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Status of Lake Taal Fisheries Amid Volcanic Threat and Covid 19 Pandemic : A Preliminary Study

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Abstract

The status of fishery resources of Lake Taal as the third largest lake in the Philippines was assessed to provide updated information on the capture fisheries following the Taal Volcano eruption and COVID-19 pandemic in 2020. Using the methodology of the National Stock Assessment Program of NFRDI, this study was conducted from January to December 2021 at 15 fish landing sites around the lake. In addition, interview schedules of 100 fisherfolk respondents from 11 coastal municipalities were also conducted to assess the effect of the volcanic eruption and pandemic on the livelihood of fisherfolk. Annual capture fisheries production was estimated at 1,004.14 MT. About 47% percent of these comprised the endangered freshwater sardine *Sardinella tawilis* while 31% are introduced species, and 22% migratory and/or native species. Current fisheries inventory showed that the number of fishers, fishing gears and fishing boats increased compared to 2018 inventory. The increased number of fisherfolk showed that more residents became dependent on the fishery resources of the lake. In the aftermath of volcanic eruption, reported impacts include reduction of fishing activity due to damaged gear and boat, fear of open water fishing, and reduction in demand for fish due to "unsafe" claims. Though many boats and gear were damaged in the 2020 volcanic eruption, passive or stationary fishing gears such as fish traps and fish corrals noticeably increased. During the peak of the community quarantine due to COVID-19, movement of fisheries products were hindered which led to the disruption of supply chain, and reduction of fishing activities due to lesser demand. Though there were times when fishing activities were halted due to recurring volcanic threat and pandemic, sustaining food and livelihood are what drive the local fisherfolk to learn to live and adjust adaptively to the current situation.

Keywords: fisherfolk, production, stock assessment, Taal Volcano, COVID-19

1. Introduction

Lake Taal is the third largest lake in the Philippines with an area of 24,356.4 ha with a maximum width of 18 km and a maximum length of 25 km (Perez et al., 2008). It is very deep with an average depth of 65 meters and maximum depth of 180 meters (Castillo and Gonzales, 1976). It is located in the island of Luzon, province of Batangas. The lake is popularly known for its beauty and tourist attractions. It has the richest ichthyofauna among the major lakes in the country and is home to the endemic freshwater sardine, tawilis (*Sardinella tawilis*); the highly prized migratory fish, maliputo (*Caranx ignobilis*); and the freshwater seasnake, duhol (*Hydrophis semperi*) - one of the only three freshwater sea snakes in the world (Papa and Mamaril, 2011).

Within the lake lies Taal Volcano, the second most active volcano in the country. The lake, the volcano, and its surrounding watershed is part of the Protected Area named TVPL or the Taal Volcano Protected Landscape, where the conservation and management of all its biodiversity is governed by the Protected Area Management Board or the PAMB. The lake has multiple uses – the most dominant and important is its fisheries and aquaculture uses. Other uses include recreation, tourism, navigation, water source and for research.

On 12 January 2020, Taal Volcano erupted after 43 years of repose, creating a 17-21 km high plume of steam and tephra (Lagmay et al., 2021). In a span of 5 hours, alert level warnings escalated from Alert Level 2 to 4 – the second highest in its category. At least 4,500 people within the danger zone were forced to evacuate to neighboring towns and provinces. Two weeks after the major eruption, the majority of the evacuees were allowed to return to their residences. After a month, Taal Volcano's alert level was further lowered to Alert Level 2 - increased unrest. Two months after the eruption, the COVID-19 emerged as a global pandemic, affecting millions of people in Luzon. Movement of people was restricted, with checkpoints visible in all *barangays* (small villages). With around 2,000 fisher dependent on the lake's fisheries resource (Mutia et al., 2018), the status of fisheries of Lake Taal is explored in this study to provide updated information on the capture fisheries production following the Taal Volcano eruption and COVID-19 pandemic in 2020. In addition, this study aimed to assess the effect of the volcanic eruption and pandemic on the livelihood of fisherfolk.

2. Methods

This study was conducted for a year from January to December 2021 in Lake Taal, Batangas, Philippines. Figure 1 shows the location of the study area.

