

Underlying Cornerstone of Bunot Lake, Palakpakin Lake, and Calibato Lake: Aquaculture Structure, Road Infrastructure, and Legal Easement

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Abstract

Bunot Lake, Palakpakin Lake, and Calibato Lake are the most problematic obstacle among the Seven Crater Lakes, and the Aquaculture Structure, Road Infrastructure, and Legal Easement are the compulsory requirements between the maar lakes. Notably, the three crater lakes remain less tangible deliberately in the conservation and tourism development, while the three rudimentary factors are indispensable in directionally improving the small lake's conditions. This article examines Bunot Lake, Palakpakin Lake, and Calibato Lake and comprehends the Aquaculture Structure, Road Infrastructure, and Legal Easement concepts. It embraces qualitative and subjective study to look into and understand the three determined concepts. The arrangement and limitation, accessibility, and littoral zone's unresolved obstacles are still elusive, comparable, and ongoing in the three crater lakes, but each one is imperative currently. In essence, these central factors are about balancing the aquaculture over-expansion and tourism augmentation on the small lakes. Overall, the three maar lakes and their three features are complemented, reciprocated, and supplemented by the lake's restoration and the aquaculture-tourism nexus.

Introduction

Bunot Lake, Palakpakin Lake, and Calibato Lake's Grounds

The Seven Crater Lakes have long been recognized in the Philippines, yet their development and conservation are uneven and skewed. Sampaloc Lake, Bunot Lake, Palakpakin Lake, Pandin Lake, Yambo Lake, Mohicap Lake, and Calibato Lake are freshwater lakes of San Pablo City in the Laguna Province, Philippines (see Figure 1, Apple Maps 2022a, see also Google Maps 2022a). From the "oblivious decades" (i.e., the 1980s to 1990s) to the present, the Seven Crater Lakes' circumstances still linger. In the past, in conservation, the Seven Crater Lakes (except Pandin Lake and Yambo Lake) have been threatened with water resources, while in development, they have been hampered by the stakeholders and communities. Notably, the water quality degradation leads to accelerated eutrophication, elevated nutrients, and disconcerted pollution, and the economic predicament prompts underdevelopment in tourism and overdevelopment in aquaculture structures (see Brillo 2017a, Brillo et al. 2019, Mendoza et al. 2019, Ballares et al. 2020, Paller et al. 2021). At present, the Seven Crater Lakes' situation has improved markedly. Generally, the water quality standards have been maintained (i.e., Pandin Lake and Yambo Lake) and upgraded (i.e., Mohicap Lake and Sampaloc Lake),

