SUSTAINABILITY OF COASTAL FISHERIES IN HIROSHIMA PREFECTURE, JAPAN: SCOPE OF COMMUNITY-BASED MANAGEMENT APPROACH TO ACHIEVE THE AIMS OF CURRENT JAPANESE COASTAL FISHERY POLICY

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ABSTRACT

Japan is considered as one of the most successful marine fishery co-management or CBFM regimes. However, in 2001 the Japanese government was obliged to introduce new measures in order to recover several species under overexploitation. One example is the Resource Recovery Plans (RRP) that in all Japan accounts 51 fisheries. This paper attempts to clarify the level of sustainability of coastal fisheries in Hiroshima prefecture, and identify main problems to achieve it by coordinating organizations such as: Area Fishery Coordinating Committees (AFCC), Fishery Cooperative Associations (FCAs) and Fishery Management Organizations (FMOs). To measure the sustainability of fisheries in Hiroshima prefecture, it was used some indicators described in the well known method RAPFISH. This technique is performed using an ordination of sets of attributes using multi-dimensional scaling analysis (MSD). Besides, we focused on the problems and challenges of the current coastal policy through a case study of Toyohama FCA. It is located in Toyoshima, an small island located in Kure city jurisdiction, Seto Inland Sea. In the dimension of ecological sustainability, some important commercial fisheries presented low scores mainly in migratory fisheries. This situation affects coastal fishers in Toyohama. Important problems mentioned by the fishers of Toyohama FCA to reach a appropriate level of exploitation of fish stocks were operation of bigger scale fishers in zones close to fishing grounds and changes of environmental conditions in the spawning grounds due to operation of other industries.

Keywords: Keywords: Japanese coastal fishery policy, Co-management, Community-based fishery management, sustainability, RAPFISH.

INTRODUCTION

Japan is considered as one of the most successful marine fishery co-management regime [1 ,2, 3]. As many coastal countries, Japanese policy has as overall objective to achieve the efficient and extensive development of fishery without overexploitation. To reach this goal, the Japanese government focuses in to establish a participatory approach to its policy, allowing the convergence of different visions of each economic unit and main actors involved in fishery operations. Literature is extensive to mention the benefits of participative approach to reach sustainability. This vision in the policy is termed by Makino and Matsuda in 2004 as “holistic fisheries coordination”.

Nevertheless, some important species’ landings have been decreasing. This situation affect mainly to coastal fishers that suffer the impact of reducing prices as well, due to the increasing imported products. Clear example is the fishery of “sawara”, Spanish mackerel (*Scomberomorus niphonius*) that almost collapsed in 1999, due to the overexploitation. The Japanese government amended the current fishery law creating the Basic Fishery Law and had to intervene and apply several measures under a recovery plan,

called Resource Recovery Plans (RRP) that in all Japan account 51 fisheries. Facing the deterioration of those fisheries the question is: If the system allow an effective coordination among users and participative approach why some fisheries collapse?

In this paper we will contribute to obtain a general appraisal of sustainability's level in coastal fisheries in Hiroshima prefecture mainly from its ecological dimension and to explore problems in the decision decision-making process among basic coordinating fisher's organizations in Japan that could affect an effective user's participation

RESEARCH BACKGROUND

Sustainability

The concept of sustainability has become prominent in almost all natural resource management situations. Its great application has important influence in resource utilization, conservation, biodiversity, and many other resource development and management issues. Most of sustainability definitions have been originated from the relationship between humans and natural resource systems system. Solow, 1991; states that the system is to said sustainable as long as the total capital of the system is equal or greater in every next generation [6].

Wimberly, 1993 give a more complete definition mentioning that "to be sustainable is to provide for food, fiber, an other natural and social resources needed for the survival of the group, such as national or international society, an economic sector, or residential category, and to provide in a manner that maintains the essential resources for present and future generations" [7]. In 1987, the Brundtland Report (World Commission on Environment and Development, WCED) expressed the necessity of "meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life. Sustainable development requires the promotion of values that encourage consumption standards that are within the bounds of the ecologically possible and to which all people may reasonable aspire at a minimum, sustainable development must not endanger the natural systems that support life on Earth: the atmosphere, the waters, the soil and living beings"[8]. WCED provides a wider view of sustainability, not only from the perspective to avoid reduction of natural capital, but also include the term of development.

