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Commentary on "OPRI's Policy Recommendations based on findings of IPCC SROCC"

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NOTE: The following is an English translation of an original Japanese article issued in January 2020.

1. Introduction: The novelty and necessity of the Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC)

The "Special Report on the Ocean and Cryosphere in a Changing Climate" (SROCC) issued by the Intergovernmental Panel on Climate Change (IPCC) in September 2019 is the first report by the IPCC that specializes in the ocean and cryosphere (polar and high mountain regions). 104 experts from 36 countries participated in the writing of the report and as many as 6,981 papers were referenced. More than 30,000 comments were received and the draft was revised multiple times based on the comments. At the 51st session of the IPCC panel convened in Monaco from September 20 to 24, 2019, discussions were held every day until late night to work out important details. It took until noon of September 24th, the last day of the session, for participating countries to approve by consensus the Summary for Policymakers (SPM) of SROCC and accept the underlying report.

The SROCC's message is clear. The IPCC is sounding the alarm that "choices made now are critical for the future," as phenomena thought to exceed the "tipping point" are already beginning to appear in certain marine ecosystems, and the oceans—and, by extension, the entire planet—are in a critical situation (IPCC press release of September 25, 2019).

A particularly noteworthy point in the SROCC's findings is that its projections for sea level rise were revised upward by a significant amount. A previous IPCC report (the Fifth Assessment Report [AR5]) contained somewhat conservative projections due to insufficient knowledge concerning the Antarctic ice sheet's contribution (AR5,WG1, Figure 13.13). However, the SROCC adds this contribution and thus makes new and more reliable predictions. As a result, the projections for sea level rise are a maximum of 110 cm in 2100 and an average maximum of 92 cm for the period of 2081-2100. This is a large value that is 10-cm higher than the AR5's projection (maximum of 82 cm for 2081-2100 SROCC SPM, B3.1; AR5 WG1 SPM Table SPM.2).

Another point that deserves mention is that the SROCC predicts ultra-long-term change beyond 2100. The SROCC makes it clear that climate change is already irreversible and thus ultra-long-term change in the oceans will continue, and that the degree of that change will vary greatly depending on current choices and the degree to which policies implemented

going forward are realized (See Figure 1 on the following page). A comparison of a scenario in which high greenhouse gas (GHG) emissions continue (RCP 8.5) and a low-emissions scenario in which GHG emissions are greatly reduced (RCP 2.6) reveals that significant differences emerge with the passage of time for all items. However, for sea level, in particular, it is predicted that sea levels will continue to rise even after the year 2300 in the high-emissions scenario. We undoubtedly stand at a crossroads at which the "choices made now are critical for the future." Given this, we must lead efforts to mitigate global climate change (reduce GHG emissions), focusing on the oceans and mobilizing the entire nation to respond appropriately to changes in ocean environments so that we may ensure sustainable development into the future. It was with this in mind that, in October 2019, the Ocean Policy Research Institute of the Sasakawa Peace Foundation announced the following ocean related policy recomendations. This discussion will examine each of the recommendations through concrete examples, and present the reports and papers upon which they are based.

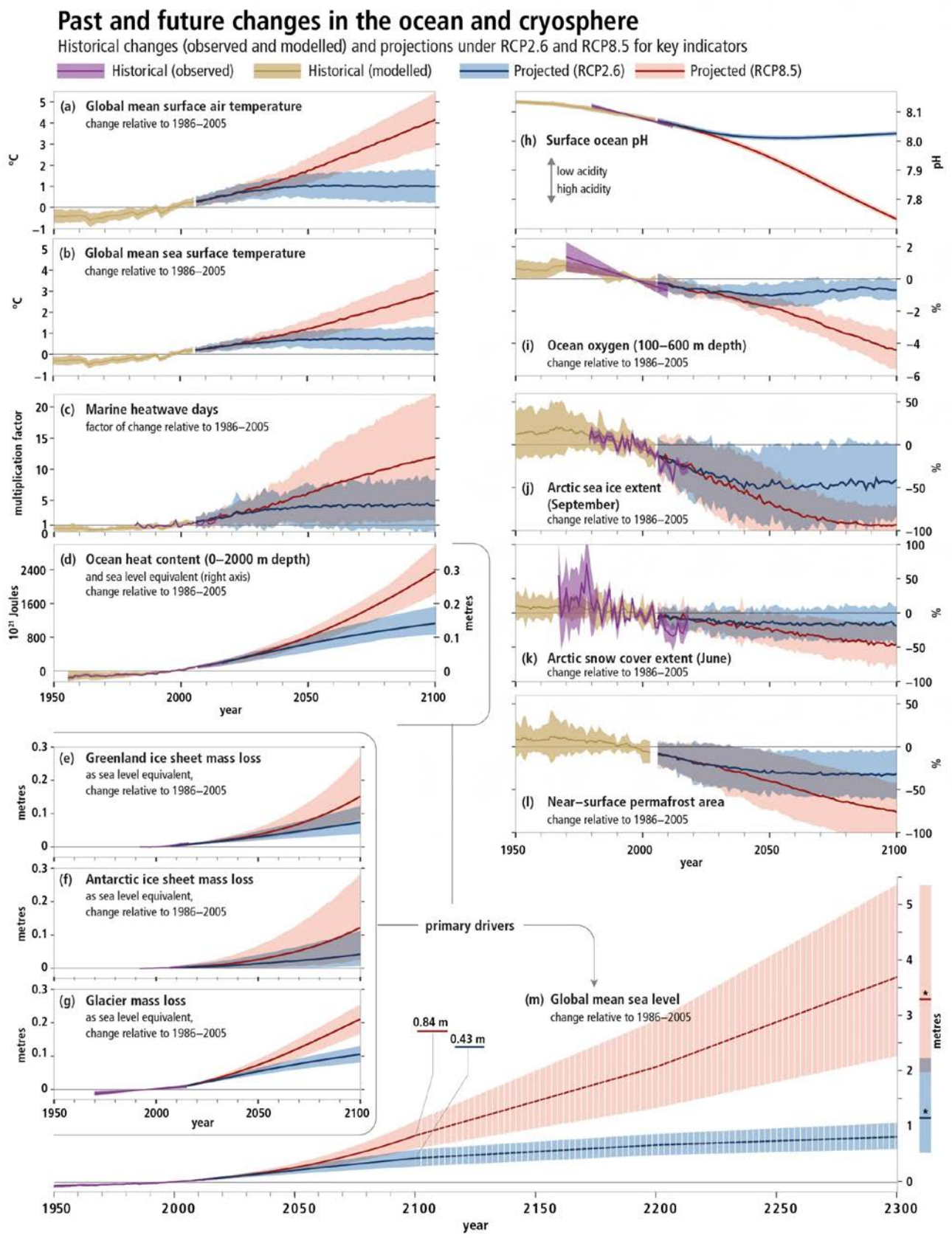

Figure 1: Past and future changes in the oceans and cryosphere

Source: IPCC, “Special Report on the Ocean and Cryosphere in a Changing Climate” Figure SPM.1

2. A detailed examination of the ten recommendations

■ Recommendation 1

Ocean-based mitigation options such as ocean-based renewable energy and improved energy efficiency in ocean-based transport may contribute up to 21% of additional mitigation measures (decrease in greenhouse gas emissions) to limit global warming to 1.5℃. The Government of Japan should further promote ocean-based mitigation that generates a win-win situation for all sectors and submit to the UNFCCC its updated and more ambitious NDCs.

