International Workshop on Area-capability Studies in Coastal Zone of Southeast Asia

December, 2015

14-15

Lecture Hall,
Research Institute for Humanity and Nature (RIHN)
Kyoto, Japan

Inter-University Research Institute Corporation
National Institutes for the Humanities
Research Institute for Humanity and Nature

International Workshop on Area-capability Studies in Coastal Zone of Southeast Asia

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Coastal Area-capability Enhancement in Southeast Asia

PREFACE

It has been passed approximate four years after beginning of "Coastal Area-capability Enhancement in Southeast Asia" project of RIHN. Including feasibility study phase, 7 years have passed after launching this project. In the beginning period of time, many members of this project were perplexed due to uncertainness of the concept of Area-capability, because it was a new word made by this project. However, currently, many members could have concrete ideas of the Area-capability through our 7 years collaborations. And many of them have been considering the importance of the Area-capability for our future in these years.

Area-capability is a new concept for evaluation of rural development. Conventional evaluation of development stands on the aspects of ampliation of fields and/or growth of productions linking to income increases. In some cases, the enhancing participation to social activity of peasants, and health of family members were taken into account. These factors are important for rural livelihoods and the data showing the improvements of these aspects have high power to persuade donors of development plans. But, on the other hands, rural development activity targeting a single and/or several aspects holds a risk to break side effects, e.g., expansion of paddy fields derives conflicts among local people and destroys the native forests around villages. These side effects of rural developments might deteriorate some important ecosystem services. Besides, income increases could not link to healthy life directory in both rural and urban areas. Therefore, to improve quality of lives in rural area, development plan should touch multiple aspects including resource and productivity growth, human resource development, harmonization with conservation of ecosystems, community developments and participation of social activities etc., at the same time.

Area-capability focus on recent regional development activities on utilizing local characteristics, the scale and types of resources used and the nature of the activities are extremely diverse. We found that efforts which have been able to continue sustainably and expanded in scope share the following elements: **(1) A local community uses a resource unique to the region**; **(2) Resource users understand the importance and take care of the environment that supports the resources used**, and **(3) A balance is struck between using and caring for resources and the supporting environment, which is evaluated by outside entities**. We believe these shared components are essential to sustainable development, and use the term **"Area-capability" (AC)** to refer to the set of factors that comprise these aspects.

In high bio-cultural diversity areas, each resource is generally small and vulnerable. Therefore, if we try to keep sustainable situation of all resources, total efforts will be enormous. However,

in these areas, a person can utilize multiple resources for various purposes. If there is high area-capability, even one resource situation was deteriorated; a person can change main target resources easily and smoothly, because the resource and utilizations already exist. In other words, capability is much important than sustainability in high bio-cultural diversity areas.

RIHN Area-capability Project has conducted several trans-disciplinary activities in Thailand, Philippines and Japan, in order to development of Area-capability concept and its approaches since April 2012. This project will be terminated by the end of March 2017. During remaining period of time, we try to sophisticate Area-capability concept and its approached to be easily adopted in would wide. We hope we can shear our experiences and ideas during this international workshop. We believe the Area-capability concept can open the new door to our future, and we are just standing the scratch.

14 December 2015
Satoshi ISHIKAWA
Kazuo WATANABE

PROGRAM

Date: 14 - 16 December, 2015

Venue: Research Institute for Humanity and Nature (RIHN), Kyoto, Japan

Monday December 14, 2015

Day 1 International Workshop (Lecture Hall)

09:00-10:00 Registration

Session 1:

10:00-10:30 Opening address
Satoshi ISHIKAWA (RIHN, Japan)

The Area-capability concept: promoting the use of local resources
Kazuo WATANABE (RIHN, Japan)

Session 2: Guest Speech

10:30-11:00 Life Cycle Assessment (LCA) and the natural environment: current assessment options and the way forward
Francesca VERONES (Norwegian University of Science and Technology, Norway)

11:00-11:30 Developing fisheries and aquaculture in Indonesia on Global Climate Change Issues
Muhammad Iqbal DJAWAD (Hasanuddin University, Indonesia)

11:30-11:50 Discussion

11:50-12:00 Photo session

12:00-13:00 Lunch

Session 3: Case Studies in the Coastal Zone of Southeast Asia and Japan

13:00-13:40 Seasonal variations in small-scale fisheries in Rayong, Thailand
Keigo EBATA (Kagoshima University, Japan)

Composition of non-economic and garbage of bottom gillnet along the coast of Rayong province, eastern gulf of Thailand
Narakorn SOMWANTHANA (EMDEC, DOF, Thailand)

Small-scale fisheries in an estuarine environment: the case of New Washington-Batan-Banga estuaries
Harold M. MONTECLARO (UPV, Philippines)

13:40-14:20	Coastal environment and human activity in Thailand **Jintana SALAENOI** (Kasetsart University, Thailand) **Sukchai ARNUPAPBOON** (SEAFDEC, Thailand) **Takashi YOSHIKAWA** (Tokai University, Japan)
	Coastal environment and human activity in the Philippines **Nathaniel AÑASCO** (UPV, Philippines) **Takashi YOSHIKAWA** (Tokai University, Japan)
14:20-15:00	Actual situation of livelihood of small-scale fishing household in Thailand: the case study in Eastern, Centre and Southern of Gulf of Thailand **Jariya SORNKLIANG** (SEAFDEC, Thailand)
	Livelihood of fishing households that operated coastal aquaculture in Bandon bay, Surat Thani **Methee KAEWNERN** (Kasetsart University, Thailand)
	A structure of fishing in Rayong province in western Thailand **Tsutom MIYATA** (Fisheries Research Agency, Japan)
	The overview and the actual state of fisheries around the Batan Estuary, Aklan, Central Philippines **Ryutaro KAMIYAMA** (Fisheries Research Agency, Japan)
15:00-15:20	Coffee break
15:20-15:40	Coastal fish diversity in the South China Sea **Nozomu MUTO** (RIHN, Japan)
15:40-16:00	Educational study of acoustic surveys in coastal shallow area at Southeast Asia **Yoshinori MIYAMOTO** (Tokyo U. of Marine Science and Technology, Japan)
16:00-16:30	Background of Rayong Set-Net, Thailand **Kamolrat PHUTTHARAKSA** (EMDEC, DOF, Thailand)
	New challenges of set-net technology transfer in Thailand **Nopporn MANAJIT** (SEAFDEC, Thailand)
16:30-17:00	"Tsukuru-Gyogyo" as Area-capability approach: A background explanation for participatory stock enhancement project of tiger shrimp in New Washington, Philippines **Hisashi KUROKURA** (The University of Tokyo, Japan)
	Stock enhancement of tiger shrimp *Penaeus monodon* in the Philippines **Jon P. ALTAMIRANO** (SEAFDEC, Philippines)
	Results of social impacts survey (tentative) **Nerissa SALAYO** (SEAFDEC, Philippines)
17:00-17:30	Research Activities in ISHIGAKI Island and MIKAWA Bay Area, Japan: Towards Transdisciplinary Research **Rintaro ONO** (Tokai University, Japan)
17:30-17:40	Announcement from comittee
18:00-20:00	Welcome Dinner (dining room in RIHN)

Tuesday December 15, 2015

Day 2 Project Annual Meeting

08:30-09:00 Registration

Session 4: Group Discussion (Lecture Hall, Room1.2, Room3.4, Room 5)

09:00-12:00 Group discussion within each component member for publications and further activities

12:00-13:00 Lunch

Session 5: Wrap-up Presentation (Lecture Hall)

13:00-13:15 Fishing gear (Thailand)

13:15-13:30 Fishing gear (Philippines)

13:30-13:45 Environment (Thailand)

13:45-14:00 Environment (Philippines)

14:00-14:15 Social (Thailand)

14:15-14:30 Social (Philippines)

14:30-14:50 Biodiversity

14:50-15:15 Coffee break

15:15-15:30 Acoustic

15:30-15:50 Set-net

15:50-16:10 Stock enhancement

16:10-16:30 Ishigaki and Mikawa

16:30-17:00 Coordination

17:00-17:15 Closing address

18:00-20:00 Casual Dinner (dining room in RIHN)

Wednesday December 16, 2015

Day 3 Study Tour

09:20	Meet in front of RIHN Guest House
09:30	Depart from RIHN
10:00-11:00	Kinkaku-ji temple
11:30-14:00	Arrive at Arashiyama area Farewell Party at Arashiyama Yoshiya Sightseeing around Arashiyama area
14:00	Depart from Arashiyama area
14:45-17:00	Kyoto Aquarium
17:20	Kyoto Tower observatory (No chartered bus on the way back) or go back to RIHN by chartered bus

• Participant Lists •

Tour guide-interpreter: Ms. Sachiyo AOKI

Jon P. ALTAMIRANO
Nathaniel C. AÑASCO
Sukchai ARNPAPBOON
Ricardo P. BABARAN
Anukoron BOUTSON
Alice Joan FERRER
Methee KAEWNERN
Nopporn MANAJIT
Harold M. MONTECLARO
Kamolrat PHUTTHARAKSA
Jintana SALAENOI
Nerissa SALAYO
Narakorn SOMWANTHANA
Jariya SORNKLIANG
Yuttana THEPAROONRAT
Yasmin TIROL
(overseas 16)

Keigo EBATA
Saki HONMA
Satoshi ISHIKAWA
Ryo KAKIOKA
Ryutaro KAMIYAMA
Masato NIKI
Mika YOSHIMURA
Kazuo WATANABE
(domestic 8)

Component 8 Coodination

The Area-capability Concept: Promoting the Use of Local Resources

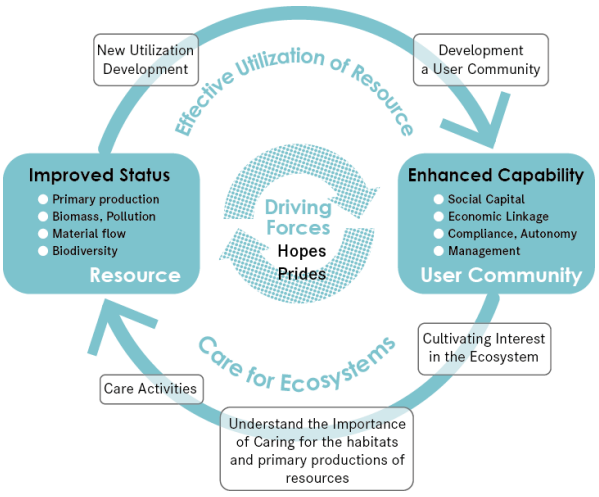
Kazuo WATANABE, Satoshi ISHIKAWA
Research Institute for Humanity and Nature, Japan

▶ Keywords: Area-capability, AC cycle, Local Resources, Community, Ecological service, Care

Field survey was conducted in the 3 different regions to understand back ground of success story of community based resource management. This study extracted universal elements from field surveys for better relationship between ecosystem and community in the specific area and created a concept which was named the "Area-capability". In Amakusa region, few people have started the dolphin watching tourism. The dolphin was treated as nuisance by the local people before the tourism, but they gradually understood the value of dolphin as local resource as the number of tourist increase. Local fisherman in the Hamana Lake was negative to participate stock enhancement project of shrimp in this region and connection among fisherman groups was also too week. As the number of production increase, however, local fisherman's groups paid attention to the project and started production monitoring and stock enhancement activities, voluntarily. Two set nets was installed to local fisherman's village by JICA foundation in Rayon province. After install them, local fisherman group succeed to exclude trawling and got new fishing field and the fish produced from Rayon has become famous. We realized that from this study 1) specific resource in an area should be connect to local community strongly, 2) resource user's community should be understand the ecosystem which provides specific resource, 3) evaluation and involvement from outsider of community is needed to encourage pride or attachment to their hometown, community and local environment. The "Area-capability" concept provide a function to support creating local community based resource management system.

1. Forward

Since the United Nations Conference on the Human Environment was held in Stockholm in 1972, much research has been done to alarm the international community of global environmental risks. Following the conference, numerous actions were taken to solve the global environmental issues on local, national regional and world levels. Nearly all of these actions began as scientific evaluations and forecasts that simulated related aspects of the natural environment. Then, some restrictions of ecosystem services utilization are set in management and/or conservation of natural resources. Many people know about the risks of widespread environmental problems, and we have a lot of data and information on natural environments around the world, however, their circumstances are growing worse.



We searched for alternative ways to discussing global environmental degradation based on ordinary people's viewpoints. We investigated how daily activities can help solve environmental issues in rural areas where there

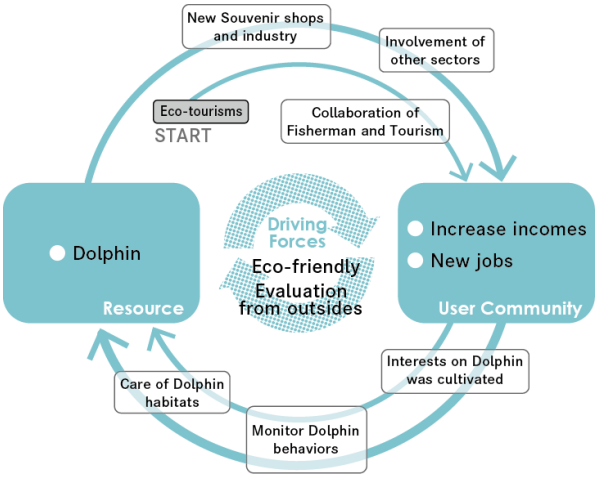
is a lot of nature. Yet the people who live in rural zone of developing countries want to lead very convenient lives without deep thinking about the environment. Our challenge is to establish a way to implement regional sustainable development that takes regional cultures and environmental features into account, in order to meet local residents' hopes and interests. Given the emphasis of recent regional development activities on utilizing local characteristics, the scale and types of resources used and the nature of the activities are extremely diverse. That said, we found that efforts which have been able to continue sustainably and expanded in scope share the following elements: (1) A local community uses resource unique to the region; (2) Resource users understand the importance and take care of the environment that supports the resources used, and (3) A balance is struck between using and caring for resources and the supporting environment, which is evaluated by outside entities.

We believe these shared components are essential to sustainable development, and use the term "Area-capability" (AC) to refer to the set of factors that comprise these elements. We developed a conceptual map showing the relationship between these three aspects, which we refer to as the Area-capability Cycle (AC Cycle). We believe that the set of factors included in AC and the AC Cycle will be useful as a checklist when developing proposals for regional development and revitalization activities, assessing the balance between use and care, and clarifying the standpoint and role of each stakeholder when evaluating projects. The principles behind AC are discussed in detail below.

2. Case Studies

1) Dolphin Watching: Itsuwa Town, Japan

Dolphin watching in Itsuwa-Machi was the brainchild of Hidenori Nagaoka, who moved to Itsuwa in 1993. Nagaoka, who was moved by seeing dolphins first hand, proposed dolphin watching to local fishermen as a means of community revitalization. The Itsuwa area had always been home to several hundred bottlenose dolphin, and their presence was taken for granted by the local residents, so no one had even considered the idea that they could be a tourism resource. In fact, to the fisherman, the dolphins, which ate the same fish they were after, were even considered enemies. For this reason, only five fishermen agreed in the beginning to offer dolphin watching tours. However, as the number of tourists steadily grew from year to year, the residents began to recognize that the dolphins were a resource for tourism, and the number of individuals engaging in dolphin watching businesses and gift shops increased. If we consider these changes in terms of the AC Cycle, the new means of resource utilization in the form of dolphin watching led to the creation of a new community of fishermen and tourist business operators, and the dolphins went from being ubiquitous enemies of fishing to an important local resource for Itsuwa. In addition, the transformation of dolphins into a resource caused fishermen to dramatically change their feelings toward dolphins and to deepen their understanding of the dolphins' ecology. Furthermore, the fishermen have made an effort to ensure a high rate of encounters with dolphins by taking steps to care for the dolphins and their habitat. This, in turn, has contributed to the branding of sustainable dolphin watching.



