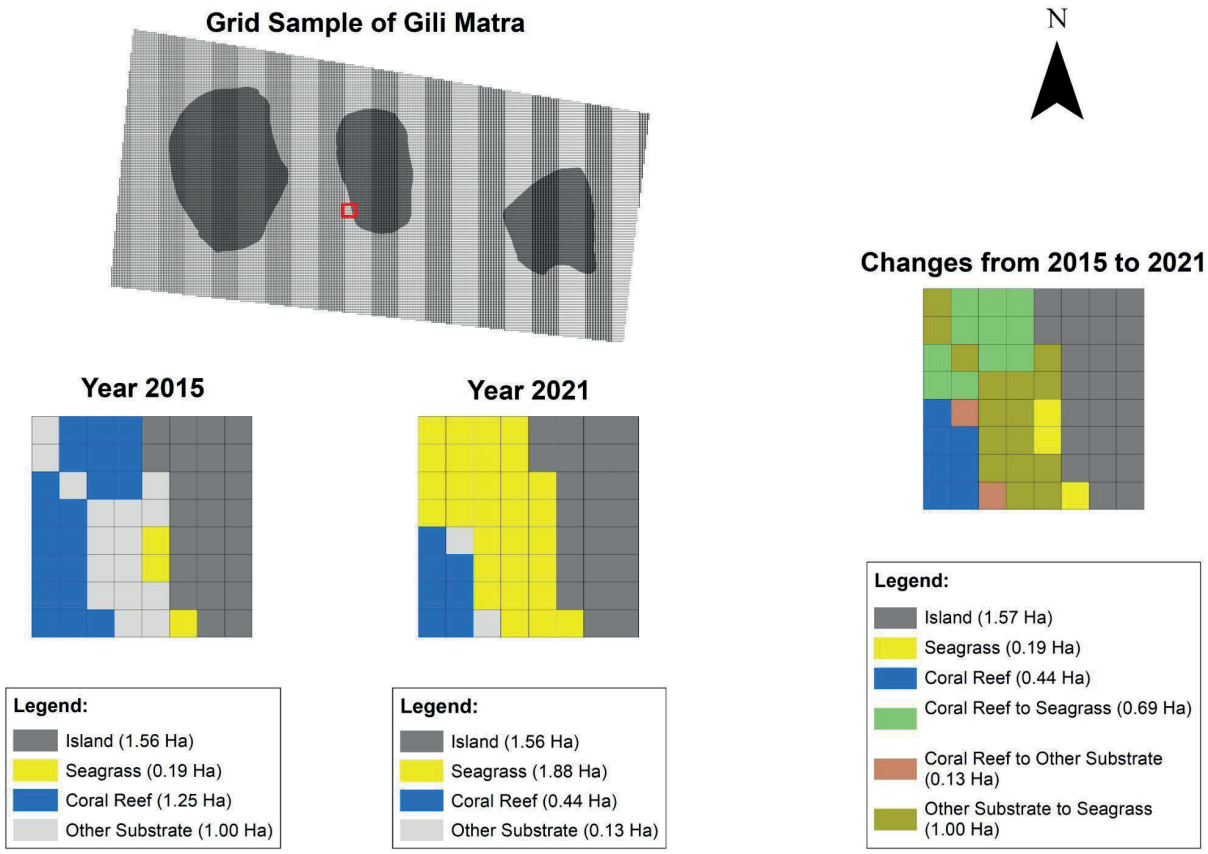


Figure 6. Illustration of ecosystem extent valuation at one grid in Gili Matra MPA

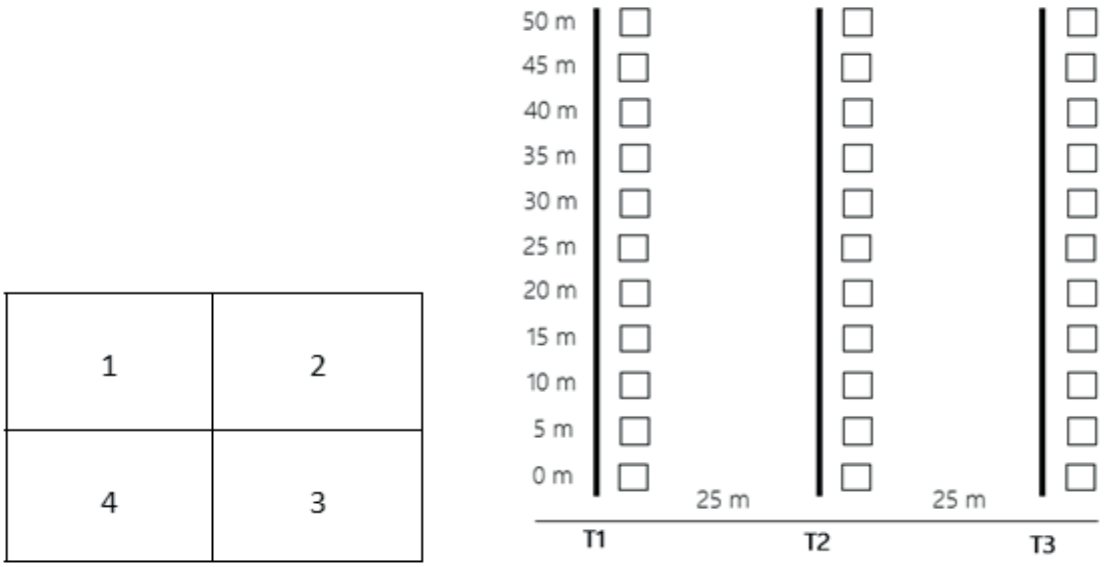
Coral Reef Condition

Ecological indicators observed in coral reef survey include coral cover, coral genera, substrate composition, reef fish abundance, reef fish biomass, and reef fish species as detailed below:

- Substrate composition was observed using underwater photo taken from quadratic transect that mounted on 50 m line transects (Muttaqin et al. 2020). Substrate composition then analysed by using CPCe software.
- Reef fish abundance and biomass were observed by visual census along the 75 m line transects with 1 m width for small fish (<10 cm), and 2.5 m width for large fish (≥10 cm) (Hill and Wilkinson, 2004). Fish abundance was calculated as number of fish per hectare, while fish biomass was calculated based on length-weight relationship for each species in units of kg/ha.

Seagrass Condition

Seagrass observations were carried out using Seagrass Watch method (McKenzie et al. 2003 *in* Yulianto et al. 2012). For each station, three line transects were made along 50 m perpendicular to the shoreline with each transect of 25 m. At each line transect, a 0.5 m x 0.5 m quadratic transect was placed to observe the percent seagrass cover. Observations on the quadratic transect were carried out every 5 m so that there were 11 squares on each line transect and 33 squares at each station. The quadratic transect was divided into four quadrants to facilitate observation and cover estimation (Figure 7). Seagrass in the quadratic transect were then recorded based on species, shoots density, percent cover, and substrate type.



(a) (b)

Figure 7. (a) Quadratics transect and (b) seagrass observation transect layout

Mangrove Condition

Mangrove was observed using plot sampling method. Vegetation data includes trees (Circumference >12.56 cm), saplings (3.14 cm < C < 12.56 cm) and seedlings (Circumference < 3.14 cm). Trees sampling was undertaken in 10m x 10m plot, while for saplings was taken in 5m x 5m sub-plot, and seedlings were taken in 1 m x 1 m subplot (Personal, 1998 *in* Bahari et al, 2020). The transects placement is presented in Figure 8. Circumferences were measured based on Diameter at Breast Height (DBH) or ±1.3 m from the forest floor. Results of the measurements including Density (trees, saplings, seedlings), Basal Area (BA), Frequency (F), Relative Frequency (RF), Relative Density (RD), Relative Dominance (RDo) and ecological indexes such as the Importance Value Index (IVI), Evenness Index (J') and Diversity Index (H'). Mangrove density indicators showed the condition of mangroves at monitoring stations.

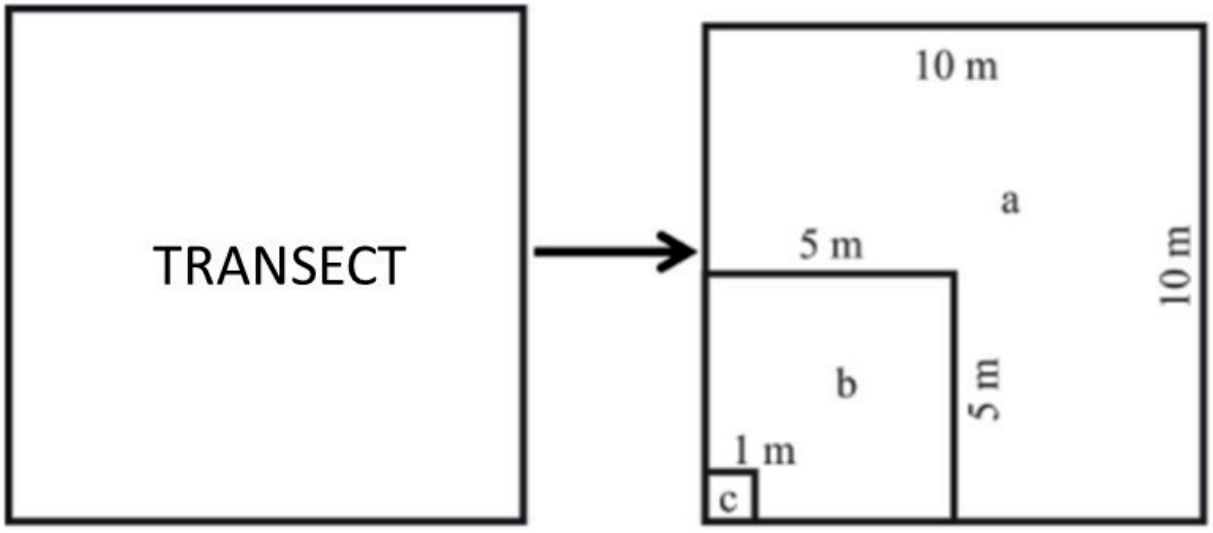


Figure 8. Methods for deploying transect plots for tree, sapling, and seedling data collection

Biophysics Condition

Biophysics conditions were observed by using: (1) satellite imagery, (2) field observations, (3) laboratory analysis, and (4) desk study. Satellite images were acquired from Landsat-8 for data of August 2015 and 2021, consist of sea surface temperature, chlorophyll-a, and total suspended solids. The images were then analysed using ArcGIS (spatial software). In-situ observation was carried out in September 2021, to measure seawater pH and dissolved oxygen using the Water quality instrument. Dissolved oxygen was measured by using DO Meter. Water samples were taken to measure BOD parameters in laboratory with standardized method. In addition, data of pH, DO, and BOD in 2015 were cited from Kurniawan (2017).

C. Economic Valuation of Ecosystem Services

Data compilation begins with the most significant social, economic, and environmental physical assets that can be identified through the scoping assessment. To derive 'value' from marine resources, we need to combine both direct and indirect economic value for biotic and abiotic assets. The direct economic value can be based on consumptive values, i.e., oil and gas extraction, while the indirect economic value can be estimated through the value of satisfaction, i.e., the aesthetic value of seascapes.

Consumptive values can be estimated from production value, i.e., fish catch, oil, and gas production. Non-consumptive value can be derived from the physical assets condition, such as habitats quality, cultural heritages, and tourism activities. Questions that can be answered from this issue, for example, what types of ecosystems and conditions that suitable for tourism activities? to what extent can these ecosystems be used for tourism?

Marine services assets are identified based on: (1) provisioning, (2) regulating, (3) cultural, and (4) supporting services. Following are examples of services in marine ecosystem (United Nations, 2020):

1. Provisioning
    - Biomass for nutrition (cultivated and wild animals, plants, algae, or fungi)
    - Biomass for materials (cultivated and wild animals, plants, algae, or fungi)
    - Genetic material from plants and animals (pharmaceutical products, genetic inventory, and conservation
    - Abiotic materials and energy (offshore oil and gas, minerals; wind, waves, solar energy
    - Abiotic: seawater as substrate for transportation
    - Abiotic: seawater for drinking or non-potable purposes (industrial cleaning and cooling)
2. Regulating
    - Carbon sequestration and storage
    - Waste mediation by estuaries (dilution, filtration)
    - Mediation of mass and fluid flows by mangroves, coral reefs, seagrasses, estuaries, and rocky beaches (e.g., coastal protection from erosion and waves)

3. Cultural
    - Physical interactions and experiences (visiting iconic seascapes)
    - Intellectual and representative interaction (artistic representation of iconic seascapes)
    - The symbolic significance of the beach and the open sea (elements that have a sacred meaning)
    - Landscape beauty
4. Supporting
    - Life cycle maintenance and habitat protection (e.g., fish rearing habitats, iconic species habitats)
    - Maintenance of life cycles of migratory species
    - Protection of biodiversity (gene pool protection)

The monetary value of ecosystem in Gili Matra MPA were determined based on their environmental services. The estimation of economic value is carried out using two main approaches, namely the market price and the non-market price. For the market price approach, the methods used are (1) productivity level, (2) replacement cost, and (3) prevention cost. As for the non-market price approach, the methods used include the expressed preference method, i.e., the contingent valuation method; and revealed preference method, i.e., travel cost method.

Environmental functions provided by the coral reef ecosystem in Gili Matra MPA comprises provision, regulation and culture. The supply function includes direct benefits from tourism, as well as research. The estimated economic value was obtained using the benefit transfer method from Bohol, the Philippines (Samonte-Tan et al., 2007) and the Mariana Islands, United States (Beukering et al., 2006). Benefit transfer is broadly defined as "…the use of existing data or information in settings other than for what it was originally collected" (Rosenberger and Loomis, 2003, p. 445 in Richardson et al., 2015). Benefit transfer is increasingly being used to meet the demand for increased information on non-market ecosystem service values in a manner relevant to the timeframe and budget within which decisions often must be made. If original valuation is not feasible, the choice is not between a new study and benefit transfer but rather between benefit transfer and qualitative judgment (Smith et al., 2002 in Richardson et al., 2015). For seagrass ecosystems, the identified environmental functions are supporting areas as regulators. Estimated economic value using the benefit transfer method from Mexico. As for the mangrove ecosystem, the identified environmental functions are the functions of supply, regulation, culture, and support. Estimated economic value using the benefit transfer method from Gazi Bay, Kenya (Hoberg, 2011) and Bintuni Bay, Indonesia (Ruitenbeek, 1992). Detailed information for the ecosystem valuation can be found in Annex 1.

Main data sources:

Data on the extent and condition of ecosystems such as mangroves, coral reefs, and seagrasses were obtained from primary data collection, official Geospatial Information Agency data, and global data portals. Estimation of the economic value of environmental services using a market price approach uses the prevailing economic value in Gili Matra for 2021. Meanwhile, the economic value of environmental services uses a non-market price approach.

D. Assessment on the Flows to the Economy

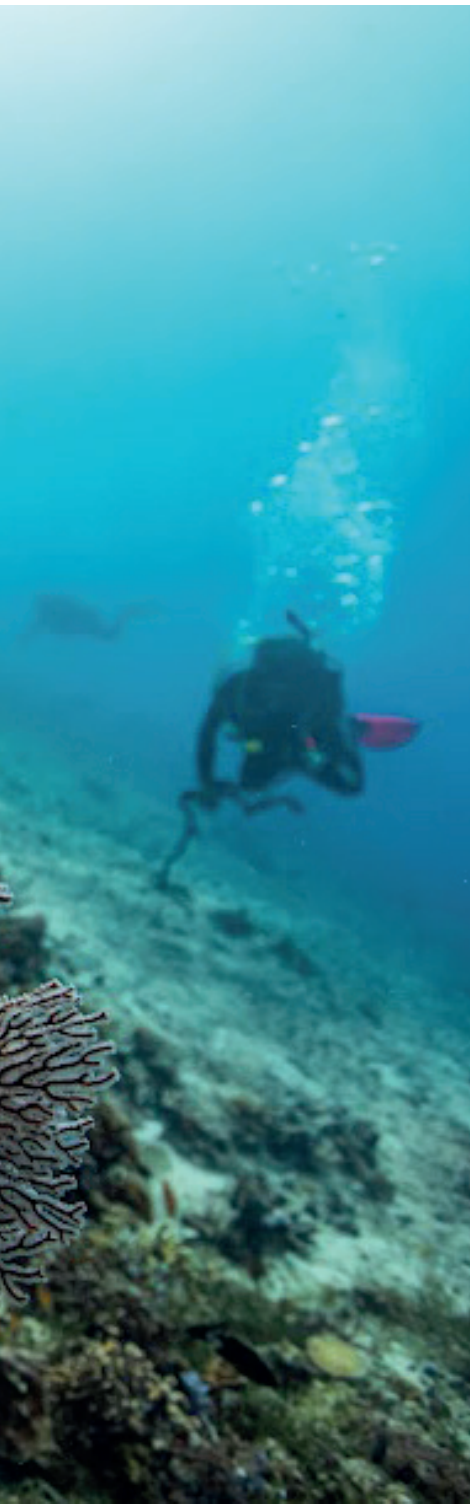
According to the field observation, the primary economic activities in Gili Matra MPA that required ocean resources supply are fisheries and marine tourism. Monetary supply and use table were established to assess the flows to the economy from ocean resources within Gili Matra MPA. Monetary value from the ecosystem assets served as the supply of resources to the economic activities. The monetary use of resources assessed for fisheries and tourism activities. For the fisheries activities, two main fishing practices exist in the area, namely net fishing, and spearfishing. As for the tourism activities, monetary gains were assessed from lodging services, food and beverages businesses, and rents contributed from the three Gili Islands. A net benefit approach was applied to both economic activities to estimate the monetary gain annually.

E. Assessment on the Flows to the Environment

Flows to the environment was assessed based on the production of waste from economic activities. Physical supply and use of waste were estimated from two main principal of waste, namely solid and liquid waste. However, for the pilot study, very little information on waste production were collected for fisheries activities in comparison to tourism activities. The physical supply of waste was aggregated from lodging services, food and beverages businesses, and rents from the three Gili islands. While the physical use of waste was separated between solid waste and liquid waste.

F. Assessment on Ocean Governance

Governance of ocean resources within Gili Matra MPA was assessed according to (a) spatial arrangement of resource used and (b) monetary investment for environment protection and gains from economic activities. The spatial arrangement was outlined from the MPA zoning plan, spatial distribution of economic activities within MPA area, rules for each spatial area, and authorized government body(ies) for ocean resource use management within the Gili Matra MPA. The monetary investment for environment protection was estimated from expenditure contributed by all parties to manage the MPA. While the monetary gain was estimated from the monetary value of economic activities and non-tax income for the government.



ECOSYSTEM ASSETS ACCOUNTS IN GILI MATRA MPA 7

A. Ecosystem extent

Key ecosystems in Gili Matra MPA consist of coral reef, seagrass, and mangrove. The total area based on MBSU grid was 2,980.84 ha (Figure 9). In 2015, the area consisted of 259.50 ha of coral reef, 76.75 ha of seagrass, 21.50 ha of mangrove, 1,905.72 ha of other substrates, and 717.38 ha of land. In 2021, the area consisted of 247.50 ha of coral reef, 102.50 ha of seagrass, 10.69 ha of mangrove, 1,891.97 ha of other substrates, and 728.19 ha of land.

