
Preface

Although scientific and technological progress and economic development have improved the well-being of the society, the expansion of human activities has led to the degradation of the natural environment and resources, raising questions about the sustainability of human society. In particular, the challenges of sustainable development in the coastal areas has been recognized from early on. While the coastal areas account for only 8% of the earth's surface, 25% of the human activities take place in there with inclusion of many cities. In response to this situation, various countries as well as international organizations have been making efforts to coordinate various human activities in coastal areas and to conserve the coastal environment under the concept of integrated coastal management or integrated ocean management. However, in the international community whose basic unit is a sovereign state, it is almost impossible to achieve a universal coastal and ocean management and this is not desirable in view of the size and diversity of the oceans. On the other hand, leaving the coastal and ocean management to national policies is also problematic. For instance, countermeasures to the depletion of saury and other fishery resources are not an issue in Japan's territorial waters, but are discussed by the North Pacific Fisheries Commission (NPFC). Therefore, coastal and ocean management needs to be considered at the cross-border regional level (beyond national borders). In the case of Japan, for example, it is indispensable to cooperate with the countries along the Kuroshio Current, which bring abundant resources, as well as domestic coastal management.

The Graduate School of Kuroshio Science, which was established in April 2004 by gathering many researchers from both the natural sciences and the social sciences at Kochi University, has launched the research field of "Kuroshio Science." That is, the area from Southeast Asia to Northeast Asia known as the Kuroshio Region and is affected by the Kuroshio Current, the largest ocean current on the earth, and through studying the ecosystem, natural environment, society and economy of this area, we strived to think how should we establish a sustainable society by the collaboration of both the natural and social sciences. That is the major goal of Kuroshio Science, which we set.

We are all aware that the deterioration of the natural environment, the degradation of natural resources and the socio-economic transformation is due to rapid economic development and this appears to stand as common issues in the countries of the Kuroshio Region, from Southeast Asia such as the Philippines to Japan via Taiwan. From this perspective, we aspired for establishing an international collaborative research network in the Kuroshio Region with universities and research institutes in the Philippines and Taiwan as our main partners, and we have been piled up to collaborate with local researchers.

It is undisputable that this research approach from both natural and social sciences is essential for coastal

and ocean management. As stated in Article 4 of Basic Act on Ocean Policy, regarding the sea, we basically have to keep a humble attitude of “not knowing about it.” Therefore, we first must enhance the natural science research about the sea. But further, when we think how to regulate human activities and/or how to utilize natural resources of the sea for development by taking advantage of the results of the natural science researches, the approach from social science is required to fully understand and maximize the principles of natural science. Even if we know the natural scientific mechanism of the changes in the coastal environment brought by coastal development, we cannot expect to realize desirable coastal management system utilizing these results from the natural sciences, without incorporating these knowledges into the legal system of environmental impact assessment. For instance, even if the mineral resources on the seabed are clarified, we will not be able to utilize them in the economic system and society unless the problems of the cost and incentive to extract them are cleared. In particular, the role of social science in this research area is thought to be essential because coastal and ocean management in the Kuroshio Region involves quite different and unique economic and legal systems in each nation within this area.

Based on the above concerns, we have first conducted biological and ecological studies on several elements of related ecosystems. These coastal ecosystems include coral reefs, seaweed/seagrass beds, mangrove estuary/forest, river ecosystem, and terrestrial forest ecosystems, which we thought to be connected to each other and mutually affected. And we have also conducted socio-economic studies on the economic activities which impact natural resources and environment of the coastal areas, and conservation activities for natural resource and the environment by local communities. For example, coral reef and seagrass bed ecosystems are very important in terms of biological production, biodiversity, and fish resource cultivation. But these are strongly influenced by factors such as land use, forest vegetation, and economic activities of coastal communities in the terrestrial area. Therefore, for the conservation of these ecosystems, we have to properly consider the relationships among them. Especially in the coastal area, not only for the agriculture, forestry and fisheries and industrial production, but also on various uses such as the navigation of ships, leisure, tourism, and (in recent years) offshore wind power generation are congested. And unfortunately, the function of the sea as “the sink for pollution” in coastal cities, villages, and industrial areas is also utilized. (The sea accepts, accumulates pollutants, and purifies some parts of them.) Conservation of coastal areas requires integrated coastal management, which comprehensively manages and reconciles such ecological factors as well as the different interests of stakeholders.

