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Adaptation to Climate Change in the Ocean and Coastal Areas

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1. Introduction

The oceans cover 70% of the Earth's surface and play an important role in stabilizing the climate system by absorbing much of the heat energy stored in the global atmosphere. In recent years, however, scientific evidence has begun to show that the marine environment is heading toward an unprecedented state of crisis in the face of climate change-induced warming, oxygen deficiency, and other changes. According to the Intergovernmental Panel on Climate Change's (IPCC) 2019 Special Report on the Ocean and Cryosphere in a Changing Climate[1], it is almost certain that the world's oceans have been warming for the past 50 years, and since the early 1990s have warmed almost twice as fast as before. Ocean warming and associated environmental changes are expected to continue this century, increasing the risk of more severe typhoons and coastal hazards, such as storm surges. Coastal populations, whose livelihoods are closely tied to the ocean, are vulnerable to the effects of climate change and are in urgent need of adaptation measures. Japan, which is surrounded by the sea and has a long coastline and many remote islands, is no exception.

However, the impacts of climate change are multisectoral, meaning there are multiple fields involved when considering adapting the ocean and coastal areas to climate change. This may be the reason why information on climate change adaptation in Japan's ocean policy is scattered, as the government agencies responsible for each sector are promoting efforts individually. Given this situation, it would be useful to have a comprehensive view of the concept of climate change adaptation in regards to the ocean and coastal areas. However, few existing literature organizes and classifies this information, nor is there a clear method to do so in Japan. Therefore, this paper provides an overview of climate change adaptation with a focus on the ocean and coastal areas, describes the current status of climate change adaptation of the ocean and coastal areas in Japan, and proposes future directions for domestic policies.

[1] IPCC. (2019). Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)].

2. Oceans and Adaptation to Climate Change

Concerns about the impacts of climate change have been recognized since the international community first began discussing climate change, with the 1992 United Nations Framework Convention on Climate Change (UNFCCC) calling for the protection of coastal and marine ecosystems and adaptation through coastal zone management. However, the link between oceans and climate change has not been a subject of the formal negotiation process, but rather a civil society-led effort to promote understanding of its importance. The preamble to the Paris Agreement reached in 2015 includes a commitment to the importance of ecosystems, including marine ecosystems, which marked a turning point and gradually raised the profile of oceans in the official framework. The accumulation of scientific knowledge on climate change and oceans through the IPCC Special Report on the Ocean and Cryosphere, adopted in 2019, accelerated this trend, and the 25th Conference of the Parties (COP25) in Madrid, Spain, in 2019, known as the "Blue COP," brought special attention to how climate change affects the oceans. The COP decision was the most important outcome of COP25, followed in 2020 by the first formal meeting on oceans under the UNFCCC, the "Ocean and Climate Change Dialogue." International efforts on oceans and climate change have also played an important role in this development, including the informal "Because the Ocean" group established at COP21 in 2015 and the "Oceans Pathway" initiative focused on signatory nations that was launched under the leadership of the Fiji Presidency at COP23 in 2017[2].

Internationally, the debate on oceans and climate change has focused on the oceans as a mitigation measure, including reducing emissions from the shipping sector, promoting marine renewable energy, and protecting the oceans and marine ecosystems as sinks (blue carbon ecosystems)[3]. Regarding adaptation measures, at the 50th meeting of the subsidiary bodies (SB50) in 2019, "oceans, coastal zones and ecosystems" was identified as one of the priority issues of the Nairobi Work Programme (NWP), which aims to disseminate and develop information and knowledge on adaptation. Under the NWP, the promotion of adaptation measures in the marine sector has just started in earnest with the launch of an expert group to consolidate knowledge and facilitate information sharing.

In recent years, extreme weather events such as large typhoons and heavy rains have caused large-scale disasters in Japan each year, and concerns about the effects of climate change have grown. In 2018, Typhoon Jebi caused major coastal disasters, mainly in the Kinki region, including storm surge damage to ports and harbors (drifting of ships and containers and flooding of power supply facilities) and flooding of urban areas such as

[2] Mai Fujii. (2020). Oceans in the United Nations Framework Convention on Climate Change. Ocean Perspectives, No. 9 [2020]. Ocean Policy Research Institute, Sasakawa Peace Foundation.
[3] Hoegh-Guldberg, O., Lovelock, C., Caldeira, K., Howard, J., Chopin, T., & Gaines, S. (2019). The ocean as a solution to climate change: Five opportunities for action. Available at: https://www.eenews.net/assets/2020/01/14/document_gw_04.pdf

artificial islands and landfills[4]. In recent memory, the July 2020 heavy rains caused widespread damage in many areas, including more than 200 deaths and damage to homes. According to the 2020 edition of the Global Climate Risk Index[5], published annually by the environmental NGO German Watch, Japan is the country most affected by weather-related disasters out of 183 countries worldwide[6]. In addition to coastal hazards, rising sea temperatures and ocean acidification due to global warming could have significant impacts on the distribution, diversity, and function of marine life and could have serious implications for Japanese society, including local industries such as fisheries and tourism[7].

