Systematizing Local Knowledge using GIS: Fisheries Management in Bang Saphan Bay, Thailand

by

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Abstract

Although local knowledge is a crucial source of information for fishery development, its generally unsystematic presentation and nebulous content makes use by policy makers or managers difficult. Based on field data obtained using Participatory Rural Appraisal (PRA) at Bang Saphan Bay, Prachuap Khiri Khan Province, Thailand, we attempt to show here how local knowledge can be effectively systematized, analyzed and displayed visually using a Geographical Information System (GIS) for use in fisheries management. PRA data on location fished, time of fishing, techniques and technology used and species targeted was obtained from local fishers then mapped using Arcview (3.1). In this way local fisheries knowledge can be converted into geo-spatial data form via GIS, and the succinct results used easily to guide fishery management and planning, especially by offering directions for rights-based fisheries and co-management.

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1. INTRODUCTION

Local or traditional knowledge is now recognized as a crucial source of information in rural and agricultural development [1, 2] including fishery development activities. Charles [3] states that "... it seems clear that one of the significant contributors to fishery collapse is the combination of (a) a lack of knowledge in some cases, and (b) a failure to use all available sources of information and knowledge in other cases". He also observes that there is increasing recognition that fishers have a base of useful knowledge, which is continually updated through their direct experience at sea, and that their support for fisheries management is enhanced if fishers are involved in discussion with their information available. Ruddle [4] also notes that taxonomies alone will not suffice to predict how, when and where a group of fishers will behave, local ways of thinking may not be fully understood without a parallel understanding of fishers' routine behavior patterns. Thus, understanding the relationships between cognition and local knowledge about fishers' behavior and its reflection in fishing activities is essential for sound fisheries management. Many scholars have described how local ecological knowledge is used by local people in fisheries management [5, 6] and many believe that it should be used more [7, 8] particularly in the context of co-management. Other researchers found that fishers' data contributes to management by 1) providing additional indices for use in stock assessment and scientific debates; 2) providing data on responses by fishers to management measures and on the status of poorly understood species; 3) suggesting novel hypotheses; and 4) enhancing long-term legitimacy of the management regime [9]. Pinkerton [10] stated that fishers who do not trust the data that management decisions are based on do not cooperate and may even develop opposing or confrontational postures.

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Charles [3] also mentions that although resource users in fishery systems have accumulated a large store of traditional ecology knowledge (TEK), in most cases there has been little effort to involve these users in determining research priorities or in the research activity itself. Almost everywhere fishery research takes place in government institutions and universities. Charles [3] suggests TEK must be incorporated into and nurtured by fishery science and management. Resource users and coastal communities can encapsulate great wisdom about what resource management arrangements function best within their cultural and belief systems, about workable approaches to improving compliance among marine resource users, and about which fishing techniques are most effective or most conservative within local contexts.

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In general, local knowledge has influenced the development process at the community level, especially in extension program planning. It becomes necessary for the planning of community development and effective extension services to learn about and understand the local situation through attaining local knowledge. On the other hand, local knowledge can also demonstrate the capacity of local people and their organization, as well as other information resources available in the community [1,2].

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The importance of local knowledge seems to decrease in development work at higher levels. Scientific knowledge and statistical data, collected and interpreted by scientists or statisticians, still plays a crucial role in policy formulation and development planning at national levels. In general, fisheries policy formulation, establishment of fishery laws/regulations, and management planning at the national level are usually based on biological and statistical data, and do not involve local knowledge. This leads to the problem of too great a generalization in fisheries policy making and management planning, such that

objectives cannot eventually be achieved. But for reasons that are not hard to fathom, it unrealistic to expect fisheries policy makers or managers to make use of local knowledge as it is generally presented, because usually it is not systematically set out and its content is often too vague for them to access and use easily. In general, as things stand at present it is more practical and seems easier for fisheries policy makers and managers to ignore local knowledge and base their decisions solely on scientific knowledge and statistical data, which are already prepared and easy to access to support their decision-making. [

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However, that situation is not good, and ought to be changed soon. In this article we present the results of field research aimed at systematizing local knowledge, then presenting it visually in the form of computer-generated maps and demonstrating how it may be used in fisheries management. If such an approach can be further refined, in addition to its usefulness in fishery management planning at the community level it could be reflected in the formulation of fisheries policy and legislation, and in planning fishery management at higher levels. The results could be used to assist both parties. They can help local fishers in presenting a clearer picture of what they are doing and thinking in their fishing activities. At the same time they can assist policy makers/decision makers in fisheries management to easily access local knowledge and to understand the situations that exist in the local communities. Systemized local knowledge will also provide crucial information to guide further in-depth research studies and training programs.

2. MATERIALS AND METHODS

2.1 Description of Study Site

The Bang Saphan Bay pilot project, located in Prachuap Khiri Khan Province, Thailand, was implemented by the Department of Fisheries (DOF) to test the rights-based approach to

Community Based Fisheries Management (CBFM). This is the only project that was given demarcated coastal waters. They comprise about 150,000 rai[1] or 240 km^2 in the coastal waters of the Gulf of Thailand. The project area covers two Tambons (Sub-districts) of Bang Saphan District and three Tambons of Bang Saphan Noi District (Table 3). Bang Saphan Bay is separated from the outside by a cape called Mae Ramphung hill, at the northern end, and by Bang Berd hill, in the south. The distance between these two points is about 23 km or 13 nautical miles. There are three small islands within the bay: Sing, Sung and Thalu islands. The bay opens toward the Gulf of Thailand. The slope of the sea bottom is generally not steep, except on the offshore side of the capes and islands. The water depth in the center of the bay is around 10 m.