In this book, while considering the requirements from the natural environment and resources side, the necessity of the human society such as resource utilization, and the mechanism of both institution and organization for conservation will also be taken into consideration. We will attempt to study the desirable way of integrated coastal and ocean management in the Kuroshio Region, including the possibility of more rational coastal use. To highlight such points, we will take three approaches such as (1) “Know”: grasping the current state of the marine/coastal ecosystem, natural environment and resources, (2) “Use”: considering desirable way for the economical utilization of the sea surface for various purposes, and for resource use by local communities (local development is necessary to proceed conservation effort), and (3) “Protect”: perceiving the actual conditions of natural resource and examining desirable directions for conservation of the natural environment and resources. As a premise, we will give an overview of the international legal order and domestic legal system surrounding the ocean. The book is organized as follows.

The Part I is the introduction of this book. First, we introduce “Kuroshio Science” and the international research collaboration network that we are trying to build in the Kuroshio Region. That is, we define the

“Kuroshio Science” and our target area where we called the “Kuroshio Region.” After that, we explain the history of our collaboration in research and education with the universities and institutions in the countries of Kuroshio Region, which was conducted under the name of “Kuroshio Science.” We envisioned such “Kuroshio Science Network” as an infrastructure for the cooperation of research and education in the Kuroshio Region, holding symposium (“International Kuroshio Science Symposium”) on a rotation basis at universities/institutions of Japan, Taiwan, and the Philippines, implementing programs to bring young researchers to Kochi, Japan using JSPS fund (“Sakura Science Program”), and publishing the scientific journal “Kuroshio Science.” Using the special scholarship program of Japanese government (Ministry of Education, Culture, Sports, Science and Technology; MEXT), our graduate school (Kuroshio Science Program, Graduate School of Integrated Arts and Science, Kochi University) enrolled graduate students from the Philippines in doctoral programs, provided education based on Kuroshio Science, and promoted to conduct joint research with professors. Through such programs, a large number of young researchers have been mentored and continue to conduct researches in the Kuroshio Region.

Next, to confirm the structure of various problems related to the natural environment and resources in the coastal areas of the countries in the Kuroshio Region. For this purpose, we assess the coastal resource management (ICM) program of the Philippines from 2006 to 2020. The implementation of ICM programs and projects by the government contributed to the improvement of habitat protection, food security measures, community livelihood opportunities, and pollution and waste management. While there were several accomplishments, problems and challenges still remain in the coastal environment and natural resources. These problems include resource use conflicts, overfishing, and pollution which make us consider the “population growth and poverty” issue.

After that, we will explain the international legal order related to the sea, particularly the legal system regarding its conservation and management. To maintain the sustainable development of the coastal area, many countries have been embracing the concept of Integrated Coastal Zone Management (ICZM) and making efforts to give it to practical shape. We compare the legal systems for ICZM among the U.S.A., Germany and Japan. Through such analysis, we propose a way to improve the Japanese legal system for ICZM.

The theme of Part II is to “Know” the current status of nature and ecosystems in the ocean and coastal areas, and the mechanism of their formation and maintenance. Here, we present the Kuroshio Current, which is huge ocean current in the world. The Kuroshio Current largely defines sea conditions in this area, and has a great impact on the nature and society of the Kuroshio Region. Then it is necessary to start by understanding its characteristic features. After confirming the basic condition of the sea in such a way, we look at the individual coastal marine ecosystems in the Kuroshio Region.

First, we will clarify the current status of the important habitats and spawning sites for fish in tropical and subtropical area, such as both coral reefs and seagrass beds. Then we evaluate their functions regarding their importance to fish resources and consider the causes of such deterioration like coral breaching, overfishing, and so on. In recent years, such ecosystems face a new threat, that is, climate change. And so we examine the impact of climate change on the fish resources of coral reefs and consider how we should manage this shift.

Secondly, we will perceive the biological communities and ecosystems in tidal flats that play a major role in maintaining biodiversity and purifying the coastal environment. We also consider the conservation of tidal flats including protection of endangered species that are in crisis due to economic development. The biodiversity of tidal flats is maintained through the coexistence of a wide variety of organisms in various ways.