Even when all of the reduction targets (NDCs) that were submitted by nations under the Paris Agreement are added together, it will be difficult to hold global warming to 1.5℃ or even under 2℃ (UNEP Emission Gap Report 2019, etc.). According to a 2018 IPCC special report commonly called "Global Warming of 1.5ºC (SR1.5)," [1] when a "world with a temperature rise of 2℃ since the pre-industrial period" and a "world with a 1.5℃ rise" are compared, it becomes evident that decisive large differences in the severity of climate-related risk and impact on ecosystems emerge, and that holding global warming to 1.5℃ will require reducing CO_2 emission to net zero by 2050. In line with this, the United Kingdom, France, Germany, New Zealand and other countries have recently announced the target of reducing GHG emissions to net zero by 2050. In fact, France and Germany responded to SR1.5 by announcing new targets that go beyond the figures included in the long-term strategies[2] they had already submitted to the United Nations Framework Convention on Climate Change (UNFCCC). (In Japan as well the Tokyo Metropolitan Government and other cities such as Kyoto City announced that they will aim for zero real emissions by 2050.) On the other hand, on June 11, 2019, the Government of Japan announced "The Long-term Strategy under the Paris Agreement." [3] It establishes that Japan will reduce its GHG emissions effectively to zero (achieving a "decarbonized society") as soon as possible in the latter half of this century. As it does not specify a specific target date, it must be admitted that Japan's long-term strategy compares unfavorably with those of other countries, and it leaves the impression that Japan has abandoned its pursuit of the Paris Agreement's 1.5℃ goal. To dispel such concerns, the Government of Japan should

[1] Official title: An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

[2] Parties are required to submit a long-term strategy based on Article 4 paragraph 19 of the Paris Agreement under the UNFCCC and a decision of the Conference of the Parties (COP) Decisions (1/CP21, para.35).

[3] A national strategy to reduce greenhouse gases (GHGs) whose formulation is required based on the "Paris Agreement," a set of international rules for global warming countermeasures (Article 4 paragraph 19, COP21 Decision 1/CP21, para.35).

reexamine its submitted intended nationally determined contributions(INDC) and resubmit more ambitious NDCs in the run-up to the Paris Agreement's commencement in 2020.

Ocean-based mitigation measures can contribute greatly to the setting of more ambitious NDCs. Within the IPCC, Working Group III is the body responsible for mitigation measures. Because of this, the SROCC, which was handled by Working Groups I and II, does not contain detailed assessments of mitigation measures. However, the Summary for Policymakers (SPM) clearly mentions that "ocean renewable energy can support climate change mitigation, and can comprise energy extraction from offshore winds, tides, waves, thermal and salinity gradient and algal biofuels" (SPM, C.2.5). Moreover, it was announced in the High Level Panel for a Sustainable Ocean Economy in September 2019 that ocean-based mitigation options (the five fields of renewable energy, reduction of emissions from ocean-based transport, "blue carbon," use of water resources associated with livestock, and carbon storage in the seabed) have great potential. A report by the panel titled "The Ocean as a Solution to Climate Change: Five Opportunities for Action" states that ocean-based mitigation has the potential to reduce GHGs by as much as 11.8 $GtCO_2$[4] by 2050 (see Figure 2 below).

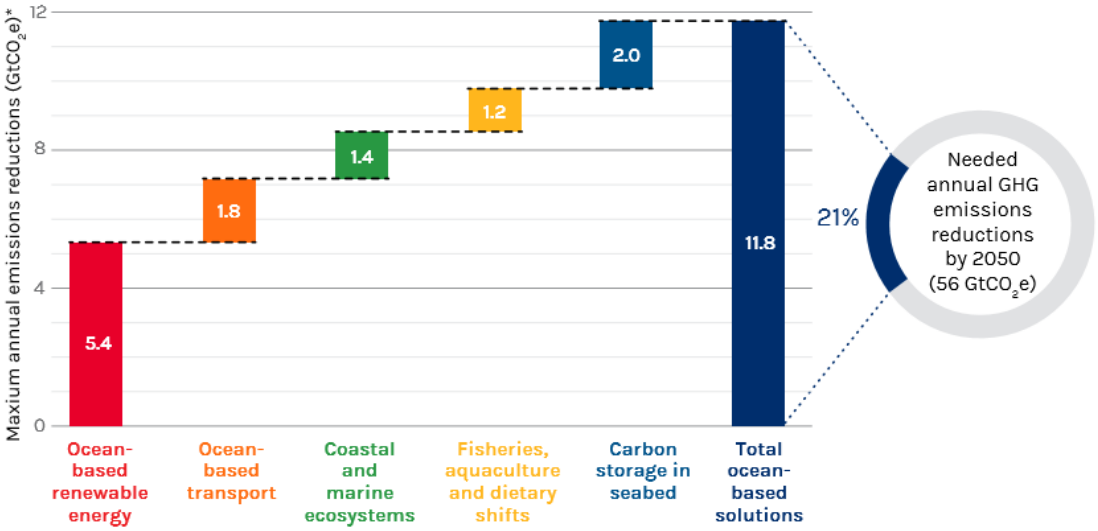

Figure 2: Potentials of ocean-based mitigation options

Source: Hoegh-Guldberg. O., et al. (2019)

[4] Greenhouse gas absorption and emission is expressed by the weight of CO_2 including carbon and oxygen (ton of CO_2: t-CO_2). In the case of global emissions, the abbreviations $GtCO_2$ or $GtCO_2$eq. (meaning "CO_2 equivalent") are used by adding G (for "giga"), meaning 1 billion. Here, $GtCO_2$ is used for Japan's emissions in order to facilitate comparison with global emissions. It should be noted that in natural sciences fields that study the global carbon cycle, CO_2 weight is expressed in terms of the weight of carbon only (carbon ton: tC). A CO_2 ton is 3.67 times heavier than a carbon ton. The amount of 11.8 $GtCO_2$ is equivalent to up to 25% of the additional emission reduction needed to keep global warming below 2℃ and up to 21% in the case of 1.5℃.

Looking at Japan's NDCs (as they were submitted in the INDC in 2015), general measures to make ocean-based transport greener and the comprehensive decarbonization of ports and harbors are included in measures serving as the basis for target building in the transport sector. [5] However, no detailed breakdown is provided. Additionally, the promotion of renewable energy (solar, wind, geothermal, hydropower, and biomass) is mentioned as one measure in the energy conversion sector.[6] However, details such as the percentage of offshore wind power generation are not mentioned.

There has been a growing movement to comprehensively grasp and visualize ocean-related issues under the UNFCCC in recent years. According to Gallo et al (2017), ocean-related issues were incorporated into 70% of the 161 INDCs submitted by June 2016 (See Figure 3 below). [7] Even greater awareness of the oceans' necessity was evident at COP 25, as, for example, the link between oceans and climate was mentioned for the first time in a COP decision (Decision 1/CP.25 paragraphs 30 and 31). Thus, it is important for Japan, a maritime nation, to apply ocean-based mitigation measures in raising the ambitiousness of its NDCs and to clearly demonstrate this effort in its NDCs.

