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Mini-Symposium on our scientific contribution to the Decade of Ocean Science

The 18th Japanese-French Oceanography Symposium entitled "Oceanography for future we want: transformation of our society for sustainable development with the changing sea" has been prepared to commemorate the 60th anniversary of the Japanese-French Oceanographic Society (SFJO) of Japan. The symposium aims to share new discoveries obtained through cutting-edge oceanographic research between participants from Japan and France, to serve to better transform human society for sustainable development and better adapt it to current changes in the ocean, marine and coastal environments. "The UN Decade of Ocean Science for Sustainable Development (UNDOS) aims to achieve a sustainable "the Ocean We Want" by 2030 through the work of research institutes and scientists from around the world working together over the next decade. The UNDOS outlined seven Decade Outcomes: a clean ocean, a healthy and resilient ocean, a predicted ocean, a safe ocean, a sustainably harvested and productive ocean, a transparent ocean and an inspiring and engaging ocean. The 18th Japanese-French Oceanography Symposium was organised in response to a common concern with the UNDOS: the need to transform society in order to overcome the crisis facing the oceans and to create a sustainable world. This web-based symposium "Mini-Symposium on our scientific contribution to the Decade of Ocean Science" featured six talks by six speakers from each of France and Japan (Table 1). Each of them corresponds to one of Decade Outcomes that is closely related to the content of each talk and present it in that order. The presentations were given in the order of the Decade Outcomes.

The mini-symposium was organised via the web on 19 October 2021 from 16:00 to 20:00 (CET). The presentations help to improve the understanding of the oceans among a wider audience and help to build a society that can appreciate the oceans. The abstracts presented to the mini-symposium are listed below the programme. This mini-symposium was supported by the Japanese-French Oceanographic Society France, *le Service pour la Science et la Technologie (SST) de l'Ambassade de France au Japon, la Fondation Franco- Japonaise Sasakawa,* the Japan Agency for Marine-Earth Science and Technology, the Japanese Society of Fisheries Science, the Japanese Society of Fisheries Oceanography, the Oceanographic Society of Japan and the Japanese National Committee of the UN Decade of Ocean Science for Sustainable Development.

Table 1. Programme of the mini-symposium on our contribution to the Decade of Ocean Science.

Time (JST)	Title	Speaker	The Ocean We Want for a sustainable future is represented by seven Decade Outcomes
16：00～16：20	Plastics contamination in the coastal areas around Japan	Hisayuki ARAKAWA	1. A clean ocean
16：20～16：40	Environmental conservation of the Seto Inland Sea, Japan	Kuninao TADA	1. A clean ocean
16：40～17：00	Marine biodiversity in the Mediterranean, in the era of global warming	Charles-François BOUDOURESQUE	2. A healthy and resilient ocean
17：00～17：20	Diversity of polydorid species (Polychaeta: Spionidae) in the English Channel (France) and on the Pacific Coast of Tohoku District (Japan)	Jean-Claude DAUVIN	2. A healthy and resilient ocean
17：20～17：40	Toward prediction of interaction between Coastal Circulation and the Kuroshio	Kiyoshi TANAKA	3. A predicted ocean
17：40～8：00	Influence of global warming on spatial distribution of *Sargassum horneri* in northwestern Pacific	Teruhisa KOMATSU	3. A predicted ocean
18：00～18：20	How frequently can we observe winds and waves for safer maritime transport?	Kaoru ICHIKAWA	4. A safe ocean
18：20～18：40	Safe seas through safe fishing work	Hideyuki TAKAHASHI	4. A safe ocean
18：40～19：00	Sustainable development and responsible exploitation. As an example, the management and exploitation of diadromous species in the context of Small-Scale Fisheries	Patrick PROUZET	5. A sustainably harvested and productive ocean
19：00～19：20	Ecosystem-Based Management approach applying to Artificial Reefs assessment: a case study of network analysis in Capbreton, France	Jessica SALAÜN	5. A sustainably harvested and productive ocean
19：20～19：40	Failure of bivalve foundation species recruitment in a context of extreme heat wave event	Franck LAGARDE	5. A sustainably harvested and productive ocean
19：40～20：00	Observing the deep and sharing the invisible: a nascent case study in the South Pacific, New Caledonia	Yves HENOCQUE	6. A transparent ocean

Abstracts presented to the mini-symposium on the on our contribution to the Decade of Ocean Science

Plastics contamination in the coastal areas around Japan

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1. Objectives

One desirable outcome of the UN Decade of Ocean Science for Sustainable Development is the "clean ocean" (https://en.unesco.org/ocean-decade). If a "clean ocean" is defined as an ocean of clear water, we want to have as few particles as possible in the seawater. In recent years, it has been reported that artificial plastic particles are increasing in the ocean. These floating particles gradually become damaged, and are known as microplastics (hereinafter MPs) when they are 5 mm or less in length (ANDRADY, 2011). Contamination by MPs is thought to have an adverse effect on various organisms living in the ocean (GALL and THOMPSON, 2015). For this reason, surveys have been conducted all over the world, from which is understood that MPs are distributed globally in the ocean. It has been reported that concentrations of MPs are higher in East Asian waters than elsewhere (ISOBE *et al.*, 2015). Distribution of MPs in the coastal waters of Japan needs investigation. This study examined the concentration distribution of plastic litter and MPs in East Asian waters, and especially in the coastal areas of Japan.

2. Survey of macro-plastic litter in Japan

A survey of marine plastic litter in Japan has been conducted since around 2014 and is carried out by observers on vessels passing through the survey areas. Plastic food packaging litter is widely distributed along the Japanese coast. Plastic bags are also widely distributed throughout Japanese waters, and numbers are locally elevated off the east coast of the Tsugaru Strait. Styrofoam and plastic bottles are extremely high near the Tsushima Strait.

