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Coping and Adaptation against Decreasing Fish Resources :Case Study of Fishermen in Lake Inle, Myanmar

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Abstract

Fishermen depend on Lake Inle in Myanmar for their livelihood. However, the lake has been undergoing environmental degradation over the years. Adding to the long-term decrease in the catch because of this degradation, these fishermen faced extremely low water levels in 2010, which they had previously not experienced. Based on field surveys, this paper aims to reveal how fishermen adapted and coped with the changing environment as well as the sudden shock of the abnormally low water levels.

Keywords: coping, adaptation, resource, fishermen

JEL classification: Q2,Q13,Q22

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Introduction

Lake Inle, the second largest lake in Myanmar in Southern Shan State (Map 1), has long been a major tourist destination in Myanmar. The tourists are attracted by the picturesque beauty of this calm lake surrounded by mountains, villages comprised of clusters of small houses standing on stilts in the lake and the *Intha* fishermen in their tiny wooden boats. The lake is a "big water pot "[1](Ohno 1978) in Shan Plateau, which stands at an elevation of 1000 m above sea level. Because of the beautiful scenery and tranquility, as well as the traditional lives of the local people, tourists assume that life has continued unchanged for hundreds of years.

However, in reality, the lives of the people, especially those of the *Intha* fishermen who depend on the lake for their livelihood, have been changing steadily and most probably at a much faster pace in recent years, due to the ongoing environmental changes of the lake. First of all, the lake is reported to be shrinking. According to one estimate, the open water surface[2] has decreased by 32.4% between 1935 and 2000 (Sidle et al. 2007). One of the major causes of the shrinkage is the sedimentation caused by deforestation in the mountains as well as the banks of the lake. Forests are disappearing partly because of agricultural encroachment, including shifting cultivation (Myint Su and Jassby 2000, 53, Aye Thiha 2005) and wood collected as fuel by local residents. The other reason is the expansion of floating gardens (Sidle et al. 2007). Tomato cultivation on the floating gardens has been practiced for a long time on the lake, but because of the transition to a market economy from the early 1990s, the number and size of tomato floating gardens have expanded rapidly. The second change of the lake is the water quality. Again, this is mainly due to tomato cultivation, which uses various agrochemicals (Akaishi et al.). The unregulated usage of pesticide affects the transparency of the lake water.[3] These changes have reduced the fishermen's catch, especially that of species unique to the lake (Myint Su and Jassby, 2000).

In addition to this long-term trend, 2010 was a traumatic year for local people. The late arrival of the monsoon and the extraordinary summer heat made part of the lake dry up in April and May 2010. The water level of the lake fell to an unprecedented level. The exact reasons for this phenomenon are yet to be investigated scientifically, but local people blame the continuous

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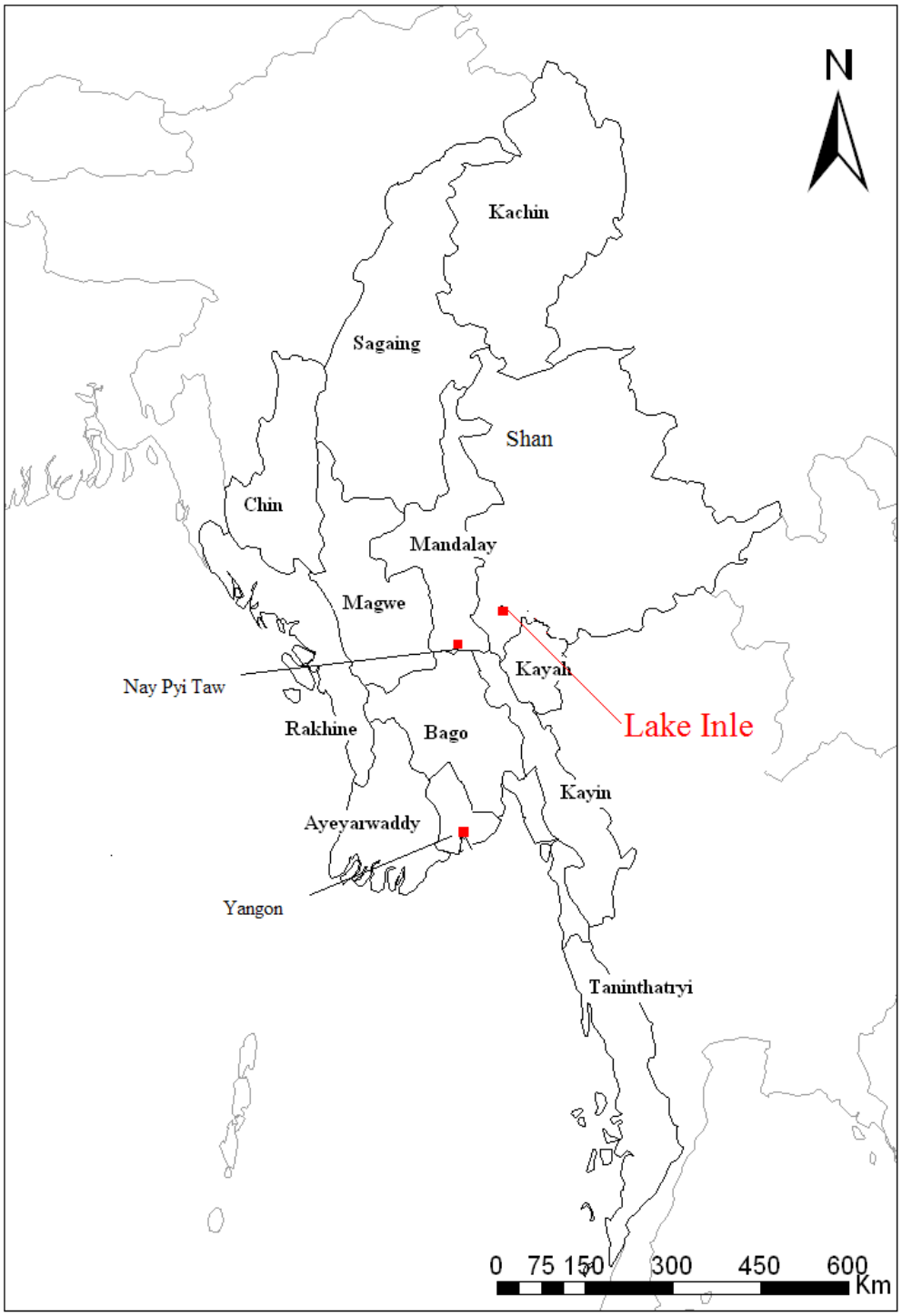
[1] The lake actually functioned as a source of water for the very first hydro power plant built in the 1950s by the Japanese government.

[2] The lake forms part of Salween River basin. The lake's center is at 20/ 30'N and 96/ 55'E. Lake Inle is 18 km long and 11 km wide and the open water area is estimated as 43.5 km^2 (Furuichi 2007).

[3] According to Myint Su and Jassby (2000, 53), 80-160 kg ha of triple superphosphate is used in one growing season. Furthermore, unskillful usage of pesticides, especially refractory organochlorine compounds, was also pointed out as a cause of water quality deterioration.