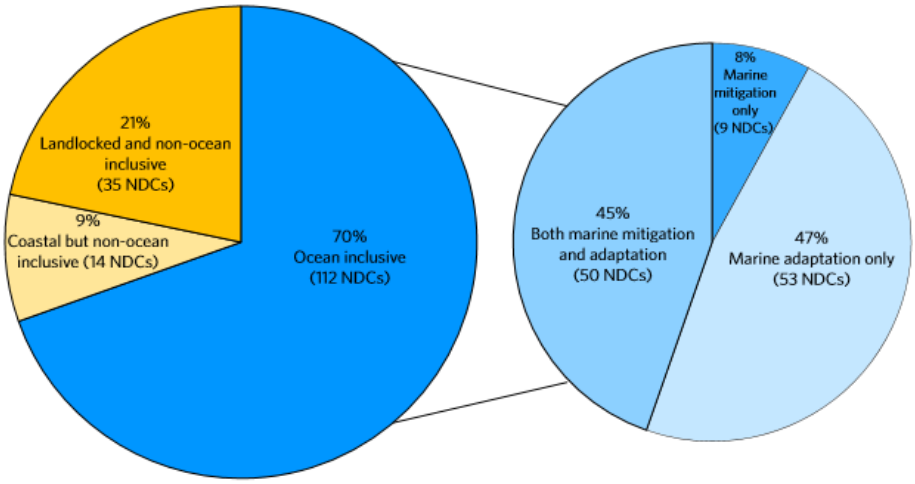

Figure 3: The incorporation of ocean-related themes in NDCs

Source: Gallo, et al. (2017)

References

・UNEP (2019). Emissions Gap Report 2019. Executive summary. United Nations Environment Programme, Nairobi. http://www.unenvironment.org/emissionsgap

・Hoegh-Guldberg et al. 2019. ''The Ocean as a Solution to Climate Change: Five Opportunities for Action.'' Report. Washington, DC: World Resources Institute. Available online at http://www.oceanpanel.org/climate

・Gallo et al. 2017. Ocean Commitments under the Paris Agreement, Nature Climate Change 7,2017,833-838.

[5] Base year emissions of 0.225 Gt-CO_2 (2013) and 0.240 Gt-CO_2 (2005): Target for 2030: 0.163 Gt-CO_2

[6] Base year emissions of 0.101 Gt-CO_2 (2013) and 0.104 Gt-CO_2 (2005): Target for 2030: 0.073 Gt-CO_2

[7] Although Japan incorporated port and harbor-related measures into some transport-sector measures in its INDC, it is counted in this paper as a "nation not incorporating ocean-related measures."

■ Recommendation 2

Japan should accelerate R&D on the carbon sequestration potential of Blue Carbon, including from seaweed, develop the estimation methodologies for its CO_2 emissions/removals and start to include the estimations in the national GHG inventory and reporting to the UNFCCC. Co-benefits of Blue Carbon such as disaster risk reduction and water quality improvement should be properly assessed; efforts toward conservation and restoration of seagrass/macroalgal beds should be further promoted.

This recommendation gives special attention to "blue carbon"[8] among the "ocean-based mitigation" options. The SROCC lists mangroves, tidal marshes, and seagrass meadows as the main coastal blue carbon ecosystems, and states that such ecosystems have the potential of mitigating yearly global emissions by as much as 0.5%. Although the emissions/removals of macroalgal beds (large seaweeds such as kombu)[9] should also be considered in addition to the three ecosystems mentioned above. However, the SROCC states that uncertainty exists regarding the mitigating effects of seaweeds (C2.4, Chap.5ES). However, research on the carbon fixation of large seaweeds is progressing. Therefore, it is important to pursue the possible mitigation effects of seaweeds (regeneration and cultivation of seaweed beds as mitigation measures) in Japan, where seaweeds are broadly distributed.

Regarding the three ecosystems of mangroves, tidal marshes, and seagrass meadows, Chapter 4 (Coastal Wetlands) of "2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands" provides formulae for calculating their CO_2 emissions/removals. However, as of 2019, only the United States and Australia calculate and report emissions/removals from these ecosystems in the "National Greenhouse Gas Inventories" in accordance with the Supplement. Japan does not calculate or report emissions/removals from blue carbon ecosystems in its national inventory except in the case of mangroves, which are classified under forests. Meanwhile, shown below are results from an estimate of annual CO_2 removals by Japan's shallow-sea ecosystems that a group of experts released in 2019. Calculated based on removal factors specified in the IPCC Wetlands Supplement as well as the group's own expertise, the estimate produced a median value for current CO_2 removal of 1.32 million tCO_2 (0.00132 Gt-CO_2)/year and upper value of 4.04 million t-CO_2 (0.00404 Gt-CO_2)/year (Kuwae, et al, 2019) .

[8] Blue carbon is "the carbon captured by living organisms in coastal and marine ecosystems and stored in biomass and sediments." (IPCC 1.5℃ Special Report Glossary)

[9] The Japanese words for "seagrass" (海草) and "seaweed" (海藻) are both pronounced *kaiso*, and therefore they tend to be confused with each other. However, "seagrass" refers to spermatophytes (plants that root on the seabed and multiply with seeds), while "seaweed" refers to algae (plants without distinguishable roots, stems, or leaves; that multiply with spores; and that are used for food). Places where they grow densely are called seagrass meadows and seaweed beds, respectively.

Table 1: Results of a nationwide estimation of annual CO_2 removal by shallow-sea ecosystems of Japan

Source: Kuwae, et al (2019)

Ecosystem		Ecosystem area (active mass) (10,000 ha)	Removal factor[*1]		CO_2 Removal[*2]	
			Mean value	Upper value	Mean value	Upper value
			(ton CO_2/ha/year)		(ton CO_2/ha/year)	
Seagrass meadows	Eelgrass meadows	6.2[*3]	4.9	33.4	30	206
Seaweed beds	Sargassum beds	8.8[*3]	2.7	5.1	24	45
	Laminaria beds	2.0[*3]	10.3	36.0	21	73
	Eisenia beds	6.3[*3]	4.2	7.9	26	50
	Total	17.2			71	167
Mangroves		0.3[*4]	68.5	68.5	18	18
Tidal flats		4.7[*4]	2.6	2.6	12	12
Total		28.3			132	404

As an advanced “blue carbon” country possessing diverse ecosystems on its coasts, Japan should ascertain, calculate, and report blue carbon emissions/reductions for the entire nation.

References
・Kuwae, et al. “Nationwide Estimate of the Annual Uptake of Atmospheric Carbon Dioxide by Shallow Coastal Ecosystems in Japan,” Journal of Japan Society of Civil Engineers B2 (Coastal Engineering), 75(1), pp. 10-20, 2019.

■ Recommendation 3

In response to rising sea levels and the increasing intensity and frequency of climate-related disasters, the Government should plan and implement comprehensive risk evaluations in coastal areas, resilient infrastructure, and ecosystem-based adaptation measures, and strengthen support to municipal governments to undertake such response measures. In addition, the Government should provide tailormade support to developing countries in the Asia-Pacific region, including small island developing states, regarding coastal disaster prevention, adaptation measures, and relocation, based on respective national development strategies and plans.

"Adaptation" is defined as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities" (SROCC Glossary). However, ascertaining climate change risks and responding to those risks are essential toward this end. According to IPCC AR5, "risk" is evaluated based on the interaction of three factors: "hazard" brought from outside ; "vulnerability" intrinsic to people, society, and ecosystems; and "exposure" expressing the degree of exposure to risk (See Figure 4 below). Addressing these factors through various measures and reducing risk amounts to adaptation.