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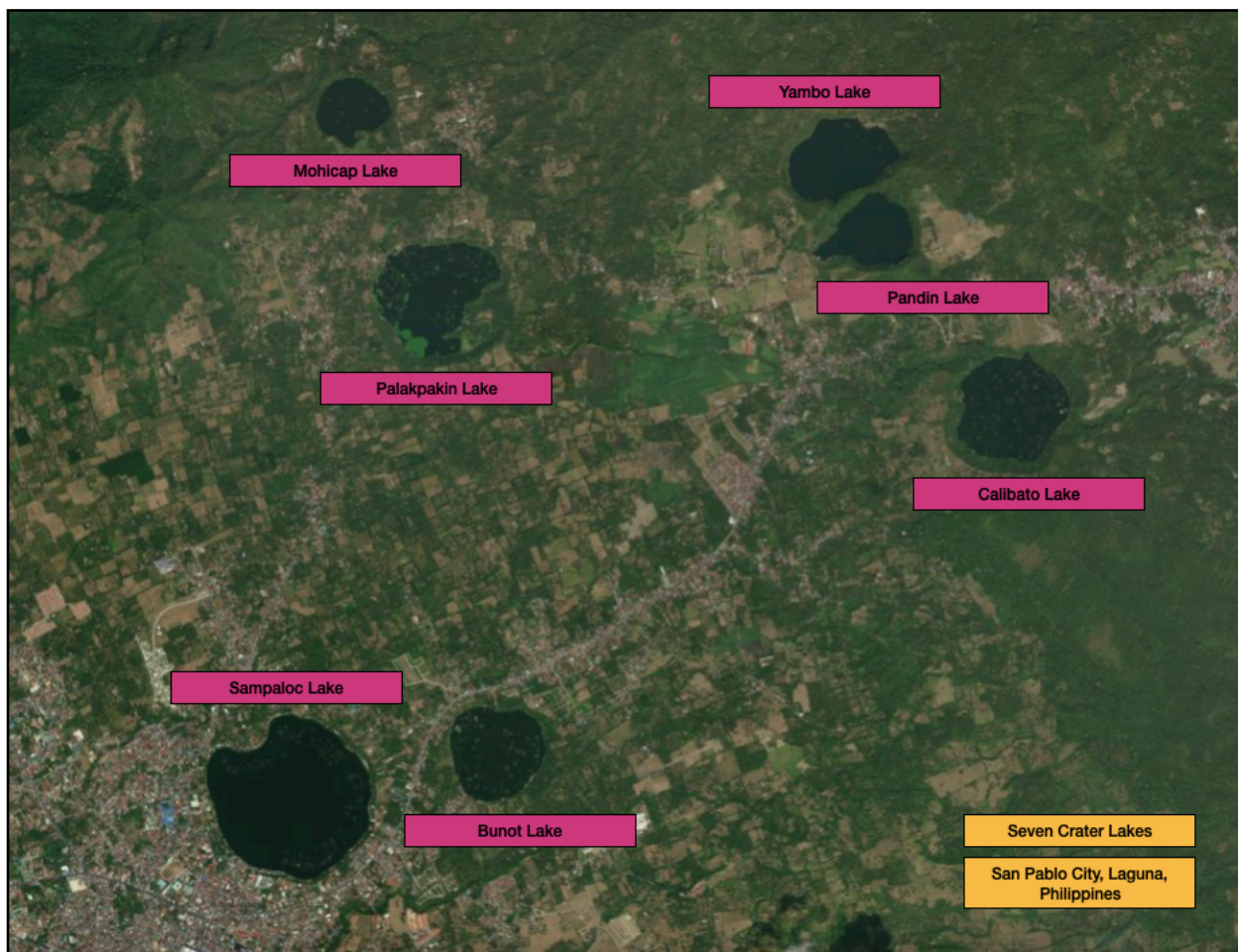


Figure 1: The Seven Crater Lakes: Sampaloc Lake, Bunot Lake, Palakpakin Lake, Pandin Lake, Yambo Lake, Mohicap Lake and Calibato Lake (Apple Maps 2022a)

the tourism development has been established (i.e., Mohicap Lake and Yambo Lake) and expanded (i.e., Pandin Lake and Sampaloc Lake), and the aquaculture structures have been consistent (i.e., Pandin Lake and Yambo Lake) and reduced (i.e., Sampaloc Lake and Mohicap Lake) (see Memorandum Circular no. 2017-03 2017, Memorandum Circular no. 2018-04 2018, Memorandum Circular no. 2021-04 2021, Memorandum Circular no. 2021-05 2021, Brillo 2022a). Thus, among the Seven Crater Lakes' concerns— Sampaloc Lake, Pandin Lake, Yambo Lake, and Mohicap Lake have enhanced considerably. However, the other three lakes— Bunot Lake, Palakpakin Lake, and Calibato Lake are behind and have less headway overall in terms of conservation and development.