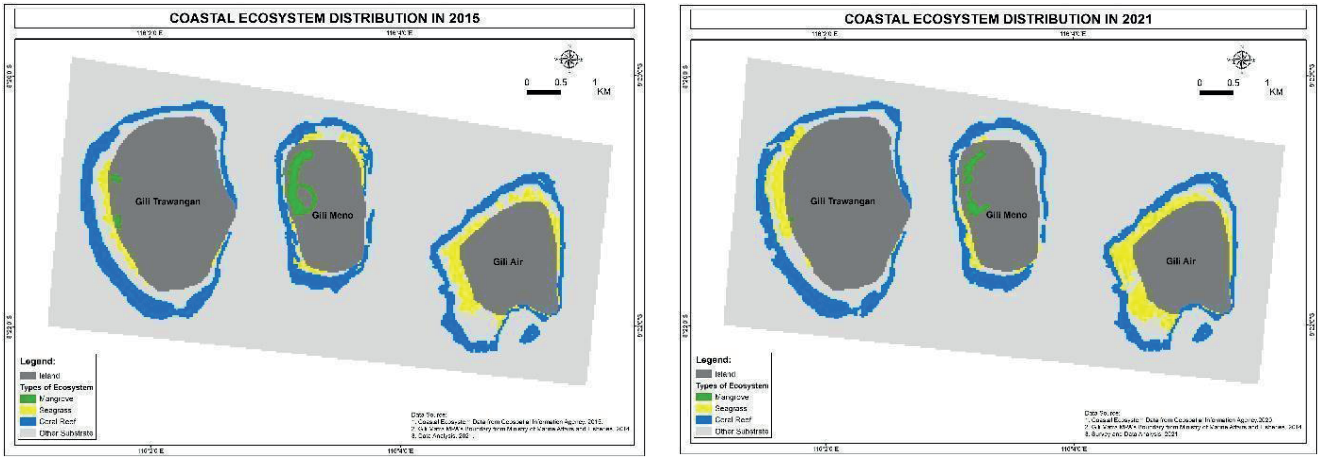


Figure 9. Ecosystem extents in Gili Matra based on MBSU

B. Ecosystem condition

Coral reef

Conditions of coral reefs were compared between 2021 and 2016 based on the zoning plan. In 2016, average live coral cover was 18.11%, with the highest found in the core zone (20.79%), followed by sustainable fisheries zone (20.40%), utilization zone (29.04%), and rehabilitation zone (13.67%) (Tarigan et al., 2017). Coral reef substrate in 2021 was dominated by rubble (30.6%) and 16.99% live hard coral (Table 3; Figure 10 and 11). This result echoed the monitoring result by BKKPN in 2019 with 32.9% of rubble. According to the zoning plan, the highest live coral cover was found in the sustainable fisheries zone (25.14%), followed by the utilization zone (13.85%), core zone and protection zone (12.92%), and rehabilitation zone (2.92%). Significant decrease from 2016 to 2021 were found in the rehabilitation zone (Figure 12). Referring to Giyanto et al (2017), coral reef in Gili Matra MPA was categorized as moderate (19% < live hard coral cover <35%).

Table 3. Average substrate cover (%) in 2021 based on Gili Matra MPA zoning plan

Zoning	Life coral	Macro algae	Soft coral	Dead coral	Other inverte-brates	Coral rubble	Bottom substrate
Core and Protec-tion	12.92	4.58	6.88	0.38	14.09	40.15	21.01
Sustainable fish-eries	25.14	5.24	6.83	0.70	9.76	32.21	20.13
Utilization	13.85	5.56	12.99	2.70	11.77	26.72	26.42
Port	36.99	12.87	0.00	0.51	21.10	17.13	11.40
Rehabilitation	2.92	6.80	0.37	0.04	3.08	20.04	66.77
Average	**18.36**	**7.01**	**5.41**	**0.86**	**11.96**	**27.25**	**29.14**

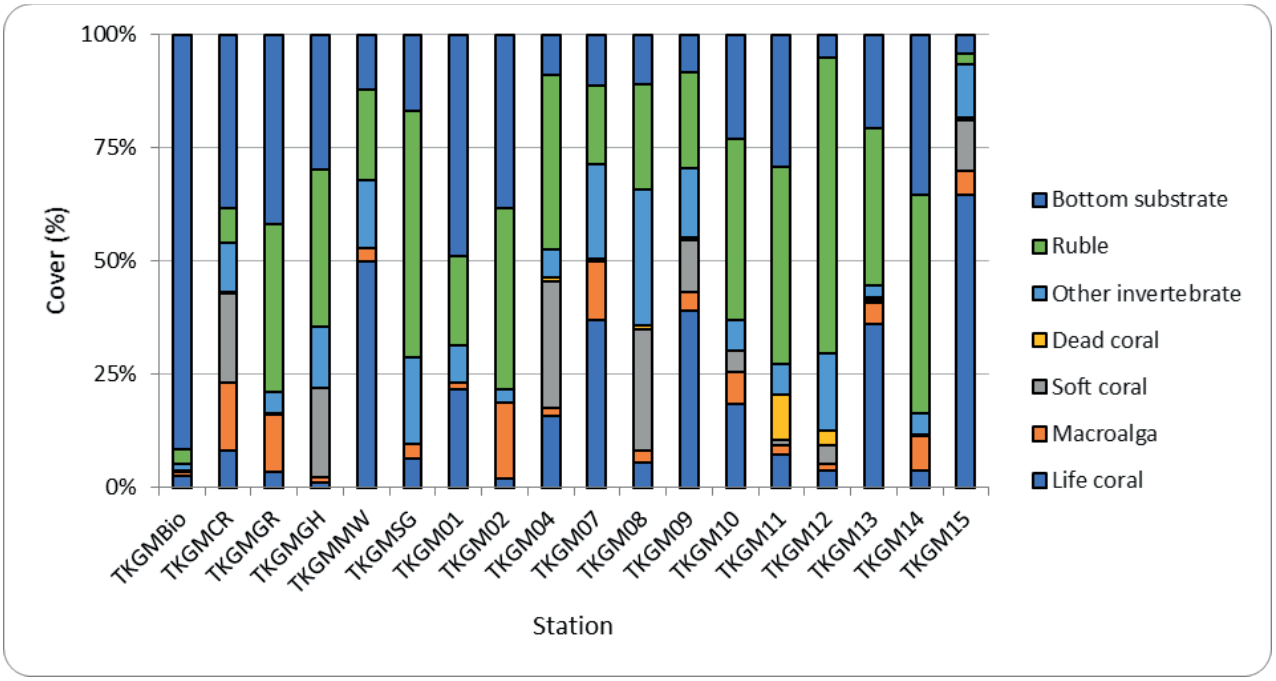


Figure 10. Substrate composition in Gili Matra MPA in 2021

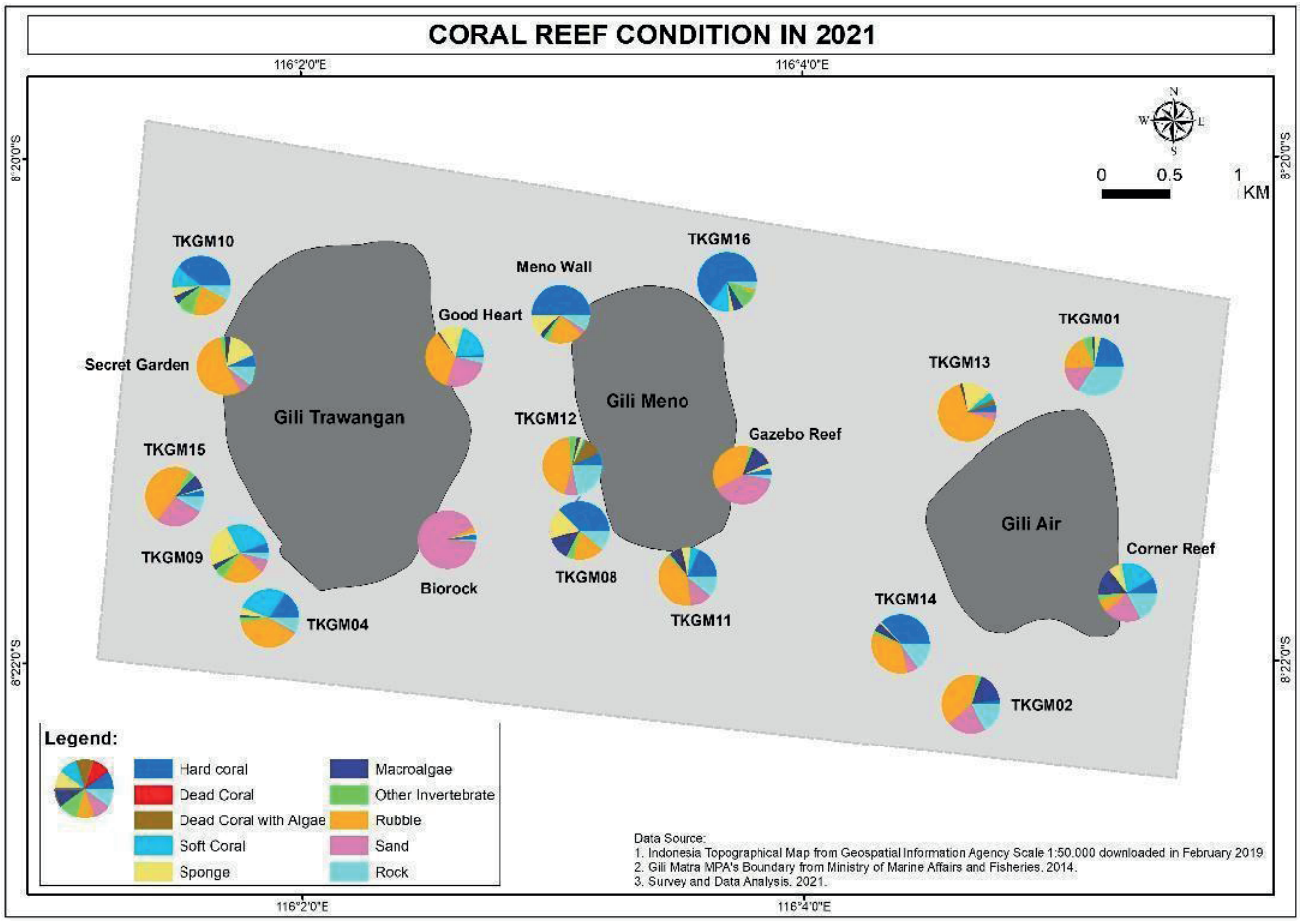


Figure 11. Coral reef cover in Gili Matra MPA in 2021

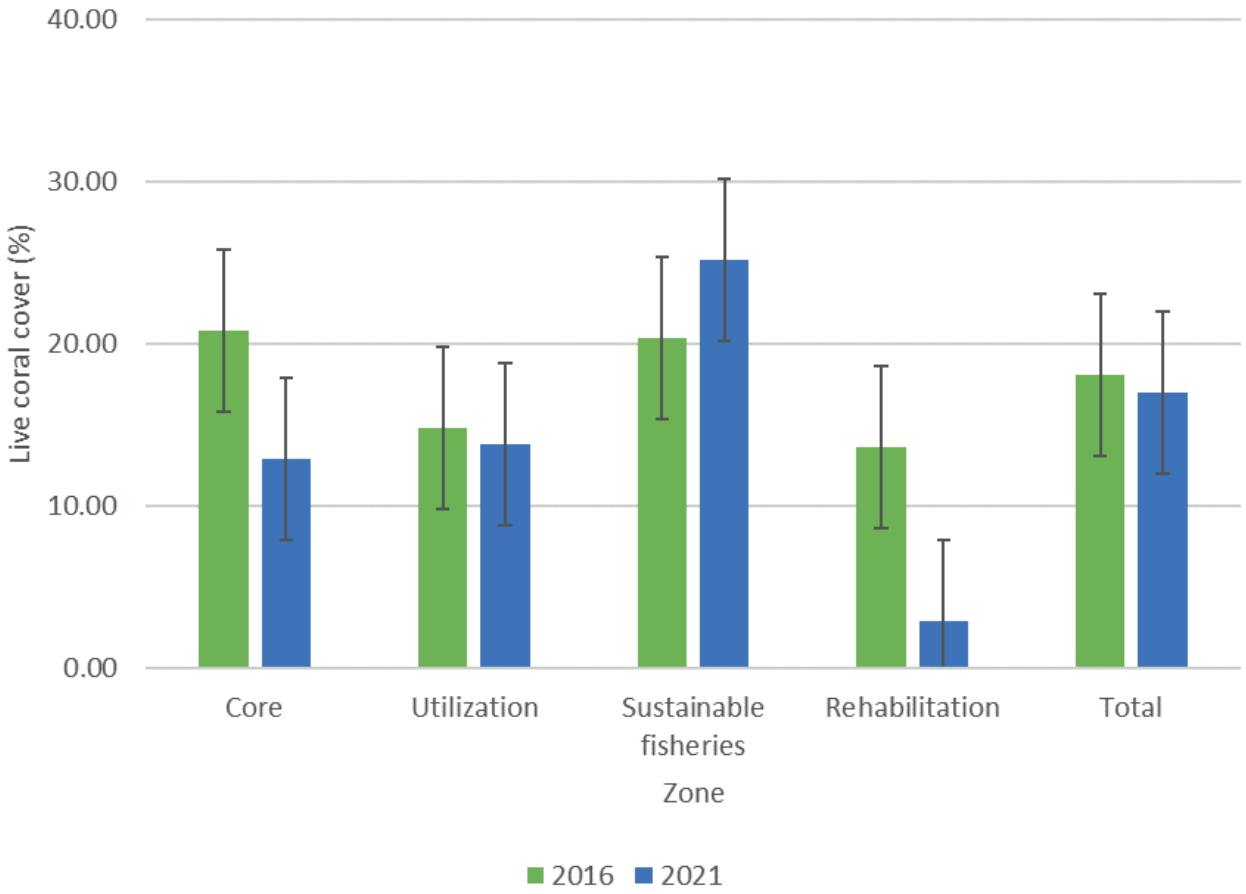


Figure 12. Live coral cover of Gili Matra MPA in 2016 and 2021

Data of reef fish in 2021 were taken from 18 sampling sites and recorded 304 fish species from 32 families (Figure 13). Reef fish abundance varies from 9,281 – 51,228 ind/ha, where the highest average abundance was found in rehabilitation zone and the lowest in utilization zone (Figure 14). No difference abundance found between 2016 and 2021. However, based on major fish families (Acanthuridae, Scaridae, Serranidae, Siganidae), Scaridae showed differences between 2016 and 2021 (Figure 15). Contrary to fish abundance, fish biomass, excluding Serranidae, showed differences in all zones between 2016 and 2021 (Figure 16 and Figure 17).

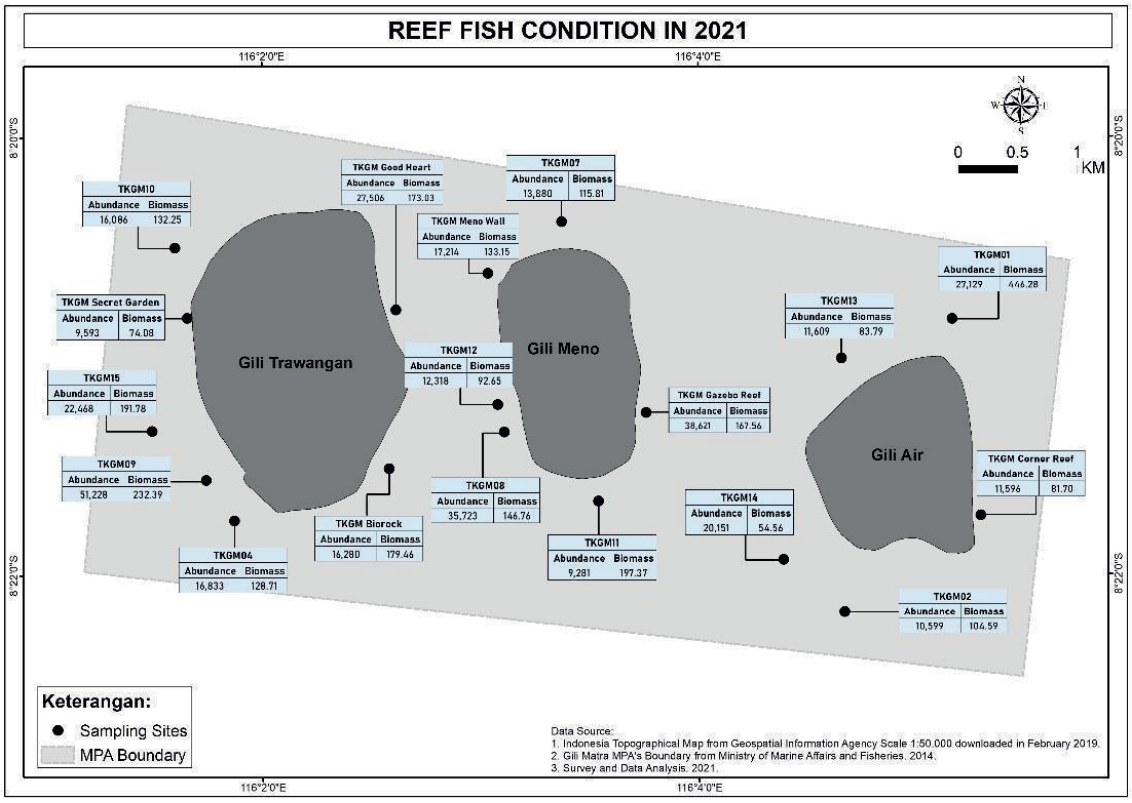


Figure 13. Reef fish condition of Gili Matra MPA from each sampling site in 2021

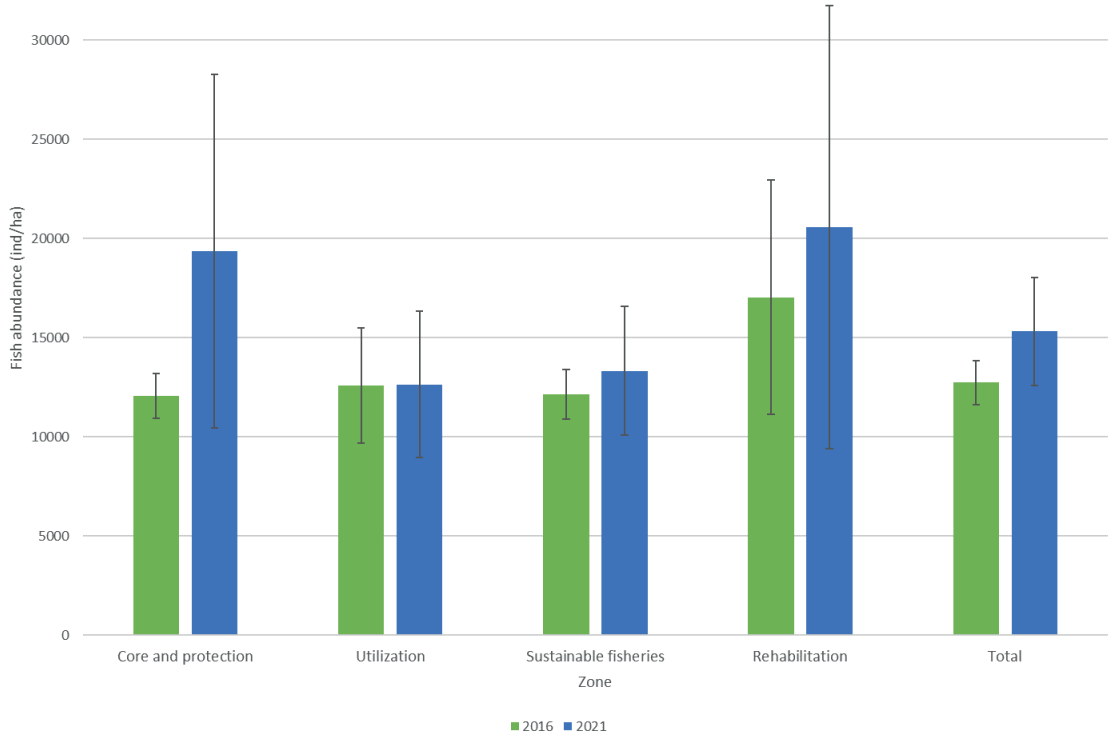


Figure 14. Abundance of reef fish in Gili Matra MPA in 2016 and 2021 (ind/ha)

