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獨步全球的海洋遊憩風險資訊平臺～GoOcean

Global First Marine Recreational Risk Information Platform: GoOcean

泰國海洋資訊

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Steadfast Effort Towards Sustainable Seas

Translated by Linguitronics
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By exploring and understanding the ocean, we are able to use marine resources responsibly, while building sustainable marine ecosystems. Taiwan possesses unique marine environments such as the rich coral reef ecosystem at Taiping Island of the Nansha or Spratly Islands. However, information on the distribution of macroalgae in the intertidal zone is insufficient. As such, this issue introduces the biota survey of macroalgae in the intertidal zone of Taiping Island conducted by the National Academy of Marine Research (NAMR). The survey successfully established biological data and built a comprehensive compilation of species to enhance the general public's basic understanding of Taiwan's macroalgae. The "GoOcean" online platform of NAMR is able to consolidate real-time information from different departments and offer risk alert for different water recreational activities. This is helpful to the public in assessing the risk levels when engaging in these activities, and serves to achieve the goal of open ocean. Collecting marine data is also beneficial for the global effort against climate risks. The recent International Issues introduces the Asian Development Bank's (ADB) report, *Sea-Level Change in the Pacific Islands Region*. It provides diligently reviewed scientific data identifying islands and regions more susceptible to sea level rises, a valuable reference for investment in the Asia-Pacific region.

The country covered by the recent issue is Thailand. Due to sustainable development programs of the United Nations, expedited regional integration of ASEAN countries and influences of other international factors, especially penalties on illegal, unreported and unregulated (IUU) fishing imposed by the European Union (EU), Thailand has proactively undertaken reform measures. Since 2015, Thailand has formulated or amended regulations governing fishing, marine resources and water navigation as an effort to consolidate the division and coordination of duties at the national level. Furthermore, it has also proposed the National Action Plan and Roadmap on plastic waste management, which aims to reduce plastic waste at the source. The Action Plan and Roadmap delineates the municipal waste treatment mechanism to be adopted before the rain season to effectively reduce land-based pollution. In 2018, the Environmental Justice Foundation (EJF) implemented the Net Free Seas (NFS) project in Thailand. With assistance from Thailand's Department of Fisheries, the project has built mechanisms that make local communities more willing to engage in recycling by reclaiming discarded fishing nets for reuse. Thailand is a prime example of how both government and NGOs can work together to build sustainable seas by contributing towards marine conservation!

Figure/ Tarutao National Park, Thailand's first national park
Source/ Tourism Authority of Thailand
https:// www.tourismthailand.org/Attraction/tarutao-national-park

Global First Marine Recreational Risk Information Platform: GoOcean

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Translated by Linguitronics
Keywords: MetOcean, Marine Recreation, Beach Safety, Risk Information, Salute to the Seas Policy

The safety risks of marine recreation have always been an unavoidable issue in the open seas. GoOcean is a marine recreational risk information platform developed and designed by the Ocean Affairs Council, National Academy of Marine Research (NAMR) in compliance with the Executive Yuan's Salute to the Seas policy, including its specific strategies and 5 major goals: openness (open seas, simplified management), transparency (information transparency, one-stop satisfaction), service (friendly measures, comprehensive facilities), education (deeper education, accessible experience), and liability (clear risks, responsibility fulfillment). We anticipate that such marine recreational risk information service technology, the first of its kind, will provide islanders who have long been banned from the sea with an innovative platform to re-connect with the ocean.

The article titled "Australia's Beach Hazard Ratings and Beach Safety Website" [1] in issue 8 of International Ocean Information spoke about how many renowned recreational beaches in Australia have reduced their safety risks. The experience in Australia shows that safety risks and risk factors that exist in beach environments include big waves, strong currents, reefs, rip currents, and other weather- and environment-related factors; however, they are also associated with people's knowledge of ocean waters, swimming skills, and experience. As such, implementing hazard evaluations for beaches to assign hazard ratings and building a website for beach safety information are effective measures to avoid and reduce safety risks by offering safety guidance to beach goers.

The NAMR referenced the experience on marine risk information service of countries such as Australia and the US with the purpose of improving the availability of safety risk information for ocean enthusiasts in Taiwan. The GoOcean platform offers weather data for marine environments and safety risk information (information transparency, clear risks) by adopting cloud IoT technology to deploy cross-agency, cross-platform, forward-looking marine science and technology, providing reference and helping the general public determine whether to partake in recreational marine activities, as well as improving people's understanding of the seas (knowing the seas), encouraging them to enter the seas (entering the seas), and teaching them to enjoy the seas (loving the seas).

GoOcean's IoT Smart Ocean Engineering

GoOcean's system integrates the Salute to the Seas Forward-looking Infrastructure Development Program's newly installed anchor data buoys, ocean radars, meteorological instruments, coastal monitors, numerical hydrodynamic and water quality simulation and prediction system, and biological and underwater imaging system. It is also connected with the Ministry of Transportation and Communications' Central Weather Bureau, the Institute of Harbor and Marine Technology, the Ministry of Economic Affairs' Water Resources Agency, the Tourism Bureau, and other domestic marine organizations, as well as marine environment monitoring data from EU and US satellites. The

system's IoT-based design utilizes network architecture as shown in Figure 1. In order to provide a good user experience (UX), the platform's user interface (UI) adopts visualized human-machine interface design and development to allow users to immediately see real-time weather and recreational risks for marine recreational activities in various sea areas on an electronic map. Static weather data is rendered and issued through a Web Map Service (WMS) while dynamic marine weather data such as wind, waves, and currents are shown via WebGL in real-time by utilizing the browser's front-end rendering technology. The system's data integration architecture is as shown in Figure 2.