3. MPs survey in Japan

The marine MPs survey was started at the same time as the litter survey. The detection method was to collect particles from the sea surface using a neuston net, to extract plastic-like particles in the laboratory, and to determine the polymer type by Fourier Transform Infrared Spectroscopy. The MPs on the sea surface were widely distributed along the coast of Japan, at an average concentration of 3.7 pieces m^{-3}. This concentration was very high compared with other sea areas in the world (ISOBE *et al.*, 2015),

and the average concentration of MPs in Tokyo Bay was 3.98 pieces m^{-3}. The concentration varied greatly depending on the location and season (NAKANO *et al*., 2021).

4. Survey of small MPs in Japan

The neuston net (mesh opening: 350 μm) was mainly used in the MPs survey, and so MPs smaller than 350 μm were not collected. For this reason we created double neuston nets, comprising two nets of 350 μm and 50 μm mesh, and investigated small MPs (hereinafter SMPs) in the open ocean (off the Tokai coast) and inner bay (Tokyo Bay). The concentration of SMPs was 1,000–5,900 pieces m^{-3} in the open ocean and about 3,000 pieces m^{-3} in the inner bay.

5. Discussion

In recent years, the Japanese Ministry of the Environment and Japanese universities have investigated the concentration distribution of marine plastic litter, MPs ($>$ 350 μm) and SMPs ($<$ 350 μm) off the Japanese coast. Gradually, progress is being made in our understanding of plastics pollution in the sea area. It is difficult to compare research data because unified methods of collecting and analysing MPs have not yet been established. In particular, no appropriate survey method has been established for SMPs. Development of methods of detecting SMPs must continue. In the future, data not only on the origin and distribution of MPs of various sizes in sea areas, but also of pollution on the beach, seabed, and organisms must be accumulated.

Acknowledgements

We appreciate the cooperation of staff from the training ships *Umitaka-maru*, *Shinyo-maru*, *Seiyo-maru* and *Hiyodori* of the Tokyo University of Marine Science and Technology. A part of this study was supported by the Environmental Research and Technology Development Fund (JPMEER20211003) of the Environmental Restoration and Conservation Agency provided by Ministry of the Environment of Japan and by SATREPS of the Japan International Cooperation Agency and Japan Science and Technology Agency, Japan.

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Changes in nutrients and their effects on fisheries after the introduction of land-based nutrient loading regulations in the Seto Inland Sea since 1973: A review

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1. Objectives

The Seto Inland Sea is the largest enclosed sea in Japan (Fig. 1). The sea is well known as beautiful landscape including about 600 islands. This sea is also an industrially developed area and about 30 million people live in the coastal area. This sea was heavily eutrophicated during 1960s and 1970s. After that, the water quality gradually improved. Here, we review the change of water quality for about the last 40 years in this sea. We will discuss the nutrient decrease, focusing on Harima Nada, the eastern part of the Seto Inland Sea based on information obtained during our previous study. Our study is in line of with the basic policy of the "14 Life Below Water" of SDGs, "Conserve and sustainably use the oceans, sea and marine resources for sustainable development". Also, in this year, "United Nations Decade Ocean Science for Sustainable Development" has started. We also conduct this research in accordance with the "Ocean decade".

2. Previous eutrophication and its environmental conservation in the Seto Inland Sea: Background of the present environmental problem

During high economic growth since the 1960s, the Seto Inland Sea became heavily eutrophicated due to serious water pollution by industrial effluent and urban wastewater. At that time, red tides often occurred. To resolve the situation, the Law for Conservation of Environment of Seto Inland Sea was enacted in 1973. Since 1973, the industrial effluent and urban wastewater were regulated by a Total Pollution Load Control System under this law. After that, the number of red tide occurrences decreased from 300 times to 100 times per year and then it is now constant under 100 times. Whereas the water quality has improved, recent seaweed (*Nori*) bleaching due to lack of nutrient has often occurred and *Nori* culture in this sea was heavily damaged despite the water quality improvement. Fish catches have also gradually decreased.

3. The nutrient dynamics in Harima Nada

The nutrient concentrations (NO_3, NH_4, and PO_4) have apparently decreased since 1970s, as has dissolved inorganic nitrogen (DIN: NO_3 + NO_2 + NH_4) (Fig. 2). However, total nitrogen (TN) and phosphorous (TP) concentrations have not apparently decreased, although TN and TP loadings to the sea were reduced 40% and 61%, respectively, from 1979 to 2009 by implementing a Total Pollution Load Control System. It suggested that the decrease of nutrient concentrations could not be explained by only reducing of TN and TP loading. To maintain the appropriate nutrient condition, we need to know the mechanism of nutrient circulation and nutrient behavior. The nutrient concentrations of this sea water should be decided by the balance of nutrient income and outgo at three sites (Fig. 3a). Those are the freshwater inflow from the river, the interface between the coastal sea and open ocean or adjacent sea, and the interface between the bottom sediment and bottom water. In three sites, we monitored the upward

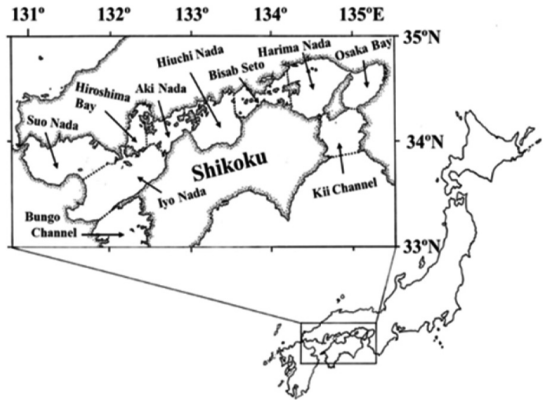

Fig. 1 Location of the Seto Inland Sea.

