Livelihood Strategy of Lake Fishing Community in Guguk Malalo Village, West Sumatra Province, Indonesia

Anugrah Sri Widiasyih [a], Rudi Febriamansyah [b], and Yuerlita [b]*

[a] *Universitas Graha Nusantara, Padang Sidempuan, North Sumatera, Indonesia*

[b] *Universitas Andalas, Kampus Unand Limau Manis, Padang 25163, West Sumatera, Indonesia*

A B S T R A C T

Lake Singkarak is a livelihood source for people who live on the banks, especially for fishing activities. Unfortunately, this fishing sector shows a decline in fish catches resulting in decreased livelihood access to Lake Singkarak. This research aims to describe the types of livelihood strategies and access to livelihood assets and analyze the access of livelihood assets of fishermen to the current biophysical and environmental conditions of Lake Singkarak. Then the researchers analyzed the access of livelihood assets of fishermen based on the types of livelihood strategies of fishermen and the relationship of types of livelihood strategies with access to livelihood assets. The research method of used is adopting the Sustainable Livelihood Framework/SLF by using index value calculations to calculate the condition of access to fishermen's livelihood assets consisting of human resource assets, natural resource assets, physical assets, financial assets and social assets. The results of this study indicate that changes in the biophysical conditions and the environment of the lake have played a role in influencing access to fishermen's livelihood assets at the study site and have implications for decreasing sources of livelihood from the lake. It was found that presently there are 6 types of livelihood strategies that are carried out by fishermen to be able to fulfill their living needs, namely Type B: Fishermen who carry out fisheries intensification and extensification (6.12%), Type C: Fishermen who have diversified their economic activities either in agriculture or non-agriculture (34.69%), Type E: Fishermen who carry out fisheries intensification and extensification and also diversification (44.9%), Type F: Fishermen who carry out intensification and extensification of fishing and also temporary migration (2.04%), Type G: Fishermen who diversified their economic activities also temporary migration (4, 08%) and Type H: Fishermen who carry out fishing intensification/extensification, diversification and also temporary migration (8.16%). In relation to access to livelihood assets, it turns out that human resource assets are the main assets that influence the alternative choices of fishermen's livelihood strategies. The alternative type of strategy for diversifying economic enterprises, both in agriculture and non-agriculture, is the most widely chosen option besides alternative intensification and extensification of fishing in lakes.

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INTRODUCTION

Geographically, the condition of rural areas is synonymous with agricultural and fishery activities, because in these rural areas there are various natural resources used as the source of livelihoods of the people, which includes land and water, both in land and sea water resources. For people who merely depend on their livelihoods from exploiting land, they are commonly referred to as farmers, while people who depend on their

sources of livelihood from exploiting water resources for fishing, are usually called fishermen.

In Indonesian government, (2004), the definition of fishermen has been specifically emphasized. It has been stated that fishermen are people whose livelihoods are from fishing businesses to meet the needs of their families. In Indonesia, the catch of fish originating from the sea, rivers and lakes has great potential as a contributor to National Income. The biggest source of income comes from marine waters, because according to Zid & Alkhudri (2016), Indonesia as a maritime country has approximately 17,500 large and small islands with a total area of 5.8 million Km^2, and about 75% of that area is ocean.

The complexity of the problems in the use of land resources is not much different from the problems that exist in the use of water resources or waters, whether sea, lake or river. In fact, the community around those fresh and sea water resources faces a variety of complex problems, especially related to the condition of common property resources, decreasing environmental quality, natural and non-natural disasters. According to Barret & Reardon (2000), the complexity of the problems related to the characteristics of these resources certainly has a direct effect on the lives and livelihoods of fishermen. In general, of course, fishing communities naturally have adapted according to changes in the condition of their natural resources. The fishing community generally has several alternative sources of livelihood that will be able to support their livelihoods. Alternative livelihoods are also called livelihood strategies, namely a combination of activities and choices that people must make in order to reach their needs.

