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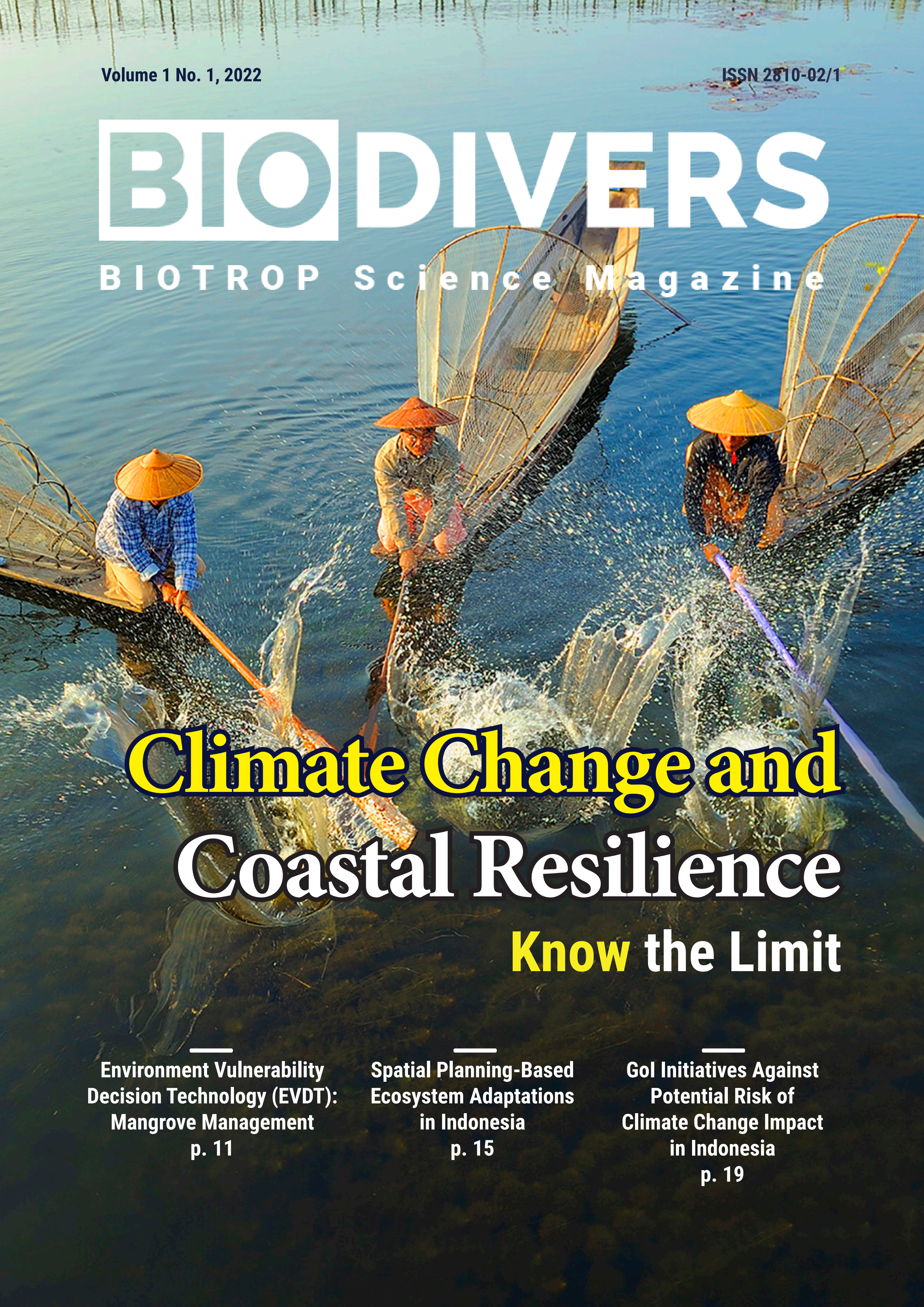

Climate Change and Coastal Resilience

Know the Limit

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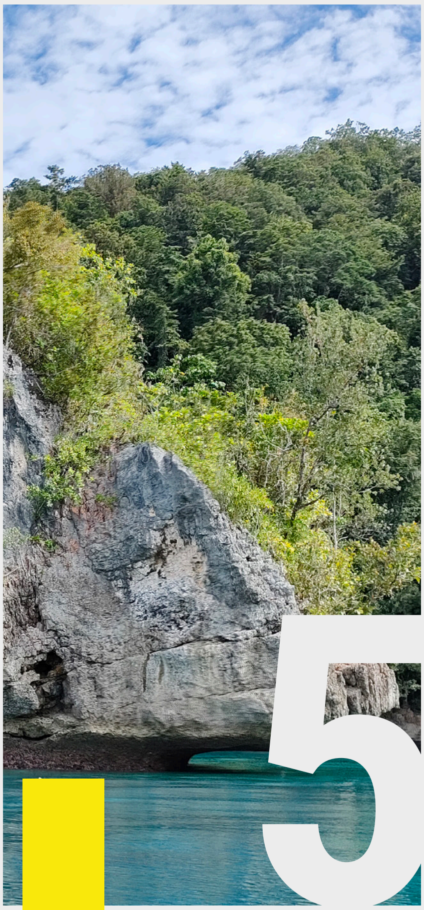


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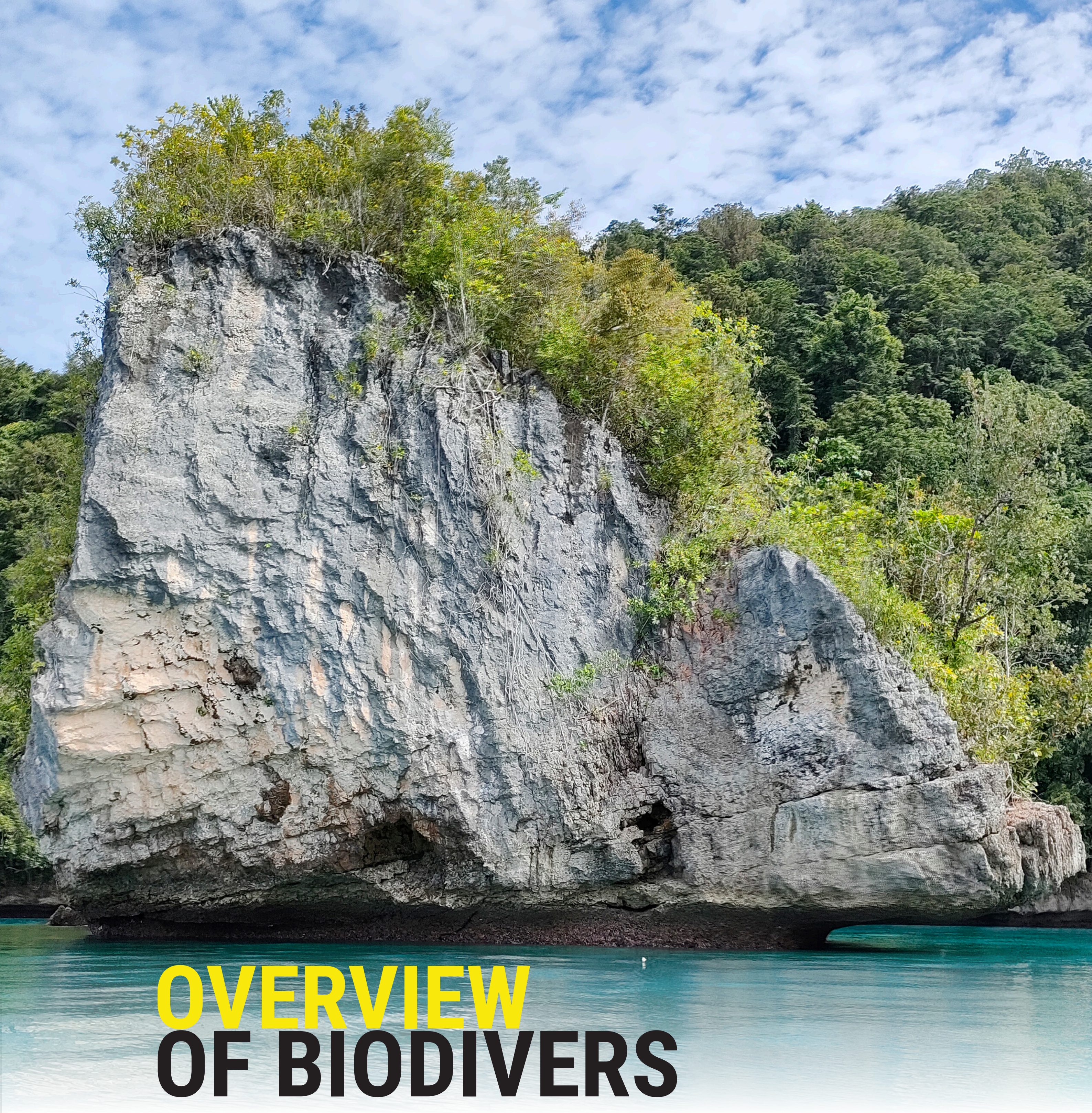


OVERVIEW OF BIODIVERS

BIODIVERS is a bio-science general audience magazine launched in December 2021 by the Southeast Asian Ministers of Education Organization Regional Centre for Tropical Biology (SEAMEO BIOTROP). It is designed as a scientific publication to increase awareness on issues related to Tropical Biodiversity from the Mountain to the Ocean (MOTO) and increase biodiversity literacy.

BIODIVERS is a bi-annual publication that focuses on the Restoration and Conservation of Unique and Degraded Ecosystems, Sustainable of Management and Proper Utilization of Biodiversity, Bioenergy, Biotechnology to Support Food Security and on Strengthening Ecosystem Resilience in Facing Global Climate Change. This magazine also envisions becoming a popular-scientific magazine for promoting and publishing research findings of scientists from SEAMEO BIOTROP and overseas. The articles will come from writers worldwide.

SEAMEO BIOTROP

Southeast Asian Regional Centre for Tropical Biology

Vision

A Leading Centre in enriching and promoting the real values of tropical biology in Southeast Asia

Mission:

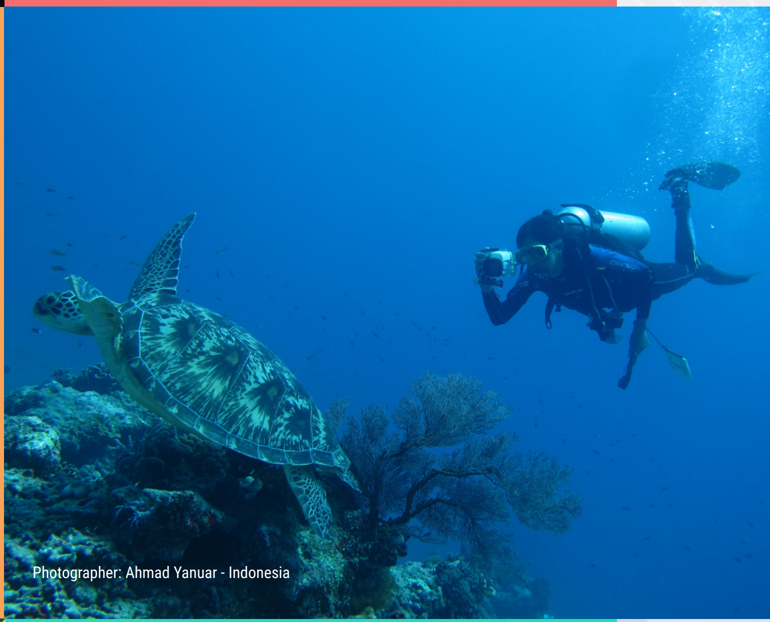
To provide scientific knowledge and build capacities of institutions and communities in conserving and managing tropical biology sustainably for the well-being of communities and the environment of Southeast Asia.