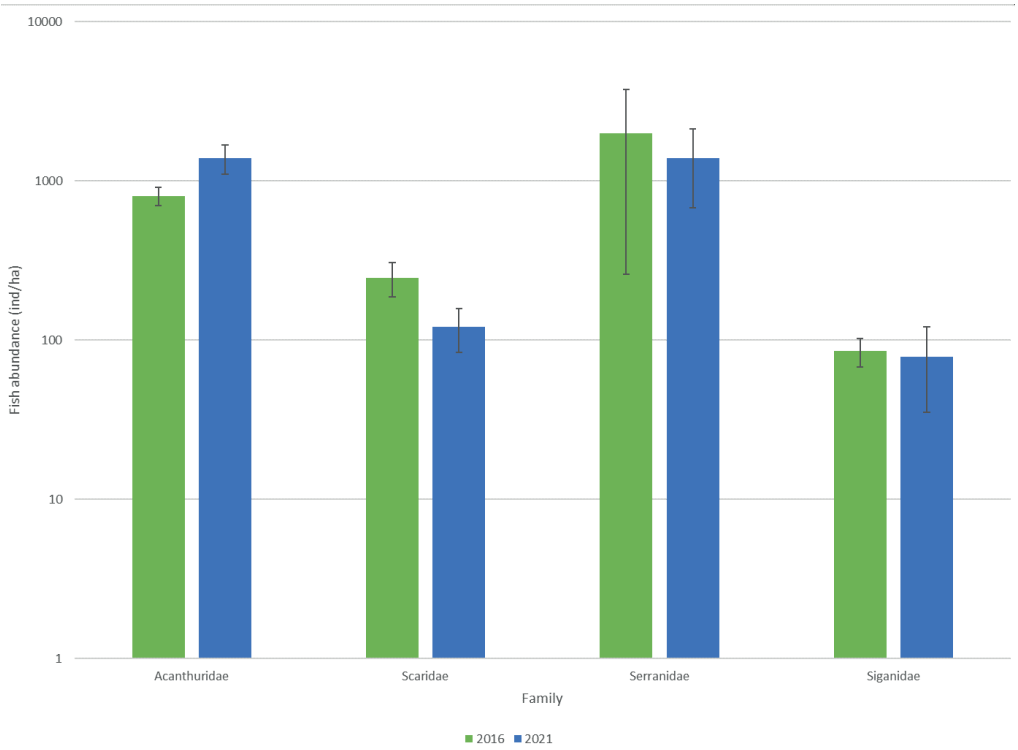


Figure 15. Abundance of major reef fish family in Gili Matra MPA in 2016 and 2021

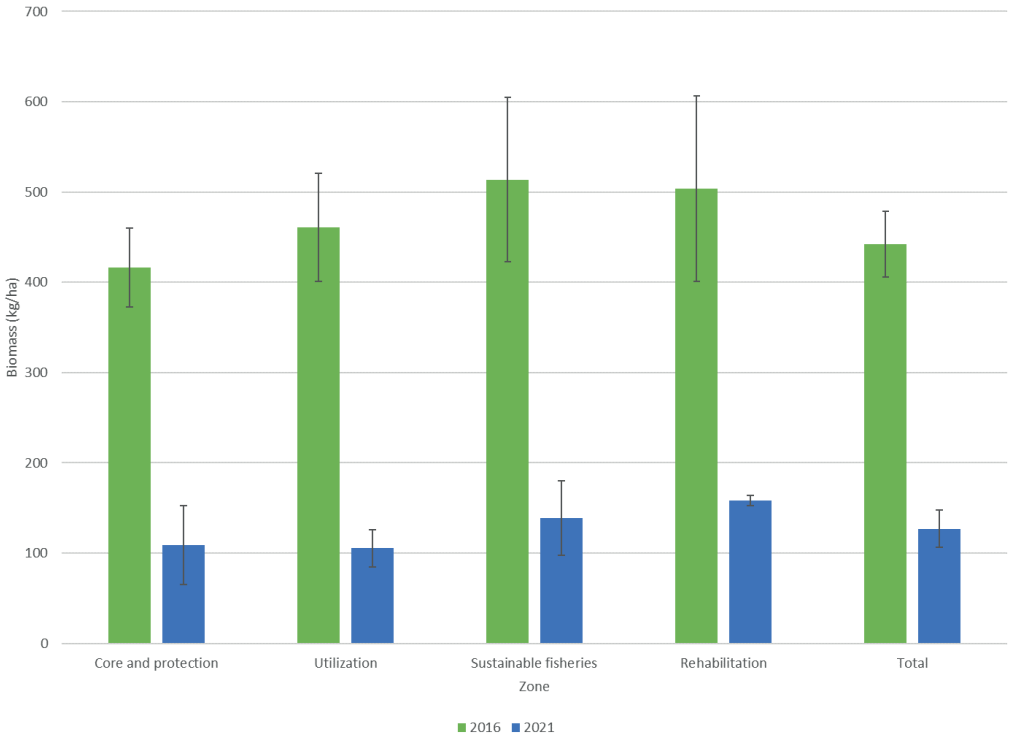


Figure 16. Biomass of reef fish in Gili Matra MPA in 2016 and 2021 (kg/ha)

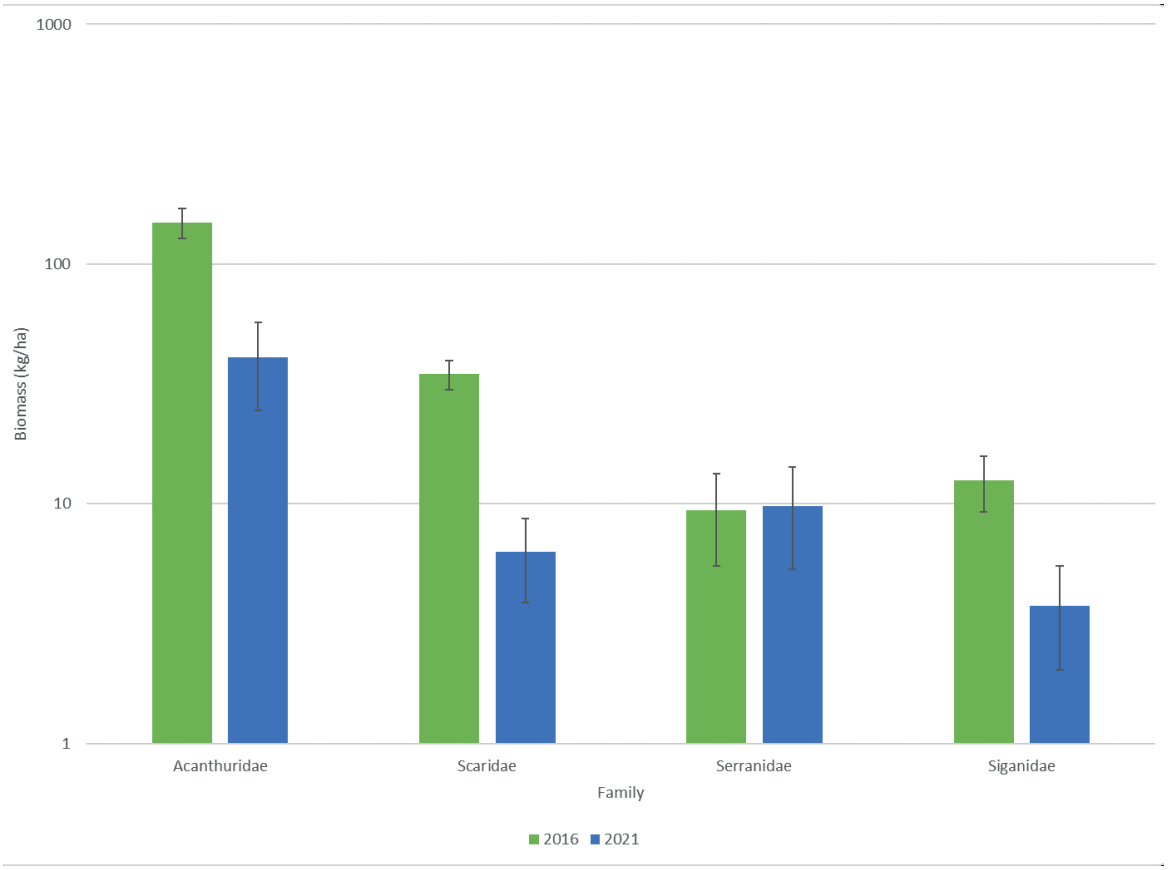
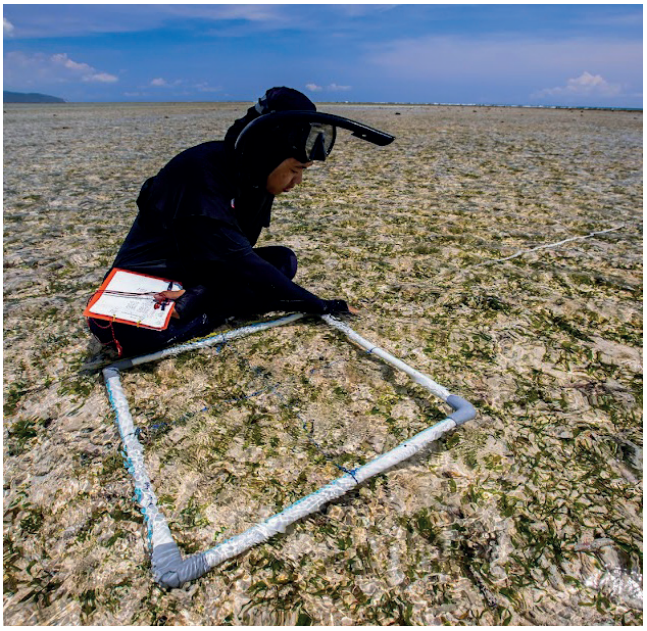


Figure 17. Biomass of major reef fish family in Gili Matra MPA in 2016 and 2021

Seagrass

Condition of seagrass between 2021 and 2016 was not compared due to absence of data for 2016 (N/A). Observation on 12 sampling sites in 2021 recorded 8 species of seagrass, namely *Cymodocea rotundata, C. serrulate, Thalassia hemprichii, Halophila ovalis, Enhalus acoroides, Halodule pinifolia, H. uninervis,* and *Syringodium isoetifolium* (Figure 18; Figure 19). Seagrass ecosystems were predominated by *C. rotundata* and *T. hemprichii*. Average seagrass cover in Gili Matra MPA was 32.28%, where the highest was found in LGM03 (82.01%). According to the zoning plan, the highest seagrass cover was found in the core zone (70.45%) and the lowest was in the rehabilitation zone (0.75%). Seagrass condition in Gili Matra MPA was considered fairly damaged (30%≤ cover ≤59.9%) (MoE, 2004a).



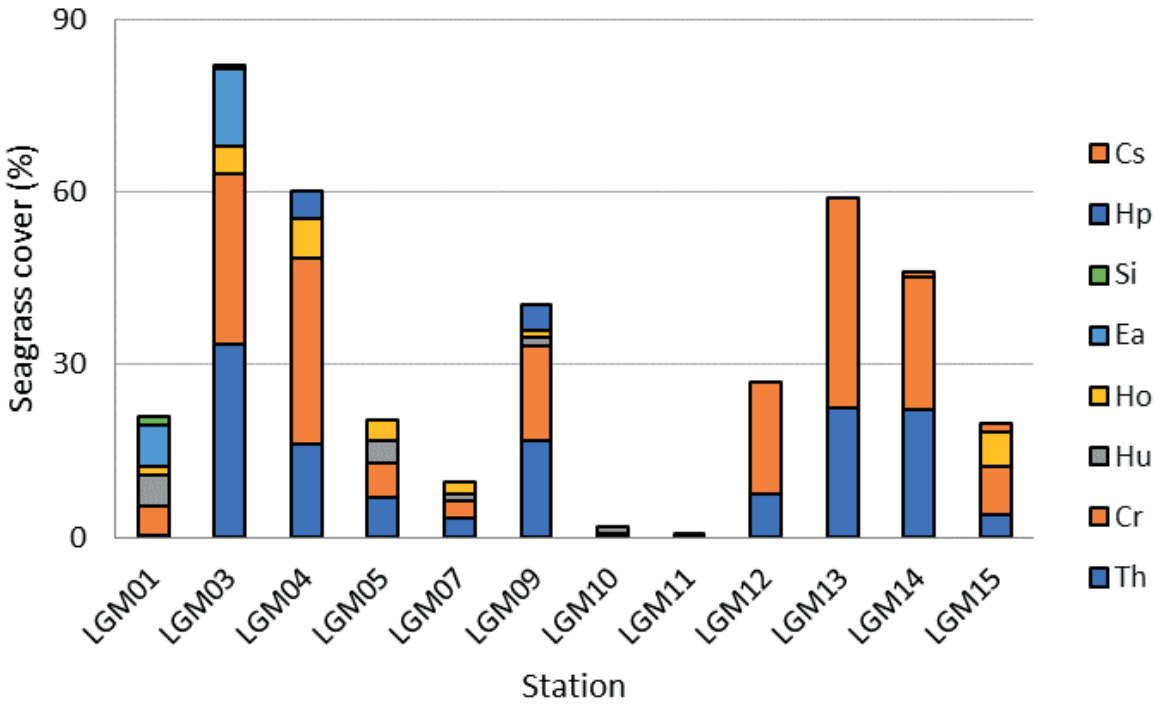


Figure 18. Seagrass species composition and cover (%) in 2021

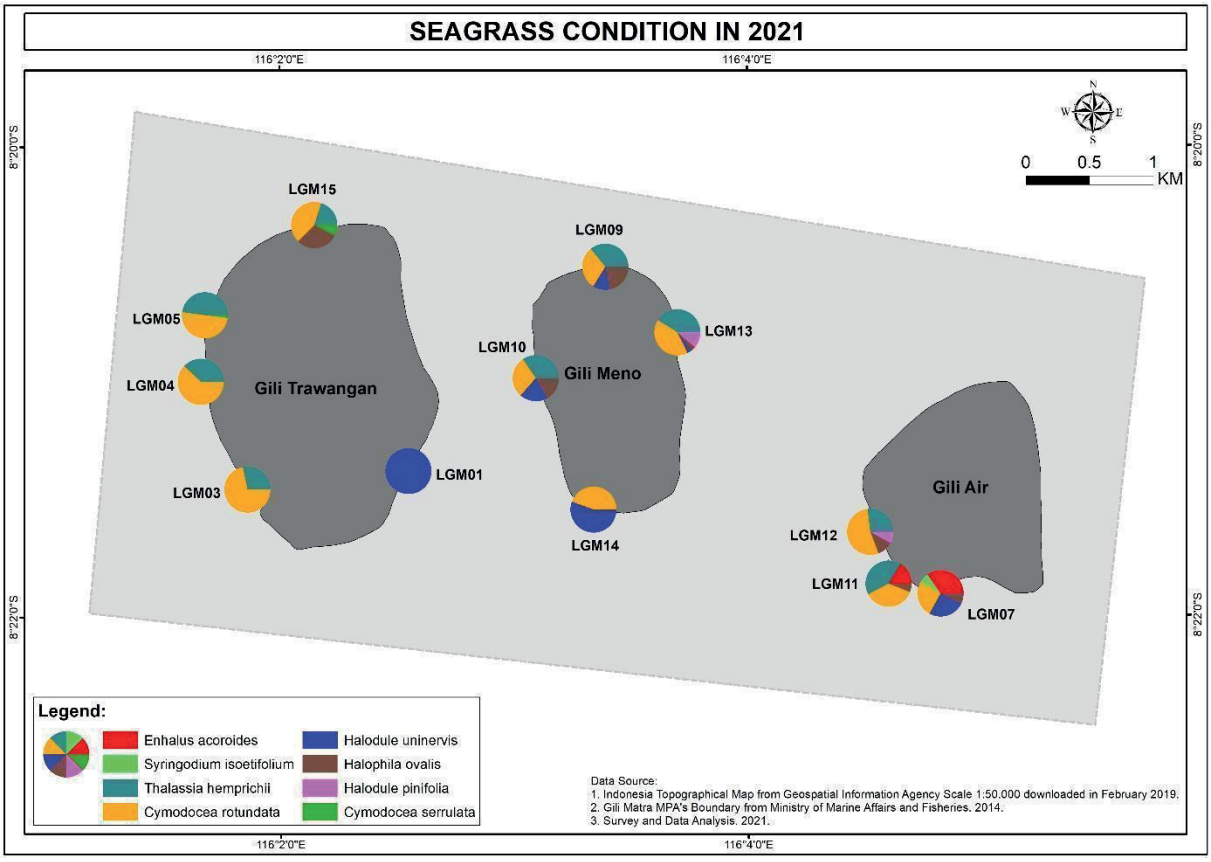


Figure 19. Seagrass cover in Gili Matra MPA from each sampling site in 2021

Mangrove

Condition of mangrove between 2021 and 2016 was not compared due to absence of data for 2016 (N/A). Mangrove ecosystem in Gili Matra is mainly found in Gili Meno (outside the MPA). Three species were recorded, namely, *Avicennia marina*, *Bruguiera cylindrica*, and *Excoecaria agallocha*. Species *A. marina* was found in all sampling sites (Table 4). Based on species, average density was 1,923 ind/ha with the highest in Station MGM06 (3,100 ind/ha) and the lowest in Station MGM08 and MGM05 (233 ind/ha). Similar to density, the highest canopy cover was found in Station MGM07 (38.35 m^2/ha) (Figure 20-22). Mangrove ecosystem in Gili Matra MPA was considered good with high density (≥1,500) (MoE, 2004b).