Thus, it can be said that Japan's awareness of the effects of climate change is gradually increasing. In June 2020, the Ministry of the Environment (MOE) issued a "Climate Emergency Declaration," and the 2020 Environment White Paper approved by the Cabinet on the same day also included the term "climate emergency" for the first time. In October 2020, the Suga government announced a goal of "achieving net-zero greenhouse gas emissions by 2050." In December of the same year, the Ministry of Economy, Trade and Industry (METI) formulated the "Green Growth Strategy through Achieving Carbon Neutrality in 2050," which is expected to rapidly accelerate domestic actions to reduce greenhouse gas emissions. In the meantime, however, the increase in risks and losses can only be stopped by improving impact assessments of climate change on the ocean and coastal areas and simultaneously implementing adaptation measures based on these projections.

3. Climate Change Adaptation in Japan's Ocean Policy

Climate change adaptation in Japan is driven by the Climate Change Adaptation Act, which came into force in 2018. The areas related to climate change impacts and adaptation are diverse and must take into account the risks in all sectors and aspects of human society. Ocean and coastal adaptation measures are required in various sectors such as fisheries and ports. Therefore, in Japan, various ministries and agencies are promoting adaptation measures within their jurisdictions. For example, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has been discussing port and coastal management in its "Committee for the Study of Coastal Conservation in Light of Climate Change" (since 2019). On the other hand, the Ministry of Agriculture, Forestry and Fisheries (MAFF) is in charge of

[4] Coastal Engineering Committee, Japan Society of Civil Engineers. (2018). Report on the coastal hazard investigation of Typhoon Jebi 2018. JSCE Journal vol. 103 No. 12 Available at: http://jsce.or.jp/journal/jikosaigai/201812.pdf

[5]The 2020 Climate Risk Index is calculated by ranking countries and regions based on the number of deaths from weather-related disasters in 2018, the number of deaths per 100,000 people, economic losses, and economic losses as a percentage of gross domestic product (GDP), and then multiplying the ranked numbers by the set weightings for each category and then adding those numbers together.

[6] Eckstein, D., Künzel, V., Schäfer, L., Winges, M. (2020). *Global Climate Risk Index 2020,* German Watch. Available at: https://germanwatch.org/en/17307

[7] Masahiko Fujii. (2020). Effects of Ocean Warming and Acidification on Marine Ecosystem and Societies in Japanese Coasts. *Journal of Fisheries Engineering*, 56(3), 191-195.

fisheries adaptation and the Ministry of Environment (MOE) is in charge of ecosystem adaptation, meaning that the efforts are currently divided by sector. However, in order to promote cross-sectoral cooperation among related agencies, the Liaison Conference of Climate Change Adaptation Research Institutions was established in March 2020 under the Climate Change Adaptation Act, and the integration of scientific knowledge in Japan is being promoted.

(1) Climate change adaptation in Japan's ocean policy

Japan's ocean policy is based on the Basic Act on Ocean Policy and the Basic Plan on Ocean Policy. The Basic Plan on Ocean Policy is reviewed approximately every five years, and the most recent version is the Third Basic Plan on Ocean Policy, which was established in 2018. As part of maritime security (securing national interests within Japan's territorial waters, etc.), the plan states, "To prepare for increased disaster risks due to climate change, such as abnormal increases in storm surges, stronger waves and sea level rise, adaptation measures should be studied for land conservation in coastal areas." noting that MLIT and MAFF should take the initiative in this regard. In addition, in line with the policy to preserve and protect the marine environment, MOE and MAFF should "promote the establishment of marine protected areas, … omitted … taking into account their importance as measures to adapt to the effects of climate change." It also mentions adaptation measures implemented to restore coral reef ecosystems and to address climate change and ocean acidification. The report also mentions "research and development for climate change prediction and adaptation" as one of the important issues that the government should address in research and development in marine research and marine science and technology and recommends the accumulation of knowledge and the expansion of information infrastructure to review climate change adaptation plans. The annual report, "State of the Ocean and Measures Taken for the Ocean" published by the Cabinet Office's Bureau for the Promotion of Integrated Ocean Policy, describes the efforts made by various ministries and agencies to promote these policies and should be referred to.[8]

(2) Oceans and coastal zones in Japan's National Adaptation Plans

On the other hand, the government's overall adaptation plan, the National Plan for Adaptation to the Impacts of Climate Change, also contains some references to the marine environment. In particular, Part 2, Basic Directions for Measures in Each Sector, refers to the "fisheries" sector, which is not directly addressed in the Basic Plan on Ocean Policy in

[8] Cabinet Office. (2020). Situation of the Oceans and the Implemented Measures with Regard of the Oceans, 2020. p66-68 https://www8.cao.go.jp/ocean/info/annual/r2_annual/pdf/r2_annual_print.pdf

terms of climate change impacts. In addition, it describes adaptation for “coastal ecosystems” and “marine ecosystems”, which is also more detailed than in the Basic Plan on Ocean Policy. In coastal areas, basic measures for adaptation to natural disasters such as storm surges and tides are proposed for ports, coasts, fishing ports, fishing villages, coastal disaster prevention forests, in addition to promotion of research and technology development. In addition, basic measures for monitoring ocean acidification, etc. are listed as “improving scientific knowledge through monitoring and its utilization,” which is similar to the Basic Plan on Ocean Policy.