Thirdly, we will consider soil, land use, and forest vegetation that have a significant impact on the coastal environment and ecosystem. Especially, recent studies suggest that conserving upstream forests is linked to protecting marine biodiversity. The Kuroshio Region is a large climatic zone from the tropical / subtropical zone to temperate zones, and the vegetation distribution changes depending on the climate and elevation. We pay attention to the forest vegetation and give overview of riparian forests in mountainous areas in Japan. The montane riparian forests in cool-temperate regions of Japan are characterized by distinctive species composition, high species richness, and species specialized to the conditions in riparian habitats. Although, riparian forests are important and unique ecosystems, there are limited studies in the Kuroshio regions except Japan. Therefore, the progress of research is expected in the future. There are many volcanos in the Philippines and Japan, as a result, the lands and soils are likely to be influenced by the past and current volcanic activities. Agriculture is flourishing around the Mayon Volcano in the Bicol region which is located in the southeastern part of Luzon Island, Philippines, despite frequent eruptive activities of that. Precipitation and ash fall appear to differ between the eastern side of the Mayon Volcano, which is closer to the sea, and the western side, which is inland, due to the effects of sea breeze and typhoons. We expect that such differences in environmental conditions will affect the composition of the soil, which is the basis of agriculture. Through clarifying soil properties, we will be able to think about what kind of land use, including agricultural activities, is desirable in this area.

In Part III, we examine the development of a new methodology for marine resource utilization and the institutional solutions to the problems associated with such a new methodology from the perspective of “Use” marine natural resources. There are two viewpoints on this. First, the conservation of the marine environment and resources often requires the involvement and understanding of the inhabitants and communities of the surrounding area. In order to increase their conservation incentives, it is important to create a mechanism in which the natural resources produced by the marine environment bring certain benefits to local residents and communities (Viewpoint A). Secondly, the use of sea surface and marine resources in new forms may produce collisions and conflicts against conventional users of sea surface or natural resources. And for smooth and efficient resource use, the mechanism for adjusting the use and the establishment of a new institution which encourages it will be required (Viewpoint B).

First of all, from viewpoint A, we will consider the exploitation of new foods utilizing the marine biological resources around the Lagonoy Gulf in the Bicol region. Of course, the local marine products of this place are utilized for food in various forms such as fresh fish, salt-dried products, and fermented foods. But most of them are processed in traditional forms. We can hope to create new value and lead to the empowerment of small and medium entrepreneurs and local communities by developing new forms of food processing such as improving the taste and preservability, and establishing distribution network. And it is also important to consider the identification of fish species when expanding new uses of fishery products such as food processing. The development of new uses for specific fish increases the pressure on them, but if the species is not identified properly, it can put pressure on other fishery resources. For example, when a closed season of fishing is established to avoid the depletion of specific fish species, effective resource conservation is difficult to implement if fishermen cannot distinguish such fishes that should be avoided. We also need to consider these kinds of issues. Next, from viewpoint B, we consider various types of energy development at sea, including offshore wind power generation, which has been developed in Europe and other countries in recent years. Thus is about to be introduced in Japan as well, but the sea surface is densely used by existing sea utilization ways such as fishing. And each utilization is systematically positioned by the ground law. When

developing offshore wind power generation and so on, it is necessary to coordinate it with these existing utilization ways. After reviewing the actual situation, we will examine the legal system that should be, but is realistic. Japan is expected to develop offshore wind power generation rapidly in near future. To resolve the problems related to setting up offshore wind power facilities, we should not only revise the concerned act, but also reconsider the whole system such as regional planning, environmental impact assessment, and litigation.

Part IV covers some kinds of initiatives, technology development, and the development of the legal system from the perspective that “Protect” and conserve the marine environment and natural resources. Firstly, we would like to introduce the efforts to restore hermatypic corals in the Bicol region of the Philippines. Coral reefs are an important ecosystem that supports both biological productivity and biodiversity in the sea. But recently they are deteriorating around the world due to a variety of factors (often anthropogenic impact). Also, in this area, hermatypic corals are being deteriorated due to various factors such as bleaching by high water temperature and destruction due to illegal fishing. Responding to this situation, coral restoration efforts (Reef Coral Restoration Program) are being attempted. Here, we introduce such efforts and analyze the process of coral bleaching and its recovery. In the coral restoration method, coral fragments are cultured/nursed under the sea and then transplanted to the natural environment to grow up. Such methodology will be explained biologically. Then, we check the natural science issues such as damage caused by typhoons and coral bleaching events, as well as the impact of political change and the development of ecotourism. And we will note that the initiatives by the partnership of local government units (LGUs) and community are important for this issue. Related to coral conservation against climate change, we survey the recent development of cytogenetic and molecular approaches in biological studies of stony coral and introduce our own research in this field.