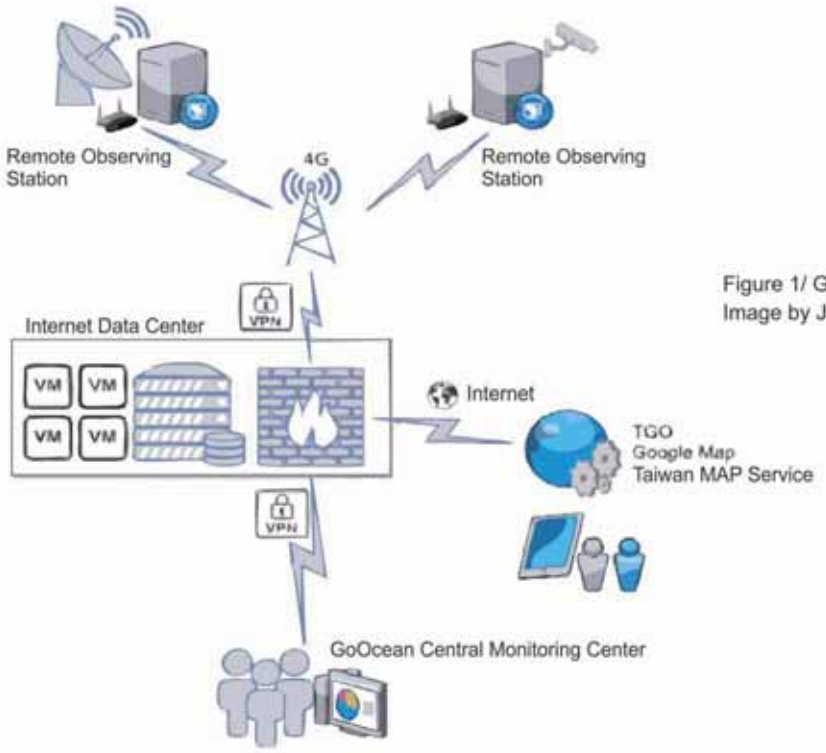

Figure 1/ GoOcean's IoT system network architecture
Image by Jian-Wu Lai

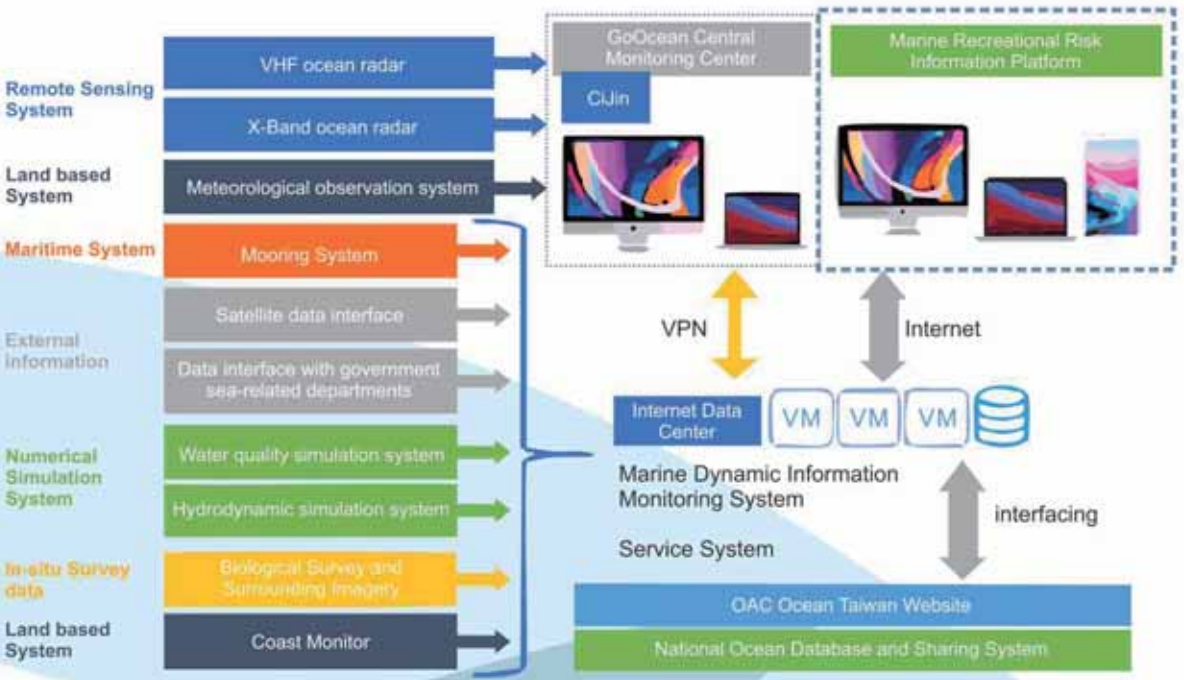

Figure 2/ GoOcean system data integrated architecture
Image by Jian-Wu Lai

First Dynamic Recreational Marine Activities Sports Rating

In 2021, the NAMR invited experts, businesses, and scholars related to unpowered marine recreational activities for multiple sessions of joint discussion, utilizing the Delphi method for statistical analysis [2]. They rated 5 types of unpowered recreational activities: diving, swimming, windsurfing, kayaking, and surfing. The rating rules are based on marine weather environment factors and there are 4 sports ability ratings: beginner, intermediate, expert, and severe sea conditions, as shown in surfing activity's rating Table 1. As such, we can perform sports ability ratings based on the selected time, beach, and dynamic marine weather conditions. The system automatically determines the recommended ability rating for various types of unpowered recreational marine activities (diving, swimming, windsurfing, kayaking, and surfing) so that the general public can evaluate their own capability and risk levels to plan appropriate recreational activities.

Table 1/ Sports Ability Rating of Surfing Activities

Ability Level / Environmental Parameters	Beginner	Intermediate	Expert	Severe Sea Conditions
Wave Height	<1.2 meters	<2.5 meters	<8.0 meters	≥8.0 meters
Wave Period	<7 seconds	<7 seconds	<12 seconds	≥12 seconds
Breaking Wave Angle	90 degrees	45~90 degrees	<45 degrees	<45 degrees
Ocean Current Velocity	<0.51 m/s	<0.51 m/s	<1.03 m/s	≥1.03 m/s

Compiled by Jian-Wu Lai

Integration of Cross-Agency Real-Time Safety Risk Information

Safety risks to marine recreation, such as swells, lightning, and ultraviolet (UV) rays, can be remotely detected using modern monitoring technologies. This allows GoOcean to provide early warnings by interfacing with the real-time data from various government agencies and applying them to safety risk alerts for recreational beaches. For example, interfacing with the real-time observation data of the lightning strike system from the Central Weather Bureau, Ministry of Transportation and Communications and Taipower Company provides lightning strike data for the past 6 hours at a data refresh frequency of once every five minutes. This allows travelers heading to wide spaces on beaches to avoid thunder and lightning from ruining their trip or even prevent the risk of fatal injury. Additionally, integration with the Environmental Protection Administration and Central Weather Bureau's hourly UV ray monitoring data from stations located across Taiwan provides reference to the general public when traveling, allowing them to make advance preparations and protect against and prevent sunburn, as well as potential skin or eye lesions, while enjoying wonderful weather and clear skies. On the other hand, swells are a hazard that often poses safety risks in marine environments for activities such as kayaking, surfing, and fishing. In order to successfully create a warning system for swells, the NAMR utilized the significant wide area, continuous, and real-time marine observation capabilities of the ocean radar system to observe wave direction, frequency, and spectrum for tens of kilometers off the coast. The separation method of wind waves and swells allows wave energy to be divided into wind and waves generated by local wind sites and swells propagated in a wide area. The wave characteristics (period and wave height) of swells are gathered and updated every 5 minutes through remote radars and early warnings are provided at little over 10 minutes in advance of swells. Combining the real-time safety risk alerts above, swell warnings and real-time lightning information can be captured as shown in Figure 3.

Figure 3/ GoOcean's integration of cross-agency real-time ocean safety risk information (Left: Swell Alert; Right: lightning)
Image by Jian-Wu Lai

Support for Domestic Marine Sporting Events

Sporting activities can make the people join as one and are symbolic of a nation's power. In addition to supporting the promotion of recreational marine activities through information related to marine environments and safety risks, GoOcean aims to utilize cloud IoT technology and data integration to support marine sporting events. By providing instantaneous, higher resolution marine weather data and marine risk information to event organizers and athletes, weather data during the sporting event can be recorded to facilitate safety risk evaluations. For example, monitoring systems were activated for the 2022 Jialeshuei International Surfing Festival hosted from September 30 to October 2 in Pingtung and the Taiwan Open of Surfing planned for November 12-20, 2022 in Taitung. The platform can also develop innovative data services based on event characteristics such as those shown on the event website of Jialeshuei International Surfing Festival in Figure 4. Not only was a 3-day forecast of sea conditions made available, but real-time observation data was integrated for reference and use by athletes and organizers.

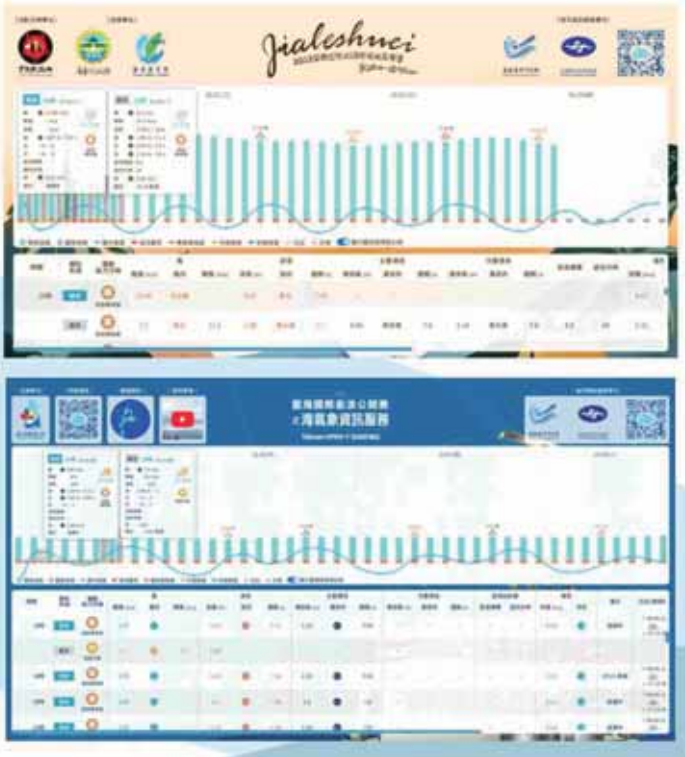

Figure 4/ GoOcean supported the event website of the 2022 Jialeshuei International Surfing Festival (Top) and Taiwan Open of Surfing (Bottom)
Image by Jian-Wu Lai

Conclusion

This article introduces GoOcean, a marine recreational risk platform that enhances the general public's understanding of the seas (knowing the seas) and encourages them to enter the seas (entering the seas). The forward-looking, human-centric technology service enables cross-agency, cross-platform integration. In a departure from the marine environment information platforms built with foreign data that the general public previously relied on for marine recreational activities, GoOcean is based on the integration of weather reports, monitoring, and forecast data from Taiwan. This offers the advantages of higher resolution and accuracy, as well as quantified ratings of safety risk information for marine recreational activities popular in Taiwan. GoOcean's dynamic marine weather data (information transparency) and safety risk information for activities (clear risks) allow the general public and recreation businesses to find rated recreational waters suitable to their capabilities so they may improve their enjoyment of the ocean and learn to love the seas. In the future, the platform aims to work with coastal management agencies to discuss and adapt beach management strategies that will contribute towards the safety and prosperous development of marine recreation.

The target audience's satisfaction level towards the usability and UI/UX of GoOcean is something that is constantly being reviewed and adjusted throughout the platform development process. In the past, Taiwan's marine recreational activities were affected by the government and the public felt like they were banned from going to the sea. The hopes and efforts by the government and businesses to make the ocean accessible in recent years have led to a gradual flourishing. The platform leverages social developments to offer an innovative application system that integrates 10 major types of marine weather data sources to provide and issue wide-ranging, highly accurate weather forecasts. Moreover, new upgrades combine telemetry and marine radar data to provide swell warnings with a shortened update frequency of 5 minutes; swells are one of the major threats to public safety in sea areas. More importantly, the platform's technology and innovative applications have had a critical impact on marine safety, making it an optimal example of successful "technology-assisted governance that benefits the public".

Statistics from the system's back end since GoOcean's open testing started in late December 2021 shows that out of all registered users, there are as many as 694 active users. The platform has accumulated over 101,619 visits, users have exchanged opinions more than 75 times, data of all sorts has been queried 207,130 times, and there have been over 78,413 shares on the media, social media, user reports, and posts. The average number of monthly users has grown despite the impact of COVID-19, making it clear that GoOcean is gradually becoming an indispensable information platform for Taiwan's sea-loving inhabitants who participate in marine recreational activities.

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Assessment of Climate Risks and Sea Level Rise in South China Sea

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Translated by Linguitronics
Keywords: South China Sea, climate risks, global warming

Carbon dioxide (CO_2) is one of the primary factors causing global warming. This is indisputable. The UN Intergovernmental Panel on Climate Change (IPCC) published their Sixth Assessment Report (AR6) on climate change and released three Working Group reports in total. The Working Group I report (WG I) published, "*The Physical Science Basis*" on August 9, 2021; the Working Group II (WG II) published "*Impacts, Adaptions and Vulnerability*" on February 28, 2022; and the Working Group III (WG III) published "*Climate Change 2022: Mitigation of Climate Change*" April of the same year. The 3 reports offer the latest global assessment on the progress and commitments for climate change mitigation while also investigating sources of CO_2 emissions with global impact, evaluating nations' commitment to address climate change and their impact on long-term CO_2 emissions goals.

