Beyond social dilemmas in sea mouth management: impacts of sea mouth opening and these responses to lagoon fisheries in the Hokkaido Region, Japan

Shimpei Iwasaki
Research Institute for Humanity and Nature
iwasaki@chikyu.ac.jp

Abstract: This paper explores linking lagoon fisheries and sea mouth management in case studies of the Hokkaido region, Japan. In nature, lagoons face dangers of closing the inter-connected mouth through sediment transport. Under the circumstances, development of lagoon fisheries largely depends on maintenance of the sea mouth bridging the sea and lagoon. However, social dilemma situations in sea mouth management tend to arise due to involvement of different interests and needs among relevant stakeholders. In this paper, case studies were conducted to explore highlighting the impacts of sea mouth opening while addressing the heterogeneity characters in sea mouth management. The findings will provide a challenge to encourage the identification of overcoming the dilemma situation over sea mouth toward sustainable lagoon fisheries.

Keywords: sea mouth, social dilemma, heterogeneity, lagoon fisheries

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1. Introduction

A lagoon is a body of shallow water separated from the sea by barriers such as low sandy dunes. Lagoon areas are maintained through sediment transport process (Anthony et al. 2009). The sediment variation determines exchange of migratory species and further plays a role commensurate with the salinity adjustment. In general, lagoons are subject to different types of environmental variables. Both extremes of river basins and sea marine are of a dynamic and complex environmental character: these are transitional

ecosystems between land and sea and between fresh and marine water. Fresh water from upstream and marine water from the ocean combine in a diverse assemblage of a fresh, brackish, and marine water ecosystem with estuarine characteristics.

With spatial and temporal changes in the lagoon environment, the unique ecosystem is endowed with highly productive natural resources and a valuable biodiversity, enabling a large number of people to make a living. Availability of fishery resources in the lagoon environment is to a great extent dependent on hydrological circulation between the sea and lagoon. Particularly, a configuration of sea mouth bridging the two spatial zones is inevitable to keep the lagoon environment and its natural resources stable. For instance, a recent case of Chilika Lagoon, India illustrated that opening a new mouth along dredging of water channels in 2000 had considerable impacts on the ecosystem function in the lagoon environment (see Iwasaki and Shaw, 2010a): proper hydrological interventions exhibited positive impacts on fisheries enhancement with a spectacular increase in fish landing quantities as shown in Figure 1. As such, maintenance of sea mouth in an appropriate manner serves as a basis for changes of fishery resource stocks in the lagoon environment. The range of lagoon fisheries management includes not only management of fishery operations practiced by fishers, but also control of varying degrees of sea mouth condition as well as watershed conservation.

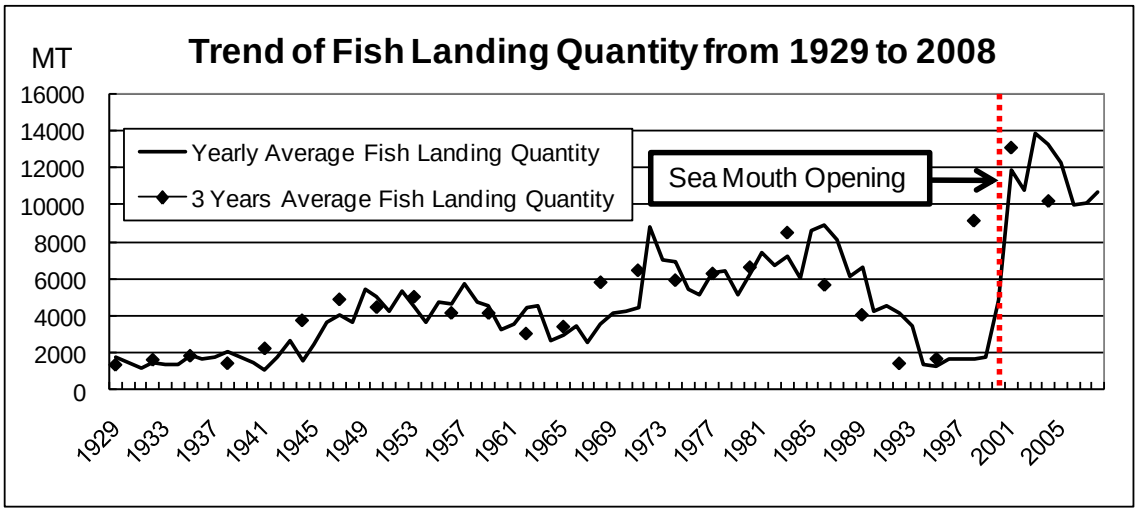

Figure 1: Impacts of opening the new mouth in 2000 (modified from DFGO 1970: DFGO and CDA 2005, and CDA data).

It needs to be mentioned that lagoons face dangers of closing the inter-connected mouth through sediment transport in nature. The process of sea mouth closure has been

faster and diversified combined with anthropogenic pressures. Maintenance of sea mouth is inevitably required to the development of lagoon fisheries. However, social dilemma situations which collective interests are at odds with self-interests tend to arise in the process of sea mouth opening. The management involves a representation of different interests and needs by relevant stakeholders. Hydrological intervention affects not only availability of fishery resources but also a wide range of consequences, requiring involvement of the sea mouth management at multiple levels. In this sense, addressing the background behind the decision-making process of the sea mouth management is inevitable to keep the lagoon environment and fishery resources stable.