Therefore, the availability of various natural resources or socio-economic activities in the vicinity of its geographical area, is an alternative source of livelihood in developing livelihood strategies, both in the agriculture, fisheries, forestry, plantation, livestock, entrepreneurship, services, construction and other sectors. The livelihood strategies chosen are those that are believed to provide a sense of security from the risk of vulnerability and will also improve their standard of living and the sustainability of their livelihoods. The strategy to be able to do more than one source of livelihood for farmers and fishermen is an adaptive strategy, because the community believes that if one source of livelihood fails, then they can continue their livelihood from other sources of livelihood to support their living needs.

Lake Singkarak is the second largest lake on the island of Sumatra, after Lake Toba. Lake Singkarak has provided many benefits not only for the surrounding community as a source of livelihood for agriculture and fisheries, but also as a water resource for electricity for the people of West Sumatra in general. The results of the study of Yuerlita (2011) shows that Lake Singkarak is an economic source for 77% of the people living in the village (*Nagari*) on the shores of Lake Singkarak. Likewise with Arifin (2005), which emphasizes that more than 400,000 people live on the slopes and banks of Singkarak, depending on their livelihoods on the waters of Lake Singkarak. Various studies state that the main results obtained from the waters of Lake Singkarak are *bilih* fish catches (*Mystacoleusus padangensis Blkr.*), as endemic fish that only live in Lake Singkarak.

In fact, at present, several studies have identified that production of *bilih* fish has decreased significantly over the past 3 decades. The results of the Yuerlita study, 2011, showed that data from the 1988 period to 2003 decreased from 736.46 tons to only 149.47 tons. The catch of Bilih fish as the main income of fishing communities and fish processing producers around this Lake, has become scarce. From various studies, it has been widely hypothesized that the decline in bilih fish production mainly occurs not only because of overexploitation but can also occur due to disruption or deterioration in the quality of ecosystems and lakes, as a result of human activities both directly and indirectly.

One of the Village or Nagari whose population depends on the resources of the waters of the lake Singkarak is Nagari Guguk Malalo, which is located on the West side of Lake Singkarak. Most of their livelihoods are farmers, fishermen or a combination of fishermen and farmers. Residents who live on the banks of the lake generally have their own boat (canoe) and traditional fishing gear. For those who solely as lake fishermen, usually a fisherman spends his time catching fish for 4-6 hours per day, then with his wife will process the catch until marketing.

RESEARCH METHODS

Study site

Nagari Guguk Malalo was chosen as the location of the study, mainly because based on previous studies it was identified that fishing communities had experienced a decline in their fish catch production, and many fishermen did various alternative jobs for their survival. Nagari Guguk Malalo is located on the West side of Lake Singkarak that topographically ranging from the coastal plain of the lake in the East, to the hills of Bukit Barisan on the West side. Settlements are generally located on the shore of the lake, while in the hills are used for agriculture, fields and gardens.
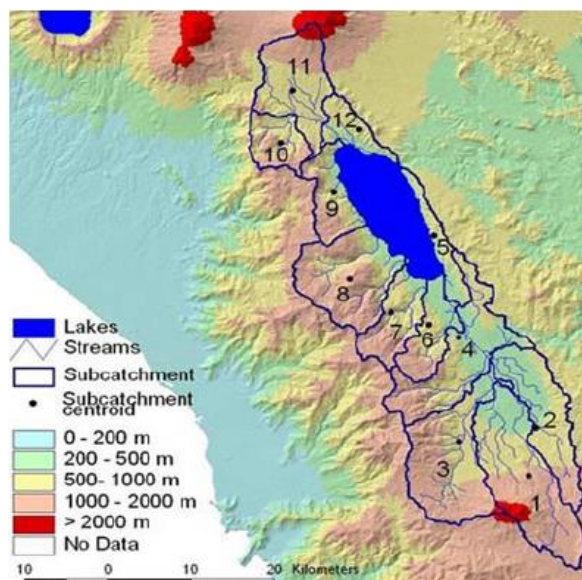