IPCC data shows [1] that the total volume of anthropogenic greenhouse gas (GHG) emissions continues to increase; average GHG emissions per year in 2010-2019 reached new records. However, inspection of growth rate shows a downward trend when compared to 2000-2009. In 2019, the total volume of anthropogenic GHG emissions was approximately 59 billion tons of CO_2 equivalent (tCO_2e), a 12% increase compared to 2010 and a 54% increase when compared to the baseline year of 1990. Nearly all types of GHG emissions are increasing; the largest increases are in CO_2 emissions from fossil fuels and industrial processes, followed by methane emissions. While the total volume of CO_2 emissions exhibited a downward trend in the first half of 2020 due to COVID-19, emissions have begun to rise again now that the pandemic is gradually coming under control.

Global Warming the Primary Factor for Sea Level Rise

Wind waves, storms and the gravity of the Moon and Sun may contribute to sea-level rise (SLR) (Figure 1), but not the main causes. The rise of temperature on the earth is melting glaciers in the North and South Poles at a faster pace than ever, making it one of the primary factors for sea level rise. The 3 following factors of sea level rise are extremely relevant to global climate change: The primary factor is the thermal expansion and contraction of sea water. Data shows that in the past 25 years, approximately 50% of the sea level rise was due to Earth's warming, caused by expansion of sea water. Next is the melting of alpine glaciers, particularly, alpine glaciers of temperate zones near the North and South Poles, which would naturally melt to a small extent every summer. Global warming and extreme climate have brought instability to the balance of snowing in winter and melting in summer, naturally causing a rise in sea level. Finally, it's the continued destruction of ice caps in Greenland, the world's largest island, and Antarctica. Global warming has accelerated the melting of massive ice caps covering Greenland and Antarctica. The infiltration of meltwater at sea level and sea water below sea level at Greenland's ice cap has accelerated glacier flow into the ocean, further exacerbating sea level rise.

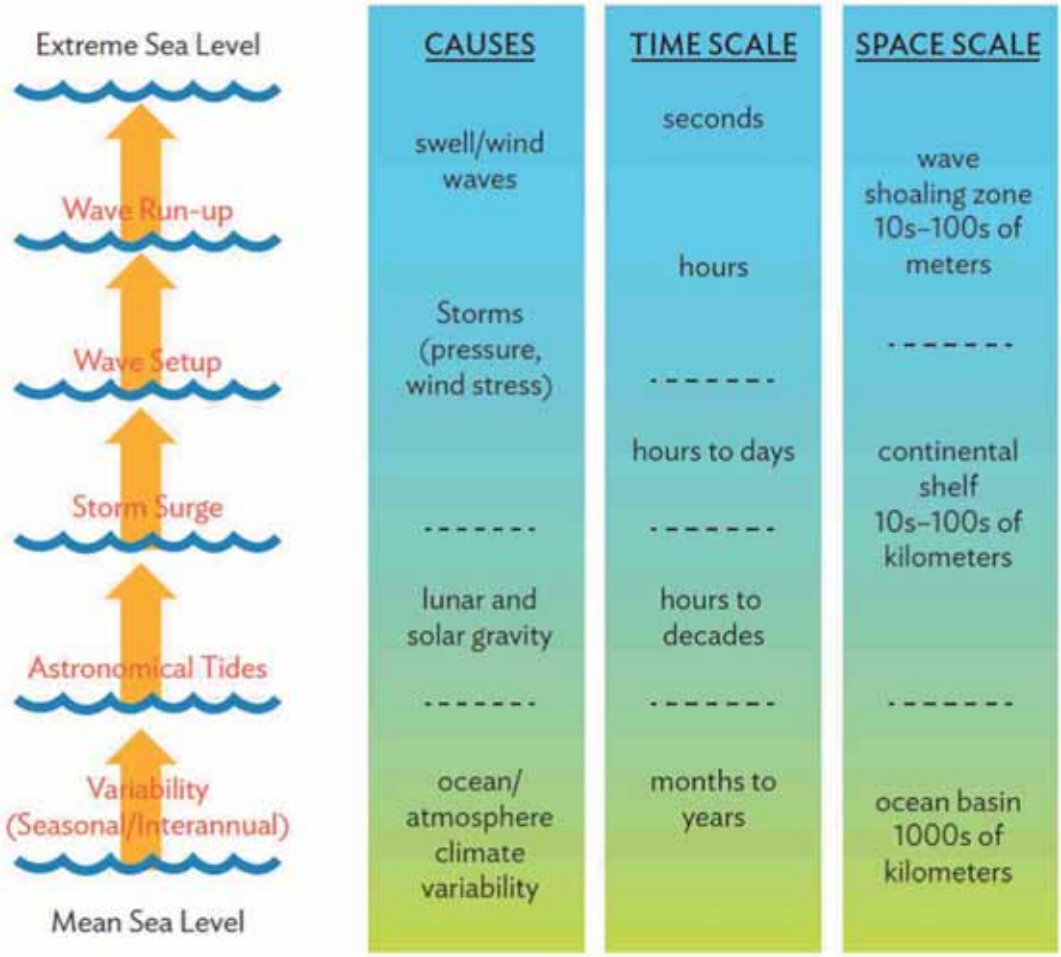

Figure 1/ Examples of various factors causing sea level rise
Source/ [2]

Greater Climate Risks Caused by Sea Level Rise

The sea level is rising at a faster rate than previously, impacting ecosystems in ways such as salt damage to aquifers and farmland and destruction of the habitats of fish, birds, and plants. Additionally, sea level rise has caused typhoons or hurricanes to make landfall more frequently than before. For instance, hurricane movement in recent years is slower than in the past and has caused increased rainfall as well as larger waves along coastlines. Inhabitants in low-lying regions of the coastline are being forced to move inland or to higher land due to floods. All of the above reinforces the credibility of the threat posed by sea level rise, in turn caused by global warming. The need to implement energy conservation and carbon reduction strategies to reduce CO_2 emissions and inhibit sea level rise grows urgently by the day. Also, the planning of appropriate GHG adaption strategies is indispensable for addressing the rise in sea level.

Sea level rise is a global issue. This article introduces the report *Sea Level Change in the Pacific Islands Region* [2], published by the Asian Development Bank (ADB) in July 2022. The report offers research data on climate risk and adaptation to serve as future guidance for countries in the Pacific Islands Region (PIR) to respond to sea level rise. The three major objectives planned in the report are: I. Establish a regional forum and financing for building infrastructure; II. Implement special projects to drive installation of renewable energy systems as well as marine and coastal management; and III.

Enhance the disaster preparedness of various countries, including developing the capacity for public financial management, statistical compilation, and data collection.

The Pacific Island Region Is Extremely Vulnerable to Sea Level Rise

The Pacific Island Region is located in the western tropical Pacific (Figure 2) and is highly exposed to tropical cyclones and other tropical storms. Countries therein have a high shoreline to land area ratio. As such, they are highly sensitive to changes in sea level, waves, and currents. Furthermore, the region's many low-lying coral atolls, reefs, or volcanic islands are especially susceptible to impact from SLR. In view of these factors, the report provides precautionary measures for investors in response to SLR, including research data from various sources that reflects advantages, disadvantages, and uncertainties. The report reviews scientific evidence on SLR and provides credible data related to SLR in the PIR as a basis for further investigation and decision-making, offering insights on matters such as long-term planning of sustainable settlements and national/regional population movements.

In 2013, IPCC published its Fifth Assessment Report (AR5) and suggested that SLR is unlikely to exceed 1 meter by 2100 relative to the 1986-2005 baseline used. This information has been widely used by ADB and other institutions to assess and manage research on SLR-related risks in the Pacific Island Region. However, subsequent review of science and evidence after the publication of AR5 has found that the presupposition of the assessment that SLR will stay within 1 meter in the future may not be accurate in the Pacific Island Region due to 5 main factors:

I. Although there is very high confidence in the direction of change for all Pacific Island Region locations, there is only medium confidence in the magnitude of change. Considering the impacts of natural fluctuations due to climate change, it seems possible that SLR may exceed 1 meter in 2100.

II. The recently published AR6 report and other research that has emerged since AR5 show that if new data is utilized and the baseline is changed to 1995-2014, SLR will not only exceed 1 meter but may possibly exceed 2 meters in 2100. It's especially worth noting that SLR will continue to rise in 2100 instead of staying within 1 meter as stated in AR5.

III. Paleoclimate records show that SLR of 5 meters within a century has occurred in the past, but such phenomenon only takes place once every several hundred to several thousand years. The consensus between experts and scholars is that such a rise will not occur before 2100, yet AR6 points out that without marine ice cliff instability, it is possible for SLR to rise between 1.7 to 6.8 meters by 2300; this can increase to 16 meters by 2300 with marine ice cliff instability.

IV. Short-term variability in high water levels associated with storm surge and waves could significantly increase regional coastal water levels above what is expected, especially with scenarios in the PIR and particularly in the western tropical Pacific.

V. Based on data collected since 2000, most islands in the Pacific Island Region are subsiding and, therefore, the impact of SLR will be magnified in Pacific Island Region nations where the land is sinking.