With this recognition, this paper explores sea mouth management commensurate with maintenance of fishery resource stocks in the lagoon environment. It presents case studies in Saroma Lake and Notoro Lake of the Hokkaido region, Japan where the mouths used to become closed every year due to sediment accumulation from the ocean by stormy weather. In the case studies, this paper highlights the impacts of sea mouth opening while addressing the nature of heterogeneity among relevant stakeholders in the decision-making process. In the next section, it sets out to give an overview of causes of sea mouth closure, in order to address vulnerable nature in the lagoon environment. Then, the study traces the history of both study sites and discusses about social dilemmas in sea mouth management. Based on the discussions, the paper provides challenges to adapt to changes in sea mouth management inherent in the heterogeneity characters toward sustainable lagoon fisheries.

2. Causes of sea mouth closure

Worldwide, there are a lot of cases where lagoon areas face dangers of closing the interconnected mouth bridging the sea and lagoon. The causes of sea mouth closure cover a broad range of factors in the ecological-social-economic system, which shall take into account local circumstances. However, such situations arise from three reasons on the whole (see Figure 2). First is soil erosion from upstream. A large number of sediments rush to downstream and then accumulate in the lagoon. Especially, sea mouth where a concentration of saline water is higher promotes agglutination and precipitation reactions of sedimentation. Land use changes such as deforestation, overgrazing and monoculture practice for cash crop tend to further accelerate the sedimentation process. Climatic and disastrous variability such as flooding, hurricanes, tornadoes, cyclones and landslides are becoming more frequent and intensive, resulting in an increasing possibility for the closure of sea mouth. Such situations are particularly applicable to the

case of Chilika Lagoon, India (see Iwasaki and Shaw 2010a), for instance.

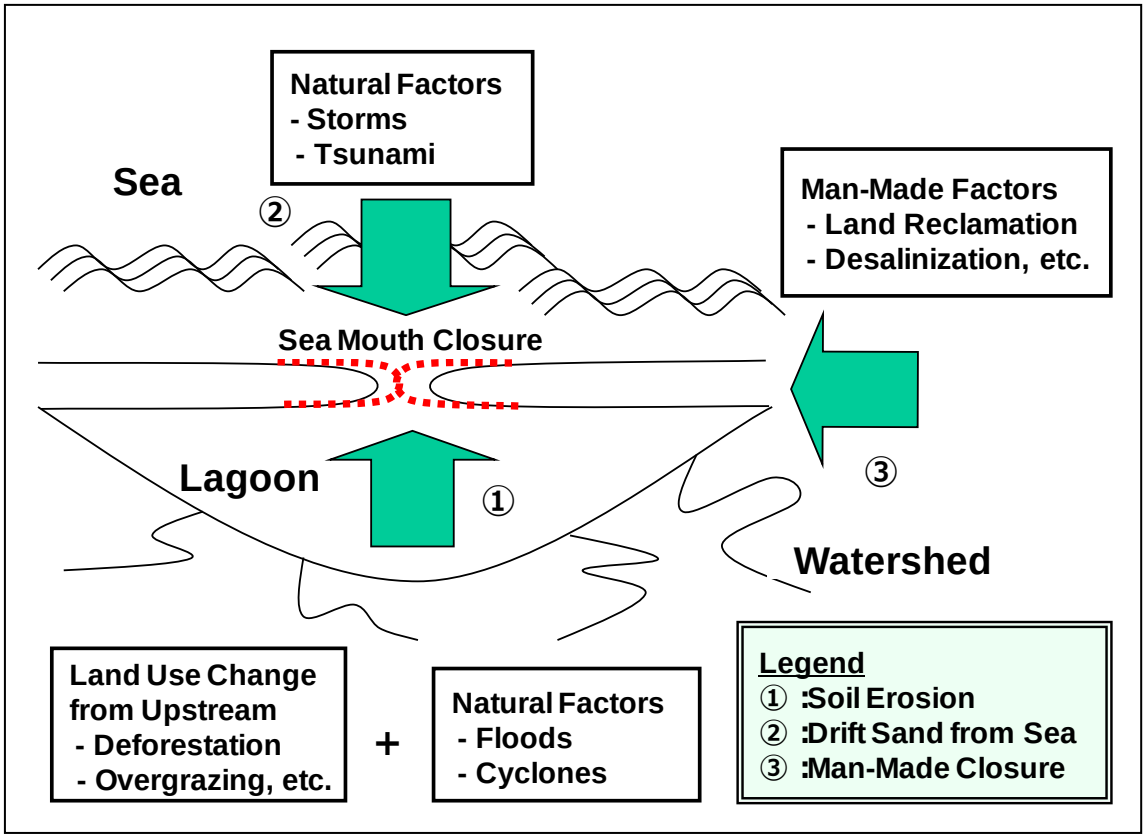

Figure 2: Three factors behind closure of sea mouth

Second is drift sand from the ocean. A strong storm or tsunami brings a lot of sandy soil into the shoal as sand dunes. Apart from soil erosion from upstream, the surging sediments from the ocean may rather attribute the closure of sea mouth to physical process. This phenomenon does fit the case of Notoro Lake and Saroma Lake in which this paper presents case studies. As will be mentioned later, the sea mouth used to become closed in around November due to stormy weather. In nature, the accumulated sediments caused overspill of water in the lagoons into the sea, with heavy rain or the melting of the snow. Accordingly, sea mouth was naturally opened. However, the temporal sea mouth closure might pose a threat to make a living, thereby leading to prerequisite task for maintenance of sea mouth opening in both sites (see section 3).

Third is man-made closure of sea mouth. Human settlements and activities are highly concentrated in many lagoon areas due to low-lying and shallowness (Hobo 1989). Apart from fishery operations, human-beings can have an easy access to such lands for the purpose of land reclamation, desalinization, and so on (Boynton et al.