Contribution of participatory approach to reach sustainability

In most fisheries in the world, management measures have evolved from input controls (closed seasons and areas, gear restrictions, days at sea) to output controls (quotas, individual trip limits) and controls on access rights to the fishery (licenses to fish or individual quota shares). The great deal of these measures is how they are originated. There is a large consensus that participatory approach is the most effective in implement them.

Participatory approach is a logical approach to solving resource management problems by partnership. Pinkerton (1989) referring about co-management has discussed a number of tasks that can more easily be accomplished by establishing well functioning participatory systems: (1) data gathering, (2) logistical decisions such as who can harvest and when, (3) allocation decisions, (4) protection of resource from environmental damage, (5) enforcement of regulations, (6) enhancement of long-term planning, and (7) more inclusive decision-making [9].

To reach sustainability is needed at least two aspects that participatory approach favors in the fishery management process: compliance to the rules and enforcement. To achieve these elements is needed another condition called regulatory legitimacy. Legitimacy can be defined as "a reservoir of loyalty on which leaders can draw, giving them the discretionary authority of loyalty they require to govern effectively" [10]. Legitimacy is however, dynamic, and depends over relationship between fishers and management authorities.

Legitimacy in fisheries is the acceptance by fishers of the applied regulations. If there is a correlation between legitimacy and compliance, fishers will create internal obligation for compliance. Jentoft, 1995; emphasizes that "the more directly involved the fishermen are in installing and enforcing the regulation, the more the regulation will be accepted as legitimate" [11].

One approach to the creation of regulatory legitimacy is to structure the management process around user participation in decision-making. Management processes are independent of particular tools, and are characterized by several attributes: their degree of performance, their structure of decision-making, their decision rules and their distribution of authority. A centralized approach at the planning stage probably will tend to have lower costs than a cooperative approach, as it is likely to take less time to reach decisions. However, implementation, monitoring and enforcement of the program might be more costly because users who were not involved in its design do not consider the regime legitimate. Conversely, if there is a lack of information to manage the fishery, the participatory approach might lead to lower transaction costs at the planning and implementation phase because fishermen can provide information on fishing patterns, catches and the status of the resource. Thus, information is crucial for fisheries management decision-making, and uncertainty in the decision-making process, could get the impression that both the outcome and the procedure is unfair.

Usually participatory approach, referring mainly in the case of co-management, is seen as fixed image of sharing power between State and community, neglecting that both ambits have different forms. By overemphasizing the formal aspect of such arrangement of power, it is possible ignore the functional side of the participation which should be understood as a continuous problem-solving process.

Decision making implies a process where actors make choices between diverse alternatives, whether this is done under considerable uncertainty or not, with different calculations of specific levels of risks, etc. Problem solving, on the other hand, has to do with the process of generating the very alternatives to be decided upon [12]. Problem solving tends to be a trial-and-error activity in which different lines of actions are tested and evaluated.

This approach to participation becomes important when we consider the behavior of ecosystems and how they respond to resource exploitation that usually is highly unpredictable. The uncertain scenario have implications for different styles of resource management, including participatory approach. Command-and-control kind of resource management does not match for ecological uncertainty. Instead, the adaptive management approach can be used, in which policies are treated as hypotheses and management as experiments from which managers can learn, so that uncertainty and surprises are accepted [13].Management processes can be improved by making them adaptable and flexible through the use of multiple perspectives and a broad range of ecological knowledge and understanding, including those of resource user communities. Such management systems tend to have capacity to adapt to change and are better able to deal with uncertainty and surprise [14,15].

Institutional context

Current Fishery Law was enacted in 1949 with important recent amendments. Under this law, marine fisheries are classified into three categories: (1) fishing rights for coastal fisheries (2) fishing licenses for offshore and distant water and, (3) free fisheries. At the same time, coastal fishing rights are classified in three types: (1) large scale set-net fishing right granted to individuals (2) demarcated fishing rights for aquaculture granted to FCAs or individuals and (3) common fishing rights (CFRs) granted exclusively to FCAs.