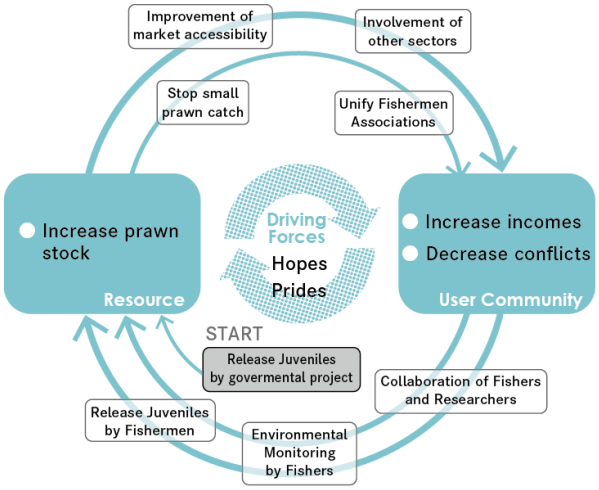
2) Village-based Set-net Fishing: Rayong Province, Thailand

The adoption of set-net fishing technology in Rayong Province, Thailand is a prime example of the creation

of a new community as a result of new resource utilization enabled by the introduction of outside technology. Small scale fishing in the form of basket fishing and spear fishing and commercial fishing using round haul netter boats had long been practiced in the area, which resulted in conflicts regarding coastal fishing rights. In order to reduce conflicts among fishermen and to gather information needed for resource management, an international organization named the Southeast Asian Fisheries Development Center (SEAFDEC) headquartered in Bangkok, Thailand decided to introduce set-net fishing technology modeled after the village-based set-net system used in Himi City, Japan. To introduce set-net fishing, the SEAFDEC staff first contacted local small-scale fishermen and created a fishermen's organization to manage the set-net, after which they provided technical support and materials to the fishermen's organization. The catch in the first year was not very good. However, the catch was improved the following year thanks to the provision of technical instruction and better fishing gear. A cooperative sellers' market synced to the fishing operations was established, and the economic foundation and management skills were strengthened. As a result of this support, by the third year, there was no longer a need to rely on subsidies or research funds. Similarly, in terms of personnel, the set nets could be managed entirely by the fishermen's organization. In this case, the introduction of set-net fishing transformed large fish and various fish species that were previously inaccessible to the shore-based small-scale fishermen into a local resource for the user community of set-net fishermen. This new resource utilization, in turn, has become the driving force for a sustainable community. The cooperative marketing and fishing operations have strengthened local human resources and have stimulated interaction among local residents, opening up the possibility for other activities. These community activities have since spawned tourism and environmental education programs based around the set nets.

3) Tiger Prawn Aquaculture: Lake Hamana, Japan

During Japan's period of rapid of economic growth in which the nation was fixated on the growth of heavy industry, much of the seashore was landfilled and reclaimed. With the loss of spawning and breeding grounds, natural fisheries resources (supply services and fundamental services provided by coastal ecosystems) deteriorated rapidly. To compensate for the lost reproductive capacity of the coastal ecosystem, the government decided to stock (raise and release) fish species important to the fisheries industry. This was the start of the aquaculture. Aquaculture research centers were established in each prefecture and began breeding and releasing hatchery-raised fish. In Shizuoka Prefecture, an aquaculture research center was established on Lake Hamana, which



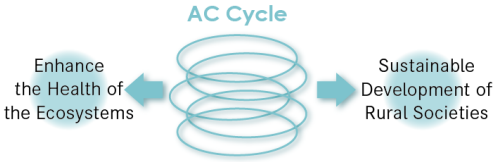
began stocking tiger prawns in 1980. The tiger prawn stocking program, which began as a top-down public works project, was not accepted by the local fishermen and received absolutely no cooperation from the local residents who did not believed stocking would be effective. Undaunted, the staff of the Shizuoka Prefecture Aquaculture Research Center persisted in collecting data for resource evaluation, researching aquaculture technology, conducting environmental surveys to identify suitable stocking sites, and continued to breed and stock tiger prawns, if only in small quantities. The young people of Shirasu village, who had watched the center's efforts in their own community, began to cooperate. With local support, the stocking of hatchery-raised tiger prawns increased dramatically. In turn, the increased harvest of small prawns resulting from this mass stocking opened the eyes of local fishermen to the potential of stocking prawns and led more and more fishermen to participate in each successive release. This series of changes aptly illustrates the AC Cycle: the obvious effectiveness of stocking heightened the fishermen's interest in the resource and supporting environment and promoted understanding of the importance of caring for the resource.

Thereafter, fishermen in the Lake Hamana area solidified as a community through the stocking of tiger prawns, and even went on to revise fishing regulations and improve distribution methods to more effectively use the tiger prawns, which they themselves had stocked. It is because so many local residents have come to participate and take action of their own accord that the community has succeeded in augmenting its resource.

3. Using the AC Cycle as a Development Index

Up to this point, we have discussed the principle underlying AC and the AC Cycle. As can be seen from the cases above, one AC Cycle can be drawn for each local resource. In other words, for a region with multiple resources, as many AC Cycles can be drawn as there are resources. Meanwhile, in the case of AC, one user community is responsible for the use of one local resource. For this reason, the existence of many AC Cycles means the existence of the same number of local user communities. Since each community is open to the people in the region, it is possible for new members to join an existing community and for members of a given community to leave whenever they choose. Furthermore, an individual may participate in multiple communities. Such changes notwithstanding, the existence of multiple communities means that individuals have that many more opportunities to interact and exchange information with others, which should facilitate cooperation among local residents in various contexts.

In other words, we believe the number of AC Cycles is an indicator of the abundance of local resources in a given region and, at the same time, an indicator of the potential for various types of cooperation. As such, we suggest that the number of AC Cycles could be used as an index for regional development.



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Guest Speech

Life Cycle Assessment (LCA) and the natural environment:
current assessment options and the way forward

Francesca VERONES
Norwegian University of Science and Technology (NTNU), Norway

▶ Keywords: life cycle assessment, ecosystems, terrestrial, aquatic, marine, impact

Life Cycle Assessment (LCA) is a methodology that aims at analysing the environmental impact of a product or a process throughout its whole life cycle (ISO 2006a; ISO 2006b). The motivation of LCA is to ensure that relevant environmental consequences and implications can be highlighted and calculated before the decision is put into practice. The life cycle typically starts with the extraction of raw materials, continues with the manufacturing phase, a use phase and ends with disposal and/or recycling. In between all these life cycle stages transport processes are included. In a first step, a life cycle inventory (LCI) is established. Here all the relevant emissions and resource uses are collected, such as how many kg CO2 have been emitted during the different processes or how many kg of iron have been used. In the next step, the life cycle impact assessment (LCIA), the consequences of these material uses and emissions are assessed. This is done by assigning damage values to each of the information collected in the LCI. There are three main safeguard subjects that emphasis is put on during life cycle assessment: human health, ecosystem quality and natural resources.

For the purpose if this talk here, we will only consider "ecosystem quality" further. Ecosystem quality is traditionally measured in potentially disappeared fractions of species (PDF) (Goedkoop et al. 1999; Huijbregts et al. 2014) or in species.yr (Goedkoop et al. 2009). Other units exist, but are not commonly used. What is important, is to see that currently LCA does actually consider species richness as its indicator of choice. The LCA community is aware that species richness as such, is not necessarily representative of "ecosystem quality" and discussions are ongoing in the UNEP-SETAC flagship project "Global Guidance for Life Cycle Impact Assessment Indicators and Methods" on the appropriate endpoint unit. The way forward will include completion of impact pathways and spatial differentiation.

Literature

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Guest Speech

Developing fisheries and aquaculture in Indonesia on Global Climate Change Issues

Muhammad Iqbal DJAWAD

Faculty of Marine Sciences and Fisheries, Hasanuddin University, Indonesia

▶ Keywords: climate change, fisheries, aquaculture, Indonesia

In Indonesia assessment of climate variability have already started. Attention from some institutions in this field is commendable. We needed a precise direction and enabled the acceleration to provide greater benefits. Right now there are many organization in charge of data and information on weather, climate, oceanography, and fish resources but it has not synergized well. There are several studies of climate change in Indonesia showed that the susceptibility (sensitivity) Indonesia's fishery resources of the ENSO (El Nino and Southern Oscillation) varies according to the existing production system. (Ghofar in 1995 and 2001, Ghofar and Mathews, 1996, Ghofar et al, 2000 as well as Mathews et al, 2001)

Lumuru fishery in the Bali Strait sensitive to ENSO with the abundant production in El Nino years and the slump in the years of anti-El Nino. As well known that Bali Strait ecosystem has supported by the frontal system, upwelling, and the effect of cross currents Indonesia (Indonesian Throughflow) and Pacific waters. The opposite effect occurs in the black tiger shrimp aquaculture in South Sulawesi, where production decreased in the years of El Nino and increased during the years of anti-El Nino. There is no general conclusion that the El Nino positive effect on fisheries and the negative impact on other fisheries or aquaculture in Indonesia. In connection with this, we need a shared understanding that there are not single institution strategies that can be useful for the management of fish resources, coastal, and Indonesia ocean that very diverse.

In the case of fish resources, four strategies can be applied. First, identifying the capture fisheries and aquaculture that vulnerable to changes or environmental variability. Second, the study of fish production systems has to begin from the climatological, oceanographic, biological until the effect on fish production. Third, constructing a dynamic model of production for each production system based on inputs obtained through the first and second strategies. Fourth, resource management plan for each production system that based on the model obtained.

It becomes evident that resource management is needed instead of numbers of potential resources, but it also need more dynamic production models that using environmental factors as a key. Therefore, only in this way can be possible for a reasonable anticipation to minimize (mitigation) ENSO impacts on coastal and ocean resources. Maintenance and improvement of the carrying capacity and environmental quality including freshwater, coastal, small islands and ocean is a general policy. For that, we need the system to anticipate global climate change and climate variability. The approach should use the integrated solution, which the dissemination of technology and mitigation in coastal communities can be done directly benefit coastal communities.

Component 1 Fishing gear

Seasonal variations in small-scale fisheries in Rayong, Thailand

Keigo EBATA[1], Anukorn BOUTSON[2], Takafumi ARIMOTO[3], Kazuo WATANABE[4], Satoshi ISHIKAWA[4]

1 Faculty of Fisheries, Kagoshima University, Japan
2 Faculty of Fisheries, Kasetsart University, Thailand
3 Tokyo University of Marine Science and Technology, Japan
4 Research Institute for Humanity and Nature, Japan

▶ Keywords: Small-scale fisheries, Catch, Fishing ground, Seasonal variation, Log-book, GPS

Small-scale fisheries using crab gill-net, fish trap, squid trap, trolling line, and hook-and-line constitute one of the important industries in Rayong, Thailand. The purpose of the present study is to clarify the seasonal variations such as catch amount and landing price, species caught and operation sites in these fisheries. Field surveys on small-scale fisheries were conducted from November 2012 onwards. Thirteen fishermen in total were targeted, and log-books were distributed to all the target fishermen who were asked to record details of their fishing operations every day. These items were (1) date of fishing operation; (2) number of fishing gear used or retrieved; (3) number of fishermen on-board; (4) species, weight and price of the landed fish; (5) time of departure and return to pier; and (6) amount and price of fuel purchase. Portable GPS devices were connected to the fishing boats to record their positions at 3-min intervals in order to determine the operation sites where fishermen deployed and retrieved the fishing gear. Fishing boats were 6.5 m long and 2.0 m wide and were made of wood with approximately 18-horse power diesel engines. On-board surveys were conducted to observe fishing operations. Data on weather conditions such as wind speed, wind direction and sea conditions were obtained from the Meteorological Department Station in Rayong Province.

Seasonal changes in wind speed in the Rayong coastal area

Seasonal changes in wind speed in the Rayong coastal area were analysed based on data collected at the Meteorological Department Station. The average wind speed from October to April was less than 2 knots; however, wind speed during the Southwest monsoon season from May to September was higher. The average wind speed was more than 4.0 knots during Southwest monsoon season and about 6.1 knots in September 2013. Thus, wind speed in the Southwest monsoon season differed considerably from that in other seasons. The Southwest monsoon affected the Rayong coastal area where fishermen conduct fishing operations.

Crab gill-nets

The fishermen used crab gill-net of a total length of 450 m, consisting of five 180 m long plane nets made of nylon monofilaments with a mesh size of 100 mm and a twine diameter of 0.3 mm. Fishermen usually left the pier for the fishing grounds at approximately 5 a.m., retrieved up some sets of gill-net and returned to the pier at approximately 10 a.m. The gill-net was retrieved about 3 days after deployment. Fishermen removed the catch from the gill-net and sold it to middlemen after returning to the pier. The predominant target species is Blue swimming crab Portunus pelagicus. The number of days per month on which fishermen conducted operations was small during the Southwest monsoon season, but increased from September (the end of the Southwest monsoon season) to February. The number of days of operation per month was greater than 20 from September to February, and the landing amount and income also increased in December,

January, and February. The fishing operation sites changed during the Southwest monsoon season. Fishermen deployed the gill-nets behind the Samet Island, an area that is not affected by the Southwest wind.

Fish traps

Fish traps were made of a wooden frame covered with a polyethylene net and wire webbing; the traps were 2.06 m long, 0.95 m wide, and 0.50 m high with an entrance. Fishermen set fish traps on the seabed around coral reefs or artificial reef with the direction of the entrance parallel to the tidal current. The soaking time of the fish traps were about one week. Fishermen went to sea for 6–7 hours to retrieve about 10 fish traps per trip. The species predominantly targeted were Rabbitfish Siganus javus and Siganus canaliculatus and Longfin grouper Epinephelus quoyanus. The number of operation days per month reduced during the Southwest monsoon season, but operation sites where fishermen deployed the fish traps did not change. Catch per fish trap (CPUE) was higher during the Southwest monsoon season than in the other seasons.

Floating squid traps

The floating squid trap was semi-cylindrical, 80 cm wide, 95 cm long and 100 cm height, and had one entrance. The trap was connected to a sinker using a rope 1.0–1.5 m in length and to a float using another rope, in order to set the trap afloat above the sea bottom with the entrance facing upwards. Egg clusters were placed inside the trap to attract squid. If egg clusters were not available, fishermen used white plastic tape to imitate eggs. Main target species were Bigfin reef squid Sepioteuthis lessoniana and Cuttlefish Sepia aculeata, which were fully mature. Thus, the trap had good selectivity for species and size. The number of operation days per month was not affected by the Southwest monsoon, although the number of the traps deployed decreased. Moreover, catch amount also decreased during the Southwest monsoon season. The traps were placed near a coastal area about 10 km off the coast during the Southwest monsoon, but is maximum about 50 km off coast in the other season.

Trolling line and hook-and-line

Trolling line and hook-and-line were largely used to catch Bigfin reef squid Sepioteuthis lessoniana and Spanish mackerel. Small fish as well as artificial lure were used as bait. The number of operation days per month as well as the catch amount decreased during the Southwest monsoon season. The trip required a whole day (about 11 hours), and fishermen conducted fishing operation in a wide area off the Rayong coast. The fishing operation site did not appear to be affected by the Southwest monsoon. The main catch from February to June is the Bigfin reef squid, and from October to December is the Spanish mackerel. Thus, main catch differed due to the season.