Figure 1. the Study site in Nagari Guguk Malalo

Table 1. Variables for livelihood strategy analysis

Types of Asset	Sub-Variable of Asset	Operational definition of sub-variable
X_1: Human resources assets	X_{11}: ratio of available family labor forces	% of the number of workers in the family compared to the number of family members
	X_{12}: ratio of education level	% of the number of family members with high school education and above with the number of family members
	X_{13}: ratio of working experiences	% of respondents' work experience with the total experience of all respondents
X_2: natural resources asset	X_{21}: ratio of catch fish production	% of fish caught production with the total fish production of all respondents
	X_{22}: ratio of available water quality	% of the total water quality scores enjoyed by respondents with the total score of water quality value in the study site
	X_{23}: ratio of lake biodiversity	% of the diversity of fish caught compared to the total diversity of fish in the lake
	X_{24}: ratio of land ownership security	% the total score of land ownership status with a total score of all ownership statuses
	X_{25}: ratio of the quality of the available land	% the total value of the respondent's land quality score with the total land quality scores at the study site
X_3: Physical asset	X_{31}: ratio of housing ownership	% the total score of the origin of home ownership with the total score of home ownership at the study site
	X_{32}: ratio of time duration from home to workplace	% ratio of the time duration from house to lake edge with the time duration to Nagari office
	X_{33}: ratio of fishing gear ownership	% of the number of fishing gear owned with the total type of fishing gear at the study site
	X_{34}: ratio of fish processing activities	% of the price of caught fish sold compared with the average price of processed fish at the study site
X_4: Financial Asset	X_{41}: ratio of remittent	% remittances received per month
	X_{42}: ratio of family income	% of the income of respondents with the average income of all fishermen in the study site
X_5: Social capital Asset	X_{51}: ratio of the role in social organization	% of the number of social organizations followed by the total numbers of social organizations in the site
	X_{52}: ratio of participation in social activities	% of amount of participation in social activities with the number of social activities on the study site

Methods for data collection

This study analyzes fishermen who have had experience of fishing for at least more than 10 years, with the consideration that fishermen already have a lot of experience in the field of fisheries and are aware of various problems and changes in biophysical conditions and influential lakes in the process of fulfilling their daily needs. In-depth interviews were first conducted with key informants consisting of community leaders, such as the Head of the Nagari, the Customary Chief, the Chair of the Fishermen's group and the Head of the Jorong (sub-village). In-depth interviews aim to get in-depth information about environmental biophysical conditions and fishermen, who can assist in developing the writing of survey research questionnaires for fishermen as respondents in this study. Data collected from the questioner interviews will be then analyzed qualitatively and quantitatively. There are 98 respondents have been chosen from the population of 129 fishermen of three jorongs in this Nagari by using the Slovin formula. Those sample respondents were choosing by applying proportionally random sampling method from that three jorongs, namely *Jorong Baing, Guguk Malalo and Duo Koto.*

Methods for data analysis

This study applies the Sustainable Livelihood Framework (SLF) from DFID (1999), where it is stated that a community's livelihood strategy is related to people's access to five types of assets, human resource assets (H), natural resource assets (N), social capital resource assets (S), physical assets (P) and financial resource assets (F). In this regard, in order to answer the first objective, the study used qualitative descriptive analysis, where all qualitative information from several key informants about the dynamics of biophysical and environmental changes in the study locations were examined from being triangulated with other information and data both secondary data, observations and literature studies. While to answer the second goal, this study combines qualitative and quantitative analysis, as follow:

Firstly. The identification analysis of livelihood strategies and access to livelihood assets of each respondent, which hypothetically consists of three kinds of livelihood strategy: (1) Fisheries intensification / extensification strategies (I), (2) diversification strategies of agricultural / non-agricultural activities (D), and (3) temporary migration strategy (M). Each respondent of fishermen in the study site may have a strategy of one or more livelihood strategies with a combination of those three kinds of strategies (I, D, and M).

Secondly, quantitative analysis of the level of access to livelihood assets owned by each respondent, which consists of 5 (five) types of assets for their livelihood; (1) Human Resource Assets (X1), (2) Natural Resource Assets (X2), (3) Physical Facility Assets (X3), (4) Financial Assets (X4) and (5) Social Capital Assets (X5). An assessment of the amount of access to these assets, generally uses the following formula:

$$X_{i} = (X_{i1} + X_{i2} + \ldots + X_{in}) / n \qquad (1)$$

where:

X_i: Average value of access of all assets i (in %)

X_{in}: Value of access to one element of asset I (in %)

Thirdly, a descriptive analysis of the relationship between types of livelihood strategies with access to assets of their livelihoods.