Figure 2/ Pacific Island Region nations in the west Pacific are vulnerable to impact from SLR

Source/ [2]

Significant Impact of Sea Level Rise in the Pacific Island Region

While recognizing all the factors that contribute to SLR impact, this report adopts a simpler method, a precautionary approach with higher global average SLR. This considers the expected impact of high water levels on the Pacific Island Region for climate risk adaptation while taking into account higher end scenarios that assume SLR will not stop in 2100. Therefore, this report utilizes AR6 premises, such as the baseline of 1995-2014, to recommend considering the following factors:

I. for all projects, a 1 m SLR scenario, for comparison with existing studies that have typically used a scenario of 1 m SLR by 2100;

II. for short- to medium-term projects (i.e., with a design life of 20–30 years), a scenario of 0.5 m SLR by 2050;

Table 1/ Estimated Value of Sea Level Rise in Pacific Island Region Nations (Unit: centimeters)

Country	Projected SLR (from Appendix 1)[a]	Historical Interannual Variability	Upper Bound of Projected SLR plus Historical Interannual Variability
Cook Islands	39–86	19	105
Federated States of Micronesia	41–90	26	116
Fiji	41–88	18	106
Kiribati	38–87	23	110
Marshall Islands	41–92	20	112
Nauru	41–89	23	112
Niue	41–87	17	104
Palau	41–88	36	124
Papua New Guinea	47–87	23	110
Samoa	40–87	20	107
Solomon Islands	40–89	31	120
Tonga	41–88	18	106
Tuvalu	39–87	26	113
Vanuatu	42–89	18	107

RCP = Representative Concentration Pathway, SLR = sea-level rise.

Source/ [2]

III. for long-term projects (i.e., with a design life greater than 30 years), a scenario of 2 m SLR by 2100; and

IV. for projects with an expected lifetime beyond 2100, scenarios of greater than 2 m SLR.

Based on the premises above, Table 1 places the 2100 SLR of 14 countries in the region at between 38-92 centimeters.

In addition to being applicable to sensitivity analysis for designing climate protection, SLR can be applied to analysis of additional costs and benefits to explore the flexibility of climate adaptation plans. The report recommends applying these scenarios to sensitivity analysis instead of acting as the minimum precautionary requirements for climate protection. Flexible climate adaptation and management plans can solve higher end SLR scenarios. Considering reliance on long-term pathways, or in other words, based on assumptions of potentially higher SLR (including economic and other factors), investment decisions on coastal infrastructure will impact subsequent investment and development; as such, subsequent climate risk assessments will not be required under the assumption of identical risk levels.

Conclusion

ADB has developed reliable forecast information in its climate risk assessment for the Pacific Island Region, included it in its assessment of climate risk in the Pacific Island Region, and proposed recommended actions, such as defining project objectives, tasks, and the required technical and labor requirements for each task at every stage. The calculation model and intellectual property of SLR has been provided to Vietnam to ensure the consistency and transparency of ADB member nations when utilizing this method.

SLR research is ongoing. The viewpoints on how to best handle current and estimated SLR impact are also changing, meaning the formulation of climate change adaptation strategies is a continuous process. This report recommends reviewing all evidence (of climate change) every 5-10 years, such as after the publication of new IPCC reports, as to evaluate and verify if there are changes in opinions due to new evidence.

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Net Free Seas in Thailand: A Marine Protection Initiative Starting from the Action of Coastal Communities

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Keywords: Thailand, discarded fishing nets, recycling, coastal communities, marine protection

Environmental Justice Foundation (EJF), an international non-profit organization, initiated the Net Free Seas project (NFS). This project encourages coastal communities to collect fishing nets discarded in the seas and thus builds a supply chain which links coastal communities who collect discarded fishing nets, recyclers who purchase the collected nets and made nets into pellets, and manufacturers who produce products by using the pellets. To this end, the EJF devised a series of actions to push for this project, including the steps for coastal communities to becoming part of the project, guaranteeing a buying price for nets higher than the market price, and the ways to identify nets that are currently accepted for recycling. The NFS project has been implemented for about three years with a few coastal communities' participation. In addition, manufactures also already used the materials recycled from fishing nets to produce products, presenting a case of circular economy. Based on this initial promising outcome, the EJF hopes to expand the NFS project to other countries, in particular the ones of West Africa, where marine plastic pollution is rife.

Thailand is located in Southeast Asia. The length of the coastline is 3,148 kilometers, bordering the Gulf of Thailand in the east and the Andaman Sea in the west. Thailand is one the world's largest fishing states with a huge number of fishing vessels up to 50,000 small fishing vessels and 10,000 commercial ships. The amount of fishing nets accidently lost or deliberately discarded into to the sea should be considerable, posing a great threat to marine life. As official Thai figures show, about 74% of sea turtles and 89% of dugongs stranded on the beaches between 2015 and 2017 had been injured by nets [1], showing the severity of discarded fishing nets.

In order to solve discarded fishing nets left of lost in oceans, the EJF initiated the NFS project with the funding coming from the Norwegian Retailers' Environment Fund. The EJF is dedicated to protecting the natural environment and the people and wildlife that depend upon it [2]. The headquarter is located in London, United Kingdom and several working stations are established in many countries. The EJF has initiated several campaigns which are relevant to the oceans, including ending illegal fishing, combating human rights abuses and slavery at sea, protecting marine biodiversity, securing sustainable fisheries, etc. [3].

The main objectives of the NFS project are threefold: I. remove fishing net waste and ghost fishing gears from the natural environment; II. provide communities with a secondary income which are engaged in collection of fishing nets; III. build environmental protection awareness among coastal communities [4]. To this end, the NFS project is dedicated to establishing a supply chain linking local communities, recyclers and product manufacturers. In other words, local communities help collect and clean used fishing nets (Figure 1) and then sell nets to recyclers with a guaranteed price. The used nets are then further cleaned, shredded and melted into pellets by recyclers. These pellets are sent to manufacturing companies to be used in the production of high-quality consumer products. This article aims to introduce the NFS project, shedding light on how the EJF guides coastal communities to participate in the NFS project and further empowers them to become part of the nets recycling solution and an actor in the marine environmental protection.

Figure 1/ Discarded fishing nets recycled and reused and can be made into new products
Image by Chung-Ling Chen

The overview of the Net Free Seas project

The NFS project is to establish a mechanism in which local communities are willing to collect and clean discarded fishing nets, and these nets are then recycled to be reused in the production of new products. This mechanism involves developing steps for local communities to join in the project, instructing communities on how to identify the nets that are accepted for recycling as well on how to clean fishing nets, proposing the ways to prevent fishing net loss at sea, and making rules that need to be complied throughout this project.

I. Steps for local communities to participate in the project

- If your community uses a lot of fishing nets or you find there are lots of discarded nets in your community, please get in touch with us on LINE.
- Find a person to be your focal point. This person will oversee net collection in your community.
- Identify a fishing net collection point in your community. This could be an area that is close to the pier or fishing boats but sheltered enough that nets won't be blow away to be washed into the sea.
- Work with your focal point to work out logistics from the net collection point to recyclers.
- The EJF will help you design a book-keeping system that is suitable for your community, recording the things pertaining to fishing nets collection.
- The EJF will train communities in how to clean the nets.
- The EJF will coordinate with you to develop a timescale in the transport of cleaned fishing nets.

II. Instruction on how to identify fishing nets acceptable for the NJF

The project currently only accepts gillnets made from nylon. It is because that nets made from nylon are extremely hard wearing and curable making them perfect for recycling. As for other types of net, the EJF will expand to accept them for recycling.

A guide containing maps and description pertaining to different types of nets was particularly made by the EJF to help fishers better identify what is and what is not acceptable for recycling. This guide also offers the information on the market price for different types of nets. As an illustration, gillnet accepted by the NJF is white or blue in color. The net is fine but stiff with the mesh size being 2.5~10 cm. The main catch of gillnet is crab. The market price for discarded nets is 2-8 baht/kg. However, the NFS buying price is 10 baht/kg. Another type of nets -trawl and fishing ropes made from polypropylene or polyethylene are not acceptable. Trawl is blue, green, black or red in color. It can be both fine and thick and is mostly used for commercial fishing with fish being the main catch. The market price for discarded nets is 2-5 baht/kg.

III. Instruction on how to clean nets

When being collected, fishing nets should be cleaned and dried. This increases the quality of pellets produced from the discarded nets and means that recycling factories are more likely to accept nets in the future. In line with this, some tips are offered on how to clean nets as seen below.

- Remove ropes and lead weights. However, don't throw them away since they might be sold out to other recycling partners.
- Separate the different types of nets and leave the nets that the NJF accepts.
- Remove any fish or other animals, twigs, leaves, pebbles or other debris from the nets.
- Clean the nets with salt or rainwater, not chemicals or freshwater.
- Dry the nets and keep them in a clean and sheltered place.
- The use of gloves is recommended while cutting, collecting and transporting the nets to avoid injuries.

IV. Instruction on how to prevent fishing net loss at sea

The easiest way to prevent damaging the marine environment is to stop nets from falling into the sea in the first place or to pick them out of the sea as quickly as possible. The ways to prevent fishing net loss at sea are offered as seen below.

- Get accurate maps from Department of Fisheries (DoF) or Department of Marine and Coastal Resources (DMCR) on where underwater coral formations lie and avoid placing nets there.
- Put flags over underwater formations so that you can see where you could snag the nets.
- If you find nets lost in the sea bring them back to shore.
- If you find a net caught on a coral reef or underwater formation but it is too difficult or dangerous to retrieve yourself, save the GPS coordinates of the location and notify the NFS them on LINE.
- If you damage your net at sea, please do not throw the net into the sea. Instead, keep it and bring it back to shore.
- If you repair your net at shore, make sure that your discarded net does not fall into the sea. Keep it and shore it so that NFS can recycle it.

V. Compliance rules for participants

The EJF asks the communities who participate in the NFS project to observe specific rules to protect children and the environment, as well as secure welfares for participants. These rules are presented below.

