



Research Article

Local Fishing System and Marketing Channel Model with Special Reference to Trapping Pond Fishing in Tung Kula Ronghai, Northeast Thailand

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Abstract | The research present the local rice-fish economy system of small farmer households in Tung Kula Ronghai (TKR), Northeast Thailand. Secondary data related to the study site were collected and analyzed to enhance primary data collection. A semi-structured interview was used for in-depth study in the community. Trapping ponds in paddy fields have developed and transferred from the old generation as local wisdom. It is the tools considering as an appropriate technology, which enables the ecosystem to continually provide services to the farmer (e.g., local food security, household income, surface water supply for rice production and enhance soil nutrients for rice crop) without damaging the ecosystem's capacity to provide the services. The marketing channel can be divided into three types are 1) travel-customer, 2) tourist-customer and 3) middlemen from many provinces to buy lots of fish from the wholesale farmer. All of these farming practices are efficient using of natural resources as the local wisdom that shield against inevitable shock in household economy and food security including encourage interaction between people in the community. The farmers in the study site obtain benefits from ecosystem services such as increasing income and maintaining food security (rice and fish) by using local wisdom. Therefore, to ensure sustainable development of rice-fish farming system in the TKR, these things should be implemented: (1) Enhancing the number of fish and biodiversity in paddy fields by reducing using chemical fertilizer and eliminate using chemical pesticides in cropping areas; (2) According to the first, to develop appropriate technologies for small farmer households that improve rice yields or other crops to be higher and stable without using any chemical; (3) Develop strategies and policies that act as a mechanism for driving society leading to organics farming production in the TKR.

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Keywords | Local fishing system, Marketing channel model, Trapping pond in paddy field, Tung Kula Ronghai, Northeast Thailand



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Introduction

In Thailand, more than 11.2 million hectares of planted areas (50.72 % of total planted areas) are rainy season rice areas which are in the Northeast region with totaling approximately 7.2 million hectares (LDD, 2018). The Northeast is the largest planted rice area in the country but farmers are mostly poor as small farmer households (Jintrawet, 1994; Barnaud *et al.*, 2006; Haefe *et al.*, 2006; Rambo, 2017). Most of the landscapes of Northeast Thailand are undulating areas. The farmers produce rice only one crop per year as the main crop in the lowland to meet household consumption with growing of low-value upland crops: cassava, sugarcane, or rubber (Rambo, 2017). Therefore, in order to be sufficient for their consumption expenditure, they have to engage in full-time agricultural work while some members of farmer households have become non-permanent laborers with off-farm activities as migration to the capital city (Barnaud *et al.*, 2006; Rambo, 2017). Currently, farmers' livelihoods have become more complex with the combination of on-farm activities and off-farm activities (Falvey, 2000; Rigg, 2005; Grandstaff *et al.*, 2008; Shirai and Rambo, 2017). In Northeast Thailand, there is an important rice production area that calls Tung Kula Ronghai (TKR). The TKR is well known that is the best quality jasmine rice planting area in Thailand (LDD, 2018). The TKR has many streams and rivers throughout the area but it is not irrigation area, most of the farmers in the TKR have also engaged in are rainfed rice farming (Wong, 1987; Phusongchun, 2002; Aengwanich *et al.*, 2005). Because the TKR is a big flooded area during the rainy season, the farmers can obtain a large number of fish produces from the flooded effect by trapping ponds in their paddy field (Pakuthai, 1986; Phusongchun, 2002; Aengwanich *et al.*, 2005). Therefore, trapping ponds can be seen scattered in paddy field in boundary of the TKR, including fishing activities during post-harvest season of jasmine rice as a livelihood of people in the TKR. Moreover, from a preliminary survey in the area, there is a particular local fish market community that play an important role on distribute fish products from the trapping ponds to many provinces in the Northeast region. What is interesting is that the TKR representing a drought areas in Thailand but it provided fish produces to local people and beyond, and how is the fishing system and the local fish market community in the TKR. However, given this lack of information to detail understanding of these. Thus,

in this paper, we seek to: (1) What is landscape of the TKR that related with local fishing system? (2) What is the system and component throughout upstream, midstream, and downstream of local fishing business system?