(3) Climate change adaptation in different sectors

In addition to these, government agencies responsible for various sectors are considering and implementing measures related to adaptation to climate change in the ocean and coastal areas. Based on the measures considered under these policies, this paper summarizes the impacts of climate change and adaptation measures in four sectors: (1) fisheries industry, (2) ports and coasts, (3) marine and coastal ecosystems, and (4) people's livelihoods.

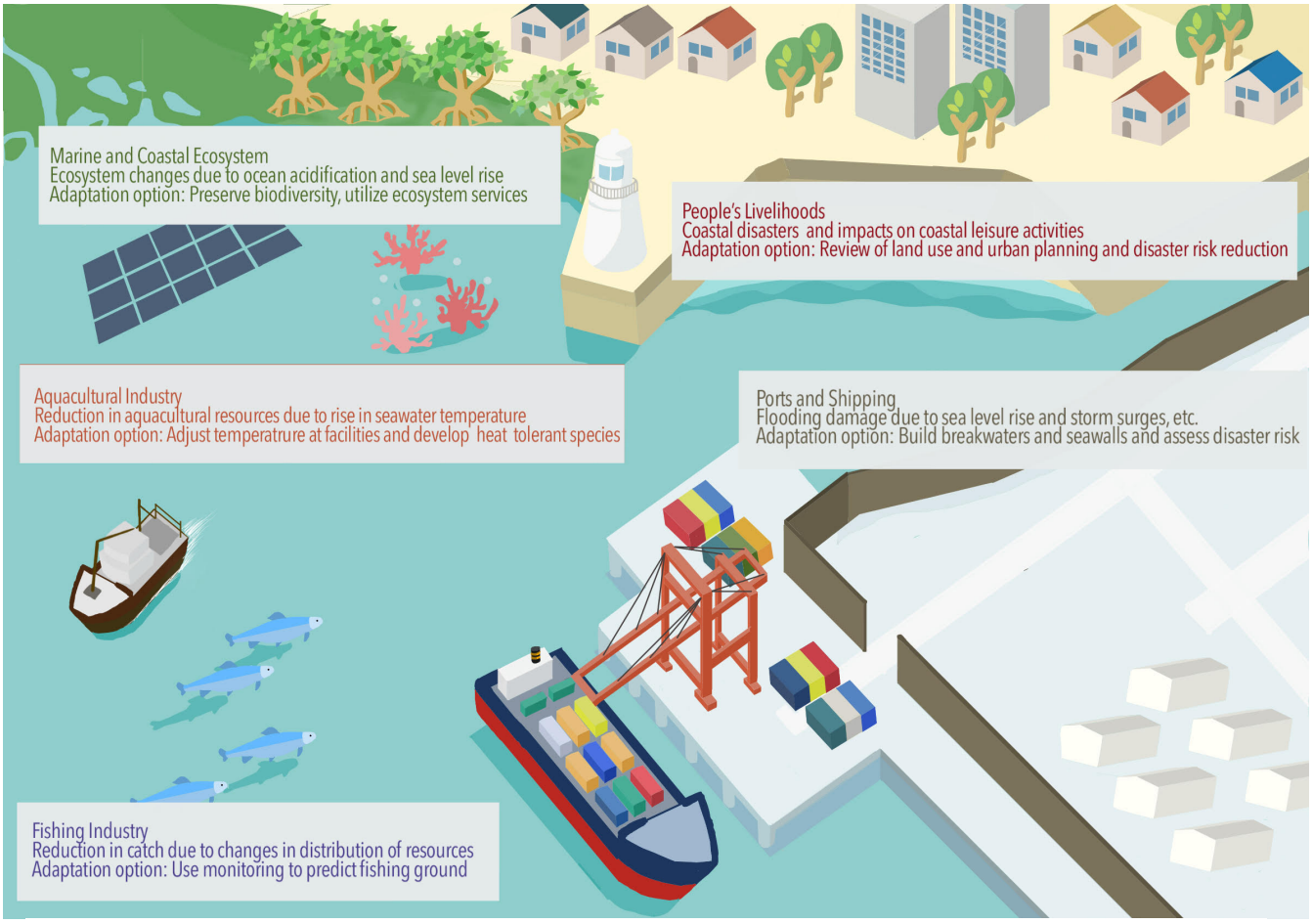

Figure 1: Examples of climate change impacts and adaptation measures in the ocean and coastal areas (prepared by the authors)

(i) Fisheries

Regarding the impact of climate change on Japanese fisheries, the reduction of fish catch and aquaculture resources has become a major issue. In the survey "Awareness and Intention Survey on Food, Agriculture and Fisheries" conducted by MAFF in 2019, 37.5% of respondents answered that "changes in the marine environment due to climate change (global changes such as global warming, acidification, etc.)" "had the greatest negative impact on the promotion of fisheries during the Heisei period (1989 to 2019)[9]. Recent studies have shown that the increase in seawater temperature has caused changes in habitat distribution and migration areas, such as the northward shift of southern fish species, even in Japan. For example, localized declines in catches of winter yellowtail and squid[10], the occurrence of warm-sea harmful plankton causing red tides[11], and damage to clam reproduction due to the expanded distribution of southern fish species such as longheaded eagle ray[12] have been reported. The rise in seawater temperature has also had a direct negative impact on aquaculture, with reports of massive scallop mortality, increased oyster mortality, and changes in production[13].