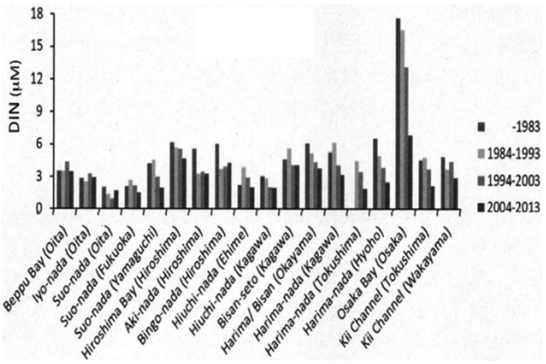

Fig. 2 Average DIN concentrations for every 10 years in each sea area (ABO *et al.*, 2018).

nutrient flux across the overlying water-sediment interface. In Harima-nada, it was estimated that nutrient flux from bottom sediment during summer was larger than nutrient inflow from the river by 3.2 times (TADA *et al.*, 2014). To know the nutrient dynamics, we are trying to reveal the budget of the nutrient cycle in the water column, including the primary production of phytoplankton, organic matter settling fluxes, decomposition of settling matter in the bottom layer, and nutrient upward flux from bottom sediments (Fig. 3b).

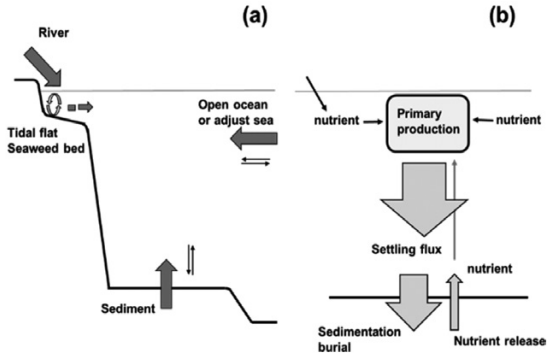

Fig. 3 Nutrient Dynamics (a) and material cycle in a coastal sea water.

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Marine biodiversity in the Mediterranean, in the era of global warming

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The Mediterranean is a semi-closed temperate to locally warm sea. It is a hotspot of species, functional and ecosystem diversity, characterized by a high rate of endemism and a number of unique ecosystems. Between 12,000 and 17,000 marine species have been reported in the Mediterranean. Only one species is totally extinct and less than ten are extinct in the Mediterranean but still present elsewhere. In contrast, many species are functionally and/or regionally extinct. The progressive arrival of a thousand non-native species has in fact considerably increased the epsilon species diversity of the Mediterranean, contrary to the naive beliefs of some environmentalists. Several of the emblematic ecosystems of the Mediterranean (e.g. the seagrass *Posidonia oceanica* meadow, the dune-beach-banquette ecosystem, the *Lithophyllum byssoides* algal rim and the coralligenous) are currently in decline. Finally, the functioning of ecosystems (relative abundance of key species, carbon and nutrient flows, food webs, and interactions between ecosystems) has been profoundly altered. The causes of these effects on biodiversity are various; the three main ones are overfishing, biological invasions and coastal development. Global warming is beginning to play a role, which will increase significantly over the course of the 21st century, but it is currently far behind other human-induced causes. The concern over the growing and irreversible effects of global warming is totally justified; but the underestimation of other threats is based on reasons which may be political or related to human perceptions and science funding, and which are discussed here.

Diversity of polydorid species (Polychaeta: Spionidae) in the English Channel (France) and on the Pacific Coast of Tohoku District (Japan)

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The polydorid (Annelida, Spionidae) contains nine genera: i. e. *Amphipolydora*, *Boccardia*, *Boccardiella*, *Carazziella*, *Dipolydora*, *Polydora*, *Polydorella*, *Pseudopolydora*, *and Tripolydora*, with each of them having a modified fifth chaetiger. Identification of polydorids remains problematic due to numerous confusions of species and their unknown distribution: i.e. several introduced species around the world ocean. Moreover, many polydorid species are known for their boring into calcareous substrates, and have been reported to inhabit various types of living and non-living calcareous structures including mollusc shells, corals and coralline algae. They cause grave damage to their calcareous hosts, and polydorid infestation is considered as a serious problem in aquaculture especially for oyster culture. Successive inventories have reported polydorids in the English Channel (FAUVEL, 1927; DAUVIN *et al*., 2003; RUELLET, 2004). There are some reports describing polydorids from the Pacific coast of Tohoku District, Japan (SATO-OKOSHI, 1999; 2000; ABE *et al*., 2020). Species Richness in both areas is compared and discussed. Moreover, in March 2018, French-Japanese collaboration led to the collection of polydorid species from the shells of feral and cultured oysters *Crassostrea gigas* (THUNBERG, 1793) along the western coast of Normandy, France. Some species were also extracted from coralline algae and other calcareous substrates. Eight species were recorded from four polydorid genera: *Boccardia, Boccardiella, Dipolydora* and *Polydora*. The two species *Polydora hoplura* Claparède, 1868 and *Dipolydora giardi* (Mesnil, 1893) were previously known in Normandy, along with another member of the genus *Dipolydora* that has not been identified to the species level. *Boccardia proboscidea* Hartman, 1940, *Boccardiella hamata* (Webster, 1879) and *Polydora websteri* Hartman in Loosanoff & Engle, 1943 represent new records in Normandy, while both *Boccardia pseudonatrix* Day, 1961 and *Polydora onagawaensis* Teramoto, Sato-Okoshi, Abe, Nishitani & Endo, 2013 are new species for European waters. We point out that collaboration with polychaete specialists to study well-known seas such as the English Channel would

allow us to discover new species, expanding the list of species actually present. This study also highlights the need to continue this partnership further identify which polychaete species infest English Channel oysters.

Toward prediction of interaction between Coastal Circulation and the Kuroshio

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1. Objectives

We are currently conducting a research project designed to investigate interaction between coastal circulation and the Kuroshio current. The goal of our project is to present a clear vision for future ocean science in bays and estuaries adjacent to the Kuroshio, meeting the expected outcome of the UN Decade of Ocean Science, especially for "A Predicted Ocean". To achieve this goal, we have three objectives: development of numerical simulation, establishment of sustainable in situ observation, and collaboration with stakeholders. Background and progress of the project is introduced in this paper.

2. Background

Coastal circulation off the south coast of Japan interacts strongly with the Kuroshio current. For example, after being detached from the Kuroshio current, meso- and submesoscale disturbances with momentum are often captured into small bays, where they drive local peculiar coastal circulation (Fig. 1). This example indicates that understanding and prediction of the interaction between coastal circulation and the Kuroshio current are necessary to achieve a healthy, safe, and resilient ocean for sustainable development including improved forecasts of regional weather and climate and better management of regional fisheries and aquaculture.