Five levels and scales of coordinating organization are instituted to facilitate the coordination among the different actors: Fishery policy council, Wide Area Fisheries Coordinating Committees (WFCC), Area Fishery Coordination Committee (AFCC), Local Fishery Cooperative Associations (FCAs).The smallest scale coordinating organizations are local FCAs. This organization constitutes a fundamental unit of government fisheries administration, and being the key organization in the implementation of official fisheries projects, an FCA belongs entirely to the local community of fishers [4]. FCAs establish several regulations such as gear restrictions, seasonal and/or areas closure, etc. besides FCAs defines the size and location of areas, and kind of fisheries allowed. Subsequently these set of regulations are compiled in a management plan that has to be approved by the prefecture office of Fishery Agency and the AFCC.

The AFCC is formed by nine elected fishers, four academics and two representatives from the government. Rights based on the Fishery Ground Plan and licenses based on the Prefecture Fishery Coordinating Regulations are granted by Prefectural governors, following recommendations or advice from the AFCC. The AFCC decides the allocation of fishing rights and licenses in areas within their jurisdiction. Also, the AFCC can restrict the attributions of fishing rights and licenses.

Wide Area Fisheries Coordinating Committees (WFCC) were established by an amendment of the Basic Fishery Law in 2001; these committees are composed of elected committee members from each AFCC and it has a higher level than that of prefectural jurisdiction. WFCC coordinate resource use and management of highly migratory species, and address Resource Recovery Plans. In all Seto Interior Sea exist only one WFCC that deal with the main species of this area. Presently, main purpose of Seto Interior sea WFCC is regarding to “Sawara” RRP.

The highest level coordinating organization is the Fishery Policy Council; this council constitutes the advisory body to the government with respect to national level fisheries coordination, design of national policy, etc.

In addition to these formal coordinating organizations, various management measures have been initiated by autonomous bodies of fishermen, called Fishery Management Organizations (FMOs) “gyogyo-kanri-soshiki”. FMOs are often formed by a group of fishers within an FCA called “bunkai”. Several “bunkai” may form a FMO. Sometimes a FMO may gather fishers from various neighboring FCAs or even from FCAs of several prefectures.

FMOs are key elements to the establishment of community-based fishery management, known in Japan as “shingen kanri-gata Gyogyo” or Resource management type fishery. CBFM is enforced through amendments of the “Marine Fisheries Resource Development Promotion Law of 1971” in 1990, establishing the “Resource Management Agreement System”. This system encouraged autonomous agreements among fishers for the purpose of conducting resource management. When agreement prevails

at a certain level within the area, the government can affirm the agreement, and it becomes and official rule. It constitutes an official support system autonomous resource management by fishers.

In 2001, the "Basic Law on Fishery Policy" was enacted in order to adjust the Japanese policy to international agreements and domestic challenges. There are two basic principles in this law: (1) securing a stable supply of fishery products, and (2) sustainable development of fisheries.

METHODOLOGY

Sustainability analysis

In this research it was used multicriteria analysis following the general structure of the well known technique as RAPFISH. This technique is a multi-disciplinary rapid appraisal technique for evaluating the comparative sustainability of fisheries. RAPFISH allow us to obtain a general picture of sustainability for fisheries operated in Seto Inland Sea of Japan. This technique employs simple, easily-scored attributes to provide a rapid, cost-effective, and multi-disciplinary appraisal of the status of fishery, in terms of sustainability [16]. Ordinations of sets of attributes are performed using multi-dimensional scaling (MDS), a non-parametric method. Normally the ordination is performed in two dimensions. Ordinations are bounded by reference points that simulate the best and worst possible fisheries using extremes of all the attributes scores, and these hypothetical "good" and "bad" fisheries define the extremes and the orientations of the axis.

For ordination method a non-parametric multidimensional scaling (MDS) is employed. A squared Euclidaean distance matrix with attribute scores normalized using z-values is employed in an MDS for ratio data. It is used the SPSS.13 statistical package which implemented the ALSCAL algorithm for MDS to produce two dimensional ordinations. Goodness-of-fit is evaluated using stress value. To examine which attributes most influence an ordination, the sustainability axis may be taken as the dependent variable in a multiple regression with the normalized attributes as the independent variables. RAPFISH software is provided directly by the authors from the Fisheries Centre belonging to University of British Columbia's site: http://www.fisheries.ubc.ca/publications/reports/report12_2.php.