SEAMEO BIOTROP Flagship Program:

Photographer: Arnold Conlu Jumpay - Philippines

Sustainable use of biodiversity, biotechnology, bioenergy, and food security

Strengthening resilience on climate change



Photographer: Ahmad Yanuar - Indonesia

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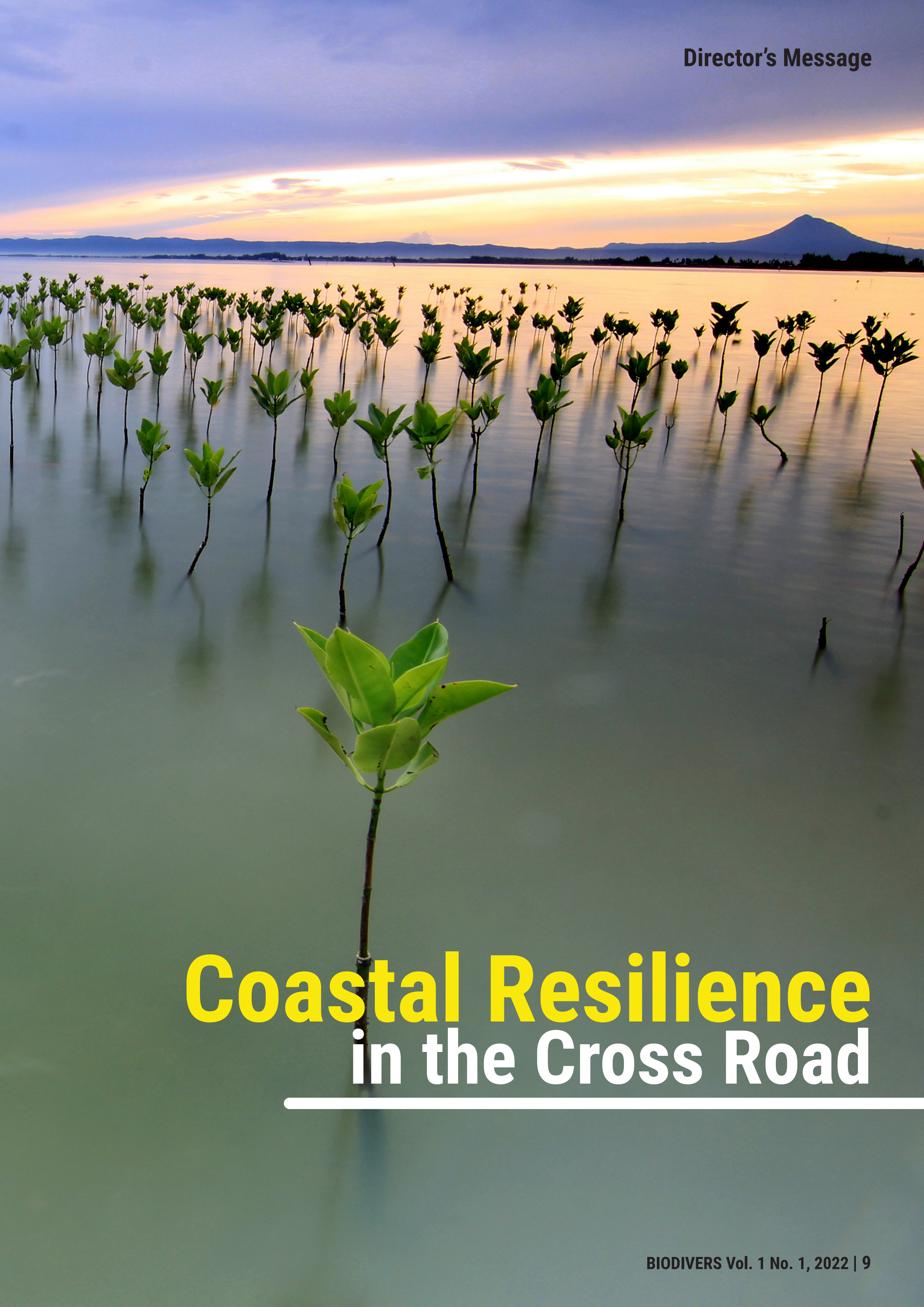
Ecosystem restoration and conservation



Coastal Resilience in the Cross Road

Director's Message

Dear Valued Readers,

Greetings from SEAMEO BIOTROP, Indonesia!

Preceding the year 2022, I am delighted to present the 1st edition of BIODIVERS, a popular scientific magazine of SEAMEO BIOTROP. For over 50 years, SEAMEO BIOTROP has been addressing critical issues on tropical biology through various programs and activities. Along the journey, we have been dealing with nature conservation, restoration, environment, human development, ecosystem, and other areas on tropical biology. To save our biodiversity, we need to also focus on climate change and coastal resilience issues, presented in our first edition of BIODIVERS magazine.

Save Biodiversity

Climate change is among real threats and challenges for all aspects of our lives, including biodiversity and ecosystem from the mountain to the ocean. Climate change causes severe disasters that threaten the safety of all living organisms and the existence of biodiversity. As we know, biodiversity has a very important role in the survival of living organisms and the environment. Biodiversity refers to various existing life forms on earth, including animals, plants, microorganisms, and the entire ecosystem they live in. Without biodiversity, there would be no ecosystems or the world, or human beings. Biodiversity is created for humans to take care of and enjoy. At a time when biodiversity and ecosystems are at risk of extinction as the impact of climate change, this also means that humans' lives are also threatened. The impact of climate change link to human health and ecosystem services.

According to Conservation International, Indonesia has the richest biodiversity in the world and is considered one of the 17 "megadiverse" countries. Indonesia's terrestrial biodiversity is home to about 10% of the global

Director's Message

Biodiversity as An Essential Part of the Solutions to Reduce the Impacts of Climate Change

Biodiversity is an essential part of the solution to climate change. In a landmark study published in 2017, nature can provide at least 30 percent of the emission reductions needed by 2030 to mitigate climate catastrophe. That's why protecting biodiversity would play an important role in achieving these emission reductions. Some ecosystems, such as mangroves, are very good at storing carbon and keeping it away from the atmosphere, which contributes to climate change. Forest and wetland ecosystems provide important buffers for the extreme weather and floods associated with climate change. Many things can cause the climate to change all on its own. Climate change has significant implications for the hydrological cycle. An often-unrecognized impact of climate change is related to food safety. Climate change may also bring increased risks for animal health, particularly in the rapidly growing agriculture and aquaculture sectors.

flowering species (estimated 25,000 flowering plants, 55% endemic), 12% of the world's mammals (515 species), 16% of the global reptiles (781 species), 17% of the world's total bird species (1,592 species), 35 primate species, and 270 amphibian species. Meanwhile, Indonesia's marine ecosystem is the world's highest marine biodiversity. The Indonesian Institute of Science records that Indonesia's marine ecosystem possesses 69% of the world's coral species (about 570 species and 83 genera of stony corals). Indonesia is also home to 3,476 fish species, 30 species of mammals, as well as 971 species of algae and 143 species of flora. It is thus, pertinent to identify the impacts of climate change on biodiversity in Indonesia and other countries, especially in the Southeast Asian region.

Climate is average weather in a place over many years. Climate change is a shift in those average conditions. For over five decades, SEAMEO BIOTROP has been actively and significantly contributing to the conservation of biodiversity and the ecosystem. We focus on promoting the notion of "Save Biodiversity" with our three program thrusts, i.e., 1) restoration and conservation of unique and degraded ecosystems; 2) sustainable management and proper utilization of biodiversity, bioenergy, biotechnology, to support food security; and 3) strengthening ecosystem resilience in facing global climate change.

Tropical Marine and Coastal Marine Biodiversity

The coastal and marine disasters due to climate change are closely related to the relationship between the oceans and the atmosphere. Oceans are carbon reservoirs in the atmosphere, including dissolved inorganic carbon and living and non-living marine biota. Furthermore, the oceans and the atmosphere are beneficial for the distribution of energy received by the earth, in terms of solar energy distribution which varies from region to region, depending on the latitude and longitude of the region. On a global scale, the Indonesian seas are directly affected by global climate which has caused climate variability of El Nino Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), Madden Julian Oscillation (MJO), and others.

Indonesia affirmed its climate commitments through the updated Nationally Determined Contribution (NDC) submitted to the UNFCCC on 22 July 2021. In accordance with the updated NDC, Indonesia is committed to reducing its greenhouse gas (GHG) emissions target unconditionally to 29% and conditionally (with international support) to 41% compared to business-as-usual (BAU) scenarios of 834 Mt CO_2e and 1,185 Mt CO_2e, respectively, by 2030. In order to achieve the 2030 NDC target, Indonesia has developed a strategy for NDC implementation through comprehensive mitigation and adaptation and disaster risk reduction strategies in line with Indonesia Vision 2045 and the Long-Term Low Carbon and Climate Resilient Development Strategy 2050/LTS-LCCR 2050.

Collaborative activities with national, regional, and international institutions would be the key to achieve the goals. As an example, West Java Province is committed to continuing the preservation of the provincial areas

Director's Message

from extreme deforestation, biodiversity loss, intense road traffic, and high pollution. The local government plays a more prominent role in research and awareness-rising work to foster innovative sustainable development practices and combat the loss of biodiversity through sustainable development integration. The collaborative activities can be done because there is a multi-stakeholder communication forum. Biodiversity loss has been eclipsed by climate change on the global agenda but these two issues are closely related and have similar impacts on human welfare and therefore, urgently must be tackled together. The West Java provincial government has been collaborating with national and international institutions and private companies in organizing this activity. As the pilot province for Climate Change Adaptation movement, West Java Province targets to reduce greenhouse gas emissions equivalent to 13.45 million tons of CO_2 through activities in strategic sectors, such as forestry, agriculture, energy, transportation and waste management.

Increase Resistance of Coastal Marine Biodiversity

Recognizing the rapid socio-economic and environmental changes occurring in the region, SEAMEO BIOTROP believes that we need to transform and refocus our flagship programs to strengthen our visibility, contribution, and role in saving biodiversity. The transformation is significantly important to alleviate poverty as well as support food and nutrition security and safety as stated in the Sustainable Development Goals (SDGs). However, the transformation is affected by the national, regional and global concerns for climate change implications. Therefore, it is pertinent to carry out collaborative actions with multi-stakeholders in saving biodiversity.

To Cope with the Challenges

In regards to coping with the challenges on biodiversity issues, SEAMEO BIOTROP promotes "the Seven Cs", as follows:

1. Changing mindset in consuming fossil fuels to renewable energy sources;
2. Combatting conversion of mangrove and seagrass ecosystem;
3. Co-creation in ensuring utilization of ecosystem services for marine and coastal resources;
4. Commitment to rising community awareness on adverse impact of climate change;
5. Campaign in environmental behavior on coastal community;
6. Coaching community partnership and engagement;
7. Competence on leadership and governance on coastal risk and management.

I thank all of our reviewers and writers for the knowledge, resources and committed trusts over the months and look forward to your continued support in taking the magazine to a greater level. I appreciate any feedback and suggestions that will help us in striving for excellence.

Happy reading and have a nice day!

Dr Zulhamsyah Imran
Director of SEAMEO BIOTROP

Photographer: Arnold Conlu Jumpay - Philippines

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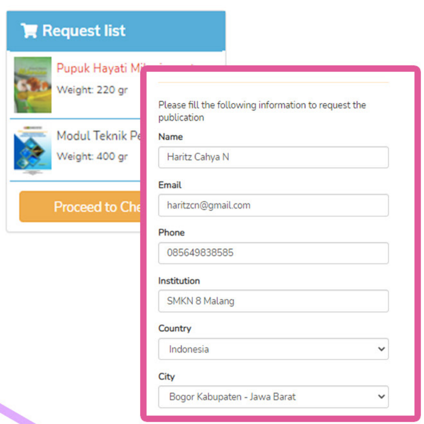
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Addressing Global Challenges, Initiating Local Actions

Currently, we are facing worldwide challenges on environmental issues such as land degradation, biodiversity loss, and climate change. These are cross-cutting issues. To overcome these pressing issues, the United Nations released the Global Conventions, commonly known as the Rio Conventions, namely United Nations Convention on Biological Diversity (UNCBD), United Nations Framework and Convention on Climate Change (UNFCCC), and United Nations Convention to Combat Desertification (UNCCD).

These global environmental efforts also follow the national interests of countries across Southeast Asia that have already ratified Sustainable Development Goals which will be measured by 2030. However, it is quite challenging to implement the global conventions to national and subnational levels. Therefore, we need strategies to accommodate the implementation of the three conventions.

To sustain biodiversity richness post-2020, it is essential to strengthening strategy by consolidating global and regional issues into the programs and activities of SEAMEO BIOTROP. To elevate partnerships with international and national institutions, the Center needs to adhere to SDGs 2030 in planning its programs and activities. SEAMEO BIOTROP needs to assume its role as a connecting hub among initiatives of multi-stakeholders to bridge science with policy and vice versa in responding to regional demands across Southeast Asia.

Among disruptive changes we are currently facing, climate change is one issue that significantly impacts stability worldwide in aspects of ecology, social, economy and health. It is important to carefully and vigilantly implement appropriate strategies to mitigate climate change and boost up the adaptation efforts toward climate change. Globally, various movements emerge as mitigation efforts, such as green lifestyle, green economy, blue economy and a circular economy based on sustainability principle.

Covid-19 pandemic, as one of the disruptive changes, leads us to a new normal era. During the pandemic, we have learned to transform constraints into opportunities in most aspects of our lives. Virtual meeting system has brought us the opportunities to share knowledge worldwide. The system has eased communication at the national, regional and international levels.

In responding to the challenges, SEAMEO BIOTROP keeps its commitment to maintaining its programs and activities to serve the community at the national and regional levels and to increase the Center's visibility by articulating "Save Biodiversity" with the encapsulated vision "Biodiversity Enrichment from Mountain to Ocean for Sustainable Human Welfare".

The Center's effort to save biodiversity aligns with the concept and implementation of Agro-Maritime 4.0 launched by IPB University. This concept offers a development platform that integrates land and sea areas inclusively and is supported by strong social and economic capital and the use of digital technology to encourage the nation's productivity. Of course, in mainstreaming the concept, related approaches are taken, such as a transdisciplinary approach, ecological area connectivity, as well as integrated and participatory. Through the spirit of transparency and inclusiveness, good governance can be built by prioritizing equality and by implementing environmentally friendly economic development.

Finally, on behalf of SEAMEO BIOTROP Governing Board and as the Rector of IPB University, I congratulate and appreciate the publication of this Biodivers magazine. Hopefully, various articles presented in this magazine increase biodiversity literacy, especially on the issue of climate crisis and coastal resilience.

Save Biodiversity!

Prof Dr Arif Satria
Chairperson of SEAMEO BIOTROP Governing Board
Rector of IPB University
Professor of Political Ecology

COASTAL AND MARINE
INITIATIVE TO CLIMATE CHANGE: AN OUTLOOK

Perdinan[ab], Syafararisa D. Pratiwi[c], Raden Eliasar Prabowo[c]
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Editorial Message

Introduction

Understanding the interaction of essential climate variables becomes important in the development of climate change initiatives in coastal and marine areas. The review of climate impacts on focused sectors is directed to obtain information on the impacts of essential climate variables and their thresholds with which further analysis can be expanded nationally. The Essential Climate Variables are a physical, chemical, or biological variable or a group of variables that critically contribute to the characterization of Earth's climate which is frequently applied to represent climatic conditions [1]. The impacts of climate on specific sectors can be learned from how much changes in the representative variables of the sectors with regards to changes in climate variables. The essential climatic variables in the domains of the atmosphere, sea, and land, interact with each other as a unified system. Ocean variables including sea surface temperature, salinity, sea level, waves, and marine biological activity are the focus of developing climate change initiatives in coastal and marine areas. These marine variables interact with essential atmospheric and land variables such as air temperature, rainfall, air pressure, wind field, river conditions, water use, and vegetation conditions. The interactions of essential climate variables further shape the global carbon cycle (Fig. 1).