- The EJF operates a zero-tolerance policy towards the use of child labor or corruption. If individuals or communities are suspected engaging in either practice, the EJF reserves the right to terminate the relationship immediately.
- Nets, ropes and other plastic materials should never be burned as this can give off harmful fumes which are damaging to health.
- No chemicals should be used to clean nets since chemicals may contaminate the environment and harm wildlife. It is advised to use sea water or rainwater to clean nets.
- The use of child labor at any point in the NFS supply chain is forbidden. However, the EJF encourages communities to offer children internships or training as this can help children build their own skills and knowledge. Their work must not interfere with their schooling, not involve long working hours or working during the night, as well as handling of hazardous chemicals or dangerous machinery, equipment and/or tools.
- The buying price of discarded gillnets under the project is guaranteed at 10 baht per kilogram. The EJF will conduct unannounced inspections to ensure the price is paid.
- The wage of the person hired under the project must be no less than the minimum wage of each province per day determined by the Wage Committee under the Thai Labour Protection Act.
- Working hours should not exceed eight working hours per day and workers should receive a minimum one hour during this period.

Initial outcome of the NFS project

The project has been into practice for about three years. With the support of Thai Department of Fisheries, several coastal communities have participated in this project. By October 2020, a total of 5.9 tons of nets were already recycled. The EJF strives to cooperate with several Thai companies and encourages them to use pellets recycled from nets to produce consumer products, such as water sports products and COVID-19 related products such as face shields, push sticks and disinfectant bottles [5].

It is worth noting that Qualy is one of the companies that joins the project. It designs products with a focus on respecting our planet and in the meantime, improving people's life. Qualy used discarded fishing nets, PET bottles and plastic bags to manufacture a wide range of sleek products, including office supplies, bathroom supplies, and kitchen supplies (Figure 2) [6].

Figure 2/ Qualy used discarded fishing nets, PET bottles and plastic bags to make a wide range of sleek products

Source/ [6]

Conclusion

The NFS project is an initiative dedicated to marine environmental protection. It was developed and implemented in Thailand by the NJF. The project encourages coastal communities to engage in the collection of discarded nets by offering a buying price for nets higher than the market price. It also instructs communities to prevent fishing net loss at sea. These efforts help build awareness of marine protection among communities.

The project has been into practice for about three years. It has established a supply chain from communities collecting fishing net, recyclers reusing the nets and making them into pellets, to companies producing new products. This indicates promising results already achieved from the project. The NJF will further expand to develop more different types of products as well as recycle different types of fishing nets. In light of the project successfully running in Thailand, the NJF hopes to expand it to other countries, particularly the ones of West Africa, where marine plastics pollution is rife.

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The Role of the Ministry of Natural Resources and Environment of Thailand in the Overall National Marine Development Policy

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Keywords: MONRE, marine policy, integrated governance

Although Thailand boasts 310,000 square kilometers of exclusive economic waters, its past strategic mindset as a land power has made it difficult to consolidate its marine and coastal policies. It does not have an ambitious national marine policy, and only after the EU issued a yellow card warning for IUU (Illegal, unreported and unregulated) fishing in 2015 did Thailand begin its comprehensive reforms of related industries. This paper describes the formation of Thailand's marine policy and the integrated governance of the Ministry of Natural Resources and Environment and marine affairs.

The Formulation of Thailand Maritime Policy

Thailand has a land area of 513,000 square kilometers (50th in world ranking) and a population of 70 million (22nd in world ranking). In terms of inland Southeast Asia, Thailand is located at the heart of Indochina and housed the major air bases for US bombings in Vietnam during the Vietnam War. In terms of maritime Southeast Asia, to the west of Thailand are the Andaman Sea and the Indian Ocean; to the south, the Gulf of Siam and the South China Sea that controls the northern part of the Strait of Malacca, making the waters a hub that connects the Pacific Ocean and the Indian Ocean. As the founding nation of ASEAN, Thailand has long been pro-American and the U.S. embassy in Thailand has the largest of any Southeast Asian country concerning embassy grounds and staff. However, in 2013, China became Thailand's largest trading partner, and military exchanges between China and Thailand have gradually increased. Hence, Thailand is a key player for the success of both U.S. Indo-Pacific strategy and China's Belt Road Initiative [1].

For a long time, Thailand has maintained a land-based national strategy for its overall national security and defense [2]. Therefore, although Thailand has 310,000 square kilometers of exclusive economic waters, it does not have a macro national maritime policy. This has given rise to much difficulty for consolidating its marine and coastal policies in the past [3]. As Thailand progresses toward its goal of becoming a developed country, environmental pollution caused by industrialization and the growing imbalance between Bangkok's industrial clusters and coastal areas have highlighted the importance of sustainable development and inclusive growth, and the balance among economic development, social and human resources, and environmental resources has become increasingly important.

However, a more important driving force comes from international factors, such as the United Nations Sustainable Development Program, the accelerated regional integration of the ASEAN, the South China Sea dispute, the U.S. crackdown on human trafficking, and the EU's imposition of penalties on IUU fishing and other international regimes. In particular, after the EU issued a "yellow card" warning to Thailand for IUU fishing in April 2015, Thai authorities began a comprehensive reform of its fisheries industry, quickly establishing a robust new legal and policy framework, as well as active loan arrangements and investments to ensure that fisheries become a more sustainable industry [4]. The most important of these was the establishment of an inter-ministerial coordinating body, the Command Center Combating Illegal Fishing, which was later transformed into the renowned Thai Maritime Law Enforcement Coordinating Center (Thai-MECC) that served as a horizontal linkage

Figure 1/ Thailand is located at the heart of the Indo-China Peninsula. Its west lies the Andaman Sea and the Indian Ocean, while its south lies the Gulf of Siam and the South China Sea. The geographical location allows it to control the northern area of the Malacca Strait, which connects to the Pacific Ocean and Indian Ocean
Image by Pride Advertising Agency Ltd.

organization for marine and coastal affairs [5]. Since then, issues such as IUU fishing, illegal immigration, drug smuggling, marine environmental protection, and ecological restoration have increasingly become the main targets of Thailand's maritime affairs management [6].

It is in the midst of this confluence of internal and external changes that formulated Thailand's first long-term national development plan in 2015—the 20-Year National Strategy (2018-2037)—set out the three priorities of "Security, Prosperity, and Sustainability," and developed a series of ocean-related plans and policies. Regarding security, the main national-level plans are the National Maritime Security Plan 2015-2022; prosperity-related plans include the 12th National Economic and Social Development Plan 2017-2022; in matters of sustainability, programs include the Environmental Management Plan 2015-2021, the MONRE's Strategic Plan 2016-2021, and the Thailand's National Biodiversity Strategy and Action Plan 2015-2021 [7].

Major national marine laws were created and amended after 2015, such as the Royal Ordinance on Fisheries 2015, the Promotion of Marine and Coastal Resources Management Act 2015, the Navigation in Thai Waters Act 1913 (amended in 2017), and the National Marine Interest Act 2019 have been created and amended to extend the scope of enforcement of these laws relating to natural resources and the environment from the territorial sea. The National Marine Interest Act 2019 extends the scope of enforcement of these laws relating to natural resources and the environment from the territorial sea to the exclusive economic zone and even to cooperation on the high seas [8].

Through these plans and policies, the Thai government seeks to effectively integrate national efforts in various areas to address both traditional areas of maritime security (e.g., safeguarding maritime interests, peaceful uses of the sea, and maritime national security) and non-traditional areas of maritime security (e.g., balance and sustainability of marine resources and the environment, development of maritime human resources, knowledge and maritime awareness, and maritime governance) through participatory management [9].

The Ministry of Natural Resources and Environment and the Integrated Governance of Marine Affairs

Integrated management of marine affairs has a certain degree of difficulty. Save Indonesia, there is no single governmental body dedicated to integrated ocean affairs management among ASEAN countries, and Thailand is no exception. Therefore, the actual implementation of aforementioned plans and policies in government institutions are scattered across various ministries, including the Ministry of Agriculture and Cooperatives, the Ministry of Transportation, the Ministry of Energy, the Ministry of Defense, the Ministry of Tourism and Sports, the Ministry of Interior, the Department of Marine and Coastal Resources, and the Ministry of Natural Resources and Environment.

Recognizing that resource development must be coordinated with resource conservation, the Thai government established the Ministry of Natural Resources and Environment (MONRE) in 2003 to promote environmental conservation and inclusive development in Thailand. The vision of MONRE is "to return the natural environment to the Thai people and to work towards the incorporation of natural resources and the environment in the Government's national agenda as these provide the basis for social and economic development" [10]. MONRE supports the proactive integration of natural resources, environmental protection, and biodiversity administration based on the principles of public participation and good governance.

MONRE promotes five key strategies through a five-year strategic plan for 2016-2021: I. protect, conserve, restore, and manage natural resources in an integrated approach to ensure responsive development and allows for sustainable and equitable resource use; II. manage surface water and groundwater in an integrated and effective manner; III. maintain and restore the quality of the environment through participatory approaches; IV. prevent and reduce the impacts of natural disasters and climate change and to promote adaptation; V. improve the efficiency of organizational management and natural resource and environmental management [11]. Through a participatory approach, MONRE acts as a bridge to support community - private sector participation with the public sector, effectively promoting the restoration of mangroves in Thailand [12], increasing the coverage of Thailand's marine protected areas [13], and ensuring Thailand's remarkable position in sustainable marine development in Southeast Asia.

MONRE has established various divisions and offices to handle various activities, such as the Office of Natural Resources and Environmental Policy and Planning (ONEP), which is responsible for planning and policy development, environmental impact assessment, and establishment of environmental reserves; the Department of National Parks, Wildlife and Plant Conservation (DNP), which is responsible for managing marine parks; and the Department of Marine and Coastal Resources (DMCR), which is responsible for promoting mangroves, coral reefs, seagrasses, and endangered species in Thailand. The Department of Marine and Coastal Resources (DMCR) is the main agency responsible for promoting the sustainable management and protection of resources such as mangroves, coral reefs, seagrasses, and endangered marine species; and the Pollution Control Department (PCD) is responsible for setting coastal water quality standards, monitoring coastal waters, and establishing pollution control zones.