Although RAPFISH is analysis that include all dimensions of sustainability (ecological, economic, ethical, social and technological), the characteristics of the available data in Seto Inland Sea just allowed to apply it for ecological dimension. RAPFISH provide a useful and rapid snapshot about sustainability of the fisheries in a very interesting visual way. However, the definition of attributes does not match with reality of fisheries in Japan. Probably is needed to adjust the attributes to the reality of each country or find the exact attributes that combine critical aspects for sustainability, discrimination power and their viable scopes. In addition the attributes seem do not consider benthonic fisheries such as shellfish or seaweed collection.

In this research were considered 26 fisheries in Hiroshima Prefecture. The number of attributes considered was five (5) described in Table 1. Scoring system were defined according to secondary data provided by Natural Research Institute of Fisheries and Environment of Seto Inland Sea, Japanese Fisheries Research Agency[17].

Table 1. List and definition of attributes used in the multicriteria analysis, and showing "Good" and "Bad" scores

Attribute	Scoring	Good	Bad	Description
Exploitation status	0,1,2,3,	0	3	Under (0); fully (1), heavily (2); over-exploited (3)
Recruitment	0,1,2	0	2	Recruitment stable (0); recruitment unstable (1); recruitment overfishing (2)
Level catch	0,1,2	2	0	Catch level were divided into 3 groups by the ratio between average period 1992-2004 and 1983-1992: low (<0.7)=0; medium (0.7-1.3) = 1; high (>1.3) = 2
Trend	0,1,2,3	3	0	Decreasing (0), unstable (1), stable (2) and increasing (3)
Migratory range	0,1,2	0	2	No. jurisdiction of mobility: 1-2 (0); 3-4 (1); >4 (2)

Decision-making and problem solving process

For the analysis of the decision-making and problem solving was set a simple comparison of factual situation in a study case in Hiroshima Prefecture, following the usual steps in the decision-making process. Problem solving is a process in which we perceive and resolve a gap between a present situation and a desired goal, with the path to the goal blocked by known or unknown obstacles. In general, the situation is one not previously encountered, or where at least a specific solution from past experiences is not known. In contrast, decision making is a selection process where one of two or more possible solutions is chosen to reach a desired goal. The steps in both problem solving and decision making are quite similar. In fact, the terms are sometimes used interchangeably [18].

Huitt in 1999 mentions that most models of problem solving and decision making include at least four phases: (1) an Input phase in which a problem is identified 2) a Processing phase in which possible alternatives are evaluated and a solution is chosen; 3) an Output phase that involves the planning to set the solution and 4) a Review phase in which the solution is evaluated and modifications are made, if necessary.

FINDINGS AND DISCUSSION

Rapid appraisal of sustainability in Hiroshima Prefecture

The table 2 shows the attributes' scores in each fishery of Hiroshima Prefecture. Spanish mackerel "Sawara", Tiger Puffer "Torafugu" (*Takifugu rubripes*) and clams "asari" are the fisheries under over-exploitation.

Table 2. Scoring for the attributes of each fishery in Hiroshima Prefecture

Attributes : Hiroshima Fisheries	exploitation status	recruitment	Level catch	Trend	migratory range
Japanese anchovy	2	2	1	3	2
Japanese Jack-Mackerel	1	0	2	2	2
Bastard halibut	1	1	0	1	0
Ridge-eye-flounder	2	1	2	2	0
Largehead hairtail	2	1	0	0	1
Red seabream	1	1	1	2	0
Black porgy	0	0	1	2	0
Spanish mackerel	3	2	0	1	2
Flathead mullet	0	0	0	1	0
Japanese seaperch	0	0	2	2	0
Ma-anago eel	2	1	1	2	0
Common Rockfish	1	0	0	0	0
Rockfish	1	0	1	1	0
JapaneseHalfbeak	0	0	2	2	1
Kyusen	1	0	0	1	0
Tiger Puffer	3	0	0	1	0
Ainame	1	0	0	1	0
Kuruma Prawn	2	0	0	1	0
Blue crab	2	0	2	2	0
"Kou" squid	2	0	2	2	0
Octopus	1	0	1	2	0
Sea cucumber	2	0	1	2	0
Squilla (mantis)	2	0	0	1	0
Turban shells	2	0	1	1	0
Clams	3	0	0	1	0
"Wakame" (seaweed)	2	0	0	1	0