The description of each variable for that quantitative analysis are shown in Table 1.

RESULTS AND DISCUSSION

Current biophysical and environmental condition of Singkarak

The hydropower plant and the changes of lake ecosystem

The community acknowledged that there were many disadvantages since the hydropower plant began operating for 175 MW. One of which results is the changes in lake water circulation, especially at the hydroelectric intake gate located in this Nagari. Its operational activities result in water level fluctuations (lake elevation). During the dry season the company drains the lake water to a critical level. While, during the rainy season, the company carries out water as a result of which hundreds of hectares of agricultural land and land (fishing ponds) are flooded with water, as well as abrasion and soil erosion along the lake's lip. This change can trigger the rise of sulfur from the bottom of the lake (bangai: local term), making the dead fish poisoned and the extinction of several species of lake biota (Masrial, 2018)

In short, the hydropower development policy has provided a change to the current condition of Lake Singkarak ecosystem. This change has slowly influenced fishermen's access to natural resources, especially access to lake resources, lake water quality, fish diversity and agricultural land use. The level of fishermen access to these assets reflects the impact of government policies and structural adjustments to fishermen's livelihoods.

The development of fishing gears

Sedentary gill nets (*langli*: local term) are still and the most widely used fishing gear by fishermen, which is 67.35% until now. Initially most of them used to catch fish using the *Alahan* system, because *bilih* fish usually spawned by trying to oppose the flow to the rivers which emptied into Lake Singkarak then laying eggs between the rocks and using other fishing tools such as *langli* (also known as *pukek bilih*), *pukek sasau* and common gill net (*jaring tebar*). In a day most fishermen get as much as 50-100 liters / day of catch (Rabumas, 2018)

Tabel 2. Fisihing gears in the study site (n = 98)

Type/name of fishing gear	Number of respondents	% of total respondents
Alahan net	27	27,55
Jaring Insang Menetap (langli)	66	67,35
Jala Tebar/Jaring Lempar	43	43,88
Jaring Insang Sasau	11	11,22
Jaring Insang Turik	5	5,10
Bagan	32	32,65

But after the changes in the lake ecosystem, only a few fishermen used the *alahan* system to catch fish because of the condition of the muddy and dirty lake water. According to key informants, the *bilih* fish did not like dirty water. From the results of observations in the field it can be seen that the conditions of the *alahan* net are mostly not maintained and used again. Likewise, the fish catches are declining, which is only 0.5 kg / day, and sometimes none at all.

The decline was caused by over fishing and the use of the un-environmentally friendly fishing gear began to increase, like the use of electric shock for several years ago, the increase use of smaller size of the net from 3/4 inch to 1/2 inch, and the more floating nets gears and *Bagan* (lift nets). As a result, the immature fish have been caught and cannot reproduce to produce new fish eggs. Therefore, in relation to fishermen's livelihoods, the decline in *bilih* fish production has a significant influence on access to natural resource assets in the form of fish production and fishermen's financial assets in the form of decreasing income from lake resources.

The lake water pollution

Water pollution of Lake Singkarak originates from various wastes of the City of Solok which flow from the large Sumani river and waste from Padang Panjang City which flows from the Sumpur river. In addition to these wastes, the source of this lake pollution also comes from agricultural waste, residents' waste and floating nets aquaculture businesses (KJA) waste. Agricultural waste comes from the area ofcommunity rice fields, especially those on the banks of the lake. During the rainy season, most rice fields are flooded, so the chemical fertilizer used by farmers mixes with lake water (Mulyadi, 2018).

Residents' waste usually comes from sewage and household waste. Communities usually use streams or small rivers close to their homes for sewage, washing and household waste. Likewise with KJA waste that uses nitrogen-containing fish feed. These wastes are submerged at the bottom of the lake because the drainage system does not flow naturally and is regulated by hydroelectric turbines. This causes waste deposits that can cause poisoning and blackened lakes (*bangai*: local term). The polluted biophysical conditions of Lake Singkarak have resulted in a decrease of fishermen access to physical assets because most of *alahan* net for *bilih* fish cannot be used anymore.

