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## 20. Future of the “Kuroshio Science” Network

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### **1. Contribution of Higher Education to Interdisciplinary Studies for Integrated Coastal Zone Management**

The “Research Center of Integrated Coastal Zone Management by Kuroshio Science” project, which aims to build a sustainable community, includes ten social and natural scientists as faculty members. The success of this project is due to the collaborative participation of researchers and doctoral students in various disciplines in addition to these core members. As introduced by Tanaka in 1. “Kuroshio Science as a Multi-Disciplinary Science and its Network in the Kuroshio Region”, the Kuroshio Science Program has been enrolling many young Filipino researchers interested in “Integrated Coastal Zone Management” and related fields to pursue fieldwork and experiments via the Japanese Government (MONBUKAGAKUSHO: MEXT) Scholarship Special Program that started in 2014 (final batch students were graduated in 2021). Oral presentations for the final public defense of the first-batch students was held in July 2017, as a joint program with the 11th “Kuroshio Science International Symposium” with the participation of several presidents of state universities in the Bicol Region of the Philippines and guests from partner universities in Taiwan. This symposium presented, widely, the research achievements accomplished as part of the students’ degrees in the social and natural sciences related to “Integrated Coastal Zone Management”. The initiative spread by word of mouth; thereafter, applications from young students from non-partner universities increased, and many students learned about “Integrated Coastal Zone Management” concepts and practices under the Japanese Government (MONBUKAGAKUSHO: MEXT) Scholarship Special Program. Ultimately, 13 Filipino students completed the program as of September 2021. After returning to the Philippines, they became active in various fields such as coastal management and research on the ecology of marine organisms. Additionally, the 13th Kuroshio Science International Symposium was organized by a graduate in Tuguegarao City, Cagayan Province, the Philippines in November 2019. It attracted 136 participants from 30 universities and institutions in the Philippines and Japan, who discussed the results of research by many graduates and other researchers. In recognition of these efforts, MEXT began the 2nd series of the “Japanese Government (MONBUKAGAKUSHO: MEXT) Scholarship Special Program” (2020-2025); via this, eight Filipino students are now conducting research for their degree.

Due to the global spread of COVID-19, however, face-to-face international communication was severely restricted in 2020 and 2021. The ceremony to commemorate the establishment of an Alumni Association, “PHILJAPKUS : Philippines-Japan Association for the Kuroshio Science Promotion, Inc.” with the participation of the presidents of Bicol University, the presidents and director (in charge of international

collaboration) Kochi University-which was to be held on September 3 and 4, 2020 at Bicol University in Albay, Bicol Region, Philippines-was cancelled. In addition, the Kuroshio Science International Symposium (which has been held since 2007) and the Sakura Science Exchange Program (which was attended by young researchers from the Kuroshio region since 2014 granted by Japan Science and Technology Agency (JST)) were also cancelled. However, there is an urgent need to promote education and research on “Integrated Coastal Zone Management” to resolve global environmental changes and the resulting instabilities in local communities. Therefore, the 14th Kuroshio Science International Symposium was held on November 13 and 14, 2021-with 287 participants from 63 institutions and universities in 6 countries-to discuss the field system of Southeast Asian countries that share cultures and climate via the Kuroshio region, one of the two major global ocean currents. On November 13, 2021 Dr. Yuji Sano, Director of Center for Advanced Marine Core Research, Kochi University, gave a keynote speech on “Ion Microprobe Analysis of Biological Hard Tissue” and presented the results of the “the Four-Dimensional Kuroshio Marine Science (4D-KMS) Research Project”, that would have ended in FY2021. Moreover, the theme of the session “Kuroshio Science towards Coastal Management,” held on November 14, 2021 focused on the achievement of the “Research Center of Integrated Coastal Zone Management by Kuroshio Science” project (see the following for the program and abstract).

Program and Abstract for the theme session "Kuroshio Science towards coastal management"

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#### Title

Kuroshio Science towards Integrated Coastal Zone Management in the Kuroshio Region

#### Program

Introduction: The Problems and Political Response for Coastal Environment and Natural Resources.

Teruyuki Shinbo.

Intertidal seagrass beds and riverine mangroves as fish habitat: Implications for coastal fish resource management

Yohei Nakamura, Allyn Duvin Pantallano, Anabelle Dece A. Espadero

Unvegetated tidal flats as habitat for endangered benthic animals: Importance of animal burrows for symbiotic species

Gyo Itani, Kristian Aldea, Yuto Shiozaki, Sota Kiriara and Yumi Henmi

Analyzing Factors of Participation in MPA Management and its Incentive Mechanisms

Emma L. Ballard and Teruyuki Shinbo

#### Abstract

Although scientific and technological progress and economic development have increased the well-being of society, the expansion of human activities has led to the degradation of the environment and natural resources, raising questions about the sustainability of human society. The coastal areas account for only 8% of the earth's surface but 25% of human population as well urban industries are located in those areas, hence promoting sustainable development is a challenge. In response to this situation, various countries and the international community have been making efforts to coordinate several human activities in the coastal areas and to conserve the coastal environment from early on under the concept of integrated coastal management or integrated ocean management. In the case of Japan, it is indispensable to cooperate with the countries along

the Kuroshio Current, which brings good things, as well as domestic coastal management. From this perspective, the Kochi University established “Research Center of Integrated Ocean Management by Kuroshio Science” and have piled up to collaborate with local researchers by using the international collaborative research network in the Kuroshio Region with universities and research institutes in the Philippines and Taiwan as main partners.