Table 4. Distribution of mangrove species of Gili Matra in 2021

No	Mangrove species	Family	Distribution					
			MGM 06	MGM 08	MGM 05	MGM 03	MGM 04	MGM 07
1	*Avicennia marina*	Avicenniaceae	+	+	+	+	+	+
2	*Bruguiera cylindrica*	Rhizophoraceae	-	+	+	-	-	-
3	*Excoecaria agallocha*	Euphorbiaceae	-	+	-	-	-	-

Remark: found (+); Not found (-)

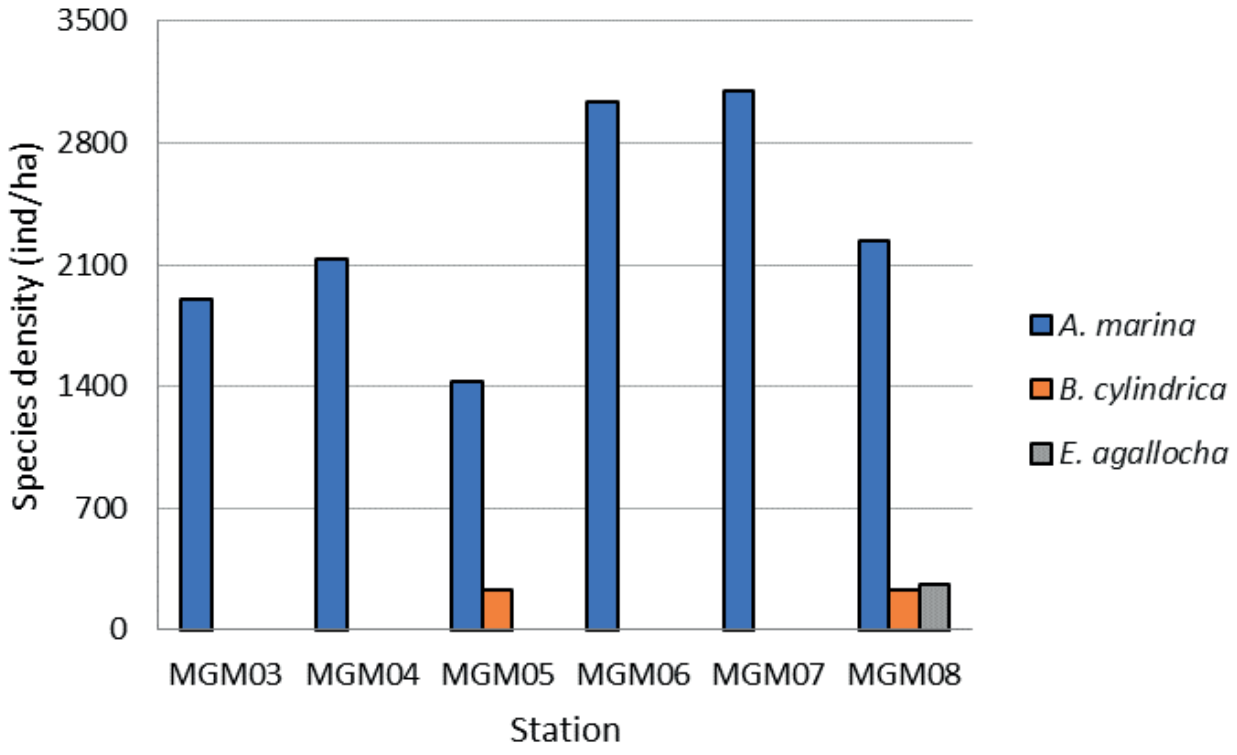


Figure 20. Mangrove species density from each sampling sites in 2021

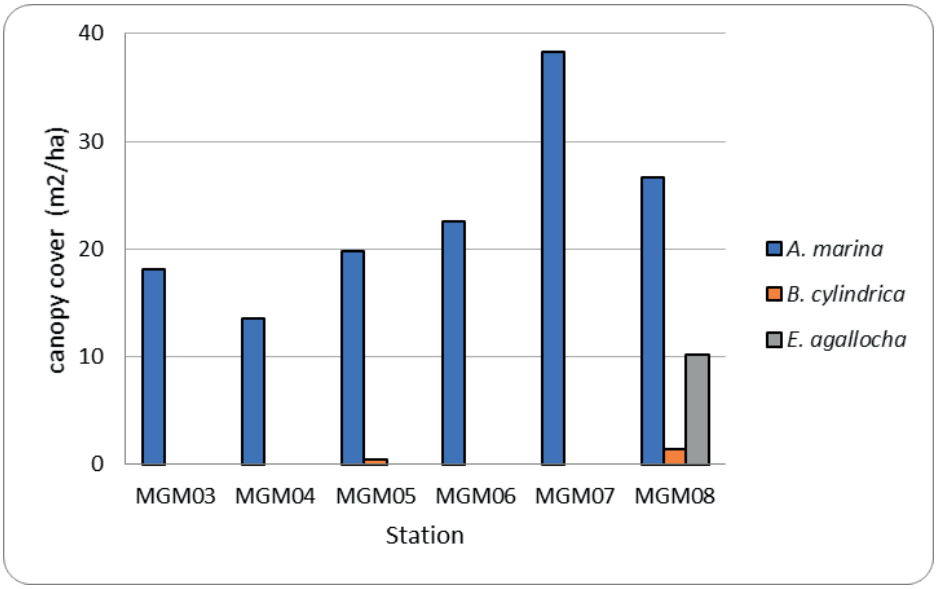


Figure 21. Mangrove canopy cover in 2021

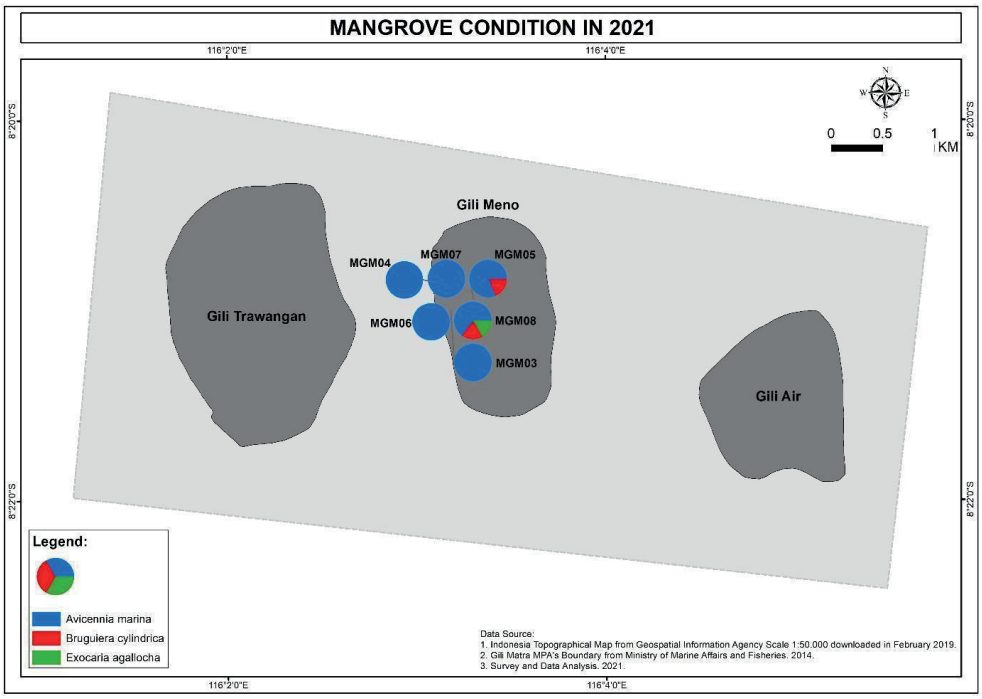


Figure 22. Canopy cover for each sampling site in 2021

Biophysics

During observation in 2021, the SST ranged between 22°C – 26°C (Figure 23) and was relatively lower than the usual SST for tropical waters during the first transition period. Referring to the average SST in Lombok Strait, SST in June-August was lower than average temperature in December-February and during the second transition period. Observation on SST from 2015 and 2021 showed values below the environmental standards (MoE, 2004c).

Chlorophyll-a distribution during observation in 2021 ranged between 0.175 – 0.190 mg/m^3. Human activities in the mainland are main inputs of chlorophyll-a to the marine environment and lower concentration is commonly observed as it goes further to the open seas (Figure 24). Satellite image analysis for TSS in 2021 showed variation between 0-180 mg/L around Gili Matra MPA, where areas of high TSS were found near to the coastline (Figure 25). The standard (MoE, 2004c) provides a benchmark of TSS for tourism areas, coral reefs, and seagrass (20 mg/L), as well as mangrove areas (80 mg/L).

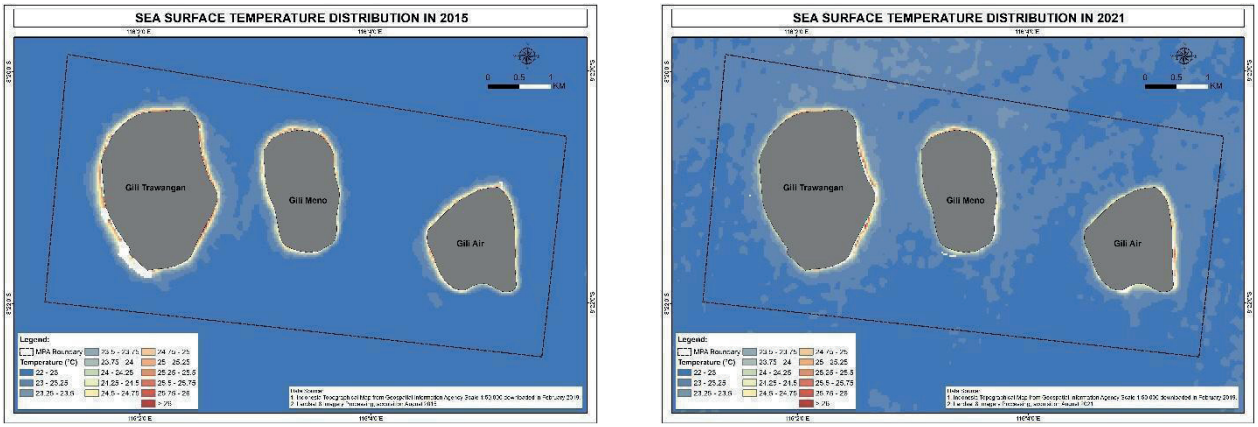


Figure 23. Distribution of sea surface temperature (SST) in the surrounding waters of Gili Matra MPA

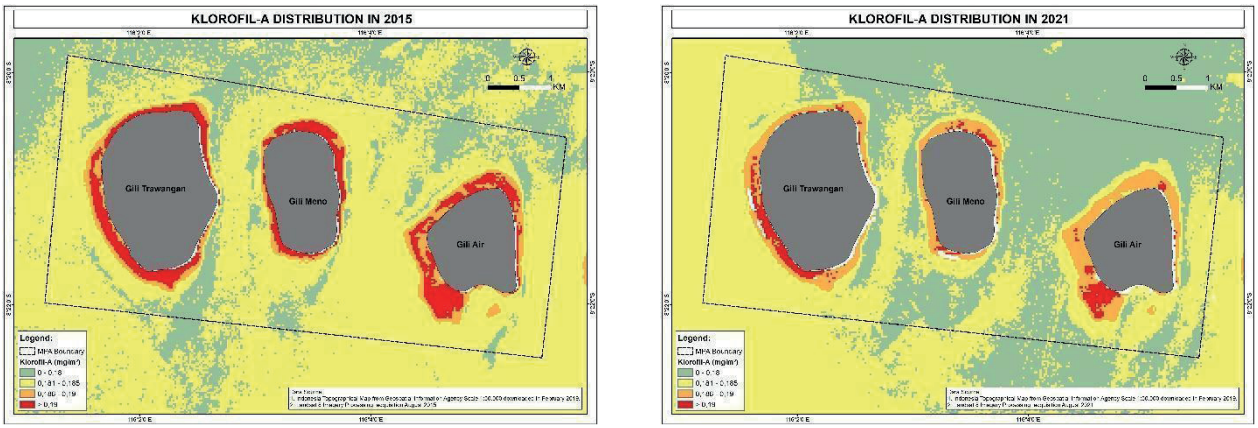


Figure 24. Distribution of chlorophyll-a in the surrounding waters of Gili Matra MPA

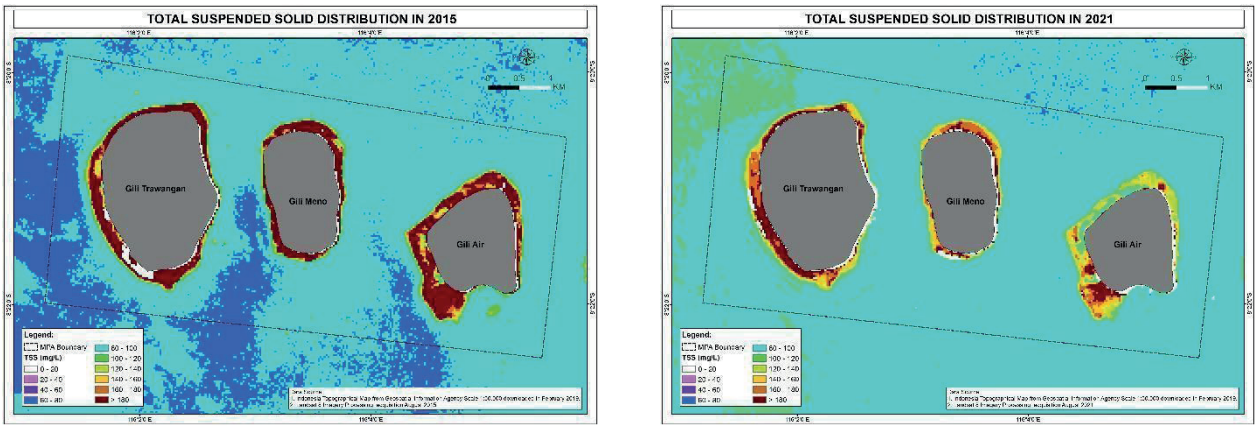


Figure 25. Distribution of total suspended solids (TSS) in the surrounding waters of Gili Matra MPA

Seawater acidity (pH) in Gili Matra MPA varied between 7.7 - 8.8 in 2015 and 7.8 – 8.1 in 2021 (Figure 26). The environmental standard is between 7.0 - 8.5 (MoE, 2004c), thus some water areas of Gili Matra MPA in 2015 were above the standards. In general, the pH in Gili Matra MPA was within the environmental standard ranges. Normal range of dissolved oxygen (DO) also found around Gili Matra varied between 8.29 - 8.40 in 2015, and between 6.92 – 8.95 mg/L in 2021 (Figure 27). DO values observed in both periods were within reference environmental standards for DO (>5.0). Biological oxygen demand (BOD) around Gili Matra Waters in 2015 varied from 1 - 2 mg/L, while sample analysis in 2021 varied from 0 - 2.9 mg/L (Figure 28). According to the environmental standard quality of 10-20 mg/L (MoE, 2004c), values of BOD observed both in 2015 and 2021 were lower than the standards and it reflects the lower organic contents in the waters around Gili Matra MPA.

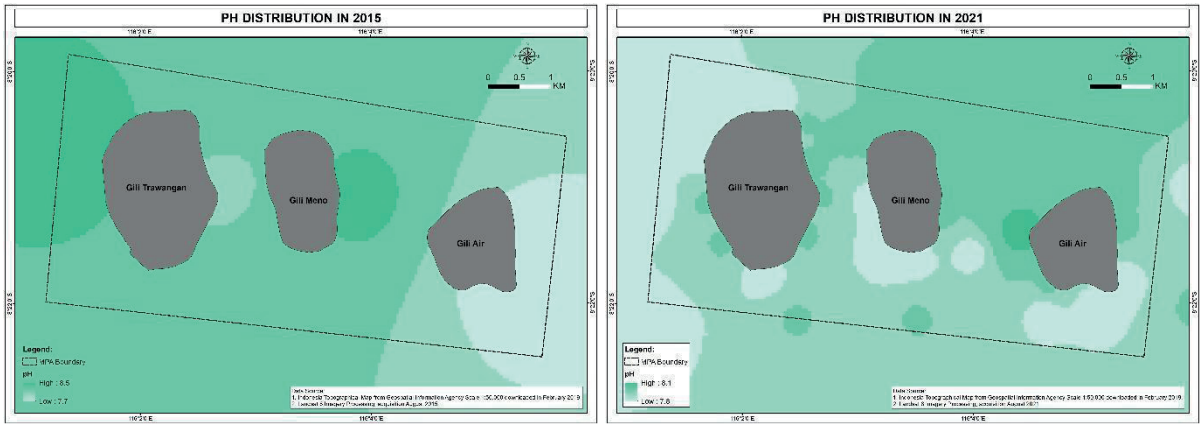


Figure 26. Distribution of water acidity (pH) in the surrounding waters of Gili Matra MPA

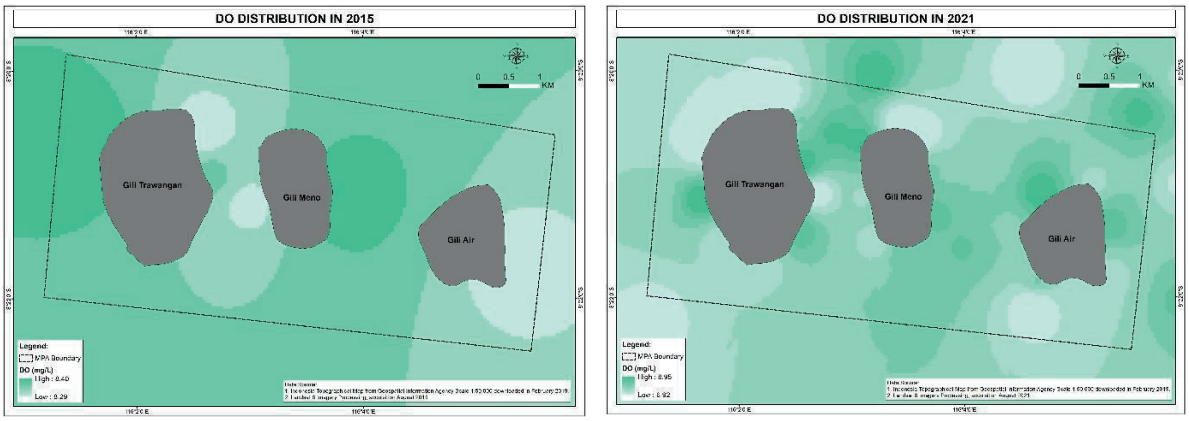


Figure 27. Distribution of dissolved oxygen (DO) in the surrounding waters of Gili Matra MPA

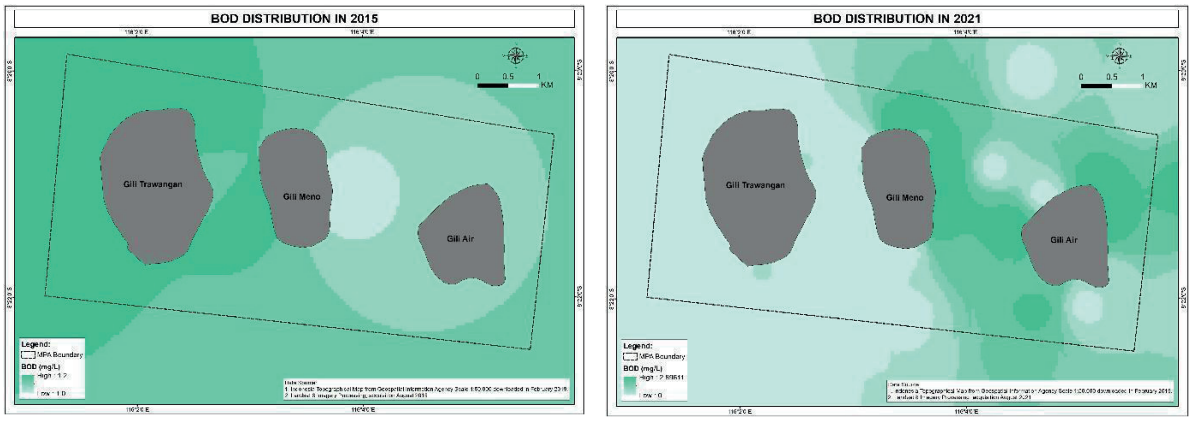


Figure 28. Distribution of biological oxygen demand (BOD) in the surrounding waters of Gili Matra MPA

C. Assets Accounts

Ecosystem extent and individual environmental assets

For the asset's accounts, ecosystem extent in 2015 serves as the opening account and the extent in 2021 serves as the closing account. Coral reef ecosystem between 2015 to 2021 gain natural expansion around 12 ha and experience degradation of 24 ha, thus in overall decrease from 259.50 ha in 2015 to 247.50 ha in 2021. The seagrass ecosystem in 2015 was 76.75 ha. It expanded naturally to 51.50 ha but lost coverage by 25.75 ha in 2021. Thus, in 2021 a total area of seagrass ecosystem reached 102.50 ha. As for the mangrove ecosystem, the coverage area in 2015 was 21.50 ha. By 2021, its coverage increased by 0.38 ha but also reduced by managed regression (human induced) of 11.19 ha at the same period. The final closing account for mangrove was 10.69 ha from 21.50 ha at the opening account. Individual environmental assets in 2021 showed that fish abundance was increased by 7,704 ind/ha while fish biomass was decreased by 290.06 kg/ha (Table 5). Increased in abundance of small fish showing a signal for recruitment.

Habitat changes occurred for all ecosystems in Gili Matra MPA (Table 6). Of the 2015 opening stock (259.5 ha), 235.50 ha coral reef remain intact, 8.25 ha changed into seagrass, and another 15.75 ha changed into other substrate. Of the 2015 opening stock (76.75 ha), 51 ha seagrass remained intact, added with 8.25 ha from previously coral reef, and 43.25 ha from previously other substrate. Changes from seagrass ecosystem was recorded for 2.19 ha into coral reefs and 23.56 ha into other substrates. Of the 2015 opening stock (21.50 ha), 10.31 ha mangrove remain intact, while 11.19 ha changed into land areas. Change of 0.38 ha land areas into mangrove was also recorded. The detailed ecosystem extent changes are provided in Table 6 and spatially shown in Figure 29.