This CBFM pilot project was developed from the Coastal Small-scale Fisheries Development Project (CSFD) which was implemented by the DOF several years ago throughout Thailand. The aim of the CSFD project was to assist small-scale fishers to improve their fishing conditions by providing such infrastructure as piers, gear storage facilities, maintenance buildings, wave breakers, rainwater tanks, boat hauling winches, and artificial reefs. The project also included establishing fishing or aquaculture revolving fund groups and the release of juveniles into the coastal fishing grounds.

However, as long as conflict over the use of fisheries resources continued between commercial and small-scale fishers, support through infrastructure and finance alone would not be enough to solve the real problems of the small-scale fishers. The conflict made it difficult for the small-scale fishers in the bay to conduct their fishing activities. So in 1999 this CBFM pilot project was formulated to deal with the conflict. It now offers a good case

[1] one rai equal 1,600 m^2.

study for understanding the problems mentioned above and the attempts by both the local fishers and the DOF to solve them.

There are about 400 fishing households in the pilot project area. About 68 % are considered those of small-scale fishers, 19 % are middle scale, and 3.6 % are semi-large scale fishers. In general, the small-scale fishers are those who use boats without engines or with long-tail or mid-engines up to 85 hp. Their fishing grounds are mostly within the project demarcated area[2]. Fishing labor is provided by one to three persons, mostly family members or relatives. They use two or three types of fishing gear in the course of the year, depending on the fishing season. The fishing gears used are several kinds of gill net, hook and line, squid jigging, scoop nets, anchovy and squid casting nets - all small enough for boats driven by long tail outboard motors - squid and fish traps, and diving for sea cucumber and seashell. Middle-scale fishermen use mid-engines of 85 to 165 hp, with a labor force of 4 to 5 persons, including the boat owner. The laborers are family members or people hired in the village. Fishing gears used are anchovy and squid casting nets of larger-size, and deep-sea swimming crab gill nets. The semi-large scale fishermen are using larger engines of 165 to 300 hp. Their fishing labor comes mostly from outside the village and most laborers are Myanmarese[3]. The fishing gears employed in this class are daytime Anchovy Purse Seines and Purse Seines (Table 4).

[2] The area of the project site demarcated by the provincial ordinance in 19 October 1999:
1. Latitude 11 °11 '48", Longitude 99°34'48" (NW point) 2. Latitude 11 °11 '48", Longitude 99°36'40" (NE point)
3. Latitude 10°58'30", Longitude 99°36'40" (SE point) 4. Latitude 10°58'30", Longitude 99°30'40" (SW point)
Distance is around 6 nautical miles between the SE and SW points, and is around 13 nautical miles between the NE and SE points.

[3] Myanmarese fishing labor can be found in most of the commercial fishing operations in Thailand. Because of a lack of Thai labors in the fishing sector, Myanmarese labor has become popular. In Bang Saphan Bay their wages are about 10% - 30% less than Thai laborers. Work permits are required for legal employment.

There are two types of local organization in the project area that function relative to fishers and fishing activities. Fisher groups are one. These are considered an informal group, but are closest to the fishers. There are nine fisher groups broadly corresponding to fishing villages at the project site. These groups were established during the period 1992-1999 (Table 3). Some are very active in organizing fisheries development programs. However, all groups maintain a revolving fund to assist in purchasing fishing gears. The second local organization is Tambon Administrative Organization (TAO). According to the geographical area, Bang Saphan Bay is under the responsibility of five TAOs (Table 3).

2.2 Materials and Methods

As resource users with several years' experience (some have more than 50 years fishing experience), professional fishers are recognized as the persons who know best about certain aspects of fishery resources. In this study it was decided to use the local knowledge of fishers in the area of the Bang Saphan Bay pilot project, which reflects their fishing behavior in the bay and its vicinity. Using Participatory Rural Appraisal (PRA) as an interactive data collection method, the fishers were asked about where, when and how they fish with different types of fishing gear, and the kinds of species they catch. The method comprised group discussions, semi-structured interviews, and resource mapping. Household surveys were also conducted to provide supporting statistical data.

The local fishers' knowledge collected through PRA was systemized into a Geographical Information System (GIS). A packed software, Arcview (3.1), was selected as the tool to present this local knowledge, Its use showed that the local fishers' knowledge of their fishing practices can be presented clearly by converting the data to geo-spatial form in a GIS. The knowledge base covers areas where they find resource species, location of the fishing areas

Comment: Most of GIS software, (like mapinfo, diva-gis, grass) can show original database. It is not a feature of arcview.

used by different type of fishing gear and the overlapping use of resource by fishers from different villages. It also pinpoints fishing operations that violate the current fishery law. The research was conducted using first PRA and then GIS, as described below.

2.2.1 Participatory Rural Appraisal (PRA): Interactive Data Collection

PRA was selected as the main tool in data collection for this study. It is an interactive data collection method that allows fishers and researchers to build a harmonious working relationship and trust. It also allows fishers to present and discuss their ideas among themselves before answering researchers' questions. This generates a sort of agreement or unity among fishers regarding their answers.

Preparation of resource maps by the local fishers was one of several elements of this PRA process. In this study resource mapping was found effective for community members to identify, locate and classify resource occurrence, distribution, use, tenure and access, and also to reveal the significance the participants attach to themj Locations of critical fishing areas, including such areas known for illegal fishing, can be identified and mapped [11] in this way. Usually, however, resource maps drawn by local people are limited in terms of accuracy of position and scale. This makes them difficult to use in follow-up activities. Learning from past experience, in this study we tried to minimize that limitation, because the resource map is intended not only for understanding the local situations of fishing communities in the bay, but also to make a map useful for future management plans in the project area. For this purpose, an official topographical map of enlarged scale with clear landmarks (fisher villages, estuaries, river mouths, project offices, and bridges, among other things), including coastal features (islands, artificial reefs), and water depth was prepared for use as a base map for discussions with the fishers.