Materials and Methods

The local fish market community located in Chumpon Buri district, Surin province (this community is located in district number 9 in the map of Figure 1) was purposively selected because the community is well known that is the famous fish marketplace of the TKR and it has been established for 35 years. And there is the only one site that represent local upstream, midstream, and downstream of local fishing system in the TKR that cover fishing prepared process from trapping pond until local market process (Table 1). The local fish market community is located in Nong Piman village, Krabueabg sub-district, Chumpon-Buri district, Surin province (12°22'33.35" N 103°15'49.15" E) where local fish from the TKR have been sold along the highway with market area of 2,876 m². Secondary data related to the study site was obtained from an online government database and local government offices (Land Development Department, 2018; Maha Sarakham provincial office, 2018; Roi Et and Yasothon provincial office, 2018; Surin and Sri Sa Ket provincial office, 2018) included books, and journals were: developed to sub-topics for the interview, collected and analyzed data to enhance primary data collection. Semi-structured interview (Simaraks and Subhadhira, 1987) was mainly used to gather information from Key Informants (KIs) by individual and group interview. In-depth interview was used to obtain some detailed information from individual participants in order to understand farmer household level to generate the conclusion of community level. The subtopics were generated to cover various aspects of physical, biological, and social-economic information of the TKR and the study site including agricultural system, trapping pond information (*e.g.*, structure, function, and maintenance), fishing processes, the role of the farmers that participated in fishing processes, marketing channel and components and relationship of the local fish market community as local upstream, midstream, and downstream that related with local fishing business system (Table 1). Criteria for selecting KIs were that they lived in the communities, they had good knowledge that relates to the sub-topics. The Snowball technique

Table 1: *Subtopics of local upstream, midstream, and downstream fishing business system that used in this study.*

Issue of study	Component	Subtopic
Upstream	Origin of trapping pond	Origin of trapping pond Age of trapping pond
	Trapping pond building	Position of ponds in paddy field Size of the pond Means of ponds building Condition of ponds building
	Trapping pond maintenances	Knowledge Experience Seasons Materials and equipment Results of the maintenance
Midstream	Fish catching	How to catch fish Knowledge, skills and technique Experience Materials and equipment Labor Fish pond price and assessment Time Problem and solving
	Fish species in trapping pond	Fish species Aquatic animal species Amount of fish and Aquatic animal
	Fish pre-processing	Knowledge, skills and technique Cleaning Grading Carrying Materials and equipment Problems and solving
	Transportation	Vehicles Distance Time Problems and solving
Down-stream	Fish trade in local market	Activity of buying and selling Time Investment Fish products and prices Farmers who participate in the fish business system and function Relationship between each farmers Problems and solving
	Processing fish products	Type of processing Fish species and prices Problems and solving
	Customer	Type of customers Purposes of purchase Problems and solving

was used to identify key informants. A total of 26 KIs were interviewed, consisting: 2 agricultural extension officers, 1 village headman, 3 farmers in the community, 7 pond owners, 2 fishing laborers, 3 buyer

farmers, 4 retailer farmers, and 4 wholesaler farmers. Group interviews were conducted two times. These were: (1) group interview in fishing processes issue with 7 participants, and (2) group interview in local fish market system issue with 5 participants, all group interview meeting used to complete and verifies the data from the individual interview. Finally, a total of 23 participants were conducted by a group discussion in order to verifies the information that data of the local fish market community phenomenon was correct as a using the data triangulation ([Chantavanich, 2011](#)) throughout generating the conclusion of development of the local fish market community. Field researchers resided in the community for the months of February and March 2019 with participant observation by participating in community activities (*e.g.*, fish-catching processes, fish cook processing, sale of fish products to customers or middlemen from outside). All qualitative data were analyzed by content analysis for fielding the research questions. Then, the data were synthesized by inductive method for understanding of local fishing by trapping ponds in the paddy field as a community economy throughout effects of ecosystem services on humans.