Table 5. Ecosystem extent and individual environmental assets accounts in Gili Matra MPA

	Ecosystem assets						Individual environmental assets	
	Coral	**Seagrass**	**Mangrove**	**Other substrate**	**Land**	**TOTAL**	**Fish Abundance**	**Fish Biomass**
Opening stock	***259.50***	***76.75***	***21.50***	***1,905.72***	***717.38***	***2,980.84***	***12,747***	***442.06***
+ Additional to stock								
Managed expansion								
Natural expansion	12.00	51.50	0.38	39.31	11.19		7,704	
Reclassification								
Discoveries								
Reappraisal (+)								
- Reduction in stock								
Managed regression			11.19					
Natural regression	24.00	25.75		53.06	0.38			290.06
Reclassification								
Extractions/ harvesting								
Reappraisal (-)								
Total reductions in stock								
Closing stock	***247.50***	***102.50***	***10.69***	***1,891.97***	***728.19***	***2,980.84***	***20,451***	***151.99***
Measurement units	hectare	hectare	hectare	hectare	hectare	hectare	ind/ha	kg / ha

Table 6. Ecosystem extent changes in Gili Matra MPA

Ecosystem function		**Closing Extent 2021 (Ha)**					**Opening**
		Coral	**Seagrass**	**Mangrove**	**Other substrate**	**Land**	
Opening extent 2015 (Ha)	**Coral**	*235.50*	8.25		15.75		259.50
	Seagrass	2.19	*51.00*		23.56		76.75
	Mangrove			*10.31*		11.19	21.50
	Other substrate	9.81	43.25		*1852.66*		1,905.72
	Land			0.38		*717.00*	717.38
Closing		247.50	102.50	10.69	1,891.97	728.19	**2,980.84**

Notes:

Figures on the right (greyed) are the opening extent of each ecosystem function, while the closing extents were shown at the bottom (greyed). The total area of opening and closing extents must remain the same as indicated by the figure in bold. Changes of ecosystem area in 2015 to another in 2021 are indicated by reading the figures on each row from left to right. Figures in italic indicate the area that remained intact.

Ecosystem extent account according to zoning plan was identified (Table 7). Decrease of coral reef extent occurred in all zones with the highest in core zone and protection zone (4.03 ha), followed by utilization zone (4.00 ha). Seagrass extent increased in almost all zones, except in rehabilitation zone (decreased by 0.41 ha). The highest expansion of seagrass extent was recorded in utilization zone (10.89 ha) followed by core zone and protection zone (8.13 ha). The mangrove areas were distributed in utilization zone, core zone, and protection zone, and dominantly found outside Gili Matra MPA. Changes on mangrove extent between opening and closing account were recorded from Gili Meno (reduced by 10.81 ha).

Table 7. Ecosystem extent account according to zoning plan

Zone	Ecosystem function	Core and Protection				Utilization					Sustainable fisheries			Rehabilitation			Port			Outside MPA				Opening
		Coral	Seagrass	Man-grove	Other sub-strate	Coral	Seagrass	Mangrove	Other substrate	Land	Coral	Seagrass	Other substrate	Coral	Seagrass	Other substrate	Coral	Seagrass	Other substrate	Seagrass	Mangrove	Other substrate	Land	
Core and Protection	Coral	29.91	1.57		2.46																			33.94
	Seagrass		13.85		4.19																			18.05
	Mangrove			0.02																			0.05	0.08
	Other substrate		10.75		34.78																			45.53
Utilization	Coral					37.86	2.31		2.88															43.06
	Seagrass					0.19	4.11		0.25															4.55
	Mangrove							0.08		0.45													0.06	0.59
	Other substrate					1.00	9.01		130.52															140.53
	Land							0.03		4.28														4.32
Sustainable fisheries	Coral										150.36	3.02	9.06											162.45
	Seagrass										1.25	32.10	18.74											52.09
	Mangrove																						0.00	0.00
	Other substrate										8.62	22.99	1,620.22											1,651.84
Rehabilitation	Coral													6.12	0.21	0.44								6.77
	Seagrass													0.25	0.61	0.38								1.23
	Other substrate															25.47								25.47
Port	Coral																11.25	1.13	0.91					13.29
	Seagrass																0.50	0.33						0.83
	Other substrate																0.19	0.49	41.65					42.34
Outside MPA	Mangrove																				10.21		10.62	20.83
	Other substrate																			0.00		0.00		0.00
	Land																				0.34		712.72	713.06
Closing		29.91	26.17	0.02	41.44	39.05	15.44	0.11	133.65	4.74	160.24	58.11	1,648.03	6.37	0.82	26.29	11.94	1.96	42.56	0.00	10.55	0.00	723.45	2,980.84

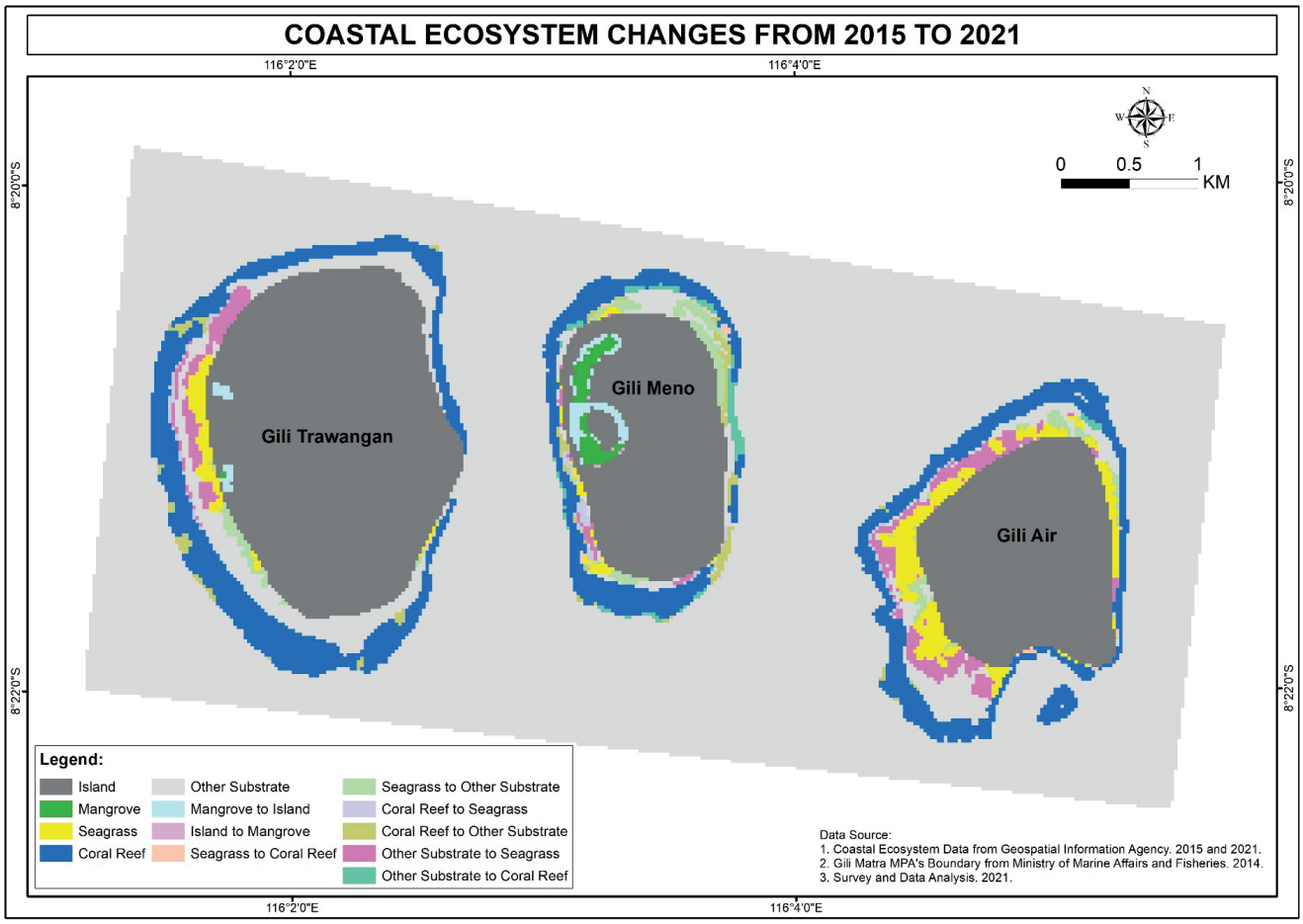


Figure 29. Coastal ecosystem changes in Gili Matra MPA from 2015 to 2021

Ecosystem condition

In the coral reef ecosystem, chlorophyll-a concentration, dissolved oxygen, biological oxygen demand and reef fish diversity show no significant changes during the observation of 2015 and 2021. In seagrass ecosystem, increase of pH, TSS, dissolved oxygen and biological oxygen demand was identified, but no significant change of chlorophyll-a concentration (2015-2021 observations). Number of seagrass species changed from 2015 (9 species) to 2021 (8 species). In mangrove ecosystem, only diversity index that change both Shannon-Wiener Index and number of species. The ecosystem condition for 2015 is presented in Table 8, while for 2021 in Table 9.

Table 8. Ecosystem condition in 2015

2015	Variable	Reference Level	Ecosystem assets					Average	Notes
			Coral	Seagrass	Mangrove	Other Sub-strates	Land		
Area	Hectare	-	259.50	76.75	21.50	1,905.72	717.38	2,980.84	*According to standard quality for seawater (Decree of Ministry of Environment and Forestry No. 51 of 2004)
Acidification	pH	7.0-8.5*	8.17	8.12	n.a.	8.15	n.a.	8.15	
Eutrophication	Chlorophyll-a (mg/m^3)	-	0.18	0.19	n.a.	0.18	n.a.	0.18	
	DO (mg/L)	>5.0*	8.34	8.34	n.a.	8.34	n.a.	8.34	
	BOD (mg/L)	20*	1.13	1.11	n.a.	1.12	n.a.	1.12	
Temperature	°Celsius	28-32*	22.98	23.74	n.a.	22.80	n.a.	22.85	
Total solid suspended	mg/L	20-80*	111.33	230.12	n.a.	95.76	n.a.	101.98	
Diversity	Shannon and Wiener Index	-	4.31**	n.a.	1.00	n.a.	n.a.	n.a.	Reef fish diversity used as proxy for coral reef condition **data 2016
	Number species	-	328**	9	4	n.a.	n.a.	n.a.	

Table 9. Ecosystem condition in 2021

2021	Variable	Reference Level	Ecosystem assets					Average	Notes
			Coral	Seagrass	Mangrove	Other Sub-strates	Land		
Area	Hectare	-	247.50	102.50	10.69	1,891.97	728.19	2,980.84	*According to standard quality for seawater (Decree of Ministry of Environment and Forestry No. 51 of 2018)
Acidification	pH	7.0-8.5*	8.16	8.15	n.a.	8.15	n.a.	8.15	
Eutrophication	Chlorophyll-a (mg/m^3)	-	0.18	0.19	n.a.	0.18	n.a.	0.18	
	DO (mg/L)	>5.0*	8.34	8.35	n.a.	8.34	n.a.	8.34	
	BOD (mg/L)	20*	1.13	1.12	n.a.	1.12	n.a.	1.12	
Temperature	Celsius	28-32*	22.97	23.50	n.a.	22.81	n.a.	22.85	
Total solid suspended	mg/L	20-80*	109.96	234.72	n.a.	93.97	n.a.	101.98	
Diversity	Shannon and Wiener Index	-	4.30	1.29	0.23	n.a.	n.a.	n.a.	Reef fish diversity used as proxy for coral reef condition
	Number species	-	304	8	3	n.a.	n.a.	n.a.	

D. Economic Value of Ecosystem Services

Coral Reef

Coral reefs in Gili Matra MPA provide both direct benefits, i.e., from fishing, underwater tourism, and research, and indirect benefits for biodiversity and coastal protection. With total area of 259.50 ha in 2015, the value of regulating function was IDR 4.37 billion/year, cultural function was IDR 33.49 billion/year, and the provisioning function was IDR 374.43 million/year. Of the three functions, the total economic value of coral reef ecosystems in 2015 was IDR 38.23 billion/year or equivalent to IDR 147.35 million/ha/year (around USD 10,525/ha/year[7]). With total area of 247.50 ha of 2021, the value of regulating function was IDR 5.95 billion/year, for cultural functions was IDR 45.62 billion/year, and the provisioning function was IDR 510.08 million/year. The totals economic value of coral reefs in 2021 was IDR 52.09 billion/year or equivalent to IDR 210.47 million/ha/year (around USD 15,033/ha/year[8]). The economic value of coral reefs in Gili Matra MPA for 2015 and 2021 is shown in Table 10.

Table 10. The economic value of coral reef services in Gili Matra MPA in 2015 and 2021

Ecosystem Services	Economic Value in 2015	Economic Value in 2021
Regulating	IDR 4,373,246,347/year	IDR 5,957,567,706/year
Cultural	IDR 33,491,509,801/year	IDR 45,624,673,622/year
Provisioning	IDR 374,435,836/year	IDR 510,084,881/year
Total	IDR 38,239,191,984/year IDR 147,357,195/ha/year (USD 10,525/ha/year)	IDR 52,092,326,209/year IDR 210,474,045/ha/year (USD 15,033/ha/year)

Seagrass

Seagrass benefits in Gili Matra consist of indirect benefits, i.e., nursery ground, carbon storage, and nutrient cycling. Total area of seagrass in 2015 was 76.75 ha, with economic value from supporting function as nursery ground was IDR 831.88 million/year, carbon storage function was IDR 314.76 million/year, and supporting function as nutrient cycling was IDR 3.46 billion/year. Total economic value of seagrass for 2015 was IDR 4.61 billion/year or IDR 60.15 million/ha/year (around USD 4,296/ha/year[8]). With area of 102.50 ha in 2021, economic value from supporting functions was IDR 1.58 billion/year, regulating function was IDR 600.42 million/year, and nutrient cycle function was IDR 6.61 billion/year. The total economic value of the seagrass ecosystem in Gili Matra MPA for 2021 was IDR 8.80 billion/year or IDR 85.91 million/ha/year (around USD 6,136/ha/year). The economic value of seagrass ecosystems in Gili Matra MPA for 2015 and 2021 is shown in Table 11.

7 According to exchange rate of 1 USD = 14,000 IDR

Table 11. The economic value of seagrass services in Gili Matra MPA in 2015 and 2021

Ecosystem Services	Economic Value in 2015	Economic Value in 2021
Supporting (Nursery Ground)	IDR 831,881,902/year	IDR 1,586,844,463/year
Regulating (Carbon sequestration)	IDR 314,767,318/year	IDR 600,429,911/year
Supporting (Nutrient Cycling)	IDR 3,469,953,087/year	IDR 6,619,059,546/year
Total	IDR 4,616,602,307/year IDR 60,151,170/ha/year (USD 4,296/ha/year)	IDR 8,806,333,920/year IDR 85,915,452/ha/year (USD 6,136/ha/year)

Mangroves

Mangrove ecosystem in Gili Matra is located outside the MPA (Meno Island). However, this ecosystem has indirect benefits for biodiversity, carbon storage, cultural, and protecting coastal areas. Mangrove area in 2015 was 21.50 ha, with economic value of regulatory function was IDR 20.99 million/year, cultural function was IDR 137.58 million/year, supporting function was IDR 2.19 billion/year, and supply function was IDR 31.02 million/year. Total economic value of mangrove in Gili Matra in 2015 was IDR 2.38 billion/year or equivalent to IDR 111.03 million/ha/year (around USD 7,931/ha/year[8]). The total mangrove area in 2021 was 10.69 ha, with economic value of regulatory function was IDR 14.91 million/year, cultural function was IDR 97.71 million/year, support function was IDR 3.13 billion/year, and supply function was IDR 22.03 million/year. The total economic value of mangrove in 2021 was IDR 3.27 billion/year or IDR 304.83 million/ha/year (around USD 21,774/ha/year[8]). The economic value of mangrove ecosystems in Gili Matra for 2015 and 2021 is shown in Table 12.

Table 12. The economic value of mangrove services in Gili Matra in 2015 and 2021

Ecosystem Services	Economic Value in 2015	Economic Value in 2021
Regulating (Shorelines Protection)	IDR 20,996,766/year	IDR 14,911,415/year
Cultural	IDR 137,589,496/year	IDR 97,712,861/year
Supporting	IDR 2,197,651,408/year	IDR 3,138,961,645/year
Provisioning	IDR 31,022,622/year	IDR 22,031,545/year
Total	IDR 2,387,260,292/year IDR 111,035,362/ha/year (USD 7,931/ha/year)	IDR 3,273,617,466/year IDR 304,836,861/ha/year (USD 21,774/ha/year)

Changes of the Economic Values in Gili Matra

In 2015, total economic values for coral reefs, seagrass, and mangroves in Gili Matra was IDR 45.24 billion/year. Changes of coral reef, seagrass, and mangrove area, however, did not significantly affect the economic value as inflation (0.58%) and real interest rate (0.054) in 2021 was higher compared to 2015. This led the increase of total economic value from coral reef, mangrove, and seagrass in 2021 to IDR 64.17 billion/year. Based on services provided by the ecosystem, areas with high economic values were scattered along the south-west coast of Gili Trawangan; south coast, northwest, and mangrove areas on Gili Meno, and southwest coast of Gili Ayer. The loss of key ecosystems in Gili Matra caused the loss of economic value from ecosystem services (Figure 30 indicated by negative value).