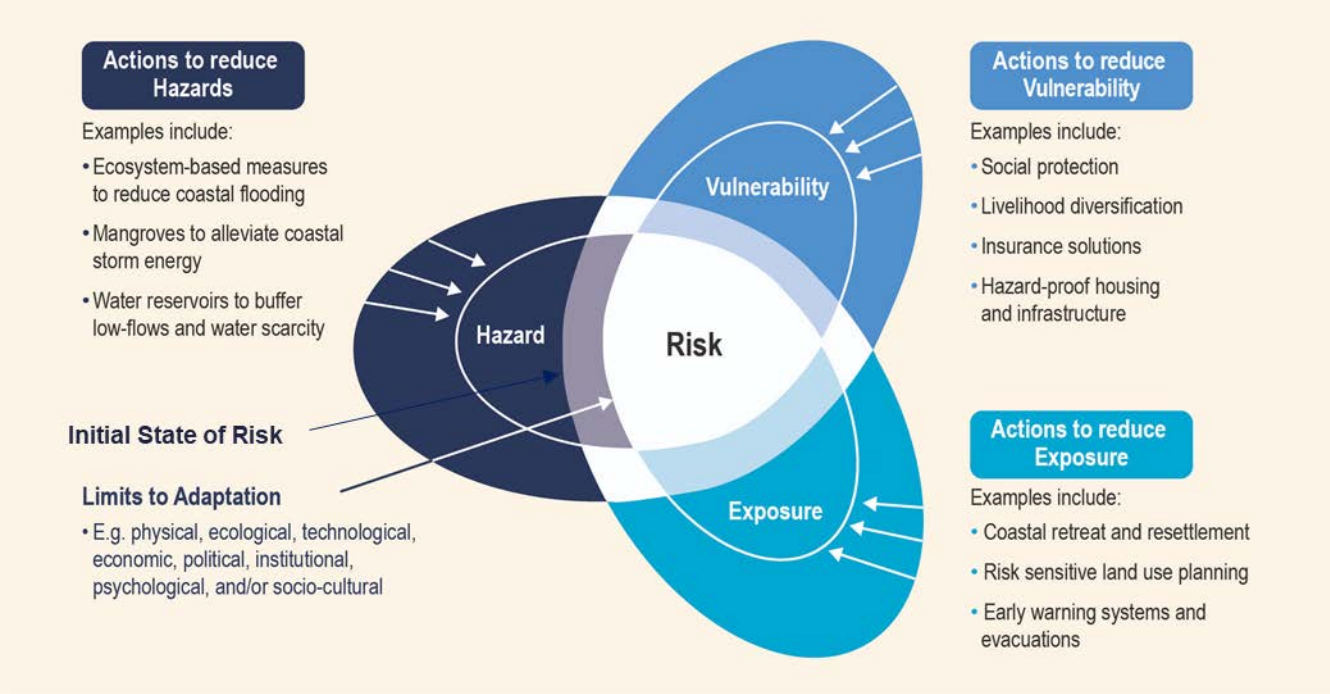

Figure 4: Schematic diagram of risk from climate change and adaptation
Source: IPCC,SROCC, Figure CB2.1

According to the SROCC, it is predicted that extreme sea levels that have heretofore occurred once a century will occur annually in low-elevation coastal cities and Small Island Developing States (SIDS) by 2050, and this can have severe impacts depending on the level of exposure. It is predicted that this same phenomenon will occur around Japan, albeit at a slower pace (SROCC SPM B3.4, Figure SPM.4)(See Figure 5 on the following page). Moreover, the SROCC notes that storm surges accompanying tropical cyclones could intensify in the future as more large-scale tropical cyclones occur and sea levels rise. Such predictions suggest that the risk to coastal regions from typhoons, storm surges, and the like will increase in Japan as well.

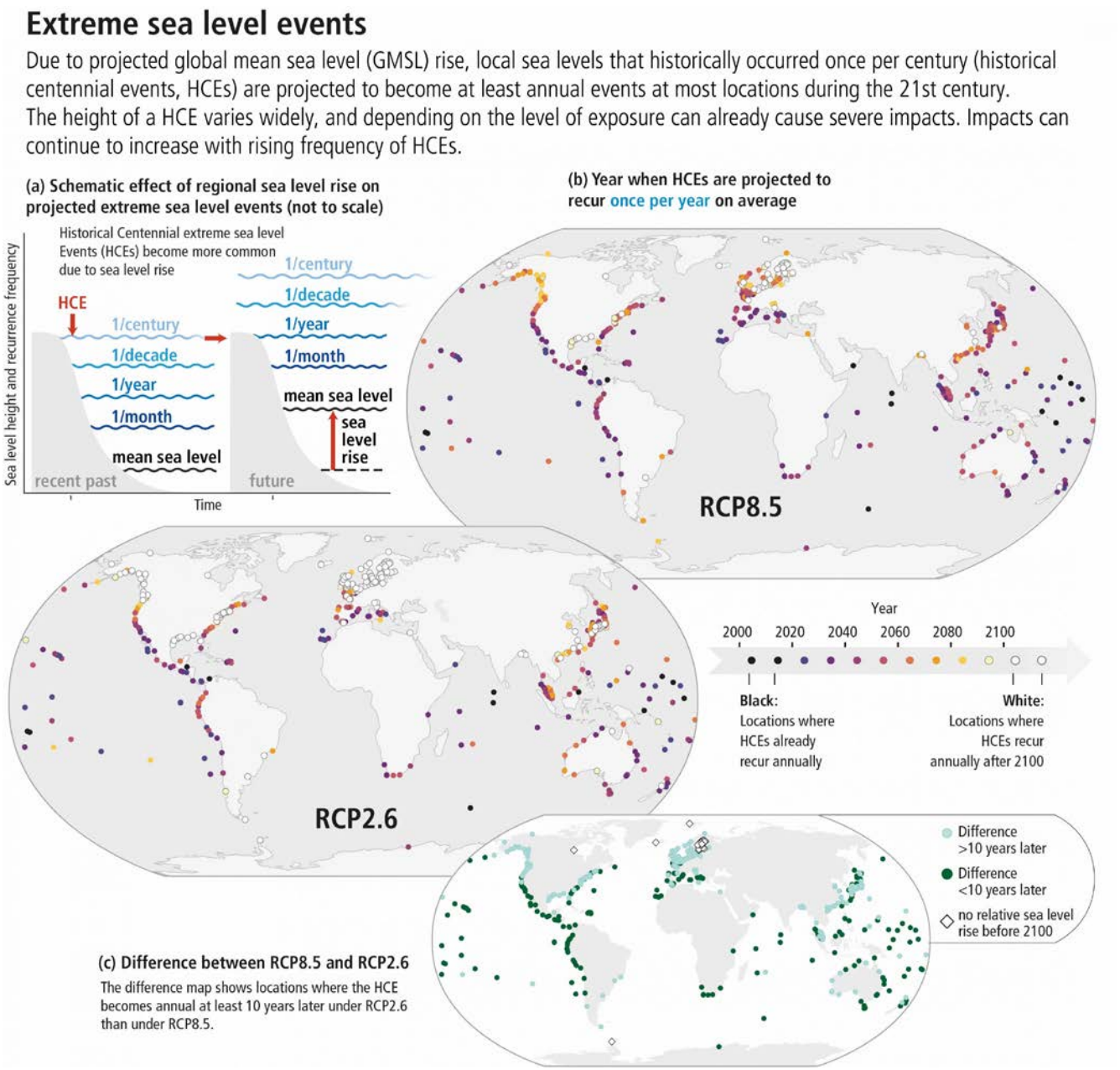

Figure 5: Rising extreme sea levels

Source: IPCC, “Special Report on the Ocean and Cryosphere in a Changing Climate” Figure SPM.4