Map 1: Location of Lake Inle



Source: Author.

sedimentation and sporadic rainfall caused by the deforestation in the surrounding mountains. People considered that a threshold in the changing environment was reached in that year. The low level of water had a huge effect on local fishermen, who were already suffering from the decreasing catch. We do not know yet whether the weather in 2010 was just an abnormal year, or the beginning of long-term climate change to which the local residents need to adapt.[4]

This paper aims to reveal how the fishermen of the lake have been responding to the deteriorating environment and the sudden shock of the extraordinary low water level in 2010, based on a field survey conducted in September 2009, March 2011 and March 2012. Environmental degradation has been reported in various parts of the country, along with the economic transformation since the end of the 1980's. However, no in-depth study has been conducted, in terms of the adaptation and coping strategy of the local people within the environment. This paper does not go beyond a case study; it is initial research on adaptation strategies against the changing climate and environment in Myanmar.

First, we need to define adaptation and coping. Following Agrawal (2008, 5) we define adaptation as "actions and adjustments undertaken to maintain the capacity to deal with stress induced as a result of current and future external changes." By its nature, this is not a single response, but action taken over time. We define coping as the "use of existing resources to achieve various desired goals during and immediately after unusual, abnormal, and adverse conditions of a hazardous event or process." Clearly, this is a collection of short-term responses. However, it is important to note that a short-term response (coping) can overlap and develop into long-term strategies (adaptation) over time (Berkes and Jolly 2001).

Which strategy is chosen depends on the available options as well as the cost for each individual / local community in taking that option. Therefore, examination of the adopted strategy, would clarify the state of the environment and the economic conditions of the specific area in question; Lake Inle and its fishermen in this case.

The paper is composed as follows. The next section provides the background of the study, including basic information on the study site. Section 2 describes the fishing conducted in the lake. Section 3 is the main part of the study, which analyzes the coping and adaptation strategies of the fishermen in the lake. Section 4 examines these coping and adaptation strategies compared to possible alternatives. And the final section presents the conclusion.

[4] In contrast to 2010, the lake flooded in 2011. Some houses and fields were damaged by this flood. This might also suggest that the climate in the area is unstable.

1. Overview of the Study Site- Nyaung Shwe Township and Lake Inle

1.1 People, Economy and Environment

Nyaung Shwe Township [5] was home to 168,551 people in 2009.[6] The population of the township, as is true for Shan States, is comprised of various nationalities. The latest population figures are not available, but based on the figures in 2001 (Table 1), the *Intha* people make up the majority in the township. "In" stands for "lake," while "tha" means "people" in Burmese. Thus, the name literally means "lake people." (Ohno 1978, Robinne 2001, Takatani 1995)[7]. As the name indicates, the lives of the *Intha* people center on the lake. They live on the shore or on the lake, and make a living by fishing, cultivating vegetables (mainly tomatoes) on floating gardens, and cultivating rice on the delta formed by the river pouring into the lake. As their houses are located on or by the edge of the lake, boat is the main means of transportation. They use tiny wooden boats without engines to go to school, market or even to neighboring houses. The way they row their boats is unique in the country. The rower stands on the boat on one leg, and hooks the other leg round the blade. In recent years, long tail boats with engines came to be utilized, carrying local passengers, agricultural products to and from Nyaung Shwe Town, or to show tourists around the lake. But for *Intha* households, the main means of transport is the small boat they depend on for their daily activities.

Table 1: Population Breakdown of Nyaung Shwe Township (2008)

Intha	70
Pa-O	10
Shan	15
Bamar	3
Taung Yo/Others	2
Total	100

Source: UNDP (2008).

[5] There are 10 townships in Taunggyi District and Nyaung Shwe is the 2nd largest township. Taunggyi District and two other districts make up Southern Shan State.
[6] Based on the figures of the Department of Fishery, Shan State.
[7] Judging from the language, *Intha* people are close to Burmese. Some says that *Intha* people are originally from Tavoy, which is located in Tanintharyi Division, since both speak in similar Burmese dialects (Woodlthorpe 1897, Ohno 1976). However, the way of life and mode of thinking has many common aspects to that of Shan people (Takatani 1995, 13).

Nyaung Shwe Township consists of 35 village tracts[8] and there are 451 villages in total. About 78% of the villages are located either to the eastern or western sides of the lake (Aye Thiha 2005, 602).

Shan State, including Nyaung Shwe Township, is famous for its five-day market. The market is held in rotation in Lake Inle area every five days. The market starts in the very early morning and ends around 9 or 10 o'clock. It is a vital opportunity for local people to exchange commodities and information. This is also where people of the lake (*Intha*) and the people of the mountain (such as *Pa-O, Taung Yo*) can meet and exchange. For example, *Intha* sell fish, tomatoes, rice and purchase wood for fuel. The market offers a wide range of goods. On market day, the village at which the market is held is filled with boats and finding a parking place is not easy. People chat with friends over tea and breakfast in the market. Almost all the villagers attend nearby markets.

The weather in the lake area is tropical monsoon, and as in other parts of the country, there are three seasons; rainy season, dry season and hot season. The mean air temperature of the area is between 16.9 to 31.5 degree Celsius, while the mean annual rainfall is 920 mm (Sidle et.al. 2007, 57). However, as noted earlier, 2010 was a very peculiar year in terms of the weather pattern. Table 2 shows the rainfall data (Nyaung Shwe Township only). The annual rainfall of the previous year (2009) was not particularly low. The problem was that it did not rain from November 2009 to March 2010 and there was far less rain in April than normal. With the unusual heat (data for monthly temperature for this year is not available, but the summer in 2010 was one of the hottest over all the country), the water level of the lake went down rapidly.

Table 2: Changes in Rainfall in Nyaung Shwe Township

(mm)