Climate change adaptation in fisheries is addressed in Section 2, Paragraph 3 of MAFF's Climate Change Adaptation Plan "Fisheries Resources, Fisheries, Fishing Ports, etc." published in 2018. In the area of mariculture, the plan includes understanding and predicting the amount of resources under environmental changes, improving the accuracy and efficiency of fishing ground predictions, collecting data on fish species that require resource management through international efforts such as tuna, and establishing a real-time monitoring system through the use of satellite information and various coastal observation information. In the field of mariculture, there are calls for technology development, including the development of countermeasures against tropical and subtropical plankton that cause red tides, the development of culture materials that are resistant to higher water temperatures, and countermeasures against new fish diseases. The plan also mentions the development of efficient ways to catch and utilize southern fish species that cause food damage, and the development of high value-added technologies that contribute to regional development. The plan also outlines adaptation measures for fishing communities, such as raising breakwaters and other fishing port facilities, and

[9] Fisheries.Agency (2019). White Paper on Fisheries in 2019, p 70
[10] Hideaki Kidokoro (2019). Impacts of climate change on migratory fish and shellfish and adaptation of Japanese fisheries. *Proceedings of the Annual Meeting of the Japanese Society of Fisheries Engineering* (pp. 153-154).
[11] Shimada, H., Kanamori, M., Yoshida, H. & Imai, I. (2016). First record of red tide due to the harmful dinoflagellate Karenia mikimotoi in Hakodate Bay, southern Hokkaido, in autumn 2015 NIPPON SUISAN GAKKASHI 82(6), 934-938.
[12] Miura H, Ito Y, Kawano D & Nakanishi G. (2020). Development of Fishing Grounds in Response to Climate Change. *Journal of Fisheries Engineering*, 56(3), 185-190.
[13] Ministry of Environment. (2020). Climate Change Impact Assessment Report.

recommends systematically developing coastal protection facilities to take into account climate change impacts.

(ii) Marine and coastal ecosystems

There are reports of changes in marine life and coastal ecosystems in many areas of Japan due to climate change[14]. Rising sea temperatures and feeding damage by algae-eating organisms have led to a decrease in seagrass beds, while rising sea levels have reportedly reduced the area of tidal flats. Ocean acidification, caused by an increase in dissolved carbon dioxide in seawater, is feared to lead to the bleaching of coral reefs and a reduction in the size of shellfish and crustaceans in the future. Observations by the Japan Meteorological Agency (JMA) indicate that ocean acidification in the waters around Japan is developing at a rate similar to the global average[15]. If this continues, adverse effects on marine life such as corals, sea urchins and shellfish are expected[13]. On the other hand, it should be noted that protecting ecosystems themselves is also an adaptation measure. Mangroves and seagrasses can reduce the impact of waves and currents, thus reducing coastal erosion[16]. Coral reefs are also known to act as natural breakwaters, preventing flooding and erosion caused by typhoon waves and tsunamis[17]. Thus, one of the negative effects of climate change is the degradation of the green infrastructure functions of these ecosystems (also known as Eco-DRR, which has received [18]much attention in recent years).

MOE is leading the development of measures to conserve these ecosystems, and the National Plan for Adaptation to the Impacts of Climate Change encourages the assessment of climate change impacts on tidal flats, saline wetlands, kelp beds and coral reefs, which are particularly vulnerable[19]. The plan also recommends that the projected impacts of climate change should be taken into account in existing measures to protect biodiversity, such as the review and proper management of protected areas in national parks, control of invasive alien species and waterside measures, and the conservation and propagation of rare species. MOE is promoting these measures in the Action Plan to Conserve Coral Reef Ecosystems (2016) and the Guidelines for Adaptation to Climate Change in National Parks and Other Protected Areas (2019)[20]. The Regional Climate Change Adaptation Planning

[14] Mimura N & Yokoki H. (2005). Impacts of Sea−Level Rise on Coastal Physical and Ecological Systems : Prediction and Response. *Bulletin on Coastal Oceanography*, 42(2), 119-124.
[15] Japan Meteorological Agency. (2021). Ocean Acidification is Progressing in Waters Around Japan. Press Release
[16] Kuwae and Tanaya. (2017). "Mitigation and Adaptation to Climate Change through the Use of Marine Ecosystems," *Journal of the Japan Institute of Marine Engineering*, Vol. 52, No. 6.
[17] Ferrario, F., Beck, M. W., Storlazzi, C. D., Micheli, F., Shepard, C. C., & Airoldi, L. (2014). The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. Nature communications, 5(1), 1-9.
[18] Ayumi Onuma. (2018). How should we expand ecosystem-based disaster risk reduction (Eco-DRR)? Green infrastructure in the Fifth National Basic Environment Plan: its economic characteristics and significance for sustainable society formation. *Review of Environmental Economics and Policy Studies*, 11(2), 61-64.
[19] Ministry of Environment. (2018). National Plan for Adaptation to the Impacts of Climate Change.
[20] Ministry of Environment. (2016). Ecosystem Conservation Action Plan 2016-2020 to Protect the Bounty of Coral Reefs.