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The PRA was carried-out in Bang Saphan Bay from April to June 2002. Group discussions were conducted in 9 fishing villages of the site at the beginning of the study, to acquire information on fishing activities and the social and economic status of the communities. More than 100 fishers, including fishers' leaders, wives, fish agents, aquaculture farmers, and owners of tourist businesses, participated in the group discussions. In some villages discussions were conducted twice because of the different working schedules the fishers who used different types of fishing gear. Each group was always asked "where, when, which species, and how they fish". Their answers were mostly given in detail; which species are caught in which area with which fishing gear. They also provided information on the depth ranges of seawater and some of the landmarks like islands, villages, estuaries or mountains, that they use identify by visual triangulation their fishing areas. To provide more accurate information as a supplement to their verbal responses, the participants also drew the location of the areas on an enlarged bathymetric map that we provided. The information was collected as shown in Table 2. Apart from discussions on the fishing ground information, the fishers were also provided with information on the fishery regulations that apply in the project area, and their opinions were discussed and noted. Information on relevant local institutions and their functions were also collected during this activity.

2.2.2 Putting Local Knowledge into GIS

GIS are "computer-assisted systems that can input, retrieve, analyze and display geographically referenced information useful for decision-making" [12]. The GIS technique is widely considered as a tool for fisheries management, but largely based on the use of remotely sensed data. There are several constraints to the use of such data, related mainly to the dynamics of the coastal context and the mobility of the key resources. In this study we

used the GIS technique but replaced remotely sensed data with proximally sensed data in the form of local fishers' knowledge (Figures 2 and 3).

To make a bathymetric map of the project area, Thailand map No. 203 (Lang Suan to Prachuap Khiri Khan Natural Scale 1:240,000 at Lat. 10° N.) presenting landlines with its main features (villages, sub-district, estuaries, main hills, etc.) was scanned at 300 dots per inch in RGB mode. The map was converted into a 1 bit [black and white bitmap picture. Vector lines were generated on the map using Corel Trace 10 with a 1:240,000 scale setting, then exported to DXF, AutoCAD R.9 file format. Contour lines (isobath), boundaries of demarcated waters of the project area and the 3-km line were drawn by hand or taken by tracing contour lines in the bitmap image map and exported to DXF file. The project file was created in Arcview 3.1, which imports all the above files as basic map of the project area. The polygon tool in Arcview 3.1 was used to draw areas of fishing grounds by reference to contour lines. Each village's fishing grounds (Table 2) were independently drawn in the form of polygons (Figure 3), the vertices of which followed indications given by the results of the PRA. Each polygon was drawn as a separate theme.

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3. RESULTS OF THE STUDY

After putting the local knowledge on the GIS map, it was found that in addition to the information on where, when and how fishers are fishing, the knowledge yields much additional information of use for future fishery management plans of the project. The information is presented in the following sub-sections:

3.1. General Information of local condition.

Figure 5 and the attached database show the local specification of the Bang Saphan Bay pilot project area. First, it presents the project area of 240 km^2, which comprises nine villages under five Tambons. The detailed information of each village and Tambon is put in the form of a database. The Tambon database has the total population of each Tambon, while village databases show the data related to fishers and their activities, namely the numbers of fishers, types and number of fishing gear. Second, it also presents the two main sets of fishing regulations applied in the project area. (These are the 3-km fishery law and the project regulations [for details of the regulations see Figure 1]). Third, it presents information on sea depth at the project site and its vicinity, with attached data containing main species caught and fishing gear used.

3.2 Utilization of fishery resources:

Figures 6 and 7 provide examples of how GIS maps and attached databases present the utilization of fishery resources by local fishers. The map presents fishing grounds classified by type of fishing gear and by fisher groups or villages who use the fishing grounds. The attached database shows the fishing seasons, species caught and the number of fishers by the types of fishing gear used.

From all the GIS maps and databases attached, ^rs@-^rv^s^ri^»£&^w^^^t can be very suggestive for the formulation of future management plans. First, there are several distinct patterns in the use of the fishing grounds by fishers from the nine fisher groups who use similar fishing gears. In general, most fish in areas that differ little in depth, but are different in distance from their fishing villages, to the north and south (see Figures 6 and 7). This means that fishers conduct their operations where the resource is available, pursuing fish regardless of "village

boundaries". The distance to the fishing ground should not be too far from their homes, especially for the small-scale fishers who have a limited capacity to invest in fuel, boat size and engine power.

Second, the GIS maps (Figures 8 and 9) show that fishers in the project area fish outside the project boundaries. For instance, in Figure 8 crab gill net fishers of Bang Berd village fish in the area of Thum Thong Bay and Pak Klong Tambon, which is outside the project boundary in the south, while the squid casting net fishermen of Fai Tha village fish in the north outside the project boundary, show in Figure 9.

Third, Figures 10 and 11 show that the fishers from the Ban Kake and Fang Dang groups using anchovy casting nets violate the 3-km fishery law. The regulations do not allow the use of this fishing gear within 3 km from the shoreline, but both groups encroach on this limit.

DISCUSSIONS AND RECOMMENDATIONS

Analysis and Suggestions for Coastal Fishery Management Plans

In Thailand, fishery resources are considered as common pool resource (CPR) under an open access regime. In the ASEAN countries, *rights-based fisheries management* and *co-management* between government and local fishers are regarded as innovative approaches for managing the coastal fisheries resources [13]. But they are expected to encourage effective management of fisheries through the delegation of selected management functions to local levels and by enabling people to recognize the need to progressively replace *"open access"* to fisheries resources with *"limited access"* regimes through the introduction of rights-based fisheries. These approaches may also facilitate the reduction of effort and encourage the use of responsible fishing gear and practices.

