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New Developments in Japan’s Marine Information Management

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Abstract

The ocean offers an extremely broad range of information that covers all phenomena arising in the ocean, such as waves and currents, water quality, marine organisms, marine minerals, and ship behavior. Due to this characteristically diverse and widely varying mixture of information, even information that has been acquired with the government’s budget has been difficult to manage in a centrally integrated manner to date. In addition to the diverse nature of the information, the poor demand for sharing information that each ministry and agency has been collecting and using for their own respective purposes is another reason for the lack of progress in consolidating ocean information.

In response to the Basic Act on Ocean Policy enacted in April 2007, Japan finally took its first steps towards integration of its ocean information. In April 2019, the Japan Coast Guard commenced the operation of MDA Situational Indication Linkages (MSIL), an information service that superimposes and displays satellite information, maritime meteorological information, and other ocean information collected and held by the government, on Web-GIS. This paper provides an overview of the background leading up to the integration of ocean information and the future outlook, while introducing the categories of ocean information and Maritime Domain Awareness (MDA) system.

1. Three Categories of Ocean Information: Cadastre, Nature, Human Activities

1.1 Social Information of the Ocean

The foundation of ocean information is comprised of social information, which offers a spatial indication of the boundary of rights and interests in the ocean. This includes port areas and mining areas, fishery rights, and training waters. Overseas, a system known as Marine Cadastre was developed in each country from around the year 2000 along with the advancement of the Geographic Information System (GIS) (Tsunoda et al, 2010[※1)]. In Japan, reviews for a cross-ministerial platform commenced with the enactment of the Basic Act on Ocean Policy in 2007, and this platform was launched by the Japan Coast Guard in the form of the Marine Cadastre system in 2012. It is characterized by its ease of management on GIS due to the small volume of information (volume of data) and few temporal variations.

1.2 Social Information of the Ocean

The second category of information, conversely, has a large information volume and significant temporal variation. This is natural science information. Tsunoda et al (2010) have presented this as information obtained through oceanographic surveys, such as physical information, chemical and environmental information, and biological resource information of the oceans. For example, hydrographic conditions, which are shown in Figure 1, are not as simple as the current charts presented

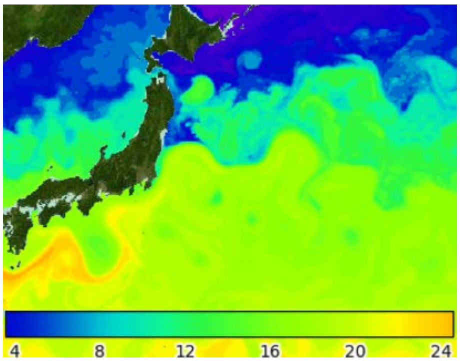

Figure 1: Estimated hydrographic conditions in May, 2019 (temperature at a depth of 50 m)
(Source: https://www.marinecrisiswatch.jp)

in an atlas. There are many eddies with a scale of about several tens to several hundreds of kilometres, and this changes from day to day. Variations in the flow channel, such as the well-known direct flow or large meander of the Kuroshio, is also a type of eddy activity, and can have an impact up to a water depth of about one hundred to several hundred meters. For those engaged in fishery activities, the natural science information of the ocean is vital not only for safe operations, but also for understanding their fishing grounds such as the junction where two ocean currents meet.

In order to capture such natural science information of the ocean, survey activities are carried out through observation vessels and other means. The long-term observation study conducted for more than 50 years by the Japan Meteorological Agency along 137 degrees east longitude is one such famous example, and basic data from the monitoring of the climate is provided worldwide. Aspects that cannot be adequately captured by vessels alone are also covered through the use of data collected by artificial satellites and automated observation equipment, including Argo Floats. An overview of such marine monitoring is shown in Figure 2. Furthermore, numerical forecasting, known as the "ocean forecast," is also carried out by incorporating such observation data into numerical simulations of the ocean. This makes it possible to predict the conditions of the ocean around Japan, including the Kuroshio, approximately one month in advance, in a way that is similar to a weather forecast.