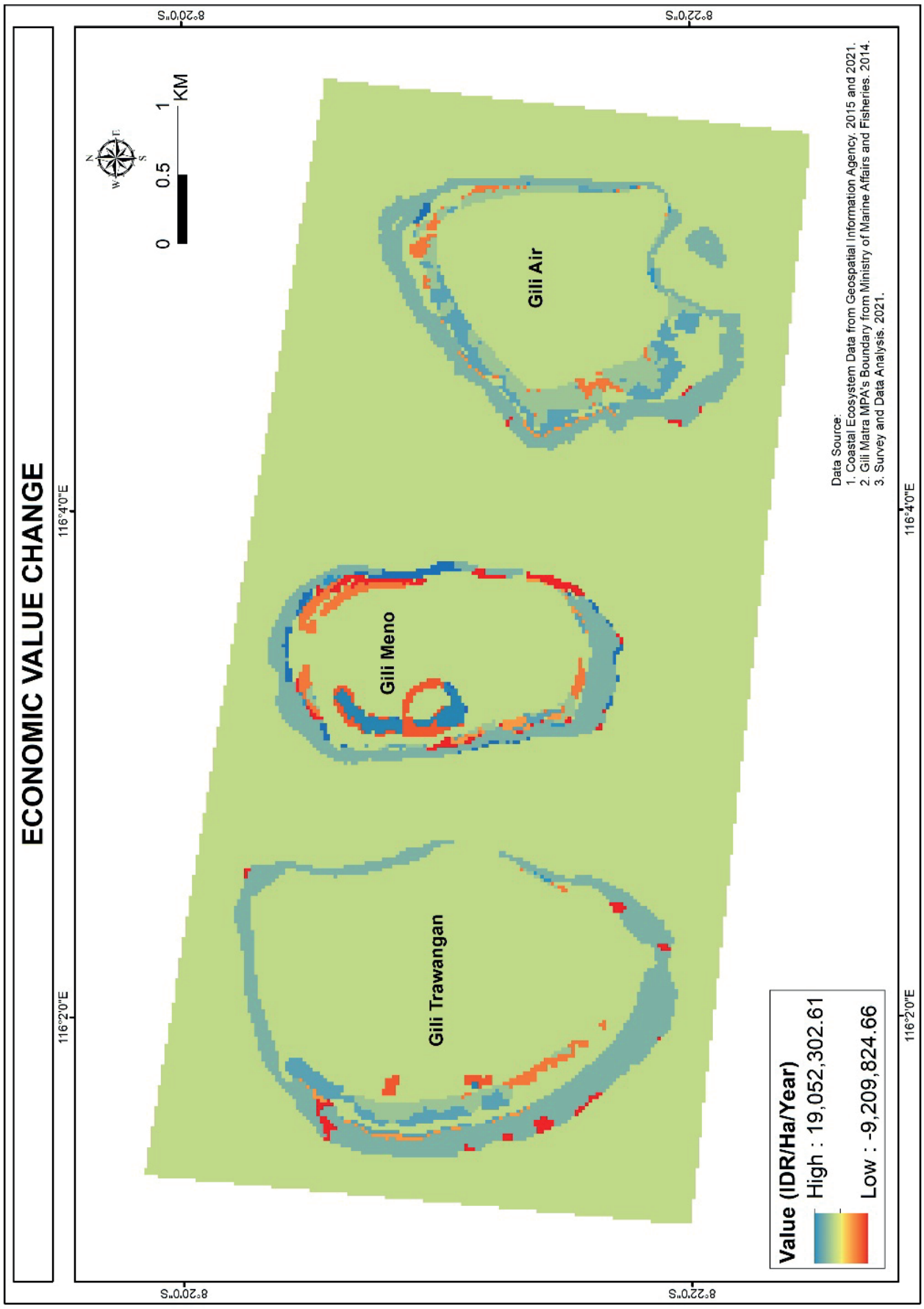


Figure 30. Economic value change of ecosystem services in Gili Matra in 2015-2021

FLOWS TO THE ECONOMY ACCOUNTS 8

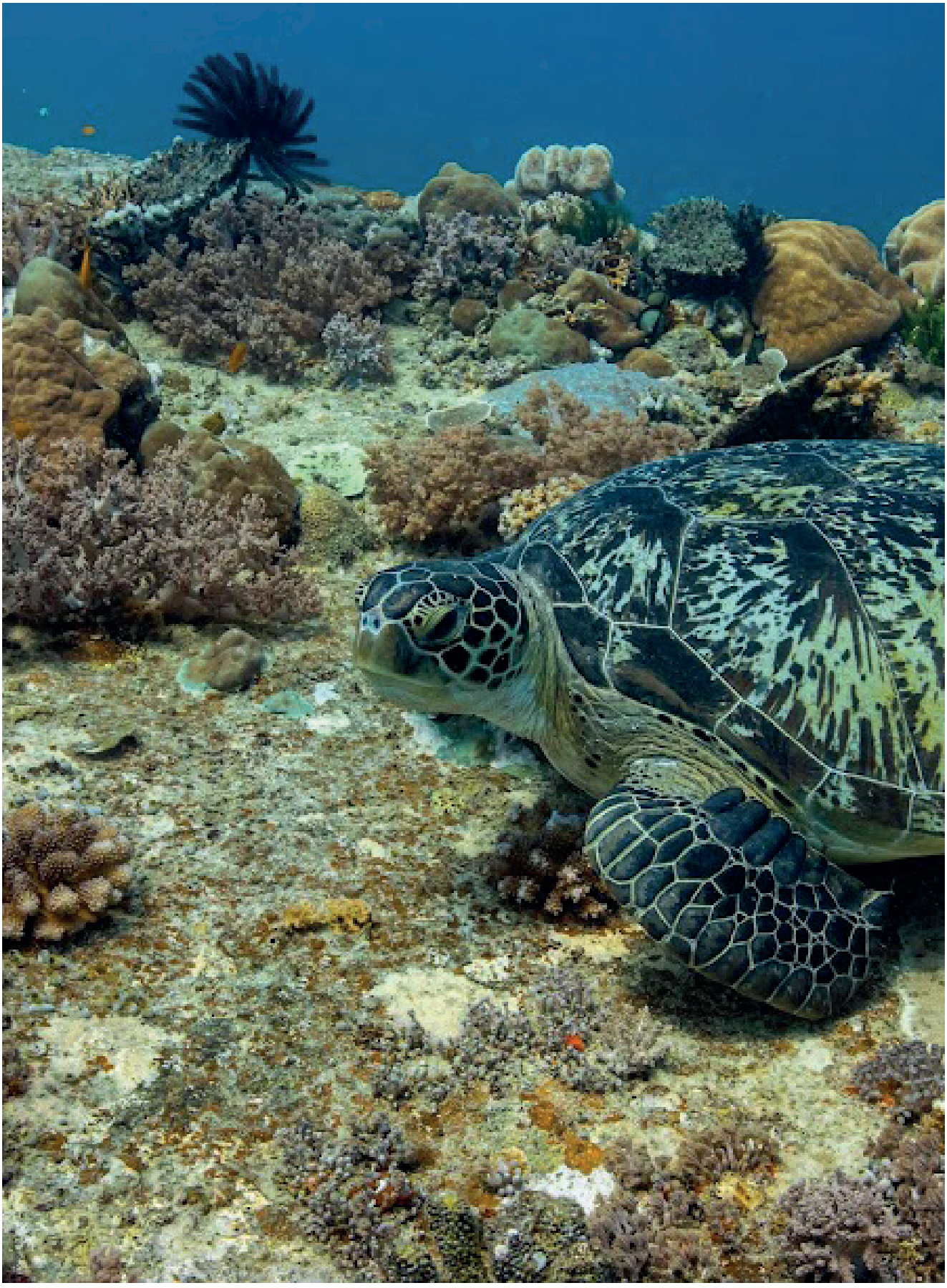
Referring to the study of asset accounts of Gili Matra MPA, the coverage of coral reef, seagrass, and mangrove in 2021 was 259.5 ha, 76.75 ha, 10.69 ha, respectively (MMAF, 2021). Economic valuation was carried out in accordance with the role and functions of those ecosystems to identify the overall monetary value. The economic value of IDR 52.09 billion/year was estimated from coral reef, IDR 8.80 billion/year from seagrass and IDR 3.27 billion/year from mangrove.

Fishing and tourism are the primary economic activities found in Gili Matra MPA. Until 2020, marine tourism was dominant in Gili Matra MPA. Due to the COVID-19 pandemic, there has been a shift in economic activity to fisheries. Fisheries activities in Gili Matra MPA involved 163 fishers who mainly use nets and speargun as their fishing gears. Net fishers usually fish in group (12 groups with total members of 104 fishers), while speargun fishers (59 people) generally work in solitary. The market value in Gili Matra MPA ranges from IDR 25,000 to IDR 35,000 per kilogram of catch. The monetary value of fishery activities in Gili Matra MPA is estimated to reach IDR 3,13 billion/year which comes from service provision (Table 13).

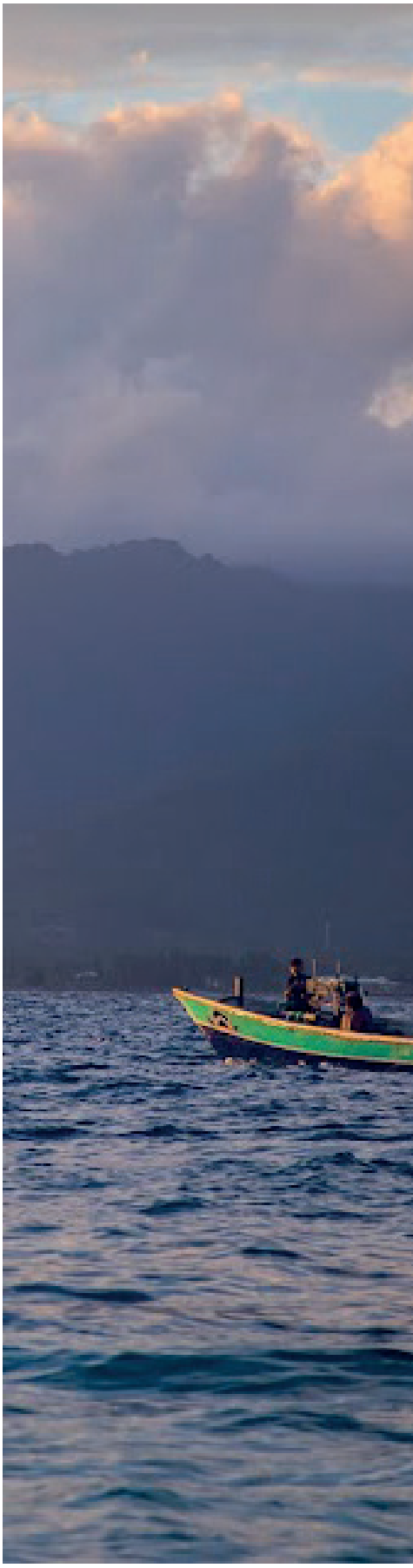
Marine tourism activities in Gili Matra MPA include diving, snorkeling, and beach tours. The core activities are providing several services, such as accommodation, food and beverages, equipment rentals, and transportation. The estimated monetary value of marine tourism activities at Gili Matra MPA reaches IDR 30.20 trillion/year. In total, the estimated monetary value of fisheries and marine tourism activities in Gili Matra MPA was IDR 33.05 billion/year. This is far lower than the estimated monetary value before COVID-19 pandemic that estimated up to IDR 1.04 trillion/year. The supply and use of natural resources in Gili Matra MPA is shown in Table 13.

Table 13. Flows to the economy in Gili Matra MPA (figures in Rupiah)

Monetary Unit	Coral Reefs	Seagrass	Mangrove	Fisheries	Tourism	Others	Total
Supply Table	**52,092,326,209**	**8,806,333,920**	**3,273,617,466**				**64,172,277,595**
Provisioning	510,084,881		22,031,545				532,116,426
Regulating and maintenance	5,957,567,706	600,429,911	14,911,415			6,572,909,032 45,722,386,483	
Cultural	45,624,673,622		97,712,861				
Supporting		8,205,904,009	3,138,961,645				11,344,865,654
Use Table				**3,134,400,000**	**30,207,812,885**	**30,830,064,710**	**64,172,277,595**
Provisioning			3,134,400,000		64,172,277,595		
Regulating and maintenance			30,207,812,885				
Cultural				30,830,064,710			
Supporting							



FLOWS TO THE ENVIRONMENT ACCOUNTS 9



Flows to the environment accounts provides information on the residuals from economic activities in the form of liquid waste and solid waste released back to the environment. Produced solid waste in Gili Matra MPA for 2021 was estimated around 2,865 tons originating mainly from marine tourism activities. It consists of mixed household and commercial waste (municipal waste), equipment and vehicles waste, metal waste, and combustion waste. Mixed household and commercial waste were the principal waste with a contribution of 99.82% (Table 14). Of the total solid waste produced, around 2,017 tons or 70.4% of the total solid waste was disposed of in landfills. A small part of the total solid waste, which is around 85 tonnes, is recycled or reused. The physical use of solid waste is presented in Table 15.

Inventory of liquid waste in Gili Matra MPA indicates that liquid waste is mainly contributed by marine tourism activities with the largest residual from Gili Trawangan (Table 16). Almost all liquid waste is channelled into sewers managed by waste companies (97.8%) and a small portion is channelled into collection tanks (1.4%). However, there is a small amount of liquid waste that is still being channelled into the sea (0.79%). The physical use of liquid waste in Gili Matra MPA is shown in Table 17.

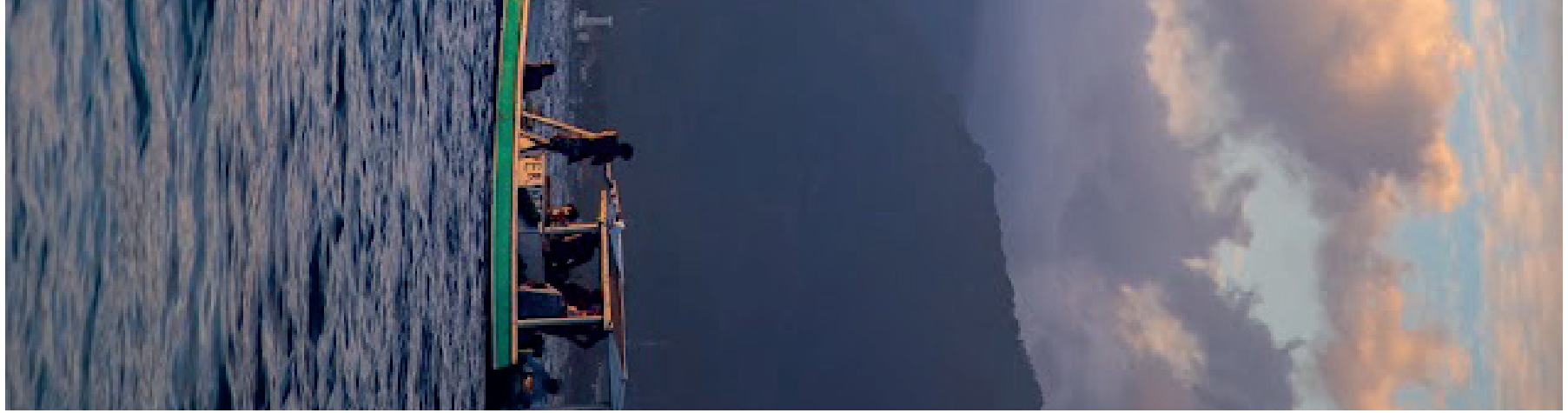


Table 14. Physical supply of solid waste in Gili Matra MPA

Substance (kg)	Consumption			Marine Activities			Flows to the Environment	Total
	Recycling and Reuse	Landfill	Others	Fisheries	Tourism	Rest of the World		
Chemical and health care waste								
Metallic waste					633	358		**991**
Recyclable non-metallic fractions					604,087	613,457.12		**1,217,544.12**
Equipment and vehicle waste					2,000			**2,000**
Animal and plan waste								
Mixed household and commercial waste					1,613,988.84	28,838		**1,642,826.84**
Mineral waste and soil								
Combustion waste					2,220	42		**2,262**
Other waste								
Solid waste					**2,222,928.84**	**642,695.12**		**2,865,623.96**

Notes: data were collected from field survey (February 2022)

Table 15. Physical use of solid waste in Gili Matra MPA

Substance (kg)	Consumption			Marine Activities			Flows to the Environment	Total
	Recycling and Reuse	Landfill	Others	Fisheries	Tourism	Rest of the World		
Chemical and health care waste								
Metallic waste	27	600	364					**991.00**
Recyclable non-metallic fractions	39,459.2	1,081,391.67	96,693.25					**1,217,544.12**
Equipment and vehicle waste			2,000					**2,000**
Animal and plan waste								
Mixed household and commercial waste	46,104	935,502.17	661,220.67					**1,642,826.84**
Mineral waste and soil								
Combustion waste			2,262					**2,262**
Other waste								
Solid waste	**85,590.20**	**2,017,493.84**	**762,539.92**					**2,865,623.96**

Notes: data were collected from field survey (February 2022)

Table 16. Physical supply of liquid waste in Gili Matra MPA

Liquid Waste (m^3)	Point of discharges			Marine Activities		Flows to the environment		Total supply
	Sewers managed by waste companies	Waste reservoir	Others	Fisheries	Tourism	Total	Of which to Ocean	
Gili Meno					2,153			2,153
Gili Ayer					1,153			1,153
Gili Trawangan					334,907			334,907
Total					**338,213**			**338,213**

Notes: data were collected from field survey (February 2022)

Table 17. Physical Use of liquid waste in Gili Matra MPA

Liquid Waste (m^3)	Point of discharges			Marine Activities		Flows to the environment		Total use
	Sewers managed by waste companies	Waste reservoir	Others	Fisheries	Tourism	Total	Of which to Ocean	
Gili Meno	22	753	5.4			781	1,372	2,153
Gili Ayer		1,064				1,064	89	1,153
Gili Trawangan	330,624	3,068				333,692	1,216	334,907
Total	330,646	4,885	5.4			335,537	2,677	338,213

Notes: data were collected from field survey (February 2022)

GOVERNANCE ACCOUNTS 10

The governance accounts were prepared by taking two important elements into account, namely the spatial use regulation within the area and the environmental management measures. The spatial arrangements in Gili Matra MPA is regulated in accordance with the zoning system, while environmental management measures refer to management activities carried out by the management unit and local government.

A. Spatial arrangements of Gili Matra MPA

The spatial use of Gili Matra MPA is regulated through the Decree of the MMAF No. 57/KEPMEN-KP/2014 on the Management and Zoning Plan of Gili Matra MPA 2014 – 2034. The spatial allocation was grouped into four zones: core zone, sustainable fisheries zone, utilization zone, and other zones. In total there are six zones within the area, namely core zone, sustainable fisheries zone, utilization zone, protection zone, rehabilitation zone, and port zone.

Core zone is an area allocated for (a) absolute protection of fish habitats and populations, (b) research activities aimed at collecting data on biological and ecological conditions, and (c) educational activities. The core zone of Gili Matra MPA covers an area of 94.81 Ha spread around Gili Trawangan (67.94 ha), Gili Meno (10.78 ha), and Gili Ayer (16.09 ha). In this zone, almost no utilization or extraction activities are allowed.

Sustainable fisheries zone is the largest spatial allocation in Gili Matra MPA which covers an area of 1,870.1 ha. This area is designated for economic activities such as fishing and marine tourism. A sub-zone of sustainable coral fisheries was situated within this zone, covering an area of 530.66 ha, spread mainly in coral reef areas. This spatial allocation is intended to facilitate fishing using traditional gears.

Utilization zone is allocated primarily for marine tourism. In the area of 207.49 ha, almost no extraction activities (taking from nature) are permitted. Since this area is mainly intended for nature tourism, almost all marine tourism activities can be carried out in this area, except for tourism activities that involve taking biota from habitats (i.e., recreational fishing).

Rehabilitation zone is allocated mainly for coral reef and seagrass rehabilitation. The total coverage area of this zone is 36.93 ha, comprises 22.95 ha of Gili Trawangan, 8.52 ha of Gili Meno, and 5.46 ha of Gili Ayer. The Protection Zone is intended primarily to protect the blue coral species (*Heliopora* sp.) which is allocated only for Gili Trawangan. While the Port Zone is an area intended to facilitate transportation from outside to Gili Matra MPA and vice versa. This zone reaches 61.64 ha, spread over six areas: one area in Gili Trawangan, three areas in Gili Meno, and two areas in Gili Ayer.

B. Economy activities in Gili Matra MPA

The dominant economic activity in this area is fishing and marine tourism. Fishers catch fish in several fishing grounds, both inside and outside the MPA. The fishing ground area of 1,855.92 ha mainly situated in the northern part. Some areas adjacent to the islands are generally fishing grounds for speargun fishers, while areas which are relatively far from the islands are fishing grounds for net fishermen. The distribution of fishing activities in Gili Matra MPA is shown in Figure 31.