Photo 1. Small scale fishery conducted in Rayong, Thailand.
(Left: Crab gill-net, Middle: Fish trap, Right: Floating squid trap)

Composition of Non-economic and Garbage of Bottom Gillnet along the Coast of Rayong Province, Eastern Gulf of Thailand

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▶ Keywords: Garbage, Bottom Gillnet, Rayong Province, Thailand

Rayong province is located in the Eastern part of Thailand with approximately 100 kilometers of shoreline along the Eastern Gulf of Thailand. There are several types of fishing gear such as gillnet, trammel net, trap, hook and line can be used for small scale fisheries and crab bottom gillnet is mainly used in this area. The main target species of crab bottom gillnet fishery is blue swimming crab and also various marine animal that live on the bottom of seafloor can be caught. The catch rate, species composition and discard species has been analysed and used for developing and improving crab bottom gillnet fishing, in order to increase the catch of target species and reduce non-target species.

The study was conducted at Kok Leam Tean, Phe sub-district, Muang District, Rayong Province during February to November 2015 with 23 samplings taken from crab bottom gillnet boat. The fishing ground, total catch and fishing effort (kilograms per day) were collected by fishermen interview while species caught were identified and weighed. Data collection was separated into 2 groups which were Target species (Blue swimming crab) and non-target species i.e. economic species and non-economic species including garbage.

The fishing ground of crab bottom gillnet fisheries were generally found at 7-14 m depth and approximately 2-8 km from shore, on the west side of Samed Island and around artificial reefs. The seabed characterization at fishing ground was sand or sand and mud. The result showed that the average catch rate of crab gill net fisheries was 9.02 kilograms per day. Blue swimming crab (Portunus pelagicus) was main target species and the catch rate was 4.72 kilograms per day, 52.31 percent of the total catch. The percentage of non-target species was 47.69 of total catch and the catch rate was 4.30 kilograms per day.

Non-target species was separated into 2 groups which were economic species and non-economic species including garbage. The economic species was found to be 11 species in total, 25.88 percent of the total catch and the composition composed of crabs shellfish and others which were 14.54 10.05 and 1.29 percent respectively. The non-economic species including garbage were 21.81 percent of total catch and the composition composed of crabs shellfish fish and garbage which were 10.17 3.14 1.02 and 7.48 percent respectively.

The non-economic species including garbage which crabs were major compositions and its was found to be 16 species such as Red-spotted box crab, Decorator crab, Gladiator Swimming crab, Purple Anemone crab, Box crab, etc. Living fauna and non-living e.g., sea urchin, sea cucumber, sea pen, marine sponge, shell, plastics were classified to the garbage group, which were not used as fishers.

Small-scale fisheries in an estuarine environment:
the case of New Washington-Batan-Banga estuaries

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▶ Keywords: Capture fisheries, fishing gears, fisheries management

In this study, the case of New Washington-Batan-Banga Bay, an estuarine body of water in Panay Island, Philippines is presented. Capture fisheries data such as fishing methods, amount of catch, and species caught were collected during the 12-month study period. In addition, a census was conducted among fishers operating in the study area to collect additional information on fishing operations and relevant socio-economic data. Interviews with key informants, fishers, local leaders and various stakeholders provided information on the social, political and economic processes in the coastal community.

The estuarine fishery in the study site is traditionally composed of crabs, shrimps and fish species such as snappers and groupers. These fishery resources are exploited using a variety of fishing gears that include stationary fishing gears (traps and lift nets), pots, nets and lines. Figure 1 shows the variety and percentage of fishing gears used by local fishers in New Washington-Batan estuaries. The most prominent fishing method is the use of traps. These traps include the shrimp trap locally called tigbacoe, fish corral taba, filter net tangab/saluran, lighted lift net bentahan, baited lift net batak-batak, and barrier net sirada. Among non-stationary gears, the most numerous gears used are pots, crab lift nets, lines and a variety of gillnets.

Among the environmental parameters, tides influence fishing operations and catch most. In gears such as filter nets, shrimp traps and fish corrals catch were highest during days when tidal level difference between the high tide and low tide was high. In days when tidal level difference was low, some fishers do not go out to fish while for those who did, fish catch were relatively lower. Other fishing gears such as lift net, pots, lines and nets were not tide-dependent, although pot operations may be affected by the lower supply of "trash fish" caught by traps which are used as pot baits.

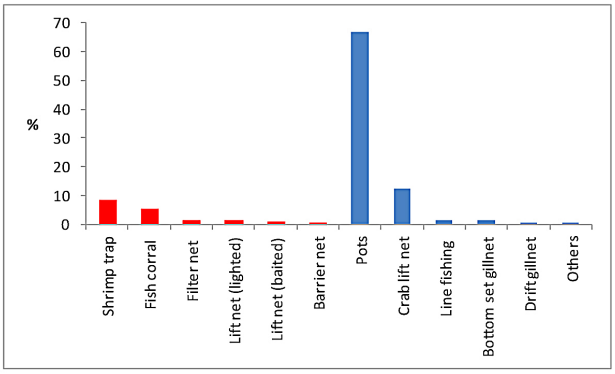

Fig. 1. Dominant fishing gears used by fishers in the New Washington-Batan estuaries to catch fish. Red bars represent gears that are stationary. Blue bars represent fishing gears that are portable.

Respondents revealed what they consider were the most pressing issues and concerns regarding their fishery and livelihood. These include weather and climate issues, theft and vandalism, increasing competition for the resource, and reduction in fish catch and income. In recent decades, catch has declined as a result of many factors such as the open-access system, decrease in fish stocks, degradation of aquatic habitats, unsustainable fishing practices, and issues in management and enforcement of laws. With climate issues for example, the impacts of natural calamities such as a very powerful typhoon on the small scale fisheries was studied.

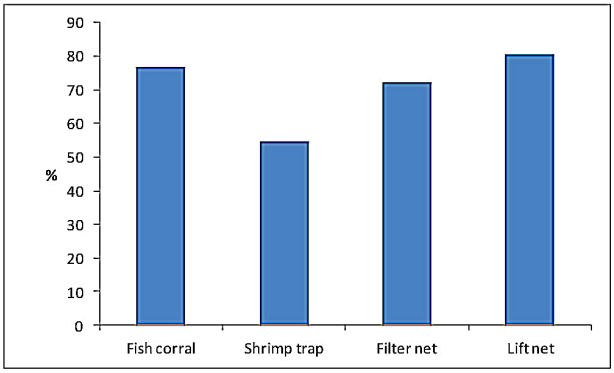

Fig. 2. Damage of stationary fishing gears as a result of an extreme weather event.

Based on the ecological, social, governance and fisheries data gathered, additional recommendations in the management of the estuarine fishery are presented.

Coastal environment and human activity in Thailand

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▶ Keywords: seawater, bottom sediments, benthos, trophic status, food-web structure, phytoplankton

In Thailand, we have been conducting environmental research in coastal area of Rayong in the east and Bandon Bay in the south. In Rayong, in order to evaluate possible impacts of set-net operation, (1) status of the seawater and bottom sediments within and around the set nets and (2) trophic levels and feeding habits of the catches of set net and other gears have been investigated collaborated with C6 (Set-net component) and other components activities. In Bandon Bay, (1) interactions between shellfish culture and local society, (2) phytoplankton composition and primary productivity, (3) bottom sediment conditions, and (4) food web structure have been investigated.

Coastal area of Rayong

(1) Status of the seawater and bottom sediments

In coastal area of Rayong, potential impacts of the set-net and other fishery activities on biological resources and environment were investigated in the year of 2013-2014 operation. Survey on seawater and bottom conditions was conducted around the set-nets at the beginning (October 2013), midterm (January 2014) and end (April 2014) of set-net. Survey was also conducted during 30 September-02 October 2014 when there was no set-net (reference period). A CTD sensor was used for basic environmental factors. Water sampling was done for suspended solids (SS), chlorophyll *a* and nutrients measurements. Bottom sediment samples were obtained by a grab sampler for acid volatile sulfide (AVS), ignition loss (IL) and water content investigations.

AVS showed constantly much lower than the criteria for identifying critical farms (2.5 mg/g dry proposed by Yokoyama 2003). AVS in the set-net stations increased with set-net operations (0.0011±0.018 mg/g dry in October 2013, 0.0016±0.0024 in January 2014, 0.0034±0.034 in April 2014), but there was no significant differences among them. Macrobenthos were composed of 6 phyla (11 classes) including Nematoda, Annelida (Polycheta), Mollusca (Gastropoda and Bivalvia), Arthropoda (Ostracoda, Copepoda and Malacostraca), Echinodermata (Ophiuroidea, Echinoidea and Holothuroidea) and Chordata (Leptocardii). Numerically dominant class was polychaeta (33.22%) through study period followed by

Malacostraca (23.94%) and Bivalvia (18.22%). Benthos density was 1.4 to 2.0 times higher in the set-net stations than that in the reference stations during the midterm and end of set-net. In contrast, ratio of benthos density in the set-net stations to that in the reference stations was 0.7 to 1.0 during the beginning of set-net and reference period. These results indicate a positive impact of set-net on benthos communities, but it seems not to continue after operation.

(2) Trophic levels and feeding habits of the catches of set net and other gears

Survey on trophic levels of the catches of set-net and other gears was conducted mainly by the set-net groups during Dec 2012-Mar 2013, Oct-Nov 2013 and March 2014. A total of 1030 samples from 36 fish species were collected for later analysis of carbon and nitrogen stable isotope ratios by a mass spectrometer fitted with an elemental analyzer (Delta V advantage and Flash EA 1112, Thermo Fisher Scientific Inc.) at RIHN. Several environmental samples including mangrove leaves were also collected; particulate organic matter (POM) and sedimentary organic matter (SOM) were also measured. Stomach contents of the fish were sorted into taxonomic groups at EMDEC and some of them were used for analysis of stable isotopes. Stable isotope analysis of the all samples has been already completed until the end of fiscal year 2014. Mean trophic level estimated from the fishery record and stable isotope analysis was stable (3.6-3.7) during these 11 years, indicating little or no impact of the set-net operation on status of the fishery resources.

Bandon Bay

(1) Interactions between shellfish culture and local communities

Historical Statistics of the yield and area of blood cockle culture in the bay from 1979 to 2010 showed that the production capacity in the past 30 years was sharply fluctuated. Government policies and natural disaster laid behind this fluctuation were examined in order to understand the relationship between the two and the impacts at present. It has been argued that the production capacity of the bay was reduced according to pollution and natural disaster. Budget from the government to restore the cultivation after hard natural disaster made new farms expand beyond the permitted cultivable areas. Moreover, hard natural disaster was found to cause the transformation of cultivated area, moving in and out of those permitted, both small and big farms.

(2) Phytoplankton composition and productivity

Phytoplankton samples were collected in rainy (August 2013) and summer (March 2014) seasons at 12 stations along the coast of Bandon Bay. Stations 1, 2 and 3 represented the east coast of the Tapi River (Kanchanadit district), stations 4, 5 and 6 were at the Tapi estuary (Mueang Surat District) and stations 7, 8, 9, 10, 11 and 12 were located on the west coast of the river (Chaiya and Tha Chang District). Salinity in the west coast was higher than that in the east during rainy season, while lower during summer. Salinity around the mouth of the Tapi River was low (less than 13 ppt) due to the flow from river. Dissolved oxygen in the west of the bay was higher than those in the east and the estuaries both in summer and rainy seasons. Phytoplankton samples collected vertically by a plankton net of 20 *u*m mesh size showed a total of 79 species in 3 divisions: Cyanophyta (3 species), Chlorophyta (4 species) and Chromophyta (72 species). Dominant genera were *Surirella* (20.34%), *Coscinodiscus* (19.58%), and *Pleurosigma* (12.95%) in the rainy season and were *Rhizosolenia* (32.62%), *Pleurosigma* (18.41%), and *Nitzchia* (14.85%) in the summer season. Richness index, Evenness index and Diversity index of phytoplankton were in the range of 1.416-1.718, 0.415-0.591 and 0.849-1.928 in rainy season and 0.780-2.509, 0.229-0.760 and 1.585-3.185 in summer, respectively.

Photosynthetic rate was measured by *in situ* incubation for 24 hrs and uptake of ^{13}C labeled HCO_{3^-} at 3 vertical layers (surface, middle, and near bottom) of 8 stations in August-September 2012 (rainy season)

and of 9 stations in March 2013 (summer season). In rainy season, values of chlorophyll *a* and primary production at the surface (0.8–19.1μg L^{-1} and 411–2732 mgC m^{-3} d^{-1}) were compared to those reported from Hiroshima Bay and Oginohama Bay in Japan, where intensive oyster cultures were conducted.

(3) Organic matters content and dehydrogenase activities of the sediment

Organic matters content and dehydrogenase activities of the sediment in cockle farms during rainy season (June 2013 and August 2013) and summer (March 2014) were investigated in Bandon Bay. In the east coast (Kanchanadit district), sediments were shown as loamy soil, sandy loam soil and loamy sand, while in the west (Chaiya district), they were sandy soil and sandy loam crumbly. Amount of organic matter accumulated in each sediment layer (depth 1-7 cm) in rainy and summer seasons was not significantly different. Sediment organic matter in the east coast, where cockles have been cultured for long time, was distinctively high comparing to the west during rainy season. Dehydrogenase activity on the surface layer (epipelagic) was quite lower than that in deep layer, hence physical, chemical and biological processes seemed contribute to nutrient cycling in sediments.

(4) Food-web structure

According that the basic features of the bay were related to bivalve production, its food-web was investigated based on carbon and nitrogen stable isotope analysis. Bivalves were collected from 6 sites in March 2013, September 2013, and February 2014. Particulate organic matter (POM) and sedimentary organic matter (SOM) were analyzed. The analysis of variance showed significant differences among bivalve species. This result suggests the difference of food habit by species. There were differences of $\delta^{13}C$ and $\delta^{15}N$ in the shell size of *Geloina* sp. at station 21. Also, correlation between the shell size and $\delta^{15}N$ has been seen in *Ostrea* sp. and *Perna viridis*. The results showed that $\delta^{13}C$ did not cause the difference except for *Geloina* sp.. Bivalves were mostly nonselective filter feeders; each of them tended to prey on different foods. Conceptually, single species in the same bay is regarded as same food habit to share, or not to be considered carefully about it. However, the above results indicate diversity on food source in different area in the same bay due to the characteristics environment of each area.

Component 3 Environment

Coastal environment and human activity in the Philippines

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▶ Keywords: water and bottom properties, food-web, chemical pollution, mangrove, shrimp ponds

Our component has been conducting comprehensive environmental studies in four coastal areas with different environmental and social conditions namely, Batan Bay Estuary (Philippines), Rayong Bay and Bandon Bay (Thailand), and Hue Bay (Vietnam). The main goal is to describe patterns of material flows in these areas with the specific objectives to investigate the following: (1) water and bottom conditions; (2) marine food-web structures; (3) water circulation patterns using ICP-MS data; (4) land utilization profiles, (5) chemical pollution; and (6) productivity of mangrove areas. Interactions of these environmental factors to human activities will be correlated and discussed. Expected outputs at the final fiscal year of the project will be two books collaborating with C2 and other components. One is a part of the series book written for Japanese citizens. The other one will be written in English and for scientists interested in trans-disciplinary environmental research in coastal areas of Southeast Asia.