Fishermen's livelihood strategy

Fishermen in the Nagari Guguak Malalo are apparently implementing 6 (six) types only of their livelihood strategy from 8 (eight) possible types of combinations from those 3 kinds of livelihood strategies (I, D and M). The types of fishermen who only work as fishermen are no longer exist, because generally due to the changes condition of their environment, fishermen have adapted their livelihood strategies (see Table 3.)

fishermen representing their ability to overcome the vulnerability of their livelihoods from lakes, so that this can support the security of their sustainable livelihoods.

Furthermore, the Type F livelihood strategies is the less strategies (only 2% of 98 fishermen) that were carried out by fishermen in the study site. Fishermen in this type, combining their alternative strategy in fishing intensification / extensification activities with the temporary migration, working as paid labor or trading in

Tabel 3. Types of fishermen's livelihood strategy in the study site

No	Type	Types of fishermen's livelihood strategy	Numbers of respondents	%
1	A	Fishermen who do not make changes their livelihood strategy	**0**	-
2	B	Fishermen who carry out fisheries intensification and extensification activities, (I) only	6	6,12
3	C	Fishermen who diversify agriculture and non-agriculture, (D) only	34	34,69
4	D	Fishermen carry out a temporary migration livelihood strategy (M) only	0	-
5	**E**	Fishermen who carry out fisheries intensification/ extensification and diversification on agriculture/ non-agriculture, (I) and (M)	**44**	**44,90**
6	F	Fishermen who carry out intensification / extensification and temporary migration, (I) and (M)	2	2,04
7	G	Fishermen who diversify their agriculture/ non-agriculrure and do temporary migration; (D) and (M)	4	4,08
8	H	Fishermen who carry out fishing intensification, agriculture/non-agriculture, diversification and temporary migratio, (I), (D) and (M)	8	8,16
	Total		**98**	**100**

The results of the analysis of identifying the livelihood strategies of fishermen in Guguk Malalo indicate that the livelihood strategies that are mostly (44.90% of 98 fishermen) carried out by fishermen are Type E, where in order to face vulnerability, fishermen will carry out the (i) and (d) alternative strategies. This (i) alternative strategy related to their activities in increasing the number of fishing gears, minimizing fishing nets and expanding their fishing areas. While, their (d) alternative strategy are related to their involvement in one or more activities such as rice farming (food crops), gardening, paid labor on farming or building construction, livestock raising, trading, processing of fish products, sewing, motor or car workshops, motorcycle taxi driver, working officially in governmental offices, and working as office security. The diversity of livelihood strategies of those

the neighboring nagari or district. Meanwhile, 2 (two) other livelihood strategies were not carried out by fishermen, namely Type A and Type D are not existed currently. In short, this figure shows that there are no fishermen who are passive in facing the vulnerability context they experience. In order to meet their needs at least they will try to carry out fisheries intensification / extensification activities to follow the trends of other fishermen in Nagari Guguak Malalo.

Access of fishermen to their livelihood assets

The value of the ratio of fishermen's access to 5 (five) types of their livelihood assets in each fishermen's livelihood strategy in Nagari Malalo is then focused on 6 (six) existing strategies (B, C, E, F, G and H), as shown

in Table 4 below. It can be seen in the table that access to human resource assets is the highest owned by fishermen in Nagari Malalo. Specifically, fishermen with livelihood strategies type B, C and E are the type of strategy which have a greater ratio of the value of human resource assets compared to the ratio of other resources assets.

Table 4. Distribution of ratio value of access to livelihood assets in each type of fishermen's livelihood strategy (in %)

Type of livelihood strategy	Human Asset	Natural Asset	Physical Asset	Financial Asset	Social Asset
Type B	**29.50**	13.16	23.43	26.25	23.61
Type C	**30.02**	23.62	23.20	16.40	22.30
Type E	**29.00**	24.32	22.38	13.69	26.61
Type F	8.65	18.18	**24.39**	10.00	16.67
Type G	20.52	15.21	17.55	10.00	**25.00**
Type H	23.73	17.38	**27.10**	10.00	10.00
Total	141.42	111.87	138.05	86.34	124.19

The existence of human resources seen from the availability of labor in the family, education, and experience of fishermen are important factors for fishermen to make alternative livelihoods, in intensification and extensification of fishing or diversification of agricultural/non-agricultural businesses.