Therefore, responses[10] to various risks become necessary. Responses to rising sea levels (including extreme sea level rise) are extremely varied. The SROCC compares the advantages and disadvantages of various responses, ranging from the installation of hard infrastructure in coastal areas to ecosystem-based adaptation measures; retention of risk through early warning systems and flood-proofing of buildings; and retreat, including planned relocation (Figure SPM5(c)). [11]

For example, with regard to ecosystem-based adaptation[12] (examples include coral preservation/rehabilitation and wetland [mangrove] preservation/rehabilitation), the SROCC notes that ecosystem management tools such as habitat restoration and species relocation/coral gardening can be locally effective in promoting ecosystem-based adaptation. It adds that such actions are most successful when they are coastal community-supported and science-based and also use local/indigenous knowledge, involve long-term reduction or removal of non-climatic stressors, and control global warming (C2.2).

Based on the knowledge presented here, it is necessary to implement integrated responses to climate change that are better matched to regional characteristics in Japan and abroad. Some local governments in Japan are formulating “local climate change adaptation plans.” [13] However, the national government should provide continuous financial and technical support so that even more local governments (and particularly, with respect to the SROCC, coastal local governments) can formulate adaptation plans and implement coastal community-based initiatives that utilize local knowledge.

Following the formulation of the Sendai Framework for Disaster Risk Reduction, measures to move disaster prevention making use of disaster-prevention/mitigation technologies into the mainstream and to build national resilience are being implemented in Japan. However, those measures should be further strengthened in preparation for the kind of escalating climate change-associated weather disasters and increasing frequency of extreme sea level events that are presented in the SROCC by seeing responses to climate change and the

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[10] The term “responses” is used here because included are measures that are not necessarily “adaptation,” such as retreat due to rising sea levels (including extreme sea levels). In general, mitigation and adaptation are seen as dual aspects of climate change response. However, there are no agreements among nations concerning how far adaptation goes and where the “limit of adaptation” begins (for example, some argue that the submergence of an island due to rising sea level is the “limit of adaptation” and that being forced to relocate as a result is also a continuation of the limit of adaptation (i.e., does not constitute “adaptation”); however, others believe that such relocation is a part of “adaptation”). Because of this, the term “response” is used frequently in the SROCC.

[11] These responses must be combined to match the characteristics of coastal communities and implemented in an integrated manner. Additionally, the sea level rise range that needs to be considered for planning and implementing coastal responses depends on the risk tolerance of stakeholders (SPM C.3, C3.4).

[12] Ecosystem-based adaptation(EBA): The use of ecosystem management activities to increase the resilience and reduce the vulnerability of people and ecosystems to climate change (Glossary)

[13]A total of 28 plans as of October 2019. Breakdown: 16 plans by prefectural governments, 7 by government ordinance-designated cities, and 5 by municipalities

mainstreaming of disaster prevention in an integrated light. The SROCC points out the extremely high likelihood that disaster-prevention investment made beforehand will be less expensive than the cost of damage caused by extreme weather events and recovery (C.6.9). At the same time, there is a need to continue reinforcing support for disaster-prevention/adaptation measures particularly for SIDS—which include small islands in the Asia-Pacific that the SROCC identifies as especially vulnerable to climate change—by making use of the knowledge Japan possesses as a leading nation in the area of disaster prevention and mitigation. In doing this, it is desirable to provide more fine-tuned support by implementing diverse responses in an integrated manner with consideration for the measures currently being executed in each country and the unique circumstances of coastal communities. In some SIDS, the relocation of coastal communities is starting to be considered as one form of response. The SROCC also mentions the effectiveness of reducing risk through planned relocation. At the same time, however, it also mentions that such relocation comes with social, cultural, financial and political constraints (SROCC SPM C3.2). International cooperation that can alleviate such restraints and fulfill each nation's needs is needed.

References

・Climate Change Adaptation Information Platform (A-PLAT) https://adaptation-platform.nies.go.jp/lets/local_list_plan.html

■ Recommendation 4

The Government should formulate and implement a comprehensive package of measures to combat climate change as well as land-based pollution (including nutrient management and reduction of plastic waste).

Regarding the link between changes in the oceans and cryosphere and the "Sustainable Development Goals (SDGs), the SROCC states that changes in the oceans and cryosphere will lessen if progress is made in achieving the SDGs. As closely related goals, the SROCC mentions environment-oriented goals—namely, Goal 13 "Take urgent action to combat climate change and its impacts" (SDG 14), Goal 14 "Conserve and sustainably use the oceans, seas and marine resources for sustainable development" (SDG 14), and Goal 15 (conservation of terrestrial ecosystems)—as well as Goal 1 (eradication of poverty), Goal 2 (elimination of hunger), Goal 3 (health and well-being), and Goal 6 (water and sanitation). Although there are some tradeoffs between responses to changes in the oceans/cryosphere and the SDGs, reducing GHGs creates more leeway for effective adaptation and sustainable development. "Climate-resilient development pathways" can overlap with pathways toward achieving the SDGs (FAQ1.2).

Within the content concerning the SDGs can be seen references to IPCC reports coming before Global Warming of 1.5℃. Mention of the SDGs within the SROCC is largely contained within the above-mentioned FAQ; however, it is noteworthy that the SROCC includes references to non-climate-caused pollution measures, such as "nutrient management," for the first time in an IPCC report. This is presumably evidence of an international preference for more comprehensive measures.

Nutrient management (eutrophication measures) is effective in reducing the combined effects caused by ocean acidification, and reducing disposable plastic products addresses not only the problem of ocean plastic but also climate change by decreasing the amount of incinerated plastic. Moreover, it can also be said that both are at the root of overconsumption of natural resources by human society. "Science 20 (S20)," the G20's science academy, issued a joint statement ahead of the G20 Osaka Summit 2019 that mentions the following as threats to the oceans: ocean warming; ocean acidification; deoxygenation and eutrophication; contamination of the oceans by pollutants, marine plastic waste; and Illegal, Unregulated and Unreported fishing practices (IUU). It also presents six recommendations for minimizing the negative impacts of these threats that serve as a reference. In Japan and abroad, it is vitally important to advance scientific evidence-based comprehensive responses to achieve SDG 13, SDG 14, and the other SDGs.

References

・Science 20 (S20) joint statement "Threats to Marine Ecosystems and Conservation of the Marine Environment" (March 6, 2019) http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-24-s20jp2019-1j.pdf

■ Recommendation 5

The Government should develop a framework for all stakeholders in the fisheries sector to share and utilize scientific knowledge and data such as long-term monitoring of fish distribution per species.

Warming ocean temperatures and other changes in the ocean environment are affecting ocean ecosystems from the surface down to the seabed and bringing changes to their geographical distribution and seasonal activities (SROCC SPM, Figure 3, 5.2.3, etc.). The SROCC predicts that the Earth's fishery resources will decrease by as much as 24.1% by the end of the 21st century if current high CO_2 emissions continue (SPM, B5.1). The SROCC also states that strengthening precautionary approaches as well as the responsiveness of existing fisheries management strategies is important in terms of reducing serious negative climate change impacts on fisheries. However, it additionally points out that there are limits to how far fisheries management can address ecosystem change (SROCC SPM C.2.3).