We are in an age when high-resolution ocean

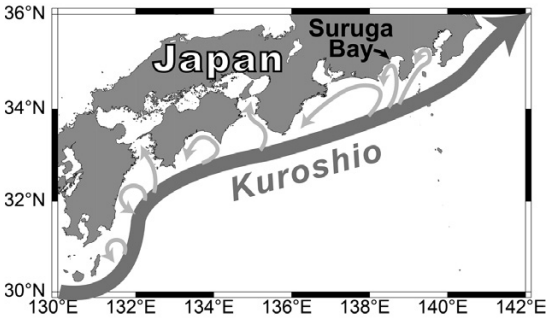

Fig. 1 Schematic of the Kuroshio current and coastal circulation off the south of coast of Japan.

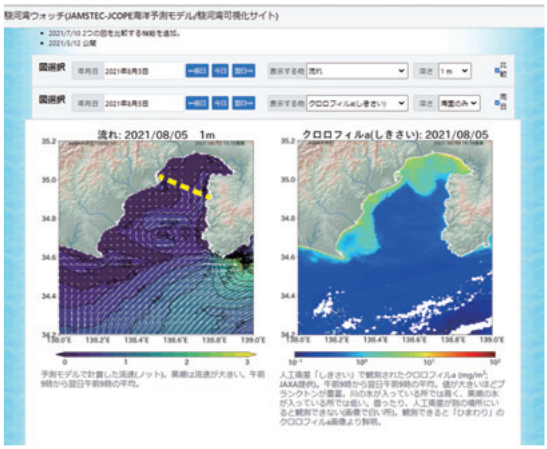

Fig. 2 Open website of JCOPE model. Left: forecasted surface currents. Right: forecasted surface chlorophyll.

circulation models have started simulating the meso- and submesoscale disturbances directly. Moreover, in situ observation has recently become easier to perform using ordinary fishing boats or commercial ships, because observational instruments have been downsized. It should be noted that in coastal seas, there are usually few research boats or ships equipped with advanced observational instruments. Therefore, we have developed a project that performs numerical simulation using state-of-the-art ocean circulation models and in situ observation using ordinary fishing boats and a commercial ship to study the

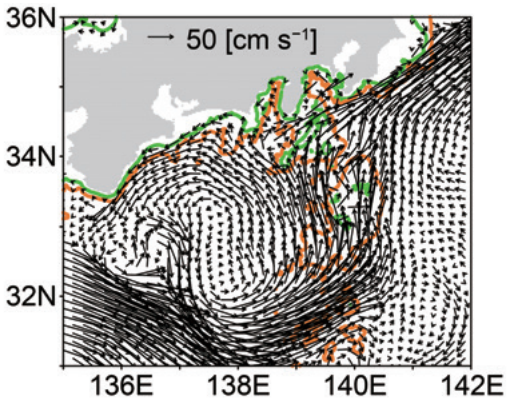

Fig. 3 Surface currents in MRI.COM model.

interaction between coastal circulation and the Kuroshio current around Suruga Bay off the south coast of Japan (Fig. 1). A key point is that the numerical simulation is validated by the in situ observations.

3. Results

Two types of numerical models with variational data assimilation are used: JCOPE model with a terrain following (s-) coordinate system has been developed by JAMSTEC (Japan Agency for Marine-Earth Science and Technology). MRI.COM model with a geopotential (z-) coordinate system has been developed by JMA (Japan Meteorological Agency). Both the models successfully reproduce complex circulation systems between the south coast of Japan and the Kuroshio, including daily variations of winds, river discharge, and tides (Figs. 2 and 3).

Two types of in situ observation are ongoing. An ADCP (acoustic Doppler current profiler) mounted on the bottom of a commercial ferry (Fig. 4) is measuring velocity profiles on a transect across Suruga Bay every day (dashed line in Fig. 2). Moreover, mooring observation (Fig. 5) has been performed to record time

Fig. 4 The ferry "Fuji", on the bottom of which an ADCP is mounted.

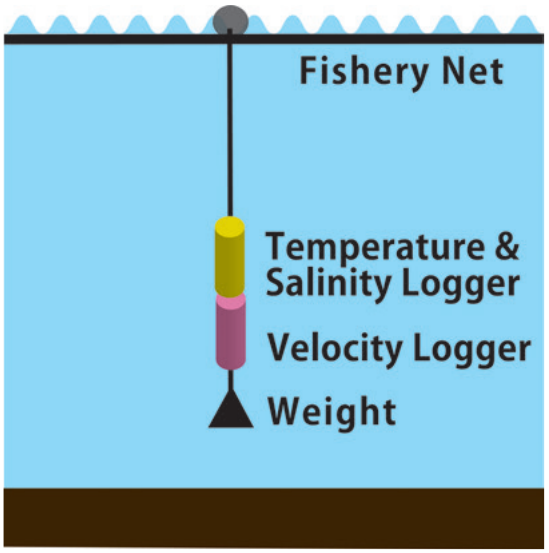

Fig. 5 Schematic of mooring system equipped with a fishery net.

series of temperature, salinity, and velocity with shorter time intervals at a few fixed positions in the bay.

4. Discussion

To achieve our project goal, synergistic collaboration with stakeholders such as local fishers and shipping agencies is essential. This is because frequent observations with high spatial and temporal resolution cannot be made without their support. In other words, there are usually few research boats or ships in most of the coastal seas. At the same time, there are many fishery problems that cannot be solved without state-of-the-art ocean science, because seawater circulation has a crucial influence on fishing grounds. In these points our project meets the goal of the UN Decade of Ocean, developing a sustainable ocean science.