Manual[21] developed by MOE promotes regional impact assessments based on the areas covered by the Climate Change Impact Assessment Report, which includes coastal and marine ecosystems. Thus, there is a mechanism to integrate ecosystems into local climate change adaptation plans.

(iii) Ports and Coasts

For ports, there are three main types of impacts: impacts to breakwaters and other external facilities and port functions, impacts to areas outside the breakwaters (piers, loading docks, industrial sites, etc.), and impacts to areas behind the breakwaters (inside the breakwaters). In addition to this, the impact on the space under the girders and the impact on shallow ground and tidal flats are also being considered. The main concerns are sea level rise, damage to facilities from storm surges and waves, and damage to people and property from flooding, and prediction of impacts through monitoring of oceanographic phenomena and "hard" and "soft" disaster prevention measures are considered to be effective[22]. To date, work has been undertaken to shape specific details for port and coastal adaptation measures, starting with the 2009 MLIT report "Port and Harbor Policies to Address Changes in the Climate Due to Global Warming"[23].

With the update of knowledge from the IPCC Fifth Assessment Report, two new committees were established in 2015: the Committee on Climate Change Impacts and Adaptation in Coastal Areas (Ports and Harbors), coordinated by the Coast Administration and Disaster Prevention Division of the Ports and Harbours Bureau of MLIT and the "Committee to Study the Impacts of and Adaptation to Climate Change in Coastal Areas" organized by the Rural Development Bureau of MAFF, the Fisheries Agency, the Water and Disaster Management Bureau of MLIT, and the Port and Harbor Bureau. In the former committee, the goal of adaptation was to reduce the increased risk of disasters such as storm surges in the external and internal areas of breakwaters and to maintain port activities, with the "Technical Committee on Climate Change Adaptation Implementation for Ports and Harbors" taking over the discussions from 2021. The latter committee set the goal of reducing the increased risk of disasters such as storm surges and protecting coastal land, and discussions on coastal protection were handed over to the "Research Committee on

http://www.env.go.jp/nature/biodic/coralreefs/pamph/C-project2016-2020_L.pdf

[21] Ministry of Environment. (2018). Regional Climate Change Adaptation Planning Manual Guidelines

[22] The Port and Harbours Bureau established the "Guidelines for Port and Harbor Storm Surge Risk Reduction Measures for Areas Outside of Breakwaters" in March 2018 and established the "Committee on Port and Harbor Storm Surge Risk Reduction Measures" in October 2018 to review measures nationwide in response to the damage caused by Typhoon Jebi, which struck Japan in September 2018. The committee held five meetings to discuss specific measures, including measures to prevent container collapse and spillage, flooding of electrical equipment, and power outages to maintain and rapidly restore port functions, and revised the guidelines in 2019.

[23] Ministry of Land, Infrastructure, Transport and Tourism (2009) "Report on Port Policies to Respond to Changes in the Climate Caused by Global Warming"
https://www.mlit.go.jp/common/000035960.pdf

Coastal Protection under Climate Change," which was established jointly by MILT and MAFF in 2019. The committee's recommendations, which were published in July 2020[24], include a policy of continuously monitoring and collecting data to predict and assess the impacts of climate change and developing adaptation measures based on this.

(iv) People's livelihoods

The ocean and people's livelihoods are closely linked, and it is necessary to consider adaptation measures to cope with changes in the marine environment which have been caused by climate change. For example, it should be noted that new forms of large-scale disasters may emerge as a result of a combination of factors, such as intensification of typhoons and cyclones, rising river levels in estuaries, storm surges and flooding. In order to prepare for such risks, it is particularly important to raise public awareness of disaster prevention in coastal areas. There is a need to share information on the long-term impacts of climate change in land use and urban planning, including housing. There is also growing concern about the impact of climate change on beaches and land conservation. In addition, the previously mentioned "Committee to Study the Impacts of and Adaptation to Climate Change in Coastal Areas" has referred to the reduction in the value of tourism resources, such as the reduction of beaches and the impact on recreation. Studies have shown that between 46% and 91% of Japan's beaches may be lost due to average sea level rise caused by climate change[25]. In addition to conventional disaster preparedness measures, detailed research is needed on how to link people's everyday relationship with the ocean to adaptation to the impacts of climate change and how to integrate this into everyday life. Examples of such initiatives that are worth noting[26] include responsible tourism[27] and sustainable tourism[28], which seek to reduce the impact of tourism on marine and coastal ecosystems and enjoy tourism while protecting these ecosystems.

The relevant policies and guidelines are summarized in Table 2. It can be seen that climate change adaptation in the ocean and coastal areas is being promoted through the general policies set out in the Basic Plan on Ocean Policy and the National Plan for Adaptation to the Impacts of Climate Change, as well as multiple policy guidelines.