Exploitation status: defined by expert opinion from Seto Interior Sea Research Institute

Figure 1 shows the ecological RAPFISH ordination for fisheries of Hiroshima Prefecture. “Sawara”, “Tachiuo”, Japanses anchovy “katakuchi-iwashi” (*Engraulis japonicus*), Halibut “Hirame” (*Paralichthys olivaceus*), Tiger Puffer and Clams “asari” are plotted as lowest ordination position of fisheries on the sustainability axis. Majority of fisheries are plotted close to “Good” on the sustainability axis. Distances in the vertical dimension of the ordination plot are interpreted as differences between fisheries that are not related to the sustainability axis.

“Sawara”, “Tachiuo” and “Katakuchi-iwashi” are easy to understand their position, due to their condition of highly mobile species. However, we find opposed cases such as clams and “hirame” that they should be plotted closer to “Good” sustainability due to they are normally under CFRs.

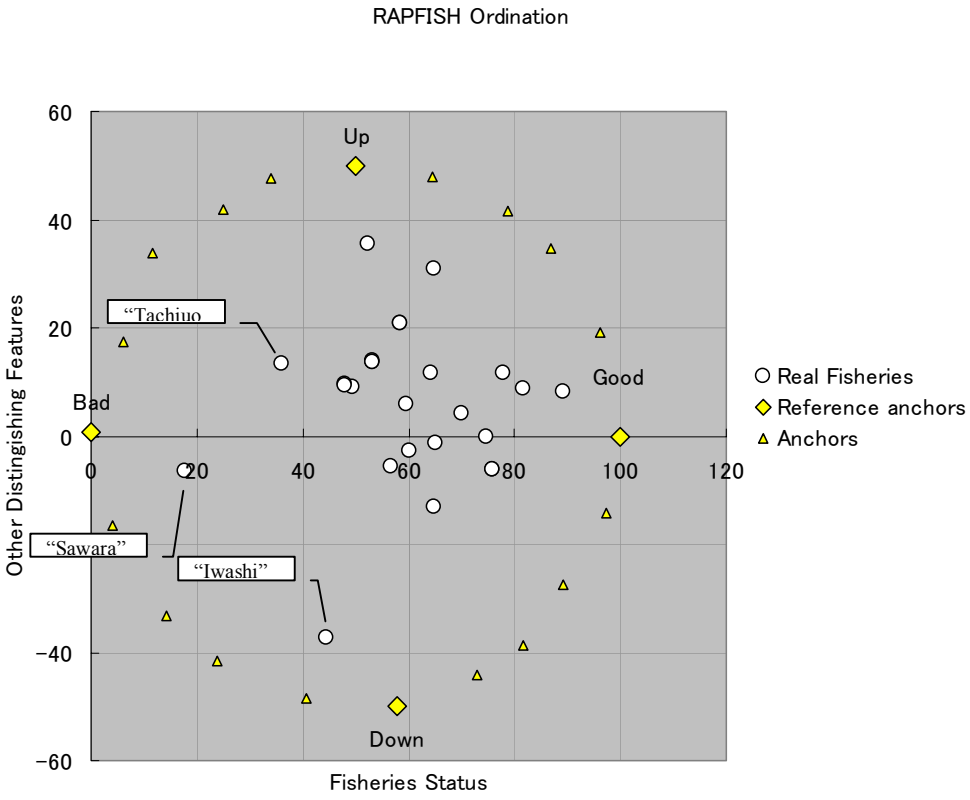

Figure 1. Ecological Rapfish ordination for fisheries of Hiroshima Prefecture.

Stress value was 0.23, considered acceptable by RAPFISH authors.