Therefore, MONRE is the main agency responsible for the management of natural resources and the environment in all types of marine and coastal areas. The DMCR can be described as the main unit responsible for marine and coastal affairs. However, the characteristics of marine and coastal resources management make it difficult for a single agency handle it alone. For example, the characteristics of coastal areas, where land and water meet, are particularly productive, but such terrain is where pollution and disasters occur most frequently. According to the United Nations, more than 80% of

marine pollution comes from land, including not only various manufacturing industries and coastal urban wastewater pollution, but also non-point pollution accumulated by fertilizers and excreta from various forest reclamation, farms, and aquaculture industries, which are beyond the jurisdiction of the DMCR.

Thailand marine protected areas (MPAs) serve as another example that illustrates this predicament. The Department of Marine and Coastal Resources must work with the Department of National Parks, Wildlife and Plant Conservation, Office of Natural Resources and Environmental Policy and Planning, and the interdepartmental Department of Fisheries (within the Ministry of Agriculture and Cooperatives), Department of Oceans (within the Ministry of Transportation), and the Department of Public Works and Town and Country Planning in making decisions about the establishment and maintenance of MPAs and marine national parks. The division of labor is coordinated between the Department of Fisheries (within the Ministry of Agriculture and Cooperatives), the Department of Oceans (within the Ministry of Transportation), and the Department of Public Works and Town and Country Planning (within the Ministry of the Interior).

To address the issue of horizontal coordination between the ministries, the Ministry of Natural Resources and the Environment has established the National Marine and Coastal Resources Committee (NMRC). The Committee is organized "under" the Department of Marine and Coastal Resources, but in practice it is chaired by the Prime Minister, with the Secretary of the Department of Marine and Coastal Resources solely acting as its secretary. The Committee has eight subcommittees, with nineteen representatives from relevant ministries and twelve independent academics and experts in the marine and coastal field, six of whom must come from the coastal community. Similar horizontal linkage committees chaired by the Prime Minister include the National Fisheries Committee (NOF) and agencies involved in maritime national defense and security issues, namely the National Maritime Interests Protection Committee (NMIPC) and the Maritime Law Enforcement Command Center (MLEC) of the Office of the National Security Council (ONSC), which is directly under the Prime Minister's Office [14].

Figure 2/ The marine and coastal issues require a cross-departmental and cross-regional integrative management mechanism. Thailand has established the Ministry of Natural Resources and Environment to undertake the vertical and horizontal liaising within the organization
Source/ https://www.tourismthailand.org/Attraction/hat-thang-sai

However, even though there are vertical and horizontal linkages, the policy of pushing the area of marine protected areas from the current 5% to 10% of the exclusive economic zone by 2030 is still under fierce debate. The main reason is that the issue involves at least three laws: the Marine National Act, administered by the Department of National Parks, Wildlife and Plant Conservation; the National Environmental Quality Act, administered by the Office of Natural Resources and Environmental Policy and Planning; and the Coastal Act, administered by the Department of Marine and Coastal Resources. The competition between these laws creates overlap or multiple enforcement, resulting in confusion and backlash from the underlying communities about what the laws allow and what they prohibit. This has also led to a continuing shortage of funding, ineffective management, and insufficient community (stakeholder) involvement in marine reserves [15]. Therefore, what Thailand's experience can offer Taiwan is that ocean and coastal issues require an integrated ocean and coastal management due to its interdepartmental and interdisciplinary characteristics. The Ocean Affairs Council (OAC), which is the highest authority for ocean affairs, should be the ideal institution to promote such an integrated management mechanism.

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Exploring Nansha
Get to Know the Diversity of Common Macroalgae

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Translated by Linguitronics
Keywords: Nansha Taiping Island, macroalgae, intertidal zone, species composition

Taiping Island, the largest natural island amongst the Nansha or Spratly Islands, is home to rich marine biological resources in the coral reefs of its nearby waters. The majority of current research focuses on fish and invertebrates while distribution data of macroalgae in the intertidal zone are sparse, making it imperative to establish relevant biological data. Surveys of macroalgae biota conducted in the surrounding shores can be utilized to understand the importance of a biological census; therefore, it is necessary to investigate native species of macroalgae at the island's shores. A research team from the National Academy of Marine Research (NAMR) gathered text and image data for macroalgae across three seasons, from July of 2021 to March and July of 2022. They successfully completed introductions for 80 common macroalgae species found in Nansha Taiping Island to raise interest and enhance knowledge on macroalgae among people who love to explore the oceans (Figure 1). On a deeper level, this allows better use and protection of the ocean by valuing precious marine resources and meeting the ideal of maintaining ecological balance in the ocean, as to ensure that the ecology in the natural island is protected and prospers.

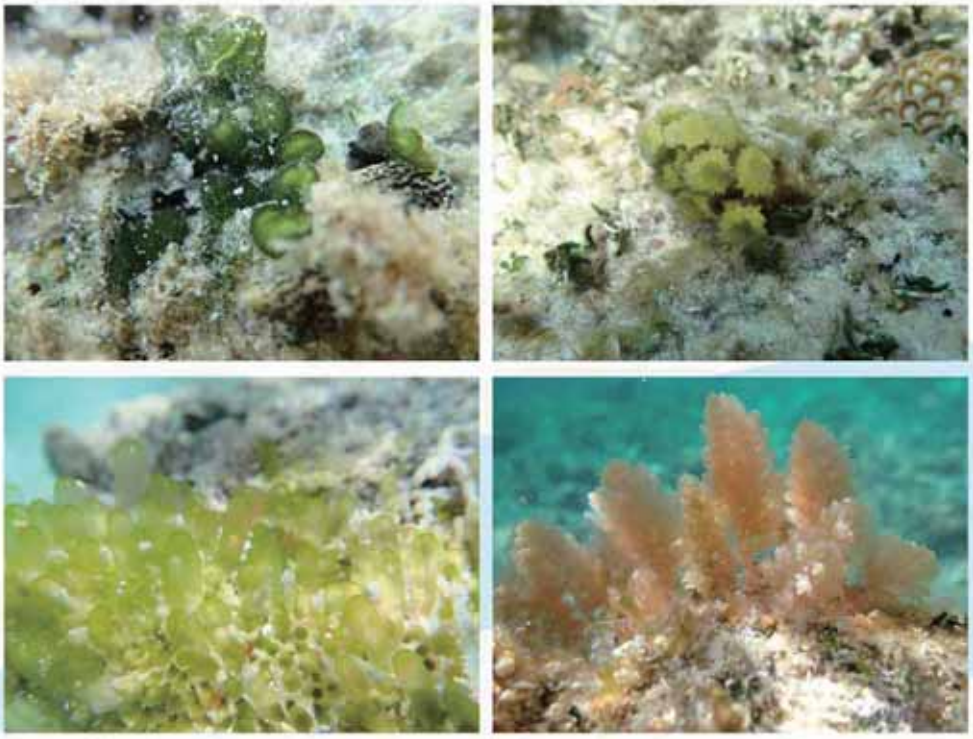

Figure 1/ Blue algae - *Brachytrichia quoyi* (upper left), Green algae - *Boergesenia forbesii* (lower left), Brown algae - *Turbinaria conoides* (upper right), Red algae - *Asparagopsis taxiformis* (lower right)
Images by Marine Ecology and Conservation Research Center, National Academy of Marine Research

Macroalgae play an important role as basal producers

Macroalgae are widely distributed in the photic zone below the intertidal zone. In addition to producing oxygen through photosynthesis, they possess a complex yet beautiful appearance and, while they differ greatly in color or size, it is difficult to distinguish among many species with the naked eye. The species composition of macroalgae has seasonal succession, in particular, and are crucially characterized by rapid growth or short life cycles only affected by changes in topography, substrate, sea temperature, light, and nutrients. They are viewed as the most critical primary producer of the marine food chain and provide good habitats and food sources for algae-eating fish, shrimp, crabs, and other marine animals; they are also used as substrate for spawning and hatching eggs as they provide a safe and excellent environment for breeding and sheltering larvae. In terms of balancing marine ecosystems, they have a stabilizing function and can delay the greenhouse effect, thereby affecting the conservation of the ocean's fishery resources as well as producing key effects such as purifying water and maintaining biodiversity in marine ecosystems. They play a decisive role in protecting marine ecology.

Explore the Coastline Around Nansha

The geographic location of Nansha Taiping Island consists of a key island topography located in the Nansha or Spratly Islands. The island is surrounded by the ocean on all sides and has an area of approximately 0.51 square kilometers, with a length of 1,360 meters, width of 350 meters, and a coastline of 2,850 meters. The island's beach terrain coastline is surrounded by an intertidal zone and topography formed by the superposition of extensive coral reefs. It is chiefly characterized by sufficient light and a fixed tide cycle that repeats daily. The alternating rise and fall of tides exposes sand to the air which erodes with seawater, forming a rolling wave-shaped coastline around the island. The frequent flow and disturbance of sand results in a beach terrain prone to change and coral reef plates that are often covered by sand; therefore, marine life settled in this habitat is difficult to identify. The island's superior geographical location hides a bounty of fishery resources and marine biological diversity. The rich ecological resources, intactly preserved undersea forests, and coastline that serves as gathering place for typical coral fish are all aspects that make it a focus of research in marine ecology and conservation.