The sea brings various benefits to human society. Human beings use this in a variety of ways in response to the various kinds of benefits, hence the approaches of utilization are also diverse which creates various problems. For example, the free access of a large number of fishers may lead to resource degradation due to overfishing, like the “tragedy of commons” phenomena. In addition, resource use conflicts may arise, e.g., fishers and tourism vendors who use the same sea surface and resources. In view of this situation, it is necessary to have a mechanism to manage resources utilization so as not to lead to degradation, and to resolve its multiple-use purposes. To start, we would like to provide an overview of the utilization and problems with regard to the coastal environment and natural resources and a discussion of political response regarding this problem. Here, we introduce the concept of integrated Coastal management. Next, we would like to check the current status of the ecosystems in the coastal areas and the mechanism of their maintenance. First, we will clarify the fish habitat functions of the intertidal seagrass beds and riverine mangrove areas and evaluate the importance of these habitats to conserve commercially important coral reef fishes. Second, we will clarify the importance of symbiotic relationships in benthic communities in unvegetated tidal flats which play a major role in maintaining biodiversity and purifying the coastal environment, and also consider the conservation of tidal flats that are in crisis for economic development, including the protection of endangered species. Finally, we look at concept of Marine Protected Areas (MPAs) as an important tool for the conservation of the marine environment and coastal resources. It is often rational to leave the management of the resources to the local residents (often they are fishers) and their communities, who use the area most frequently and know it best (also called Community-based Management). It is not easy to form a substantially-functioning MPA with enough participation of residents. Here, taking MPAs in both Bicol and Cagayan Provinces in the Philippines as a case study, we would like to explore the determinants that local residents consider to participate in MPA management, and analyze the incentive mechanism to encourage and sustain participation.

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As a related event, the 8th “Sakura Science Exchange Program” was held from November 12 to 17, 2021. JST recommended holding an online program; therefore, the educational seminars were conducted based primarily on the following three themes with the participation of young researchers from nine institutions in the Philippines and India:

- 1) Results of research on the sustainable utilization of marine minerals and biological resources
- 2) Results of research from the “Research Center of Integrated Coastal Zone Management by Kuroshio Science” project
- 3) Developing tourism in coastal areas of Taiwan and efforts towards regional development through fishery and forestry in Japan.

Thereafter, participants introduced case studies considering the SDGs in their respective countries; a general on these themes discussion was also held. Additionally, graduate students at Kochi University introduced videos created by the Mt. Yokogura Natural Forest Museum (Ochi town), Kuroshio Biological Research Foundation (Otsuki town), Makino Botanical Garden (Kochi city) and Muroto UNESCO Global Geopark (Muroto city), the natural richness of Kochi Prefecture, and their research and activities on

biodiversity conservation. Finally, international students taking first-grade doctoral courses presented their research plans and discussed them with the participants.

In the afternoon of November 15, 2021, an event commemorating the establishment of the “PHILJAPKUS” was held online. Sixty-five participants from the Philippines, Taiwan, and Japan, which are part of the international network of the Kuroshio Region, attended the event. Recent research results were featured by alumni from the Philippines, India, and Japan, and the President of Bicol University, Officer-in-Charge, Bureau of Fisheries and Aquatic Resources, Regional Office 2, the Director of the Marine Science Institute of the University of the Philippines and Chancellor of University of the Philippines Visayas gave congratulatory addresses.

Apart from the keynote speeches, theme sessions, and related events, there were over 60 oral and poster presentations, indicating a high level of interest in “Integrated Coastal Zone Management” and “Marine Resource Analysis” among the presenters and participants. Over 10 inquiries were received regarding the third batch of students for the Japanese Government (MONBUKAGAKUSHO: MEXT) Scholarship Special Program (2020-2025), applications for which will close in February 2022. It is hoped that they will return to their home countries after learning “Integrated Coastal Zone Management” concepts through their own studies towards a degree.

## **2. Emphasis on Research and Higher Education in the Field of Marine Resource Science**

This “Research Center of Integrated Coastal Zone Management by Kuroshio Science” project focuses mainly on terrestrial and coastal biological resources, industries, and local communities; however, the consideration of various marine resources has been inadequate. To develop the activities of this project, it will be necessary to enhance the research on and education system for marine resources at Kochi University. We will establish the “Marine Resource Science” course in the Kuroshio Science Program in FY2022 (April).