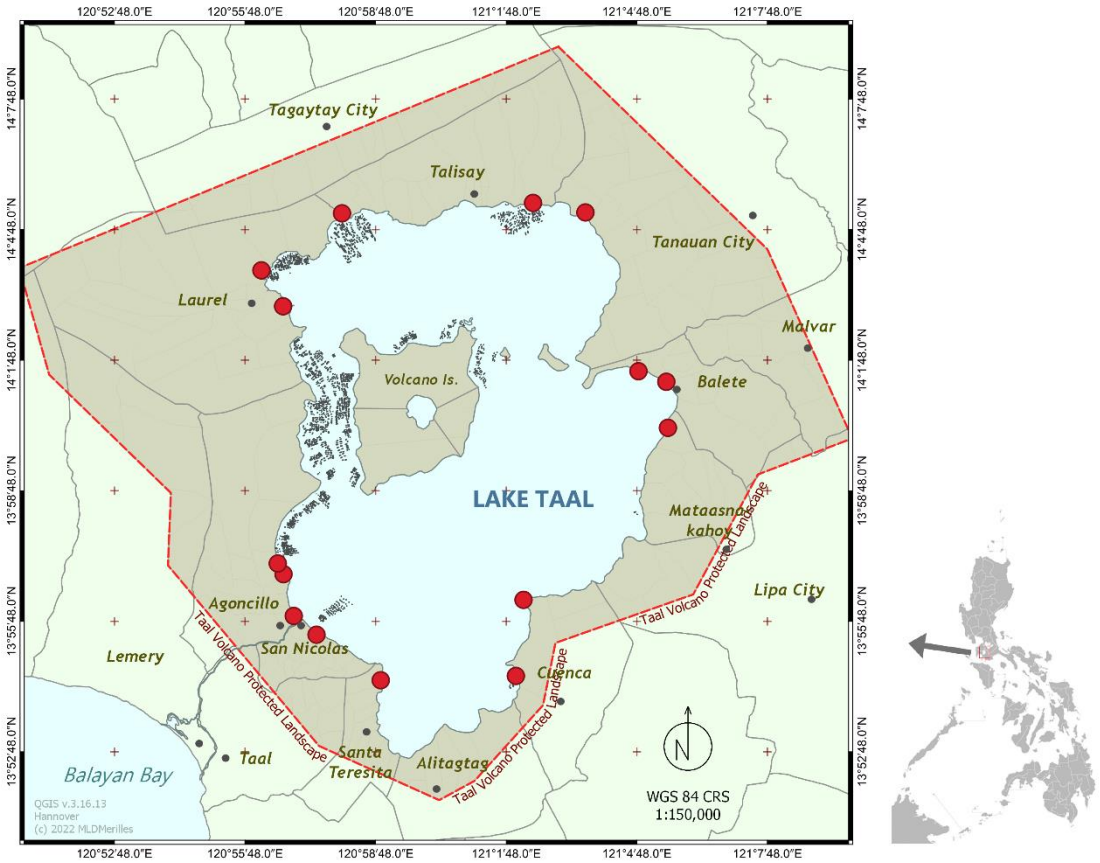

Figure 1. Location map of study area and landing sites (red dots)

Landed catch survey

Following the data collection methods of the National Stock Assessment Program (NSAP) of NFRDI (Santos et al., 2017), actual fish catch were monitored for 10-11 days in 15 major landing centers (Figure. 1) surrounding the lake. Total enumeration of the landed catch per day (LCD) per species per landing center was recorded. From this, monthly production (MP) was estimated per landing center using the following computation:

$$MP = \frac{D}{d} \times \sum \quad LCD \qquad (1)$$

where *D* is the total number of fishing days in a month and *d* is the number of monitored fishing days for the specific month. Annual production was computed by summing all monthly estimates. Species composition was classified according to their occurrence. The corresponding production estimate of each species and the production estimates of the top 10 species were enumerated.

Inventory

A separate survey (census) of fisherfolk, fishing gear and boat was carried out in all coastal barangays of the lake. The following information was collected: number and profile of fisherfolk per barangay, gear utilized by each fisherfolk and number of boats (both motorized and non-motorized) owned by each fisherfolk. Data were summarized per municipality and barangay.

Interview schedule

A total of 100 fisherfolk engaged in capture fisheries in the lake were interviewed to assess the effect of the Taal Volcano eruption and pandemic on the livelihood of fisherfolk. The target respondents were based on the record of the number of fisherfolk in each municipality. A semi-structured questionnaire on the effects of Taal Volcano eruption and COVID-19 pandemic on the livelihood and fishing operation including the socio-economic condition of the respondents were administered by enumerators/interviewers in each municipality.