Results and Discussion

General information of Tung Kula Ronghai

The TKR comprises a low-land area of 5892.2 km² (include residential area) in center of the large basin-shaped Korat Plateau in the Northeast Thailand ([LDD, 2018](#)). It covers 13 districts in 5 provinces: Maha Sarakham province, Roi Et province, Yasothon province, Surin province, and Sri Sa Ket province. The most of soil type is poor nutrient sandy loam, quick water drain and tended to be salty because of rock salt in Maha Sarakham formation ([LDD, 2018](#)). Three seasons can be divided: the rainy season starts from June to October, the cool dry season from November to February, and the summer season from March to May. The annual rainfall is between 1,200-1,400 mm. and the temperature is between 17.3° -36.2° C, and there are many streams and rivers through the area but surface water supply is able for year round in particular areas ([LDD, 2018](#)). There are 9 streams with a total of 3,372.1 km² with Nam Mun River and Lam Soei stream are covered 56.94% of the streams ([Boonjue, 2007](#)). Generally, in the rainy season, the lowland (approximately 1,600 km²) are flooded ([LDD, 2018](#)). In average flood year significant parts in the areas, usually, spread of 2-5 km wide

along these rivers are inundated (Wong, 1987). The inundation in the Tung Kula plays a vital roles on agricultural system (e.g., increasing crop productivity, raising fish or aquatic farming, and watering for beef cattle), on food sources of humans (e.g., native fish and shrimp), and on ecosystem (e.g., habitat of aquatic animal and microorganism, food source for animals and improving quality of soils) (Aengwanich *et al.*, 2005; LDD, 2018). It might be beneficial for rice-fish system according to several reports that studied about rice-fish farming (Fernando and Halwart, 2000; Katano *et al.*, 2003; Yamasaki *et al.*, 2004; Thanh, 2011; Ahrmed *et al.*, 2011; LiangLiang *et al.*, 2015; Ren *et al.*, 2018). In addition, from the farmers aspect understand that the flooding stimulate the migration of numerous fish into trapping ponds in paddy field in the TKR according to several reports (Pakuthai, 1986; Phusongchun, 2002; Aengwanich *et al.*, 2005; Boonjue, 2007; Jantabood, 2010). The map of TKR is shown in Figure 1.

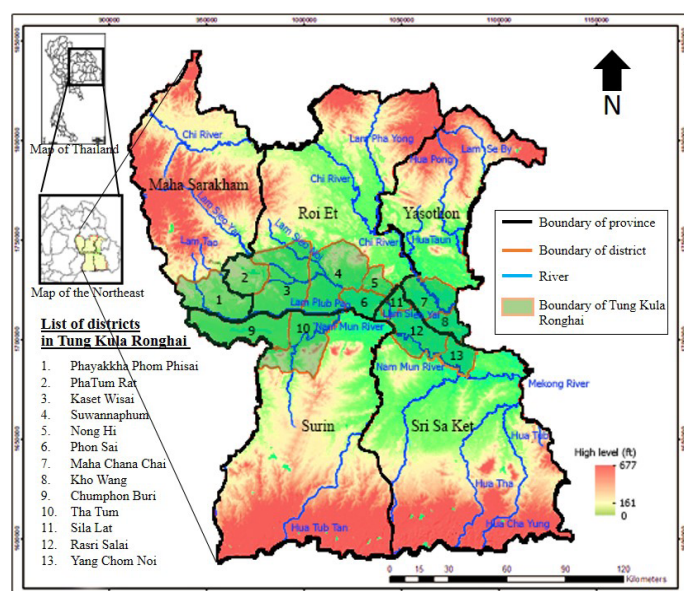


Figure 1: Map of Tung Kula Ronghai, Northeast Thailand.

Activities of small holder farmer in the Tung Kula Ronghai

In Thailand, it is well known that the TKR is the best quality jasmine rice planting area in Thailand. Most farmer households in the Tung Kula engage in are rainfed rice farming. They have grown rice as a major crop in the lowland. Normally, there are two major varieties of rice in the TKR: RD6 rice variety (glutinous rice) for household consumption needs, and KDML105 rice variety (jasmine rice) for sales. Both RD6 and KDML105 are medium duration and photoperiod sensitive varieties (Rambo, 2017). The rice growing season is between late June or early July and