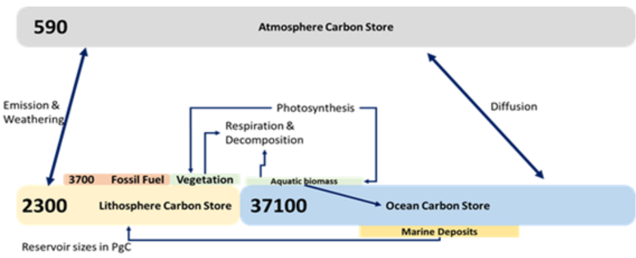
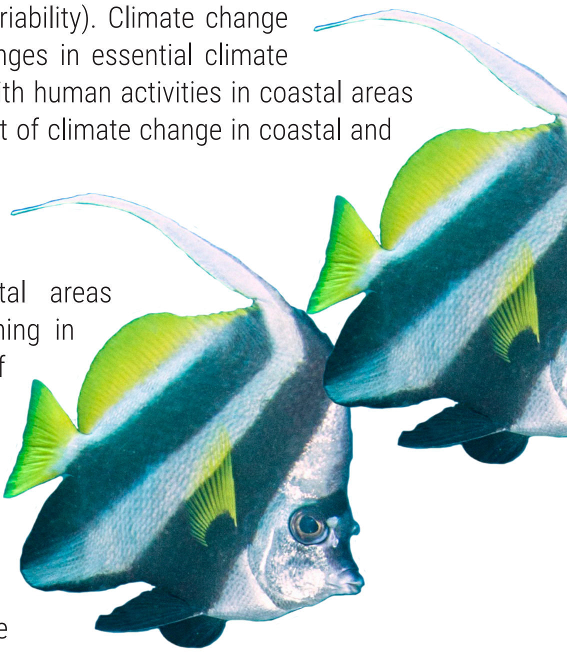


Figure 1. The global carbon cycle and its reservoir (Source: Sarmiento and Gruber 2002)

The global carbon cycle assesses carbon stores in each of the essential climate domains (atmosphere, ocean, and land) [2]. Carbon stores in the ocean include dissolved inorganic carbon and living and non-living marine biota. Atmospheric carbon includes concentrations of greenhouse gases from both natural and anthropogenic processes. Land carbon includes sedimentation, fossil fuels, freshwater systems, and soil carbon. The oceans store the most carbon (about 37100 PgC) followed by land and then the atmosphere. The sea plays an important role as an agent of climate change control through the development of climate change initiatives in coastal and marine areas.

Climate change in coastal and marine areas is driven by the activities of coastal communities through the fishing and aquaculture industries, pollution related to

human activities, coastal activities, and tourism activities [3]. Climate change has an impact on various levels of biological organization ranging from species (changes in air temperature), habitats (ocean acidification, and changes in salinity), and ecosystems (sea-level rise, and climate variability). Climate change assessed from changes in essential climate variables coupled with human activities in coastal areas increases the impact of climate change in coastal and marine areas.



The development of climate change initiatives in coastal areas focuses on intervening in various impacts of climate change. The impacts of climate change interventions include sea air heat flux, evaporation, Q10 parameter, algae blooms, sea level pressure, changes in upwellings phenomena, mass extinctions, changes in marine CO_2, changes in local species, changes in ocean currents, extreme weather events, changes in wind fields, scenarios climate, changes in rainfall, changes in river flow, changes in sea ice extent, changes in climate patterns, disease, invasive species, coral bleaching, increased storm events, oxygen conditions, changes in salinity, UV radiation, ocean acidification, sea-level rise and changes in air temperature. The phenomenon of the impact of climate change reduces the carrying capacity of species, habitats, and biodiversity ecosystems in coastal areas that provide coastal and marine ecosystem services.

Indonesia Outlook

Coastal and marine areas become one of the important assets in Indonesia. Indonesia's coasts and seas are the home and source of livelihood for millions of Indonesian coastal communities. Indonesia's sea area is 6.4 million km^2 with a coastline of 95,181 km. The Indonesian Sea is home to 50,875 km^2 of coral reef biodiversity, 34,900 km^2 of mangroves, and 2,934 km^2 of seagrass beds. The Indonesian Sea is the world's largest fish producer with 9.93 million tonnes per year and is a supplier of 10% of the world's fishery commodities. The Indonesian Sea is home to 6 of the 7 species of sea turtles in the world. The Indonesian Sea binds 17,504 islands of Indonesia and makes Indonesia the largest archipelagic country.

Climate change is significantly affected by various development sectors in Indonesia, including Coastal and Marine. The climate projection shows the trend that temperature will rise 0.45 - 0.75 °C, and rainfall reach 2.5 mm/day [4,5]. Marine climate parameters are also predicted to experience changes, such as sea-level rise will reach 0.8 - 1.2 cm/year, and the extreme increase of wave height of 1.5 m [1]. This change will trigger a decrease in sea surface salinity to 32.1 psu in 2040, lower than in 2000 which reached 33.2 psu. This climate trend shows a correlation with more frequent climate extreme events that trigger ecosystem damage in Indonesia, including the marine and coastal sectors [1,6].

The impacts of climate change will influence coastal and marine resources because these resource ecosystems are vulnerable to stress due to environmental changes. Rapid changes in environmental conditions potentially increase disruption to the survival of a species because there is little time to adapt or migrate to an environment that is still tolerable. In 2030, it is estimated that the waters will face various driving factors that will affect marine ecosystems, especially the increase in sea surface temperature and a decrease in pH [7].

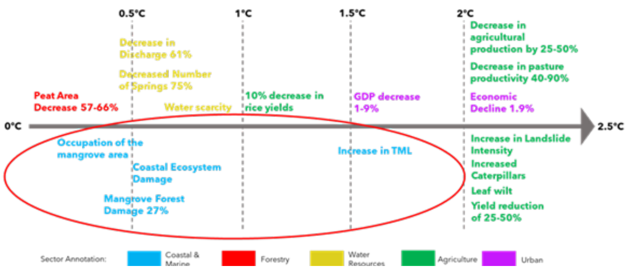


Figure 2. Identification of the impact of rising temperatures based on the collection of Climate Change Vulnerability, Impact, and Adaptation (CCVIA) studies in Indonesia (Source: MoEF 2017)

A collection of Climate Change Vulnerability and Impact Assessment (CCVIA) studies in Indonesia showed that increasing temperatures at various levels will have an impact on many aspects of the marine and fisheries sector (Fig. 2) [8]. An increase in temperature of 0.5 °C will trigger the occupation of mangrove areas which will automatically damage coastal ecosystems. Further, an increase in temperature of 1.5 °C has the potential to trigger coral reef degradation by up to 90%. Moreover, climate change will pose direct threats to the coast such as extreme waves, tidal flooding, coastal erosion, widespread inundation in lowlands and swamps, intrusion of seawater into groundwater, to small islands that lose their territory due to being submerged. This condition will be further exacerbated by patterns and trends of human development in coastal areas. The adverse impacts of climate change (2021-2050) were estimated to reach 2.87% of GDP [9]. Inevitably, climate change action is urgently needed to reduce the risk caused by climate change.

Responding to the potential risk above, the Government of Indonesia (GoI) paid serious attention to the impacts of climate change in the country. The GoI committed to strengthening the country's strategy for addressing climate change by ratifying the Paris Agreement in 2016 through Law No.16/2016. Recently, the GoI has submitted a document of updated National Determined Contribution (NDC) to the UNFCCC in the middle of 2021. In comprehending the updated NDC, the GoI developed the NDC Roadmap to formulate strategies to achieve the targets of the NDC document [10]. The Indonesia NDC document [10] prescribed that the main goals are to build climate resilience and increase adaptive capacity to manage the risks in achieving resilience on economic, social and livelihood, and ecosystems and landscapes. To address the climate change impact, the NDC roadmap proposed eight strategies to implement the NDC commitment. One of the strategies is a landscape-based approach, which calls for the integration of land and marine spatial planning policies. The development of a sustainable investment scheme mechanism based on climate change risk is also mentioned in the context of managing the coastal and marine sector in Indonesia.

Furthermore, in 2021 GoI through Indonesia's National Development Planning Agency (BAPPENAS) has recently launched a policy recommendation document titled *Kebijakan Pembangunan Berketahanan Iklim* (PBI) or Climate Resilient Development Policy as a guideline for handling climate change for local and regional governments [11]. However, there are not many regulations that can be used as legal protection related to efforts in managing climate change impacts in the coastal and marine sectors. Until now, the regulation used is Law Number 1 of 2014 concerning Management of Coastal Areas and Small Islands, which does not explicitly mention climate change. Further regulation is needed regarding climate risk management activities to protect ecosystems in coastal areas and small islands according to the type, level of risk, and disaster area, as well as the responsibilities of the government, local government, and the community.

Potential Initiatives

Apart from the limited capacity for policy and regulation, Indonesia has a lot of resources and modalities that can be utilized. There are also many research findings and technologies that have been adopted by government agencies. However, it is not easy to implement the research and technology to a lower level such as in regional areas and the grass root community. Considering these opportunities, there are many initiatives that can be developed in an effort to manage the coastal and marine sector in Indonesia, especially on the risk due to climate change. The potential of ocean carbon and the implications due to changes in its concentration are challenges in the formulation of climate change mitigation. Meanwhile, we also need to adapt to unavoidable changes in climate variables. Even so, the potential for climate hazards around the coast is still very possible to reduce the risk with climate risk management. There is a need for the connectivity of multi-stakeholders initiatives that bridge science to policy and policy to science in responding to the initiatives across coastal and marine issues. There is a need to strengthen strategy to sustain the richness of coastal and marine resources post-2020.

No less important is how to develop various climate change action efforts with the ocean economy. Reminding that Indonesia's seas are very rich in natural resources, it is also important to note that the Indonesian seas are a big source for Indonesia's GDP. Various problems that still hit Indonesia's oceans include sustainable marine production related to overfishing, fishing techniques, and speeding up recovery (restoration). Furthermore, it is important to pay attention to the carrying capacity of marine and coastal ecotourism in Indonesia so that sustainable tourism can be realized. Coastal tourism management is also inseparable from the need to build sustainable infrastructure in order to overcome pollution related to waste opportunities which is still one of the big problems in Indonesia.

With many modalities of research findings, technology, resources, and decision-makers. Indonesia has a rare opportunity to put all the modalities firmly of regional efforts in favor of integration. It is urgent and important to create a region in which cooperation, rather than competition, driver innovation and progress in coastal and marine issues.

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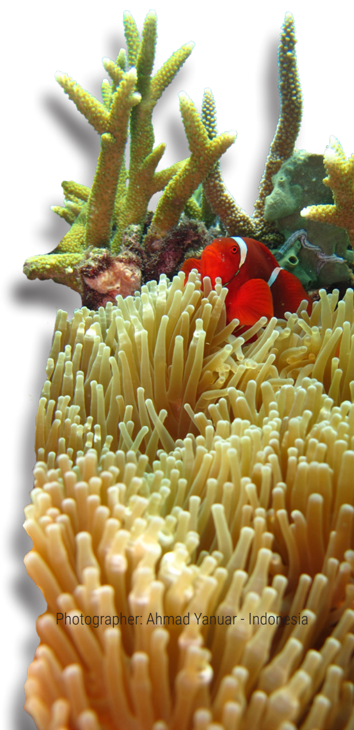
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ENVIRONMENT VULNERABILITY DECISION TECHNOLOGY (EVDT)

Mangrove Management

Climate change adversely impacts the coastlines of many countries. Satellite technology and remote sensing modeling can help us understand the climate change phenomena and predict, prepare and defend ourselves against future disasters

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Remotely Earth Observation: EVDT Approach

The transformation in Remote Sensing and Earth in the last decade has undergone rapid development. Remote sensing and Earth Observation are two different fields but have similarities and complement each other.

Remote sensing is a remote observation from a platform that is far from the object being observed with various levels of observations of satellite data, aerial data, and ground-based observations (e.g., geophysical equipment) from altitude [1]. Meanwhile, Earth Observation is a collection of information about physical, biological, and related data about the planet. Earth Observation based on satellite technology is relevant to providing information that is important for the health of the coastal regions, especially for archipelagic nations like Indonesia. The technology included satellite earth observation, satellite positioning and navigation, human space flight and microgravity research, satellite communication, space technology transfer, and research infrastructure.

Various new observation platforms are available to help scientists and researchers to process data, one of which is Environment-Vulnerability-Decision Technology (EVDT). Environment-Vulnerability-Decision Technology (EVDT) is a multi-disciplinary, integrated modeling framework to improve environmental management, policymaking, and observation platform design. The framework guides the creation of an integrated model customized for each application with a specific set of stakeholders and designed using systems architecture.

The Environment-Vulnerability-Decision-Technology (EVDT) Modeling Framework will integrate four models into one tool that can be adapted to specific applications. The four models address the following: Earth Science Models of the Environment; Human Vulnerability and Societal Impact; Human Behavior and Decision-Making; and Technology Design for Earth Observation Systems including satellites, airborne platforms and *in-situ* sensors. The capabilities provided by this framework will improve the management of earth observation and socioeconomic data in a format usable by non-experts while harnessing cloud computing, machine learning, economic analysis, complex systems modeling, and model-based systems engineering [2].