The Seven Crater Lakes are considered small maar lakes. The social sciences literature on small lakes in the Philippines has slowly become notable in the academic works from 2015 to the present (e.g., Borja 2012, Brillo 2015a, Brillo 2022b, Brillo 2022c). Although the physical-natural sciences journal articles are numerous, the social sciences written works in the Seven Crater Lakes, despite not many, have also gradually increased steadily (e.g., Brillo 2017a, Quintal et al. 2018, Paller et al. 2021, Brillo 2022a). The social sciences outputs are spearheaded by Sampaloc Lake and Pandin Lake studies, while the remaining small lakes contribute residual (see Brillo 2016a, Google Scholar 2022a, Google Scholar 2022b). Of the seven maar lakes studies— Bunot Lake, Palakpakin Lake, and Calibato Lake have the main enduring issues and are minimally addressed compared to the rest. In the past, the three crater lakes have mentioned the following issues: limited financial resources, lacking workforce, local politics, lesser concentration of efforts, excessive fish cages/pens, exceeding use of artificial/commercial feeds, congested shoreline settlements, domestic waste and sewage, absent of drainage system, deteriorating water quality, proliferating water hyacinth and algal bloom, recurring fish kill, steady siltation, wanting to institute tourism, debased access

pathway, and devoid of lakefront easement (Brillo 2015b, Brillo 2016b, Brillo 2016c, Mabansag et al. 2019, Guevarra et al. 2020 see also Laguna Lake Development Authority 2006a, Laguna Lake Development Authority 2006b, Laguna Lake Development Authority 2008a, Laguna Lake Development Authority 2008b). With these, Bunot Lake, Palakpakin Lake, and Calibato Lake are consciously regarded as the most problematic among the Seven Crater Lakes.

In aquaculture development, Bunot Lake, Palakpakin Lake, and Calibato Lake are considered the most suitable for water-based culture, particularly tilapia cage farming. Since 1976 when the introduction of tilapia floating cages in Bunot Lake and subsequently disseminated in Palakpakin Lake and Calibato Lake, the three lakes have become extensively expanded, making them congested. The fish cages have become the small lakes' inherent feature; thus, aquaculture development is well-established but excessive (Brillo 2015b, Brillo 2016b, Brillo 2016c, see also Brillo et al. 2019). On the other hand, Bunot Lake, Palakpakin Lake, and Calibato Lake's tourism activities are generally dormant. The three lakes are viewed as having excellent potential for tourism development and thus expected to have traction following Sampaloc Lake and Pandin Lake's tourism initiative and expansion, yet they did not materialize. Tourism development has been occurring in Sampaloc Lake (being the biggest among the seven maar lakes, within the city proper, and the primary symbol of San Pablo City) and Pandin Lake (being the recognized pioneer of the ecotourism enterprise among the Seven Crater Lakes but each), of the three small lakes has continuously failed to happen or commence the inception (e.g., City Government of San Pablo 2015, Brillo & Boncocan 2016, Brillo 2020, see also Brillo 2016d, Brillo 2017b). Consequently, Bunot Lake, Palakpakin Lake, and Calibato Lake's aquaculture development and tourism development prospects are not versus (by supplanting) but interlinking and compensating for the

tilapia cages' excessiveness (by limiting) and the tourism campaign's inadequacy (by extending).

With all of the above— Bunot Lake, Palakpakin Lake, and Calibato Lake continue to face critical impediments among the Seven Crater Lakes. The three maar lakes remain less tangible deliberately in conservation and development, still limited continuously in the scholarly social sciences literature, and so far demanding decidedly in retrieving and regaining the water resources' stature. These information gaps also have uncertain agenda in undertaking the three small lakes' foremost direction. This is why the ongoing issues need to delve into San Pablo City's three crater lakes. Thus, this paper looks into and understands the three essential concepts— Aquaculture Structure, Road Infrastructure, and Legal Easement, concerning Bunot Lake, Palakpakin Lake, and Calibato Lake. The three requirements are fundamental, as whatever the hindrances mentioned in the three maar lakes will have to be addressed, confronted, and tackled. These underlying cornerstone factors are also urgent at present, yet less emphasized and satisfied in academic study. Aquaculture Structure, Road Infrastructure, and Legal Easement should concurrently proceed in order to substantially improve the small lake conditions, as they complement and supplement each other. Ergo, this article embarks as follows: (a) Bunot Lake, Palakpakin Lake, and Calibato Lake's Grounds (i.e., Introduction); (b) Concepts for Analysis, Methodology, and Methods; (c) Results and Discussion (i.e., The Three Crater Lakes of San Pablo City, and The Three Essential Factors: Aquaculture Structure, Road Infrastructure, Legal Easement); and (d) Concluding Remarks.