Decision making/ problem solving process

The study area is located in the island of Toyoshima, situated in Seto interior sea of Japan, at Hiroshima prefecture under the jurisdiction of Kure city (Figure 2). The place has a population of 2,009 people according to a census 2004. From this number around 59% is active population, in which 32% are related to fisheries activities. Majority of fishers, around 68% are ranged over 60 years old, confirming the trend of increasing aging in fishing villages in Japan. Tachiuo (Largehead Hairtail, *Trichiurus lepturus*) is the main specie landed in Toyohama. This specie constituted 75% of total landings of the FCA and 58% of total landings of "Tachiuo" in Hiroshima prefecture. Fishing units are constituted by family base. For fishing "Tachiuo" is used pole and line ("Hippon-tsuri"). Most of the fishers catch "Tachiuo" under the jurisdictional waters of Hiroshima, however there is an important number of them that operates also in in the vicinity of Oita Prefecture, Kyushu Island. This situation constitutes an uncommon practice in compares to majority of fishers in Japan.

Hiroshima Area, Japan

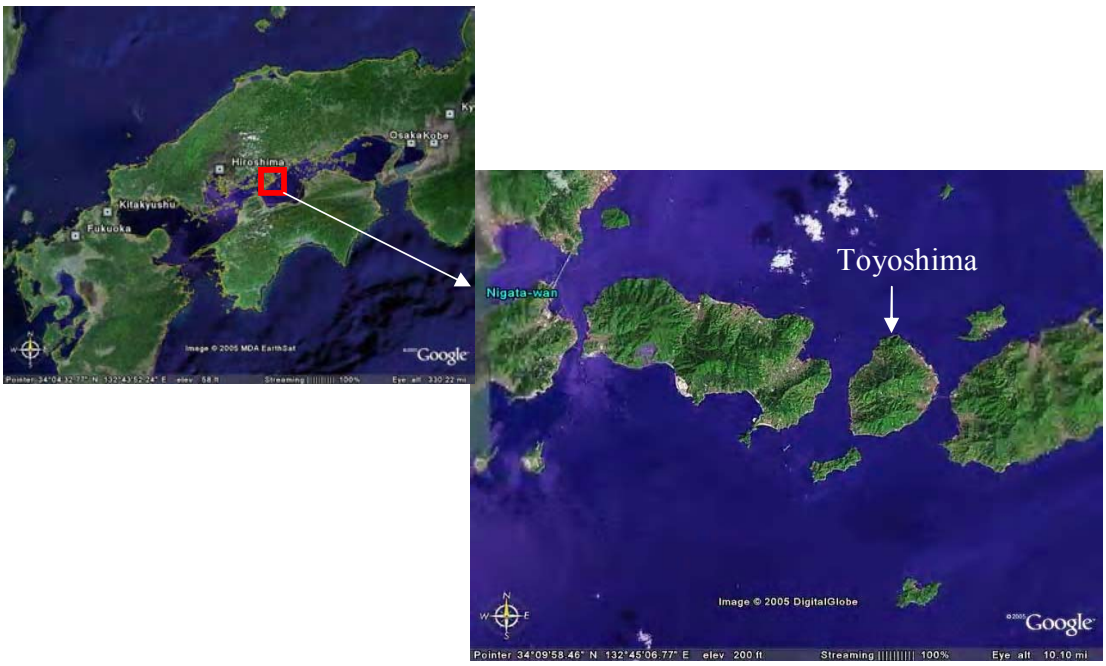

Figure 2. Map of the area of Hiroshima and Toyoshima Island

The name of the local FCA is Toyohama FCA with 130 members. Common Fisheries Rights as is shown in the figure 3, are granted for in the vicinity of Toyoshima Island and Oozakishimo-jima Island. Main specie captured in the fishing ground is "Madai" seabream (*Pagrus major*)