In Batan Bay Estuary, the specific research objectives are the following: (1) preparation of a land utilization map by GIS; (2) determination of the origins of water and minerals by ICP-MS & Sr in water and sediments; (3) estimation of mangrove production; (4) determination of iso-scape in mangrove areas; (5) estimation of litter production by mangrove forests; (6) assessment of material flows in the sea (food-web structure); (7) investigation on the role of microhabitats as shrimp nursery; (8) assessment of mangrove rehabilitation on benthic faunal community (9) assessment of chemical pollution (heavy metals, agricultural chemicals, etc.); (10) determination of water and bottom conditions including AVS levels; and (11) assessment of temporal changes in hydrographic conditions.

The activities (both completed and upcoming) and preliminary results are as follows:

(1) A GIS map showing land-use profile is currently being finalized. **(2)** To understand the current physico-chemical state and the key factors that contribute to water quality, spatial variations in elemental and isotopic Sr compositions were determined in water samples collected from 36 sites surrounding the bay area. In general, dissolved concentrations of the elements of concern in coastal waters (e.g. Pb, Cd, Ni, Sn, Cu) were within the current regulatory limits set by the Department of Environment and Natural Resources (DENR) of the Philippines. The spatial distribution of Sr isotope ratios ($^{87}Sr/^{86}Sr$) suggests that the estuary water is mostly ocean influenced ($^{87}Sr/^{86}Sr \approx 0.70916$; Sr concentration 51.40-80.87 μmole/l). However, a number of stations within the estuary exhibited very different $^{87}Sr/^{86}Sr$, suggesting possible anthropogenic

influences in the local scale. Inland water bodies including river tributaries of the bay generally exhibited lower Sr concentration (0.71-5.50 μmole/l) and $^{87}Sr/^{86}Sr$ ratios (0.707-0.708), which correlates well with the lower salinity levels (0-2.3 ppt).

[(3) (4) (5)] To clarify the contribution of mangrove plants as a producer in the ecosystem, $\delta^{13}C$ was measured for 202 mangrove plants and for surface sediment organic matter collected at 157 points. Sampling was conducted from June 2012 to September 2013 (just before Typhoon Haiyan). The $\delta^{13}C$ of mangrove plants varied from -31.6 to -27.9‰ reflecting that all of mangrove plants were C_3 plants. Back mangrove plants tend to showed higher $\delta^{13}C$ reflecting higher osmotic stress for these plants comparing to true mangrove plants which evolutionally developed mechanisms against salinity. As $\delta^{13}C$ of mangrove plants (-30.3±1.6‰) was far lower than $\delta^{13}C$ of phytoplankton (-25.2±1.6‰), the relative contribution of mangrove origin organic matter could be estimated by determining $\delta^{13}C$. Samples from the rivers connected to the bay and the inner part of the bay showed lower $\delta^{13}C$ reflecting the importance of terrestrial and mangrove origin organic matter in these points. Microspatial scale variation of $\delta^{13}C$ of sediment organic matter also observed along the gradient from remnant mangrove stands (-27.5‰) to open water (-24.8‰) located within a hundred m distance. As a conclusion, the spatial pattern of sediment $\delta^{13}C$ in the bay well explained by the distribution of mangrove forest and two entrances of the bay in 1953, even the most of the mangrove was lost during the 1990s and one of two entrances was closed 20 years ago. It suggests that the long lifespan of sediment organic matter and the relative stability of sediment in the bay.

(6) To grasp the food web structure of marine products and relationship with the characteristics of fishing gears in small scale, marine products were collected at 7 sites by different fishing gears in March and June 2014. In total, 1,181 individuals (include formalin samples and same species in different sites) in 7 sites in March; and 2,036 individuals in 7 sites in June have been collected for CN isotope analysis. Food web structures from $\delta^{13}C$ and $\delta^{15}N$ will be examined through seasonal and spatial differences including features of various fishing gears.

(7) To assess role of abandoned ponds as shrimp nursery areas, shrimp and fish assemblage structure with different ages and conditions were surveyed at 8 sampling stations (established during the initial sampling in Sep 2013) and at 2 additional stations during the second to forth sampling in March, September 2014 and March 2015. Small shrimp and fish were collected by towing a small seine net in the middle tide during the daytime, 3 times over 10 m tow at each station over the bare substrate in ponds and fringe of mangroves, or over vegetation at a seagrass station. The results (exclude March 2015; detail analysis was not yet finished) suggest that fish diversity decreased with culture pond constructions but abandoned ponds still provide habitat for particular shrimp and fish species. Density of fish and shrimps were not clearly different between abandoned ponds with bare substrate and mangroves. Samples taken in March 2014 (after the super typhoon in 2013) showed reduced diversity and abundance of shrimp and fish for most stations, implying an impact of the natural disaster. However, detail result of 2015 March sample would allow clearer conclusion. Stable isotope and gut contents will also be analyzed for further discussion.

(8) The impacts of mangrove rehabilitation on benthic faunal community in Batan Bay, Panay Island, Philippines, were investigated by assessing both numerical and functional response of community structures. The benthic invertebrates were collected from 5 replicate quadrats (20×20 cm) by excavating the soil to a depth of 20 cm in natural mangrove areas, rehabilitated areas, and abandoned fishponds in October 2014 and April/May 2015. The soil was sieved through 1 mm mesh, and the residue was preserved. Benthic organisms were later sorted from the soil, identified to the most possible taxonomic level, counted, and wet weighed. In addition, the carbon and nitrogen stable isotope ratios of the samples were estimated by using an IRMS (Thermo Fisher Scientific Co. Ltd.). Results show that the abundance and biomass are not significantly different among natural mangrove areas, rehabilitated areas, and abandoned fishponds. However, species

richness was highest in natural mangrove areas. The carbon and nitrogen stable isotope ratios indicated that food chain length of natural and rehabilitated mangrove areas were longer than that of abandoned fishponds. Overall, mangrove rehabilitation could easily recover functionality of the benthic faunal community but not numerically.

(9) To ascertain the degree of metal contamination in water, sediments, finfishes and shellfishes, 51 water samples, 32 sediment samples and 27 finfishes were collected in June 2012. Shellfishes (9, 4 and 7 species of crustaceans, gastropods and bivalves, respectively) were also collected in October 2013. Samples were processed and measured for heavy metals using ICP-MS for water and FAAS for sediments and fishes. Metal concentrations in sediments ranged from ND – 1.38 μg/g for Cd; 16.57 – 143.02 μg/g for Cu and 3.18 – 28.53 μg/g for Pb. Generally, finfishes are safe for human consumption based on their heavy metals (Cd, Cu and Pb) contents. Twelve samples consisting of 4 crustaceans, 4 gastropods and 4 bivalves have Cd concentrations higher than the FAO/WHO standard (5 μg/100 g). Among the shellfish samples, only gastropods exhibited Pb concentrations beyond the standard of 150 μg/100 g. These gastropods species also accumulated Cu metal and exhibited 2 – 14x greater than the standard (1000 μg/100 g). Most of the shellfishes are good accumulators of Cd, Cu or Pb or combinations of these metals and are generally unsafe for human consumption based on the FAO/WHO standards. In addition, to clarify the pollution status by spilled oil in Cebu, Philippines on August 16, 2013, we collected coastal sediments at Cordova, Cebu, Philippines on August 19, 2014 and August 28, 2015. We analyzed polyaromatic hydrocarbons (PAHs), alkylated PAHs and hydroxylated PAHs due to their toxicity on aquatic organisms. Total PAH concentration in St.1 was 4.88 mg/kg dry weight and each PAH also showed the highest concentration. On the other hand, total alkPAH concentration in St.2 was 6.07 mg/kg dw and each alkPAH showed the highest concentration except for alkylated naphthalenes. The diagnostic ratios suggest that source of oil pollution in St.1 and 2 were petrogenic but not in St.3. Hydroxylated PAHs as metabolites of PAHs were detected in all stations and seawater. These results suggest that the sampling sites in Cordova were still polluted by spilled oil even 1 year after oil spill.

(10) The sediment acid volatile sulfide (AVS) concentrations were measured for samples collected at 0-1 cm, 1-2 cm, 5-6 cm from the sediment-water interface for two sampling periods (February and June 2013). Sediment mean AVS ranged from 0 to 0.6601 mg S/g dry sediment in February 2013 and a relatively higher range of 0.183 to 1.198 mg S/g dry sediment in June 2013. It was noted that the critical level of (AVS >0.2 mg/g) were mostly monitored in fishpond sediments in contrast to the lower AVS found in river sediments. Sediment mean organic matter ranged from 3.5 to 24.6% dw with higher level of OM found upstream of rivers and areas with mangrove and a strong correlation was observed between AVS and OM (r^2>0.9). On the other hand, dissolved oxygen in water (near the sediment-water interface) ranged from 1.9 to 9.9 mg/L. Most sites have DO concentration below optimum level for fish (4 mg/L) especially near ports and mangroves while some areas with DO level higher than 4 mg/L were monitored in the mouth and middle of rivers. This result conforms to the observations that higher AVS concentrations are associated with organically rich and anoxic sediments and lower concentrations are found in oxic sediments with lower organic matter.

(11) Together with local counterparts from CFMS-ASU, nutrient levels (P, N, etc…) and plankton composition and abundance were determined from March to July 2014. Results are currently being processed and proposal is being prepared for the CFMS-ASU to conduct independently the second set of field and laboratory activities.

Finally, the destruction of mangrove, abandonment of shrimp ponds, overfishing, and stock enhancement of tiger prawn are considered to be human activities that have substantial impacts on natural environments on Batan Bay Estuary.

Component 4 Social

Actual situation of livelihood of small-scale fishing household in Thailand: the case study in Eastern, Centre and Southern of Gulf of Thailand

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▶ Keywords: Fishing household, Livelihood, Rayong area, Prachuab and Chumphon area, Surathani area

1. Pourpose

The data collection on actual situation of livelihood of small-scale fishing household in Thailand aimed to express current status and compare situation of fishing household of three area in gulf of Thailand are located in eastern part at Rayong province, Center part at Bangsapan Noi and Bangsapan district of Prachuab Kiri khan province and Pathew district of Chumphon provinc, and southern part at Surathani province.

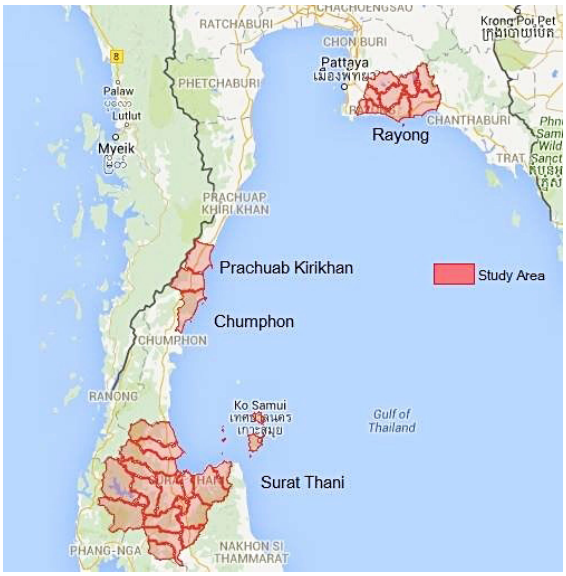

Fig 1: Area of data collecting

2. Data and materials

The dada were collected through semi structure questionnaire interview for 297 at Rayong, 286 at Prachaub and Chumphon and 316 at Surathani. The result focus on General information, Livelihood, Regarding business and Personal information of respondent.

3. Results

In part of general information in three areas were found that there are same information are following age of fishermen highest in during 41-50 year old, and respondents education are primary school, there are member in family mode in 4 and 3 people, and more than half of them are native people in the area , and main religion is Buddhism.

Table 1. General information of fishing household for three area

Data	Rayong area	Prachuab Kiri Khan and Chumphon area	Surathani area
Gender			
Male	97.60 %	97.90%	66.80%
Age			
41-50 year old	33.00 %	30.80%	36.70%
Education level			
Primary school	80.80%	75.40%	75.30%
Number of family's member	Mode : 4 ps	Mode : 3 ps	Mode : 3 ps
Former address			
Native province	81.50%	89.86%	59.00%
Other	18.50%	10.12%	41.00%
Religion			
Buddhist	98.65%	99.65%	84.80%

For livelihood and regarding business part found that fisheries are main occupation for three area and fishermen have fishing experiences around 26 years old. And income form fishing of three are area are 383,730, 520,483, and 521,458 respectively it was no significant difference at the 95% level confidence. They also have supplementary income by in Rayong area from agriculture same as in Prachuab and Chumphon area, however Surathani area, supplementary income from aquaculture.

Most of business will sale they product through middleman. In personal information part shown that fishermen's household income of each area are following; 20,928, 17,859, and 31,026 respectively, it is was no significant difference at the 95% level confidence for Rayong and Prachaub Kiri Khan while Rayong with Surat, and Prachuab Kiri Khan with Surat, there is significant difference at the 95% level confidence. Fishermen in three area have fundamental facility for they living e.g. television, washing machine, refrigerator, fan mobile phone and motorcycle, also they health were identify in this survey by from fishermen perception more than half of them said they are good health anyway this survey also check they health on blood pressure, weight height and waistline when use data form survey on blood pressure found that average blood pressure in Rayong is 140/90, Prachaub Kiri Khan and Chumphon is 138/89, and Suratthani is 138/89, it is in quiet high when compare with normal blood pressure(90 - 119 / 60 – 79) shown that average blood pressure of fishermen in three area quiet high they. And for weight and high it use for calculate Body Mass Index (BMI) it found that average of BMI of each area as follow Rayong is 33.56, Prachaub Kiri Khan and Chumphon is 23.37, and Suratthani is 24.99 it show that fishermen in three area quiet fatness when compare with BMI standard(less than 18.5= Thin, during 18.5-22.9 = normal, 23.0-24.9= plump, and more than 25.0 = fatness). The situation of livelihood in fishing household show that fisheries are main occupation for three area and three area have similar situation on socioeconomic in fishing household.

Component 4 Social

Livelihood of fishing households that operated coastal aquaculture in Bandon bay, Surat Thani

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▶ Keywords: Small-scale fisheries, Aquaculture, Livelihood, Bandon Bay

Bandon bay located in Surat Thani province, southern of Thailand covering approximately an area of 1,070 km^2. The inner bay that extends for 80 km coast, where most mollusc culture areas are located, covers an area of 480 km^2. With gradually sloping intertidal zone of the coast, it has a mean water depth of 2.9 m with respect to mean sea level. There is a large band of mudflats extends along the coast to about 2 km of off shore area. Since Bandon bay receives most of the surface freshwater runoff from Tapi-Phumduang river watershed. This geographic condition leads to nutrient enrichment in the bay and abundant of natural marine resources. Therefore, the bay is one of the most country's productive coastal areas that production come not only from capture fisheries but also aquaculture which support domestic demand with high return.

To identify coastal area capability and strengthen suitable management approach in this area, investigation of fishing household livelihood and their perspective in current career are necessary. The survey for data collection therefore was conducted during 2012-2014. A total of 316 small scale fishing households from 5 districts namely Chaiya, Thachang, Muang, Kanchanadit and Donsak were interviewed using structured questionnaire. In addition, information from local administrations in study area was also collected. Among these amount, 87 fishing households operated aquaculture as a source of their family incomes. Since aquaculture especially mollusc culture is an important activity in the bay and is recognized as a signature product of country. This paper therefore aims to point out demographic data, income sources, activities and problems on production, product distribution of those 87 fishing households. It also provided information on their attitude on fishery management, social capital and livelihood.