The environment model uses earth science methods to estimate the state of environmental phenomena as follows:

1. The vulnerability model captures the societal impact of environmental changes, including ecosystem services.
2. The decision model captures human behaviors and policy consequences.
3. The technology model provides tools to design earth observation systems or select earth observation technologies such as satellites, airborne sensors, and in-situ sensors.

Adopted EVDT framework can give more benefit to national governments for sustainable development using future space technology. The EVDT framework has been applied to policymaking in Pekalongan, Central Java, Indonesia. The study included measuring the coastal environmental health, planting mangroves to stabilize the coast for coastal resiliency, improving biodiversity in the mangrove areas, and informing the policymakers. The satellite data are used to estimate flooding and then submit a proposal to the policymaker to prevent flooding or protect an area from flooding.

Besides being used in Indonesia, the use of EVDT is also used in Rio de Janeiro, Brazil. Researchers already demonstrated the tools in the viability of the framework case study of the mangrove forests in the Guaratiba area. These mangroves are vulnerable due to urbanization and rising sea levels. They provide a variety of ecosystem services, including serving as a mechanism for carbon sequestration, supporting subsistence fishing, preventing coastal erosion, and attracting an ecotourism industry. The case study of mangrove and community health in Rio de Janeiro demonstrates all four model components [2].

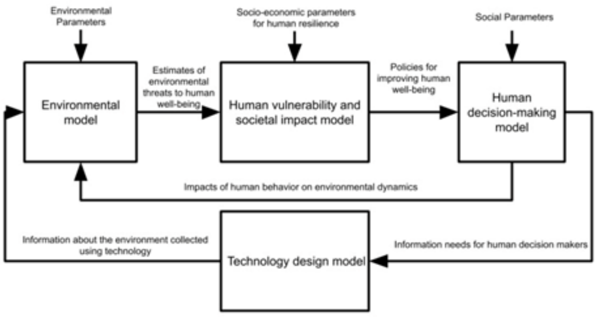

Figure 1. The baseline version of the environment-vulnerability-decision-technology model
(Source: Reid & Wood 2020)

Mangrove Management and Remote Technology

The Environment Model on a study of mangrove and community health in Rio de Janeiro was built upon work by biospheric scientists Fatoyinbo and Lagomasino. They used earth observation data, cloud computing, and machine learning to track mangrove extent, health, and vulnerability overtime for a 600 km^2 area, as well as work

Figure 2. The mangrove conservation area in Serang City area, Banten Indonesia
(Source: Rosita & Darwati, SEAMEO BIOTROP, taken on 14 November 2021)

by the ESPAÇO research group at the Federal University of Rio de Janeiro on the local mangrove ecosystem [2].

In Indonesia, the effects of pollutants and environmental damage in urban areas will impact mangrove management,

Figure 3. Mangroves trap and cycle pollutants, chemical elements and sediments
(Source: https://www.lewisaqui.com/the-importance-of-preservation-and-protection-of-mangroves-in-the-landscape/)

so it is necessary to synchronize the problems in urban areas with mangrove management forests. Mangroves that grow at the end of large rivers act as the last reservoir for waste from industry in urban and upstream villages carried away by river flows. Mangrove forest areas can accumulate heavy metals in the ecosystem where they grow. Mangroves can act as a biofilter for air pollution. The ecological balance of the beach's aquatic environment will be maintained if mangroves are maintained because mangroves can function as a biofilter, binding agent, and pollution trap. Several studies have confirmed that mangroves have a high tolerance for heavy metals [3, 4].

Mangroves tend to accumulate heavy metals found in living plants' ecosystems [5]. The mangrove system cannot stand alone but is related to other ecosystems. Linkages between ecosystems form a more extensive system, namely watershed. The heavy metal accumulation ability is different for each species [6]. Furthermore, mangrove plants accumulate metals [6]. The largest metallic weight is found in the roots. However, other factors such as mobility and metal solubility also affect the accumulation of heavy metals in plants. Based on their mobility and solubility, the ability of plants to accumulate heavy metals according to order is as follows Mn > Cr > Cu > Cd > Pb [7]. Mangroves are good hyperaccumulators. Mangroves do not only grow on soil with a high concentration of toxic elements, but they also collect/accumulate these elements in stems and leaves in large quantities that may even be higher and lethal to other living organisms [8].

Mangrove forests are also among the most rapidly disappearing ecosystems in the world. A significant cause of global mangrove destruction is the development of shrimp ponds, rice, and oil palm plantation. Without the mangroves protecting the coastal areas, more people, more land and more property damages or loss are expected. Mangroves are one of the vital coastal resources capable of delivering exceptional ecosystem services. Among the many mangroves services are sediment accumulation, storm surge protection, carbon sequestration, and climate change mitigation/adaptation in vulnerable coastal areas. Mangroves are ecologically and economically important in enriching coastal biodiversity, supporting fisheries, yielding commercial forest products, and protecting coastlines from the fierce effects of cyclones, floods, waves, and other natural calamities. Mangroves are also known as “oceanic rain forest”, “tidal forest”, “roots of the sea”, “Blue Carbon Forests” and “coastal woodlands” [9, 10].

Future Research Innovation Connectivity

Geospatial information is needed to support policy formulation, decision making, and implementation of activities related to terrestrial space. Geospatial information can be provided through terrestrial survey results and or remote sensing interpretation results. Terrestrial survey results can be pretty detailed and have high accuracy. Indonesian territory has 16,671 islands with a land area of 1,900,000 km^2. Therefore, terrestrial surveys will be expensive and take a long time, and it will be challenging to map dynamic land object changes. The remote sensing interpretation method is expected to overcome the problem of providing geospatial information quickly in Indonesia [11].

Indonesia’s challenge regarding remote sensing and earth observation research is that remote sensing satellites in Indonesia are still not optimal and it still depends on satellites belonging to other countries such as Sentinel, Terra, Landsat, Spot, and others. To answer this challenge, a research collaboration between research institutions needs to be improved in addressing problems such as decreasing soil fertility, environmental pollution, wide yield gaps, greenhouse gas emissions, increasingly uncertain weather due to climate change, increasing intensity of pest and disease attacks, and the inefficient use of land. Effective and efficient land management and monitoring can produce recommendations to overcome these problems. We need remote sensing data with human assistance to analyze and validate data in the field.

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SPATIAL PLANNING-BASED ECOSYSTEM ADAPTATIONS IN INDONESIA

"Science-based environmental factors, human wellbeing, and sustainable development can be strengthened by applying Spatial Planning-based Ecosystem Adaptations (SPBEAs)".

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Coastal Management: SPBEA Approach

Climate change has significantly impacted the coastal environment. Floods, coastal abrasions, and shoreline retreats are examples of those impacts caused by storm surges, high tides, or sea-level rise which have been triggered by climate change [1]. The impact is aggravated by human behavior in utilizing the existing natural resources. Conversion of coastal ecosystems to extensive agricultural areas or settlements and uncontrolled groundwater discharge are a few examples of human exploitation which could impair the function of the coastal ecosystems. Groundwater discharge is the movement of groundwater from the subsurface to the surface. Controlled groundwater discharge will influence the majority of baseflow. The interaction of groundwater and surface water allows water to flow for maintaining habitat and nutrients to the aquatic ecosystems. Uncontrolled groundwater can influence the changing of people's behavior. Therefore, it is important for people to adapt to climate change for reducing the impact of climate change.

Adaptation is compliance in natural and human system response to climatic stimuli. Ecosystem-based adaptation is a strategy to adapt to climate change that harnesses nature-based solutions and ecosystem services to the adverse effects of climate change [2]. Nature-based solutions in coastal management are a broad concept connecting green infrastructure, natural infrastructure, ecosystem-based adaptation, ecosystem-based mitigation and ecological engineering to ensure the sustainability of coastal environments.

Ecosystem-based adaptation to climate change impacts in coastal spatial planning, particularly shoreline retreats, has been promoted at the international, national, and even local levels. However, scientists' opinions vary on how to implement the adaptation on the spatial-planning practices. Therefore, science-based environmental approaches in addressing concerns on human wellbeing and sustainable development in ecosystem-based adaptation can be strengthened by applying spatial planning-based ecosystem adaptations (SPBEAs).

The SPBEA concept design was carried out hierarchically, starting from the determination of the coastal zone (Fig. 1). The basic spatial data used for the SPBEA model have been fully acknowledged, including land system, land use, soil, slope, climate, water parameters, conservation zone, land ownership, and/or government spatial plans. Meanwhile, the features in SPBEA should at least include the protection zone, greenbelt, ponds, settlements, and infrastructure.

This model was applied in Sayung Subdistrict, Demak and Pekalongan, Central Java, Indonesia [3], and the Mekong Delta in Vietnam [4]. The study areas have experienced massive shoreline retreats. A multicriteria analysis (MCA)

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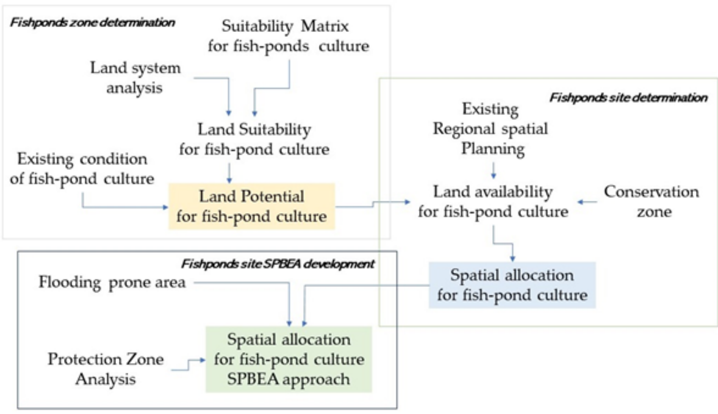

Figure 1. The steps of spatial-planning-based ecosystem adaptation (SPBEA) model development
(Source: Dewayani et al. 2021)

method was used for developing the model by using the Geographic Information System (GIS) technique, divided into three steps: 1) the fishpond zone determination, the output of this step was the land potential for fishponds; 2) the fishpond spatial site determination, where the output was the model of spatial allocation for fishponds; 3) SPBEA fishpond site development, with the output being the SPBEA site management planning model. The results show that the SPBEA model is the best practice for combatting shoreline retreats caused by tidal waves and/or sea-level rise. The spatial site management should improve the coastal protection zone and the sustainable fishpond zone by implementing a silvofishery approach.

This spatial analysis structure implements the concept proposed for the spatial planning and management of inland aquaculture. In contrast to spatial suitability analyses that are generally based on AHP, the SPBEA filters the results of the land assessment analysis using the land system data, which basically defines the natural characteristics of the land. The input of the land system in the SPBEA analysis represents an improvement of the ecosystem approach, the characteristics that can be derived from the land system spatial data. Restoring the natural conditions of the ecosystem by zoning can also be applied using spatial information on conservation areas and greenbelts. SPBEA is also conducted in a more detailed spatial arrangement of the site, where ecosystem components must also be part of the fishpond culture zone. The SPBEA concept is a solution to climate change impacts, particularly in coastal areas.

Risk Management Tools

Indonesia has been conducted a national adaptation plan to overcome the climate change disasters in coastal areas. Integrated coastal management tools have been implemented to overcome the problems in some areas, such as: 1) coastal protection made from concrete rings, 2) large rock revetment; 3) coastal protection made from geo-tubes along 3 - 4 km; 4) CCSP (Corrugated Concrete Sheet Pile) built by the provincial government; 5) coastal embankment, as well as 6) coastal conservation area (mangrove). The integrated coastal management tools were developed as risk management tools.

As one of the risk management tools, SPBEA can be analyzed using GIS software. GIS is an efficient and effective technique since it can assist in modeling and summarizing complex spatial data into a spatially specific requirement in spatial planning [5,6]. GIS application as a decision-making tool, especially in spatial planning and spatial adaptation modeling, has been widely implemented in various countries. Asian countries such as Indonesia, have also used GIS as a tool for spatial planning decision support system development [5,7].

The development of SPBEA using the GIS technique, on the other hand, cannot rely on a single technique but requires a multicriteria analysis (MCA) which combine spatial analysis techniques, such as buffers and overlays, as well as new algorithm development and the use of surveying and remote sensing for generating input data. However, the spatial data and the GIS technique used may vary depending on the specific spatial requirements for planning. Remote sensing data was also used to analyze and to identify normalized difference water index (NDWI) using the near-infrared (NIR) and shortwave infrared-1 (SWIR-1) bands to assess the tidal flooding into the area. High-resolution remote-sensing image analysis is also used to delineate the existing land use. A visual interpretation is employed for high-resolution remote-sensing images, which classifies the analyzed area into the mangrove, net ponds, fishponds, settlements, gardening/roads, and rivers.

A coastal adaptation of detailed marine spatial planning has to be employed to mitigate the threat from the ocean. An adaptation strategy using risk management tools is needed to manage the environment and aquaculture. In Pekalongan, mangrove development is one of the SPBEA solutions to inhibit climate impacts. In 2021, about 1.05 ha of mangroves were planted around the Mangrove Information Center (Fig. 2). For 2021 - 2023, the government plans to develop a support funding partnership with CSR and NGOs to protect the existing coastal mangrove and develop more coastal mangroves. The mangrove trees stabilize shorelines against erosion by holding the soil in place. Meanwhile, mangrove seedlings that take root on sandbars help stabilize the sandbars over time into small islands [8]. Therefore, the water volume will decrease. By decreasing the water volume, mangroves can inhibit flood and erosion. The mangrove management should be conducted separately and need longer planning time to improve community

Figure 2. Mangrove development in Pekalongan (Source: https://www.khairulleon.com/2017/08/wisata-gratis-di-taman-mangrove.html)

livelihood [6]. Mitigation that is suitable for Pekalongan should be determined by criteria that support coastal resilience, including physical, social and environmental resilience [9].