[24] Ministry of Land, Infrastructure, Transport and Tourism (2020) "Proposal for Coastal Protection in the Context of Climate Change" https://www.mlit.go.jp/river/shinngikai_blog/hozen/teigen.pdf
[25] Udo K & Takeda Y. (2014). Uncertainty in Estimation of Future Beach Erosion in Japan due to Sea Level Rise. *Journal of Japan Society of Civil Engineers, Ser. G (Environmental Research)*, 70(5), I_101-I_110.
[26] Fang, W. T. (2020). Responsible Tourism. In Tourism in Emerging Economies (pp. 131-151). Springer, Singapore.
[27] Harris, R., Williams, P., & Griffin, T. (Eds.). (2012). *Sustainable tourism*. Routledge.
[28] Neto, F. (2003). A new approach to sustainable tourism development: Moving beyond environmental protection. In Natural resources forum (Vol. 27, No. 3, pp. 212-222). Oxford, UK: Blackwell Publishing Ltd.

Table 1: Climate change impacts and adaptation measures in different sectors in the ocean and coastal areas

Sector	Major impacts of climate change	Description	Possible adaptation measures
Fisheries	Decline in catches	Decreased or increased catches of specific species in certain areas due to changes in the distribution or migration range of fishery resources.	Monitoring with research vessels and satellites Improving the accuracy of fishing ground forecasts and understanding of resource levels under environmental change Development of fishing methods that can adapt to changes in the marine environment
	Decline in aquaculture	Increased mortality of aquaculture resources and yield changes due to increased seawater temperature. Effects of isoyake, etc.	Temperature control and other measures for aquaculture facilities Conversion to high water temperature tolerant aquaculture species, species development and fish disease control measures
Marine and coastal ecosystems	Ocean acidification	Bleaching of coral reefs and reduced size of shellfish and crustaceans	Monitoring of the status quo
	Changes in coastal ecosystems	Decrease in seagrass beds, tidal flats and shallow water areas due to sea level rise and erosion, with a consequent decrease in green infrastructure functions	Protection of ecosystems and active use of ecosystem services
Ports and coasts	Impact on breakwaters and other external facilities and port functions	Damage to breakwaters due to changes in sea level and wave conditions and storm surge anomalies, and reduced logistical functions for marine transportation	Technology to develop and build breakwaters and seawalls that can withstand more frequent hazards. Monitoring of oceanographic phenomena Strategic development and maintenance of coastal protection facilities, taking into account areas of high risk of damage and the timing of upgrades
	Impact on land outside breakwaters (docks, loading docks, industrial land, etc.)	Damage to cargo handling machinery, breakwaters, waterways and anchorages from disasters and floods, reduced port functions and decreased utilization of cargo handling capacity	Assessments and dissemination of disaster risks and utilization in the preparation of port BCPs
	Impacts on breakwaters and seawalls and the land behind (within)	Increased flooding damage due to breaches caused by overturning waves and currents and the inflow of seawater, with associated damage to people and property	Understand the impact on coastal protection facilities and strategic maintenance, such as optimizing upgrades Review land use and community development plans in light of disaster risk
People's livelihoods	Coastal Disasters	New forms of major disasters due to the combined effects of rising river levels, storm surges and estuarine flooding	Review of urban planning, including land use and town planning More sophisticated forecasting and warning, disaster preparedness and evacuation plans
	Impact on marine recreation	Negative impact on tourism due to coastline decline and loss of beaches and ecosystems	Promote ecotourism, "responsible tourism" and other activities consistent with the protection of marine ecosystems

Table 2: Policies related to climate change adaptation in the ocean and coastal areas

Name	Related Ministry	Ocean and coastal areas covered
Basic Plan on Ocean Policy	Cabinet Decision (2018)	Fisheries, Ecosystems, Ports and Coasts, Livelihoods
National Plan for Adaptation to the Impacts of Climate Change	Statutory Plan (2018)	Fisheries, Ecosystems, Ports and Coasts, Livelihoods
MLIT Climate Change Adaptation Plan	MLIT (2015)	Ecosystems, Ports and Coasts
MAFF Climate Change Adaptation Plan	MAFF (2018)	Fisheries
Regional Climate Change Adaptation Planning Manual	MOE (2018)	Fisheries, Ecosystems, Ports and Coasts, Livelihoods
Climate Change Adaptation Guidelines for National Parks and Other Protected Areas	MOE (2019)	Ecosystems
Guidelines for Measures to Improve Fisheries in Response to Climate Change	Fisheries Agency (2017)	Fisheries

4. Cross-sectoral Adaptation Measures in the Ocean and Coastal Areas

As mentioned above, the current situation in Japan is that sectoral efforts are being made to adapt to climate change in the ocean and coastal areas. However, the lack of a comprehensive ocean and coastal climate change adaptation body may lead to a lack of cross-sectoral consideration of effective approaches and assessment of multiple risks. It is important to consider adaptation needs not covered by existing frameworks, as well as adaptation across the ocean and coastal areas (seascapes). What practical steps can we take to promote comprehensive, cross-sectoral ocean and coastal adaptation? As a starting point, the NWP Ocean and Coastal Zones Expert Group proposed three cross-sectoral approaches in a report released ahead of a forum under the 2019 workplan[29].