Concepts for Analysis, Methodology, and Methods

This paper embraces qualitative and subjective study to examine and understand the three determined concepts— Aquaculture Structure, Road Infrastructure, and Legal Easement, of Bunot Lake, Palakpakin Lake, and Calibato Lake. Broadly, this research harmonizes the relativism (or constructivism) stance, which deploys the distinctive viewpoint in interpreting reality (e.g., Brillo & Simondac-Peria 2021, Brillo 2022a, see also, Summer & Tribe 2008, Crotty 2015). A qualitative study simply means a research approach to understand social circumstances systematically. A subjective study plainly represents a research perspective to explain via an interpretative manner descriptively. Overall, this study investigates and comprehends the three maar lakes' current situation vis-a-vis the three underlying factors.

Bunot Lake, Palakpakin Lake, and Calibato Lake explore the critical concepts— Aquaculture Structure, Road Infrastructure, and Legal Easement by analyzing their impasse. In this small lake study, Aquaculture Structure refers to the configuration of the fish cage areas, explicitly the settled arrangement and limitation on the fishing zone. Road Infrastructure refers to the accessibility of the community and tourism development, particularly the established road and designated route to the maar lake from the urban areas and populations. Legal Easement refers to the regulation of the littoral zone, specifically the right for public use and preservation on the shore, as opposed to illegitimate utilization of the land along the lake's margins. These central factors are necessary and integral in conserving and developing the three crater lakes, especially in embarking on and dealing with prolonged problems for the inhabitants and communities. More so, these essential criteria accept the principles that inland water conservation and aquaculture-tourism development are not opposed but crux and supplement to the small lakes.

In the modus operandi, the research information is generated from the online/email interview, site observation, authority website, archival documents (i.e., official papers, records,

reports), journal articles, and web maps (i.e., Apple Maps, Google Earth, and Google Maps). The empirical data are systematically analyzed through content analysis and outlined using the three underlying factors of the three maar lakes. The study inclines to retrieve meaningful characteristics, whether categorizations, themes, or patterns. As a caveat, the research's restriction is confined to Bunot Lake, Palakpakin Lake, and Calibato Lake only since the three maar lakes have the most obstacle among the Seven Crater Lakes, less literature in the social sciences, and more proximity in inspection and evaluation. Incidentally, the terms small lake, maar lake, and crater lake, as well as the concepts and factors, are designated as identical or interchangeable with this paper. Moreover, a small lake here is demarcated as water bodies with a surface area of 2,000,000 square meters or less threshold (while large lakes are above this). This restricted-size motive is connotative and subjective, following the distinction of the Seven Crater Lakes, the goal of this research, and the matter of the small lakes in the Philippines (e.g., Brillo 2015a, Brillo 2017c, Brillo 2022a, Brillo 2022b). Besides, this academic work aspires to be a precursor to studying and learning the social science scholarship of small lakes in this country as much as possible.

Results and Discussion

Bunot Lake, Palakpakin Lake, and Calibato Lake

Bunot Lake, Palakpakin Lake, and Calibato Lake are part of the Seven Crater Lakes of San Pablo City, Laguna Province, Philippines. These three small lakes are described as tropical-freshwater and dish-shaped maar lakes. A maar here is generally a volcanic crater that forms when magma contacts groundwater sparking an explosion that produces a water-filled bowl (e.g., US Geological Survey 2015, Geology.com 2022). The three maar lakes are also components of the Laguna Volcanic Field (sometimes known as San Pablo Volcanic Field) that is situated between Laguna de Bay (i.e., the largest lake in the Philippines), Mount Banahaw-San Cristobal Protected Landscape, and Mount Malepunyo Range (see Figure 2, Google Maps 2022a, see also Global Volcanism Program 2013). Moreover, Bunot Lake, Palakpakin Lake, and Calibato Lake are regarded as eutrophic— currently excessive nutrients, which have more repercussions on ecosystems, aquatic resources, and the populace; in contrast to mesotrophic in the remaining crater lakes, following Carlson's Trophic State Index for lakes (e.g., Mendoza et al. 2019, Brillo et al. 2019, Paller et al. 2021, see also Fuller & Jodoin 2016). Furthermore, the three small lakes are considered premier in terms of conservation threat and development wane among the Seven Crater Lakes, as the stakeholders' focus on the initiatives and actions are still waiting.