The rate of ocean surface temperature rise in the seas around Japan is +1.12℃/100 years, which is higher than the global average rate of ocean surface temperature rise (+ 0.54℃/100 years) (Japan Meteorological Agency). This suggests that stratification is progressing and nutrient return to the euphotic zone is diminishing; in other words, that biological productivity is decreasing (Furuya, 2014). In actuality, decreases and increases in fish catches appearing to be caused by changes in ocean surface temperature are being reported in all parts of Japan. For example, Spanish mackerel catches have increased in the Sea of Japan near Kyoto and Fukui since 2000 (Kidokoro, 2019). In another example, yellowtail catches have been increasing in northern Japan but decreasing in Kagoshima (Shishido et al, 2016). Rising ocean temperatures are also contributing to decreasing Japanese common squid catches along the Sea of Japan side of Honshu that are being seen primarily in the summer (Kidokoro, 2019). Active, forward-looking measures must be taken for regional adaptation to this phenomenon. And executing such measures will require (1) ocean environment simulations based on high-quality, long-term monitoring data, and (2) real-time environmental information.

The SROCC points out that fisheries management depends heavily upon data collection and monitoring systems, and therefore it will require the aggregation of knowledge for taking effective adaptation measures in fisheries (e.g., through better monitoring, modeling, and decision support frameworks) as well as the building of forecasting and early warning systems. It makes the appraisal that improving the coordination of marine protected areas and integrated coastal management (in other words, improving ocean governance) is an important factor in promoting adaptation to climate change in fisheries resource management (SROCC Chap.5 ES,5.5.2.2.3).

It has been pointed out that continuous ocean monitoring is becoming more difficult due to financial circumstances (Furuya, 2014). However, the importance of monitoring for fisheries to adapt to climate change should be recognized anew, and fishery practitioners who will be impacted by changing catches (not only fishery operators but also fishery processors and others) should, as a group, share data and implement measures for adapting to climate change.

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・Kidokoro, "*Kiko Hendo ni yoru Kaiyu-sei Gyokairui no Henka to Nihon Gyogyo no Tekio*" (climate change-caused changes in schooling fish species and Japanese fisheries' adaptation), Japanese Society of Fisheries Engineering FY2019 Academic Lectures (Spring Symposium), pp 11-12, 2019.
・Shishido, et al, "Catch fluctuation of yellowtail species in relation to fluctuations in the geographical catch center," Bulletin of the Japanese Society of Fisheries Oceanography, 80(1), pp. 27-34, 2016.
・Furuya, "Fisheries science in the age of global environmental change," Fisheries Science, 80(1), pp. 84-85, 2014.

■ Recommendation 6

The Government should set and utilize marine protected areas (MPAs) in a strategic manner by using local (indigenous) and scientific knowledge and taking changes in the ocean into account to enable biodiversity conservation and sustainable use of ecosystem services.

The SROCC classifies ocean-based adaptation measures (adaptation measures to climate change in the marine environment, ocean ecosystems, and coastal communities) into three areas, which are (1) ecosystem-based adaptation measures, (2) infrastructure development-based adaptation responses, and (3) socio-institutional adaptation responses. Within the concept of (3), the SROCC mentions marine protected areas (MPAs) and integrated coastal management as examples of adaptation responses for fishery resources management and notes the importance of improving their coordination (see the previous paragraph).

Looking at the establishment of MPAs, the numerical target of "making 10% of ocean and coastal areas MPAs by 2020" was established in the Aichi Biodiversity Targets adopted by the Convention on Biological Diversity in 2010 as well as in SDG14. It is reported that this target has already been achieved when viewed globally. [14] However, in the case of Japan, only 8.3% (approximately 369,000 km^2) of the waters Japan has jurisdiction over (inland waters, territorial waters, and EEZ: 4.47 million km^2) are MPAs. Thus, Japan must take immediate steps to reach the international target. As one such step, the government revised the Nature Conservation Act in April 2019 and newly established "marine protected areas for conservation of offshore seabeds." The government must designate the first of these new MPAs at an appropriate scale by 2020 to fulfill the Aichi Biodiversity Targets. On the other hand, the SROCC points out that (ocean) governance arrangements for MPAs, etc., are too fragmented to provide integrated responses to the increasing and cascading risks from climate change (SROCC SPM, C.12.). Additionally, it mentions an estimate that, although the global area of MPAs is increasing, just 2% of the ocean is managed well enough, and thus refers to the importance of implementation and management (SROCC 5.5.2.2.3).

Regarding the problem of fragmented MPA arrangements, in recent years there has been active discussion on the necessity for "networking" [15] that links multiple MPAs in a network.

[14] As of January 2019, approximately 17.3% of the world's water areas under national jurisdictions, and approximately 7.5% when the high seas are included, are designated in MPAs. It is estimated that these figures will surpass 23% and 10%, respectively, in 2020. (Osawa, 2019)

[15] According to the IUCN, an MPA network will be "A collection of individual marine protected areas operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels, in order to fulfil ecological aims more effectively and comprehensively than individual sites could alone. The network will also display social and economic benefits, though the latter may only become fully developed over long time frames as ecosystems recover." The linkage of MPAs in a network is

Additionally, discussions looking ahead to post-Aichi Biodiversity Targets initiatives are beginning. One of them is a "30 by 30 Initiative" ("30 by 30" refers to the placement of at least 30% of the world's oceans under MPAs by 2030) that the UK government proposed in September 2018. Support for the initiative is growing, as ten countries[16] (as of September 2019) have already declared their agreement with it. Japan, too, should accelerate discussions on domestic MPAs with a view to 30 by 30 while also ensuring that its MPAs do not become ineffective undertakings that exist "on paper" only.

The seas under Japan's jurisdiction are the world's richest in terms of biodiversity (Fujikura et al., 2010). To conserve this rich biodiversity and utilize its blessings (ecosystem services) sustainably, Japan must expand its MPA network by following the procedures set at the Conference of the Parties to the Convention on Biological Diversity (COP 9) of 2008. A prerequisite for this is the further enhancement of scientific knowledge on marine biodiversity. Additionally, it is vitally important to strategically expand MPAs and promote their management, operation, and networking with consideration for future changes in the ocean by utilizing locally-rooted traditional knowledge. With such advanced initiatives as a background, Japan will be able to drive discussions on post-Aichi Biodiversity Targets in the Convention on Biological Diversity (targets following the Aichi Targets with a focus on 2030) as well as negotiations for a convention on the conservation and sustainable development of marine biological diversity beyond areas of national jurisdiction (BBNJ).

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■ Recommendation 7

The Government should encourage research relevant to monitoring the ocean and cryosphere (e.g., the ARGO project and Arctic monitoring) toward long-term and comprehensive global ocean monitoring. International cooperation should be enhanced by providing information-sharing systems and means for domestic and international human resource development, as well as to address insufficient data availability in the Global South.

presented as important for maintaining biodiversity in international instruments of the Convention on Biological Diversity, including the Aichi Biodiversity Targets.