Secondly, we introduce the development of onshore fish aquaculture technology. In Japan, the cultivation of high-priced fish species has continued while changing species (when many fish farmers cultivate the same fish species, the fish price naturally collapses by higher supply). But intensive fish farming has a high burden on the coastal environment, such as water pollution and deterioration of the bottom environment due to excessive feeding. In addition, sea surface aquaculture basically requires a “demarcated fishery right,” which is acting as a barrier to entry. In recent years, the technology for onshore aquaculture has been developed as a means to get rid of such difficulties, and it is entering the stage of commercialization. Here, we introduce the current state of the burden on the coastal environment due to sea surface aquaculture and the technology of onshore aquaculture to reduce it. Especially, we discuss new methodology for the treatment and prevention of infectious diseases and monitoring of fish stress. Both infectious diseases and fish stress are big problems in fish farming. We believe that such researches are essential for establishing a sustainable aquaculture system.

Thirdly, we kick around Marine Protected Areas (MPAs) as an important tool for the conservation of the marine environment and coastal resources, and consider the conditions under which they function effectively. MPAs are established in a place through legal basis (legislative measure) that prescribes the ways to protect the ecosystem and resources of the area. But the legislation does not always mean that protection is done effectively. Generally, although MPAs are restricted areas it is often accessible to a variety of entities, including illegal fishers. Although it depends on the type of regulation, it is necessary to manage the sea area in various means in order to carry it out effectively. However, because the maritime police services of the central government are often inadequate, it is rational to include the local residents (often they are fisherfolk) and their community in the management of the waters, as they are the ones who use the area most frequently and know it best (Community-based Management). In that case, it is necessary to set up a management

organization in which the local community and residents can actively participate, while delegating sufficient authority to them. Yet, it is not easy to form a substantially-functioning MPA management organization with enough participation of residents and to succeed in managing MPA. Here, taking MPAs in both the Cagayan Valley region in the northern part and the Bicol region in the southeastern part of the Luzon Island, Philippines as a case studies, we explore the determinants for local residents to participate in MPA management, and consider the incentive system to encourage such participation. From the discussions, to ensure successful integrated coastal zone management, it is absolutely imperative to build the system that both the administrative side (government, local government) which prepares the framework of the legal system and budget, and the actual management side (the local residents and their organizations) which implement management works in the field under that framework can cooperate with together effortlessly. Regarding the incentive system for encouraging the participation of local residents, we compared monetary incentives (e.g., Bicol) with mechanisms that benefit the entire community through livelihood projects (Cagayan), and consider the challenges of monetary incentive system, which is the current mainstream in the Philippines. Further, through the empirical analysis about factors of residents' participation in MPA management, we propose an improvement of incentive system for it.

In Part V, we think the future concept of the “Kuroshio Science” network, which has produced the various collaborative researches introduced in this book. Then as one direction of the development of the activities of “Kuroshio Science,” we would like to devote some space to the issue of collaboration about biotechnology. Recently, local universities in the Philippines have been invested in government budgets and are developing laboratory equipment. But at the same time, know-how to operate them is required. Kochi University is also cooperating with such development and supporting the construction of a genetic engineering experimental system at a local university. We would like to introduce such efforts as an example of partnership among Kuroshio Science Network. And we propose improvements for the stable implementation of biotechnological research in State Universities and Colleges (SUCs) in the Philippines. Thus, the international network of education and research in the Kuroshio Region is budding and growing, such as the cooperation in collaborative MPA research by the approaches from both natural and social science. Finally, we summarize the initiatives and fruits of our “Research Center of Integrated Coastal Zone Management by Kuroshio Science” project. And we think about how we should make effort to develop the Kuroshio Science Network from the standpoint of Kochi University. At last, we conclude our belief toward the direction that we should advance with the friends of the Kuroshio Region.

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