1. Rights-based management

Designing boundaries of resources areas and identifying resource users is one of the principles for a long-term management of CPR [14]. The *use and management rights,* who manages what and who utilizes what to what extent, will be limited within the boundaries. When measures are put in place to manage the CPR resources that have been used under an open access regime, someone will lose and someone will gain in the short-term. The designed boundaries might succeed or fail; one key factor is that fishers who normally benefit from the fishery resources before the boundaries are delineated may feel that the new regulations within the boundaries will reduce their long-term benefit from the resources. To avoid possible conflict an understanding of local conditions is necessary. This may be done through a consultation process with local people that can help them to build their understanding and compliance with the new regulations.

The use of Local knowledge-based GIS in the study area highlights three issues related to such demarcation of those boundaries. These are described in the following sub-sections.

1.1 Overlapping of village fishing grounds

Around 1995 the DOF tried to promote a fishing right system in coastal fisheries, based on the following definition: *"The fishing right is a kind of a property right, by which fishermen will have exclusive rights to use the sea areas and resources, which have been specified in each fishing right. In this system, a Territorial Use Right in Fishery will be granted to a fishermen's group based upon a legal framework (law) established by the government. Within the Fishing Right System, fishermen themselves may create their own fisheries management systems, which should result in the conservation of fishery resources as well as an improvement to their income and living conditions* [15]. It was planned to introduce the

system through a project called "Pramong Na Ban", or "fishing in front of the village". But because the definition criteria of the use rights boundaries were not clearly explained, many fishing communities rejected the innovation. Most understood that their fishing grounds would be limited only to areas in front of their villages, as the project name suggested. The fishers could not accept that idea, so the opposition of many scuttled the project.

From the local specification of Bang Saphan Bay, one key piece of information for designing the fishery resource boundaries found is the existing fishing grounds used by local fishers. From findings on *the overlapping of the fishing grounds* by fishers from different villages who use similar types of fishing gear, the boundaries for *resource use rights* cannot be set in just one small area, for example, in front of each fisher community. So it is not necessary to design one fishing boundary for one village. Several villages can share fishery resources if the total fishing capacity does not exceed the estimated renewable capacity of the resources[4], or at least so that fishers can still derive a profit from their catch. In the case of Bang Saphan Bay, the boundary for the resource area can be the same as the present area demarcated by the project. It should not be divided into smaller areas for each fishing village, as such a division would cause great conflict over the fishing grounds among the nine villages.

1.2 Fishing outside the boundaries

At present local fishers in the bay fish both inside the project area and outside the boundaries. At the same time, outside fishers operate in the project area. There is no limitation of the fishing effort!. All fishers just follow the fishery regulations that are applied to the project area.

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At the beginning of the data collection process, most project fishers in the group discussion proposed that the *"use rights"* inside the project boundary should be exclusive to the fishers

from communities in the project site. But after their fishing grounds were drawn on the map, they realized that many of them are fishing outside the project area. So they quickly realized that if they do not allow outsiders to fish inside the project boundaries, then they may not be allowed to go outside the project boundary to fish.

As a result of this data collection process most of the fishers interviewed changed their opinions on this issue, as can be confirmed by data from the household survey. The results of the survey show that about 94% of 144 project fishers were willing to allow outside fishers to fish within the project boundaries provided they follow the regulations to be set up by the local committee. About 70% of them said that the outsiders should pay a fishing fee and tax, and about 85% said they should contribute money to the management activities conducted by the local fishers. However, only 31.9% agreed to involve outsider fishers as the managers of the fishery resource in the project area. From this it may be concluded that most fishers in the project area suggest that the *"use rights"* over fishery resources inside the boundary could be shared with outsiders under some conditions of management, which should be designed with exclusive *"management rights"*, at the community level, by project fishers.

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1.3 Locally inappropriate standard regulations

Regarding the establishment of management measures and regulations, Ostrom [14] stated that "each target area needs different rules, because of different physical, cultural, economic systems and political relationships. Without setting different rules, appropriators or resource users could not take advantage of the positive features of the local resources". In the case of Thailand, most of the fishery regulations are applied throughout the coastal provinces, e.g., they specify that destructive fishing gears (trawlers, push nets, clam draggers) are not allowed

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[4] It should be noted that the allowable catch inside the boundary is another independent subject that needs further study

to operate within 3 km from the shoreline, and anchovy casting nets are not allowed to operate within 5.4 km from the shoreline of every coastal province. Because of its high economic value in the export market, small-size anchovy, called "Saimai fish"[5], encourages fishers to risk violating the fishery laws. Fishers in Bang Saphan Bay target Saimai fish in waters not more than 10 m deep, and the area of abundance is found at about 4-8 m in the areas less than 3 km from the shoreline. They feel that such regulations should consider the water depth rather than the distance from the shoreline. The management measures on this species are also not so clear to fishers, because, they say, on one hand the government allows the export of Saimai fish to other countries, but on the other they try to force local fishers not to catch it. Moreover, about 20% of the fishers interviewed do not believe that the Saimai fish are juvenile anchovy, as concluded by the researchers.