the harvesting season is started in late November or early December. According to the conventional view, the rainfed rice farming in the TKR is unproductive, the average amount of rice produce is 2.07 t/ha due to poor resource base: sandy soils, limit of surface water supplies, and limit of erratic rainfall (Pakuthai, 1986; Rambo, 1991; Limpinuntana, 2001; Phusongchun, 2002; LDD, 2018). Since most of the landscape of the TKR is flooding lowland, either field crops: sugar cane and cassava or fruit/vegetable: garlic, shallot, and watermelon planted by few farmers in their specific areas (Maha Sarakham provincial office, 2018; Roi Et - Yasothon provincial office, 2018; Surin - Sri Sa Ket provincial office, 2018). Livestock raising (e.g., buffalo, cattle, poultry, and pig) are keeping for home consumption or neighbors sharing and for sale to the market. Most farmers in the TKR have dug farm ponds for supplemental irrigation by using water pump machine. The farm ponds contribute to stabilization of rice yield during limited or erratic rainfall. Moreover, the main purpose of some farm ponds is fish trapping in the paddy field (Pakuthai, 1986; Jantabood, 2010). Trapped fishes are sold to middlemen and local markets as well as partially keep for home consumption. All of this, as a general view of farmer households in Northeast Thailand, farm income is still not sufficient for household consumption expenditure, not even for farming investment or paying off their debts. Almost all of the farmer households in the TKR depend on off-farm activities to gain their income, they spend time doing off-farm jobs or short-term migration to seek employment outside their province or Bangkok or overseas for increasing their household income (Shirai and Rambo, 2017). The activities calendar of farmer households in the TKR is shown in Figure 2.

Trapping pond in the Tung Kula Ronghai

As a particular area, farmers in the TKR acquire natural fish produces every year as an annual deposit interest by having trapping pond in their paddy fields. Trapping pond in paddy fields have developed from small bund building to keep fish from the streams or the rivers during the rainy season, the position of small bund is on the lowest zone might be the corner or the center of paddy field. Then, the small bunds have become digging pond from laborers, and to increase the larger amount of pond size and the number of ponds in their paddy fields by the excavators. Normally, trapping pond is an inheritance along with farmland from their farmers' parents or might be digging more by landowner. A study by Jantabood (2010) reported

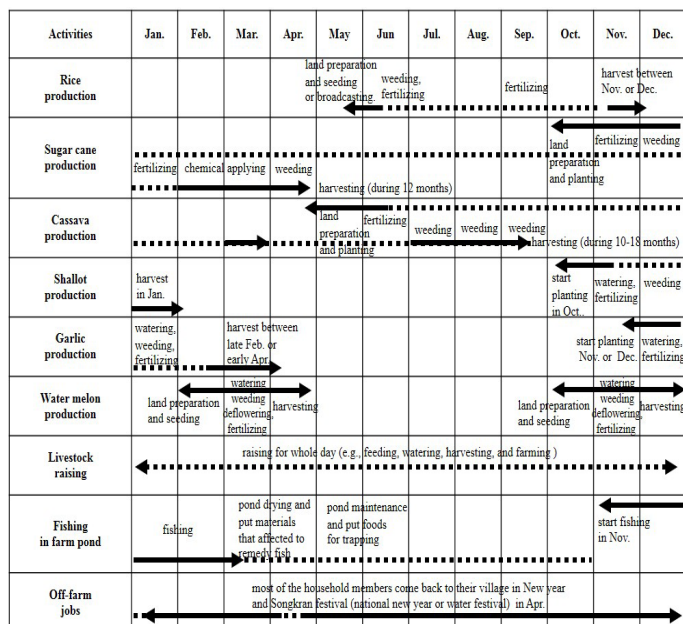


Figure 2: Activities calendar of farmer households in the TKR.

age of trapping ponds is between 10-80 years with the average trapping pond is 23.00 years. The study also determined the average size of the trapping pond is 12.5 meters in wide, 23.5 meters in length, and 2.6 meters in depth with the average amount of trapping pond area is 884 square meters. The study also reported the number of trapping pond with rice area in case of Roi Et province is between 1-11 ponds (the average is 3.60 ponds/household) with their farmland: 10-97 rai/household (rai is the traditional area unit of Thailand, 1 rai = 0.16 ha) or 1.60-14.56 ha. In case of the study site (Surin province), the number of trapping ponds per household is only 1-3 ponds because the farmers have few farmland (5-30 rai/household or 0.80-4.80 ha). As a result, in both cases pointed that the number of trapping ponds might be related to the number of agricultural areas of the farmers. However, from trapping pond owners' aspect, suggested the ratio of paddy area and trapping pond should be 10-20 rai/pond because a large number of ponds are difficult to manage fish catching and pond maintaining. Moreover, many dug ponds in the small size area does not mean increasing of fish produces but it means losing rice planting areas. Jantabood (2010) reported relationship between the positions of the trapping pond and distance of rivers that affected the number of fished in the trapping pond. The study shown the best position that highly obtain number of fishes should be far away from the river more than 500 meters, and the current from river should not be too strong. The trapping ponds are found in several villages in the

TKR area and also found in some villages outside the TKR area but in small numbers. A trapping pond in the TKR is shown in Figure 3.