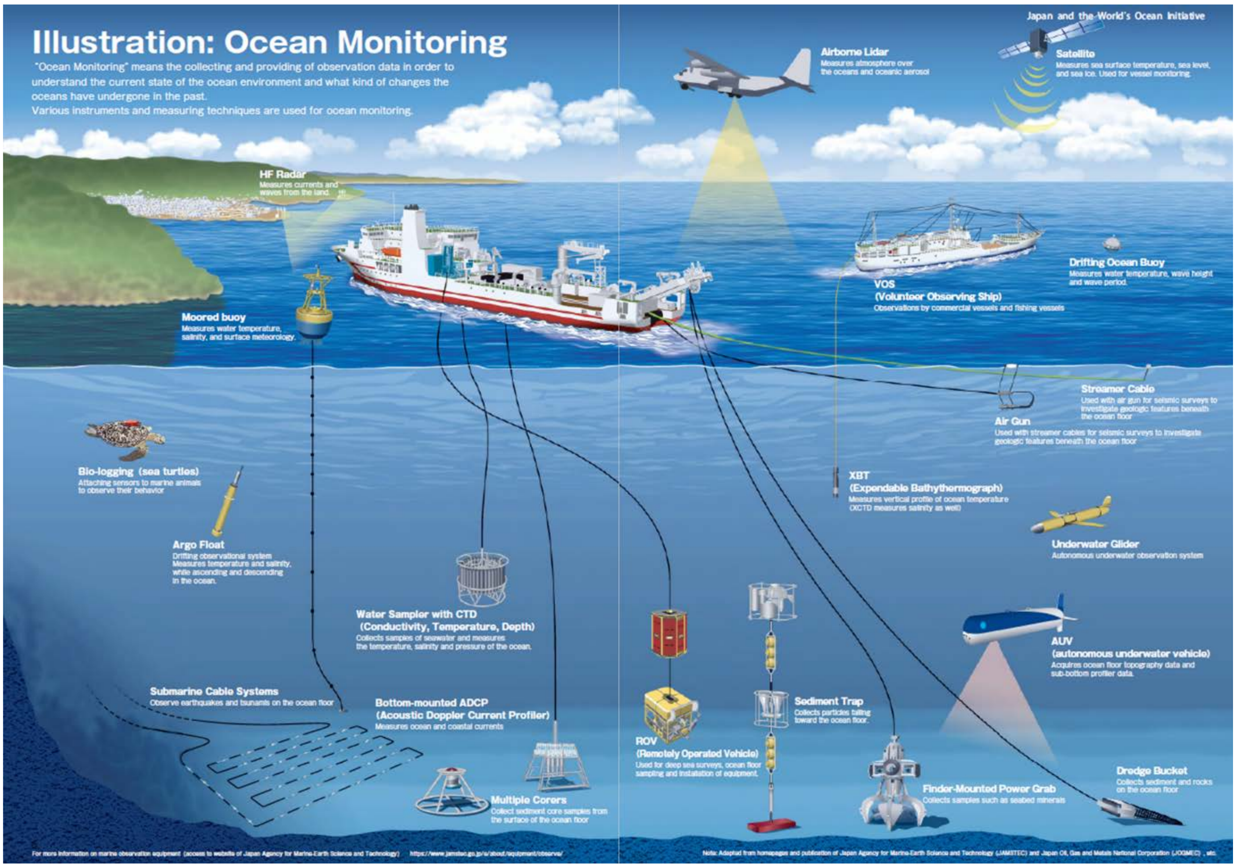

Figure 2: Overview of ocean monitoring (Source: White Paper on the Oceans and Ocean Policy in Japan 2019)

1.3 Information on Vessels

Finally, the third category of information is a type of ocean information that has recently been attracting attention. This is information that is related to vessel activity, which changes every day. While it had been difficult to comprehensively capture the movements of vessels that move on the seas (such as fishing vessels, commercial vessels, and navy vessels), the situation was drastically transformed with the emergence of a system known as the Automatic Identification System (AIS), which automatically transmits and receives vessel information such as vessel name, position, and destination through VHF-band radio waves to facilitate the exchange of information between vessels, and between vessels and land facilities. When it first became mandatory for vessels that meet a certain criterion to be fitted with the AIS under the International Convention for the Safety of Life at Sea (SOLAS), which entered into force in 2002, this system was used as a tool to ensure safety of navigation in congested waters, etc., in line with the objectives of the SOLAS. However, as it enabled anyone to receive vessel information that is transmitted through VHF band, AIS became a means of capturing vessel movement.

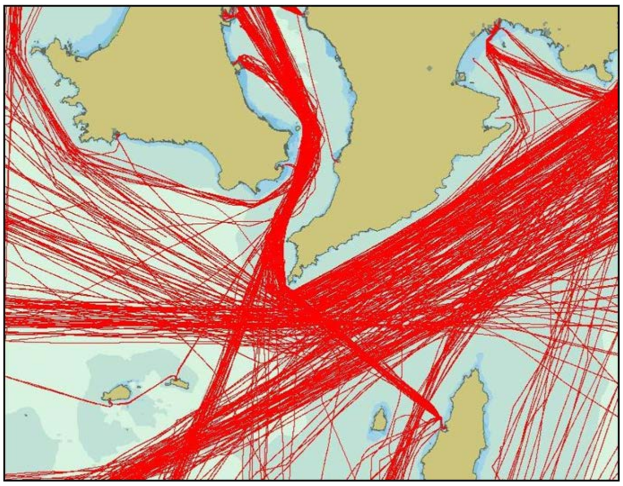

Figure 3: Example of how vessel movement is captured through the AIS (around the Osumi Peninsula)
(Source: 10th Regional Coast Guard Headquarters)