The Timbulsloko, Sayung Subdistrict, Demak, has implemented a conservation strategy for its coastal areas through a hybrid engineering method using SPBEA as a risk management tool. Hybrid engineering combines technological and ecosystem-based solutions that use a permeable structure as a sediment trap, followed by

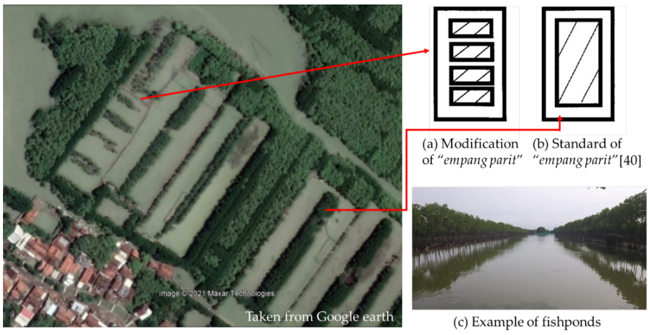

Figure 3. Silvofishery practices and mangrove development management in Timbulsloko, Sayung Distrik, Demak. (Source: Dewayani *et al*. 2021)

mangrove belts planting as a coastal protection ecosystem against the effects of abrasive tidal waves (Fig. 3). The use of mangrove belts is not only for coastal protection but also to manage the fishpond activities of the local community as an ecosystem-based approach.

The key advantages of this integrated spatial planning-based ecosystem adaptation are: 1) erosion can be inhibited by SPBE; 2) drastically reduced costs for coastal maintenance and repair; 3) flood protection; and 4) improved protection for people living immediately near the coastal area. Therefore, mangrove development is the best practice in coastal management that would help people in their adaptation toward climate change hazards.

Way Forward Strategies

As a concept, this study can become a guideline for the implementation of SPBEA issues in the future. Furthermore, site-based SPBEA arrangement requires input from the local community as the direct object of spatial planning. Therefore, a community-based SPBEA approach is needed. However, there is often a weakness in the spatial planning practice, especially in developing countries. This is a realm of government policy, both local and central, that needs further action to achieve sustainable spatial planning and prosperous rural communities. The implementation of spatial planning-based ecosystem adaptations can assist decision-makers to address environmental impacts from a spatial perspective and can make planning decisions more transparent.

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GOI INITIATIVES AGAINST POTENTIAL RISK OF CLIMATE CHANGE IMPACT IN INDONESIA

The Government of Indonesia takes serious consideration toward climate change and other environmental issues. Through its three programs of 1) Improving Environmental Quality; (2) Enhancing Disaster and Climate Resilience; and (3) Low Carbon Development, Indonesia committed to reducing GHG emissions and improving ecosystem restoration activities

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Photographer: Rio Fatahillah - Indonesia

Potential Risk of Climate Change Impact in Indonesia

As an archipelagic country, Indonesia has 514 regencies/cities facing the threat of hydrometeorological disasters due to climate change, particularly, floods and droughts. The disaster can affect the marine and coastal environment, water, agricultural land and health. This potential loss can cause disruption to people's livelihoods in Indonesia.

Indonesia's climate projection data on the RPC Scenario shows that there will be a change in rainfall patterns. Extreme variability will be higher regardless of the use of the scenario. Higher frequencies of extreme dry and wet climate probability are above normal. This condition will have an impact on the increasing average sea level rise of 0.9 cm/year in 2006-2040. These potential hazards arise within the absence of climate resilient management in the coastal areas. Increasing temperature of 0.45 - 0.75 °C, sea-level rise of 0.8 - 1.2 cm/year and extreme waves height increase of >1.5 m will elevate the vulnerability of the 18,000 km of the Indonesian coastline. This condition can make economic losses by IDR 244.5 trillion in 2020-2024 [1].

Due to this climate hazard in the coastal areas, 10 coastal provinces are threatened by the greatest potential of economic losses. The biggest to smallest affected provinces are Central Java, DKI Jakarta, South Sulawesi, West Java, Bali, Bangka Belitung, South Sumatera, Central Sulawesi, Riau and Aceh. The disaster loss database is developed by the National Development Planning Agency (BAPPENAS), the National Disaster Management Authority (BNPB), the Ministry of Home Affairs in cooperation with United Nations Development (UNDP) and the Department of International Development of the United Kingdom (DFID of UK) based on the DesInventar, which is a free, open-source methodology and software (Fig 1). The tool has a range of options for analysis allowing the national and sub-national authorities and Disaster Risk Reduction (DRR) practitioners to understand disaster trends, patterns and their impacts in a systematic manner. With an increased understanding of the disaster trends and their impacts, better prevention, mitigation and preparedness measures can be planned to reduce the impact of disasters in communities.

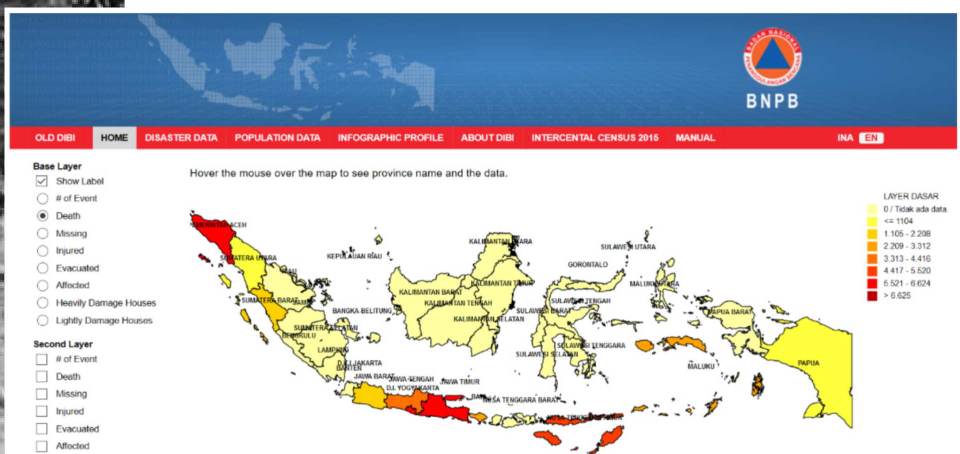

Figure 1. Web-based and Open-source Disaster Loss Database, Indonesia
(Source: BNPB website)

The Action of the Government of Indonesia on Climate Change Resilience

Indonesia is making efforts to build climate resilience, to minimize economic and social losses caused by hydrometeorological disasters and changes in environmental conditions due to climate change. This is done through economic transformation strategies, such as the green economy and low-carbon development (PRK). Based on a study by the National Development Planning Agency, due to the impact of climate change, Indonesia has the potential to suffer losses up to IDR 115 trillion in 2024. With the implementation of the Low Carbon Development and Climate Resilience policy intervention as stated in the 2020-2024 National Medium-Term Development Plan (RPJMN), the potential economic loss could decrease by up to 50,4 percent to Rp 57 trillion in 2024. The PRK emphasizes priorities on five sectors, namely waste management and a circular economy, green industry development, sustainable energy development, low carbon marine and coastal areas, and sustainable land restoration. Meanwhile, climate-resilient development focuses on 4 (four) main priorities which have priority locations distributed throughout Indonesia.

To make environmental issues one of the government's developments priorities, through a long process of producing a planning document (RPJMN), Indonesia has successfully incorporated three programs, i.e., 1) improving Environmental Quality; 2) Enhancing Disaster and Climate Resilience; and 3) Low Carbon Development. Improving the environmental quality is done by improving the quality of water, air, seawater, land cover and handling pollutants, and by increasing the environmental quality index to 69.7 in 2024. Enhancing disaster and climate change resilience is carried out through strengthening the convergence between disaster risk reduction and climate change adaptation by reducing GDP potential loss of 1.25% compared to total GDP, by 2024. The implementation of low carbon development through emission reduction policies and emission intensity in priority areas (energy, transportation, land, waste, industry and marine) is conducted by decreasing 27.3% of emission and 31.6% of emission intensity compared to baseline, by 2024.

Through Presidential Regulation No. 18 of 2020, Climate-Resilient Development (PBI) has become one of National Priorities (PN) # 6 in the National Medium-Term Development Plan (RPJMN) 2020-2024. The climate-resilient development policy is the implementation of the Sustainable Development Goals (TPB/SDGs), Low Carbon and Climate Resilience Strategy, Sendai Framework, and the fulfillment of the Paris Agreement targets. Climate resilience is very important because Indonesia is located

Photographer: Harianto - Indonesia

on the equator between two oceans so that a dynamic climate pattern is created, namely, one that takes place quickly (rapid onset) and in a relatively long period of time (slow onset).

The Climate-Resilient Development (PBI) regulates 1) Priority Locations and List of Climate Resilience Actions; 2) Central and Regional Institutions; 3) The Role of Non-Governmental Institutions in Climate Resilience; 4) Funding Sources to Support Climate Resilience Plans and Actions; (5) Monitoring, Evaluation and Reporting Mechanisms; and (6) PBI Executive Summary Book.

The policy of Climate Resilient Development is not only a climate change adaptation activity but also a policy breakthrough in disaster reform efforts and efforts to reduce economic losses due to climate hazards. Active collaboration from all relevant parties is very much needed to provide meaningful results that are felt by the community.

Financial Support on Climate Change and Coastal Resilience in Indonesia

The targeted sectors of economic loss reduction by climate-resilient development in RPJMN 2020-2024 are the marine and coastal, water, agriculture and health sectors. To support this program, the Ministry of Finance of Indonesia (MoF) declared that the average of the allocated state budget for climate change for 2018-

2020 is 102.65 trillion rupiahs per year. Around 88% of the budget is used to finance green infrastructure, while 12% is for supporting activities such as regulations and policies, research and development, capacity building and community empowerment. The MoF has already issued multiple Green Bond and Green Sukuk from 2018 to 2021 as alternative sources of green financing. The latest one is SDGs Bond in 2021 which is amounted to 500 Million Euros. The SDGs bond is not only focused on the Green and Blue sector but also the Social sector. The SDGs bond is projected to finance various projects such as the development of renewable energy, energy efficiency, climate resilience, sustainable transportation, waste management, sustainable natural resources management, green tourism, green building, sustainable water management, Micro, Small, Medium Enterprises (MSME) financing, food security, basic services (health and education) and basic infrastructure.

Green Project Highlights

Indonesia has mangrove areas totaling 3.2 million hectares (ha) and an area of approximately 3 million hectares of seagrass beds which can store up to 17% of the world's Blue Carbon reserves. Blue Carbon ecosystems are able to provide employment and income for local economies, improve water quality, support healthy fisheries, and provide coastal protection. The need for strengthening national strategies for the improvement and development of blue carbon ecosystems, including coordination between stakeholders. The green project mobilizes the funding for programs/projects to optimize blue carbon, supported by data clarity and project feasibility. The project also aims to achieve the blue sector's annual contribution to 12.5% GDP in accordance with Indonesia's Vision 2045. Therefore, an annual investment of IDR 1,928 to 3,307 trillion is required [2].

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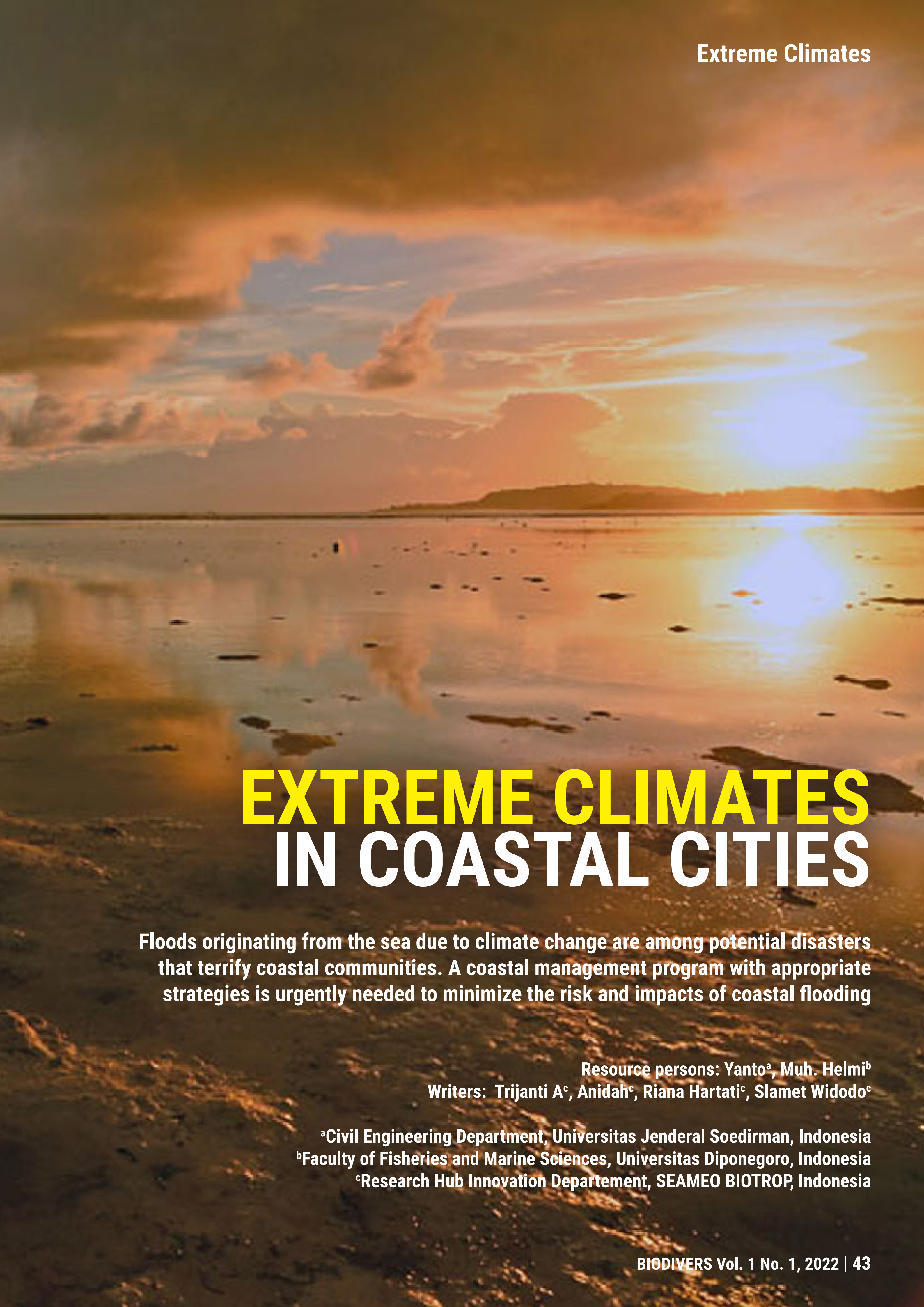