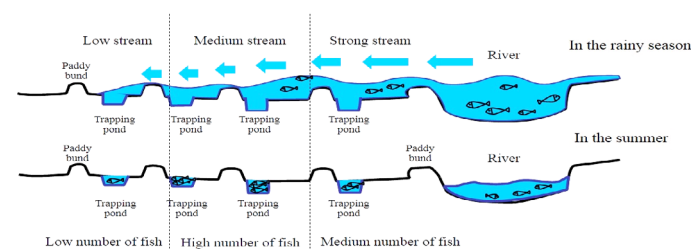


Figure 3: Trapping pond in the TKR.

Table 2: List of fish product prices in the local fish market community.

List of product	Fresh fish price (baht*/kg)		Dried fish/smoked fish (baht*/kg)	
	Min	Max	Min	Max
Sneak-head fish (big size)	80	110	280	350
Sneak-head fish (medium size)	70	90	280	350
Sneak-head fish (small size)	35	44	-	-
Catfish	45	60	280	350
Climbing perch	25	50	-	-
Spotted spiny eel	200	280	-	-
Thai river sprat	-	-	480	600
Fermented fish	8	13	-	-
Pickled fish	-	-	80	100
Green frog	-	-	280	350

* Exchange rate is 31.72 baht per 1 US dollar (February 2019)

From survey in February 2019.

Native fish species and fish's prices in local fish market in the Tung Kula Ronghai

Generally, fish species are found in trapping ponds which resemble survivable-fish. It can: breathe and move on land; consume everything (e.g., plankton, aquatic insect, and plant); live in the mud as a tactic to live longer without having enough water according to characteristics of fish that found in rice-fish system in the Mekong Delta, Vietnam (Thanh, 2011). Main fish species in the TKR: Sneak-head fish (*Channa striata*), Catfish (*Claris macrocephalus*), Climbing perch (*Anabas testudineus*), Spotted spiny eel (*Macrognathus siamensis*), and Thai river sprat (*Clupeichthys aesarnensis*), including species of small green frog. However, at present, key informants suggested that the number of fish and fish species are decreased by affecting agricultural practices: to transform native

rice varieties to breeding rice varieties, non-chemical to chemical application, eucalyptus tree planting, indigenous fishing tools to the water pump, construction of roads and irrigation system that across its fish travel lines according to (Pakuthai, 1986; Phusongchun, 2002; Boonjue, 2007; Jantabood, 2010). The fish products are sold in the local fish market community in Chumphon Buri, Surin province (district no.9 in Figure 1) that has been established for 35 years. Fish products can be divided into two types: fresh fish, and processed fish (e.g., dried fish, smoked fish, fermented fish, and pickled fish). The fish prices depended on the demand of fish species, size of fish, or during festival: New year festival and Songkran festival which is Thailand traditional New Year or called water festival that Thai people celebrate in April), especially, some years, when rain is less than normal. The list of fish prices is shown in Table 2.

Role of the farmers in fishing processes in the local fish market community

People who participated in the fishing process by trapping pond in the paddy fields can be divided into five types:

Trapping pond's farmer owners: They are farmers who have trapping pond on their paddy field. This type might be the others farmer types. A farmer in the community might have 1-3 trapping ponds/household depend on the number of their land. Every year, before the rainy season, pond owners will add materials as fish feed (e.g., cattle manure, chicken or duck manure, termite nest from the local forest, animal bone, leather, and even instant fish feed product) and to make an artificial environment (e.g., tree branch with astringent test, mud from a pond that never dried) into the pond for inducing fishes that come with the streams or the rivers to stay in. The farmers suggested about kind of the tree branches that has a preventing disease which is accord to the study found that tree branch with astringent test is having tannin, also called tannic acid, effects on wound healing, inhibit bacterial growth, fish disease prevention, and help to adjust pH balancing (Seedabuth, 2006). In addition, it can prevent thieves who use the fishing net. During the rainy season to the early cool dry season (June-November), there are a few farmers that feed fishes in their trapping ponds by manure or instant fish feed. Before fish catching, people who involved in a fishing process in the pond (e.g., pond owner, fishing laborer, and middleman) participate in worship by

giving food, cigarettes, liqueur, roasted sticky rice, and a pair of roasted fish to the spirits as a forgiving the spirits who own the pond. In the fishing process, all of the fish in the pond were not caught, some young-age fishes are still remaining in the pond. Then the ponds will be set to dry out as a pond cleaning, and the ponds will be removed some mud or soil around the edge of the pond to avoid shallow pond. Pond owners obtain income approximately 5,000-20,000 baht/pond depending on the number of fish and the fish species having in the pond.

Fishing labor farmers: Almost all of them are hired farmers (approximately 300-500 baht/day or 9.45-15.76 dollars/day) to catch fish in the trapping pond. In the farmers aspects identified that they are quite riskless from the fish business in the local fish community but still be important persons in the system. Some of them have skills for estimating the number of fish throughout fish-catching skills that avoid damaging the fish. They estimate the number of fish at night by listening jumping fish sound and deal with the pond owner at night (at the same day). During that night (about 2.00 am), a water pump machine is used for draining water to the level that fish are still alive. The reasons of draining at night are: this process takes a lot of time because the amount of large water in the pond, the other processes are remaining, and deliver the fish to middlemen should be on time (in the morning or before noon). In the morning (5.00-6.00 am), the other hired laborers (about 5-6 persons) arrived at the pond and start catching, cleaning, grading, carrying the fish into the tank, and transporting it to the local fish market community. In transportation, all farmers reflected it is the main problem. Because fish will die or be damaged during transportation. Therefore, it is a challenge for agricultural extension officers or academics to develop technology to resolve this problem. All processes spent 4-5 hours depended on the distance between the trapping pond and the local fish market community.

Fish buyer farmers: Farmers in this group can be either a fish buyer or a retailer. The buyer farmers have the same skills as the fishing labor farmers (fish estimation skill). The buyer farmer is important to the system because they connect almost all of the components in the fishing system: pond owner, fishing laborer, wholesaler, and retailer. The buyer farmers might approximately connect 10-200 pond owners with 30-400 trapping ponds around the TKR. In the group

interview, farmers suggested being the buyer farmer requires a high investment. In a year, for investment, a farmer has to have at least 300,000-400,000 baht/year (9,457.75-12,610.34 dollars/year) for buying fish in the pond 30-40 ponds. Some buyer farmers in the local fish market community spent 2-3 million baht/year for their business. In the fish buying system, they deal with their businesses by trust and credit system so that credibility and trust is very important.

Wholesale farmer: Farmers in this type play role as a middleman is in their community. The wholesale farmer requires the highest investment in business because they provide the money to the fish buyer farmers in order to buy fish from pond owners. They also play a role as the keys that connects people in the local fish market community to meet fish consumption demand of people from outside. The wholesale farmer might connect with the middlemen from outside at least 30-50 middlemen. Middlemen from outside come from many provinces around or far from the TKR (shown in Figure 5). All farmer types identified that the highest-value market sharing is the path of wholesale market.

Retail farmer: This type is the farmer who sells many fish products by the stall located on the highway near their community as a local fish market. They have two essential skills: sales skills, and cooking skills (to make dried fish, smoked fish, fermented fish, and pickled fish). These farmers do not have a high investment compared with the fish buyer farmers and the wholesale farmers. However, some retail farmers might spend about 100,000 baht/year (3,152.58 dollars/year) for buying fish from the fish buyer farmers and the wholesale farmer in order to sell to customers as a traveler. When the fishing season of the community is finished (around March to April). To satisfy the market demand, fish products including aquatic and wild products have been imported from Cambodia at a border markets in order to continually sell in their community year-round (Figure 5). All farmer types work in fishing processes together shown in Figure 4.