Bunot Lake is solely situated in Barangay Concepcion and about 3 kilometers from the San Pablo City Plaza. This lake is very close to Sampaloc Lake (i.e., deemed as the "primus inter pares" among the Seven Crater Lakes) and the second nearness to the city proper, following the remaining small lakes. In the water dimensions, Bunot Lake has a surface area of 305,000 square meters (30.5 hectares), a maximum depth of 23 meters, and an elevation of more or less 110 meters overall (see Laguna Lake Development Authority 2008b, City Government of San Pablo 2015, Laguna Lake Development Authority 2019). In the water inflow, Bunot Lake has no inlet (i.e., the water volume entering or coming into the lake); hence, it is fed water by rainfall, surface runoff, and submerged/surfaced springs. In the water outflow, Bunot Lake is an open lake (i.e., exorheic lake) that discharges an outlet (i.e., the water volume flowing or going out of the lake) in Sabang Creek¹ going to the Malamig-Bañadero River (see also Environmental Management Bureau CALABARZON Region 2018, Apple Maps 2022b, Google Maps 2022b).

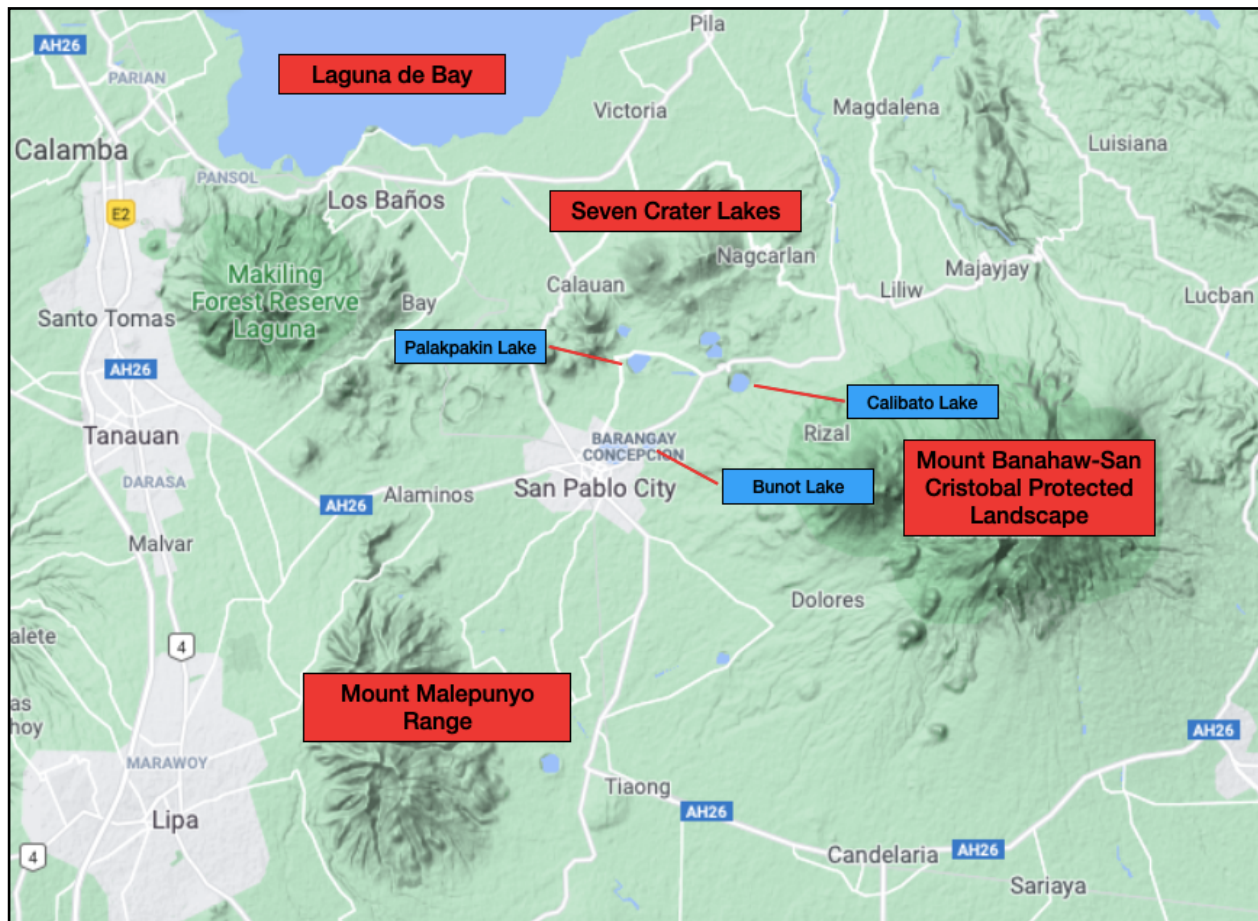


Figure 2: Bunot Lake, Palakpakin Lake, and Calibato Lake: The Seven Crater Lakes, Laguna de Bay, Mount Banahaw-San Cristobal Protected Landscape, and Mount Malepunyo Range (Google Maps 2022a)

Palakpakin Lake is situated in three territorial districts: Barangay San Lorenzo, Barangay San Buenaventura, and Barangay Dolores, and about 5.9 kilometers from the San Pablo City Plaza. This lake is the second biggest in size and the shallowest in depth among the Seven Crater Lakes. In the water dimensions, Palakpakin Lake has a surface area of 479,800 square meters (47.98 