2. Co-management: Establishment of local management institutions

Pinkerton [16] states that "Complete co-management is based more on the collective rights of a group than on individual rights.. .resource uses are based fundamentally on the ability of the group with the rights to act in their collective interest. This means that the group exercising collective choice rights must have at least one *institutiort'*. Further, this means that, a local institution is an essential component in co-management process. To delegate fisheries management functions and authorities to any local communities, it is necessary for the government agencies to seek a formal or registered local organization to guarantee that their delegates follows the administrative regulations and formal procedures. Meanwhile fishers are seeking an institution that is properly representative and able to raise their concerns and interests. In most cases the local fishers' representative institutions are informal or non-registered organizations.

[5] *Saimai fish* (Thai name) is a juvenile of round body type anchovy: *Encrasicholina heteroloba.* It is about 1.5 - 2 cm in

Since 1997, the new Thai constitution has allowed local people to participate in natural resource management through local institutions. The TAO and its committee members comprise representatives of local people nominated through an election process and officers appointed by the government. It is recognized as such a local institution by most people. In some rural development perspectives, this institution has been delegated authority and budget from central government for developing their areas of responsibility. The budget has been spent mostly for infrastructure construction in the rural areas. However, from the aspect of natural resource management, there is still no clear scope of the authority of the TAO.

The advantage of the TAO is that it is considered as a formal and legitimate local organization under the administration law. Therefore some fishery social researchers have suggested that the TAO could be an option as a local institution, which could represent local fishermen and could be responsible for the delegated management functions and authority [17, 18, 19]. This suggestion can be reasonable when fishing is a major economic activity, or when fishers form the majority of the population in a particular Tambon or sub-district, because the issues concerning the fishery sector will not be neglected. In the Bang Saphan Bay project, if the TAO is selected as such a local institution, five TAOs would have to coordinate to manage the fishery resources within the bay. However the statistical data of Bang Saphan Bay shows that the fisher population is very small in each Tambon. For instance, in Mae Ramphung Tambon the number of fisher households is about 4.3% of the total, while in Phong Prasart Tambon it is about 1.4%, in Bang Saphan Tambon about 4.2%, in Pak Praek Tambon 4.4%, and in Sai Thong about 6.4%. Thus the fishers' problems and

length. After processing the price selling to middleman is about 100-150 baht/ kg. The export markets are Taiwan, Hong Kong and Japan.

needs would probably be relegated to just a minor issue in the TAO's deliberations (statistical data from [20])

In assessing the advantages and limitations of both local institutions, the TAOs and fisher groups in coastal fisheries management, it may be that the advantages of one institution can counterbalance the limitations of the other. Fisher groups are considered as the real representatives of the resource users who are crucial in raising the problems, management issues and solutions concerning the fishing sector. But mostly they are informal or non-legitimized institutions. In contrast, the TAO is considered as a legal local institution which represents the local people of each specific geographical area, but they may not be the representatives specifically of the fisher population. To establish local institutions for the co-management of coastal fisheries in Bang Saphan Bay, fisher groups and the TAOs need to act together as key players for coastal fisheries management functions at local levels. The linkage and working mechanism within nine fisher groups and five TAOs and between these two institutions should be established.

CONCLUDING REMARKS

Local knowledge presented through GIS maps can be used as fundamental information not only for fisheries management planning but also for future in-depth scientific research, especially for studies on fishing grounds for some specific species. Instead of random sampling by a research vessel, local knowledge can provide probable target areas that a research vessel can focus on. Fishers always seek out available fishery resources, so their information on the fishing grounds for each species is updated through everyday fishing activities. It is dynamic information that can change quickly, but such intervals may be still long enough to make the information usable for further research study and management

planning. To make it more useful, the GIS map should be updated when there is significant change in the local communities, but the local communities can do the updating for their own purposes. However, Pederson and Hall-Arber [21] caution that many fishers are reluctant to share their knowledge because it might be used against them. They also regard some information as proprietary. Therefore it is important for researchers to build up strong rapport with fishers. Once trust is established fishers will be willing to give the information about their fishing grounds and other aspects of their knowledge.

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Table and Figure Captions

Table 1. Fisher groups, fishing gear/ technique used and catch species in Bang Saphan Bay.

No.	Fishing Gear/ Method	Species	No. of fisher groups operating
1.	Squid Casting Net	Squid *(Loligo chinensis, L.duvauceli, L.edulis)*	9
2.	Anchovy Casting Net	Anchovy *(Encrasicholina heteroloba)*	9
3.	Anchovy Purse Seine	Anchovy *(Encrasicholina heteroloba)*	1
4.	Squid Trap	Cuttle fish *(Sepia pharaonis, Sepistenthis lessoniana)*	5
5.	Crab Gill Net	Blue Swimming Crab *(Portunus pelagicus)*	8
6.	Fish Gill net	Indo Pacific Mackerel *(Rastrelliger brachysoma)*	6
7.	Diving	Flag pen shell *(Atrina vexillum)* & Sea Cucumber *(Holothuria atra)*	3

Table 2. Information collected from PRA: fishing gears used, village names and the area of fishing operation.

1. Squid Cast Net

No.	Fishing Village	Fishing ground			Remark
		Depth	North	South	
1	Ao-yang	8-20 m.	Mae Ramphung Mt.	Phang Dang V.	
2	Fai Tha	4-15 m.	Ban Krood	Bang Berd V.	
3	Bang Saphan	8-40 m.	Mae Ramphung Mt.	Bang Saphan Noi V.	
4	Nong Samed	9-12 m.	Mae Ramphung Mt.	Thalu Island	
5	Bang Saphan Noi	14-28 m.	Nong Samed V.	Bang Berd V.	
6	Ban Kake	12-40 m.	Thalu Island	Bang Berd V.	
7	Chai Thalay	5-14 m.	Thalu Island	Bang Berd V.	
8	Fang Dang	7-20 m.	Mae Ramphung Mt.	Thum Thong Mt.	
9	Bang Berd	5-30 m.	Thalu Island	Thum Thong Mt.	