Moreover, two forms of technological innovation in recent years have dramatically propelled the monitoring of vessel movement forward. The first is artificial satellites, which not only made it possible to analyse the movement of vessels around the world through the receipt of AIS information seamlessly from satellites, but also enabled the monitoring of vessels at high frequency through the use of satellite information, alongside the launch of a large number of small satellites that can capture images of the sea. Images of the sea are useful for monitoring suspicious vessels that are operating with their AIS switched off. The second technological innovation is artificial intelligence (AI). The massive volume of AIS information, which can no longer be adequately processed by humans alone, as well as images of the sea, can be efficiently and effectively analysed through the use of the latest AI technology, and applied for monitoring purposes. By comparing this information with the vast volume of past vessel data that has accumulated, it is possible to extract information on vessels with abnormal behaviour through AI technology.

2. Maritime Domain Awareness (MDA) and Consolidating Ocean information

2.1 Advancement of MDA in Japan

According to the Basic Plan on Ocean Policy, which is revised by the government every five years, Maritime Domain Awareness (MDA) is defined as “The efficient understanding of situations associated with the oceans while bearing in mind how to handle the effective collection, consolidation, and sharing of diverse information about the ocean that contribute to maritime security, ocean environmental protection, marine industry promotion, and science and technology development.” As this is a concept developed in the United States in response to the synchronized terrorist attacks on September 11, 2001, MDA tends to be perceived as a concept with security implications. However, it involves the collection, consolidation, and sharing of a broad range of ocean information, such as information on the marine environment. As explained earlier, information about the ocean is diverse and of a wide variety, and capturing information accurately, even for general information such as data on the waves and ocean currents, can have great significance for security. From this perspective as well, it makes sense for MDA to target a wide range of ocean information, and it is possible to understand MDA from a dual-use viewpoint.

In Japan, reviews on MDA commenced with the establishment of a liaison and coordination council for MDA-related ministries and agencies in May 2015, in cooperation with the National Security Secretariat and the Secretariat of the Headquarters for Ocean Policy (now the National Ocean Policy

Secretariat) under the Cabinet Secretariat. This liaison and coordination council published a concept paper in October 2015, in which it establishes that the ideal vision of MDA in Japan is not limited to the area of security, but includes a wide range of objectives such as natural disaster measures, and comprises information and systems with a basic three-tier structure. Furthermore, the document on srengthening the capacity of MDA approved by the Headquarters for Ocean Policy in July 2016, presents a structure headed by the National Security Council, the Secretariat of the Headquarters for Ocean Policy, and the National Space Policy Secretariat as the three "control towers," with the Japan Coast Guard managing and operating systems in the first and second tiers. Here, the three tiers are established as follows: the first tier is information systems that can also be used by the private sector; the second tier is information and systems that are shared among government agencies; and the third tier is the real-time sharing of information between ministries and agencies that are related to security. The review of MDA in Japan became more in-depth in response to these decisions, and MDA was upgraded as a new item in Chapter 2 of the third Basic Plan on Ocean Policy, approved by the Cabinet in May 2018. MDA is positioned as a measure that serves as a "foundation for contributing to reinforcement of maritime security," which is also clear from the positioning of "Comprehensive Maritime Security" at the beginning of the Basic Policy in the third Basic Plan on Ocean Policy. Reviews and the development of systems related to MDA are progressing based on this Basic Plan.

2.2 Start of the Operation of Information Systems to Handle MDA

In April 2019, the government consolidated the ocean information collected and held by itself, and commenced the operation of MDA Situational Indication Linkages (MSIL), an information service that superimposes and displays the information on Web-GIS. This service targets the first and second tiers of MDA that the Japan Coast Guard is responsible for, and information from the first tier is made widely available to the general public through the Internet.

The main characteristic of MSIL is that it consolidates the wide range of ocean information managed by the relevant ministries and agencies, and integrates both the social information and natural science information of the ocean on the same central platform. While there is also much information that has not been included in the first tier, such as vessel movements, the consolidation of Japan's ocean information has finally reached its starting point with the operation of this system. Through MSIL, there are also plans to actively apply this ocean information, which is also a public asset, to the maritime industry.