1996; Katsuki, et al. 2009). In Songkhla Lake, Thailand, for instance, the construction of sluice gates at Pak Ra Wa was undertaken to prevent salt-water intrusion from the Bay of Thailand for farming purposes (Iwasaki and Shaw 2009, 2010a). As the years passed, extending demands and overconsumption of water resources in household, agricultural and industry sectors of Songkhla Lake watershed have been placing considerable pressures for dam constructions in the lake as well as establishment of the water gate. These cases are largely linked to the representation of different values by other stakeholders except fishers at multiple levels. In this sense, the nature of heterogeneity with different interests and needs of human-beings, in terms of livelihood and location, shall be taken into consideration at the watershed level in sea mouth management.

3. The multiplicity issues of sea mouth management

It is obvious that sea mouth management affects the availability of fishery resource stocks in the lagoon environment. Meanwhile, it becomes clear to recognize that a configuration of sea mouth is greatly exposed to various environmental factors along with anthropogenic pressures. To pursue the maintenance of lagoon ecosystem (particularly fish ecology), it is important for the stakeholders to share common ideas on how sea mouth be dealt with. From here, this paper sets out to explore human interactions of sea mouth management by focusing on lessons learned from Saroma Lake and Notoro Lake of the Hokkaido region, Japan. It endeavors to address a nature of ‘‘heterogeneity’’ in its management activities: the research highlights complex backgrounds of sea mouth management undertaken by relevant stakeholders.

3.1. Profile of study area

On the north-eastern Hokkaido, there are many large and small lagoons along the sea of Okhotsk. Out of them, eleven lagoons have an area of more than 1 km^2. From a topographical standpoint, embayments formed by the postglacial marine transgression have remained as the lagoons behind spits or barrier islands built across sea mouths. The sea of Okhotsk is considered one of the richest north temperate marine ecosystems in the world and one of the most biologically productive of the world’s seas. Thus, the lagoon environment connecting to the sea of Okhotsk endows with highly productive environment in which fishing is a principal benefit. Particularly, the representative lagoons in the Hokkaido region include Saroma Lake and Notoro Lake (see Figure 3).

The former is the largest lagoon in Japan. The size and circumference of the lake area is around 151 km^2 and 91 km, respectively. Meantime, the latter (around 58 km^2) is the second largest lagoon in Hokkaido, 32 km in circumference. The local people in both lagoons faced a common challenge of sea mouth management, but different behaviors and actions had been taken to deal with it.

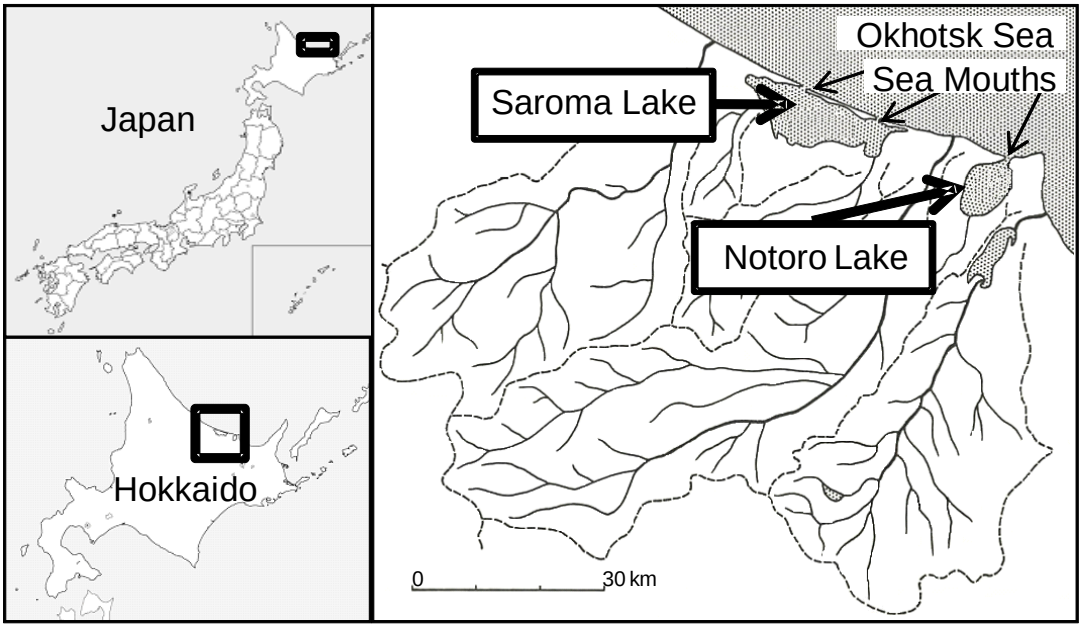

Figure 3: Map of Saroma Lake and Notoro Lake

3.2. Case of Saroma Lake

Saroma Lake covers three municipalities (Tokoro town in Kitami city, Saroma town in Tokoro county and Yubetsu town in Monbetsu county). In 2007, 413 fishers are members of three fishery cooperative associations (FCAs) in each village which were established in 1948 (ACLS, 2011). The lake is one of the most prominent scallop productions places in Japan where fishers developed breeding and culturing scallop fisheries, so-called "*Saroma System*". The *Saroma System* was built as a result of opening of first mouth in 1929 and its adaptive responses by related stakeholders to deal with the changes in the lagoon environment (see Iwasaki and Shaw 2010a, 2010b). Opening of first mouth was at a major turning point of fisheries development in Saroma Lake so that this paper highlights the background of its decision process and the effects of sea mouth opening in the lake.