2. Anchovy Casting Net

No.	Fishing Village	Fishing ground			Remark
		Depth	North	South	
1	Ao-yang	7-14 m.	Mae Ramphung Mt.	Bang Berd V.	
2	Fai Tha	4-15 m.	Mae Ramphung Mt.	Bang Berd V.	
3	Bang Saphan	6-13 m.	Nong Samed V.	Bang Berd V.	
4	Nong Samed	6-12 m.	Thalu Island	Bang Berd V.	
5	Bang Saphan Noi	9-20 m.	Nong Samed V.	Bang Berd V.	
6	Ban Kake	5-9 m.	Mae Ramphung Mt.	Bang Berd V.	
7	Chai Thalay	6-12 m.	Thalu Island	Bang Berd V.	
8	Fang Dang	7-20 m.	Mae Ramphung Mt.	Thum Thong V.	
9	Bang Berd	3-15 m.	Thalu Island	Bang Berd V.	

3. Anchovy Purse Seine

No.	Fishing Village	Fishing ground			Remark
		Depth	North	South	

1	Nong Samed	6-12 m.	Thalu Island	Bang Berd V.	

4. Squid Trap

No.	Fishing Village	Fishing ground			Remark
		Depth	North	South	
1	Fai Tha	8-9m.	Mae Ramphung Mt.	Bang Berd V.	
2	Nong Samed	7-9 m.	Mae Ramphung Mt.	Bang Berd V.	boat engine < 50 hp.
		up to 40 m.	Ban Krood V.	Bang Berd V.	boat engine > 50 hp.
3	Bang Saphan Noi	10-20 m.	Mae Ramphung Mt.	Bang Berd V.	opened season (16 May – 14 February)
		30-45 m.	Mae Ramphung Mt.	Bang Berd V.	closed season (15 February – 15 May)
4	Fang Dang	8-20 m.	Mae Ramphung Mt.	Thalu Island	opened season (16 May – 14 February)
		20-40	Ban Krood V.	Thalu Island	closed season (15 February – 15 May)
5	Bang Berd	10-20 m.	Thalu Island	Thum Thong Mt.	opened season (16 May – 14 February)
		10-30 m.	Mae Ramphung Mt.	Thum Thong Mt.	closed season (15 February – 15 May)

5. Blue Swimming Crab Gill Net

No.	Fishing Village	Fishing ground			Remark
		Depth	North	South	
1	Ao-yang	2-7 m.	Mae Ramphung Mt.	Ao-yang V.	
2	Fai Tha	5-20 m.	Mae Ramphung Mt.	Thalu Island	
3	Bang Saphan	4-8 m.	Mae Ramphung Mt.	Nong Samed V.	
4	Nong Samed	2-30 m.	Mae Ramphung Mt.	Sung Island	
5	Bang Saphan Noi	2-10 m.	Mae Ramphung Mt.	Thalu Island	
6	Chai Thalay	5-20 m.	Thalu Island	Bang Berd V.	
7	Fang Dang	2-15 m.	Mae Ramphung Mt.	Thum Thong	Normal season (end of January – beginning of October)
		15-30 m.	Mae Ramphung Mt.	Thum Thong	Monsoon season (end of October – beginning of January)
8	Bang Berd	7-14 m.	Thalu Island	Bang Berd V.	boat engine < 50 hp.
		15-30	Thalu Island	Lan Ped Island.	boat engine > 50 hp.

6. Indo-Pacific Mackerel Gill Net

No.	Fishing Village	Fishing ground			Remark
		Depth	North	South	
1	Ao-yang	10-15 m.	Mae Ramphung Mt.	Bang Berd V.	
2	Fai Tha	4-22 m.	Mae Ramphung Mt.	Thalu Island	
3	Bang Saphan	5-20 m.	Mae Ramphung Mt.	Fai Tha	
4	Nong Samed	18-20 m.	Mae Ramphung Mt.	Thum Thong	
5	Bang Saphan Noi	4-20 m.	Mae Ramphung Mt.	Bang Berd V.	
6	Bang Berd	10-30 m.	Thalu Island	Bang Berd V.	

7. Shell & Sea Cucumber Diving					
No.	Fishing Village	Fishing ground			Remark
		Depth	North	South	
1	Nong Samed	6-8 m.	Around Thalu, Sing and Sung Island		
2	Bang Saphan Noi	6-8 m.	Around Thalu, Sing and Sung Island		
3	Fang Dang	6-8 m.	Around Thalu, Sing and Sung Island		

Table 3. Fisher groups, sub-district and district in the project site.

District	Tambon (Sub-district)	Fisher Groups/ Villages	The year of establishment
1. Bang Saphan	1. Mae Ramphung (TAO)	1. Bang Ao-yang, 2. Bang Pak Klong Bang Saphan	1992 1999
	2. Phong Prasart (TAO)	1. Ban Fai Tha	1995
2. Bang Saphan Noi	1. Bang Saphan (TAO)	1. Ban Nong Samed, 2. Ban Pak Klong Bang Saphan Noi	1998 1994
	2. Pak Praek (TAO)	1. Ban Kake	1998
	3. Sai Thong (TAO)	1. Ban Chai Thalay, 2. Ban Fang Dang, 3. Ban Bang Berd	1998 1998 1992

Table 4. Categorization of fisher types in Bang Saphan Bay.