Acknowledgements

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Influence of global warming on spatial distribution of *Sargassum horneri* in northwestern Pacific

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1. Introduction

Seaweed and seagrass beds are one of the most important primary producers in coastal areas and provide a habitat for many organisms, and their ecosystem services per unit area are estimated to be about ten times those of tropical forests (Costanza *et al*., 2014). Large seaweeds and seagrasses spend a long period of their life history as anchorage and are not able to move actively. The effects of ocean warming on benthic organisms that live fix on hard substrates are clearly visible as changes in their distribution areas. Komatsu *et al*. (2014) estimated changes in the distribution of *S. horneri* based on surface water temperature data for 2050 and 2100 estimated under the A2 scenario of IPCC (2000), which assumes high economic growth and regional identities. However, the spatial resolution was coarse (1.1° longitude and 0.55° latitude) and made coastal water temperatures problematic. Thus, predictions of surface water temperatures with higher spatial resolution were desired.

Institute of Applied Mechanics of Kyushu University (RIAM) has been developing a model, DREAMS, for estimating future water temperature distributions in the northwest Pacific Ocean with high spatial resolution. Using the surface water temperature in 2100 calculated by DREAMS, we estimated the future geographical distribution of *S. horneri*, which is the most widespread and biomass-rich species in northwestern Pacific and important species forming floating rafts in the East China Sea (e.g. Komatsu *et al*., 2008; Mizuno *et al*., 2014). We also examine the impact of global warming on the relationship between yellowtail juveniles that use *S. horneri* floating rafts as a habitat.

2. Water temperature distribution data

The model DREAMS_B (Hirose, 2011) with a high spatial resolution of longitude 1/4° x latitude 1/5° is used to calculate the future ocean environment in the Northwest Pacific Ocean under the RCP8.5 high reference scenario (a scenario in which the maximum possible amount of greenhouse gas emissions is assumed to continue until 2100). Based on the results, we used the surface temperatures in 2000 and 2100 as estimates for August, the month with the highest surface temperatures, and February, the month with the lowest surface temperatures. Based on this range of maximal and minimal water temperatures in the coastal zone in which *S. horneri* could grow, we estimated the coastal area where the *S. horneri* can grow based on the surface water temperatures in 2100.

3. Growth temperature range of *Sargassum* horneri and its distribution in 2000

On the Sea of Japan coast, *S. horneri* grows as far south as Amakusa Peninsular in Nagasaki

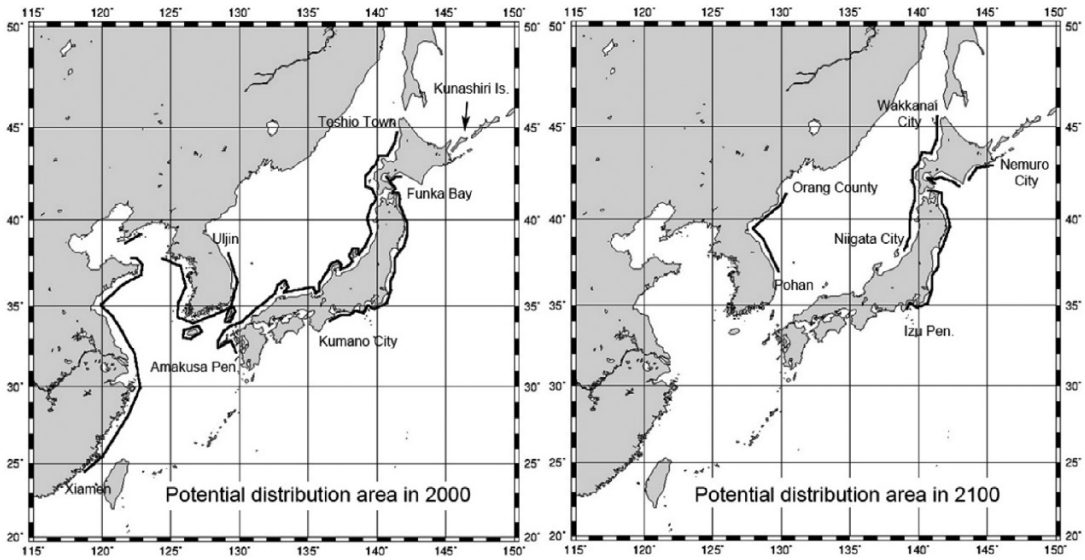

Fig. 1 Map showing potential geographical distributions of *Sargassum horneri* (solid line) in 2000 (left panel) and 2100 (right panel).

and as far north as Teuri in Hokkaido Prefecture, while on the Pacific coast, it grows as far south as Mie Prefecture in Kii Peninsular and as far north as Kunashiri Island (UMEZAKI, 1984). We tuned Umezaki's north and south ends of *S. horneri* distributions according to our field surveys. On the East China Sea - Sea of Japan side along the Japanese coast, the distribution of *S. horneri* ranged from Amakusa Peninsula in Kyushu in the south to near Teuri Island in Hokkaido in the north, and on the Pacific side along the Japanese coast, from Kumano City in Mie Prefecture in the south to Funka Bay in Hokkaido in the north. According to the geographical distributions of *S. horneri*, sea surface temperature (SST) in February, which is the coldest month of the year, in the coast where *S. horneri* grows is 15℃ at the highest and 4℃ at the lowest in East China Sea - Sea of Japan side and 14℃ at the highest and 4℃ at the lowest in the Pacific side of Japan. The SST in August, which is the highest month of the year in the coast where *S. horneri* grows is 28℃ at the highest and 22℃ at the lowest in East China Sea - Sea of Japan side, and 28℃ at the highest and 20℃ at the lowest in the Pacific side of Japan. Based on these results, the potential distribution range of *S. horneri* was estimated to be around Xiamen, Fujian Province in the south and Uljin, Korea on the east coast of Korean Peninsula in the north along the Eurasian coast (Fig. 1).

4. Predicted distribution of *Sargassum horneri* in 2100 and impact on yellowtail juveniles

Based on the predicted water temperatures in February and August of 2100, we estimated the potential distribution range of *S. horneri* (Fig. 1). Along the Eurasian coast, Sea of Japan and Pacific coast of Japan, the potential geographical distribution of *S. horneri* was estimated to move northward. Maximum water temperatures in summer were the main factor limiting the distribution of *S. horneri* in these areas.