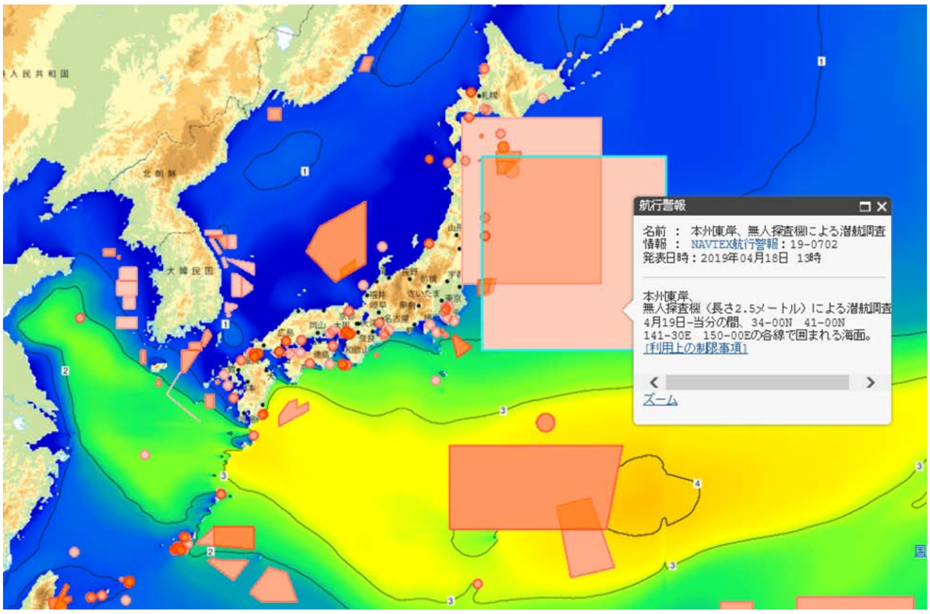

Figure 4: Example of information display on MSIL
(Superimposition of navigational warning zones on a wave map) (Source: Prepared based on https://www.msil.go.jp)

3．Ocean information in the Future—Towards Ocean Information Ventures

As explained above, the positioning of MDA initiatives as a "foundation for contributing to reinforcement of maritime security" in the third Basic Plan on Ocean Policy played an important role in the realization of the consolidation of ocean information through MSIL, which had previously been difficult to realize. We could say that MDA has created a major demand for the sharing of information. Meanwhile, in addition to this policy-related perspective, a technological perspective that covers the aspect of the advancement of information technology is also vital. In other words, Geographical Information Systems (GIS) and the data processing technologies that support GIS have advanced by leaps and bounds over the last decade, enabling the real-time handling of natural science information, which is characterized by vast information volume and significant temporal variations. Technological innovation is gradually bringing about significant changes to the world of the ocean. In the near future, how will it impact ocean information systems?

For example, autonomous operation technology is developing in the shipping sector just as it has advanced in the automotive sector, and demonstration experiments of these ships are being conducted around the world. As autonomous-operating ships need to share a large volume of navigation-related data with the land, there is the possibility that ship information could move swiftly in the direction of Big Data in the future. The fisheries industry has also changed its direction significantly towards becoming a "profitable fishery industry," in response to the amendments to the Fishery Act in December 2018. The highlight of these amendments is the IoT fishery industry, underscoring the fact that the information revolution is advancing even in the fishery industry, including in the aquaculture industry. Furthermore, moves to establish offshore wind farms have also accelerated with the entering into force of the Act on Promoting Utilization of Sea Areas in Development of Power Generation Facilities Using Maritime Renewable Energy Resources in April 2019.

There have also been advancements in the development of technology for collecting information. For example, Planet Labs, Inc. has achieved daily monitoring through high-resolution images produced by using close to 200 small satellites. VHF Data Exchange System (VDES), a next-generation AIS, may commence operations during the 2020s, and is expected to function as base communications infrastructure on the seas. Other forms of technological innovation include the development of ultra-compact marine observing buoys and technology for understanding ecosystems known as "Environmental DNA," and the list of new and innovative technologies goes on. The organization that embodies such ocean information management in the near future is Google, the giant of the IT sector. Global Fishing Watch, an international non-profit organization established in June 2017 with the support of Google, harnesses AI to eradicate illegal fishing. By analysing a vast volume of information about fishing vessels through means such as artificial satellites and AIS, it visualizes fishery activities around the world and releases this information to the public. The actual situation with regard to fishery activities that had been kept within a "black box" till now, has been brought to light through Google.

Going forward, ocean information will become a mixture of wheat and chaff, and will be accessible to anyone who has the means and skills to do so. It will be up to the user to make it into worthless trash, or to transform it into a treasure trove. MSIL is one such mixture, and motivated initiatives by the private sector will stimulate the further utilization of ocean information. Information ventures will also emerge in the maritime sector, just as in various other industries. These will promote new uses of the ocean, and the creation of a virtuous cycle for ocean information and utilization of the ocean is anticipated.

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