EXTREME CLIMATES IN COASTAL CITIES

Floods originating from the sea due to climate change are among potential disasters that terrify coastal communities. A coastal management program with appropriate strategies is urgently needed to minimize the risk and impacts of coastal flooding

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Flood in the Cities

Floods become the top third disasters that take the most lives globally after droughts and storms [1]. The economic losses caused by floods reach USD1,1 trillion globally, or 31% of the total reported economic losses due to disasters [1]. Floods have also been reported to hit big cities in nearly every country since the last century. Extreme weather, sea-level rise, and other climate change impact play important roles in the flooding mechanism.

A flood is defined as an event or condition where an area or land is submerged due to an increased volume of water [2]. Floods can occur by the overflow of inland waters (fluvial flood), excess of extremely heavy rainfall (pluvial flood), or inundation of land areas along the coast by seawater (coastal flooding). Fluvial flooding occurs when the water level in a river, lake, or stream rises and overflows onto the banks, beaches, and surrounding lands. Fluvial flooding can also occur when extreme rainfall events create floods that are not dependent on many flowing water bodies. Some floods also happen due to the inundation of seawater's land areas along the coast, known as coastal flooding. This type of flooding is triggered by extreme climate change. It can occur not only when there is a storm wave produced when the air pressure at sea falls, the wind is significantly strong but also when both the wave set-up and swash, producing the run-up altogether, are powerful (Fig. 1)

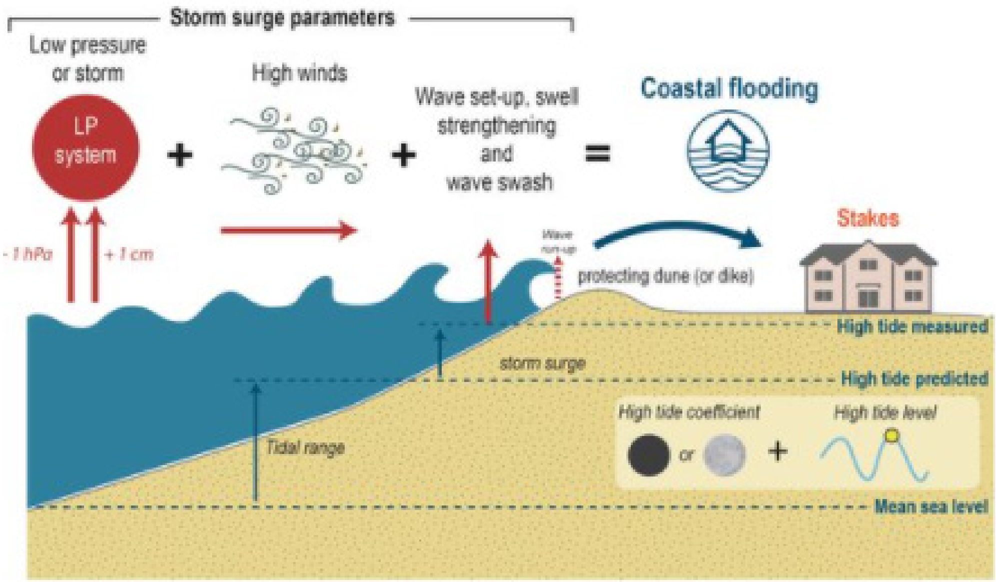

Figure 1. Coastal flooding mechanism
(Source: Yanto 2021)

Common causes of coastal flooding are extreme windstorm events co-occurring as the high tide (storm surge) and tsunamis. Coastal flooding occurs at low speed with an average depth of 50 cm and occurs in hours. In addition, these events usually caused no fatalities, so people think that is common. This event can affect future temperature fluctuations and sea level waves that can cause land subsidence and greatly influence human lives in the long term.

Globally, coastal flooding as a threat due to sea-level rise and storm surges that expose port cities in many countries has emerged in the last decade [3]. Many coastal communities around the world live at risk from coastal flooding. According to the UCCRN technical report titled "The Future We Don't Want", the total urban population at risk from sea-level rise could number more than 800 million people, living in 570 cities, by 2050 if emissions don't go down as mandated in the Paris Agreement (Fig. 2) [4].

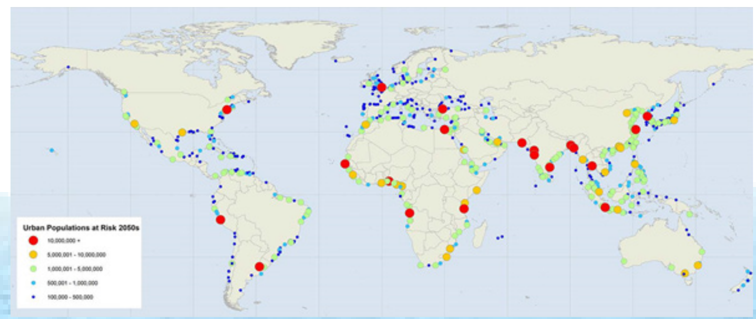

Figure 2. Cities a risk from sea level rise of 0.5 meters by 2050s
(Source: UCCRN 2018)

Global initiatives and networks play an essential role in addressing the effect of climate change. C40 is a network of mayors of nearly 100 world-leading cities collaborating to deliver the urgent action needed to confront the climate crisis. City mayors are the key persons at the city level due to their decision to affect global achievement facing climate changes. New York City and Jakarta are both coastal areas and already dealing with the effects of climate change. They pursue local action through science-based decisions to develop a resilience strategy to strengthen coastal protection. New York City has completed the flood-proof project namely Rockaway Boardwalk, which integrates coastal protection and numerous recreational facilities within the park, parallel to the beach and boardwalk. Meanwhile, the Indonesian capital Jakarta has developed a city-wide climate adaptation strategy that includes a Sea Defense Wall Master Plan with assistance from the Dutch government [4].

Besides Jakarta, other cities in Java also facing the same threat. Some data show that permanent tidal inundation has occurred in Demak, Pekalongan and Semarang. Permanent tidal flood inundation at Sayung, Demak Regency in 2003 - 2014 caused the inundation area to reach 2,073 ha in 2014. Meanwhile, the inundation area in Semarang in 2011 reached 1,211.2 ha. Permanent tidal inundation in Demak and Pekalongan resulted in land subsidence between 8.65 to 14.25 cm/year in both regions based on Persistent Scatterer Interferometry (PSI) Monitoring 2016 - 2021. Besides Demak and Pekalongan, land subsidence observed by LAPAN in 2015 - 2020 also occurred in Jakarta (0.1 - 8 cm/year), Bandung (0.1 - 4.3 cm/year), Cirebon (0.28 - 4 cm/year), Tegal (2.1 - 11 cm/year), Semarang (0.9 - 6 cm/year), and Surabaya (0.3 - 4.3 cm/year).

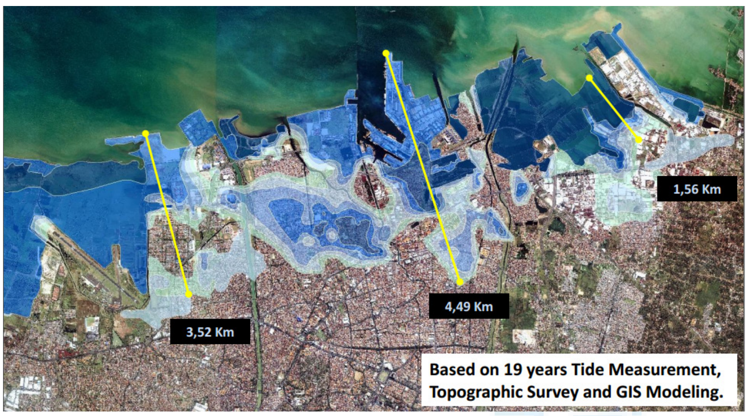

Figure 3. Sea level rise simulation model at Semarang, Central Java
Note: Sea level rise = 77.5 cm (100 years SLR simulation model)
(Source: Helmi 2021)

Some of the main factors causing land subsidence include 1) Natural consolidation/compaction of young alluvial land; 2) Uncontrolled groundwater abstraction; 3) Building and Infrastructures weight, and 4) Local tectonic movements. Based on the geospatial model of the existing and predicted inundation model in 2020 to 2035 conducted by Helmi (2021), the inundation distance from the shoreline will be further away landward, increasing between 2 - 3 times after 15 years. Data show that the total area inundated by seawater will increase every year (Fig. 3). The areas most affected by inundation are the residential areas, followed by rice fields/crops planted areas, industry, and barren land.

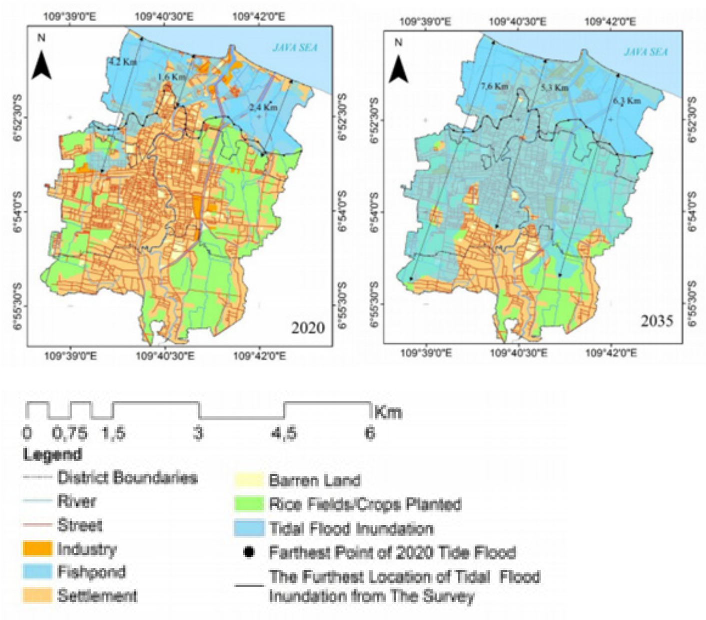

Figure 4. Geospatial model of existing and prediction inundation model in 2020 to 2035
(Source: Helmi 2021)

Human and Nature-Based Solution

Spatial observation

A coastal management program with appropriate strategies is urgently needed to minimize the risk of coastal flooding and to reduce its impact when it occurs. Several adaptation options that potentially mitigate the effects of tidal flooding conduct spatial observation such as Earth Observation (EO). The adaptation options also include the implementation of Coastal Protection "sea belt," a combination of seawall and breakwater, including hard and soft engineering approaches. Earth observation has a critical role in attaining success in terms of sustainability at scale, being a source of rich spatial and temporal datasets that complement other types of data, such as census information, civil registration, vital statistics, and in situ measurements [5].

Earth observation, including monitoring, understanding, and predicting marine coastal hazards, can be carried out using a variety of sensors to monitor coastal zone characteristics, various metocean variables relevant for different coastal hazards, and some coastal hazards

Photographer: Septiani Dewi Ariska - Philippines themselves. Metocean is the abbreviation of meteorology and oceanography. It includes atmospheric and physical oceanographic variables such as characterized wind, waves, sea level, bathymetry, sea currents, sea-ice (thickness, extent), seawater properties (salinity, temperature, stratification), water quality parameters.

Extensive research into coastal sustainability issues has highlighted EO data and technologies opportunities to support coastal management efforts, particularly environmental monitoring. Marine Spatial Planning [6] and coastal sustainable urban development [7, 8] efforts by actively combining multiple data sources, including EO data, can yield potential solutions to increasingly complex problems [6, 7, 8].

The exploitation of Big EO Data enables global mapping of natural resources along the coast, ranging from fisheries, water quality and bathymetry, and natural hazards, including storm surges, coastal inundation, and sea-level rise (SLR). Some examples of innovative advanced EO applications include 1) Optical water types for coastal water quality monitoring; 2) Species niche habitat distribution mapping; 3) Complementary multi-platform coastal bathymetry; and 4) Coastal inundation mapping and prediction and storm surge risk assessment.

Sea belt as a barrier

In addition to mitigation through EO, coastal protection by installing sea belts as barriers is also needed as the first step in preventing flooding on the coast. The primary reason to construct protection structures is to protect the harbor and other infrastructures from sea wave effects such as erosion and coastal flooding. The typical approach to any threat of coastal erosion or flooding has been hard engineering sea defenses or coastal protection structures. Various structures are considered or used as coastal protection structures, such as groins, seawalls, bulkheads, breakwaters, and jetties.