3.2.1. Shio-kiri: traditional sea mouth management

Prior to 1929, there had been a temporal sea mouth in Tohutsu (see Figure 4). During the period from November to June, the old mouth became closed every year due to stormy weather. Closure of old mouth had considerable adverse impacts on people livelihoods, in terms of the availability of lagoon fishery resources, boat navigation to the sea, increasing flood risk, agricultural work and so on: closure of sea mouth was unable to exchange migratory fish species on which fishers were dependent and obstructed the passages of boat navigation for the ocean. At the same time, it hindered the exchange of water between sea and lake, resulting in the lower salinity level that affects many living creatures for survival. Not only fishers but also other villagers were suffered from floods because the closure of sea mouth made the lake overflowing when it rained heavily. Floods brought physical damages in terms of human being, agricultural fields and infrastructures. On this account, neighboring residents including the Ainu[1] (traditional tribe) in the lake united together and opened the closed mouth every spring. Such traditional collective actions, which have been locally known to be "*Shio-kiri*" among them, made great contributions to sustaining lagoon and marine fisheries to maintain the existing ecological-social-economic system and mitigating the impacts caused by floods.

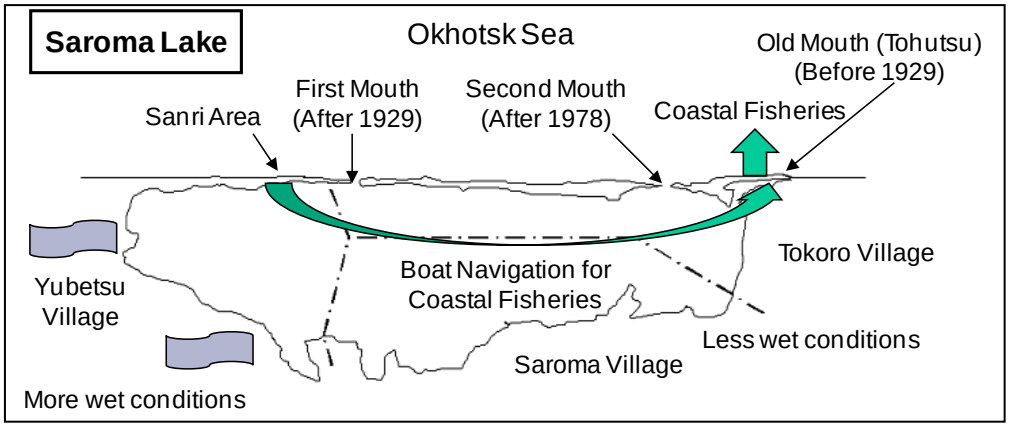

Figure 4: Location of Saroma Lake with historical changes of sea mouths

[1] In the past, the Ainu used to live in Ezo region (old name for Hokkaido) including Saroma Lake and Notoro Lake, where was separated from the mainland of Japan. However, the Ainu were attached by the mainland people during the Edo (1603-1868) and Meiji (1868-1912) periods. Consequently, the Ainu had been assimilated into the Japanese in various ways. The transition of forced assimilation was applicable to the case of Saroma Lake and Notoro Lake where the Ainu used to harvest various natural resources including aquatic animals, but they were incorporated into the framework of modernized economy in Japan.

3.2.2. Opening of first mouth

Opposed to the traditional custom (*Shio-kiri*), however, there occurred an unexpected incident in 1929. The local peoples in Yubetsu village opened a new mouth (first mouth) without community representation in the other villages. In those days, fishers in the lake could be divided into two categories. One category belongs to those who were engaged in lagoon fisheries while the other was composed of those who went fishing in coastal marine. In the latter, there were two ways to go fishing in the ocean. Fishers could sail on the ocean via a sea mouth at Tohutsu, or they trailed their boats on the sand to go to the ocean. As shown in Figure 4, the residents in Tokoro village were easily accessible to the old mouth and then started coastal fisheries without considerable efforts. In the meanwhile, the residents in Yubetsu village, which was furthest from Tohustsu place used to require more time and energy to go fishing in the ocean via the mouth. Otherwise, there was no choice but to trail their boats on the sand bar. The option caused damages to their boats, resulting in shorter validity date in use.

Under the circumstances, the fishers in Sanri area, which was a part of Yubetsu village (see Figure 4) were reported to have changed or expanded their fishing grounds from the lake to the coastal marine since around the year of 1920. They always faced the difficulties over boat navigations for coastal fisheries, irrespective of the traditional "*Shio-kiri*" interventions. It was so intolerable dilemma so that they gradually decided to open a new mouth near their living area in 1925, though their attempts were failed (Yubetsucho-shi Hensan Iinkai 1965). Furthermore, the momentum of efforts to open a new mouth, as opposed to commonly shared governance of sea mouth management at Tohutsu, expanded to all residents in Yubetsu village in addition to the fishers in Sanri area. It was largely tied to the topographical characters associated with hydrological circulation in and around Yubetsu village. Compared with Saroma and Tokoro villages, many residents in Yubetsu village had more suffered from overflow caused by snowmelt water. Even though elaborations were traditionally made on opening the old mouth every spring, the land in Yubetsu village, which was furthest from the mouth still remained moist soil conditions. The moist lands did not fit practice of agriculture so that new immigrant settlers forced to live apart from neighborhood for farming (ibid). In addition, these conditions augmented higher risk of flooding, causing damages to human and physical assets. Hence, opening of a new mouth were of special significance for Yubetsu villagers, in terms of mitigation of flood hazards and farming as well as easy access in the sea. Consequently, their growing aspirations became a stepping stone to set off an excavation on state-owned land without any permission from the other

surrounding villages (Saromacho-shi Hensan Iinkai 1966). Importantly, Yubetsu village created a budget for the excavation so that around 80 workers from the neighboring residents were mobilized, resulting in opening of the first mouth in 1929 with the help of heavy storms.