3. Results and Discussion

The total annual production of the lake for 2021 was estimated at 1,004.14 mt. The top 10 species and their corresponding production is shown in Table 1. The top species is still the endemic freshwater sardine *Sardinella tawilis,* followed by milkfish *Chanos chanos*, tilapia *Oreochromis niloticus*, black chin tilapia *Sarotherodon melanotheron*, Midas cichlid *Amphilophus citrinellus*, flag-tailed glass perchlet *Ambassis miops*, silver perch *Leiopotherapon plumbeus*, tank goby *Glossogobius giuris*, Manila sea catfish *Arius manillensis*, and Jaguar guapote *Parachromis managuensis*. Overall, species composition consisted mainly of the endemic *tawilis* (47%), introduced species (31%) and migratory/native species (22%).

Table 1. Production (mt) of top 10 fish species in Lake Taal, 2021

Scientific name	Local name	Occurrence	Production (mt)
Sardinella tawilis	tawilis	Endemic	470.54
Chanos chanos	bangus	Migratory	152.32
Oreochromis niloticus	tilapia	Introduced	146.47
Sarotherodon melanotheron	aroyo	Introduced	104.81
Amphilophus citrinellus	pula, red tilapia	Introduced	40.25
Ambassis miops	ning-ning	Migratory	37.25
Leiopotherapon plumbeus	ayungin	Native	13.90
Glossogobius giuris	biya	**Native**	10.53
Arius manillensis	kanduli	Introduced	9.37
Parachromis managuensis	dugong	Introduced	6.05
Others			12.66
TOTAL			**1,004.14**

Compared with previous studies, tawilis still dominated the capture fisheries of the lake (Mutia et al. 2018) even when Tawilis Closed Fishing Season is being implemented during March to April that year. In this study, there were 49 fish species recorded in the actual landed catch survey. Of these, 34 are native and/or migratory, 14 introduced and one endemic. Though tawilis remained the top species, the composition and volume of introduced species has noticeably increased.

Based on the inventory of fisherfolk, the number of active fishers in the lake is around 3,508 (Table 2). In a span of 3 years, there is around 16% increase in the number of fishers this year compared with 2018. Five municipalities gained more than 20% fishers (Agoncillo, Balete, Cuenca, Laurel, and Tanauan City) while two municipalities declined more than 20% of the number of fishers (Talisay and Alitagtag) and three

municipalities showed minor change in the inventory of fishers (Mataasnakahoy, Santa Teresita, and San Nicolas).

Table 2. Number of fishers in Lake Taal per municipality based on inventory

Municipality/ City	No. of fishers	
	2018*	2021
Agoncillo	249	303
Alitagtag	53	27
Balete	437	644
Cuenca	110	152
Laurel	339	510
Lipa City	nd	78
Mataasnakahoy	260	305
San Nicolas	683	672
Santa Teresita	70	64
Talisay	521	412
Tanauan City	213	341
TOTAL	**2,935**	**3,508**

*based on NFRDI-FFRDC unpublished data. nd - no data available

The pronounced change (increase/decrease) in the number of fishers in each municipality were attributed to the following: 1) the growing population along the lake's coastline (Agoncillo, Laurel, Tanauan, Cuenca); 2) relocation of Volcano Island residents, particularly within the municipalities of Balete and Talisay; 3) fishers became inactive due to change in livelihood opportunities (Alitagtag, Santa Teresita, and San Nicolas). Overall, the increase in number of fishers suggests that more people are becoming dependent on the lake's fishery resource.

Based on the inventory, there were 22 distinct fishing gears recorded in 2021, and among these, gillnet had the most number of units and number of fishers engaged (Table 3). Compared with previous data, the number of units and fishers engaged for almost all fishing gear types increased. The number of gillnets increased to around 32%, and the number of gillnetters increased to 42% in a span of three years. More passive gears were also noted such as fish corrals, hook and line, fish pots such as traps, etc. This suggests that fishing pressure continues to increase in the lake.

Table 3. Number of fishing gear units and fishers engaged based on inventory

Fishing gear	2018*		2021	
	Units	Fishers engaged	Units	Fishers engaged
gillnet	23,566	1,825	31,261	2,593
fish pots	5,978	590	4,109	634
hook and line	764	134	1,127	83
beach seine	25	525	22	546
push net	17	115	4	59
fish corral	5	5	21	19
others**	413	262	3,498	575

*based on NFRDI-FFRDC unpublished data.

**spear gun, air gun, fish spear, fyke net, rake, lift net, catch net, drive-in net

Consequently, the number of boats, both motorized and non-motorized, also increased. In the municipalities of Agoncillo, Tanauan, Balete, Cuenca, and Laurel, the number of motorized boats considerably increased compared to 2018 data (Table 4). These areas have remote locations that are only accessible by boat, hence the observed increase in boat number. The areas of San Nicolas, Santa Teresita, and Talisay showed decline in boat number, possibly due to the decrease in number of active fishers and/or missing/damaged boats accounted for during volcanic eruption.