hectares), an average depth of only 7.5 meters, and an elevation of more or less 100 meters overall (see Laguna Lake Development Authority 2008b, City Government of San Pablo 2015, Mendoza et al. 2019). In the water inflow, Palakpakin Lake has inlets (i.e., Pagbuga Creek¹, traveling mainly through Calibato Lake, and Prinsa Creek¹, contributory from Pandin Lake), and it is also fed water by rainfall, surface runoff, and submerged/surfaced springs. In the water outflow, Palakpakin Lake is an open lake that releases an outlet in Padparan Creek¹ proceeding to Calauan Municipality, Laguna (see also Apple Maps 2022c, Google Maps 2022c).

Calibato Lake is a transboundary, situated primarily in Barangay Santo Angel, San Pablo City and subsidiarily in Barangay Antipolo and Barangay Tala, Rizal Municipality, Laguna, and about 7.6 kilometers from the San Pablo City Plaza. This lake is the deepest in depth and the largest in freshwater volume among the Seven Crater Lakes. In the water dimensions, Calibato Lake has a surface area of 430,000 square meters (43 hectares), a maximum depth of 156 meters, and an elevation of more or less 170 meters overall (see Laguna Lake Development Authority 2008b, City Government of San Pablo 2015, De Leon et al. 2022). In the water inflow, Calibato Lake has inlets (i.e., Eliw-

eliw Spring¹ in San Pablo City and Nalagalas Falls¹ in Rizal Municipality, the principal tributaries coming from Mayton River), and it is also supplied by rainfall, surface runoff and various surrounding springs. In the water outflow, Calibato Lake is an open lake that discharges an outlet in Pagbuga Creek¹ going to Palakpakin Lake, Barangay San Lorenzo (see also Apple Maps 2022d, Google Maps 2022d).