The demographic data of 87 small scale fisher, who operated aquaculture indicated that most of respondents were man (66.7%) and nearly half of them had age between 41-50 years old. However, like other sector in fisheries, most of them have education level only at primary school. Family members ranged between 1-3 persons. The results showed that main sources of income of them came from aquaculture, capture fisheries and trading in village. Approximated incomes of those sources were 0.84, 0.41 and 0.37 million Bath per year respectively. Due to availability of mudflat area, main aquatic species cultured in Bandon bay were cockle (*Anadara granosa*) and oyster (*Crassostrea belcheri*). Meanwhile sea bass (*Lates calcarifer*) was also cultured both in cage and earthen pond. The information from the last crop cycle indicated that cockle, oyster and sea bass culture are about 1 year.

Labor used in aquaculture activities ranged from 1-6 persons with average of 2 persons. Although aquaculture was a good income source for respondents, however more than half of them (54.7 %) faced with some problems with high seriousness level such as increasing of operation cost (seed, cultured materials), slow growth rate, degradation of water quality. They also concerned on environmental problems such as water discharges from land based shrimp farming and industry factories and freshwater runoff. Like a common practice of small scale fisher in Thailand, most of production was sold to middle man who determined

product price and rather transported it by boat than car or motorcycle.

According to view point of respondent on fishery management aspects, like other groups of respondents which have not operated aquaculture, although they agreed that fishery resources such as fish, shrimp, crab or mollusc in the sea are considered as a common property and fishery is open access activity in Thailand, do fishing under this principle may lead to over-fishing and fishery resource reduction. However, more than half of them (60.9%) thought that fishing activities should be open access. Only 39.1% of respondents did not agree with this concept and about 79% of those indicated that only village members should have right to do fishing in their fishing area. Almost respondents (90.8%) have ever heard of fisheries management in and around their fishing ground and knew that the purposes of fishery management are to conserve enhance fishery resources for sustainable utilization. Management activities in the study area that recognized by respondents were prohibition on fishing during spawning period, mesh size control for net. Respondents agreed that fishery management is necessary for this area. In their point of view, when the catch production reduced about 50% of current volume, some fishery management measures should be implemented. If fishery management is installed to maintain fishery resources, they could bear for 30% catch reduction at beginning of implementation. However, they could bear for that situation only within 2 years. The results on social capital indicated that more than half of respondents were not member of organization in their community. Only some respondents were members of fishing group, socio-civic group. Almost respondents believed that they have ability to borrow money. Relatives and neighborhood were the one who could give helps when emergency cases happened. In general public views of life, they satisfied current financial situation of family. Almost of them (98.9) were still happy with current life. Only 48.3% of them worried about low and uncertain income, children education and health. However, they still lived with high hope. They thought that rich natural resources are very important for maintaining their career and protecting the environment should be given priority even if it causes slower economic growth and some loss of returns. The information from this study revealed Bandon bay has a good capability to generate income for local communities. Small scale fisher who operated aquaculture in Bandon bay have good livelihood, however management measured still needed for sustain their career.

Component 4 Social

A structure of fishing in Rayong province in western Thailand

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▶ Keywords: welfare of fisher, income, fishing cycle, fishing gear, target species

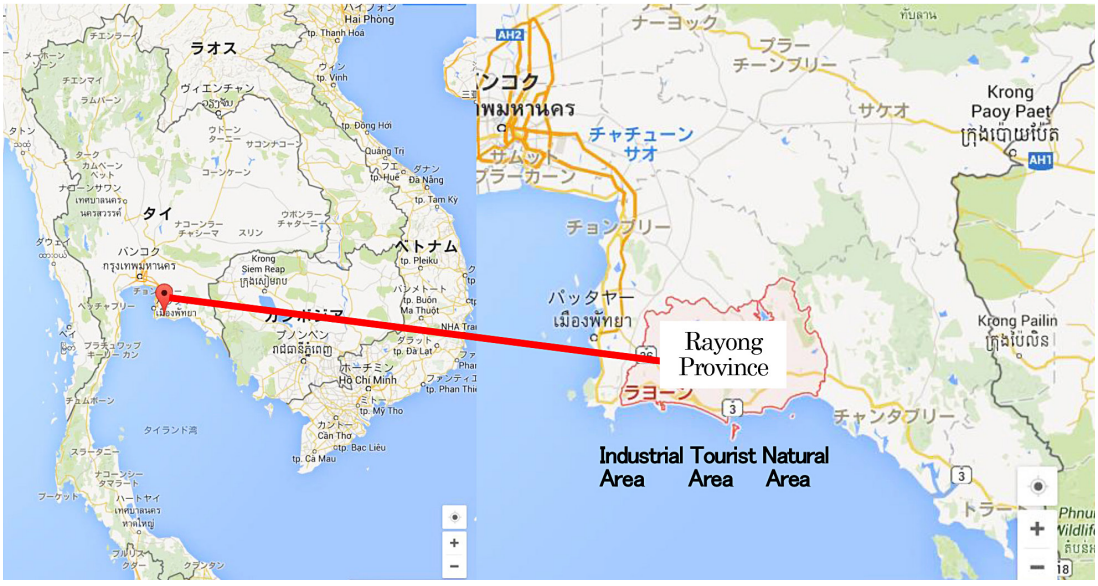
1. Introduction

The general direction of development in Southeast Asia is to attract firms from somewhere and construct industrial facilities for level-up living standard of local people with a destruction of nature. Now days, it needs sustainable development with harmony with nature, which is defined as Area Capability.

Therefore, we formulated the hypothesis which natural abundant area was high catch, high income, and high welfare for a fisher. And we tried to validate the hypothesis by comparison with fishing villages located in natural area, tourist area, and industrial area.

2. Research site

The site is Rayong province on the following map, Rayong province includes Banchang Disterict, Muang District, and Klaeng District.



Source: Google map

3. Materials and Methodologies

We conducted the face to face survey with questionnaire to fishers in the research site, and collected 297 fishing household data. We divided the data by three areas where were Industrial area, Tourist area, and Natural area (The above right map) because the district fisheries officer (local government officer) advised to divide three areas to us. We employed the descriptive statistics, and the Ordered Logit and Generalized Ordered Logit for analysing a consciousness of fisher regarding welfare/happiness. The model of Ordered Logit is the following.

$$Y^* = \sum \beta' x + \mathcal{E}$$

Y^*= unmeasured latent variable; X= independent variables

$$Y=1, \quad -\infty < Y^* < a_1$$
$$Y=2, \quad a_1 < Y^* < a_2$$
$$Y=3, \quad a_2 < Y^* < \infty$$

Y= observed variable; a= threshold

$$\text{Prob}\,(Y=1) = \Lambda\,(a_1 - \beta' x)$$
$$\text{Prob}\,(Y=2) = \Lambda\,(a_2 - \beta' x) - \Lambda\,(-\beta' x)$$
$$\text{Prob}\,(Y=3) = 1 - \Lambda\,(a_2 - \beta' x)$$

Prob= probability; Λ= Logistic cumulative distribution function

Furthermore, Generalized Ordered Logit is almost same of the above, but the model is relaxed restrictions of the β', and a_1 and a_2, which β' is fixed in each Prob function, and a_1 and a_2 are bilaterally symmetric, because this model is better than the Ordered logit generally. It needs score test of comparison with Ordered Logit and Generalized Ordered Logit, after that, an analyst decides a model.

4. Results

The main target species was swimming crab and the main fishing gear was crab gill net in three areas. The high season of the fishing was from May to October and half of fishers answered high season in other months, and almost all fisher operated the fishing as low season from November to April.

The average incomes were respectively 146 thousands baht in Natural area, 205 thousands baht in Tourist area, and 266 thousands baht in Industrial area. The income in Industrial area was 1.8 times higher than the income in Natural area.

The catch and price of swimming crab in each area were the following Table 1. The average prices of each area were respectively Industrial area 189 Baht > Natural area 171 Baht > Tourist area 162 Baht. And the high seasonal catch values of swimming crab per day in each area were respectively 4,522 Baht in Industrial area > 3,828 Baht in Tourist area > 3,020 Baht in Natural area.

Table 1. The high season price and catch of Swimming Crab in each area

	Min-Price	Max-Price	Ave.-Price	Catch/day
Natural Area	150	191	171	18
Tourist Area	150	175	162	24
Industrial Area	151	227	189	24
All Areas	150	199	175	23

Sale destinations from fishers were middle person, end customer, fish retailer, and restaurant in order of the share (Table 2). And the destinations were not different from each area (Chai test).

Table 2. Sale destinations from fishers

	Middleman		Fish retailer		Restaurant		End customer		other	
Nature	32	54%	6	10%	3	5%	14	24%	4	7%
Tourist	103	61%	14	8%	13	8%	34	20%	4	2%
Industry	78	68%	13	11%	3	3%	20	17%	1	1%
All Areas	213	62%	33	10%	19	6%	68	20%	9	3%

Regarding a happiness of fisher in a present life, almost all fishers answered "Happy", but some fishers answered others. The difference of the answer in each area was insignificant (Chi test), so we analysed pooled data by Generalized Ordered Logit.

The score test was significant, and the BIC of Ordered Logit was less than one of Generalized Ordered Logit, but the AIC of Ordered Logit was higher than one of Generalized Ordered Logit (Table 3). The Pseudo R^2 were respectively Ordered Logit 0.2074 and Generalized Ordered Logit 0.2535. So, we employed the results of Generalized Ordered Logit.

Variables of Finance and Health under threshold 1 were significant, and variables of Finance, Health and Constant were significant under threshold 2 (Table 3).

The satisfactions of Finance in each area were that Tourist area and Industrial area were almost same, but Natural area was different from the other areas and high score in comparison with both areas (Figure 1).

A difference of health condition of fishers in each area was insignificant (Chai test).

5. Consideration

Some researchers believe that closing time of the fishing operation is in monsoon season, but almost all fishers operated their fishing through all year. The main target species was swimming crab in all areas and the cheapest price area was Tourist area. We inferred that the reason of low price in the area was small size of the crab because of no difference of sale destination in each area.

The income was from 146 thousands baht to 266 thousands baht, the wage in Thailand was from 76 thousands baht to 156 thousands baht (National statistics in Thailand), the fisher's income was not bad in Thailand. However, the fishing income in Natural area was not good in Rayong province.

However, the happiness was not different from each areas. The happiness needed high Finance and Health. The Health condition in each area was no difference, but the income of household in Naturel area was lowest and almost half of income in Industrial area. Why was the happiness in each area indifferent? Because the consciousness of fisher's satisfaction for finance in Natural area was high, it was not real income but consciousness. This is important factor for happiness/welfare of a fisher.

Our hypothesis was almost invalidated, that natural area was high welfare in comparison with industrial area. But the happiness was not different from each area despite the low income of Natural area because fishers in the Natural area satisfied the financial situation in their households.

The remained research problem should be clarified a formation in detail of fisher's satisfaction for finance in Natural area.

Table 3. Results of Ordered Logit and Generalized Ordered Logit

Independent V: Very Happy 5~Very Unhappy 1 -> Very Happy 3; Happy 2; ~Very Unhappy 1									
Ordered Logit Estimates					Generalized Ordered Logit Estimates				
Number of obs = 292					Number of obs = 292				
Replications = 500					Replications = 500				
Wald chi2(6) = 48.18					Wald chi2(6) = 33.97				
Prob > chi2 = 0.0000					Prob > chi2 = 0.0007				
Log likelihood = -146.79143 Pseudo R2 =0.2074					Log likelihood = -138.264 Pseudo R2=0.2535				
	Observed Coef.	Bootstrap Std.Err.	z			Observed Coef.	Bootstrap Std.Err.	z	
Finance	0.461	0.090	5.150	***		0.799	0.255	3.13	***
Anxiety	0.763	0.318	2.400	**		1.251	3.083	0.41	
Hope	0.109	0.136	0.800			-0.187	0.294	-0.64	
Health	0.571	0.194	2.950	***		0.830	0.364	2.28	**
Nature	-0.240	0.503	-0.480			-0.417	1.673	-0.25	
Industry	-0.445	0.357	-1.250			-0.570	0.667	-0.86	
Constat						-3.958	3.664	-1.08	
*a*1	2.320	0.876	2.647	**	Finance	0.28	0.10	2.73	***
*a*2	8.142	1.195	6.812	***	Anxiety	0.52	0.40	1.31	
					Hope	0.30	0.20	1.48	
					Health	0.46	0.27	1.69	*
					Nature	-0.04	0.92	-0.05	
					Intustry	-0.13	0.49	-0.26	
					Constat	-6.68	1.57	-4.26	***
AIC:	309.5829	BIC:	338.9969		AIC:	304.5283	BIC:	356.0029	
Score Test		Likelihood-ratio test LR chi2(6)=17.46 (Assumption:constrained nested in unconstrained) Prob>chi2=0.007							

Finace,very dissatisfaction 1~complete satisfaction 10; Anxiety,Yes 1, No 2
Hope, Much 4,Some 3, Litte 2,None 1; Health,Very good 4, Good 3, So-so 2, Bad 1

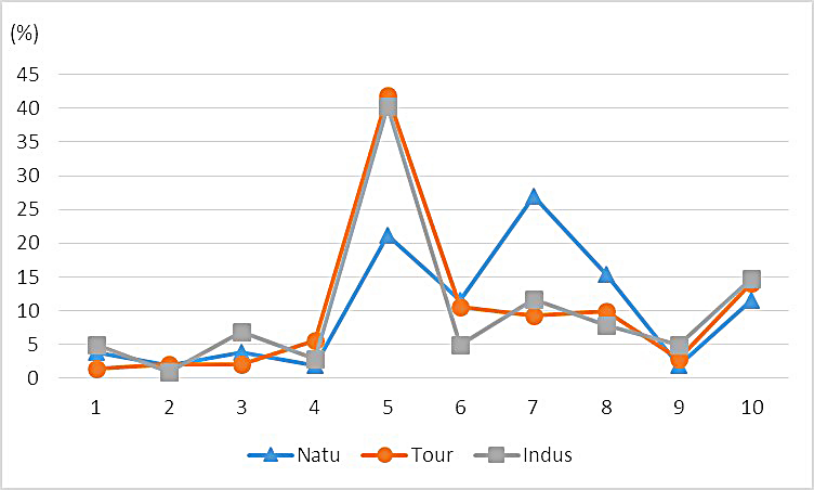


Figure 1. Satisfaction for finance in present time

Component 4 Social

The overview and the actual state of fisheries around the Batan Estuary, Aklan, Central Philippines

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▶ Keywords: multi-species, multi-gear, small-scale fisheries, fishing gear classification, Philippines

1. Introduction

Southeast Asia is gaining importance in the world fish supply. Indeed, Southeast Asia accounts for 19% of world fisheries and aquaculture production in 2009, although the percentage was only 9% in 2000. To manage and sustain these rich resources, it is necessary to understand human society and economy which utilize them. However, socio-economic studies on fisheries in Southeast Asia have not been accumulated enough. This is consider to be a problem under the situation where fishery resources in the area tend to be depleted, which are often caused by overfishing (Stobutzki et al, 2006).

This study explores socio-economic status of fisheries around the Batan Estuary, Aklan, Central Philippines. First, we overview fisheries in the Philippines and the Batan Estuary based on previous studies and statistics. Then, we clarify the actual state of fisheries in the area by analyzing data obtained by household survey in selected coastal villages.

2. Overview of fisheries in the Philippines and the Batan Estuary

Coastal ecosystems in the tropical area have very high biodiversity, and Southeast Asia has the highest biodiversity among them (Tittensor et al, 2010). Because of this ecological background, fishers can catch various species of fishes, and fishing gears used by them also have much variety. Therefore, fisheries in Southeast Asia are characterized as multi-species and multi-gear (SEAFDEC, 2003). These fisheries are mainly operated by small-scale fishers. It is estimated that, in developing countries, the small-scale fisheries account for 93 % of fishing population, and for 56% of fishery production (Mills et al, 2011). In Indonesia and Thailand, small-scale fisheries account for 90% and 79% of total number of fishing vessels respectively (Stobutzki et al, 2006). In Malaysia and Vietnam, small-scale fisheries accounts for 29% and 63% of domestic fishery production respectively (Stobutzki et al, 2006). Thus, another characteristic of Southeast Asian fisheries is small-scale.