According to YAMAMOTO *et al.* (2007), the optimum SST for yellowtail spawning in East China Sea is 19–21°C. In February and March 2100, the surface temperature range of 19–21°C in East China Sea was 122–124°E, 27–28°N in February and 125–129°E, 31–33.8°N in March. There is no possibility for 20-day-old yellowtail juveniles to encounter *S. horneri* in East China Sea (Fig. 1).

How frequently can we observe winds and waves for safer maritime transport?

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1. Introduction

Observations of offshore sea states are difficult since the ocean is wide and far from lands where people are living. In general, however, timescales of most oceanic variations are long, so any observations are significant even if they are intermittent. Especially, recent progress of numerical models and data assimilation techniques enables us to forecast oceanic conditions from limited observational data.

However, atmospheric conditions govern sea surface winds, and sea surface waves forced by them. Therefore, their timescales are often smaller than the other oceanographic variations. This also means that assimilation of a single measurement can improve the numerical model only for a small adjacent time and location. To improve accuracy of long-term forecast of the model for offshore winds and waves, therefore, we need denser observations. This would be a critical problem for safe offshore marine transport. In other words, selections of safe and economic ship routing would strongly depend on observation density of observe offshore winds and waves. In this presentation, we discuss how often we can observe offshore winds and waves by various methods.

2. Winds

The most essential method to observe offshore winds is in situ measurements by ships. Although locations of observations are limited to ship routes, this method can provide temporally continuous observations. Nevertheless, this method could be strongly biased, since no observations are available when wind conditions are severe, which would be critical for forecasting safe marine transport. Meanwhile, moored buoys and surface drifters can provide continuous in situ observations outside the ship routes. However, their locations are significantly limited comparing to the vast size of oceans, since their maintenance and deployment costs are too high to cover wide areas.

Satellite observations are the most practical method of observing global winds. Various types

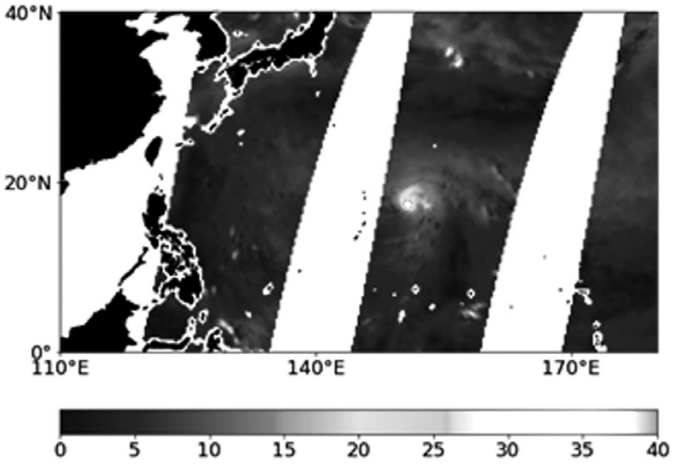

Fig. 1 Wind speed distribution (ms^{-1}) in the afternoon on 29 August 2018 (by JAXA AMSR2 sensor).

of sensors on satellites can estimate sea surface wind speeds, but most of them indirectly measure the amplitude of short-wavelength wind waves that respond to local wind speed. Within a short period, global distribution of wind speeds can be measured (Fig. 1), and these observation data will be available soon after they are downlinked to ground stations. By combining several sensor records, offshore wind speeds at an arbitrary point can be observed several times in a day, which are now essential inputs for wind forecasting.

3. Waves

Unlike winds, quantitative measurements of waves by ships are difficult since a sailing ship generates additional waves around herself. Therefore, buoys and surface drifters become an essential in situ method for observing offshore waves, which shows that locations of *in situ* wave observations are significantly limited. Furthermore, no satellite sensors other than altimeters can provide a direct estimation of wave heights, or amplitude of swells. Although satellite altimeters cover global ocean, they cannot provide horizontal two-dimensional coverages, as in Figure 1; observation points of altimeters are confined along tracks just below the satellites. Thus, observations of offshore wave heights are significantly intermittent both in time and space. These sparse observations are not commonly used in practical numerical wave model estimations.

Recently, a new method has been proposed to observe wave heights by ships. As shown in Figure 2, GNSS signals reflected at the sea surface are received together with direct signals. Since the reflected signals travel longer distance than the direct signals, the distance between sea surface and the antenna can be estimated from this difference (GNSS Reflectometry, or GNSS-R). More frequent observations of offshore wave heights could be possible by using such GNSS-R methods.

Acknowledgements

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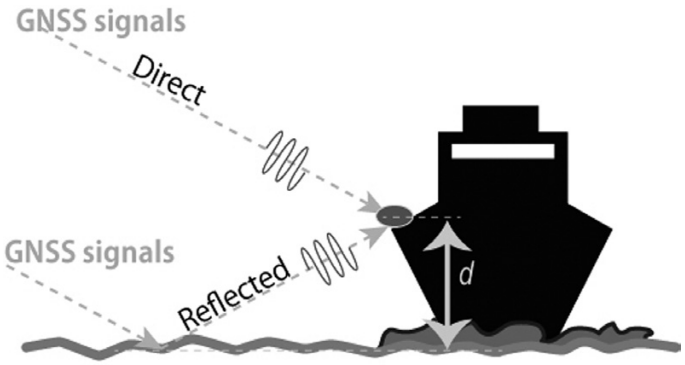

Fig. 2 Concept of GNSS-Reflectometry.

Safe seas through safe fishing work

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1. Introduction

Fishery is a dangerous industry in Japan. Fishery stands third when considering the highest occupational accident rate by industry (MINISTRY OF HEALTH, LABOUR AND WELFARE OF JAPAN, 2020). The number of Japanese fishers is declined steadily to around 150 thousand in the 2010s—a quarter of that in the 1970s (FISHERIES AGENCY OF JAPAN, 2018). Furthermore, nearly 40% of fishers are 65 or older. While the Japanese population is declining and aging, but fishers are weakening at a greater rate. The fact that fishery is still a dangerous industry might be a cause of the weakening, along with the deterioration of fish catches and the economic situation. To revive the Japanese fishing industry, it is important to develop a safe working environment. In this presentation, I have illustrated my research efforts on fishers' work safety and related national efforts in Japan. Based on the findings, the steps required for ensuring fishers' work safety have been discussed.