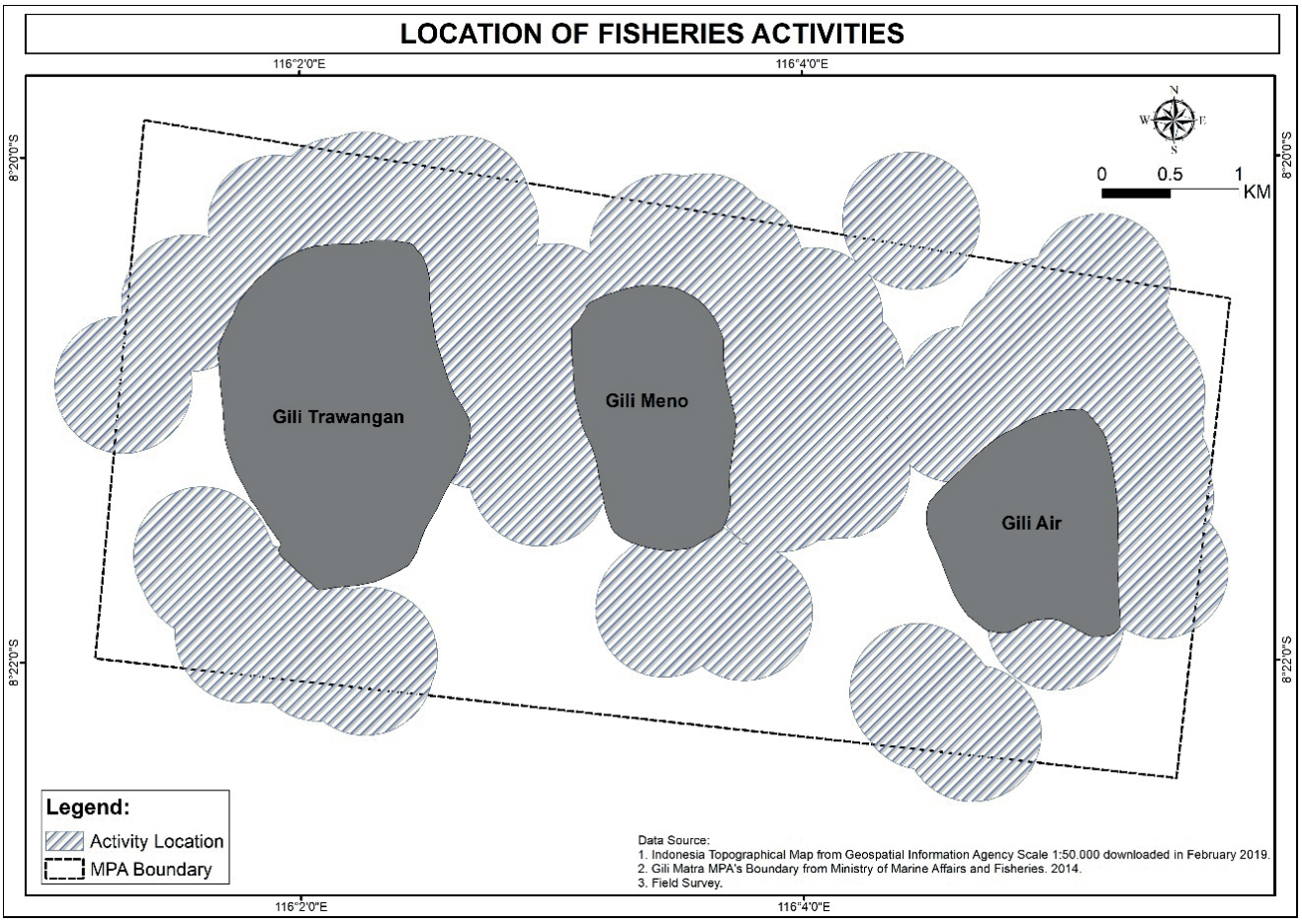


Figure 31. Fishing grounds in Gili Matra MPA

Typical activities of marine tourism in Gili Matra MPA including snorkeling, diving, surfing, canoeing, and swimming. Tourism activities in the Gili Matra MPA are shown in Figure 32. Among all marine tourism activities, snorkeling and diving are the dominant ones. Snorkeling generally takes place within the area of Gili Trawangan and Gili Meno, and the northern and southern coast of Gili Ayer, covering areas of approximately 75.64 ha (Figure 33).

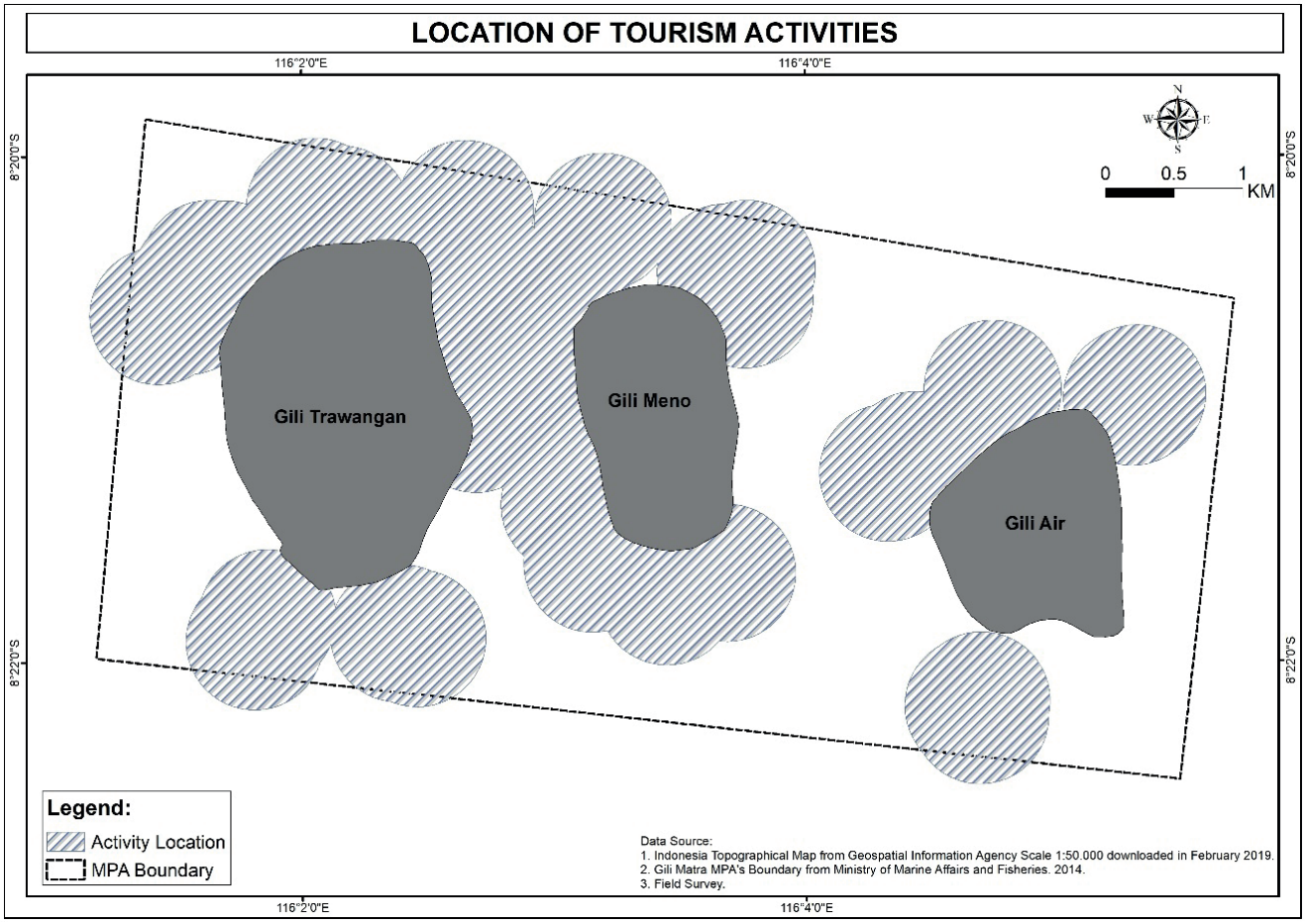


Figure 32. Area utilized for marine tourism activities in Gili Matra MPA

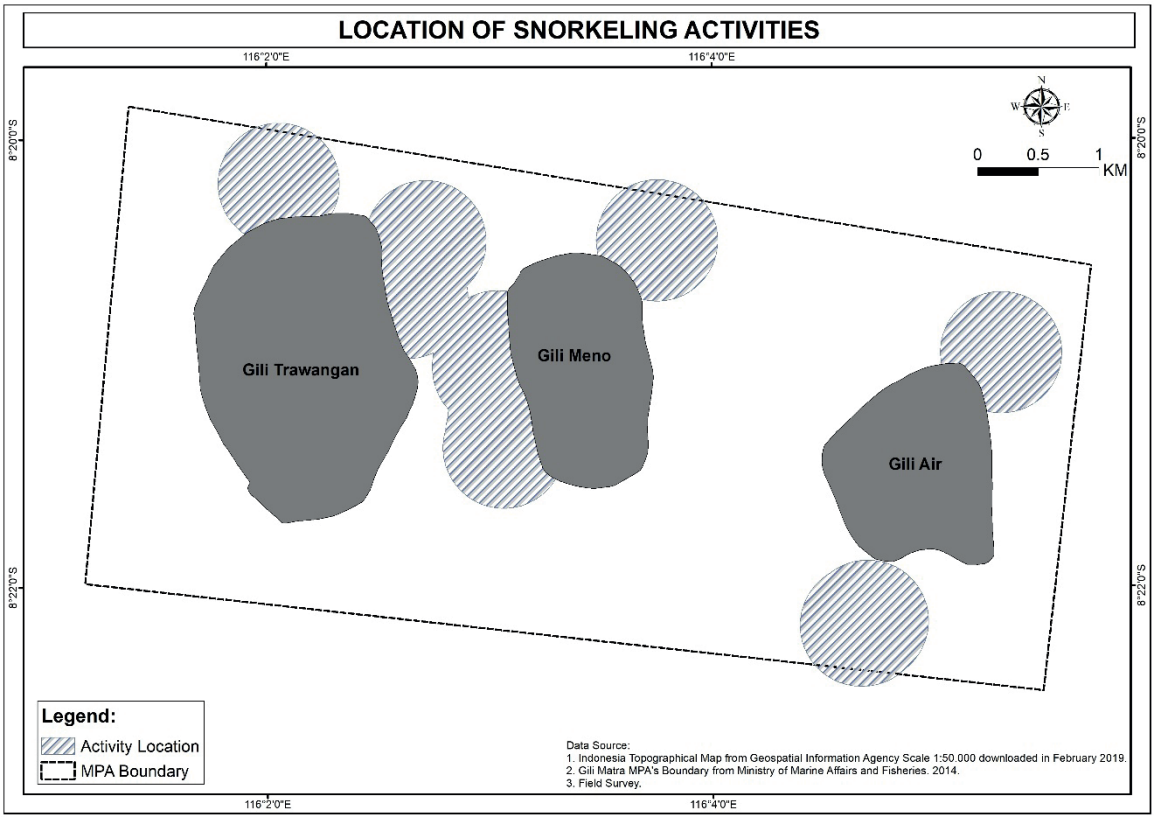


Figure 33. Snorkeling area in Gili Matra MPA

Gili Matra MPA is known as popular diving spot with a fairly high diving intensity. Dive operators not only provide tour services but also several diving classes for various levels. Diving is centred in the northern coast of Gili Trawangan and Gili Meno, with other areas scattered around southwest of Gili Trawangan, western coast of Gili Meno, and northern coast of Gili Ayer. Area of diving spots cover about 806.28 ha. Distribution of the diving activities is shown in Figure 34.

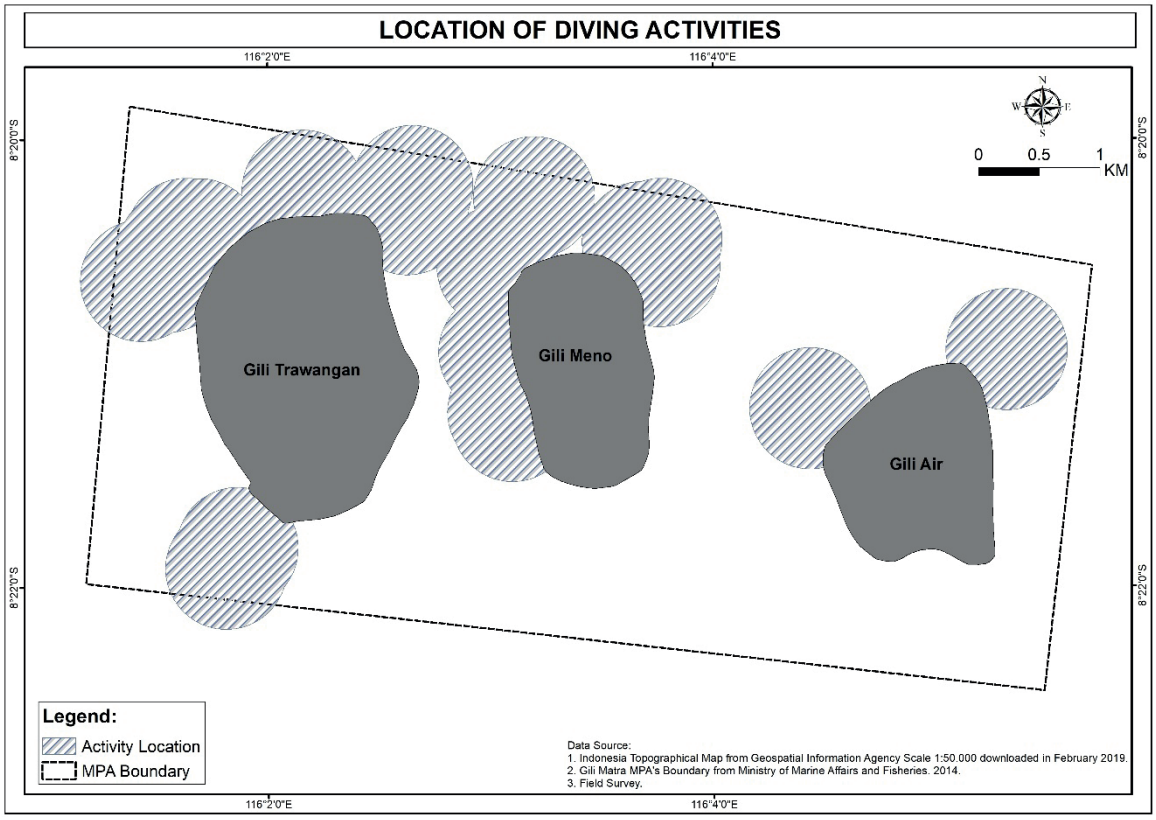


Figure 34. Diving area in MPA Gili Matra

Besides snorkeling and diving, Gili Matra MPA also accommodate activities such as surfing, canoeing, and swimming. Surfing generally takes place in the southern coast of the three Gilis, as well as the eastern part of Gili Trawangan, using the area of approximately 387.12 ha (Figure 35). Canoeing is commonly found in the northern part between Gili Trawangan and Gili Meno which covers an area of approximately 133.42 ha (Figure 36), while swimming generally takes place in the northern part of Gili Ayer (Figure 37).