The coastal waters in the Philippines have mangrove forests and coral reefs (Giesen et al, 2007), and they have the highest biodiversity in the world (Carpenter and Springer, 2005). In the case of the Malalison island, it is reported that reef fishers used various types of fishing gears including gill nets, hook and line, spear gun, and scoop net (Amar et al, 1996). Small-scale fisheries (municipal fisheries) account for 98.8% of fishing population in the Philippines and for 56% of the volume of annual fishery production. Thus, Philippine fisheries are considered as typical cases of multi-species, multi-gear, small-scale fisheries.

Among 17 Regions (wide administrative division) in the Philippines, Region VI (Western Visayas) had the highest small-scale fisheries production in value terms in 2011, according to the national fisheries profile. Our study site, the Batan Estuary, is located at the northern coast of the Panay Island in Region VI. The coastline of the Batan Estuary is shared by three municipalities including New Washington, Batan,

and Altavas. According to the municipal fisheries profile 2012, total population of three municipalities was 101,382, and 80% of them lived in coastal villages. Almost 5,000 people worked in fishery related industries like fisheries, aquaculture, trading and processing. Small-scale fishers accounted for 43.5% of them while fish farmers and commercial fishers accounted for 39.3% and 13.3% respectively. Small-scale fisheries in three municipalities produced 3,248t in 2012 while commercial fisheries produced only 1,812t which was from New Washington only. Thus, fisheries industries are important in the communities around the Batan Estuary, and small-scale fisheries are the most important among them.

According to Municipal fisheries profile 2012 fishers around the Batan Estuary used more than 10 types of fishing gears including fish corral, gillnet, long line, crab lift net, spear gun, stationary lift net, crab pot, hand line, fish pot, filter net, beach seine, drag net, push net, drive-in gill net, and fish barricade. It was reported that 463 species were caught by these fishing gear (Babaran et al, 2000). Therefore, the coastal area of the Batan Estuary is considered to be a typical case of multi-species, multi-gear, small-scale fisheries.

3. Actual state of fisheries around the Batan Estuary

It is said that more than hundred of languages are spoken in the Philippines. Fishing gears often have several different local names, and it sometimes causes difficulty in figuring out the actual state of fisheries. For example, Umali (1950) reported that "the same gear was charged different rates due to overlapping of dialect or local names, and many fishermen were sometimes unjustly penalized because of the absence of a standard classification." We gathered data for this study by household interview surveys where respondents usually answered in the local language. It is highly possible that the same fishing gear was answered in different local names. Therefore, it is necessary to group fishing gears not only by using their local names but also by another way.

The purpose of this study is to clarify the actual state of fisheries around the Batan Estuary based on data obtained by household survey. In the process, we grouped fishing gears in the answers based on the similarity of target fish species because we considered if there are two fishing gears which has different local names but catch same target species, they may be the same type of fishing gear.

3.1 Methods

3.1.1 Data

The household survey was performed in the 11 fishing villages around the Batan Estuary, from Aug. 24 to Nov. 3, 2012. Respondents (n = 467) were randomly chosen from all fishing households in each village (1,142 households in total). In Altavas, we interviewed with all fishing household since the total number in the town was not many. Data collectors, who can speak local language and had trained by researchers for two days, performed interviews with the structured questionnaire prepared for this study. The questions included types of fishing gears, the locations of fishing ground, target fish species, number of fishing days, the volume of catch and the amount of income from the catch.

3.1.2 Analysis

To group fishing gears, we conducted hierarchical cluster analysis based on the similarity of target species. The similarity was defined by the probability of appearance P_{ij} of species i in fishing gear j, which was calculated by the formula, $P_{ij} = f_{ij} / g_j$. Here, g_j refer to the number of households who owned gear j, and f_{ij} refer to the number of households who catch species i by gear j. P_{ij} was calculated for all fishing gears (n = 61) and fish (n = 64) appeared in answers. Then, hierarchical cluster analysis was performed using Squared Euclidean distances and Ward's method.

This cluster analysis was considered to have a limitation because it cannot distinguish fishing gears whose target fish are similar but whose structures and/or fishing methods are totally different. Therefore, we also performed interviews with fisheries technicians in Local Government Units and experts in local

universities to get English names for all fishing gear. The English names were considered to reflect the structure of fishing gear or the method of using it. Therefore, by comparing with the information on English name, we validated the results of the cluster analysis and finalized the grouping of fishing gears. We considered fishing gears can be grouped when they were in the same cluster and also had same English name, meaning they have the same structure/ fishing method and target same fish. Using this finalized grouping, we aggregated the data on fishing vessels, fishing ground, its operation and production.

3.2 Results

Figure 1 shows the result of the hierarchical cluster analysis. The differences between groups were clearest when clusters were cut at the distance of 10 (Figure 1). For example, the cluster A included ignat, panaboy, pangilanga, taboy and ugnat, whose main target was gobies. Also their English names were "drive-in gill net for goby" according to local technicians. In a similar way, the cluster B mainly included scoop nets whose main target was acetes. Although other clusters were composed of various types of gears, cluster C, D, F, G and H had specific target fish including mud crab, anchovy, mackerel or herring, and shrimp respectively. The cluster E was composed of gears which didn't have similarity to others. Sixty one fishing gears were grouped into 37 groups by finalizing the grouping. It was clarified the fish corrals targeting shrimp was operated by 217 households (46%) and it was the biggest majority. Table 1 shows the actual state of 10 major fishing gear groups. This table clearly shows the difference of characteristics between groups. For example, the average fishing days of the fish corral for shrimp and the lift net for anchovy were more than 300 days in a year while the average fishing days of long line and crab lift net were around 150 days in a year.

4. Discussion and conclusion

We succeeded to group 61 local names of fishing gears into 37 groups. This grouping successfully showed the difference between fishing gears. One example was the difference in fishing days in a year and this result indicated there was a fishing gear which was operated during a whole year while another was operated seasonally for only half of a year. These results can be utilized by researchers and managers to avoid such confusions as Umali (1950) had reported. The future analysis will include the comparison of income from the catch between fishing gear groups. With regard to the gears operated seasonally, it will be important to clarify how they earn income during off season of the fisheries.

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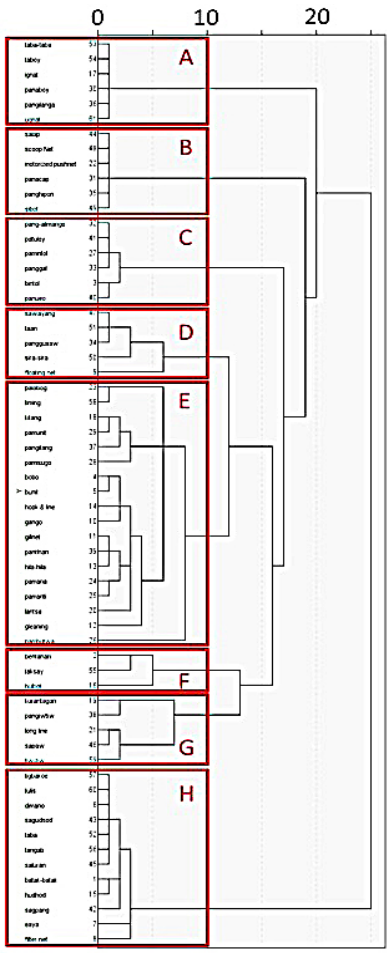

Figure 1.
The result of the hierarchical cluster analysis (Euclidean distance, Ward's method).
The red boxes indicate clusters cut at the distance of 10.

Table 1. Types of fishing vessel and fishing ground, average daily catch and average fishing days in a year of top 10 major fishing gear group around the Batan Estuary

Cluster	English name	Target fish	No. of Households	Fishing vessel	Fishing ground	Average daily catch (kg/day)	Average fishing days in a year (days/year)
H	Fish corral	Shrimp	217	Non-motorized	Rivers/Bays	4.22	308.7
E	Gill net	Not specified	62	Non-motorized	Rivers/Bays/ Open sea	6.30	230.5
A	Drive-in net	Goby	54	No vessel/ Non-motorized	Rivers	6.94	254.6
H	Push net	Shrimp	39	Non-motorized/ Motorized	Rivers	5.00	225.5
E	Long line	Not specified	27	Non-motorized	Rivers/Bays/ Open sea	4.94	140.9
C	Crab lift net	Mangrove crab	26	Non-motorized/ Motorized	Rivers/Bays	3.96	168.7
E	Hook and line	Not specified	25	Non-motorized/ Motorized	Rivers/Bays/ Open sea	7.92	221.0
B	Scoop net	Acetes	25	Non-motorized	Rivers	11.90	215.8
F	Lift net	Anchovy	23	Motorized	Bays	8.67	325.7
E	Crab pot	Swimming crab	20	Non-motorized	Rivers/Bays/ Open sea	7.23	242.8

Coastal fish diversity in the South China Sea

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▶ Keywords: Coastal fish fauna, species diversity, genetic diversity, population structure, DNA barcoding

The coast of South China Sea is home to a tremendous biodiversity. More than 3,500 marine fish species are recognized, providing an important basis for livelihoods of local people in various ways. Accurate identification of fish species, each species having unique biological characteristics, is crucial for their sustainable utilization. In addition, understanding the processes by which such high marine fish diversity in the area has been generated and maintained is also necessary. The latter provides us with insights as to how the biodiversity will respond to the future impacts of global environmental changes and human activities, and thereby allows us to design appropriate management strategy. Notwithstanding, these issues have still largely not been addressed for marine fishes in this area, undermining appropriate resource management.

We have been conducting a research activity that is specifically designed to overcome the current situation in the South China Sea as mentioned above. The research activity is divided into two major components, focusing on different levels of marine fish diversity in the area: 1) Discovering the species diversity of marine fishes in the South China Sea, with providing practical identification methods of the species, and 2) clarifying spatial distribution of genetic diversity within species (= genetic population structure) of selected marine fishes, with particular focus on commercially important species in the Southeast Asian Countries. Outlines and progresses of these two activities are provided below.

1) In order to clarify the marine fish species diversity in the South China Sea, we aimed to make pictorial field guides to fishes of Northern Gulf of Thailand (Thailand), and Panay Island (Philippines) (as separate volumes). A color photograph of each species is provided in the field guides accompanied by information on ecology and distribution as well as morphological description. In addition, DNA barcodes will also be shown for some taxa for which DNA sequence data are available, providing a direct connection between the online DNA barcode database and the field guide for fishes of Panay Island (see below). Fish specimens used in the field guide for Panay Island are collected from several fish markets, so as to encompass all species found in those markets. We have already published the guide to the fishes of Northern Gulf of Thailand, which provides photographs and morphological descriptions of 372 species. For the guide to the fishes of Panay Island, more than 2,000 specimens including at least 500 species have been collected so far. The final number of species is expected to be around 600, making it the most extensive field guide

published to date for a single locality in Southeast Asia. Each specimen is given a unique voucher number and deposited in the University of the Philippines Visayas Museum of Natural Sciences. The specimens will be stored permanently and thereby shape a concrete basis for further fish diversity studies in the future. During the course of the study, we have discovered some specimens possibly representing new species. We have also published a fish collection building and procedures manual as a mean of capacity building for researchers interested in the fish diversity studies. Finally, we are now expanding the scope of our activity to cover the fish fauna in Batan Bay, located in the northern Panay Island. Researchers from UPV are taking an initiative of the survey in Batan Bay supported by Japanese collaborating members.

DNA barcoding is a species identification system based on sequence diversity in Cytochrome Oxidase subunit 1 gene (COI) of mitochondrial DNA (mtDNA). Development of a DNA barcode is highly dependent on the accurate initial (morphological) identification of the species: on the premise that the initial identification of the reference specimen on which reference barcode is developed is correct, the technique allows us to identify specimens for which morphological characters are not available. Such specimens include fishes in their early life history stages (eggs, larvae, or juveniles), processed foods, stomach contents of organisms etc. We combined the DNA barcoding technique with the field guide so that the species presented in the guide can be identified not only based on morphology, but also using the DNA barcoding technique. One or a few specimens from each species are subjected to mtDNA sequencing analysis to produce a reference DNA barcode of the species. These barcodes are made publicly available through online database that is specifically intended to serve as a DNA barcoding platform (BOLD system). On the other hand, direct links to the barcodes of each species deposited in the database are provided in the field guide.

2) Understanding the spatial distribution of genetic diversity within species (= genetic population structure) is fundamental to biodiversity studies. Each of the spatially distributed populations is considered as a single evolutionary unit, each of which undergoes genetic changes through time more or less independent from each other. It also has considerable significance for fisheries management, because each of those populations is considered as a single "stock", being demographically independently from each other. We have been studying genetic population structures of selected marine fish species that are commercially important in the Southeast Asian countries. The target species include *Atule mate*, *Megalaspis cordyla*, *Selar crumenophthalmus*, *Decapterus macrosoma*, *D. macarellus* (Carangidae), *Rastrelliger kanagurta*, *R. brachysoma*, *R. faughni* (Scombridae), *Scolopsis taenioptera* (Nemipteridae), and *Sillago sihama* (Sillaginidae). For each species, specimens are collected from 2–4 localities on the coast of South China Sea, including Panay Island (Philippines), Kuala Terengganu (Malaysia), Rayong (Thailand), and Ha-long Bay (Vietnam.) Partial sequences of mtDNA were obtained from each specimen, being subjected to a variety of population genetic analyses.

Marine fishes are generally thought to be genetically homogeneous across a wide geographic range owing to their high mobility. Our results showed a unique population structuring pattern for each species, with some species exhibiting significant spatial heterogeneity within the South China Sea. For example, specimens of *R. brachysoma* were clearly divided into two highly differentiated populations between Rayong and Panay Island. We propose that each of these two populations is representing a separate and independent stock, and therefore should be managed separately. On the other hand, most of the rest of the species are apparently geographically homogeneous within the South China Sea. Nevertheless, some of them exhibited significant genetic variation that are *not* associated with locality, and this calls for further investigation. We suggest that such a pattern can be explained by historical geographic events involving repeated sea level changes driven by the glacial-interglacial cycle in the Pleistocene.

Educational study of acoustic surveys in coastal shallow area at Southeast Asia

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▶ Keywords: echo sounder, acoustic survey, shallow area, educational study

In Japan, there is a significant decrease in catches of coastal fisheries in recent years. Fishermen have been pointing out how the fishes are now smaller in size and how the number of yearling fishes has decreased. These phenomena have clearly indicated the decreasing of fish stocks and prompted Japan government to conduct coastal stock assessment surveys to look into the matter. Aside from stock assessment, it is also important to understand current situation of the industry and to evaluate the risk of overfishing and the necessity of resource management.

Fish stock assessment is usually conducted by acoustic surveys or by net samplings using a research vessel and for acoustic surveys, scientific echo sounder are commonly used. Unlike the ordinary fish finders, in addition to the usual functions, these scientific echo sounders can also measure the quantity(the density) of fish by processing the echo reflection(the target strength) from the fish. Despite that these fish finders are extremely efficient for fish stock assessment, there are difficulties in stock assessments due to the expensive cost of fish finders and the lack of specialists or researchers that can analyse the data. And also, in present, only larger vessels can afford to equip scientific echo sounders. This made it more difficult to conduct stock assessments in shallow coastal and bay areas. Despite the need to assess the abundant fisheries resources in these shallow areas, there is almost no stock assessment survey done in these areas.