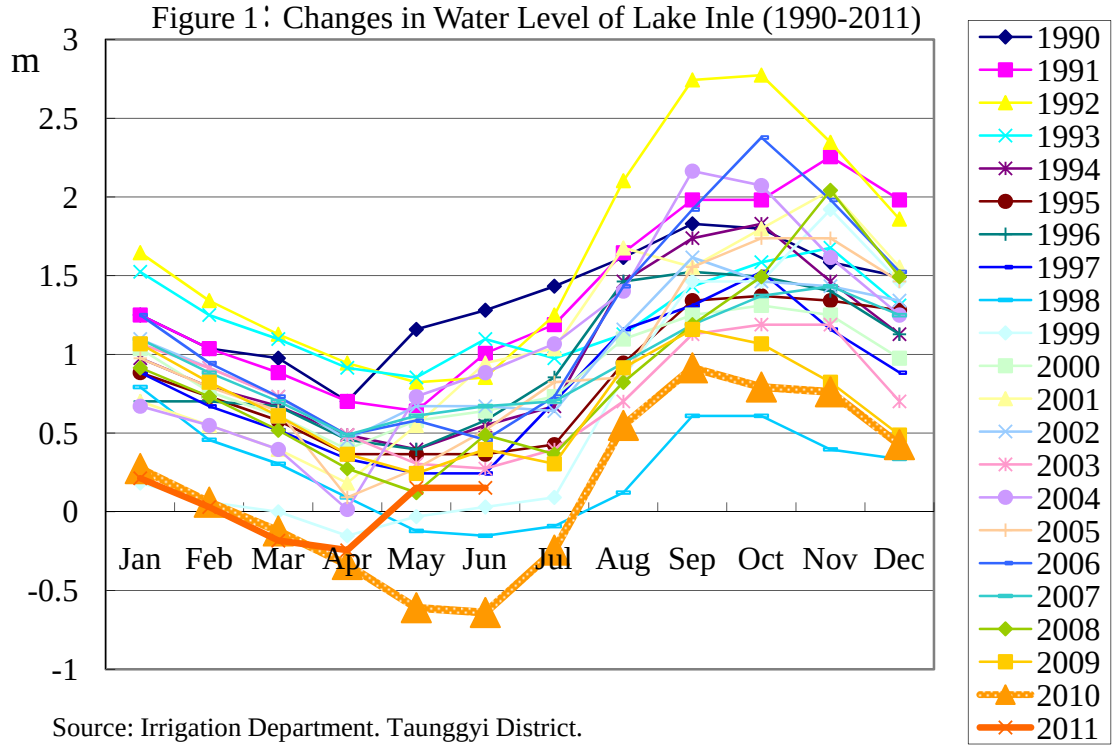
Month	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Jan	0	1	0	0	0	0	0	1	0	0	11	30	0	0	0	0	0	0	0	16
Feb	0	0	0	0	25	0	0	0	0	0	0	25	0	0	0	16	0	0	0	0
Mar	0	0	43	17	0	0	16	0	27	1	0	0	0	26	0	0	10	15	0	20
Apr	27	100	9	5	14	37	36	59	60	0	33	26	87	47	83	0	72	35	24	110
May	71	135	55	99	67	90	90	61	183	335	175	81	419	31	87	140	92	118	53	162
Jun	108	116	154	61	129	58	49	130	51	72	41	103	113	95	97	80	105	89	59	79
Jul	167	58	61	83	103	185	89	43	84	132	27	40	130	242	109	75	87	55	151	114
Aug	371	126	233	109	173	121	106	172	194	208	160	144	140	107	232	126	198	309	247	-
Sep	198	207	248	180	147	104	123	335	144	117	162	225	245	230	328	71	289	240	221	-
Oct	193	173	91	180	42	22	46	99	131	300	155	91	28	136	184	159	232	30	113	-
Nov	28	4	23	73	76	45	50	126	0	23	101	0	21	61	24	77	18	0	5	-
Dec	15	0	5	0	0	2	0	0	0	10	0	0	0	63	0	0	0	0	20	-
Total	1180	919	923	807	776	665	605	1026	875	1198	866	766	1182	1039	1144	744	1103	892	892	-

Source: Department of Meteorology and Hydrology, Myanmar.

[8] Village tract is the lowest unit of administration.

Figure 1 shows the water level of the lake. The Irrigation Department monitors the water level at the very north edge of the lake (Nande Village) and the location is recorded as 882.85 m a.s.l. Thus the figure is shown taking 882.85m a.s.l. as zero. As shown, the water level was low throughout 2010, and fell dramatically from March to July 2010. This is a measurement of only one specific location, thus in other locations within the lake, the water might have dried up completely. In that case, people could not use their boats, even to visit nearby houses. Walking on the bottom of the lake is not easy because the soil is too soft to walk on. It is not difficult to imagine the serious effect that this extreme event has had on the livelihood of *Inthas*, especially that of the fishermen.

Figure 1: Changes in Water Level of Lake Inle (1990-2011)



Source: Irrigation Department. Taunggyi District.

2. Fishing in the Lake

Lake Inle[9] is not an open access fishing ground. The lake is supposed to be managed as "open fisheries," where the government collects license fees according to the gear each fisherman uses. However, since it was difficult to collect these fees because of a shortage of human

[9] Lake Inle is divided in *Inle Inn* and *Sakar Inn*, which is downstream of Lake Inle. This paper only deals with *Inle Inn*.

resources and institutional backup, the management of the lake was entrusted to Mr. K since around 1999/2000.

Mr. K is 70 years old in 2012 and he is *Intha*.[10] Since he has been working in the fishery business since the early 1990s (he started aquaculture in 1991[11]) and has a good local social network, he was granted the right to manage Lake Inle (both *Inle Inn* and *Sakar Inn*). The right was granted by paying a lump sum for each Inn to the Department of Fisheries, and he was allowed to collect the fishing fees from the fishermen. Later this grant was formalized to be awarded to the local Myanmar Fishery Federation (in this case, Myanmar Fishery Federation, Taunggyi District). Since Mr. K has been the chairman of the local federation, he continued to be in charge of the lake until 2009/2010, up until the grant was awarded to the State Federation level[12]. Virtually everybody living in the lake knows his name, even if they do not necessarily know his face.

This grant took a similar form to leasable fisheries.[13] Under leasable fisheries, according to the regulations, the fishing right is given exclusively to the individual who wins the bid (leaseholder) and only the leaseholder has the right to exploit the resource. However, in many cases, "discretionary power" affects the process and a "good leaseholder" may be awarded the right continuously (FAO 2003). The lease fee would be increased annually, by around 10 %. The leaseholder normally subleases the fishing right to individual fishermen in the area. At the same time, the lessee is responsible for stock enhancement and sustainable usage of the resource.

In the case of the grant of the management right of Lake Inle, Mr. K paid the lease fee to the Department of Fisheries (300,000 kyat[14] for *Inle Inn* in 2009/10) and he needed to provide seed stock to the value of 30% of the lease fee (90,000 kyat in 2009/10). He subleased the right to the fishermen of Lake Inle and collects an annual fee of 3,000 kyat (2009/10) per fisherman[15]. Out of the 3,000 kyat, 500 kyat is paid to his agents as a collection fee. Agents are generally village headmen, who have good knowledge of the villagers. The fishermen can fish

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[10] He is originally from Nyaung Shwe, but spent ten years in the mountains, in the resistance army of Pa-O, before he came down to settle in Nyaung Shwe again. He understands the Pa-O and Shan language, but cannot speak them.

[11] He started hatchery in 2004. His fingerlings are sold in the local area, while some have been marketed to other area such as Ayeyarwady, Bago, Yangon, Mandalay, Kayar and Eastern Shan State since 2006.

[12] Currently the chairman of the State MFF is the taking the responsibility.

[13] For the detailed framework of leasable fisheries, see FAO (2003). Because of the similarities, the author assumes that FAO (2003) treats the case of Lake Inle as one of the leasable fisheries.

[14] The average exchange rate was 887 kyat per US dollar in 2010 (Source: JETRO-Yangon Office).

[15] Under the management of open fisheries, the license fee is supposed to be collected according to the gear. However, since it is too cumbersome to do so, he decided to make the collection as a lump sum, regardless of the number of gear used.

with any legal gear for the whole year after paying this fee. There were about 1,500 fishermen operating in Lake Inle[16] in 2009/2010, according to Mr. K.