Types of Fishing Operation	Type of Engine	Size of Engine	Number of fishing Labors	Source of Labors	Fishing Gear Used
1. Small-scale	1. All of long tail engine 2. Mid engine	No engine up to 85 hp.	1-3 (including boat owner)	1. family member	1. Fish trap 2. Squid trap 3. Crab gill net 4. Shrimp gill net 5. Fish gill net (Indo pacific mackerel, mullet, silago, pomfret, and rocky fish) 6. Diving for shell and sea cucumber 7. Anchovy casting net (green light, long-tail boat) 8. Squid cast net (green light, long-tail boat) 9. Jelly fish scoop net
2. Middle Scale	Mid engine	> 85 hh. up to 165 hp.	4-5 persons (including boat owner)	1. family member 2. hire from others	1. Anchovy cast net 2. Squid cast net 3. Deep sea crab (water deeper than 20 meters) 4. Trawler
3. Semi-large Scale	Mid engine	>165 hp. up to 300 hp.	6-25 persons (including boat owner)	1. hire from others villages 2. Myanmarese	3. Anchovy Purse Seine 4. Purse Seine

Information from fishers and project staff, 2002
Note: Categorizing the scale of fishersn requires that all criteria be considered together.

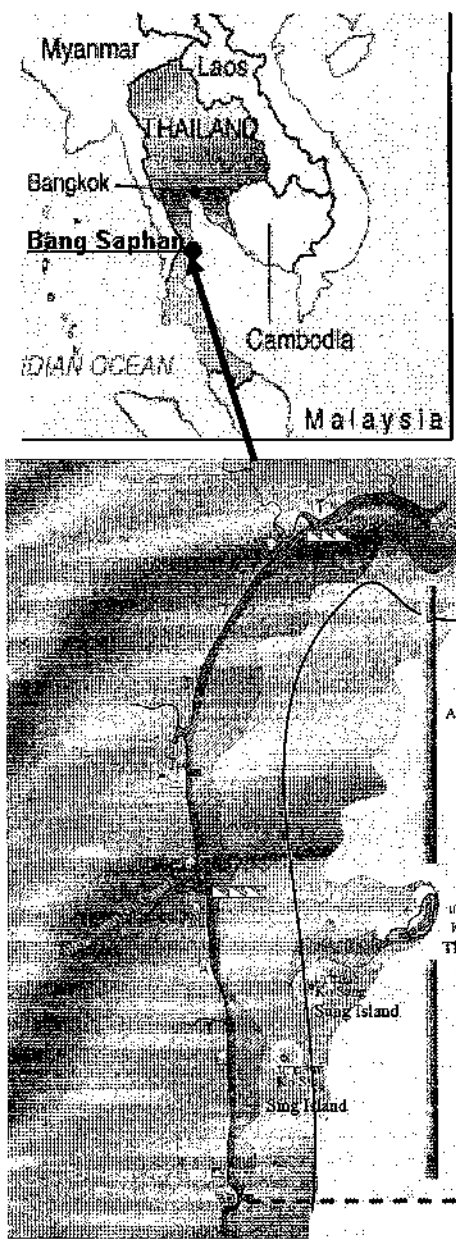

Fig. 1 Map of demarcated area in Bang Saphan Bay and fishery regulations apply to the project site

- - - - Demarcated area of the project
The regulations within the project area are:

1. No types of trawler are allowed to operate
2. Push net fishing boats with engines are not allowed to operate
3. Clam draggers with engines are not allowed to operate
4. Purse seiners with engines are not allowed to operate, except for daytime anchovy purse seines, which are allowed to operate, but outside 3 km from the shoreline

_____ 3 km. from shoreline
The regulations within 3 km from the shoreline are:

1. No types or sizes of trawlers are allowed to operate
2. Anchovy cast net fishing with luring light are not allowed.
3. Clam draggers with engines are not allowed to operate
4. Push netters with engines are not allowed to operate
5. Anchovy cast nets with luring light are not allowed to operate within 3 nautical miles, which is about 5.4 km. (in the case of the Bang Saphan project officer who uses the 3 km. limit)

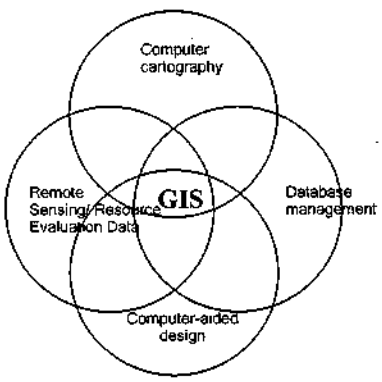

Fig. 2 The relationship of computer-aided design, computer cartography, database management and remote sensing information systems/ resource evaluation data with GIS. *(origin [22]).*

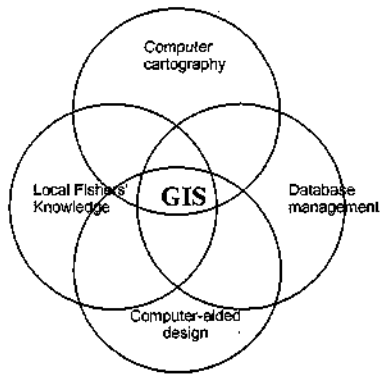

Fig. 3 The relationship of computer-aided design, computer cartography, database management and local knowledge with GIS.