In terms of marine research, “marine resource development” has been garnering attention as a highly important policy issue for Japan, which has a vast EEZ that is 12 times the size of its land area and the 6th largest globally. Kochi Prefecture has also recognized that the development and utilization of Earth’s resources will be a major pillar of regional revitalization by continuously making policy proposals to the Agency for Natural Resources and Energy. This will help accelerate efforts toward the practical use and commercialization of methane hydrate off the shore of Kochi Prefecture to promote industry through energy self-sufficiency. At Kochi University, various marine research projects such as the Kochi University Special Project “the Four-Dimensional Kuroshio Marine Science (4D-KMS) Research Project” and “Earth Exploration COE” project are being promoted mainly by the Center for Advanced Marine Core Research, Kochi University and world-leading research results have been obtained.

In Marine Resource Science course, subjects for Marine Bioresources (“Biodiversity”, “Molecular Biology” and “Virology” for Aquatic Organisms) and Marine mineral resources (“Mineral Resource Geology” and “Sea Floor Mineral Resources and Environments”) will be provided. In addition, related classes for metabolism and its analysis (“Natural Product Biosynthesis”, “Pharmacology”, “Instrumental Analysis” and “Bioinformatics”) and geoscience (“Earth, Environmental, and Planetary Science”, “Biogeochemistry” and “Physical Oceanography on the Kuroshio”) and can be selected.

### 3. Toward University-Wide Initiatives

For the purpose of reform, all national universities in Japan were incorporated in 2004; moreover, each activity is conducted based on mid-term plans set every six years. In 2008, during the second half of the first mid-term (FY2004-2009), the “Graduate School of Integrated Arts and Sciences” was established in 2008 by integrating all doctoral and master’s programs at Kochi University based on the philosophy of the “Graduate School of Kuroshio Science” established in 2004. In the second mid-term phase (2010-2015), Kochi University promoted the construction of an education and research system to promote “symbiosis between the environment and humankind” that makes the most of its location, human resources, and achievements. Additionally, “the Faculty of Regional Cooperation” was established to foster human resources for regional revitalization. In the third mid-term period, several undergraduate courses related to “Integrated Coastal Zone Management” (“Faculty of Agriculture”, “Faculty of Education” and “Faculty of Science”) were reorganized. The “Research Center of Integrated Coastal Zone Management by Kuroshio Science” is an important research topic of the third mid-term. The President of Kochi University defined the motto of Kochi University as “Super Regional University” in 2018. The goals for the fourth mid-term period (2022-2027) were to: 1) be a university that can support and change the region; 2) contribute to the development of a sustainable regional society as the core of a regional cooperation platform; and 3) be a university that can engage in interactions, exchanges, and collaborations globally. The following is an action plan for education, research, regional cooperation, and globalization:

#### A. Education

To educate human resources to contribute to the development of local and international communities by improving their autonomous abilities to work with diverse peoples and influence the world.

#### B. Research

To promote the creation of knowledge and value that are both internationally accepted and contribute to local communities by leveraging the strengths of research centered on “ocean,” “life,” and “field sciences,” and foster scientists with a global perspective.

#### C. Regional cooperation

To play a central role in regional collaboration platforms to address and resolve regional issues.

#### D. Globalization

To support the establishment of international students in the region (Kochi, Japan and Southeast and East Asia) and open up the future of internationalization in the region.

In particular, “ocean,” “life,” and “field sciences” are the key issues for research and “Integrated Coastal Zone Management” will be an important issue for Kochi University in the future.

Additionally, “regional revitalization” is a new keyword for promoting “Integrated Coastal Zone Management”. Addressing the aging of society is a key issue in Japan and Taiwan in the Kuroshio region. In rural areas with a declining birthrate and rapidly aging population, in particular, the natural population decline and resulting economic decline are accelerating. The stagnation of the local economy leads to an exodus of young people, resulting in the creation of a negative spiral. In 2019, four universities in Japan (Kochi University, Chiba University, Ryukoku University and Shinshu University) and six ones in Taiwan (National Chi Nan University, National Cheng Kung University, National Kaohsiung University of Science and Technology, National Sun Yat-sen University, National Taiwan Ocean University and Tunghai University) began collaborating on local development activities based on “regional revitalization”. In February 2021, the

“Center for Regional Sustainability and Innovation” and “Kuroshio Science Program” at Kochi University co-hosted an online workshop for specific “regional revitalization” activities in both countries. In November 2021, the “TJ Alliance (Taiwan Japan Alliance)” was established between the ten universities and the “Regional Revitalization Forum” was held as an event related to the 8th “Sakura Program” to share the current status of regional revitalization efforts with young researchers in the Philippines and India as well as Japan and Taiwan. In FY2021, Kochi University decided to provide its own scholarship for doctoral students in the Kuroshio Science Program with research activities related to “Integrated Coastal Zone Management” and “regional revitalization.” Further development of the Kuroshio Science Network is expected in 2022 and beyond.