As described earlier, *Intha* fishermen use small wooden boats without engines[17] and they use several types of gear when fishing. There are four main types of gear: set gillnet (*Htaung pyit*e), hook and line (*Nga Myar Than*), *Saung* and fish trap (*Myone*).[18]

The gear most widely used is the set gill net and hook and line. With the set gill net, *Intha* fishermen can fish in the day or at night. The fishermen say that the catch is better during the night, but some prefer fishing during the day because at night there is a risk of their fishing net being stolen while they are asleep on the boat. The main fish species currently caught by gill net are tilapia, featherbacks (*ngape, Notopterus* spp.*)*, and snakehead (*ngayan, Channa* spp.*)*. The catch of some local species (type of carps) that are unique to the lake such as Inle carp (*ngaphaine, Cyprinus intha)* and *ngalu (Crossocheilus latius)* is said to be decreasing year by year. Tilapia came to account for a large share of the catch, compared to other species, but its market value is generally much less per unit (the price of tilapia was 700-800 kyat per viss[19] while other fish is 2500-4000 kyat per viss).

Hook and line uses small shrimp as bait and its target is high value fish such as *ngape, ngaphaine*. The fishermen go out to the lake in the morning (8 or 9 o'clock) and come back the following morning. They might return for a quick meal during a day, but stay over the night at the lake. On the way back home the next morning, they collect small shrimp for bait for an hour or two. The fishermen rest on that day and the next day go out again. Thus, the long-line fishermen normally fish 12 times a month.

The *Saung* is an icon of the *Intha* fishermen, which can be found in various pictures of Lake Inle. Ironically, however, the *Saung* is no longer in common use because its catch is low. Fishermen normally start fishing in the morning (around 8' o'clock) and finish in the evening.

The use of fish traps is relatively new in this area. These traps are generally adopted as a response to the overall decreasing catch. The main target of the traps is tilapia. Fishermen set the traps in the morning and collect them in the evening. Some leave the traps for 24 hours. The number of traps determines the catch, but is limited by how many traps each fisherman can afford. Some fishermen replace the traps every two months, while others use them for a year by repairing them whenever necessary.

Fishermen combine the gear they use and use different gear depending on the season or the

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[16] The number of fishermen in *Sakar Inn* is also around 1500.

[17] In 2012, the author observed some fisherman started to use small engines on these boats. However, the number seemed to be not large.

[18] Other gear is used especially in small streams around the village, such as *main*, *cast net*.

[19] Viss is a unit used in Myanmar and it is equal to 1.6 kg.

expected catch. The most common combination at the time of the survey was set gill net and fish traps, as the fishermen can just leave the traps while they fish by set gill net. The other combination is set gill net and hook and line. In this case, the fishermen divide the season, for example 8 months for set gill net and 4 months for hook and line. A fisherman learns how to row the boat and fish with each type of gear as a child.

Fishermen can fish throughout the year if they wish.[20] However, generally, the catch in the rainy season is larger than that in the dry or hot season. Furthermore, the actual fishing period varies according to the earning opportunities available to each household. For example, those who farm (such as paddy and tomato cultivation) go fishing only after the completion of agricultural work (from around September). If they do not have other income sources, they depend on fishing throughout the year. The number of days they spend fishing also varies widely among households, but the maximum is 24 or 25 days per months, as they normally rest on the five nearby market days.

Most of the catch from the lake is sold either within the village (including the village brokers) , buyers who buy fish on the boat, or on the five nearby market days or Nyaung Shwe Town, while some is eaten at home. The sale in the five-day markets is important, as these markets are the major center for exchanging products. Some portion of the fish is sold in Nyaung Shwe Town and marketed to other parts of Southern Shan State. Considering their methods of fishing and the marketing, these *Intha* fishermen are not "commercial fishermen" but rather "subsistence" or "artisan" fishermen, whose market is local and income sufficient only for subsistence.

3. Fishermen's Adaptation and Coping Strategy

3.1 The Study Villages and its Fishermen

Village A and Village P were selected for the interviews of individual fisherman. Both villages are located within the lake. Village A is part of *Nande* Village Tract and Village P is part of *Nam Pan* Village Tract (Map 2)[21]. There were 307 households in Village A and 253 households in Village P in 2011, and the inhabitants were all *Intha*.

A breakdown of the main occupation by household was not available.[22] However,

[20] The law prohibits fishing in the breeding period, which is around June to August. However, this law is not strictly enforced. Those who have farmland or a floating garden may be able to abide by the law, but others without any means may break the law in order to survive.

[21] Nande Village Tract has 8 villages and Nam Pan Village Tract has 11 villages, which is large compared to the number of villages in a tract in the rest of Myanmar.

[22] Unlike agriculture (especially as found in the rice sector), there has been less government interest in individual employment. Thus, there is no formal system of recording the occupation of

according to the village chairmen, about 60% engage in fishing in Village A, and 80% in Village P. Some cultivate tomatoes on their own floating gardens (about 30% of the households in Village A, but only about 10% in Village P). The fishermen use the major four types of fishing gear described in Section 2.

In Village P, fish farming started around 2006. There were about 60 households engaged in fish farming in 2009. The first person started farming on the recommendation of Mr. K, who has his own hatchery besides his house.[23] The farming method is quite unique. The *Intha* people live in stilt-houses on the lake and fish in the water beneath their houses. They circle the stilts with nets and release the fingerlings purchased from the hatchery. The species they most commonly breed is grass carp (*Myet sa nga mi chin- Ctenopharyngodon idella*)[24]. Except for the initial few months when the fish are fed with rice bran (until the fish grow to about 12 cm in length), the feed is weed collected in the lake. Considering that the cost of feed is often a burden in aquaculture, farming grass carp is cost-saving as they do not have to pay for the feed. The fishermen normally collect the weed for about one hour every day. The fish are breed for almost one year under the house and then they are sold in the nearby market.

There is no fish farming in Village A, even in a normal year, due to the lower water availability (both in terms of quality and depths) around and under the house. Other income opportunities are limited. The most common type of work is casual daily labor (the majority work in tomato cultivation), but there are other skilled jobs such as carpentry. The dominant type of work for females in both villages is cheroot making at home. Some households may have family members who work in hotels or other tourist services, but these opportunities are still few. There is little immigration to other cities or other countries. In summary, the scope of the household economy is still confined within/surrounding the village.

The fishermen were selected from these two villages for two reasons. The first reason is the commonality: these two villages are typical *Intha* villages, where the people's livelihoods heavily depend on the lake, especially on fishing. The other reason lies in their difference. As noted earlier, fish farming is possible in Village P, but not in Village A. Generally, farming is being adopted as an alternative strategy as the natural catch decreases. Therefore, including those fishermen who are also engaged in farming should show whether fish farming is a valid adaptation strategy for *Intha* fishermen's households.