However, the other villages, especially Tokoro village, fiercely opposed to and sought suspension of the excavation. That is why the motivations for excavation were not embedded in maintenance of the lagoon environment, as traditional customs called ‘‘*Shio-kiri*’’ used to entail the component. On this account, turbulent relationships especially between Yubetsu and Tokoro villages had been aggravated. In this sense, it is apparent that different motivations behind opening of the old mouth and the first mouth were historically identified in Saroma Lake. Opening of a new mouth may not always be an incentive to maintain hydrological variability that is a basis for lagoon ecosystem service and function.

3.2.3. Opening of Second Mouth

Opening of first mouth in 1929 caused trouble among the related stakeholders especially between Yubetsu and Tokoro villages. The interventions altered to a great extent the lake environment, which did not seasonally close the first mouth and increased the salinity level, resulting in the dramatic change in fish production. Oysters which used to be concentrated on Tohutsu were almost disappeared due to tidal change, increased salinity level and associated higher water temperature. The fishers who were dependent on oyster harvesting had to find a different source of income. However, it needs to be mentioned that the configuration of first mouth fortunately led to improvement of fishery livelihood conditions with a spectacular increase in fish landing quantities except oysters in hindsight. In particular, it is worth noting that an engineer from Hokkaido Fisheries Experimental Stations happened to discover a lot of juvenile scallops on the surface of oyster shells, resulting in the effects of sea mouth opening. The discovery provided all the fishers and FCAs living in the lake a chance to unite together in the base of culturing scallop fisheries in the lake. Consequently, an inter-cooperative fishery institution so-called “*Aquatic Cooperation of Lake Saroma (ACLS)*” was established with the aim of building the adaptive fisheries management system in terms of utilization, culture and protection. The main roles of ACLS were to develop cooperative fisheries[2] in and around Saroma Lake beyond the competing

[2] The introduction of ACLS enabled to share their variant water zones and manage fishery resources in the continuum ecosystem. The presence of ACLS led fishers to build cooperative fishery governance system effectively (see Iwasaki and Shaw 2010a,

conflicts among them.

Under the fishery cooperative system, opening of the second mouth was undertaken in 1978. Since 1965, the management of scallop culture in Saroma Lake has started along the right lines. Accordingly, the fishers added more facilities for the operation, resulting in degradation of hydrological circulation in the lake. Along water contamination from upstream, the hydrological change accelerated the lake eutrophication. In particular, the eastern side of the lake had been worse water circulation since the first mouth was opened and in turn the old mouth (Tohutsu place) was closed in 1929. The condition of water quality was severe in the eastern side where red tide problems have been arose as a result of emergence of north-eastern airflow due to Okhotsk anticyclogenesis. Due to this, growth rate of scallop in the eastern side was slower than the rate in the western side where the first mouth provided well-circulated cycle between the sea and lake. To pursue the improvement of the hydrological cycle, the fishers in Tokoro village started to raise appeals for opening a new mouth in the eastern side of Saroma Lake to relevant government agencies. Numerous attempts at the excavation were made through a lobbying group which was established in 1964. It took long time to fulfill their requirement, but the Hokkaido (prefecture) government secured 2.7 billion Yen for the budget. However, it needs to be mentioned that some people in Yubetsu village used to believe that opening a new mouth in the eastern side of Saroma Lake may cause the first mouth to be disappeared because two mouths out of the lake cannot happen as the old mouth was closed. This was a causing ripple in Yubetsu village. Taking into account their turbulence, the Hokkaido government commissioned a survey on environmental impact assessment in the case of the excavation. Based on the findings from the scientific evidence, importantly, the official clearly stated that the Hokkaido government will take on the responsibility, thereby convincing Yubetsu villagers to accept the construction. Consequently, the second mouth was opened in 1978. The effort improved the lake water environment so that it enabled scallops and oysters to grow faster in the eastern side as same as in the western side.

Unlike the case of first mouth, opening of second mouth was initiated with consensus building among relevant stakeholders. Although both cases in common successfully improved the lagoon environment that is essential needs of fish ecology, the process of sea mouth management was quite different in the two, in terms of shared ideas or visions. The case of second mouth faced the challenge of different opinions especially between Tokoro and Yubetsu villagers. In this respect, a role of facilitator (Hokkaido government) played a leading role for the consensus building effort. Of

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2010b).

special note is use of scientific knowledge in sea mouth management. Scientific consensus and packaging of scientific knowledge could be translated into decision-makings at that time. In this sense, the scientific community has the ability to play a leadership role in being an agent for influencing policy makers, practitioners, and local communities. Role of scientific evidence will make great contributions to consensus building as a catalyst action.

3.3. Case of Notoro Lake

The nature of Notoro Lake is very similar to Saroma Lake. The lake connecting to the sea of Okhotsk endows with highly productive ecosystem service in which fishery resources are present. 32 fishers which are members of Nishi-Abashiri FCA are dependent on the attractive resources. In 2008, the main production of Notoro Lake fisheries is breeding and culturing scallop (approximately 3,879 tons), followed by salmon (approximately 249 tons), flat fish (*Pleuronectes schrenki*) fisheries (approximately 65 tons), shrimp (*Pandalus latirostris Rathbun*) (approximately 33 tons), Japanese surfsmelt (approximately 26 tons), and so on. Importantly, the fish production in the lake has been largely commensurate with the management of sea mouth as was illustrated later.

3.3.1. Competing conflicts over sea mouth

When it comes to autumn, it is said that the sea mouth of Notoro Lake used to be closed due to accumulation of drift sand from the ocean by stormy weather. The closed mouth elevated the water level in the lake and was naturally opened as a result of the overflow after around three years. Kinenshi Henshuu Iinkai (1987, 1989) indicated that the size of Notoro Lake (58 km^2) used to increase around 120 km^2 of its full capacity at high tide. Prior to the active settlement from other places especially the Honshu island of Japan, the higher variability of the water level had not brought about major obstacles to make a living. Rather, the immigrants and lumbering companies which collected the timbers from the upstream could benefit, in terms of easy transportation.