I. Intertidal Zone Distribution

Macroalgae are commonly found in the intertidal zone at Nansha Taiping Island's coastline, where the substrate consists of coral reef plates (Figure 2). The width and area of both shallow and deep parts of the coastline are not uniform while the substrate can be further categorized into 4 zones in the order of the coral sand zone, reef zone, reef platform zone, and coral fringe zone. As one travels further from the coastline, the species of macroalgae become more abundant and diverse.

- Due east and due west: Wider intertidal zone with width of approximately 400-500 meters.
- Northwest and due north: Wide to medium intertidal zone with width of approximately 300-350 meters.
- Due south and southeast: Narrower intertidal zone with width of approximately 150-200 meters.

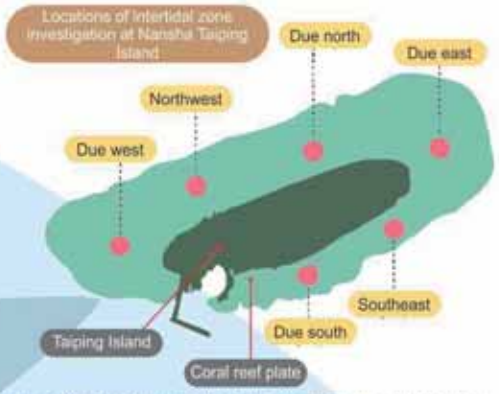

Figure 2/ Locations of intertidal zone investigation at Nansha Taiping Island
Image by NAMR

II. Hydrological Information Search

The ideal timing for investigating macroalgae or gathering samples at Nansha Taiping Island is during major low tides. First, the month, date, and time of low tides must be ascertained. Special attention must be paid to changes in sea current or weather before going into the water. Thunderstorms are momentous as they are a major deterrent for snorkeling or scuba diving investigations. To view daily changes in sea current and tide forecasts, a smartphone or computer can be used to visit the National Ocean Database and Sharing System (NODASS) established by NAMR in 2022. It offers a comprehensive marine database and allows for full utilization of marine data and information services to search for hydrological information and stay updated on changes in various sea areas (URL: https://nodass.namr.gov.tw/).

III. Timing for Exploring the Intertidal Zone

The Nansha Islands are located in a tropical marine climate zone prone to typhoons during summer. Due to southwesterly flows, the ocean water is often mixed with fine sand that causes turbidity and indirectly results in harsh conditions in the nearby seas. The poor visibility makes investigation via scuba diving extremely challenging. The opposite is true in spring as sea conditions stabilize and clearer waters allow for excellent visibility, making it the optimal time to study macroalgae species underwater.

Gathering Information on the Species Composition of Macroalgae in Nansha

I. Identification Method and Data Analysis

According to the ecological research method proposed in the 2020 NAMR report Overall Plan to Establish Marine Ecological Survey and Monitoring Network and Standards in Taiwan, it is necessary to utilize waterproof digital cameras to take vertical or micro distance photos of macroalgae to record their color and appearance as well as confirm the species of algae within the frame in order to effectively utilize the limited time available during major low tides. All of the digital photographs taken are stored inside a computer and compared to the algae habitats and descriptions from macroalgae books to establish a catalog and gather information on these species.

II. Statistical Results

Over the past 2 years, NAMR's research team has studied the composition of macroalgae species in Nansha, with quarterly surveys conducted in July of 2021 as well as March and July of 2022. The resulting numbers of macroalgae species identified in 6 sample areas of Nansha Taiping Island's intertidal zone during 3 separate seasons were 76 species in 40 families and 4 phylum, 60 species in

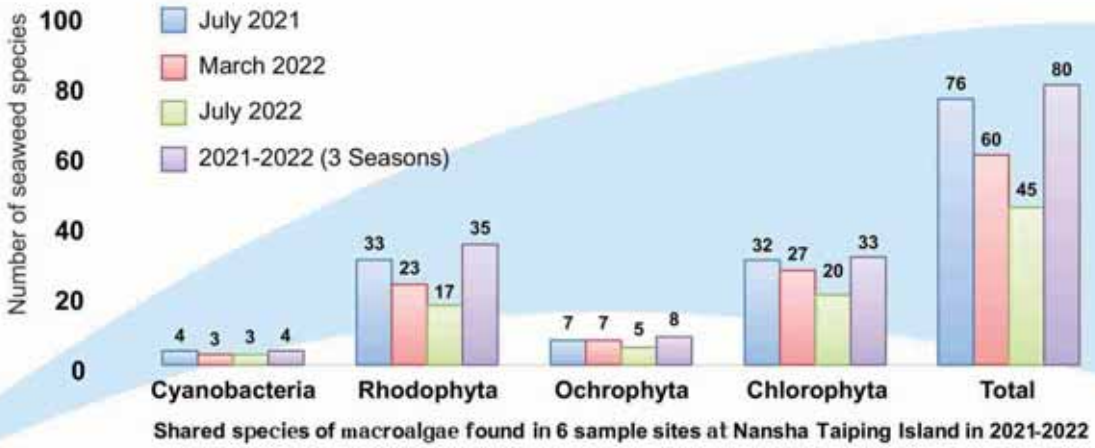

Figure 3/ Shared species of macroalgae found in 6 sample sites at Nansha Taiping Island in 2021-2022
Image by Marine Ecology and Conservation Research Center, National Academy of Marine Research

36 families and 4 phylum, and 45 species in 24 families and 4 phylum, respectively. Statistical analysis was performed on all of the data to analyze shared species, finding a total of 80 species in 40 families and 4 phylum (Figure 3). The results of this survey provide a more comprehensive understanding of macroalgae distribution in all zones and can be used in research of marine ecology and conservation.

Exploring Common Macroalgae Species in Nansha Taiping Island

I. Science Textbook of Macroalgae

NAMR's research team compiled a macroalgae species catalog in 2021 and 2022. Due to the challenges of marine transportation and restrictions to the return time of vessels, the research team grasped the rare opportunity to visit Nansha on two trips. They brought their investigation tools during good weather in the morning and afternoon and used underwater diving masks to observe underwater ecological environments. They snorkeled around the island's intertidal zone and recorded macroalgae species composition with waterproof digital cameras, samples, measurements, and photos. They completed the text and introductions for 80 common macroalgae species (Figure 4); the book is titled 80 Seaweeds of Taiping Island, Nansha Islands to meet the requirements of marine education and this scientific topic [1]. The book is a biological compilation of 233 types of macroalgae recorded in Nansha Taiping Island from 1981 to 2022. The 80 species of macroalgae investigated by NAMR's research team are introduced in the book in hopes of offering the public a further understanding of the macroalgae found in Taiping Island.

Figure 4/ 80 Seaweeds of Taiping Island, Nansha Islands
Image by NAMR

II. 4 Major Families of Macroalgae

Today, the taxonomy of macroalgae is constantly being updated and the website Algaebase [2] is essential to search for each species or every biota in taxonomic rank to conform with academic correctness. The 4 current major families of macroalgae are blue algae (Cyanobacteria), red algae (Rhodophyta), brown algae (Ochrophyta), and green algae (Chlorophyta). In summary, when describing the species of macroalgae observed in the intertidal zone of Nansha Taiping Island starting from those closest to the shore: Cyanobacteria are the most primitive organisms and simplest algae. They are primarily cyan in color and capable of enduring dryer and hotter habitats with most growing in high tide zones. Chlorophyta have the largest number of species, appear green in color, and prefer strong light. They're often exposed to the air during low tide, settle in more drought resistant environments, and are mostly distributed in the supratidal zone. Ochrophyta are

either brown or light yellow in color and mainly grow around the mid tidal zone and low tides. And Rhodophyta are commonly red or purple in appearance and do not like strong light. They prefer low light and are often found near low tides or below the subtidal zone (Figure 5).

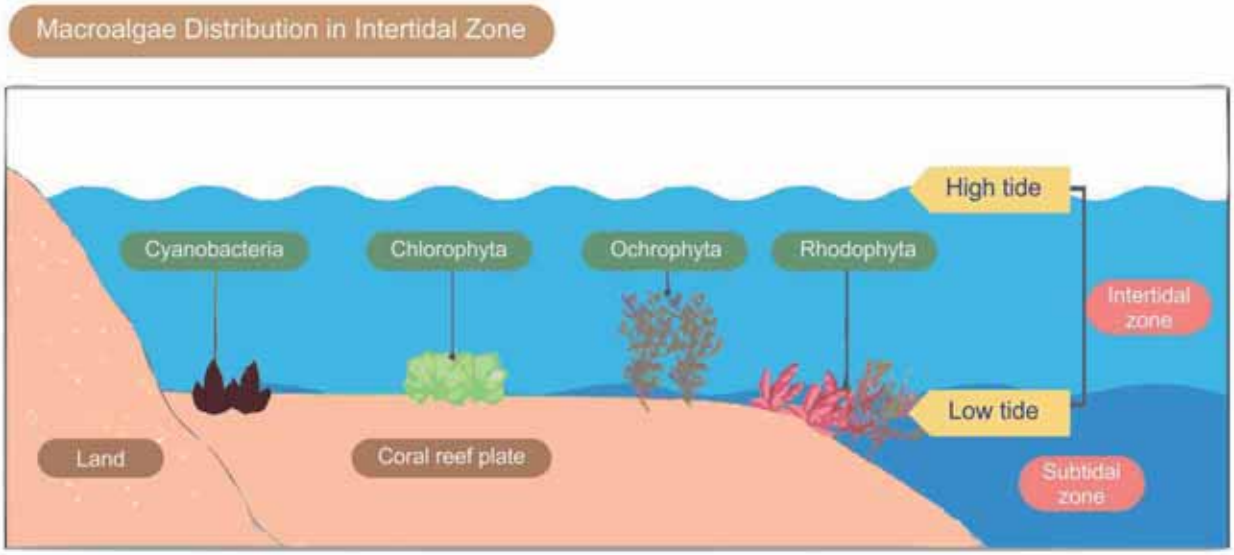

Figure 5/ Macroalgae Distribution in Intertidal Zone
Image by NAMR

Prospect

NAMR's research team studied Nansha Taiping Island in 2021 and 2022, making a list of macroalgae species sampled from 6 sites within the intertidal zone and accumulated species composition data across 3 seasons. After measuring the hydrological data of the 6 sample sites using scientific instruments, it was found that Nansha's seawater temperature is mainly between 25-30℃. The daily changes of tides and susceptibility to the strength or weakness of natural light causes macroalgae species to grow and reproduce in their habitat unstably. During the investigation, samples of native macroalgae species were taken to develop simple tissue culture techniques and temporarily preserve these species at Nansha Marine Station before transporting them back to NAMR's Germplasm bank. This reduces the extinction risk of native species and opens future opportunities to combine artificial seedling preservation and habitat restoration, utilizing Nansha Taiping Island's unique tropical marine climate to perform phasic preservation of seedlings for transport and placement, as to meet the needs of in situ and ex situ conservation. In the future, they can be utilized to develop marine education and other popular science related knowledge.