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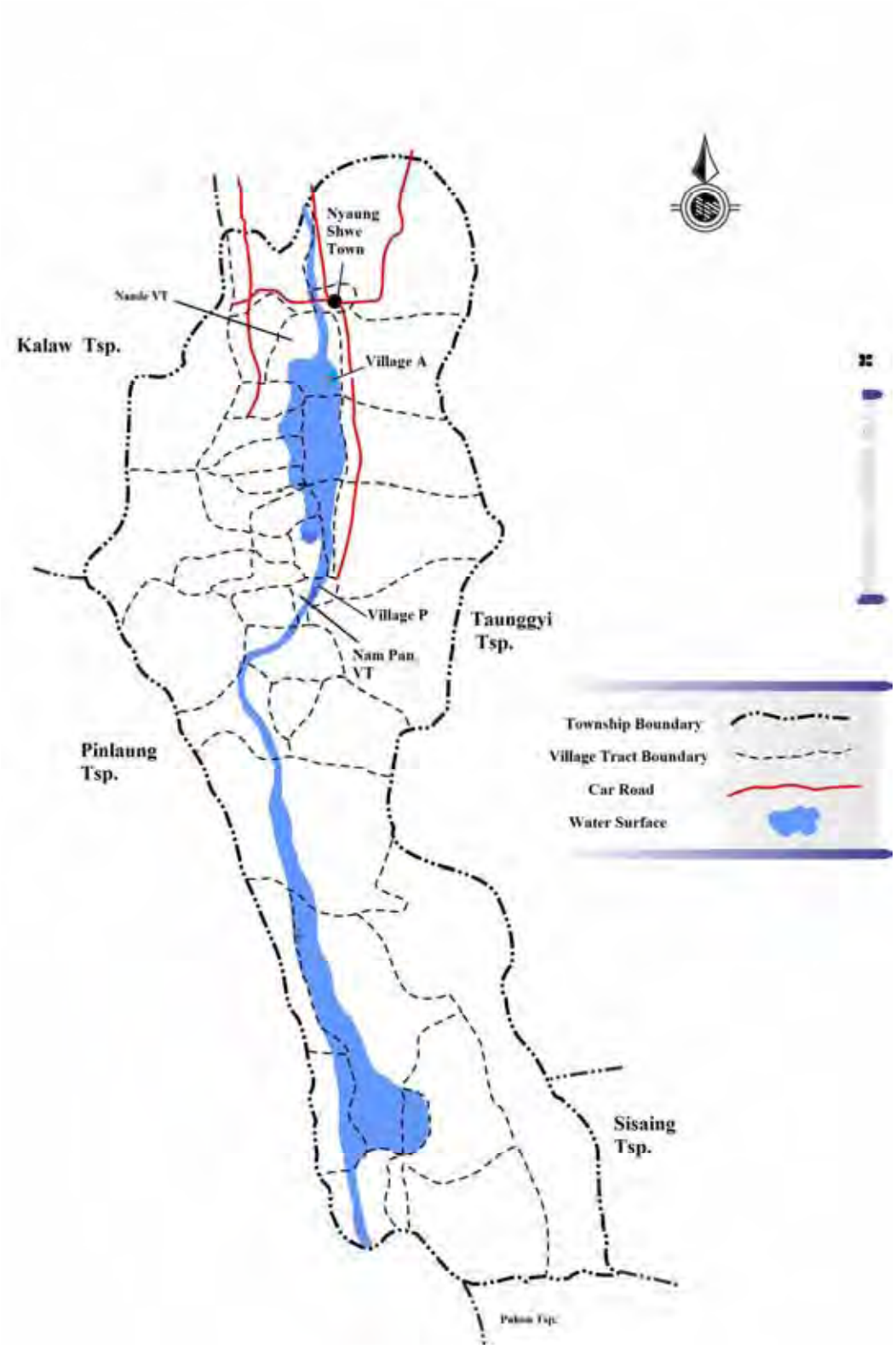
each household.

[23] He had already passed away when the author visited for the intensive interview in 2011.

[24] In the interviewed sample, there were two households out of 16 households who also tried to farm common carp and Inle carp together with grass carp. The rest of the households farmed grass carp only.

Map 2: Nyaung Shwe Township and Location of Study Village.



Source：Department of Forestry, Myanmar.

The interview was conducted on 50 fishermen, 23 from Village A, and 27 from Village P.[25] As it was not possible to have a complete list of households by occupation, we requested the village chairmen to invite anyone who was engaged in fishing and was available on that particular day (interviews were conducted for three days in Village A and two days in Village P). In this sense, the fishermen were not randomly selected. However, given that we covered different livelihood patterns and a wide range of income levels, the interviewed samples are not biased to specific segments of village people. The interview was conducted by local enumerators in Burmese, using the questionnaire prepared by the author. The author was at the interview and checked the questionnaire each time to clarify points that needed further explanation in direct conversations.

Table 3 shows basic information on fishermen households in two villages. Since there is no statistically significant difference in the samples between the two villages (number of households, age, educational level of household head and household income) the discussion proceeds without dividing the samples according to village.

Table 3: Characteristics of Sample Fishermen

	Number of Samples	Age of Household	Number of family members	Education (Completed Years)	Average Income (kyat)
Village A	23	46.6	4.9	3.6	1,186,286
Village P	27	43.1	5.1	4.0	1,279,691

Source: Author's Survey.

Table 4 shows the interviewed sampled households categorized by their major income source. These households had five different livelihood patterns.

Table 4: Number of Households According to Main Income Source

Fishing	Fishing+ Fish Farming	Fishing+ Tomato	Fishing +Fish Farming+ Tomato	Fish Farming	Total
21	10	13	4	2	50

Source: Author's Survey.

[25] Originally, we planned to interview 28 households in Village A, but it turned out that five households did not engage in any fishing activities.

Before moving on to the adaptation /coping strategy of fishermen, we examined the composition of household income. The households were classified into five according to their income level and the average incomes are shown in Table 5. The column “other “includes income from casual labor, cheroot making and carpentry, etc. As shown in the table, the level of both fishing and tomato farming income determines the overall level of household income. Those well-off households (Class V) earned sufficient income from both fishing and tomato farming.

Table 5: Composition of Household Income (kyat)

	Fishing	Fish Farming	Tomato	Others	Total
I	247,428	-30,000	-236,667	192,500	173,261
II	368,049	-41,600	17,800	267,889	612,138
III	525,322	54,733	-110,000	425,644	895,700
IV	1,021,957	-6,000	81,333	357,033	1,454,324
V	1,307,593	-44,167	2,310,000	539,017	4,112,443
				(%)	
I	142.8	-17.3	-136.6	111.1	
II	60.1	-6.8	2.9	43.8	
III	58.6	6.1	-12.3	47.5	
IV	70.3	-0.4	5.6	24.5	
V	31.8	-1.1	56.2	13.1	

Source: Author's Survey.

For fishing, the following gear is used (Table 6). Note that this is the gear used in 2010, so this would also include households that have already taken adaptation action. The set gill net is used widely, with a combination of other gear as well. On the other hand, usage of the *Saung* is limited.

Table 6: Fishing Gear Used in 2010 in Two Villages

Set Gill Net	Set Gill Net+ Trap	Set Gill Net+Hook & Line	Set Gill Net+*Saung*+ Trap	Hook & Line	Hook & Line+ Trap	*Saung*	*Saung*+ Trap	Trap
19	10	9	1	3	2	1	1	2

Source: Author's Survey.