(i) Integrated Coastal Zone Management (ICZM)

Integrated Coastal Zone Management (ICZM) is a coastal zone management tool that was first introduced in Agenda 21 Action Plan at the 1992 Earth Summit and has since been widely adopted internationally as a tool to bring together coastal zone stakeholders to achieve an effective and integrated coastal zone ecosystem management. By planning for the long-term impacts and costs of climate change in the ICZM policy cycle, adaptive climate change in coastal areas can be achieved. There is also good practice in Cork in southern Ireland, where climate change adaptation strategies have been developed for

[29] UNFCCC. (2020). *Adaptation of the Ocean, Coastal Areas and Ecosystems Scoping Paper on Closing Knowledge Gaps and Advancing Action*. A Background Paper for the Nairobi Work Programme 13th Focal Point Forum to be held at COP25, Madrid, Spain

ICZM target areas, engaging a wide range of stakeholders in ICZM and using accumulated local risk data to develop adaptation measures at the regional level [30].

(ii) Marine Protected Areas (MPAs), Marine Spatial Planning (MSP)

A zoning management tool similar to ICZM, but with the aim of protecting ecosystems, is called a Marine Protected Area (MPA). MPAs allow for the ex-ante regulation of marine areas where biodiversity conservation is particularly important and allow for the promotion of natural regeneration initiatives to restore damaged ecosystems. The establishment of MPAs is also considered an effective means of providing adequate protection to ecosystems that are considered particularly vulnerable to climate change impacts. Efforts to integrate climate change adaptation into marine protected areas are already underway. In the case of Jamaica's Portland Bight Protected Area, the Climate Change Action Plan published in 2013 includes a multi-year strategy to address ecosystems and communities vulnerable to climate change, provide climate change education programs, and restore mangrove forests. MSP is a broader concept than the MPA, and it has been the focus of the UNESCO Intergovernmental Oceanographic Commission (IOC) and other agencies as a tool to bring stakeholders together on a consultative basis to reach consensus on the future development, use and protection of marine areas[31]. Similarly, MSP can be expected to incorporate a climate change adaptation perspective.

(iii) Nature-based Solutions (NbS)

Nature-based solutions (NbS) is a relatively new concept introduced by the International Union for Conservation of Nature (IUCN) and the European Commission (EC), and has gained prominence in the context of COVID-19 for green recovery, forming a key element of EU green deal policy.[32]1 As defined by the IUCN, NbS is “actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits”[33]. It is an approach that deals with climate change impacts through the conservation, sustainable management, and restoration of nature and ecosystems. Within NbS, the use of ecosystem services as part of an overall climate change adaptation strategy is also referred to as “Ecosystem-based Adaptation” (EbA). One example is the conservation and restoration of tidal flats that feature purification functions that are expected to contribute to water purification in coastal areas[34]. In recent years, EbA has been

[30] O'Mahony, C., Gray, S., Gault, J., & Cummins, V. (2020). ICZM as a framework for climate change adaptation action–experience from Cork Harbour, Ireland. Marine Policy, 111, 102223.
[31] Tomohiko Tsunoda. (2020). Progress in Integrated Ocean Management and Prospects for Marine Spatial Planning (MSP) in Japan. OPRI Perspectives No. 15 [2020]. Ocean Policy Research Institute, The Sasakawa Peace Foundation
[32] Kanako Morita. (2020) International Debate Related to Nature-based Solutions
[33] IUCN (2021). IUCN Global Standard for Nature-based Solutions: a user-friendly framework for the verification, design and scaling up of NbS: first edition. Gland, Switzerland: IUCN.
[34] Ministry of Environment. (2016). Adaptation to Climate Change in the Biodiversity Sector.

increasingly recognized and practiced in various countries under international frameworks such as the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC). For example, in the Pacific, the Secretariat of the Pacific Regional Environment Programme (SPREP) is implementing the Pacific Ecosystems-based Adaptation to Climate Change Project with support from Fiji, Vanuatu and the Solomon Islands. As mentioned above, ecosystems such as mangroves, coastal wetlands and coral reefs have a role to play in disaster preparedness and mitigation, as well as in reducing environmental impacts such as sea level rise, and their protection can itself increase resilience to climate change.

These cross-sectoral approaches are useful in promoting adaptation measures in Japan because they encourage the participation of diverse stakeholders and facilitate the promotion of ecosystem conservation and risk management in the ocean and coastal areas from multiple perspectives. In fact, efforts to use these approaches are making progress in Japan. On the other hand, there are still some challenges in using ICZM and MPA to protect the natural environment and ecosystems in Japan. For example, ICZM was first stipulated as a law in Japan in Article 25 of the Basic Act on Ocean Policy, and ICZM was clearly positioned as one of the 12 basic measures promoted by the government. However, unfortunately the coordination and integration of integrated management policies based on enhancing the value of coastal ecosystems has not always been smooth in Japan compared to the United States and other countries[35]. MPAs were first mentioned in the Basic Act on Ocean Policy and have been defined and institutionalized through the 2011 Marine Biodiversity Conservation Strategy[36]. In Japan, there are no sea areas explicitly designated as “marine protected areas”, but it is estimated that Japanese style MPAs, which follow the definition in the “Establishment of Marine Protected Areas in Japan” released by MOE in May 2011, occupy approximately 8.3% of the sea and exclusive economic zone[37], but in terms of number and area, it is said that about 90% of these MPAs are for the purpose of fisheries resource management[38]. Given this situation, there is a need to reconsider these initiatives in the context of climate change adaptation. For example, in recent years, interest in ecosystem-based climate change measures has grown in Japan, and MOE is working to compile guidelines to promote ecosystem-based climate change adaptation (EbA) [39]. It is hoped that such a study will also include a focus on strengthening aspects that contribute to adaptation, while building on existing initiatives such as ICZM and MPA.