Seawalls are large protection structures built using different construction materials, such as rubble mounds, granite masonry, or reinforced concrete. Seawalls are commonly built and run along the shoreline to prevent coastal structures and areas from detrimental ocean wave actions and flooding driven by storms. Various arrangements or configurations might be employed, including curved face seawall, stepped face seawall, rubble mound seawall. Bulkheads can be constructed with concrete, steel, or timber. There are two major types which are gravity structures and anchored sheet pile walls. In addition, groins are structures constructed by wooden or concrete structures perpendicular to the shoreline. They work by blocking part of the coastal drift, whereby they trap or maintain sand on their upstream side. Other structures are jetties constructed at river estuary or harbour entrance and extended into deeper water to oppose sandbars and limit currents. The last one is breakwaters which are offshore concrete walls that break waves out at sea so that their erosive power is reduced when they reach the coast [9].

In general, this hard engineering approach has some weaknesses, such as unsustainable and short-term with high impact on the landscape or environment and tend to be expensive. Some areas need other less costly alternatives, long term, attractive and sustainable. One of the choices is the soft engineering approach that works with the natural processes of the area by using the natural materials, features, and functions to absorb or reduce wave impact like mangroves [10]. Mangroves provide several critical ecosystem services, namely coastal protection and fisheries production.

Mangroves in coastal areas can reduce the height and energy of wind and swell waves passing through them, reducing their ability to erode sediments and cause damage to structures such as dikes and seawalls. Mangroves also reduce winds across the water's surface and thus, prevent the propagation or re-formation of waves. Mangroves with a complex structure of dense aerial roots and low branches, with various species of different ages and sizes, are most likely to be effective at reducing wave heights.

Option for flood risk management

Flood risk management strategies aim to reduce the probability and/or consequences of flooding events. Actions that address flood risk in areas under continual development include 1) strengthening the existing or constructing new protective structures; 2) increasing natural retention and storage capacities, such as the "Room for the River" projects in the Netherlands [11]; 3) expanding insurance for flood damage and improving flood resilience [12]; and 4) upgrading forecasting, early warning, and preparedness systems [13]. In this context, the data generated during the EO is the key to investing in the development of a patented approach to flood hazard calculation.

Based on information extracted from EO data, researchers and decision-makers can conceive and apply effective policies for environment protection and sustainable management of natural resources. To take advantage of all potential, users need to handle hundreds (or thousands) of EO data files, of different spectral, temporal, and spatial resolutions, by using or developing software scripts to extract information of interest [14]. So, in the current era of big spatial and EO data, there is a need for the next generation of spatial data infrastructures (SDIs) to properly deal with this vast amount of data.

In addition, the engagement of stakeholders in socio-economic-environmental modeling processes is key to developing a holistic qualitative model. For example, a system dynamics modeling approach capable of considering all socio-economic components and ensuring that all issues and relevant policy opinions have been addressed. Many models have a degree of flexibility concerning the spatial and temporal scales they can be implemented. Still, identification of relevant scales is essential in selecting the most appropriate modeling approach. The purpose of the modeling is likely to be a critical factor in this decision. Nature-based solutions (NBS) have been coined to encompass the answers available that provide opportunities for alleviating water-related challenges. In the context of modeling NBS to manage water-related challenges, a high level of spatial detail may be required.

More NBS implementation provides evidence for the benefits and risk-reduction capabilities of floodplain-based NBS, such as reconnecting and protecting floodplains. Floodplains can have the capacity to manage infiltration, overland flow, improve hydrological connectivity, regulate water supply, serve as biodiversity hotspots, and provide countless other benefits [15]. However, the degree to which floodplains can fulfill those functions depend on the presence and interaction of various biophysical factors.

To answer all these challenges requires the cooperation of various stakeholders, especially researchers and policymakers. Collaborative research with multiple fields of expertise such as remote sensing, mapping, hydrologists, and environmentalists is needed to produce integrated and applicable research. This is important to answer all challenges related to the impact of climate change on coastal cities.

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KRESA.ID

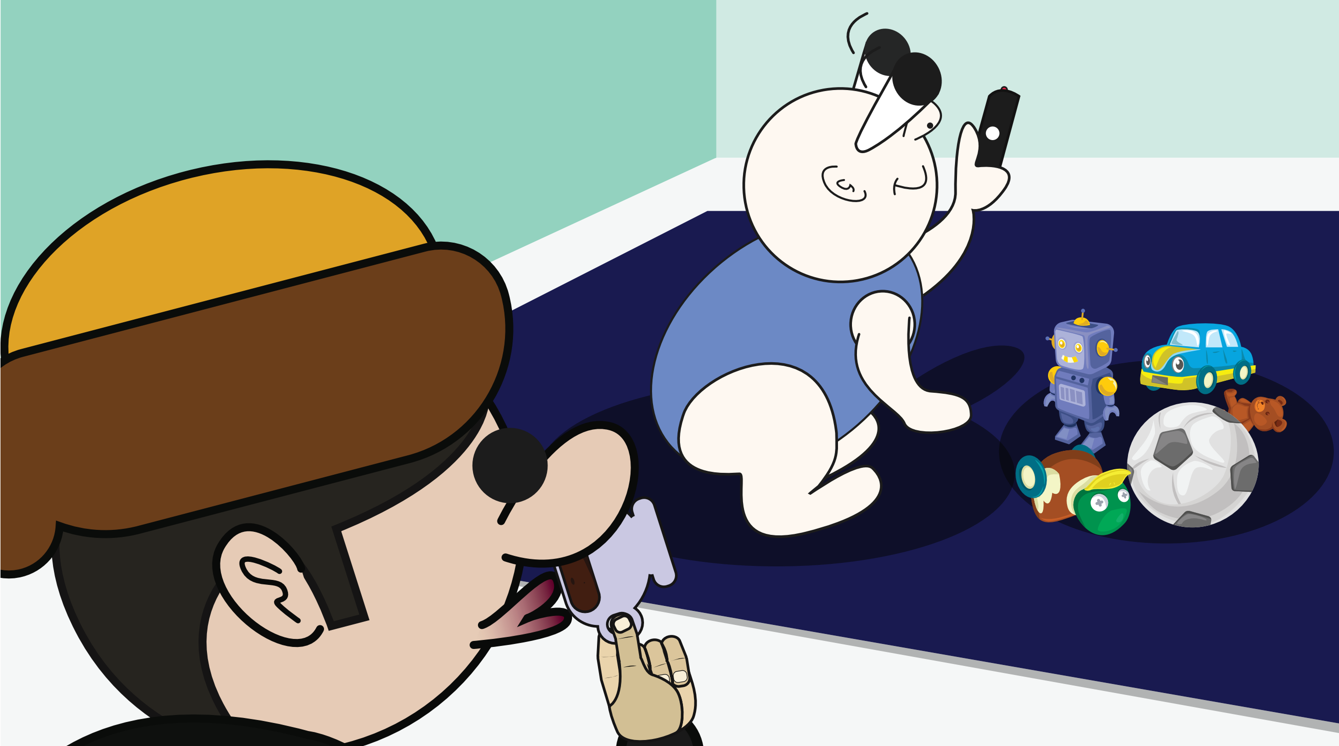
warung LUR!
Temani kopi paling setia

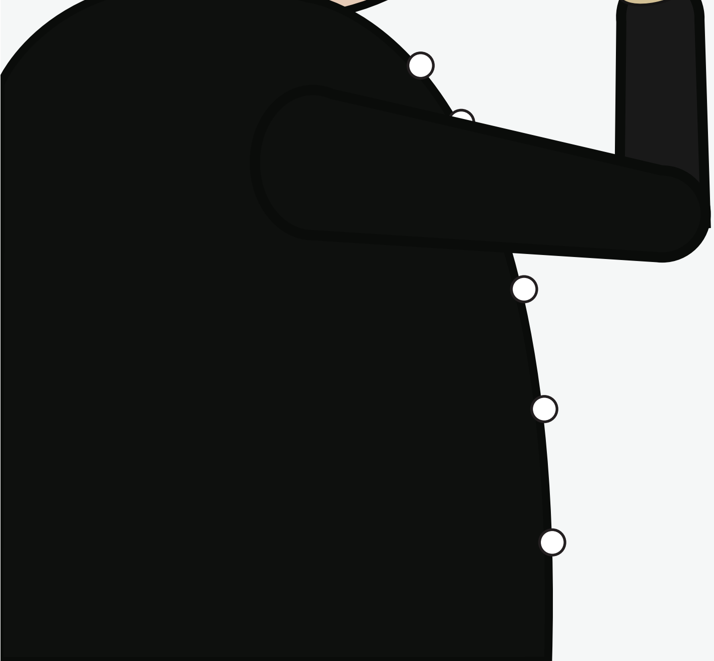
The scene:

Sunday morning,

kids have fun watching The Mat Geci Series on youtube while their parents enjoy Kopi Aren Lur!

07:00
Sun, Jan 1st 2022





For kids

Mat Geci The Series

on Kresa Indonesia Youtube

Every Sunday, 7 a.m

For parents

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MARINE AND COASTAL MONITORING: NANOSATELLITES TECHNOLOGY

Research on nanosatellite technology needs to be developed on a large scale toward space technology research. The system utilizing satellite-based space technology is suitable to tackle the constraints on the geographical range and structure of the Indonesian Archipelago in facing global climate-change

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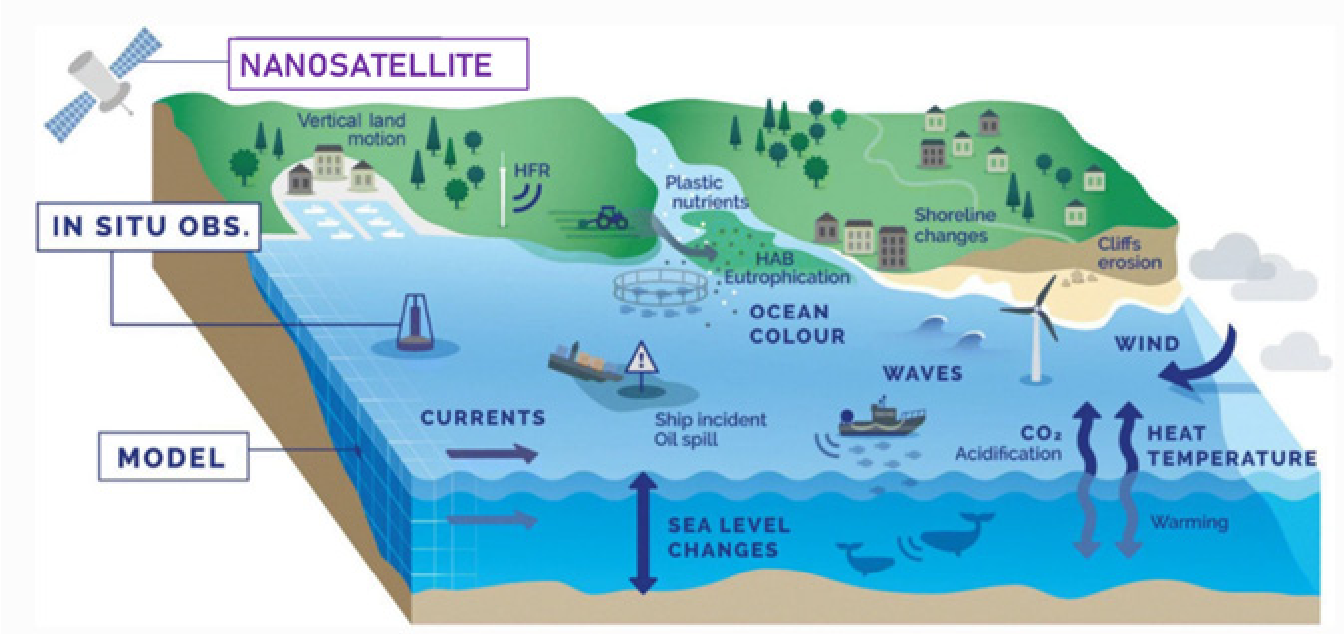

Figure 1. Nanosatellite technology as an instrument for global climate change monitoring (Source: Mellet *et al*. 2020)

NANO SATELLITE TECHNOLOGY:
A Monitoring Tool for Marine and Coastal

Marine and coastal areas have large social, economic and environmental values. Those areas are densely populated, have critical infrastructures as economic assets, and center of human activities for tourism, fisheries and navigation. Coastal areas are also very productive ecosystems in terms of marine resources. Currently, coastal zones are exposed to various natural and anthropogenic hazards. Earth observations using remote sensing satellites, provide invaluable information to reduce the risks associated with marine hazards, sustain coastal zone monitoring programs and support forecasting and early warning systems [1].

Remote sensing technology is widely used as an effective tool in disaster risk management. Disaster risk managers or experts need to monitor the environmental situation, simulate complicated disaster occurrences as accurately as possible to develop better prediction models, suggest appropriate contingency plans and prepare spatial databases using remote sensing data. The remote sensing data can be used very effectively to immediately assess the severity of impact damage due to earthquakes, landslides, flooding, forest fires, cyclones, and other disasters. Nanosatellites for marine coastal monitoring are used for earth observation/remote sensing; disaster mitigation and climate change; ocean weather, aerosol and air quality; marine debris and pollution; surveillance; and for ocean mapping, trophic state and habitat.