The abnormal weather in 2010 affected tomato cultivation as well as fishing. Depending on the location of floating gardens, water was scarce and the harvest was much lower than that of normal years for some households. Some farmers gave up cultivation early in the season because of the water shortage (none of those sampled). Since the initial cost of tomato cultivation is large (seed, fertilizer, and pesticide cost account for a large share of the total production cost) once the crop fails, it can result in severe financial damage. That makes the tomato income of Group I, II and III negative. One household said their harvest in 2010 was one-third that of 2009.[26] However, as is obvious from Group V, if the harvest is at normal levels, a very high income can be achieved that far surpasses the income from fishing (seven households cultivating tomatoes in Group V earned a positive net income, ranging from 1 million to 5 million kyat).

The reason for the negative income from fish farming is the same as that for tomato cultivation. The purchased fingerlings died before they got big enough to sell, affected by the lack of water. The normal survival rate of the fingerlings is reported to be about 80%. However, in 2010, the average of the survival rate (16 households) was only 34%. Some harvested the fish before they were big because they feared that the fish would die. The average fish farming income fell to – 15,250 kyat. If the normal survival rate is assumed and the level of cost is the same, the income would have been 98,180 kyat. Compared to the initial cost of tomato cultivation, that of fish farming is relatively small and thus the income loss is less in scale.

At least for 2010, the sample fishermen households had to make up the loss from tomato cultivation and fish farming with their income from catching fish (plus some other income such as cheroot making).

[26] As the number of farmers cultivating tomatoes was less and the overall harvest was not good, the market supply was naturally less than in the previous year, 2009. Therefore, the market price was two or three times higher in 2010. Thus, if a farmer was fortunate not to be affected by the low level of water, the income from tomato cultivation could be very high.

3.2 Trend of Catch, Adaptation and Coping

3.2.1 Decreasing Catch

The income composition in the previous section shows that fishing remains the core income source, though tomato cultivation is the leading boost to household income. However, as noted in the introduction, the fish catch is steadily decreasing in Lake Inle. Table 7 shows the year that each fisherman felt that the catch decreased. More than 70% of fishermen perceived a decrease of catch after 2006 (There were six fishermen who responded that the decrease was from 2010.

Table 7: Year That Each Fisherman Perceived Decrease in Catch

Year	Number of Fishermen
Before 2000	1
2000-05	10
2006	6
2007	10
2008	7
2009	6
2010	6
Total	46

Source: Author's Survey.

Note: Two fishermen who could not respond to the question were excluded.

3.2.2 Adaptation

This section examines the adaptation strategy of fishermen against the decreasing catch. Table 8 summarizes their response.[27] The total number is 48, as two households who engage in fish farming only were excluded here.

The most common strategy is to increase the number of hours spent fishing, i.e. the fisherman decides to spend more time using specific gear. Twenty-two fishermen adopted this strategy. Nineteen fishermen used set gill nets, while one fisherman used *Saung* (increased by

[27] Fourteen households out of 48 did not take any measures. There are two possible reasons for this: those households with sufficient income may not need to take any action or the households might have also been suffering but they might be on the edge of collapse, in terms of labor and capital availability. We were not able to obtain information at the interview. One way to examine this is to check the interrelationship between income and response. However, data is available only for 2010, which show the incomes after the shock, and that may include the effect of a response, thus this is not good data for examining the correlation.

2 hours) and two fishermen used fish traps (3 hours and 15 hours). All of them started to increase their hours spent fishing after 2006 (except one who could not provide the exact year).

Table 8 : Adaptation Strategy by Household

Increase hours	9
Increase hours + Fish farming	5
Increase hours + Other income source	5
Increase hours+ Gear+ Fish farming	1
Increase hours+ Fish farming + Other income source	2
Increase gear	5
Increase gear + Fish farming	1
Increase gear+ Other income source	1
Fish farming	4
Other income source	1
None	14
Total	48

Source: Author's survey.

Next we examine the changes in time spent fishing with set gill net, as most time spent fishing is by this type (Table 9).

Even before they increased their time spent fishing, fishermen spent between 8 and 16 hours fishing per time (average of the sample fishermen is 11 hours). After they increased their time spent fishing, it ranged from 10 to 22 hours (average increased time was 5 hours). This shows that the fishermen spend very long hours on the lake. Out of the 18 fishermen whose year of starting to increase their time spent fishing is known, 10 fishermen increased their time spent fishing in 2010, and 3 in 2011. However, it is difficult to discern whether these responses were adaptation strategies or one-off coping strategies for the dramatic decrease of catch in 2010 (see Table 10 below). As pointed out in the introduction, a coping strategy may overlap and develop into an adaptation strategy. As fishermen started to fish for long hours after 2010 and continued to do so in 2011, we regard it as an adaption strategy.

No fisherman increased their time spent on hook and line fishing because most fishermen already spend the whole day fishing when using this gear.

Three fishermen changed the time they spent fishing with set gill net from night time to day time. Strictly speaking, this is not to increase the catch. As noted earlier, there are many cases in which fishing nets are stolen at night. Some fishermen reported that their nets were

Table 9: fishing Time Changes (Set Gill Net)

	Sr		Fishing Time		Engaged Time (hours)			Year of change
			Before	After	Before	After	Change	
Time Increased	1	Night	22-6	15-6	8	15	7	2010
	2	Night	16-4	16-9	12	17	5	2010
	3	Night	16-8	12-8	16	20	4	2006
	4	Night	15-8	13-8	12	14	2	2006
	5	Night	16-8	14-8	16	18	2	2010
	6	Night	15-4	17-8	13	15	2	2008
	7	Night	15-8	14-8	12	13	1	2010
	8	Night	17-3	17-4	13	14	1	2010
	9	Daytime	3-16	3-3	13	24	11	2010
	10	Daytime	6-20	6-26	16	22	6	2011
	11	Daytime	8-16	8-22	8	14	6	?
	12	Daytime	7-17	7-22	10	15	5	2011
	13	Daytime	8-14	8-18	6	10	4	2010
	14	Daytime	6-18	6-22	12	16	4	2011
	15	Daytime	8-16	6-18	8	12	4	2009
	16	Daytime	8-16	6-17	8	11	3	2010
	17	Daytime	8-16	6-17	8	11	3	2009
	18	Daytime	7-20	7-23	13	16	3	2010
	19	Daytime	4-16	3-16	12	13	1	2010
Time Change	1	Daytime	15-8	8-19	18	11	-7	2009
	2	Daytime	16-8	8-17	16	9	-7	2010
	3	Daytime	15-7	7-19	17	12	-5	
No Increase/ change	1	Night	15-9		19	19		
	2	Night	15-7		16	16		
	3	Night	15-6		15	15		
	4	Night	16-7		15	15		
	5	Night	15-6		15	15		
	6	Night	20-5		9	9		
	7	Daytime	6-18		12	12		
	8	Daytime	7-18		11	11		
	9	Daytime	8-17		9	9		
	10	Daytime	7-16		9	9		
	11	Daytime	7-16		9	9		
	12	Daytime	7-16		9	9		
	13	Daytime	9-16		7	7		
	14	Daytime	9-16		7	7		

Source: Author's survey.

stolen from one to five times a year. Purchasing fishing gear several times within a year is a heavy economic burden for some fishermen. This might be an extreme case, but one fisherman had to stop sending his daughter to school because he needed to purchase a fishing net again and could not afford the cost of schooling. Changing the time of fishing to day time is a measure that minimizes the risk of unexpected cash outflow, by sacrificing the (slightly) higher level of catch he can expect from fishing at night.