- Biological Information: Establish an annual list of native species in the habitat and provide sustainable data on the biodiversity of macroalgae.
- Seed Conservation Technology: Develop macroalgae seedling culture and seed conservation technology to achieve the sustainable use of restoration resources.

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Waste Management and Measures in Thailand

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Keywords: Thailand, waste, management and measures

The growth of global human population, associated with economic development and commercial consumption, has resulted in an accumulating un-negligible problem on waste management and consequently the marine pollution. Thailand, like many other developing countries, shows an increasing trend in the urbanization and rapid growth of economic condition and human population, but also faces a challenge in significant increase of waste generation, especially for the plastic waste production. It is estimated that annual amount of solid waste could double from the current levels by 2025 [1-3]. In Thailand or other Asian countries, any urban services or community activities, such as households, business enterprises, commercial markets, institutional facilities, construction, and municipal services, may generate solid waste. Similar with other developing countries, the waste is composed of a large proportion near 50% of organic materials, e.g., food waste, followed by paper, plastic, clothes, wood, rubber, leather, glass, and other solid forms of waste. However, it does not include hazardous and infectious waste or sewage in definition [3][4].

Waste generation and management

Along with increasing economic development and growth, the waste generation in Thailand is increasing as seen with the global trends. The increasing rate of waste volume is predicted to be 2% annually [5]. Although this is considered a small percentage, a large amount of waste leaking into the environment and plastic waste easily observed in the rivers and marine environment can still cause environmental concerns due to limited landfill space. Approximately more than 20% to 45% of the waste was generated from the Bangkok metropolitan area, about 30% from other municipality areas, and less than 40% from outside the municipality areas [5][6]. Studies show that the plastic usage in Thailand has increased by 7-8% per year. In average, every individual produces eight bags per day, which generates around 200 billion bags each year [7][8]. The plastic waste is regarded as hard to dissolved and definitely causes substantial pressure to the territorial and marine environment.

The waste in Thailand and most Asian countries is composed of highly biodegradable organic materials, of which a large proportion, larger than 50% in average, is high moisture content, such as common seen food waste. The component of waste in wet mass basis can reach up to 70% in some provinces of Thailand, for example Samutprakarn and Pattaya [9]. According to previous studies, the waste composition in Bangkok and other selected municipalities in Thailand varies substantially. In general, the solid waste is dominated by food waste; however, the proportions of paper and plastic waste range from 4-25% and 4-28%, respectively, among these cities and areas. This could be highly relating to the consumer patterns, lifestyle, and economic status [6]. For example, the high commercial and economic activities in Bangkok area lead to a 1.5 kg waste generation rate per person per day in average. In contrast, the waste generation rate in other municipalities such as Nonthaburi and Angthong is about 0.6 kg per person per day, less than half of that in Bangkok area. However, compared to Bangkok and other urban cities, every person could produce up to 5 kg waste in average per day in popular tourist areas in Thailand, such as Patong beach in Phuket [1]. The solid waste and plastic waste generated in tourist hotspot areas is higher than that produced by local resident populations, suggesting that the increase of waste could highly relate to commercial activities.

According there is no survey or relevant information to distinguish the origin of solid waste or plastic waste in the tourist hotspot areas, a research report shows that plastic content accounting for about 17% of the total solid waste in popular tourist areas or other adjacent districts, based on the analysis conducted by the Pollution Control Department (PCD) of Thailand. In the tourist hotspot areas, most plastic waste can be collected and recycling used. It is estimated that only 10% of the plastic waste remains uncollected after the consumer end, which generates about 10,000 tons of plastic waste per year [1]. Open burning is an easy and relatively cheap way to reduce the volume of uncollected plastic waste in Thailand. People usually handle the waste via open burning. Except for disposal on land, more than 90% of uncollected plastic waste is primarily openly burned [1].

Waste recycling and reuse

Because of the low cost of plastic products, Thailand is the highest plastic consumer per capita in Asia. In average, every individual in Thailand consumes 40 kg of plastic products in a year. Most of the products are plastic bags, of which retail and convenience stores can consume 60% of plastic bags and market vendors use the remaining 40% [10]. Studies showed that the waste management system in Thailand may be ineffective; approximately 80% of plastic waste belongs to land-based origin, which is transported through rivers, runoff, beach visitors, and drainage systems, into the ocean. This is not even including illegal dumping and uncollected plastic waste. The rest 20% of marine plastic waste comes from ocean fishing, aquaculture, and other activities [11]. Unlike Japan who produces high amount of plastic products, their successful waste management system has kept plastic waste hard to discharge into the marine environment [12].

Reusing and recycling activities have been encouraged actively by the Thailand government recently, which resulted in a substantial reduction of the waste. For example, the population in Bangkok increased year by year, but the quantity of waste decreased continually, which could be attributable to the reusing and recycling activities [6]. Therefore, the Thailand government encourages recycling activities in municipalities where solid waste generation rate is high or in the large municipalities such as Bangkok and other adjacent regions; their recycling activities should be maintained for improving recycling efficiency and reduction of the waste generation. More than 1.5 million tons of waste is recycled each year, accounting for more than 10% of the total waste generated. However, there are more than 4.5 million tons of commercially recyclable materials discarded in Thailand every year. In particular, approximately 60% of high potential recyclables, such as metals, paper, plastic, and glass, which can be potentially recycled and reused in various commercially manufacturing and industrial activities, are currently discarded [12].

The plastic consumption in Thailand began from 1970s and rapidly increased along with the worldwide trend of single-use plastic bags, which causes serious problems in marine plastic pollution in the following 20-30 years. Due to the transboundary risk to the ocean, marine plastic pollution seriously threatens marine wildlife and coastal ecosystems, and even more the health and livelihoods of the people living along the coast [13]. Although the majority of plastic packaging is directly sent to waste sites, research data showed that only 15-25% of the plastic waste was recycled in Thailand [14]. Most plastic is used for packaging, cans, boxes, tools, containers, equipment, and so on, which requires a long time to dispose the plastic. Therefore, reuse or changing the packaging may be the best suitable and efficient way to handle the plastic products.

Action plan and roadmap

The National Action Plan and Roadmap on plastic waste management was launched by the Thailand government to serve as a framework and direction for preventing and managing plastic waste. The main measures in the action plan include the reduction of plastic waste at sources,

reduction of single-use plastic products at consumption process, and plastic waste management post the consumption [1]. Meanwhile the Thailand government plans to improve waste collection in urban areas and develop an efficient waste collection system in rural areas, as well as well-managed disposal facilities including open dumpsites and controlled dumps [15]. On the 3R (reduce, reuse, and recycle) principle, the government first strengthens the concept of circular economy and develops responsible production and consumption.

As for the current stage, effective policy and management include the city-wide clean-up measures just before the start of the rainy season to reduce land-based marine pollution, as well as the improvement to integrate laws and regulations for supporting the implementation of measures [15]. The timeline of the roadmap can be divided into three phases. The aim of the first and second phases before 2022 is to stop using hard-degradable plastics such as foam food containers, plastic straws, and plastic bags and cups. The goal of the third phase is to 100% recycle targeted plastic wastes by 2027 to accomplish the conservation concept of circular economy and plastic reduction [15]. The action plan provides essential base to develop the roadmap of waste management in Thailand.

Figure/ The plastic waste is regarded as hard to dissolved and definitely causes substantial pressure to the territorial and marine environment
Image by Pride Advertising Agency Ltd.

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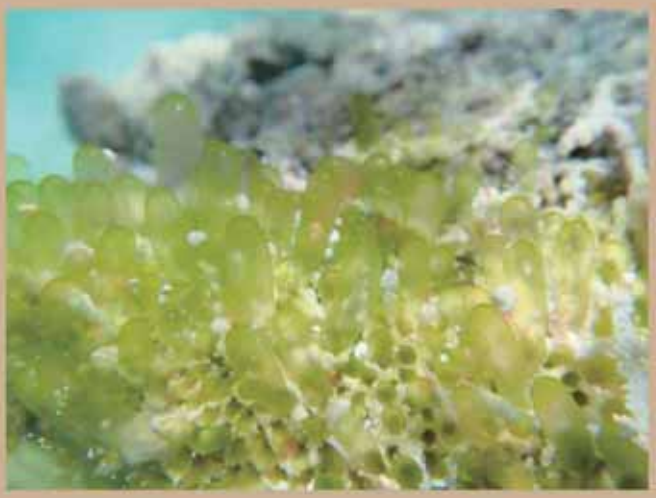

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