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5. Summary

The Ocean and Climate Change Dialogue, held in December 2020, was the first formal meeting of UNFCCC to focus on oceans. At the Dialogue, signatory nations, non-signatory nations and non-state actors (such as international organizations, civil society organizations, and research institutes) discussed how to enhance ocean-based climate change mitigation and adaptation actions while promoting understanding of the linkages between climate and oceans and related challenges[40]. In Japan too, there is a need to further strengthen adaptation measures in the marine sector. However, the current situation is that each marine-related sector is working in silos, with several separate and interrelated policies and guidelines. The challenge for the future is how to coordinate and integrate these policies. As a first step, using the cross-sectoral approaches described above and incorporating an adaptation perspective into existing coastal zone management initiatives can provide a basis for improving adaptive capacity in coastal and marine areas and engaging different sectors. Building on this foundation, it is important to establish the following three types of linkages:

The first is the linkage between research institutes and practitioners. The aforementioned liaison meeting between research institutes is noteworthy as it is an important step towards cooperation between research institutes in various sectors. On the other hand, in addition to cooperation at the planning stage, information sharing with practitioners must be further enhanced to encourage cooperation at the plan implementation stage. The Social Implementation Program on Climate Change Adaptation Technology (SI-CAT)[41], implemented by the Ministry of Education, Culture, Sports, Science and Technology from 2017 to 2019, is a pioneering example of collaboration between social implementation institutions, such as technology development agencies and universities, and local governments to support the development of adaptation plans based on science and technology, including climate prediction data. In the future, we hope that the base for cooperation established in this way will not remain at the planning stage but will also be used to implement the plan and measure its effectiveness in the medium and long term.

The second type of linkage is regional cooperation. Under the Wide Area Action Plan for Climate Change Adaptation project to be implemented from 2020 by MOE, the Wide Area Council (an organization that discusses adaptation issues across prefectural boundaries in each of the seven blocks in Japan) is collecting information. Each council has set themes for subcommittees (those considered particularly important in each block) to share information

[40] The informal summary report of the "Ocean and Climate Change Dialogue" (released on May 1, 2021) recommends further use and promotion of NbS in the ocean and coastal adaptation under UNFCCC and encourages their inclusion in the National Adaptation Plan (NAP) development process. It was suggested in the international discussions that it is important to improve our understanding of the ocean and coastal ecosystems and to use them appropriately to address the impacts of climate change.
https://unfccc.int/sites/default/files/resource/SBSTA_Ocean_Dialogue_SummaryReport.pdf
[41] https://www.restec.or.jp/si-cat/index.html

and develop adaptation measures. For example, the theme set for the Kyushu-Okinawa block is “Adaptation to climate change impacts on ecosystem services in coastal areas,” and the theme set for the Chugoku-Shikoku block is “Adaptation to climate change impacts on fisheries and other local industries in the Seto Inland Sea and the Sea of Japan.”[42] On the other hand, even in areas that do not fall into this category, such as Tokyo Bay, it may be necessary for local governments facing the same sea area to establish their own consultative bodies to consider adaptation measures to common problems. Relevant stakeholders must follow a common path to address the region's unique climate change and marine risks.

Finally, linkage between adaptation and mitigation measures, or the optimal combination of these measures, must be found[43]. By integrating mitigation and adaptation measures, it is hoped that synergies can be created[44] . For example, green infrastructure is often used as an adaptation measure while also having a range of mitigation benefits, such as reduced energy use, natural cooling, and carbon sequestration[45]. In the case of oceans, recent attention has focused on the contribution of blue carbon ecosystems (marine ecosystems that sequester and store carbon) to mitigation and adaptation. For example, wetland conservation contributes to mitigation not only by sequestering blue carbon, but also to adaptation by reducing and preventing coastal erosion and mitigating the effects of storm surges[46]. In order to design marine spaces based on these interactions, it will be important to work with companies and technical institutes involved in mitigation as well as adaptation.

By creating these various connections and increasing opportunities to see and discuss the ocean and coastal areas in their entirety, we should be able to promote ocean adaptation in a more comprehensive way. The Basic Plan on Ocean Policy is reviewed roughly every five years, with the next plan scheduled for 2023. The review is expected to begin in earnest early next year and will require further discussion of climate change adaptation. While efforts to address marine-related mitigation measures are accelerating, adaptation to the impacts of climate change on the ocean and coastal environment cannot be ignored. It is hoped that the new Basic Plan on Ocean Policy will promote ocean adaptation in a manner that involves many relevant sectors.

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[43] Wanglin Yan, Tomohiro Ichinose and Tanji Kazunori. (2011). Bringing together mitigation and adaptation in the search for new paradigms that respond to global climate change.
[44] However, it should also be noted that there are trade-offs between mitigation and adaptation measures (e.g., infrastructure development for coastal protection is often accompanied by increased energy use).
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