Table 4. Number of boats per municipality based on inventory

Municipality/ City	2018*		2021	
	Motorized boat	Non-motorized boat	Motorized boat	Non-motorized boat
Agoncillo	50	46	78	61
Alitagtag	11	27	12	12
Balete	113	41	292	90
Cuenca	79	14	89	11
Laurel	42	91	100	175
Lipa City	nd	nd	15	24
Mataasnakahoy	96	27	95	43
San Nicolas	180	94	150	105
Santa Teresita	36	39	21	31
Talisay	128	129	47	89
Tanauan City	76	58	113	43
TOTAL	**811**	**566**	**1012**	**684**

*based on NFRDI-FFRDC unpublished data. nd - no data available

The socio-demographic profile of key fisherfolk respondents interviewed a year after the event (Taal Volcano eruption) is shown in Table 5. The mean age of respondents was 47. Majority were male, married and had high school level educational attainment. The mean income of Php 4,500 (87.80 USD) which ranged from Php 1,000 (19.51 USD) to Php 20,000 (390.24 USD) implies that the majority of the respondents were poor. Respondents had a mean fishing experience of 28 years, ranging from 2 to 50 years.

Table 5. General characteristics of fisherfolk respondents in Lake Taal, 2021

Characteristics	Respondents
Number of respondents	100
Age (years)	
20 – 29	5
30 – 39	22
40 – 49	24
50 – 59	35
60 and above	14
Mean	47
Educational attainment	
no formal education	1
elementary level	42
highschool level	53
college level	2
college graduate	2
Sex	
male	91
female	9
Civil status	
married	92

single	7
widow/er	1
Average income	Php 4,500/month
average fishing experience (years)	28

In the aftermath of volcanic eruption, most of the reported impacts by local fisherfolk include damaged houses, fishing gears and boats. In terms of physical damage, the majority (59%) of respondents had major to 100% damage to their houses (Table 6). Thick blankets of ashfall caused roofs of houses to crash while earthquakes and ground subsidence caused foundation of houses to fall apart and walls to crack. Since their houses were then uninhabitable, most of them stayed further on evacuation sites while others settled on relocation sites. Some relocation sites were located within the same municipality, while the majority of those who lost their homes, specifically the previous residents of Volcano Island, were relocated in a nearby province. In some residential areas in Agoncillo, houses became submerged in lakewater while other areas exhibited receding shorelines, estimated at 10-50 meters further from the previous shoreline.

Table 6. Assessed physical impacts of Taal Volcano eruption to 100 capture fisher in Lake Taal.

Impacts	% of Respondents (n=100)
Damage to house	
100% damaged	25
75% damaged	34
partially damaged	6
no damage - ashfall only	35
Damage to fishing gear	
100% damaged	36
partially damaged	8
missing	10
no damage - ashfall only	45
Damage to boat	
100% damaged	11
partially damaged	13
missing	5
no damage - ashfall only	71

Aside from houses, some fishing gear of the respondents, specifically traps and gillnets, and boats also were damaged, if not missing, after the volcanic eruption (Table 6). Despite these reported damages, fishing operations continued for the majority of respondents (82%). But because the threat of volcanic eruption is still imminent, the majority of them were still afraid of open water fishing. Hence, fishers made use of fish traps that were set-up along the coastal areas. Fish traps were also convenient and practical because of the abundance of tilapia which escaped from damaged fish cages to the open waters. However, even though there were plenty of tilapia in the market, there was less demand for fish from Lake Taal because of the spread of "unsafe" claims (Merez, 2020). But after the government conducted laboratory analyses and revealed that fish consumption from the lake was safe (Aguilar, 2020), the demand for fish gradually increased.

Other impacts cited by the respondents include damage to agricultural crops - mostly caused by ashfall; deceased livestock (pigs, poultry, goat); looting of home equipment, fishing gears, livestock, etc., no buyers of fish catch, impassable roads due to ground subsidence, and mental/emotional distress caused by further volcanic activities.