Local fish marketing channel in the community

The customers in the local fish market community can be divided into three types: (1) Travel-customer represent people who live around the community or live in the city near the local fish market community, regularly travel to work in their other area. This kind of customer buys fish produces in the evening (when

going back home). Hence, the number of fish products by buying from them may not be much but regularly; (2) Tourist-customer represent group tour that visits the local fish market community as one route of their tourism. Tourists usually buy large quantities of fish products, making retail farmers earn lots of profit; (3) Middlemen come from many provinces (e.g., Surin, Roi Et, Maha Sarakham, Sri Sa Ket, Yasothon, Udon Thani, Khon Kaen, Nong Khai, Kalasin, Loei, Bueng Kan, and Bangkok) to buy lots of fish from the wholesale farmer. Then, they will sell large fish products through several marketing channels (e.g., community flea markets, local markets, and restaurants) that distribute to many provinces in Northeast Thailand and other regions. This marketing channel allows people from other areas to access natural fish consumption which is considered a different taste than fish meat from fish farming. Figure 5 shown the local fish marketing system and the marketing channels.

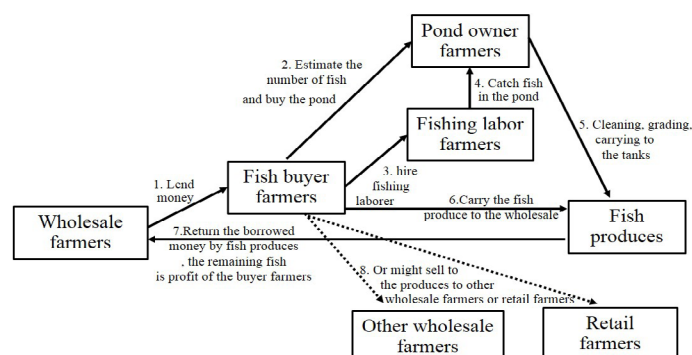


Figure 4: The fishing processes in the local fish market community.

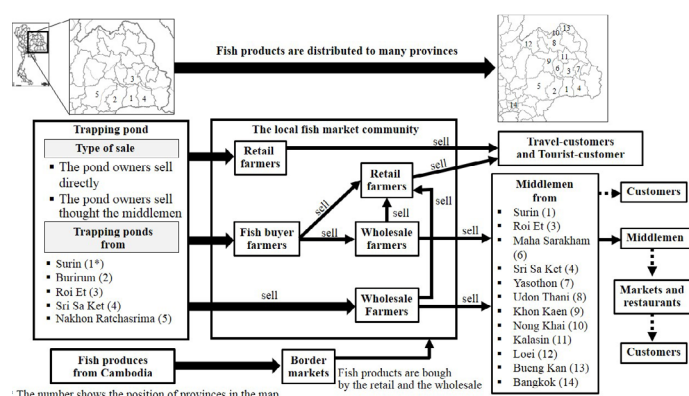


Figure 5: The local fish marketing system and the marketing channels.

Local fishing by trapping pond in paddy fields as an ecological services model

Trapping pond in paddy fields is an effective fishing tool has developed by local wisdom. Many years ago, the knowledge of trapping ponds has been transferred from old generations to meet the quality protein

from natural fish. Nowadays, it has become a valuable source of income for people in the community. This tool is also considered as an appropriate technology using in rice-fish system that enables the ecosystem to provide services (e.g., local food security, household income, surface water supply for rice production, and enhance soil nutrient for rice crop) to the human social system and agro-ecosystem of people in the community. Moreover, it is supported natural fishes by habitat of many fishes, spawning ground and fish nursery including conserves other creatures in the ecosystem. These ecosystem services obtained from rice-fish farming system accorded many countries (Lightfoot *et al.*, 1992; Katano *et al.*, 2003; Giap *et al.*, 2005; Dugan *et al.*, 2005; Thanh, 2011; Ahmed *et al.*, 2011; LiangLiang *et al.*, 2015; Ren *et al.*, 2018). According to the farmers' concept of trapping pond, it formed the demand for fish consumption continues throughout year round, fish remaining are sold which is not maximizing profit. Even though, nowadays household income is an important part of small farmer households, the farmers still conduct their trapping ponds to continually remain the fish population for next year to obtain ecological services and to maintain the carrying capacity of the ecosystem. It is different from a case of using a fishing tool in commercial fishing in the ocean that killing a large number of marine animals, which in turn led to a change in the social system (Marten, 2001). It also different from general fishing at natural water resources in the northeast, Thailand such as swamp, stream, or river. Because the farmers do not need to travel to water resources to catch fish especially water resources in the north is rare as a drought area (Aengwanich *et al.*, 2005; Barnaud *et al.*, 2006). Moreover, trapping pond investment is low but high return which considers from maintenance of trapping pond that relies on local materials with local wisdom. Local fishing by trapping ponds in paddy fields is a synergistic interaction between agro-ecosystem and ecosystem that human social system and adapt to their environment as well as ecosystem adapt to the human social ecosystem. Small farmer households readjust their lands as a mosaic pattern in the region to obtain ecosystem services but they do not use intensively that the ecosystem's ability to provide is damaged as overexploitation which depletes their natural capital. While human social system adapted for working together in all levels of people in the local fish market community. Moreover, this system allows the farmers to diversify their risk when the rice yield is bad as well as their off-farm incomes reduced but