In Asian countries, coastal fisheries are extremely important in the sense of food security. However, especially in Southeast Asia, there is hardly any stock assessment done on the important commercial species in coastal areas. There are some institutions like SEAFDEC who conduct stock assessment in Southeast Asia coastal water but due to the lack of the number of specialists or researchers that can conduct acoustic survey, it is still impossible to conduct enough surveys to understand the fish stocks in the areas. Most of the fishermen are capable of using a fish finder, but to use fish finder for stock assessment requires special training and knowledge about acoustic survey. In Southeast Asia, such training and education are not offered even in higher education institutions. There are many researchers who received higher education or even PhD regarding underwater acoustic technologies from japan universities, but very few of them continue to specialize in this field after returning to their home countries. Training experts in underwater acoustic consumes a lot of time and effort as it requires a wide range of basic knowledges including physics, electrical and electronics, statistics and biology etc. And when it comes to implementing the actual acoustic surveys, there are also challenges like the difficulties to determine species by echo data, the expensive cost of fish finders, the usage of equipment limited to larger vessels and the time and effort required to analyse extremely abundant data. These challenges are for many countries, but they are much more severe in Southeast Asia due to the education and survey systems in these countries.

Hence, in order to enhance acoustic stock assessment in shallow coastal area of Southeast Asia, we attempt to develop a new acoustic survey system that enables stock assessment by only using the usual commercial fish finders that can easily be found on most of the coastal fishing boats. Without any modification on the fish finder itself, this new survey system implement a newly designed data recording system that records acoustic signals. The newly developed system was tested in-situ.

Most of the existing commercial fish finders process acoustic signals digitally. This is why modifications such as adding a D/A converter are required for signals output. And in most cases, signals processing are done according to each manufacturer of the fish finder. This makes it difficult to determine if the signals are being revised or calibrated. To cope with this matter, we developed a new system with an interface that can extract signals between a commercial fish finder and the transducer. By using this new system, it will be possible to conduct surveys by using the existing fish finder on smaller boats. Surveys will no longer be limited by the size of boats and the type of the fish finders.

In our studies, we used the GP-1670F, a common GPS fish finder by Furuno that is widely used in small fishing and leisure boats. It is equipped with GPS plotter function and transmits two frequencies:50kHz and 200kHz. The oscillator used is 520-5PSD. And by using NMEA0183-RS232C, the boat position and depth information will be transferred to the computer. In the prototype signals acquisition unit, the ultrasonic transmitting signals from the fish finder will work as a trigger and the receiving amplifier will amplify the echo of the reflected waves. The signals are then digitalized by the AD converter and recorded into the computer. However, most of the commercial fish finder is not capable of transmitting only one of the frequencies. This makes it difficult to differentiate the frequencies by the trigger signal. And also, the reflected signals are weak and need to be amplified. Therefore, we designed a receiving amplifier with a band path filter that only amplifies 50kHz signals. It is also capable of two levels of amplifying. The gain at 50kHz is LOW 58.0dB;HIGH 77.7dB and the gain at 200kHz is 6dB. 200kHz signals output via AD converter will be an almost 0V.

The reason of using 50kHz is because it is less influenced by the beam range and the environmental changes underwater. These make 50kHz the appropriate frequencies for easy fish finding. On the other hand, 200kHz has high resolution in distance. It will be much easier to capture the echo from small fishes and by using 200kHz, it is possible to conduct much more detailed observation. However, the experimental sites in our studies is only 20m deep and the normal 200kHz beam range will be too narrow to be used in these shallow sites. Hence, in order to maximize the transmitting area, we chose to use 50kHz.

For AD converter, we used the Pico Scope 4224 by Pico Technology. The sampling rate is max.80Ms/sec., the resolution 12bit and the power is via USB. This Pico Scope is usually used as a digital oscilloscope. Device drivers and control demands etc. are provided by the manufacturer and it is easy to develop software for recording signals into computer. Here, we used the Fish Finder by Fusion Inc. to record CSV files into computer. The sampling frequency is 19.53kHz and sampling number is 800. It is capable to record 1500m/s echo waves from as deep as 30m. As for the fish finder used in this study, the transmission interval and the pulse range are automatically altered according to the depth and this will cause the changes of the trigger intervals and the length of data recording. Therefore, we maintain the setting of the depth to 80m to avoid the changes in the transmitting interval and the pulse range.

For the CSV files, the time is not recorded. And so we used the converter NMEA2000-0183(IF-NMEA2K2) to enable NMEA0183-output of boat positon and depth information. These information are then recorded using Windows-HYPERTRM.EXE and later used to synchronize the time and the acoustic data.

As the final outcome of this study, we expect to complete a manual that can be used as a textbook for acoustic surveys in shallow water. We have completed the development of the system and have held lectures

in Kasetsart University. Along with the actual surveys in-situ, we will complete the manual.

And regarding the newly developed interface, we have received consent from the manufacturer to publish the circuit diagram. This will help us to enhance the usage of the system and the education in Southeast Asia. And with this circuit diagram, we expect to complete a manual that can be used even by beginners. As for the software, due to copyrights, we are planning to develop another software that can be openly used.

Background of Rayong Set-Net, Thailand

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▶ Keywords: set-net, technology transfer, community-based management, Rayong Province, Thailand

Japanese type set-net fishing gear (Otoshi-ami) was introduced in Rayong Province, Thailand, on 2003 as a trial challenge by SEAFDEC (Southeast Asian Fisheries Development Center, Training Department) with funding support from the Government of Japan through the Japanese Trust Fund, for implementing the experinatal study since 2004 by EMDEC (Eastern Marine Fisheries Research and Development Center, Department of Fisheries, Thailand), in collaboration with Tokyo University of Marine Science and Technology (TUMSAT) funded by Japan Society for Promotion of Science (JSPS) and Himi City funded by JICA Grass-root Partnership Program.

The project aimed to introduce the set-net as a tool to and an alternative fishing gear to develop sustainable coastal fisheries management based in Rayong province. EMDEC and SEAFDEC have established the partnership for supporting fishers group to operate the set-net gear for the purpose to empower the fishing community with the eco-friendly gear that do not damage the fisheries resources, under a cooperation project named as “Introduction of set-net fishing to develop the sustainable coastal fisheries management”. The project was conducted on the collaborative activities with local fishers group, with technical and material support from Himi City, Japan.

The project site is located at Mae-Ram-Pueng Beach, Rayong province, Eastern Gulf of Thailand. The fishing gear has been designed with reference to the “Otoshi-ami” Japanese type set-net, which can be consisted of the leader net, playground and the chamber net for trapping fish through the slope net, installed at 3.0-4.8 km distance from the coast at a depth range of 11-13 m on sandy sea floor. Since 2006, two units operation system was started with the setting location coordinates as 12° 35' 36"N - 101° 20' 48" E, and 12° 34' 30"N - 101° 21' 18" E, respectively. The gear dimension is 45×140m in width and length with a 250 m long leader net as the initial design on 2003, and modified to be slimmer as 20×155 m main net design on 2004. The hauling operation is usually done in early morning, every two days, with Thai-style two wooden boats of 65-85 HP in-board engine without auxiliary machines in the beginning with 11-15 fishers by manual hauling of the chamber net to harvest the catches from the set-net. After introducing the larger FRP boat with the line hauler, the operation time and man-power can be successfuly reduced. Due to the SW Monsoon effect, the fishing season was limited for 7-8 months from late September to early May.

Fishing efforts were 78-109 days/year or 14±2.6 days/month during the fishing season. The average daily catch was 211.5-368.6 kg with the marketing values of 5,037-11,480 baht in 2004-2014. Monthly average catch and value was 3,293.4-4,546.1 kg and 72,674-155,769 baht, for resulting into the yearly total as 12,193-31,801 kg and 508,711-1,088,591 baht.

According to the catch composition, over 72 species are listed, mainly pelagic migrating species with the dominances of *Selaroides leptolepis* (33.67%), *Amblygaster leiogaster* (15.61%) and Belonidae (10.00%). Length compositions of the 6 most economic species were 6.75-21.75 (12.45±0.17) cm for *Selaroides leptolepis*, 21.75-178.25 (66.22±48.82) cm for *Alectis indica*, 10.75-22.25 (17.35±0.25) cm for *Amblygaster leiogaster,* 6.75-29.75 (17.64±3.23) cm for *Atule mate*, 11.75-135.25 (66.22±10.16) cm Belonidae, and 4.75-25.25 (15.18±0.68) cm for *Rastrelliger brachysoma*.

Since the technology transfer of Japanese-type set-net at Rayong Province, the catch and marketing record has been accumulated with the periodical survey of length composition of major economic species, under the official permission on set-net research activity for 10 years, so as to establish the concept that Japanese-type set-net is appropriate tool to promote and strengthen the community-based management for the coastal fisheries and fishery resources restoration. Due to the termination of 10-years permission on 2014, the installation and operation of set-net was suspended for recent two years. Currently, the process to declare the fishing license area was requested to the relevant authorities by the fishers group.

Component 6 Set-net

New challenges of set-net technology transfer in Thailand

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▶ Keywords: set-net, technology transfer, Choko-ami, community-based management, sustainable coastal fisheries management, Area-capability

Since 2003, the Department of Fisheries and Southeast Asian Fisheries Development Center in collaboration with small-scale fisherman of Rayong Province have carried out the research project on "Set-Net fishing for the sustainable coastal fisheries management' at Mae Rumpheung beach, Rayong Province. Otoshi-ami, Japanese-type set-net technology was introduced through the technical assistance of Tokyo University of Marine Science and Technology (TUMSAT) by JSPS program and Himi city, Toyama prefecture by JICA-Grass root partnership program. The objectives of that project was ; a) to reduce fishing pressure on the coastal fishing ground, b) to develop common policy for large scale coastal fishing gear management, c) to protect coastal fishing ground from fishing pressure of commercial fishing gears and d) to enhance the coastal resources by the rehabilitation of coastal fishing ground around set-net construction. Rayong set-net project was also considered and selected as one of case study for the Area-capability project under the RIHN since 2012.

The results of 11 years Rayong set-net project was greatly successful, so that the small-scale fishermen developed their new way of life through the group operation for establishing the saving in both investment cost and fisheries resources.

Past challenges of technology transfer of Japanese-type set-net in Thailand

Thailand, in the past, bamboo stake trap was the popular traditional fishing gear in the Gulf of Thailand during the period from 1940 to 1970, where its target catch was among others the coastal pelagic species such as Indo-pacific mackerel Rastelliger neglectus. It is a passive and stationary fishing gear fixed on the sea beds, made of mainly bamboo and partly a palm tree.

In 1949, set-net fishing was firstly introduced to Thailand based on the technology which originated from Japan. After the 2nd World War, when people in the region had more chances to establish contact with Japan, for opportunity to be educated in Japan, so that the knowledge and experience gained were transferred to their home countries. The set-net fishing introduced to Thailand since 1949 was for the Masu-ami, and in 1953 for the Otosh-ami by Commander Sawang Chareonpol (the former Director General of the Department of Fisheries of Thailand for 1978–1983) after he graduated from Hokkaido University of Japan. Shallow water set-net, the Japanese type of Choko-ami had also been tried in 1983 at the coastal waters of Samet Island, Rayong Province. Unfortunately, the technology was not disseminated at that time, because there were still plenty of fish in Thai waters and it was very easy to go fishing by using simple fishing

methods with the aim of harvesting the coastal fisheries resources.

Recent technology transfer of Japanese-type set-net in Rayong, Thailand

The latest set-net technology transfer was promoted during the International Set-Net Fishing Summit in Himi City on 2002. With emphasis on the gear as an important coastal fisheries management tool as the community-based coastal management, the set-net fishing technology operation was initiated by Training Department of the Southeast Asian Fisheries Development Center (SEAFDEC/TD) on 2003. For the purpose to empower the coastal fishing community in the developing countries, the Japanese-type of set-net, large-scale trap net fixed in the coastal waters, was introduced as an appropriate tool to promote the cooperative works among individual small-scale fishers for aiming the optimal fishing ground use in coastal communities. The case study in Thailand is the first success story to introduce the Japanese-type of set-net in Rayong province, originally initiated by SEAFDEC/TD on 2003, with other institutional support both from Thailand and Japan. The lessons learned through the project activities on community-based set-net, are the importance of capacity and ownership building for all the related local stakeholders both for fishers and supporters, for the purpose to enhance the area capability to establish the driving force cycles toward the sustainable use of coastal fisheries resources and public awareness on coastal environment. Similar projects have been conducted in other areas such as promotion of set-net (Choko-Ami Type) for sustainable coastal fisheries management in Sriracha, Chonburi Province under the Sriracha Fisheries Research Station, Faculty of Fisheries, Kasetsart University on 2008. Set-net fishing for community-base fisheries management in Bangsaphan, Prachuapkhirikhan Province on 2011 under the responsibility of Marine Fisheries Technology Research and Development Institute, DOF Thailand.

Since the technology transfer of Japanese-type set-net at Rayong Province on 2003, the catch and marketing record has been accumulated for 11 years under the official permission on set-net research activities. Due to the termination of permission on 2014, the process to extend the permission period was requested to the group, so that the installation and operation of set-net was suspended for recent two years (2014-2015).

New challenges of set-net technology transfer in Thailand

Shallow water set-net (Choko-ami type with the size of 5×5×50 m, depth of 5 m) have been challenged in the area of Phetchaburi Her Majesty the Queen encourages 'sea farm' practice which located in Tambon Bang Kaeo, Ban Laem District, Phetchaburi Provice, Gulf of Thailand. For the purpose to study the possibility of artificial breeding of some high value species from set-net. Sea ranching of some species could be done in connection to brood stock collection and artificial breeding from set-net catch in the area of sea farm for green mussel *Perna viridis*. Juvenile of some important and economic species could be enhancing and nursing under the Her Majesty the Queen encourages 'sea farm' practices or could be developed for sustainable aquaculture in the future. In this connection, set-net have been considered as one of the most appropriate fishing gear using for collecting those mentioned species for this purpose.

Two fishing trips have been done under this project. The 1st trip for survey, installation and demonstration. The fishing ground survey was conducted by SEAFDEC/TD team at the site which has a permission for set-net experimental area covering 1 km^2, based on the suggestions and comments from the local fishers for the current direction and fish migrating route. The result from survey showed the average depth as 4.7 m with 1.5 m tidal range. Various types of boats were engaged for the installation process. Completed for installation process on 1st May 2015. The demonstration of set-net fishing operation was done on 2nd May 2015. Total of 2 boats were engaged for fishing/hauling operation, as the larger boat for observation and small boat for hauling operation by 3 project's staffs and 2 SEAFDEC staffs on board as an advisors. The

demonstration required 20 minutes. SEAFDEC team worked together along with, since the initial stage of the installation process until completion of the installation at the end. Good viewpoints, useful suggestions and comments were advised to the working team for further and future development. The 2nd trip was done during September 2015, for re-adjusting, changing and replacing the new netting panels for the chamber net with the larger size dimension of 8×25 m (original size is 5×5 m), as well as the practical training of daily gear maintenance.