Whilst still recovering from the volcanic eruption, fishing operations declined again because of the enhanced community quarantine (ECQ) declared in Luzon due to COVID-19 pandemic. No to limited fishing activities were noted by the majority of the respondents (46%) during ECQ (Table 7). Strict

lockdown and checkpoints were enforced in all barangays - hence no to limited fish trading were allowed. Local traders from other municipalities were reportedly not allowed to go to the fish landing centers because of strict enforcement of barangay checkpoints, hence fishermen opt to either sell their catch to their neighbors or use it for their own consumption. There were also reports of middlemen having no buyers during this time. This led to the disruption of the supply chain. Despite strict implementation of ECQ at first, other respondents (20%) stated they were still able to continue fishing after some time because they were able to sneak behind checkpoints. Others were able to transport their catch to market via boat, allowing them to escape past checkpoints. Eventually, local traders were able to secure "Food Pass" which allowed them to trade to fish landing centers and deliver fish outside the province (DA-AMAS, 2020).

Table 7. Status of fishing operation and sources of livelihood and adaptation measures of 100 capture fishers in Lake Taal during ECQ.

Status of fishing operation	**% of Respondents***
no to limited fishing	46
limited buyers/ middlemen	27
none, continuous fishing operation	20
no to few catch	5
missing gear	1
Source of livelihood	**% of Respondents***
none, only fishing	41
government assistance	28
construction work	20
planting crops/ ornamental plants	8
mini-store/ peddling	8
dependent on relatives	6
cage caretaker/ harvester	5
boat construction and fish trap fabrication	3
tricycle driver	1
Adaptation measures	**% of Respondents***
follow health protocols	74
find other source of income	10
be more economical	3
not necessary	13

*Data reflect multiple responses per interviewee.

After two months, the movement of the supply chain gradually eased as ECQ was downgraded to GCQ (general community quarantine). It is during this time that the number of fish corrals were increasing. According to the owners of fish corrals, their earnings greatly helped them during the pandemic. The capital needed for establishing a fish corral is much lower compared to a fish cage.

Because fishing was restricted, the respondents noted having a hard time during ECQ. Majority of respondents (41%) declared no additional source of income that time (Table 7). Most of them relied on government assistance (28%) in the form of canned goods, rice, noodles, cash, agricultural seeds, etc. To others who did not receive government assistance, their other sources of income came from construction work sidelines (20%), planting crops and ornamental plants (8%), *sari-sari* store (mini-store), food stalls or *paglalako* (peddling) (8%). Others rely on their relatives or sons/daughters' remittances (6%), sidelines as cage caretaker/harvester (5%), boat construction and fish trap fabrication (3%) and as tricycle driver (1%). The diverse yet low-skilled job alternatives of fisherfolk reflect their lower educational attainment, the majority of which only attended elementary to highschool level (95%).

As part of their adaptation to the "new normal", the majority of the respondents maintained health protocols such as wearing of face mask and face shield, social distancing, frequent hand-washing/alcohol

application, and home quarantine (74%). Some focused on obtaining other sources of livelihood (10%) and becoming more economical (3%) to get through the pandemic. Other respondents (13%) cited adaptation was not necessary because their situation was still the same even without the pandemic.

In terms of fishes caught, Table 8 shows the list identified by fisherfolk respondents on their fish catches after the volcanic eruption and during the ECQ. Majority of them cited tilapia (*Oreochromis niloticus*) as top fish species caught in the two events. The rest of the commonly caught fish species cited were part of the Top 10 fish species identified based on landed catch survey (Table 1).

Table 8. Fishes caught after volcanic eruption and during ECQ of 100 capture fishers in Lake Taal.

		% of Respondents	
What fishes were caught		**after the volcanic eruption?**	**during ECQ?**
Oreochromis niloticus	tilapia	86	73
Chanos chanos	bangus	57	48
Sarotherodon melanotheron	aroyo	28	33
Parachromis managuensis	dugong	15	21
Amphilophus citrinellus	pula/ red tilapia	14	27
Sardinella tawilis	tawilis	11	19
Glossogobius giuris	biya	6	12
Leiopotherapon plumbeus	ayungin	7	7
Arius manillensis	kanduli	4	8
Caranx ignobilis	maliputo	3	3
others		6	11

*Data reflect multiple responses per interviewee.

4. Conclusion

A year after the Taal Volcano eruption and the emergence of global pandemic (COVID-19), the capture fisheries production of Lake Taal remained to be dominated by the endemic freshwater sardine *S. tawilis*. Fishing pressure still continues to increase as evident in the increasing number of fishers, fishing gears and boats. The locals were still highly dependent on the lake's resources despite the volcanic threat and especially during the pandemic. Even though there were difficulties in these last two years, sustaining food and livelihood are what drive the local fisherfolk to learn to live with volcanic threat and COVID-19 pandemic.

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