While fishermen who carry out livelihood strategies F and H that carry out intensification/ extensification and irregular migration outside the region, generally are fishermen who have large asset ratios in physical facilities resources, especially fishing gear and processing. Table 5 below shows information on the distribution of alternative types of livelihood strategiesundertaken by fishermen in response to changes in biophysical and environmental conditions in the Nagari.

Table 5. Distribution of respondent at each type of livelihood strategy

No	Alternative kind of livelihood strategy applied by each respondent	Type of livelihood strategy					
		B	C	E	F	G	H
I: Intensification/ekstensification of fishing activities							
1	Add more fishing gear	5		**34**	2		5
2	Reduce the size of fishing net	5		14	0		5
3	Expand the fishing zone	1		10	1		4
D: Diversification of economic activities in agriculture and non-agriculture							
1	Working on rice farming		15	**37**		1	4
2	Working on dry land farming		25	**34**		3	3
3	Working on cattle farming		0	**1**		0	0
4	Working on local trade		4	9		0	1
5	Working as paid labor		7	11		0	0
6	Working on fish processing		4	5		0	3
7	Working as driver of rented motor bike		1	2		0	0
8	Working as tailor-man		0	**1**		0	0
9	Working on motor repair workshop		1	3		0	0
10	Working as official in village office		0	2		0	0
11	Working as security officer		1	2		0	0
M: Migration							
1	Irregular migration (works outside the area periodically)				2	4	8

Note: one respondent might do more than one alternative for each kind of livelihood strategy (I), (D) and (M).

It can be seen that the type of strategy for diversifying economic activities in both agriculture and non-agriculture is the most common type of strategy, especially for fishermen groups which are included in the types of livelihood strategies C and E. While fishermen who are of type E are mostly fishermen (44.90%, see Table 2), which not only diversified in agriculture and non-agriculture but also carried out strategies for intensifying and extending its fisheries, especially by increasing the number of fishing gears.

Here, the relationship between changes in environmental biophysical conditions and changes in the livelihood strategies of fishermen in the study locations is increasingly apparent, where changes in environmental

biophysical conditions have intensified efforts to intensify and extend arrests, in addition to a number of people who have diversified to not be too dependent on fish resources in lake waters.

The condition of access to livelihood assets turns out to affect the strategy that will be carried out by fishermen. Every fisherman has different problem, so it requires different strategies to overcome them. The lower the value, the lower asset ownership of the fishermen and vice versa if the value is high, the ownership of the asset is also high, as previously explained.

CONCLUSION AND RECOMMENDATION

Biophysical conditions and lake environment, which are seen from changes in lake ecosystems, environmentally friendly fishing gear and excessive fishing capacity, lake pollution and ultimately have an impact on decreasing fish production which is an external factor that directly affects access to livelihood assets consisting of human resource assets, natural resources, physical assets, financial assets and social assets called internal factors. This makes the condition of fishermen in the context of vulnerability which causes the condition of their livelihoods to be disturbed, especially from the lake. Declining sources of livelihood will have implications for decreasing access to other livelihood assets.

Of the five access to livelihood assets, fishermen have one of the five livelihood assets that can support fishermen to make a variety of livelihood resources that will be able to sustain their livelihood needs in a sustainable manner and be able to maintain their economic accessibility. The livelihood strategy consists of six (6) types of livelihood strategies namely Type B, Type C, Type E, Type F, Type G and Type H. Of the 6 Types of Livelihood Strategies, for each access that plays a role in different livelihood strategies. For Livelihood Strategies Type B, Type C and Type E assets, because fishermen have access to high human resource assets from other assets. Type F livelihood strategies 24.39% and Type H 27.1%, have high access to physical assets in supporting the fulfillment of their livelihood strategies. And only Type G is 25%, which has a high value of access to social assets among other assets.

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