More than 20 species were recorded, as economically important species such as Spanish mackerel *Scomberomorus spp.*, Short mackerel *Rastrelliger brachysoma*, Snapper *Lutjanus spp.*, Barracuda *Sphyraena spp.*, Kelee shad *Hilsa kelee*, Shrimp scad *Alepis djedaba*, Banded scad *Alepes kleinii*, Spotted scat *Scatophagus argus*, Torpedo scad *Megalaspis cordyla*, Yellowstripe Scad *Selaroides leptolepis*, Queen fish *Scombroides spp. Scomberoides sp.* Hilsa *Hilsa Ilisha sp.* Tooth anchovy *Thryssa hamiltonii*, Rabbitfishes *Siganus spp.*, Smoothbelly sardinella *Amblygaster leiogaster* including Squid *Loligo spp.*, and Bigfin reef squid *Sepioteuthis lessoniana*. The juveniles of these economic species have been collected and immediately transferred alive within 20 minutes to the hatchery station for further study. As the result from this successful case study, the Phangnga Coastal Fisheries Research and Development Center, DOF, Thailand also proposed for the similar project activities to conduct in the area of Phangnga Province, located in Andaman Sea. Then the latest of set-net technology transfer in Thailand have been challenged since October 2015.

"Tsukuru-Gyogyo" as Area-capability approach:
A background explanation for participatory stock enhancement project of tiger shrimp in New Washington, Philippines

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▶ Keywords:Batan Estuary, Lake Hamana, Participatory approach, Stock enhancement, Tiger shrimp, "Tsukuru-Gyogyo"

Area-capability is a new idea expressing capacities to improve human societies by sharing abilities, necessities, knowledge and intentions to overcome various social problems and to facilitate affluent society through bottom-up approaches. "Tsukuru-Gyogyo", a coined term in 1970s in Japan, which is sometimes translated as "cultivating fisheries" or "culture-based fisheries", is expressing activities of fishers to conserve and control aquatic resources and environment for insurance of their catch. There are several negative criticisms to Tsukuru-Gyogyo from its uncertainty of economic efficiency and negative impact to ecological systems, though it gives fishers confidence and responsibility to manage resource conditions and environment by themselves. Among various methods for "Tsukuru-Gyogyo", release of "fish seed" produced in controlled environment by local fishers has prominent enlightening effect. A typical example is release of the kuruama prawn juveniles in Lake Hamana. The Release of juvenile shrimp started in Lake Hamana as a test project to confirm the impact to the resource condition in 1978. The project needed cooperation of local fishers to implement acclimatizing rearing and impact survey, though the fishers are skeptical of the impact to the catch and they participate the project with bad glance. After 5 years of the pirot project, local fishers propose to donate 5% of their profit from the harvest of kuruma prawn as othe fund to continue the project. Through 5 years participation, fishers could have sense of responsibility and confidence to conserve their resources.

Batan Estuary is a brackish lake connected with Sibuyan Sea. The shallow shores of the lake were used to be covered with dense mangrove forests forming complicated shorelines that provide rich nurseries to aquatic organisms. Because of such productive conditions, the lake was rich in fisheries resources some 30 years ago, but mangrove forests have been extensively converted to shrimp culture ponds in the 1980s (Altamirano et al., 2010). Habitats for various living organisms including fisheries resources such as tiger shrimp were lost. The drastic changes in coastal environment combined with excessive fisheries caused collapse of estuarine resources within a few decades (Altamirano and Kurokura, 2010). Price of tiger shrimp is highest among shrimp species in the local market and the collapse of tiger shrimp resource resulted in a corresponding loss of main income source for local fishers. This decrease in income combined with changes in distribution structure (Kamiyama et al., 2015) forced fishers into operation of destructive fishing methods. In addition, shrimp culture production also suffered a collapse due to diseases in 1990s. Recently, many shrimp culture ponds that were constructed by converting coastal mangrove forest in the estuary have been left abandoned and some are naturally recovering with a succession of mangrove species. Those wasted shrimp ponds are expected to function as nurseries for coastal fish resources.

The present status of the environment and fisheries in the New-Washington-Batan Estuary is providing us an opportunity to implement a social experiment to confirm the importance of participation of local fishers

in activities such as Tsukuru-Gyogyo for enhancement of area capability in the area. The research project of "Coastal Area-capability Enhancement in Southeast Asia" has been carrying out a subproject to examine the possibility of stock enhancement operation by participation of local fishers in intermediate culture of releasing tiger shrimp juveniles for acclimatization and impact research after release. We spent nearly three years for establishment of a system for "seed release" including site selection of intermediate culture, procurement of healthy shrimp seeds, methods of intermediate culture and impact surveys. Activities included social preparation to motivate active collaboration and participation among local people, government and academe for stable implementation of "seed release" maintenance, monitoring and impact survey. This is the report of feasibility surveys for three years including baseline research of people's consciousness in target area.

Stock enhancement of tiger shrimp *Penaeus monodon* in the Philippines

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▶ Keywords: community-based, estuary, mangroves, livelihood, rehabilitation

The Component 7 of the Coastal Area Capability Enhancement (CACE) Project of RIHN focuses on the Community-Based Shrimp Stock Enhancement Project (SSEP) in collaboration with Philippine partners – SEAFDEC Aquaculture Department and the Aklan State University (ASU). The main objective of this component is to evaluate prospects for tiger shrimp *Penaeus monodon* stock enhancement in the New Washington Estuary (NWE), province of Aklan, in terms of fisheries and social aspects.

The fisheries aspect of this component deals with site-specific assessments and on site experiments to identify various technical requirements for rearing and releasing of tiger shrimps in NWE. Six trials of intermediate rearing of shrimps were conducted from 2013 to 2015. Out of the six intermediate culture trials, three were successful to produce shrimps for release. The second trial in April 2014 had 4% survival, releasing 15,000 shrimps. Trial tagging experiment using plastic wire tags was done for 100 shrimps. The third trial in July, 2014 released 120,000 shrimps (44% survival) with 240 tagged. The 4th trial in November suffered very high mortality as caused by series of typhoons affecting the site. The 5th trial yielded the best success in producing an estimated 250,000 shrimps (51% survival) of desired size in 30 days and were released in May (250 tagged). The latest run (June 2015) was not successful because of typhoons and prolonged rains were again experienced earlier than expected causing mortalities of bigger shrimps.

On the other hand, the social aspect primarily involves socioeconomic profiling of stakeholders and further periodic monitoring surveys. Socioeconomic evaluation in NEW was done through meetings with the LGU and local communities in the island barangay of Pinamuk-an in New Washington. A baseline socioeconomic survey of 200 households in Brgy Pinamuk-an was done in March 2013 involving four target groups: 1) fishers without organizational affiliation, 2) fishers who are members of fishery organization, 3) community members in fishery-related livelihoods; and 4) fishers with gears owned and located in NWE. The baseline survey mainly showed low levels of understanding and experience on stock enhancement but willingness to participate in activities. Another survey was conducted in November 2015 to understand the effect of shrimp stock releases on a number of socioeconomic parameters of the target project beneficiaries by comparing from the 2013 baseline survey. Initial results showed that daily minimum catch volume barely increased from 1.50 kg in 2013 to 1.53 kg in 2015. In contrast, Daily maximum catch volume decreased from 8.25kg in 2013 to 6.43 in 2015. Meanwhile, monthly income from all sources, including fishing, increased by 13.4% from PhP 4,053 to PhP 4,597. Perceptions about resource condition generally improved specially for shellfish, crustacean and mangrove, but less for seagrass and fish. Perceptions about participation in community and fisheries affairs also improved. However, perceptions about leadership capacity in the

community declined while LGU financial support increased but not significant. Awareness about stock enhancement was mainly due to meetings (56%), community members (19%), LGU and SEAFFDEC/AQD staff (9.2%) and less from participation in the project (3.4%) and the PSFA (6.7%).

Only 10.3% of the 195 respondents caught tagged *P. monodon*, mostly using active gear (65%) and 35% used passive gear. About 33% think that the *P. monodon* caught was from the project (SSEP), 37% think otherwise, and 29% cannot determine. Nonetheless, 32% understand the SSEP, 31% believe SSEP will contribute to increased catch and income; while 37% have no idea and 1% not yet convinced. Unfortunately, the community's interest to participate in SSEP declined from 96.9% in 2013 to 81.5% in 2015. The interest in the project was mainly due to expectation of improved livelihood and income (67.9%) and knowledge (7.5%). There was also a decline in expectations about SSEP benefits in terms of catch and income; and the willingness to regulate harvesting declined from 80% in 2013 to 73% in 2015. Those who favored: 1) seasonal regulations slightly declined from 25 to 24% from 2013 to 2015; 2) regulation of illegal gears declined from 66.7 to 55.9%; 3) size limit of shrimp catch pieces also declined from 71 to 54%; and 4) the establishment of sanctuary also favored by 29.7% during the 2015 survey.

Actual catch monitoring is continuing, primarily using 20 fixed stations with "tigbakol" or fish corral/set net. Baseline data from monitoring showed that from Jan-Dec 2013, the combined tiger shrimp catch from all 20 stations was only 13 pcs for the whole year. On the average, only 1 pc of *P. monodon* was caught by 20 *tigbakol* per month in 2013, and increased to 6.75 pcs per month in 2014, while initial results in 2015 showed 8 pcs monthly average catch for the same set of gears. Alternatively, this study also monitors shrimp catch fish traders in immediate island of Pinamucan. From the batch released in May 2015, 15 out of 250 tagged shrimps were captured so far. Initially, this directly translates to 6% recovery which can be considered as good. In Japan, shrimp release and recovery are often <5% (Kitada and Hamasaki, 2006).

Immediate increase in catch after rearing and release activities can clearly be seen, indicating very active fishing pressure in the area. Unfortunately, good catch were not sustained and steep decline in tiger shrimp harvest were evident afterwards. This suggests that there is a need to mitigate impacts of overfishing, through some fisheries management intervention like catch regulations. In view of this, the social aspect of this study initiated a series of consensus-building discussions in October 2015 with the local government units (LGU); the Pinamuk-an Small Fishermen's Association (PSFA) and the Aklan State University. The discussions aimed to implement local action plans that will enhance societal benefits from the release of shrimp juveniles, including regulations and alternative livelihoods options. Therefore, stock enhancement activities need to be coupled with effective fisheries management and enforcement to maximize success, both in terms of fisheries and social impacts.

Component 9 Ishigaki and Mikawa

Research Activities in ISHIGAKI Island and MIKAWA Bay Area, Japan: Towards transdisciplinary research

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▶ Keywords: Coral reefs, Underwater heritage, Mangroves, Tombolo, Biodiversity, Environmental education

Towards "Area Capability Enhancement" in ISHIGAKI Island and MIKAWA-bay area of Japan, this component has been focusing on a new way of improving interactions between human and nature through conducting a large number of activities in interdisciplinary perspective. The following are the details of our activities divided into three categories: 1.natural scientific research; 2.social scientific research; and 3.educational activities etc. in each area.

• ISHIGAKI Island

1. Natural scientific research

One research topic in ISHIGAKI Island is to study the influence of the spring water on the biological production processes. Water samples were collected at 20 sites in the island. We are analysing the water samples by the ICP-MS (Inductively Coupled Plasma Mass Spectrometry) method and are planning to measure the stable isotope from the samples. We plan to make the water quality distribution map of the ISHIGAKI Island to describe the linking material flow at this site. Additionally, we focus on the environment of the mangrove area that provides the base of marine food chain and the ecosystem services. Short term intensive observation about the material flow around the mangrove area has been conducted.

Another research activity is to conduct an underwater archaeological survey around coastal area of ISHIGAKI, TAKETOMI, and KUROSHIMA Island. The underwater surveys have been conducted by divers mainly archaeologists with underwater robots made by our team. The purpose of these surveys is to make the detailed underwater map and to identify the cultural and historical significance of each underwater site. Our past studies already confirmed the archaeological significance of these sites, hence they are also potential as a marine resource for education and tourism for local communities. With such understanding, we also have tied to provide our archaeological results and information sites to local schools, students, and professional divers by conducting of environmental education, special exhibition at the local museum, and town meeting.

2. Social scientific research

Study on ocean policy is one of the outputs of this category. Dr. Yamada in this team has conducted a survey on conservation and sustainable use of ecosystems in ISHIGAKI Island from the viewpoint of ocean policy. He has analysed current situation and ocean policy of neighbourhood areas, and also successfully drew up the "*Basic Plan on Ocean Policy for ISHIGAKI Island*" in collaboration with local governmental office and communities.

Another topic is a survey on actual situation of the coastal use in ISHIGAKI Island. In spite of the fact that there are various types of coastal uses (e.g. fishery use, recreational use, conservational use etc.), there have been no huge conflicts among coastal activities, and a harmonized coastal use has been formed in the area. And this fact has significantly contributed to the regional development as well. This study has clarified above situation and indicated challenges that the area faces towards further development.

3. Educational activities etc.

We have been holding a variety of environmental education classes aiming to improve the perceptions of local residents on natural environment, eventually aiming to improve the human-nature interactions in the area. We are not only aiming to hold the classes, but also aiming to grasp the perception changes of local residents on regional resource conservation and the usage. "Underwater robot class", "Mangrove class", "Underwater heritage class" are the environmental classes we have held for the time being.

In addition, we also hold town meetings with local residents in annual basis with various topics such as "The ways of ocean use in ISHIGAKI Island" in 2012, "A new appeal point of ISHIGAKI Island-Underwater robot and heritage" in 2013, "The future of YAEYAMA from environmental education" in 2014.

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• MIKAWA Bay Area

1. Natural scientific research

The purpose of the scientific investigation is to understand biogeochemical cycles and ecosystem structure in MIKAWA Bay area. We are doing research on marine environment and biological resources including water, ocean bed sediments, benthos, seaweeds, bivalve species, and zooplanktons. We collected water samples at 20 sites, ocean bed sediments at 20 sites, 25 species of benthic animal samples, and three species of seaweed samples. Water and sediment samples were analyzed by stable strontium isotope analysis. The map as to the distribution of the strontium isotope shows the characteristics of watershed about each Toyo River and Yahagi River which are the largest river in observation area. Thirteen bivalve samples from 7 sites were collected to investigate the genetic variability and population structure of the bivalve species in MIKAWA Bay. Among these samples, universal primers (LCO1490 and HCO2198) amplified the CO1 gene (mtDNA) of 8 bivalve species (*Dosinia japonica*, *Moerella rutila*, *Mactra chinensis*, *Ruditapes philippinarum*, *Scapharca subcrenata*, *Solen strictus*, *Mactra veneriformis*). We will investigate the genetic variation of these species based on the DNA analysis. We also study seasonal variations of the zooplankton community in MIKAWA Bay to discuss environmental factors to maintain species diversity and interspecific relationships. We have made a database of those marine species and are updating it in regular bases.

2. Social scientific research

On one hand, we focus on the traditional fire festival and seaweed use in MIKAWA area. The purpose of the survey on fire festival is to understand the socio-spatial structure and the historical transformation of the local communities. In the survey on the seaweed use, we are trying to clarify the social role of the seaweed use in the community from the viewpoint of minor subsistence.

On the other hand, we focused on ocean education activities, clarified the functions and functional requirements of Fisheries Cooperative Association (FCA), as well as its social significances in ocean education through a case study of HIGASHIHAZU FCA in MIKAWA area. In the long history of Japanese fishery, the FCA has played an important role not only in fisheries industry, but also in supporting overall fishing communities.

3. Educational activities etc.

We have conducted a training class to study natural observation at the tidal land as our university lecture in Mikawa bay area. We have been holding a series of "Natural Observation Meeting" in collaboration with local residents (HIGASHIHAZU FCA and local governmental office etc.) in MIKAWA bay area as well. And also continue to hold town seminars in annual basis with various topics, such as "The power of the nature and the treasure of the CHIYIKI (local area)" in 2012, "The people and the ocean of HAZU" in 2013, "Activity Report in Mikawa bay" in 2014.

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