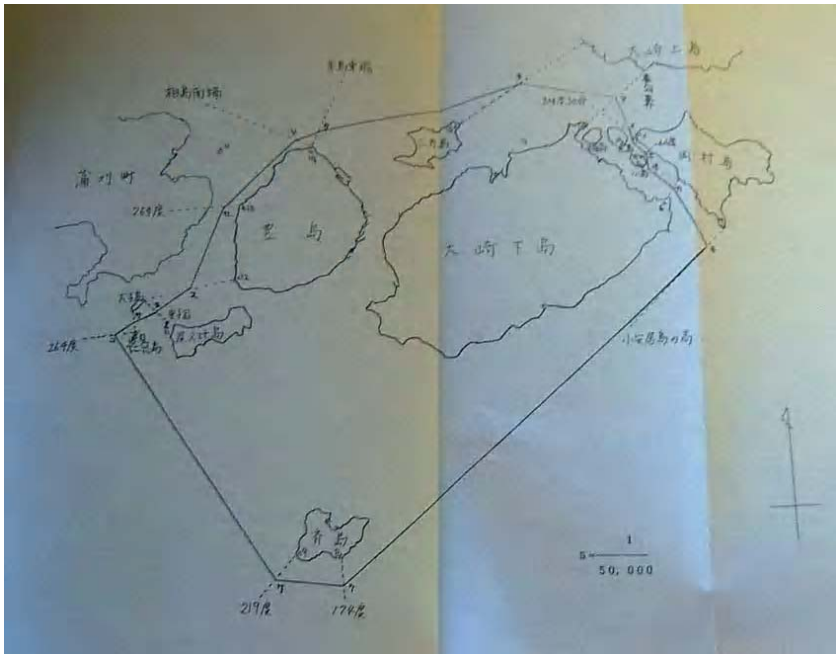

Figure 3. Map of the Common Fishery Rights area for Toyohama FCA

In base on Huitt's phases mentioned previously, Toyohama FCA shows the following aspects related the participative decision-making process:

Input phase: Present main problems are centered in the declining of "Tachiuo" and decreasing trend in its prices. These complain are addressed directly to the Prefectural officers through the President of the FCA. However, rarely the situation of one FCA is discussed in upper level of coordination meetings unless the problem is a common situation for several FCAs. In the case of Hiroshima, "Tachiuo" is not a priority in terms of management although its captures correspond to 3rd. in the landings' rank. AFCC presently discuss about "sawara" and possible conflicts or issues that deal with other Prefectures. The ecological conditions of the species are monitored by the Seto Interior Sea Research institute and they proposed several measures to the Prefecture office in order to alleviate overexploitation of the resources.

Processing phase: Management measures proposed by the Seto Research Institute and Prefecture are discussed with the fishers in special meetings in order to inform and discuss possible modifications. The special meetings are set in several areas in order to involve the totality of FCAs in Hiroshima Prefecture. The participation of fishers is limited to FCAs directors' board. Many times there is disagreement among fishers about definitions and scopes of the measures. In the case of Toyohama FCA, members have few chances to propose solutions and influence in "Tachiuo" management because it is not a main concern for the Prefecture. However, FCA remains as main decision makers on management in the CFR.

Output phase: Most of the FCAs do not participate actively in control or monitoring of fulfillment of management measures in external waters of CFR, although in Japan there is high compliance. For

example, in Hiroshima Prefecture the government's officer control on field the right size of nets, sometimes accompanied by the President of the FCA. However, inside of the CFR the FCA place several measures that enforce the measures set by the Prefecture.

Review Phase: The evaluation is made mainly by the Prefectural office and Seto Research Institute. Results are discussed in meetings with the fishers or in the normal coordination meetings.

CONCLUSIONS

Although majority of the species have shown good scores in sustainability, some of the main commercial fisheries have revealed different results. There are different causes that may explain this condition but finally we face the old problem of migratory species are difficult to manage because of their condition of open resources. One clear example is "sawara" that its high demand and technological changes at beginning of 90's generated overexploitation that finished with the collapse of the fishery in 1999. The same situation occurs for "Tachiuo" main fishery of Toyohama FCA. "Tachiuo" is not a priority in Hiroshima Prefecture but is one of the main issues of concern among prefectures in Kyushu Island and Yamaguchi. A clear conclusion from sustainability analysis is that the actual participative model, co-management or community-based co-management in Japan do not avoid the "tragedy of the commons" among fisheries in which there are no property rights.