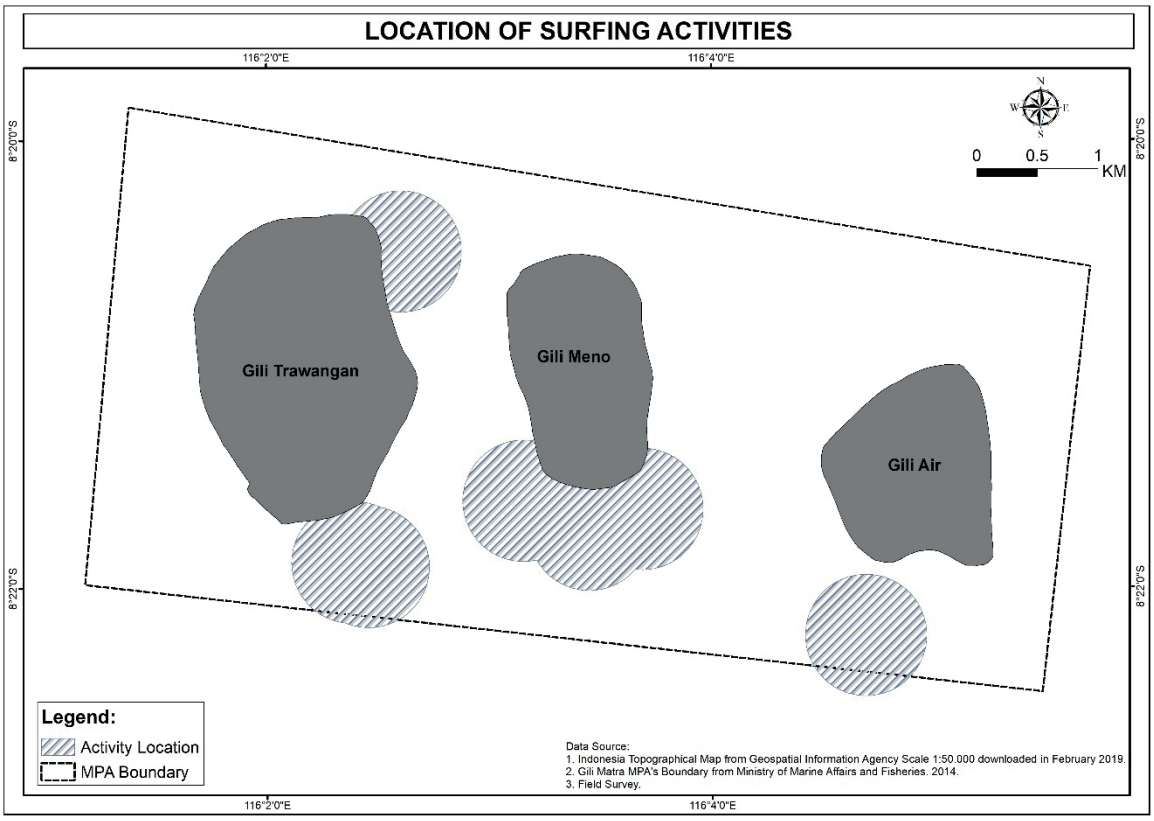


Figure 35. Surfing area in Gili Matra MPA

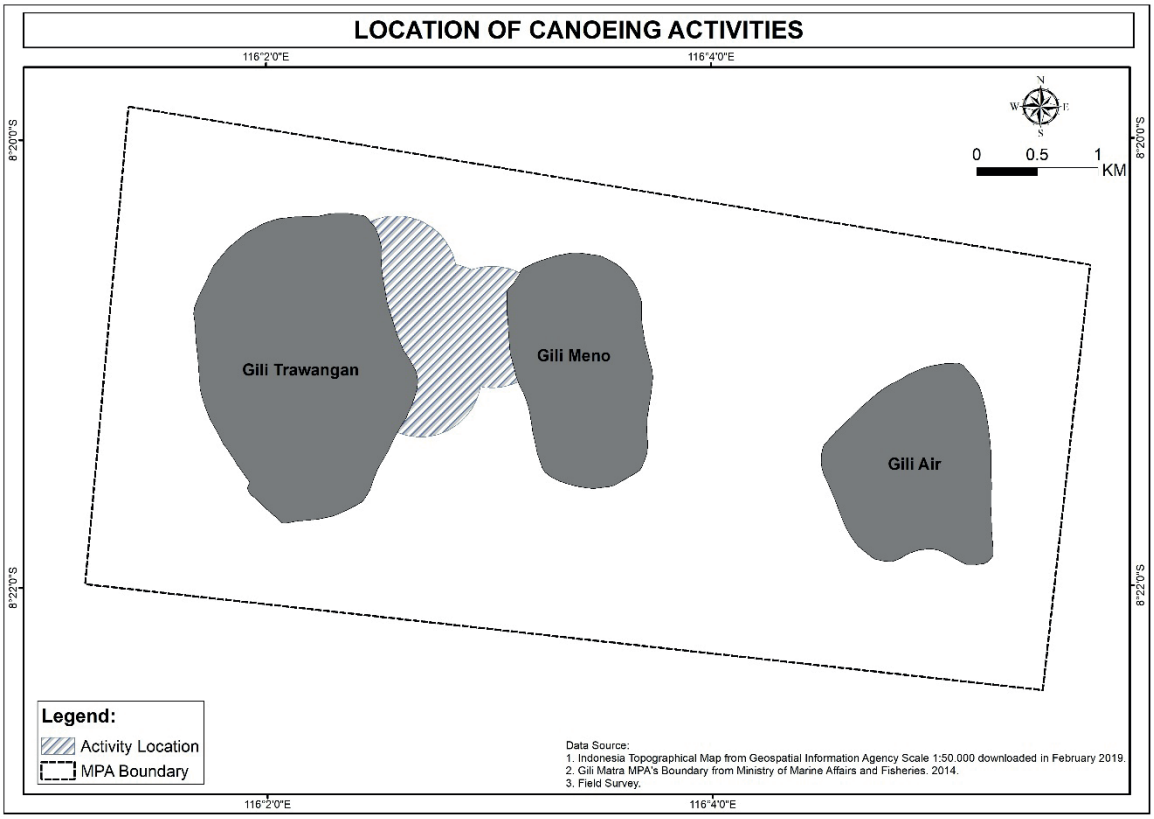


Figure 36. Canoeing area in MPA Gili Matra

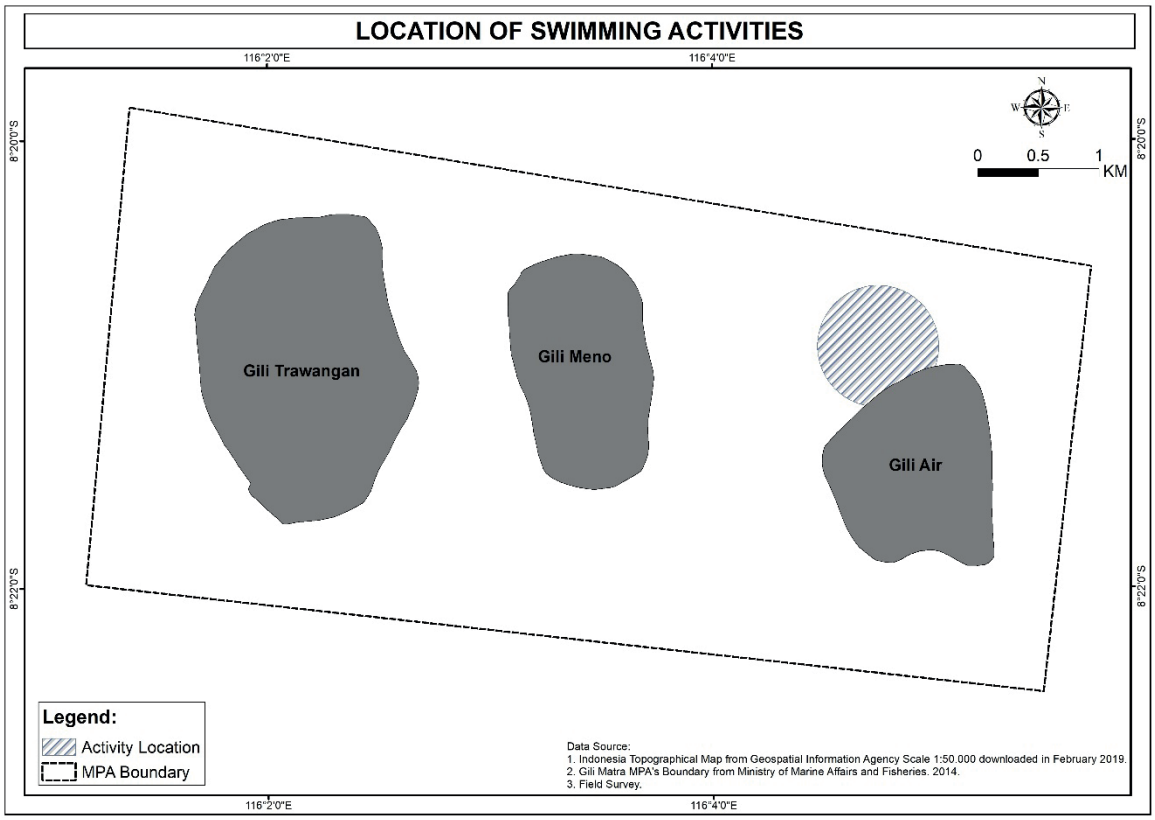


Figure 37. Area of recreational swimming in Gili Matra MPA

C. Environmental management measures

Gili Matra MPA is managed under the authority of the MMAF. Technically, BKKPN Kupang is responsible for the management of Gili Matra MPA. The Working Unit (*Satuan Kerja/Satker*) of Gili Matra MPA under BKKPN Kupang carries out its management function by referring to the Management and Zoning Plan of Gili Matra MPA 2014 – 2034 under the vision of "Realization of the effectiveness of Gili Matra MPA management to ensure the sustainability of marine, social, cultural and community welfare".

To implement the management function, the strategy is focused on strengthening the (1) institutional arrangement, (2) area management, and (3) socio-economic and cultural aspects. Currently, the management of Gili Matra MPA has entered the second medium term period with a focus on activities:

1. Institutional strengthening
    a. Improvement of human capacity
    b. Harvest control
    c. Partnership and collaborative management
    d. Sustainable funding
    e. Monitoring and evaluation

2. Strengthening the area management
   a. Capture fisheries management and sustainable aquaculture
   b. Development of environmental services and marine tourism
   c. Seafaring management
   d. Monitoring and evaluation of resource condition
3. Strengthening the socio-economic community
   a. Community empowerment
   b. Increasing the community's environmental awareness
   c. Development of information dissemination and communication mechanisms
   d. Preservation of customs and culture
   e. Monitoring and evaluation of the socio-economic conditions of the community in the area.

Alongside *Satker*, the management of Gili Matra MPA also involves the officials from Gili Indah Village, North Lombok Regency, and the West Nusa Tenggara Provincial government. *Satker* Gili Matra MPA actively coordinates and synchronizes actions with the local administration.

D. Governance

The spatial arrangement shows that 3.21% of the total MPA is core zone, which access is strictly restricted. Regulation regarding capture fishing in the MPA is applied based on fishing gear as follows:

a. Handlines can be used in all zones except the core zone
b. Spearguns and longlines are allowed in the sustainable fisheries zone
c. Net fishing is allowed in the sustainable fisheries zone outside the sustainable coral fisheries sub-zone
d. Fish aggregating devices (FADs) may only be used in the sustainable fisheries zone outside the sustainable coral fisheries sub-zone
e. Destructive fishing in any forms is prohibited in all zones

In general, arrangements for marine tourism activities include:

a. Diving is allowed except in core zone and port zone
b. Snorkeling and swimming are allowed in the sustainable coral fisheries zone, utilization zone, protection zone, and rehabilitation zone
c. Surfing and canoeing are allowed in the sustainable fishing zone and utilization zone
d. The use of anchors in tourism activities is not allowed in all zones except in port zone

A summary of the spatial arrangement in the Gili Matra MPA area is shown in Table 18.

Satker Gili Matra MPA spent budget close to 595 million Rupiah in 2021 and collected 19.1 million IDR as Non-Tax State Revenue (PNBP) (BKKPN Kupang, 2021). In addition to the *Satker* Gili Matra MPA, Gili Indah Village provide about 45 million Rupiah in 2021 to regional resource management operations. The economic value estimated from fisheries and tourism sector was IDR 3.13 billion and IDR 30.20 billion, respectively (Table 19).

Table 18. Governance accounts: spatial arrangements of Gili Matra MPA

	Unit area (ha)	Reference(s)
Zoning		
Core zone	94.81	MMAF Ministerial Decree No. 57/2014 regarding the Spatial Planning Management of Gili Matra MPA 2014 - 2034
Protection zone	7.44	
Sustainable fishing zone	1,870.10	
Sustainable reef fishery sub-zone	530.66	
Utilization zone	207.49	
Rehabilitation zone	36.93	
Port zone	61.64	
Regulation and Institutional Authorities		
Fishery		
Tourism activities that are allowed are (1) diving (except in core zone and port zone); (2) swimming and snorkeling (except in core zone, sustainable fisheries zone, port zone); (3) recreational speargun fishing (only in the sustainable fishing zone); (4) catamarans (except in core zone and protection zone); and (5) surfing (only in sustainable fisheries zone and utilization zone) Licensed tours: underwater marine walk (only in the utilization zone and port zone)	1,855.92	MMAF Ministerial Regulation (*PERMEN KP*) No. 47/2016, *PERMEN KP* No. 31/2020, *PERMEN KP* No. 10/2021, *PERMEN KP* No. 18/2021, Law No 45/2009 Article 9 paragraph 1
Authority agency: *Satker* Gili Matra MPA Other parties: Marine and Fisheries Agency (DKP) of West Nusa Tenggara Province, Department of Agriculture, Plantation, Forestry, Marine and Fisheries (PPKKP) of North Lombok Regency		
Tourism		
Rules: Maximum fishing boat size: 10 GT Fishing gears allowed: handlines, squid fishing rods, drift gillnets, basic longlines Other acceptable fishing practices: speargun The only fishing aids allowed are FADs	1,284.20	*PERMEN KP* No. 47/2016, *PERMEN KP* No. 31/2020, *PERMEN KP* No. 10/2021, *PERMEN PAREKRAF* No. 4/2021
Authority agency: *Satker* Gili Matra MPA Other parties: DKP of West Nusa Tenggara Province, Department of PPKKP of North Lombok Regency		

Table 19. Governance Accounts: environmental economic activities in Gili Matra MPA (figures in Rupiah)

	Fishery	Tourism	Government
Cost of environmental protection			640,530,500
MMAF			595,102,000
Village			45,428,500
Economic value of environmental service	3,134,400,000	30,207,812,885,28	

CLOSING 11

The preparation of the Ocean Accounts in Gili Matra MPA has produced information of ecosystem assets, flows to the economy, flows to the environment, and ocean governance. The ecosystem assets accounts show reduction in coral reef and mangrove ecosystems, in contrast to seagrass ecosystems which have increased over the last six years (2015-2021). Based on services provided by the ecosystems, in 2021 the total benefit of coral reef was IDR 52,09 billion/year (approx. USD 3,72 million/year), seagrass was IDR 8,80 billion/year (approx. USD 629,023/year), and mangrove was IDR 3,27 billion/year (approx. USD 233,829/year). Supply from ecosystem values were used by fisheries, tourism, and other activities. Fisheries in Gili Matra MPA is estimated to reach IDR 3,13 billion/year which comes from service provision, while marine tourism, which core activities are providing several services, resulted monetary value of IDR 30,20 billion/year. Those economic activities resulted solid waste (70.4%) and liquid waste to the environment. Management and Zoning Plan of Gili Matra MPA for 2014 – 2034 is currently implemented. The Government also spent budget close to IDR 600 million in 2021. Meanwhile, value obtained from Gili Matra area in 2021 was IDR 33 billion.

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Annexes

1. Valuation Methods for Ecosystem Benefits

Valuation Methods	Site	Economic Value	Coefficient	Year	Sources
Avoided Damages and	Marine Bohol Triangle, Philippines	Regulating Services (Annual value of mangrove ecosystems	14 USD per capita		Economic valuation of coastal and marine resources: Bohol marine triangle, Philippines. Samonte-Tan, et.al (2007)
Replacement Costs			1.610 USD per ha		
Market Based Approach	Saipan, Northern Mariana Islands Commonwealth of the United States	Commercial Fishery	15 USD per capita	2006	The Economic Value of the Coral Reefs of Saipan, Commonwealth of the Northern
			106 USD per ha		Mariana Islands. Beukering et al. (2006)
Discrete Choice Experiment		Recreational Fishery	23 USD per capita	2006	
			72 USD per ha		Note: Summary of results from van Beukering et al. (2006) for Northern Mariana Islands. Original results are converted from US dollars in 2004 prices into international dollars in
Market Based Approach		Underwater and nautical tourism	9 USD per capita	2006	2009 prices using purchasing power parity and GDP deflator factors from the World Bank World Development Indicators. Total values were converted to a per hectare basis
			1.595 USD per ha		using an area of coral cover of 7159 ha
Market Based Approach		Associated tourism	1.913 USD per capita	2006	
			13.045 USD per ha		
Avoided Damages Costs		Coastal Protection	408 USD per capita	2006	
			2.782 USD per ha		
Market Based Approach		Research Education	40 USD per capita	2006	
			273 USD per ha		

2. Economic Valuation for Coral Reef

Exchange rate of 2021 (per Nov 21)	14,262						
Income per capita Filipina (2020)	3,299						
Income per capita Indonesia (2020)	3,870						
Income per capita Mariana Island (2019)	20,660						
Income per capita Indonesia (2019)	4,135						
Regulating Services							
Coral Reef Extent	259.50		ha				
Regulating Service Value USD		1,610	/ha/year				
Income per capita Filipina per year	3,299		USD				
Income per capita Indonesia per year	3,870		USD				
Economic value with factor income adjustment	1619.02		NEbiodiv_s(Y_p/Y_s)^b				
Exchange rate USD 1	14,262						
Economic value of regulating service /ha	23,090,428		Rp/ha/year	with income adjustment x exchange rate USD			
Economic value of regulating service of Coral Reef	**5,991,966,076.00**		**Rp/year**	**6,315,532,244.00**	**2021**	**4,373,246,347**	**2015**
	1,619.02		USD/ha/year				
	-0.0056		Transfer Error				
Cultural Services							
Coral Reefs Extent	259.50		ha				
Cultural Service value in USD	13,117		/ha/year				
Income per capita Mariana Island per year	20,660		USD				
Income per capita Indonesia per year	4,135		USD				
Economic value with factor Income adjustment	12,398.88		NEbiodiv_s(Y_p/Y_s)^b				
Exchange rate of USD 1	14,262						

Economic value of cultural service /ha	176,832,777	Rp/ha/year				
Economic value of cultural services of coral reefs in Gili Matra	**45,888,105,688.00**	**Rp/year**	**48,366,063,396.00**	**2021**	**33,491,509,801**	**2015**
	12,398.88	USD/ha/year				
	0.0579	Transfer Error				
Provisioning Services						
Coral Reefs Extent	259.50					
Total biomass for primary species	98.85					
Total biomass of coral reefs	25,652					
Total Value	**513,030,058**	**Rp/year**	**540,733,681**	**2021**	**374,435,836**	**2015**
TOTAL ECONOMIC VALUE OF CORAL REEFS	**52,393,101,823.00**	**Rp/Year**	**55,222,329,321**	**2021**	**38,239,191,984.00**	**2015**

Consumer price index and inflation						
2015	2016	2017	2018	2019	2020	2021
119,48	123.93	127.9	131.96	135.34	102.99	
3,41	2.61	3.7	3.16	1.87	0.58	

r = 6%	
Inflation = 0.58 % (2021)	
Real interest rate corrected by inflation factor	0.054

3. Economic Valuation for Seagrass

Exchange rate of 2021 (per Nov 21)	14,262					
Income per capita US (2020)	66,060					
Income per capita Mexico (2020)	18,170					
Income per capita Indonesia (2020)	3,870					
Supporting Services (Nursery Ground)						
Seagrass Extent	76.75	ha				
Supporting Service Value in USD	1,150	/ha/year				
Income per capita US per year	66,060	USD				
Income per capita Indonesia per year	3,870	USD				
Economic value with factor income adjustment	1.041,28	NEbiodiv_s(Y_p/Y_s)^b				
Exchange rate USD 1	14,262					
Economic value supporting /ha	14,850,761	Rp/ha/year	with income adjustment x exchange rate USD			
Economic value supporting seagrass	**1,139,795,873.00**	**Rp/year**	**1,201,344,850.00**	**2021**	**831,881,902**	**2015**
	1,041.28	USD/ha/year				
	0.1044	Transfer Error	0			
Regulating Services (Carbon sequestration)						
Mangrove Extent	76.75	ha				
Economic value regulating service USD	394.0	/ha/year				
Exchange rate USD 1	14,262					
Economic value regulating /ha	5,619,228	Rp/ha/year				
Economic value of cultural services Seagrass Gili Matra	**431,275,749.00**	**Rp/year**	**454,564,639.40**	**2021**	**314,767,318**	**2015**
	394.00	USD/ha/year				
	0.0000	Transfer Error				

Supporting Services (Nutrient Cycling)						
Seagrass Extent	76.75	ha				
Supporting Service USD	4,585	/ha/year				
Income per capita Mexico per year	18,170	USD				
Income per capita Indonesia per year	3,870	USD				
Economic value with Factor Income adjustment	4,343.40	NEbiodiv_s(Y_p/Y_s)^b				
Exchange rate USD 1	14,262					
Economic value supporting services /ha	61,945,623	Rp/ha/year	with income adjustment x exchange rate USD			
Economic value supporting services of seagrass	**4,754,326,542.00**	**Rp/year**	**5,011,060,175.00**	**2021**	**3,469,953,087**	**2015**
	4,343.40	USD/ha/year				
	0.0556	Transfer Error	0			
	326,658.0763	Transfer Error				
TOTAL ECONOMIC VALUE OF SEAGRASS	**6,325,398,164.00**	**Rp/Year**	**6,666,969,665.00**	**2021**	**4,616,602,307**	**2015**

r = 6%

Inflation = 0.58 % (2021)

Real interest rate corrected by inflation factor 0.054

4. Economic Valuation for Mangrove

Exchange Rate of 2021 (per Nov 21)	14,262					
Income per capita Kenya (2020)	2,014					
Income per capita Indonesia (2020)	3,870					
Regulating Services (Shorelines Protection)						
Mangrove Extent	21.50	ha	Source: A case study in Gazi Bay, Kenya			
Value of regulating service USD	92	/ha/year				
Income per capita Kenya per year	2,014	USD				
Income per capita Indonesia per year	3,870	USD				
Economic value with Factor Income adjustment	93.82	NEbiodiv_s(Y_p/Y_s)^b				
Exchange rate USD 1	14,262					
Economic value regulating /ha	1,338,072	Rp/ha/year	with income adjustment x exchange rate USD			
Economic value regulating service of mangrove Gili Matra	**28,768,539.62**	**Rp/year**	**30,322,040.76**	**2021**	**20,996,766**	**2015**
	93.82	USD/ha/year				
	-0,0226	Transfer Error	0			
Cultural Services						
Mangrove Extent	21.50	ha				
Economic value cultural service USD	600.9	/ha/year				
Income per capita Kenya per year	2,014	USD				
Income per capita Indonesia per year	3,870	USD				
Economic value with Factor Income adjustment	614.80	NEbiodiv_s(Y_p/Y_s)^b				
Exchange rate USD 1	14,262					
Economic value cultural /ha	8,768,236	Rp/ha/year				

Economic value cultural services Mangrove Gili Matra	**188,517,071.50**	**Rp/year**	**198,696,993.40**	**2021**	**137,589,496**	**2015**
	614.80	USD/ha/year				
	-0.0226	Transfer Error				
Supporting Services						
Mangrove Extent	21.50	ha				
Carbon price	15	U$/ha	Ruittenberk 1994, Bintuni, Papua			
Rupiah exchange rate	14,262	per 1 USD				
Regional minimum wage Teluk Bintuni	3,184,225	Rp / month				
Regional minimum wage Lombok Utara	2,184,485	Rp / month				
Economic value with Factor Income adjustment	14,075	NEbiodiv_s(Y_p/Y_s)^b				
Exchange rate USD 1	14,262					
Economic value supporting /ha	200,739,552	Rp/ha/year				
Economic value of supporting services of coral reefs in Gili Matra	**3,011,093,279.00**	Rp/year	**3,173,692,316.00**	**2021**	**2,197,651,408**	**2015**
	14,075.13	USD/ha/year				
	0.0133	Transfer Error				
Provisioning Services						
Mangrove Extent	21.50					
Total biomass for primary species	98.85	kg/ha				
Total biomass of mangrove	2,125	kg/year				
Total Value	**42,505,381**	**Rp/year**	**44,800,671.10**	**2021**	**31,022,622**	**2015**
TOTAL ECONOMIC VALUE OF MANGROVE	**3,270,884,270.00**	**Rp/Year**	**3,447,512,021.00**	**2021**	**2,387,260,292**	**2015**
r = 6%						
Inflation = 0.58 % (2021)						
Real interest rate corrected by inflation factor	0.054					