The development of satellite technology is currently increasingly advanced. The trend shows that in the last decade the production of satellites has led to the technology of small-sized satellites (micro and nanosatellites). A nanosatellite is a satellite having a mass of 1 to 10 kg, with a standard cubesat that lasts for 10 years. The most popular nanosatellite size is 3U dimension which is 30 cm high, 10 cm wide and 10 cm long. The nanosatellite is becoming popular due to its shorter development time, more affordable price, highly available COTS components, low latency because of low orbit, and less battery power for communication. Nanosatellites were developed for space research and for the development of satellite technology at a lower cost compared to conventional satellites. The cost of launching a nanosatellite is cheaper because a nanosatellite is launched by using a piggyback method or riding a rocket or satellite launched using the Poly-Pico Satellite Orbital Deployer (P-POD). One rocket can carry 1-3 nanosatellites to be launched into LEO orbit [2].

Since 1766, nanosatellites had already been launched in 76 countries, worldwide. Some 541 companies participated. In Southeast Asia, some countries also develop and launch similar programs. Singapore launched 7 programs, Thailand 5, Malaysia 2, Philippines 2 and Vietnam 2. And as forecasted, over 2,500 nanosats will be launched within the next 6 years (www.nanosat.eu).

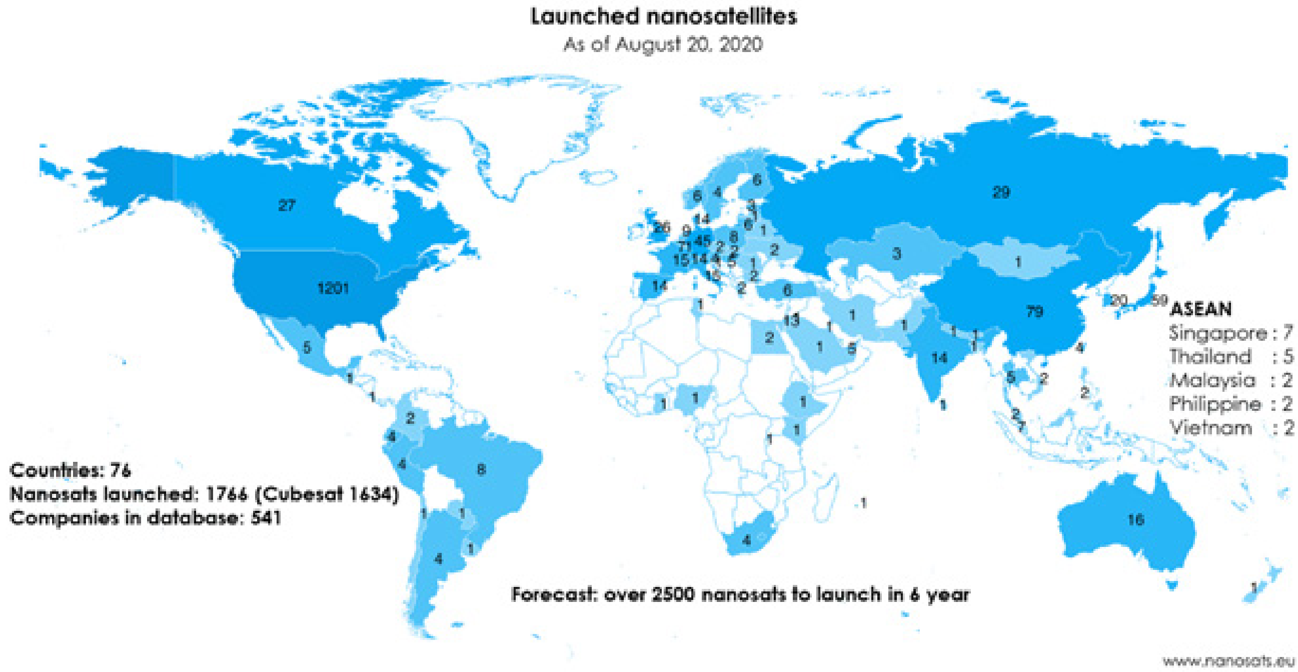

Figure 2. Launched nanosatellites as of 20 August 2020
(Source: www.nanosats.eu)

Almost all nanosatellites use passive satellite sensors. Now, some nanosatellites equipped with Radar and Lidar technology are developed by NASA and Georgia Institute in the USA.

Nanosatellite technology is already approved and implemented as an instrument for global climate change monitoring. In 2018, SEAHAWK was launched for ocean color monitoring. PLANETSCOPE, from France, is used to identify bathymetry, benthic habitat and seagrass species mapping in shallow water. In 2019, HARP, launched by the University of Maryland, is a hyper-angular rainbow polarimeter for aerosol and cloud particles study. In June 2021, BeaverCube was launched by MIT-STAR Lab, using coastal imaging with IR dan VIS sensor for tracking excess soils, sediments, decaying leaves, pollution and other debris.

Nanosatellite Development in Indonesia

Indonesia has been a satellite user since 1976 by launching the PALAPA satellite and became the first ASIAN country to use satellite technology for telecommunications. Since 2003, Indonesia has been trying to develop microsatellites independently and cooperate with developed countries. The National Institute of Aeronautics and Space (LAPAN) as a satellite technology development agency in Indonesia has launched Indonesia's first microsatellite named LAPAN-TUBSAT in 2007. This micro-sized experimental satellite opens a new chapter for Indonesia in mastering satellite technology [3]. Indonesia has also successfully launched the LAPAN-A1/LAPAN-TUBSAT satellite, the LAPAN A2/LAPAN Orari satellite, and the LAPAN A3/ LAPAN-IPB satellite [3].

Figure 3. The design of Surya Satelit 1 (SS-1)
(Source: http://fkmtfindonesia.or.id/blog/mengintip-club-riset-nanosatellite-mahasiswa-tf-universitas-surya/)

Currently, Indonesia is developing the LAPAN-A4 satellite. Like its two predecessors, this fourth-generation satellite is entirely made in Indonesia. The main mission of this fourth-generation satellite is to observe the earth, in regards to the environment and natural resources, using an optical imager. Another mission of LAPAN-A4 is the monitoring of maritime traffic using the Automatic Identification System (AIS) which is capable of recording millions of ship data per day globally. This satellite also

Sources: Satellite - Satelit LAPAN A3. pusteksat.lapan.go.id; Globe - https://www.pexels.com/id-id/foto/planet-bumi-220201/

targets the scientific side by carrying a magnetometer payload. The LAPAN-A4 satellite will be launched using India's rocket launcher (ISRO) in 2022.

In 2016, LAPAN collaborated with Surya University to develop a nanosatellite called Surya Satellite-1 (SS-1). Surya Satellite-1 (SS-1) is the first nanosatellite in Indonesia with an Automatic Packet Reporting System (APRS) mission. Indonesia plans to launch this satellite in April 2022 in Japan. The condition of the nanosatellite is now entering the final stage of development. The disadvantage of this satellite lies in its incapability of taking pictures with a high resolution because of its small capacity.

However, the Government of Indonesia has built a Multifunction Satellite Project Earth Station for the Republic of Indonesia Satellite (Satria-I) in Cikarang, Bekasi Regency. These earth stations or gateways are part of the terrestrial segment that will connect the satellite with the earth observation office. Apart from Cikarang, ten other gateways will be built in Batam, Banjarmasin, Tarakan, Pontianak, Kupang, Ambon, Manado, Manokwari, Timika, and Jayapura.

The development of satellite infrastructure in Indonesia is expected to mitigate the risk of climate change. The development of nanosatellite technology can be of great support, in mitigating natural disasters, for the BNPB, BMKG and all other Indonesian institutions. The realization of the nanosatellite technology development program can be an emerging technology for marine coastal monitoring. Implementation and development of nanosatellites can be a national pride for space technology development in Asia.

Future Research of Nanosatellite

The need for the use of satellite technology is overgrowing every year around the world. This triggers technology competition. The Asia and Pacific region is no exception, where satellite technology has been widely used for telecommunications, remote sensing and science missions. The specific condition of Indonesia's territory makes the need for satellite technology becomes increasingly higher compared to several other countries. With the development of the digital era, the need for satellite technology is not only for a communication tool but also for various applications such as remote sensing for observation and monitoring of agricultural, plantation, urban, forest, coastal and ocean areas for various needs, atmospheric observations, space and climate weather predictions (weather satellites), navigation satellites, scientific and communication satellites.

Research on the development of nanosatellite technology needs to be established toward large-scale space technology research. The system for utilizing satellite-based space technology is able to overcome the constraints that emerged from the geographical range and structure of the Indonesian archipelago in facing global climate change. Geospatial Information then becomes crucial for supporting Disaster Risk Reduction Management activities.

The development of nanosatellites are continuously carried out by satellite data provider companies. Research on nanosatellite technology involves universities in collaboration with the country's space agency. Several universities conduct research and development on nanosatellites including Technische Universität Berlin, Santa Clara University, Tokyo Institute of Technology, Stanford University, University of Tokyo, Hokkaido Institute of Technology, Nitte Meenakshi Institute of Technology, University of Applied Sciences of Southern Switzerland (SUPSI), Zhejiang University, Nanyang Technological University, Kyung Hee University, and many other universities [4]. Various countries participate in the race to develop nanosatellites. The players in this technology are still dominated by the American and European countries. For the Asian region, nanosatellite research is dominated by India, Japan and China.

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The IndoBIC (Indonesian Biotechnology Information Centre) was established initially in 2003 as the cooperation between the International Service for the Acquisition of Agri-biotech Applications (ISAAA) and the Southeast Asian Regional Centre for Tropical Biology (SEAMEO BIOTROP).

IndoBIC, as one of the regional network of Biotechnology Information Centres (BIC) in Southeast Asia, is expected to strengthen the links it has made and the partnerships being established. While focusing on effective communication strategies to bring across information on biotechnology, it hopes to explore further other tools to widen its reach, and maintain its credibility so that it can be truly the regional hub of relevant and accurate information on agricultural biotechnology.

In line with the objectives of BIC in general, the objectives of IndoBIC are to :

- Serve as a hub of the regional network for current science-based information on agricultural biotechnology.
- Support national programmes on agricultural biotechnology by providing strategic information for decision-making.
- Act as a centre for information dissemination for various stakeholders.
- Coordinate with regional and national network nodes on the exchange, processing, synthesizing, packaging, as well as distributing agricultural biotechnology science-based information using appropriate formats for various stakeholders.

The programmes have two specific goals i.e.

1. to Help national programmes facilitate the development of a policy environment conducive to the application of biotechnologies, and
2. to Promote public understanding of scientific advances in crop biotechnology.

Stored-Product Insect Pests

PHOSPHINE RESISTANCE

Controlling stored-product insects is most often carried out by **FUMIGATION** using various **FUMIGANTS.**

PROPER FUMIGATION TECHNIQUE

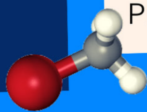
- Able to maintain concentration for an adequate period of exposure
- No leakage during fumigation
- Use the recommended application dose

A gaseous pesticide that can kill pests at a **specific concentration and time**.

CH3BR

Limited use due to ozone layer depletion issues

"Montreal Protocol 1992"



PH3

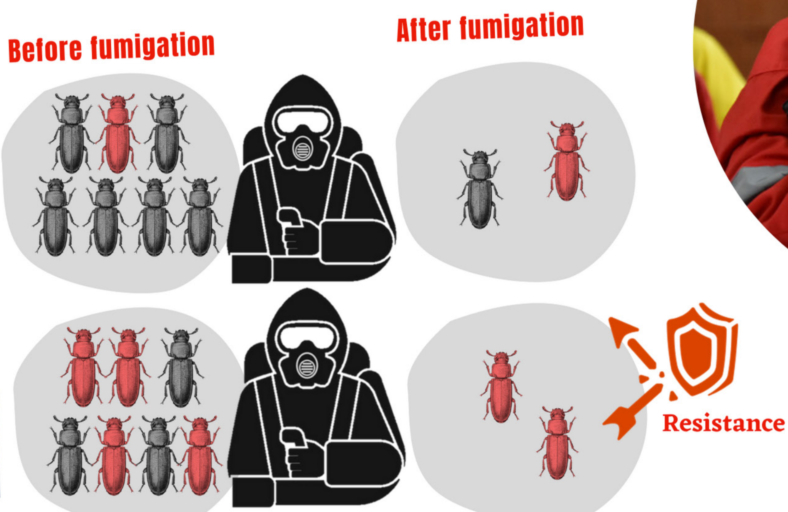
Colorless, flammable, extremely toxic gas with a disagreeable garliclike odor

Is the only option for many years

"Improper fumigation techniques, along with repeated and continuous applications that do not meet the standard can trigger the development of **RESISTANCE.**"

FIRST GENERATION

LATER GENERATION



"When the same insecticide (phosphine) is repeatedly used against a pest population, some insects will survive the same dose that kills the insect population. Those that survive will pass on that survival trait to their offspring."

STATUS OF INSECT RESISTANCE IN INDONESIA

Distribution of stored-product insect pest-resistant strain against phosphine in Indonesia: resistant strain in red color, susceptible strain in blue color.

●: *Tribolium castaneum* ■: *Rhyzopertha dominica* ▲: *Sitophilus* spp. ⬟: *Cryptolestes* spp. ⬣ : *Corcyra cephalonica*

HOW TO MANAGE PHOSPHINE RESISTANCE?

- Ensuring the highest fumigation standards (good and proper fumigation technique) by strictly following the recommended minimum concentrations and exposure periods to avoid under-dosing.
- Conduct pest management by implementing integrated stored-product pest management principles consisting of 75% prevention, 20% inspection and monitoring, and 5% control, so that the use of phosphine is minimized.
- Accelerate the adoption of alternative fumigants (phosphine rotation with other chemicals).

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