However, Notoro Lake faced a similar challenge of competing conflicts over sea mouth among relevant stakeholders as the case of Saroma Lake experienced. Once the immigrants settled down, some of them started to be engaged in not only fisheries but also agriculture in the area. But, the farmers sometimes forced to abandon their own fields in case of sea mouth closure especially in combination with the year of much melting snow. It is reported that the closure caused 300 ha of the farm fields and 300 ha

of picking grass fields to be uncultivable (ibid). At the same time, the overflow had done damage to roads and railway, thereby leading to traffic accidents. It also prevented migratory fish species in lay from moving in and out the lake, becoming extinct. Nevertheless, there was a wave of immigration in the area where those people had looked for a new start in that area. Consequently, competing conflicts over sea mouth management had been taken place with heterogeneous values, interests and objectives.

3.3.2. Formation of cooperative society for sea mouth opening in Notoro Lake

As the years passed, the farmers suffering from the overflow in their fields started to open the sea mouth at night stealthily. The attempts raised a strenuous objection to the fishers who had been dependent on the lake fisheries, getting into trouble with police. A record indicated that local representatives from the farmers presented a petition to the regional government to secure the permission of the opening (ibid). Accordingly, the competing conflicts between fishers and farmers had become serious. In response to this, the ward mayor in the area of Notoro Lake encouraged related stakeholders to organize a cooperative society for solution of sea mouth management. Importantly, the cooperative society was approved by Abashiri town, securing the legitimacy for budget allocation to the maintenance of sea mouth from the government. The mayor's elaboration successfully created common arena for discussions and implementations of the sea mouth opening, in the name of "*Cooperative Society for Excavation of Sea Mouth in Notoro Lake*".

The organization held general meetings in every April to determine the way of opening the sea mouth. It served as a basis for coordination of building a consensus for the decision and participation of the opening. Although the sea mouth was closed by storm weather in every autumn, the members including fishers and farmers strived to jointly reopen it in a collective manner. The duration of sea mouth opening in Notoro Lake is shown in Figure 5. Indeed, their efforts achieved effects of fishery resource enhancement and improvements of agriculture and infrastructure. It found that the man-induced sea mouth raised breeding of a large number of young scallops in 1933, leading to one of the most income source from the fisheries at present. Yet, the reopening was not simply appreciated by the members because some fishers expressed their concerns about possibility of decreased population of specific fish species (ex. flat fish) in response to the earlier implementation after thawing season. Thus, there sometimes occurred quarrel among the members especially between fishers and farmers, irrespective of establishment of the cooperative society.

Meanwhile, repeated petitions for the prevention of annual sea mouth closure had

been presented to the government on behave of the cooperative society, though these attempts were failed. On this account, a lobbying group was further created in 1955 by relevant agricultural cooperative society, in order to propel their demand into action. Yet, the attempts had not been directly led to their fruition.

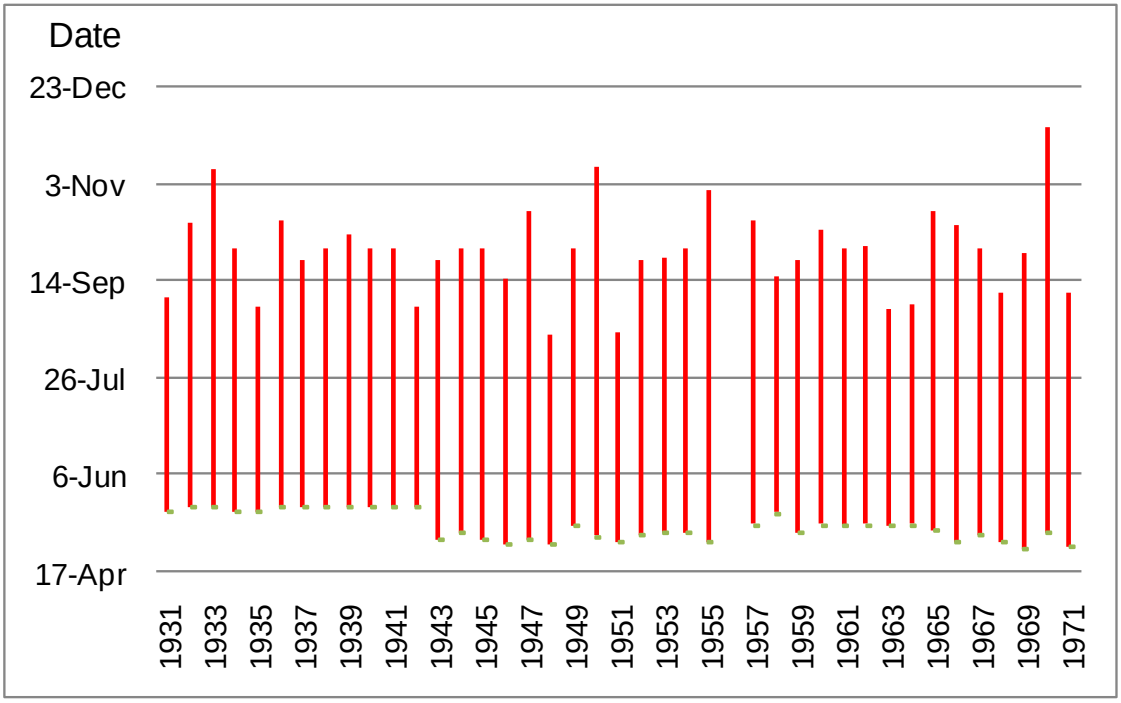

Figure 5: Duration of sea mouth opening in Notoro Lake from 1931 to 1971 (modified from Kinenshi Henshuu Iinkai 1987).