The second strategy is to increase the fishing gear by using an additional type of gear or using additional traps. Fishing gear was increased for set gill net, hook and line and fish trap. In order to increase the fishing gear used, unlike the fishing hours, the fishermen bear a financial cost.

Fish farming has already been explained in the previous section. There are 15 sampled households that engaged in fish farming. The year of starting fish farming was as follow: one fisherman in 2008, five fishermen in 2009 and nine fishermen in 2010. The majority stated that they started fish farming quite recently in response to the decreasing catch. However, as already discussed, the water shortage in 2010 had a devastating effect on fish farming against their high expectations. As a result of this bad experience, at the time of the interviews, two households decided not to start fish farming again in 2011.

The increase of other income source included engaging in agricultural labor (six cases mostly working on tomato gardens, and one case each for carpenter, own tomato cultivation and working in a hotel). This includes the work of the fishermen and their family members.

Judging from the number of cases, *intensification of fishing* (increasing fishing hours, number of fishing gear) surpassed the *diversification of income source* (fish farming and doing other jobs). The reasons are as follows: The fishermen take the response that incurs the least (financial) cost. From this point of view, increasing fishing hours requires only more labor (i.e. does not bear any financial cost). If there were ample alternatives that would make the opportunity cost of labor high, they would not have taken this choice to invest more labor on this scale. However, in reality, as described earlier, the available income earning opportunities are limited and those opportunities available do not generally yield a high level of income. Subsequently, fishermen spend extremely long hours on a small boat, trying to exploit the decreasing resources further. Fishermen who have the money invest in more gear, but this option is not open to every fisherman. This choice also obviously leads to further exploitation of the fish resources.

3.2.3 Coping Strategies

In addition to the decreasing catch, fishermen faced a marked decrease in catch in 2010. Table 10 shows changes in catch according to fishing gear and fish species between 2009 and 2010. Again, this is only the subjective figures of the fishermen. Regardless of the gear or fish species, and despite their efforts to respond to the decreasing catch, *Intha* fishermen experienced a huge decrease in catch in 2010.

Table 10: Catch in 2010 Compared to 2009, According to Fishing Gear and Species

Gear / Fish	Set Gill Net		Longl Line and Hook		Trap		*Saung*	
		Cases		Cases		Cases		Cases
Tilapia	71%	20	–	–	50%	6	50%	2
Ngape	61%	4	55%	5	–	–	–	–
Ngayan	62%	8	47%	3	–	–	–	–
Ngaphein	80%	3	–	–	–	–	47%	3

Source: Author's Survey.

What was their response to this decreasing catch? This is coping action, which is basically a collection of short-term responses. Table 11 lists the action taken by the sampled households, together with the adapting strategy they had been taking before the shock.

The table shows that the most common form of response is the liquidizing of assets, i.e. the sale of gold. Even with liquidizing of assets, some households needed to reduce consumption or stop their children from going to school. All but three households were already taking action against the decreasing catch, but they had to sell what they had saved from their meager income.

If they have no gold to sell these households might take out loans. Table 12 indicates the debt situation of sampled households in 2010. This table contains both the loans from informal sources and microfinance. Microfinance programs have been run by the United Nations Development Program (UNDP) in Nyaung Shwe Township since the late 1990s, and Village A is in the program. On the other hand, Village P used to be in the program, but it ended in 2008, because of a default problem by the lender-villagers. And even for Village A, some households decided to stop taking the loans. Thus, the very right column of Table 10 indicates the way the loan was spent if the households were in the scheme before, but not in 2010. The interest rate charged for microfinance credit is 3.75% per month, so it is definitely lower than the prevailing informal rates, considering collateral is not needed for microfinance credit.

Table 11: Coping Strategies after Adopting Adaptation Strategy

Sr	**Gold Sale**	**Reduce Consumption**	**Stop Schooling**	**Adapting Strategy**
1	600,000		○	Increased hours + Fish Farming
2	500,000	○		Increased gear
3	320,000			Increased gear
4	300,000			Increased hours
5	250,000	○	○	Increase hours + Other Income source
6	150,000			Increased hours + Gear+ Fish Farming
7	80,000	○		Increased hours + Fish farming+ Other income source
8	80,000			Increased hours
9	50,000			Increased hours
10	30,000			Increased hours + Fish Farming
11	15,000			Increase hours + Other Income source
12	10,000			Increased hours + other income source
13	600,000			None
14	250,000			None
15	20,000			None

Source: Author's survey.

About half of the sampled households (52%) were taking out informal loans on various scales. Some were taking both informal and microfinance credit. When we look at the usage or purpose of the informal loans, the share of consumption loans is small, in terms of the frequency as well as the scale. Rather, the share of production credit (especially those for tomato cultivation) is outstanding. Although households had to take out loans because of the shock in 2010, with the extent of microfinance used for production purposes, a good portion of households would be in debt regardless of the shock, in order to continue their cultivation or fishing. Thus, with the prevailing high interest (some are charged 10% per month with collateral), it might be difficult for fishermen to seek further credit in response to the emergency situation in 2010. Finding a credit provider is difficult, and the burden repayment is high.

Therefore, to cope with the shock in 2010, the fishermen households had to liquidize their assets, namely gold, while some also had to reduce consumption or stop their children going to school. With their maximum efforts spent on intensify fishing (both in terms of hours and gear), and limited availability of other income sources, these are the only means that they were able

to adopt.

Table 12: Condition of Debt

	Informal Source				Microfinance		
Sr	Amount (kyat)	Interest rate (% per month)	Collateral	Usage	Amount (kyat)	Usage	If participating microfinance , its purpose
1	500,000	10%		Tomato			Tomato
2	300,000	10%		Tomato			
3	200,000	10%		Tomato			Tomato
4	200,000	6%	Gold	Tomato	160,000	Tomato	
5	200,000	10%		Tomato			
6	100,000	10%		Tomato			Pig Breeding
7	100,000	6%	Gold	Tomato	160,000	Tomato	
8	100,000	6%	Gold	Tomato	160,000	Tomato	
9	100,000	6%		Tomato	160,000	Tomato	
10	50,000	0		Tomato	160,000	Tomato	
11	200,000	3%	Gold	Gear Purchase	120,000	Pig Breeding	
12	45,000	8%	Gold	Gear Purchase	50,000	Child Deliverly	
13	30,000	10%		Gear Purchase			Net Purchase
14	100,000	8%		Education			
15	70,000	10%		Education			Tomato
16	200,000	5%	**B**oat	Medication			Net Purchase
17	20,000	6%		Child Deliverly	120,000	Pig Breeding	
18	100,000	10%		UNDP Repaymeent	150,000	Pig Breeding	
19	20,000	4%	Gold	UNDP Repaymeent	160,000	Tomato	
20	100,000	3%	Gold	Consumption	200,000	Tomato	
21	30,000	10%	Gold	Consumption			
22	20,000	0		Consumption			
23	5,000	0		Consumption			Net Purchase
24	5,000	0		Consumption			
25	5,000	0		Consumption			
26					250,000	Tomato	
27					200,000	Tomato	
28					200,000	Tomato	
29					160,000	Tomato	
30					160,000	Tomato	
31					200,000	Gear Purchase	
32					160,000	Gear Purchase	
33					150,000	Gear Purchase	
34					120,000	Gear Purchase	
35					6,000	Gear Purchase	
36					300,000	Pig Breeding	
37					200,000	Pig Breeding	
38					100,000	Pig Breeding	
39					8,000	Pig Breeding	
40					6,000	Pig Breeding	
41					120,000	Education	
42					120,000	Education	
43					12,000	Education	

Source: Author’s survey.