[16] Belize, Costa Rica, Finland, Gabon, Kenya, Seychelles, Vanuatu, Portugal, Palau, and Belgium

The Argo project is an international program that observes and ascertains salinity and seawater temperatures in oceans around the world in nearly real time using observation devices called “Argo floats” (official name: profiling floats). With some 200 of the approximately 3,900 Argo floats deployed globally being contributed by Japan, efforts to expand the observation network for biological and chemical monitoring are moving forward. In addition, Japan is making significant contributions to long-term marine monitoring. Such contributions include fixed-line observations of 137 degrees east longitude by the Japan Meteorological Agency and monitoring of sea ice areas by the AMSR series of orbiting sensors of the Japan Aerospace Exploration Agency (JAXA).

On the hand, as is readily apparent in figures contained in the SROCC (the African coast in Figure SPM.4, etc.), there are clear north-south disparities in observational data between regions of developed countries and regions of developing countries. Closing these gaps will be essential to the accurate ascertainment of not only future changes in the oceans but also in the global environment. It is also stressed in the United Nations Decade of Ocean Science for Sustainable Development (2021-2030), which was proclaimed by the UN General Assembly in 2017. As Japan strengthens its observation and research, it should simultaneously lead the development of inexpensive observation equipment that is easily introduced into developing countries as well as monitoring standardization, the building of data-sharing systems, the development of human resources, and the transfer of technologies.

■ Recommendation 8

The Government should promote innovation in Japanese scientific technologies (e.g., spearhead the achievement of zero-emissions from vessels /micro pH sensor).

Recommendation 1 pointed out the potential of five mitigation options concerning oceans. Of them, the value of promoting innovation in ocean-based transport and renewables, in particular, is large. The International Maritime Organization (IMO) aims to halve GHG emissions from international ocean-based transport by 2050 and to eliminate GHG emissions during the current century. In Japan, the development of hydrogen-powered vessels for coastal and other shipping as well as similar technologies is progressing through what is called a “productivity revolution in the maritime industry” (i-Shipping). It is hoped that Japan will proactively develop policies for realizing world-leading innovation toward halving emissions even earlier, by the 2030s.

In the area of offshore wind power generation, even when only fixed-foundation wind turbines (which are feasible within a short period of time) are considered, the potential to generate 91 GW exists. However, Japan generates just 65 MW, while global installed

capacity is 22 GW (as of the end of 2018). [17] Japan must accelerate industrial initiatives in addition to legislative moves, such as the enforcement of the Act of Promoting Utilization of Sea Areas in Development of Power Generation Facilities Using Maritime Renewable Energy Resources, set the goal of doubling the percentage of wind power (energy mix that includes onshore wind power) by 2030, and systematically promote the development of its power grids and base ports. At the same time, Japan should promote ocean current power generation using the Kuroshio Current, which has enormous potential equivalent to approximately 205 GW. In addition, Japan must promote technical development for all of the five mitigation options, such as carbon capture and storage (CCS).

There is also plenty of room for innovation toward strengthening global systems for observing the ocean environment, a point that was mentioned in Recommendation 7. In particular, the development of biological and chemical Argo floats and ultra-deep-sea Argo floats will bring new data that will be extremely useful in understanding global environments of the future. Moreover, the development of small and inexpensive observation equipment will likely help eliminate north-south disparities.

It is important to position such innovation as a core of Japan's future industrial competitiveness and to build a mechanism for promoting environmental investment in ocean-related fields and providing financial support.

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■ Recommendation 9

All stakeholders, including all ocean sectors, should enhance resilience and cultivate knowledge through promoting education and climate literacy. It is also crucial for women to participate in the decision-making process regarding climate change policies and resource management.

A point that deserves noting concerning the SROCC is that it mentions aspects of cultural science (e.g., knowledge of indigenous peoples/local communities, etc.) much more often than the Fifth Assessment Report (AR5). A new term—"climate literacy[18]"—appeared in the Summary for Policymakers (SPM). Moreover, the report gives attention to the necessity of

[17] In simple comparison of installed capacity, 91 GW is equivalent to 91 large-scale (approximately 1 GW) nuclear plants.
[18] In past IPCC reports, "literacy" was primarily used when mentioning the problem of low literacy rates among women. However, in the SROCC, it is used as a word highlighting the importance of knowledge vis-à-vis climate change and its utilization.

promoting climate literacy as well as of using the local knowledge of coastal communities and knowledge possessed by indigenous peoples, such as those of the Arctic, in addition to scientific knowledge.

The SROCC lists education and climate literacy alongside monitoring and forecasting of climate change, addressing social vulnerability and equity, sharing of information, and institutional support as important factors for improving resilience to climate change and sustainable development (SMP, C4). The SROCC provides as background for this report that educational attainment has the strongest effect on raising climate change awareness and that education plays an important role in terms of people's climate change action and adaptation (Lee et al., 2015) (SROCC Chap.1,1.8.3).

The role that education plays here is not limited to the conveying of accurate scientific knowledge. It is important that opportunities also be provided for learning that the effects of climate change are not equal, that inequities can emerge at all levels—among generations, among nations, and among regions—as a result of them, and about people's responses and countermeasures to them. Understanding climate change comprehensively, including the basic fact that "climate change is caused by human activity, generally leads to stronger resilience to climate change.

Building an educational system that enables the kind of learning described above is necessary in order to spread climate literacy throughout Japan's school education. The first thing needed for this, on the education side, is to develop the skills of teachers. To do this, Japan should enhance the descriptions of ocean and climate change problems as well as of disaster prevention and mitigation appearing in government curriculum guidelines, using as the basis the scientific knowledge presented in the SROCC and other reports that have been approved/accepted by all countries (195 IPCC member States), and also promote the preparation and use of supplementary materials to promote understanding of climate change on both the teaching and learning sides. [19]

The SROCC makes almost no mention of problems that are unique to women. However, it does mention that "In the case of climate change, ..women are often more vulnerable to the impacts of climate change and may be disadvantaged in the process and outcomes of climate policy" (Glossary, gender equity). A recent study indicates that, based on case studies in Africa and western Asia, the burden on women (and particularly young or uneducated or women of low social classes) increases as a result of food shortages, worsening access to water, relocation of settlements, and long-term work away from home by men that comes as a consequence of such circumstances (Rao et al., 2019).

[19] For example, materials that the Ministry of the Environment prepares for "Global Warming Prevention Communicators" (people recruited and trained by the MOE to convey information on global warming; website registration is required) can serve as references by teachers who provide environmental education on climate change and accompanying changes in the oceans.

The Government of Japan should further promote gender equality within Japan and also, in light of the threat to people's survival from climate change in developing countries and the fact that women can be put in a more vulnerable position as a result, provide support for climate change adaptation to developing countries. In this respect, the expansion of climate literacy will help promote the participation of individuals, including women, in decision-making on matters (such as food distribution and management in the region/community and adjustment of fish catches) that are directly linked to their daily lives and also concern climate change by applying traditional and local knowledge. Discussion of gender equality in Japan does not always take place within contexts having a direct association with climate change. Nonetheless, the achievement of gender equality is a goal of the SDGs, and the promotion of women's active participation can become key in transforming our society into a sustainable society.

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■ Recommendation 10

The business sector should build a long-term strategy/plan based on its own climate-related risk assessment and convert it into a business model. In addition, both mitigation and adaptation (e.g., expansion of disaster prevention technology and provision of services to counteract risks from climate change) should be promoted in the process of creating business opportunities.