3.3.3. Construction of unshifting sea mouth and its impacts

Under the circumstances, an unexpected result related to their demand was taken place. In 1969, the government decided to prevent the sea mouth from being closed, for the purpose of use in operations for a new fishing port categorized as the fourth class[3] and an associated marine product processing place by reclaiming land from the lake. The construction was derived from responding changes in the socio-economic circumstances: entry of more large-scale vessels with higher fish production in Abashiri FCA, which is based in the coast of Abashiri next to Notoro Lake, had been expected[4],

[3] The fourth-class fishing port is defined as the place located on isolated islands or at remote place but important place for developing fishing grounds or providing fishing vessels with shelters (Article 5 of the Fishing Port Law).

[4] However, the new fishng port has been nearly-defunct contrary to the government's expectation due to multiple causes including the reduction in fishing grounds, higher energy prices, and decreased population of wide-ranging fish (ex. *Cololabis saira*).

requiring improvement of the management in the Abashiri FCA, not the fishers in Notoro Lake. In this situation, the cooperative society agreed with the government's decision, but the fishers did not compromise on details: the government's decision with heterogeneous objective (development of Abashiri FCA) in mind might be a matter of vital importance for the fishers in Notoro Lake: changes in the hydrologic cycle by the unshifting sea mouth and water pollution from the processing might incur the risk of availability in fishery resources in the lake.

Although the construction was finally determined in 1969, the fishers in Notoro Lake countered the threat from the construction in a way that a special task committee was set up in 1971. The committee played an important role in identifying potential issues and building legitimacy as a countermeasure against the construction. The committee firstly conducted a hearing survey with regard to environmental impacts on opening of the sea mouth in Saroma Lake and then a series of hearing from the construction and internal discussions were implemented. On the basis of the survey results, the committee on behave of the fishers in Notoro Lake presented the petition to the government authority. Finally, these elaborations were taken into account properly in the implementing process of the construction. At last, the sea mouth was opened without any conflicts in 1974. Obviously, the fish landing quantity in Notoro Lake has been drastically increased after the opening in the year (Figure 6). The hydrological interventions achieved spectacular increase of scallop production in the lake.

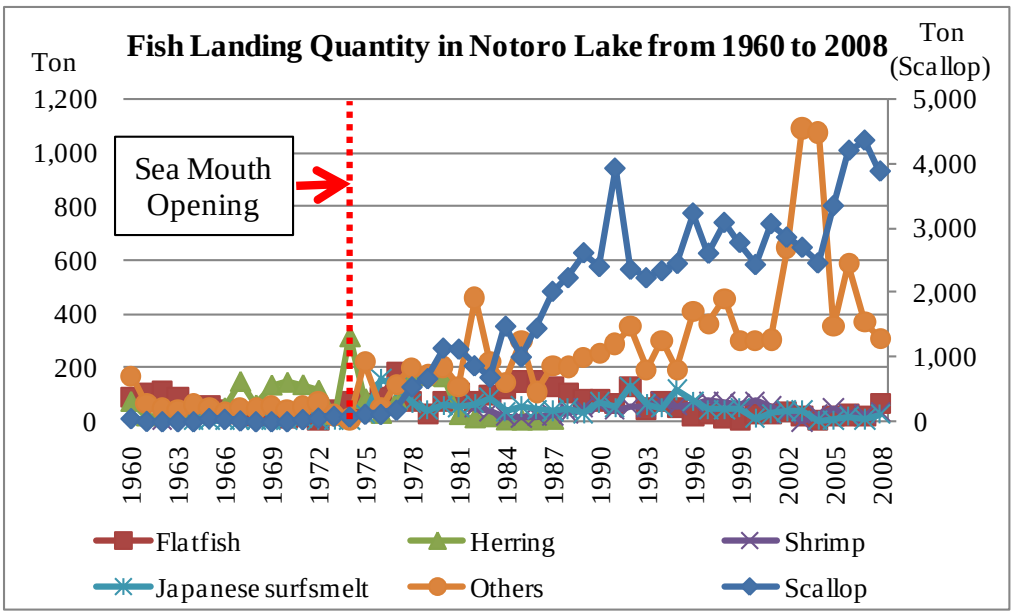

Figure 6: Impacts of sea mouth opening on fish landing quantity in Notoro Lake (modified from Abashiri City data).

4. Beyond social dilemma over sea mouth management

In nature, lagoon areas face closure of the interconnected mouth through sediment transport. Related to this, the evidence from the case studies strongly indicated how important opening the sea mouth is to lagoon fisheries enhancement. The sea mouth acts as a bridge between the sea and lagoon to keep the lagoon environment and its natural resources including migratory species stable. In addition, the hydrological intervention benefits flood controls especially for the purpose of maintenance of agricultural fields and infrastructure. Opening the sea mouth itself might be highly appreciated by the relevant stakeholders as was illustrated in the case studies. But it needs to be mentioned that there would be a possibility of the sea mouth management becoming social dilemma over the way of when, where and how opening of the sea mouth be initiated. The detailed operation of the opening might bring different effects of expected outcomes among the stakeholders, respectively. The major effects of sea mouth opening in Saroma Lake and Notoro Lake are shown in Table 1. Even among the fishers, there existed different expected outcomes of sea mouth opening in the cases of Saroma Lake and Notoro Lake. The different perspective might give rise to competing conflicts over the sea mouth management, causing the reckless opening without the representation of the other stakeholders as the first mouth was opened in Saroma Lake. Such practices without ample consensus-building among them might create a massive crisis in the lagoon environment and/ or the human relationship. Therefore, creating institutional arrangements for the opening is highly appreciated as an integral part of sea mouth management. The opening of the sea mouth may not always be an incentive to maintain hydrological variability that is a basis for lagoon ecosystem service and function. Rather, other incentives may be embedded in the decision process. These backgrounds need to be shared among beneficiaries who pertain to heterogeneity characters for the use in sea mouth management.