they still get food and household income from fish produces by their trapping pond. All of these farming practices are efficient using of natural resources as the local wisdom that shield against inevitable shock in household economy and food security including encourage interaction between people in the community. Local fishing by trapping ponds in paddy field as an ecological services model is shown in Figure 6.

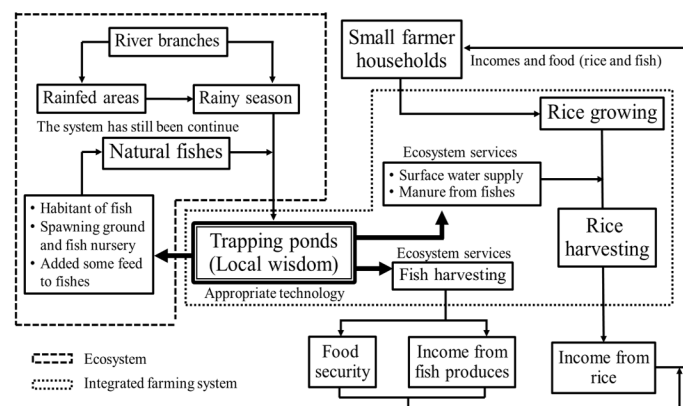


Figure 6: Local fishing by trapping pond in paddy field as an ecological services model.

Conclusions and Recommendations

Research on local fishing by trapping ponds in the TKR found that the TKR is a large rice planting in Thailand with frequent flooding because there are many streams and rivers but it is not still an irrigation area. However, the TKR is a special area that can obtain natural fish that come with the streams and rivers during the rainy season. Thus, trapping ponds have been developed by local wisdom in order to obtain ecosystem services. While fish species resemble survival fish (e.g., move on land, consume everything, and live in the mud) and it is different taste comparing with fish raising by humans. In the community, the role of each farmer in the fishing processes varies by their resources, knowledge, skills, connections, and funding. Even though the trapping pond is a tool taking lots of natural resources, natural fish produces can still serve to the offspring because the trapping pond including fish meaning considers the carrying capacity of the ecosystem. The group discussion suggested that in addition to improving technology that reduces the damaged of fish produces during transportation, sustainable development in TKR is very important. Therefore, to ensure sustainable development of rice-fish farming system in the TKR, these things should be implemented: (1) Enhancing the number of fish and biodiversity in paddy fields by reducing using chemical fertilizer and eliminate using chemical pes-

ticides in cropping areas; (2) According to the first, to develop appropriate technologies for small farmer households that improve rice yields or other crops to be higher and stable without using any chemical; (3) Develop strategies and policies that act as a mechanism for driving society leading to organics farming production in the TKR.

Novelty Statement

The fishing method in paddy fields by trapping pond showed in this study is the specific system. This study is the first report that describes current situation of the local fishing systems and also describes the link between farm and ecosystem management in order to continually obtain ecological services.

Author's Contribution

Phassakon Nuntapanich: Designed the study and methodology, analysis and interpretation data and revision of the manuscript for final submission.

Hathaichanok Nuntapanich: Designed methodology, data collection and analysis and interpretation data.

Woraman Maicharoen: Reviewed relevant literature, data collection and wrote original draft.

Conflict of interest

The authors have declared no conflict of interest.

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