The SROCC asserts that to hold down temperature increases, substantial changes in the day-to-day activities of all actors, including business (the private sector) will be required (1.8.3). The Fifth Assessment Report (AR5) presented seven strategies[20] for creating a society that is resilient to climate change. Continuing this, the SROCC states that studies since AR5 have highlighted the need for transformations. As an example relating to the SROCC, it presents shifting from a paradigm skewed toward hard infrastructure by, for example, including "retreat" in risk management responses for coastal cities. Moreover, it

[20] 1) Broaden participation, 2) Maintain diversity and redundancy, 3) Encourage learning and experimentation 4) Foster complex system understanding, 5) Manage connectivity, 6) Manage slow variables and feedbacks, 7) Enhance polycentric governance

indicates that transformation in the context of ocean and cryosphere changes can be strengthened by transdisciplinary collaboration between actors in the scientific community, government, the private sector, civil society, and affected communities. (SROCC Figure CB2.2).

The private sector cannot be a party in concluding the Paris Agreement, which is an agreement among nations. However, the advancement of action by all actors, including the private sector, is required, and the sharing and exchange of information among actors under the Marrakech Partnership, etc., is intended. Furthermore, it is essential for sustainable corporate development that companies formulate long-term strategies and plans for both mitigation and adaptation and fundamentally review their business based on climate change-related risks. Transformation that addresses the increasing seriousness of climate change is an urgent challenge. Thus, companies must execute concrete countermeasures in terms of both mitigation and adaptation, such as making ambitious reductions in their GHG emissions and continuing business based upon the effects of disasters and other consequences of climate change. Additionally, whether or not a company is steadily implementing such measures is becoming something that investors consider when appraising companies. Thus, it is expected that companies will be bringing in ESG investment and financing, an approach that is attracting growing interest. On the other hand, it must be remembered that not executing measures is a form of management risk for companies. The government will also need to take actions so that companies recognize the risks and opportunities associated with climate change and implement appropriate measures. The disclosure of information relating to climate change has become a matter of importance in recent years. As a result, it is becoming increasingly common even in Japan for management strategies to be formulated by making use of the Task Force on Climate-related Financial Disclosures (TCFD). [21] More than 212 companies in Japan are TCFD supporters. Nevertheless, it is not so easy to say that use of the TCFD among small- and medium-sized enterprises is growing. Because of this, the government must go beyond simply preparing guidelines to promote substantive risk analysis and disclosure, and in particular, it must provide support to companies that have assets in vulnerable regions, such as coastal regions. Moreover, as companies see climate change as an opportunity, it is expected that they will endeavor to establish with government assistance various business models that use existing technologies and new ideas from startups to expand the markets of businesses capable of contributing to mitigation and adaptation. The promotion of even

[21] The TFCD was established in 2015 by the Financial Stability Board (FSB) based on a request from the G20. The TFCD actively promotes the disclosure of financial information concerning climate change. It recommends disclosures in four areas: Governance, Strategy, Risk Management, and Metrics and Targets. Companies supporting the TFDC total 920 companies worldwide and 212 companies in Japan (as of December 2019).

more private-sector participation and the development of a foundation for climate change risk-resilient business activity based on such approaches is required.

Company-led international networks and initiatives that address climate change and the SDGs can be found throughout the world. Prominent among them is the "UN Global Compact." [22] Acting jointly with other organizations, the UN Global Compact set up and operates the "Science-Based Targets Initiative (SBTi)" for member companies that sets "Target Climate 1.5℃" as one target for 2020. The SBTi asks member companies to set targets for reducing carbon dioxide emissions that conform with the Paris Agreement. (Conformity with the 2℃ is mandatory, and conformity with the 1.5℃ target is recommended. However, the SBTi is reiterating its call on member companies to work toward the 1.5℃ target in response to the Global Warming 1.5℃ special climate report.) As of November 2019, 312 companies around the world and 58 companies from Japan are presented as companies that have registered targets. Ocean-related companies from Japan that have registered targets are NYK Line (GHG emissions reduction 50% by 2050; corresponding to the 2℃ target) and Kawasaki Kisen (the same) in the ocean-based transport sector. International corporate groups standing alongside the SBTi to promote mitigation measures include "RE100," an alliance of companies that was formed in 2014 with the aim of powering their businesses with 100% renewable electricity (59 companies around the world have committed to this target, two of which are Japanese companies), and "We Mean Business," a platform comprised of companies, international organizations, think tanks, NGOs, and others that promotes measures to combat climate change (1,120 members worldwide).

Even more companies should promote emissions reductions throughout their supply chains by joining such corporate groups and setting emissions reduction targets. To that end, it is important that the Government of Japan actively present the initiatives of leading companies as "best practices" and provide support so that more companies will follow them. It is hoped that even more companies will look beyond the 2℃ target and take steps toward a more ambitious goal ("zero emissions in 2050") that aligns with the 1.5℃ target.

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[22] The UN Global Compact was advocated by then UN Secretary-General Annan and launched in 2000. Just under 14,000 companies from 160 nations are members, 341 of which come from Japan (as of November 2019).

3. Conclusion

As was mentioned at the beginning of this paper, the SROCC's message is clear. It is unambiguously shown that the entire planet is in a critical state, as changes have already begun to appear in the oceans and cryosphere and there are predictions of even greater change in the future.

This is not about some "far away world." Japan is a maritime nation that possesses the world's sixth-largest exclusive economic zone in terms of area and a long coastline. Its people's lives are closely associated with the sea, and the nation has developed by benefitting from its richness. The changes that are occurring (and will occur) in the ocean that is so close to us can have significant impacts on the lives of the Japanese people. We, the people living today, must bear it in mind that our choices will determine the future of Japan and the world.

As the Global Warming of 1.5℃ special report clearly states, there is a great difference in the climate change impacts and risks to people and ecosystems in a world where temperature rises 1.5℃ (since the Industrial Revolution) and a world in which it rises 2℃. In 2015, the world's nations, including Japan, agreed to chart a course toward a decarbonized society. However, even if measures based on the reduction targets (NDCs) that parties to the agreement have actually submitted were completely carried out, temperature rise would be about 3℃ at the end of the current century. This makes achieving the Paris Agreement's goals difficult. The future of Japan and the world depends on raising the ambitiousness of these targets and then reaching them.

Against this backdrop, the link between the oceans and climate was mentioned for the first time in a COP decision at the 25th Conference of the Parties (COP 25) to the United Nations Framework Convention on Climate Change (UNFCCC) held in December of last year. This and other developments point to recent growing awareness of the oceans' importance in the climate change problem. At the same time, however, there has been growing international criticism of Japan's dependence on coal-fired power generation in recent years, and this topic was discussed both inside and outside COP 25's venues. Now is the time for Japan, as a maritime nation, to apply ocean-based mitigation measures toward raising the ambitiousness of its NDCs and to clearly demonstrate this stance through its NDCs. And in parallel with this, Japan should lead the world in promoting initiatives that use the oceans as a "mitigation measure" to reduce GHG emissions. In other words, there is a need to use Japan's technical capabilities and experience as a maritime nation to lead efforts to mitigate global climate change with a focus on the oceans, and for the entire nation to respond appropriately to changes in ocean environments.

The author hopes that these recommendations and the associated discussion will serve as a

useful reference when various actors take action in response to the climate change/ocean-related problems described herein. This paper was compiled by the author with advice and cooperation (including help in some of the writing) provided by research fellows of the Ocean Policy Research Institute.