Table 1: Major effects of sea mouth opening in Saroma Lake and Notoro Lake

Components		Major effects of sea mouth opening
Livelihoods	Fisheries (Lagoon)	Water salinity level, Water temperature, Water flow, Soil condition, Vegetation, Exchange of migratory fish species
	Fisheries (Ocean)	Navigation to the ocean

	Agriculture	Exposure to water, Salinity level of water and soil under the ground
Life Style	Human life	Frequency of flood disasters
	Infrastructure	Exposure to water
	Drinking Water	Salinity level of water under the ground

Indeed, the case studies adapted to respond to the completing conflicts over the sea mouth management in a way that institutions were created and played a significant role in building their consensus properly. Although unexpected opening of the first mouth was taken place in Saroma Lake, creation of Aquatic Cooperation of Lake Saroma (ACLS) built better fishery cooperative governance among the competing FCAs. The common arena for discussions made shared visions for management of lagoon fisheries that include the sea mouth management. Likewise, the cooperative society for the opening of the sea mouth was organized in Notoro Lake to bridge between the fishers and the farmers in an united manner. From 1931 to 1974, the cooperative society reconciled the conflicting interests among them and encouraged the members to cooperate together for the reopening in every spring. In order to break out of the dilemma, stakeholder involvement is prerequisite for ensuring the legitimacy of conflict resolution over the sea mouth management. Furthermore, the lessons learned from the case studies put high emphasis on scientific consensus and packaging of scientific knowledge in the decision making process. It enables the relevant stakeholders to share commons ideas with regard to problem identifications and these expected countermeasures in a comprehensive way. Active use of scientific knowledge and skills (ex. application of environmental impact assessment) will act as a catalyst so that the scientific community has the ability to play a leadership role in being an agent for influencing policy makers, practitioners, and local communities. Given the process of sea mouth closure has been faster and diversified in the contemporary world, the detailed operation of sea mouth management shall be taken into account with stakeholder involvement and active use of scientific knowledge.

References

ACLS (Aquaculture Cooperation of Lake Saroma). 2011. *Homepage of aquaculture cooperation of Lake Saroma*. http://homepage3.nifty.com/saromako/ (accessed June 2011).

Anthony, A., J. Atwood, P. August, C. Byron, S. Cobb, C. Foster, C. Fry, A. Gold, K. Hagos, L. Heffner, O. D. Kellogg, K. Lellis-Dibble, J. J. Opaluch, C. Oviatt, A.

Pfeiffer-Herbert, N. Rohr, L. Smith, T. Smythe, J. Swift, and N. Vinhateiro. 2009. Coastal lagoons and climate change: Ecological and social ramifications in U.S. Atlantic and Gulf coast ecosystems. *Ecology and Society*, 14(1), 8. http://www.ecologyandsociety.org/vol14/iss1/art8. (accessed June 2011).

Boynton, R. W., D. J. Hagy, L. Murray, and C. Stokes. 1996. A comparative analysis of eutrophication patterns in a temperature coastal lagoon. *Estuaries*, 19(28):408–421.

DFGO. 1970. The Chilka lake. Directorate of Fisheries, Government of Orissa: Cuttack, India.

DFGO and CDA, eds. 2005. *Collection and estimation of fish, prawn and crab landings statistics in the Chilika Lagoon, Annual Report – 2003-04*. A collaborative programme of Department of Fisheries, Government of Orissa and Chilika Development Authority, Bhubaneswar, India.

Hobo, T. 1989. *Yomigaere Mizuumi* (in Japanese). Dou Zidai Sha, Japan.

Iwasaki, S. and R, Shaw. 2009. Human security and coping brackish environmental hazards in fishing communities of Songkhla Lake, Thailand. *Asian Journal of Environment and Disaster Management* 1(1):65-78.

Iwasaki, S. and R, Shaw. 2010a. *Integrated lagoon fisheries management: resource dynamics and adaptation*, Emerald Publishers, Bradford, UK.

Iwasaki, S. and R. Shaw. 2010b. Coastal fishery management and community participation in Lake Saroma, Hokkaido, Japan. In *Communities and Coastal Zone Management*, eds. R. Shaw and R. R. Krishnamurthy, Singapore: Research Publishing Service.

Katsuki, K., K. Seto, R. Nomura, K. Maekawa, and B. Khim. 2009. Effect of human activity on Lake Saroma (Japan) during the past 150 years: Evidence by variation of diatom assemblages. *Estuarine, Coastal and Shelf Science* 81:215–224.

Kinenshi Henshuu Iinkai, ed. 1989. *Notori hatijunenn-shi* (in Japanese). Kinen Zigyo Kyousankai, Japan

Kinenshi Henshuu Iinkai, ed. 1987. *Kyoudo-shi Ubaranai* (in Japanese). Kaiki Kaikou Hatijunen Kinen Zigyo Kyousankai, Japan

Saromacho-shi Hensan Iinkai, ed. 1966. *Saromacho-shi* (in Japanese). Saroma Town, Saroma, Japan.

Yubetsucho-shi Hensan Iinkai, ed. 1965. Yubetsucho-shi. Yubetsu Town, Yubetsu, Japan.