2. Efforts to understand the actual labor situation in the fishing industry

Fishing has always been considered dangerous in Japan. However, when I started my study twenty years ago, there was little knowledge about the actual dangers involved in fishing and their extent. To observe the actual work involved in fishing, I boarded various fishing boats nationwide and recorded their work. By applying ergonomic techniques to my findings, I analyzed the kind of work involved and the

extent of burden exerted by each kind on the fisher's body. In small trawls, one of the popular fisheries in Japan, a lot of time was spent on fish sorting, during which there was a heavy physical burden on the lower back of fishers (e.g. TAKAHASHI, 2015). Based on these findings, improvement measures were also proposed (e.g. TAKAHASHI *et al.*, 2017). As an advanced measure, an assistive suit was proposed to reduce the burden on the lower back while working in leaning postures (TAKAHASHI *et al.*, 2021). I am trying to apply this approach to other fisheries, including fisheries in other countries, to expand my knowledge.

Not a few fishers do not wear life jackets despite the availability of essential work safety equipment on board. I asked some fishers to use and compare different jackets in their line of work. There is a wide variety of work styles, and the suitability of jackets varies with the type of work (TAKAHASHI *et al.*, 2020). This knowledge should be applied to other fisheries to enable the dissemination of suitable jackets according to the type of work.

3. Recent national efforts to secure fishers' occupational safety

Parallel to my research, national efforts have also been gradually increased for fishers' occupational safety in Japan. I have been involved as a committee member in major cases as discussed below:

In 2013, a project funded by the Fisheries Agency of Japan was initiated to secure a safe work environment for fishers. The main objective of the project is to hold seminars for fishers nationwide and facilitate their learning of basic occupational safety. More than 5,000 fishers have attended the seminars to date. Although the project is not large enough to reach all fishers, it is steadily contributing to disseminate the knowledge of safety in fishing work.

In 2016, life jacket use was discussed in a joint meeting held by the Ministry of Land, Infrastructure, Transport and Tourism and the Fisheries Agency of Japan. It was decided that, in principle, all passengers of fishing boats would be required to wear life jackets.

In 2020, the Ministry of Agriculture, Forestry, and Fisheries of Japan hosted an expert meeting on new occupational safety measures in some industries, including fisheries. A norm and a check-sheet were created for each industry, summarizing work safety issues that business operators must consider.

4. Discussion

Over the last decade, knowledge of fishers' work and the problems associated therein has gradually accumulated. National efforts are being made to address the problems. It is important to establish a simple and effective method of occupational safety, distribute it to fishers all over the country, and continue these efforts until occupational safety is established. Infrastructure that enables the continuity of long-term projects must be built. I hope that the working environment of fishers will improve significantly in the United Nations Decade of Ocean Science for Sustainable Development (2021–2030).

Acknowledgements

The surveys introduced in this presentation were realized by the kindness and cooperation of fishers as well as other relevant parties. I am grateful to my colleagues for the support extended to me during this study. Parts of the surveys were carried out under a public project funded by the Fisheries Agency of Japan. I would like to thank Editage (www.editage.com) for English language editing.

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Sustainable development and responsible exploitation. As an example, the management and exploitation of diadromous species in the context of Small-Scale Fisheries

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Abstract

Defined in a report of the World Commission for Environment and Development (1988), the Sustainable Development is positioned at the convergence of 3 areas of equal interest: economy, social and environment. The definition and the implementation of a sustainable development policy is a negotiation process among actors with different powers from an economic and social point of view. Some are strong, others weak or absent. Some are directly concerned for their social and economic future by the productivity of the natural environment while others are not. Some are never present at the negotiation table such as future generations and the Nature itself.

The definition of a sustainable development policy is based on different principles such as: Precautionary principle (Article 15 of the Earth Summit declaration in 1992); Principle of prevention; Polluter-pays principle. In France, the Precautionary principle is included into the French Constitutionality Corpus in 2005 but, with some modifications by comparison with the initial definition. In particular, the notions of "economically bearable cost" and "effective and proportionate measures" have been added. So, in most cases, the environmental sphere is disregarded when socio-economic interest is at stake

and the equilibrium between the 3 components: economic, social and environmental of the sustainable development is not respected.

In that context, the sustainable exploitation of aquatic living resources is more and more difficult to achieve in accordance with the Maximum Sustainable Yield, the level of which continues to decline with the degradation of continental, estuarine and coastal environment under the pressure of many anthropogenic factors. It is particularly the case for diadromous fisheries (but many fisheries of coastal fish species are in the same situation) the future of which is seriously affected by a sectoral legislation that focuses its attention, for the sake of convenience, mainly on the regulation of fisheries and less on the decrease of the footprint of many uses that greatly affect the productivity of the natural environment.

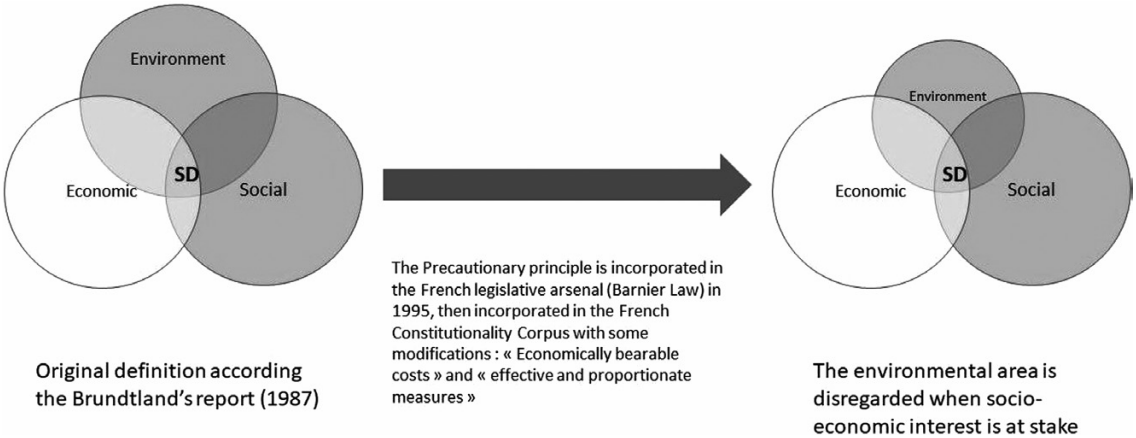
It is the reason why the communities of fishers prefer to speak of responsible exploitation rather than sustainable exploitation particularly with regard to small scale fisheries. The responsible exploitation is more than a simple fishing activity, it includes: production of fish in the respect of fishery legislation in order to minimize the footprint of the fishery, environmental watch to participate in the management of the aquatic living resources and its habitats, whistle-blower to draw attention of public authorities to the risk of irreversible environmental damages.