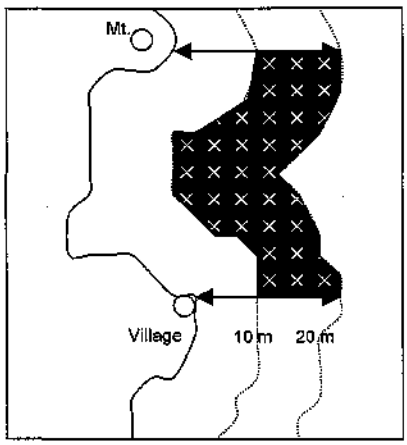

Fig. 4 An example of reference points used to draw a fishing ground polygon. Depth range from 10 to 20 m while north and south limit are referred land mark e.g. a mountain and a village or an island

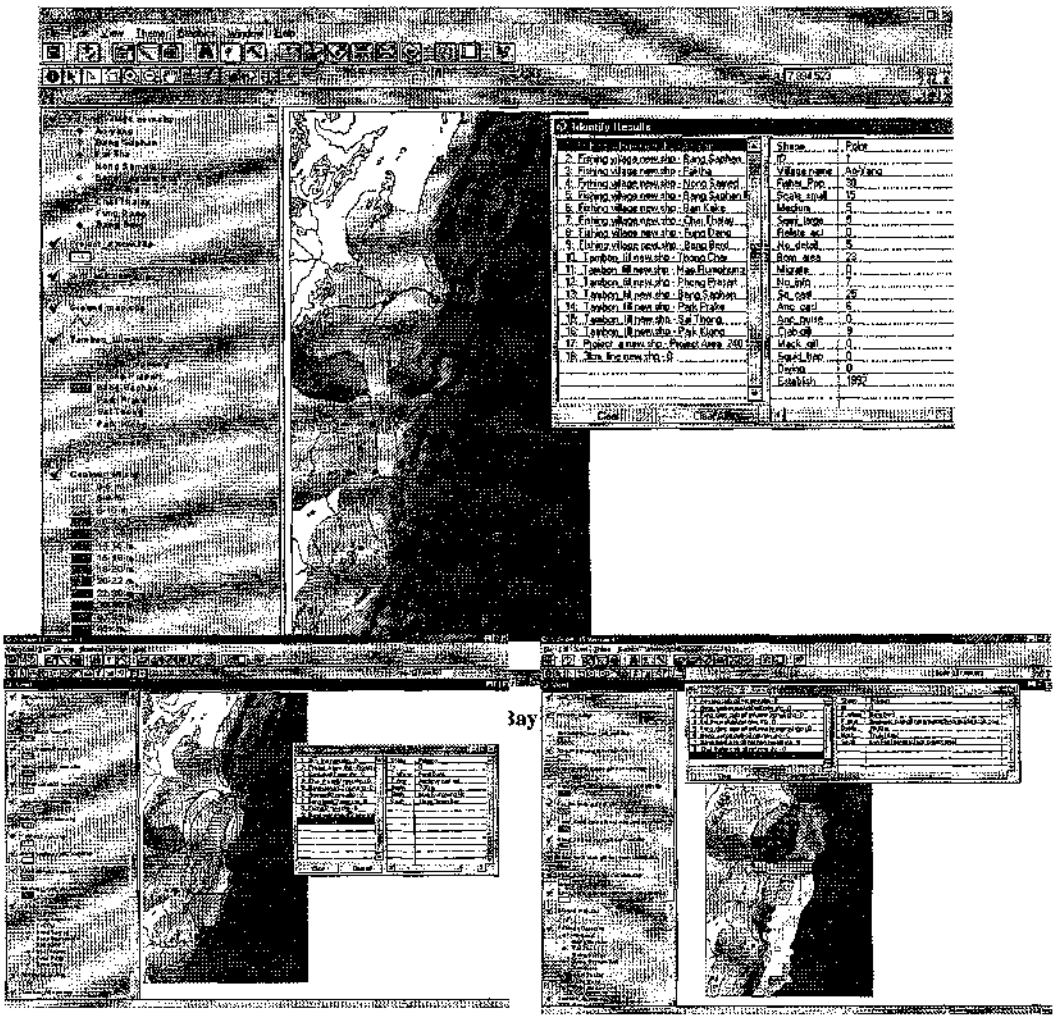

Fig. 6 Overlapping of anchovy cast net fishing ground

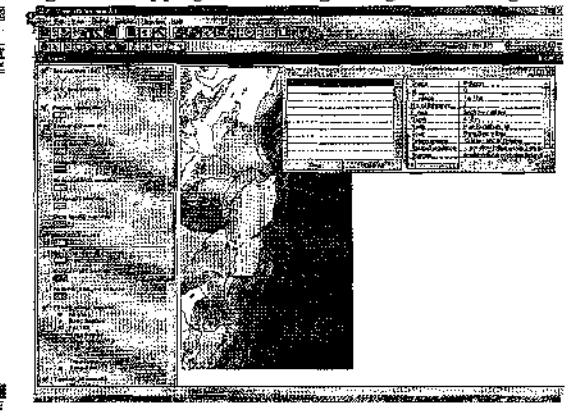

Fig. 7 Overlapping of swimming crab gill net fishing

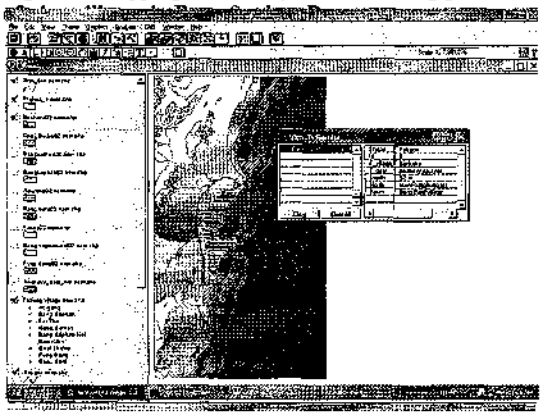

Fig. 8 Swimming crab gill net fishing ground of fishers in the Bang Berd fisher group.

Fig. 10 Violation of fishery regulations by fishers using the anchovy cast net in the Bau Kake fisher group.

Fig. 11 Violation of fishery regulations by fishers using the anchovy cast net in the Fai Tha fisher group.