Another conclusion that we can make is about the low level of fisher's participation on decision-making process in fisheries out of CFRs. At this level, participation of fishers in the decision-making process is merely consultative with few opportunities to share their problems and contribute for solutions. In Toyohama FCA there is no regular contact between President and other members. Mostly of the activities of the FCA are oriented to carry out formalities related to the CFR and administrate other functions of the FCA. Though, fisher remains as main decision makers under the context of CFR is important to pay attention that some fishing communities are strongly dependent of fisheries out of CFRs as the case of Toyohama FCA..

As we mentioned an over-emphasizing of the structure of co-management may not contribute to the goals that fishery policy is pursuing. Considering the always changeably fisheries condition is better to strength other approach that consider a more flexible and dynamic approach such an adaptive model promoted by several scholars.

REFERENCES

[1] Makino, Mitsutaku and Hiroyuki Matsuda. 2005.Co-management in Japanese coastal fisheries: institutional features and transaction costs. *Marine Policy* (29), 6, pp. 237-242

[2] Schmidt, C. 2003. Fisheries and Japan: A case of multiple roles? *International Symposium on Multiple Roles and Functions of Fisheries and Fishing Communities*; Aomori, Japan. 19 pp.

[3] Lim, C., Matsuda, Y. and Shigemi, Y. 1995. Co-Management in Marine Fisheries: The Japanese Experience. Coastal management, 23, pp. 195 – 221.

[4]Ruddle, Keneth. 1992. Adminitration and conflict Management in Japanese coastal fisheries. *FAO, Rome, 1992*. National Museum of Ethnology, Osaka; Japan.

[5] Yamamoto, Tadashi. 2000. Collective Fishery Management Developed in Japan- Why Community-Based Fishery Management has been well developed in Japan. *IIFET 2000 Proceedings.*

[6] Solow, Robert. 1991. Sustainability: an economist7s perspective. *Marine Policy Center*, WHOI, Woods Hole, Massachusetts, USA.
[7]Wimberly, Ronald. 1993. Policy perspectives on social, agricultural and rural sustainability. *Rural Sociology*, pp.1- 29.
[8] WCED, 1987. Our Common Future. World Conference on Envrionment and Development. *Oxford: Oxford University Press*; 400pp.
[9] Pinkerton, Evelyn. 1989. Cooperative management of Local Fisheries, New Directions for Improved, Management and Community Development. *University of British Columbia Press*, Vancover.
[10] Nielsen, Jesper R.2003.Anaalytical framework for studying: compliance and legitimacy in fisheries. *Marine Policy*, 27, pp. 425 – 432
[11] Jentoft, Svein and Bonny McCay. 1995. User participation in fisheries management. Lessons drawn from international experiences. Marine Policy (19), No.3, pp. 227 - 246
[12] Carlsson, Lars and Fikret Berkes. 2005, Co-management: concepts and methodological implications. *Journal of Environmental Management* 75: 65 – 76.
[13] Holling, C. S., and Meffe, Eric.1996. Command and control and the pathology of natural resource management. *Conservation Biology* 10, pp. 328 - 337
[14]Berkes, Fikret and Carl Folke, 1998. Linking social and ecological systems, management practices and social mechanisms for building resilience. *Cambridge University Press*, Cambridge.
[15] Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C.S., Walker, B., et al., 2002. Resilience and sustainable development; building adaptive capacity in a world of transformations、*International Council for Science, ICSU Series on Science for Sustainable Development* No3.
[16] Pitcher, Tony and David Preikshot. 2001. RAPFISH: a rapad appraisal technique to evaluate the sustainability status of fisheries. *Fisheries Research* 49, pp. 255 - 270
[17] Nagai, Tatsuki and Yasuki Ogawa. 1997. Fisheries Production. *Sustainable Development in the Seto Inland Sea, Japan_From the viewpoint of fisheries*, Eds. T. Okaichi and T. Yanagi, Terra Scientific Publishing Company (TERRAPUB), Tokyo, pp. 61- 94
[18] Huitt, William. 1992. Problem solving and decision making: Consideration of individual differences using the Myers-Briggs Type Indicator. *Journal of Psychological Type*, 24, pp. 33-44.