A more socio-ecosystem based approach is needed. Many studies conclude that small scale fisheries and generally artisanal fishing is more a way of life than a profession. It is essential to recognize the diversity, complexity and dynamics of this kind of activities. This is possible at the scale of the territory for the implementation of a genuine environmental governance, the fourth component of the sustainable development and to take into account a fifth component, the culture in the sense of knowledge and know-hows as the expression of intergenerational solidarity.

Contents

As early as 1972, the UNESCO General Convention adopted a convention for the protection of the world's cultural and natural heritage and underlined the need to maintain the balance between natural and cultural goods. This agreement was further confirmed by the Earth summit in Rio in 1992: in addition to the ecological footprint, it was essential to introduce the notion of a cultural footprint.

It is clear that governance as defined in the classical framework of sustainable development based on a so-called balance between the three spheres of interest: economic, social and environmental is a failure both socially and environmentally. As mentioned previously, the compromises for the implementation of a sustainable development policy have too often been made at the expense of weak actors, i. e. those who live directly off the goods and services of Nature. Yet



it is these actors who often integrate into their cultures (in the sense of knowledge and know-how) and their heritage, the cross-generational links that take future generations into account in the negotiation process via the transmission of knowledge and respect for Nature, a non-human actor very often absent from these negotiations.

As an example: The project Nature and Culture developed by the two SFJOs.

Ecosystem-Based Management approach applying to Artificial Reefs assessment: a case study of network analysis in Capbreton, France

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For more than fifty years, Artificial Reefs (ARs) have been deployed in France to answer world decrease of harvested fish stocks. The main objective of these structures is to sustain artisanal fisheries and enhance fish's biomasses. However, despite of the ARs worldwide deployment and the increasing research on their design, performance and management, the

understood of their effectiveness regarding the production and protection still remain a point of interest for scientists and managers. As known in Japan under the name "Sato-umi", ARs are one of the main tools used to manage and support biodiversity for a "win-win" interaction between human activities and ecosystems. But there is a lack of feedback and long-term monitoring, that raises several questions regarding their, both, social and ecological benefits. Network analysis is useful to address diverse ecological, social, economic, management questions, but at our knowledge few studies combine social and ecological in a single analysis. Understanding link between social and ecological network helps in the establishing of Ecosystem-Based Management for sustainable use of marine resources. By coupling social and ecological network analysis in a single study, we aim to provide holistic results in order to contribute and enrich Ecosystem-Based Management. We've applied network analysis on French AR's located in Capbreton in the southern part of the Bay of Biscay, Atlantic French coast; manage by an environmental association named "Atlantique Landes Récifs" for more than twenty years. In this aim, provide social and ecological analysis, we will firstly present our results to identify the stakeholders' objectives throughout Actor Network Theory tool and reveal the social-ecological process guiding AR's project development. Then we apply the network analysis framework to reveal the keys stakeholders and define the strongest links between them. We've found that local stakeholders support effective ARs management by relying on a large social network. Thus, this web of actors has been enhanced by time and integrate various scales of stakeholders, from local to international, for instance with Japanese researchers through SFJO colloquium. Our network analysis approach allows to enrich social aspect with ecosystems indicators, using ecological trophic modelling. This analysis highlights interactions between species at different trophic levels as they are based on the quantification of flows of energy and matter in ecosystems. Coupling with Before-After Control Impact (BACI) approach, the trophic analysis could provide effective overview to assess artificial structure net benefits on the marine ecosystem, such as low influence on fish assemblage. The comparison of the ecosystem state before and after a range of five to twenty years of ARs deployment by using a trophic modelling and *in situ* data is an innovative approach that has only been experimented in Laizhou Bay (China). Our results shown that ARs stakeholders' involvement and collaboration supports ensure their long-term protection of biodiversity and an effective AR's management. This social-ecological approach provides an integrated framework with an operational and innovative method.

Failure of bivalve foundation species recruitment in a context of extreme heat wave event

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Abstract: Bivalves are important regulator of coastal lagoons providing a wide range of ecosystem services, but these environments are very sensitive to climate change. Here, we present the ecological cascade of an extreme heat wave until the recruitment failure of a bivalve foundation species, the oyster *Crassostrea gigas*. Results show evidence that high salinity and temperature modified largely the planktonic community with a shift on small-sized taxa. These trophic changes had no impact on food accumulation by oyster larvae, but act on the metamorphosis process where the development of gills by young juveniles could not be adapted to these small particles. The result is a recruitment failure of oysters and the stimulation of annelid development, a trophic and space competitor, more adapted for the ingestion of small particles. This new knowledge prove that the ecological limits of oyster larvae are narrower than the physiological limits in this context of marine heat waves.

Observing the deep and sharing the invisible: a nascent case study in the South Pacific, New Caledonia

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France (IFREMER) and Japan (JAMSTEC), through their long collaboration history, agreed to develop and run in common the first deep sea observatory in the South Pacific, around New

Caledonia. Besides its scientific and technological aspects, the project will give much importance to local and regional stakeholders engagement with overarching principles such as the convergence on common goals, effective communication, co-production of information and knowledge, and the need for innovation.