4. Discussion on the Adaptation and Coping Strategies of *Intha* Fishermen

To understand and contextualize the adaptation and coping strategies of *Intha* fishermen, the framework of Agrawal (2008, 19-21) is useful. Agrawal classifies the possible adaptation/coping strategy into five options; *mobility, storage, diversity, community pooling and market exchange.* Mobility applies to pooling the risks across space. Migration is one option. Pastoralists in dry regions are a good example, as they move around searching for better places. *Storage* applies to pooling and reducing risks over time. If the producers have the capacity to store their products over time by processing or freezing, these products can be stored until required. *Diversity* applies to production, consumption and employment, such as cropping different varieties, seeking other income opportunities, and eating different kinds of food. *Communal pooling* applies to the joint ownership and/or usage of assets and resources. When an individual alone cannot cope with the changing environment and resources, collective action may be required. And finally, *market exchange* applies to risk pooling based on market institutions. According to Agrawal, this is a versatile strategy that can cover the functions of the four other strategies, but it requires highly developed institutions.

Next we consider the strategies of *Intha* fishermen in the light of these five options. Fishermen in Lake Inle cannot apply *mobility* with a decreasing catch. As it is a closed system under leasable fisheries, their fishing grounds cannot be changed. People's migration (both domestic and abroad) is also not gaining momentum in this area, if compared to other parts of the country[28].

Storage is also not a feasible option at the moment. They do not process the fish, but just sell them fresh in the market. It is primitive in terms of marketing, but as fishing in the lake has no large-scale commercial prospects, it is highly likely to continue in this way.

Diversification also has little prospect at present. Diversification in the fishery sector would be fish farming. On a stable basis, it can supplement income (but as it is small-scale farming underneath the houses, the expected income is not high as indicated in Section 3.1), and there is little scope for expansion. Furthermore, not all villages are suitable for this type of fish farming; as it requires a certain depth and good water quality (Village A is not suitable in this context). *Diversification* in livelihood is also very limited. Tomato cultivation provides an attractive income for local residents. However, the formation of new floating gardens was prohibited in the late 1990s, due to environmental concerns. To purchase a garden, requires 100,000-400,000 kyat per unit (100 *alan* =0.32 acres), which poor households normally cannot

[28] The dry zone, one of the most poverty stricken areas in the country, has seen an outflow of the rural population, especially to Malaysia in recent years.

afford, even if there were a floating garden for sale. Agricultural wage labor (average wage was 1,500 kyat per day) is also not stable, especially if it is only for tomatoes whose labor demand is concentrated in just three months. The opportunities for females are confined to cheroot making. Cheroot making earns only 500-800 kyat a day. Of the sampled households, 85% had female laborers engaged in cheroot making. One young woman who had graduated from university (Taunggyi University) came back to the village and engaged in cheroot making. Since cheroots are mostly favored by the older generations in rural areas, it is highly doubtful that demand will continue to grow in future. Thus, dependency on cheroot making has low prospects.

No mechanism for community pooling of risks has been established against the decreasing fish resources either on a village level or lake level, though all residents are aware of the phenomena.

What is the reason for this? Ostrom (1990, 42-45) points out three problems in realizing collective action for sustainable management of a common pool resource. First is the problem of supplying a new set of institutions. Second is the problem of making a credible commitment. Third is mutual monitoring. These problems allow little scope for success in the case of Lake Inle.

At the village level, the interests of the villagers do not necessarily coincide. For example, the usage of agrochemicals for tomato cultivation is blamed for deterioration of the water quality, but controlling agrochemical usage would be against the interests of tomato farmers. Furthermore, some fishermen are also tomato farmers, that allows them to have a much higher income than by fishing alone. Thus, it would be very difficult to obtain consensus even within the village. Thus, it is difficult to gain the momentum to create new institutions and make a credible commitment among the fishermen.

The other difficulty lies in the scale of the resource, i.e. the lake. One way of sustaining the fishery resources may be controlling the fishing period. As noted earlier, fishing is officially prohibited for three months in the rainy season (June to August), which is the spawning season. Nevertheless, as we saw, fishermen continue to fish throughout the year if they need to do so to survive. They have no other option. The scale of the lake makes it difficult to reach any consensus as well as to place an enforcement mechanism among fishermen. If one fisherman starts fishing in the prohibited period, others would follow. The fact that there were many cases of fishing nets being stolen is as much a reflection of their hardship as their morals. Only competition exists among the fishermen. Even if the government tried to enforce the rule, it is not pragmatic given the size of the lake, and the fact that the majority of fishermen go fishing at night. The other problem that has been occurring, but is not clear from the individual

interviews, was the usage of illegal fishing gear, i.e. fishing with battery shocks (fishermen would be reluctant to admit this in interview). With such a battery, it would be possible to catch 2-3 viss per hour (note some fishermen find it difficult to catch 1 viss per trip even though they spend long hours on the lake). The grant holder, the Myanmar Fishery Federation, which is supposed to be the organization responsible for the resource management of the lake seems to have little capacity to do so[29].

The final option, *market exchange*, is probably the most remote strategy for *Intha* fishermen. There is no momentum or institution that would enhance risk pooling through a market exchange mechanism in the local economy of Lake Inle.

Conclusion

Lake Inle and Nyaung Shwe Township is not only a major tourist destination but also an area where various kinds of official assistance are provided by international organizations and NGOs. Besides the microfinance programs, several projects, including some small-scale infrastructure and watershed management programs, have been implemented to improve the economic welfare of the local people.

For the last 10 years, Myanmar government has also been keen to halt the environmental degradation of the area. They set up a greening project of 20 miles radius of Lake Inle (Conservation of agriculture, forestry, land, water, birds and animals) in 1997. All the related authorities are in the committee, and they prohibited the establishment of new floating gardens. A stock enhancement program to the lake was also initiated in 2005/06. Nevertheless, it seems that the deterioration of the environment and decreasing fish resources has accelerated. They have not found any effective measures to stop sedimentation (i.e. deforestation) or to maintain the water quality. Moreover, the abnormal weather caused a huge shock in 2010.

The current adaptation strategy of *Intha* fishermen is to exploit the resources through intensified fishing, involving longer hours fishing and the use of more efficient fishing gear. Some fishermen use illegal gear or steal other fishermen's nets. If abnormal weather patterns such as those in 2010 occur again soon, some households may be devastated, without any means of support. The prospects of the fish resources of Lake Inle and those dependent on the fish resources for their livelihood are gloomy and drastic measure are required in the near future.

[29] Mr. K used to arrest 40-50 fishermen per year who used illegal gear. He made them sign that they would not use illegal gear again, in front of the village headman. If any continued, he had to take official action and hand them over to the police.

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