Aquaculture Structure, Road Infrastructure, and Legal Easement

The threesome concepts—Aquaculture Structure, Road Infrastructure, and Legal Easement, are the bedrock in examining and understanding the impasse of Bunot Lake, Palakpakin Lake, and Calibato Lake. In other words, these three central factors are scrutinizing the hindrances on the three maar lakes at present.

(i) The Aquaculture Structure, as mentioned, refers to the configuration of the fish cage areas, specifically the settled arrangement and limitation on the fishing zone. Notably, this pertains to the alignment and the restriction of the tilapia floating cages concerning the inhabitants and the small lakes. The study embraces the fish cages since they have been deeply rooted and integrally exist, past to the present, in the aquaculture development of Bunot Lake, Palakpakin Lake, and Calibato Lake (as well as the remaining Seven Crater Lakes). The arrangement means the systematic layout and order of the fish cage belt in the maar lake's surface area. Explicitly, the fish structure zone is beyond the shoreline, encompassing the

¹These mentioned are local names (i.e., Sabang Creek for Bunot Lake; Padparan Creek, Pagbuga Creek, and Prinsa Creek for Palakpakin Lake; and Eliw-eliw Spring and Nalagalas Falls for Calibato Lake).

navigational lane (i.e., no structures allowed for transport [e.g., aquaculture materials and feeds]) and access lane (i.e., no structures allowed for passageway [e.g., recreational purposes]); the fish cages are measured in the maximum size of 600 square meters (i.e., 30 meters X 20 meters), and the distance between them and their sides is 5 meters (such as Bunot Lake, Palakpakin Lake, and Calibato Lake) or 10 meters (such as Pandin Lake and Yambo Lake), following the Laguna Lake Development Authority (LLDA).

The limitation means the standardized constraint of the fish cage allocation in the small lake's surface area. Particularly, the fish structure allowable ceiling of 10 percent of the total lake area, prescribed by the Philippine Fisheries Code as amended (see Republic Act no. 8550 1998, Republic Act no. 10654 2015). In the Seven Crater Lakes at present, the limit is either 5 percent (such as Pandin Lake and Yambo Lake) or 10 percent (such as Bunot Lake, Palakpakin Lake, and Calibato Lake) of the total lake area, following LLDA (see Memorandum Circular no. 2017-04 2017, Laguna Lake Development Authority 2019, Memorandum Circular no. 2021-04 2021, Memorandum Circular no. 2021-05 2021, Bureau of Fisheries and Aquatic Resources 2022). The LLDA is a government agency with exclusive jurisdiction over Laguna de Bay's water rights and other bodies of water, including the Seven Crater Lakes (see Republic Act no. 4850 1966, Presidential Decree no. 813 [as amended] 1975, Executive Order no. 927 1983, Laguna Lake Development Authority 2022). Consequently, the LLDA prescribes special powers, functions, and duties in preserving and developing Bunot Lake, Palakpakin Lake, and Calibato Lake.

In the arrangement and limitation, the three small lakes' fishing zone is verified via ocular inspection and viewed using web maps. In Bunot Lake's arrangement, the fish cage belt has not been fully implemented and regulated by LLDA (see Figure 3, Apple Maps 2022b, see also Google Earth 2022a, Google Maps 2022b). The tilapia floating cages are not thoroughly assembled and clustered in the lake's structure zone. In other words, the fish cage operators do not completely comply with the agency's directive. In the dimension, the fish cage's size and distance are not consistent nor correspond to the LLDA's regulation. The tilapia floating cages and their intervals are not proportionate (i.e., the fish enclosures are irregular, and the modules and clusters are inconsistent) in the aquaculture structure zone. Thus, the fish cage operators have not yet faithfully maintained the authority's requirements. In the navigation and access lane, Bunot Lake's corridor is affected, and the pathway zone is less promulgated. The water pathway is elemental for transport and passageway to be uncluttered and organized in the maar lake. Hence, the designated zoning map has to be endorsed by the authority and accepted by the populace. In Bunot Lake's limitation, the fish cage allocation still exceeds the allowable limit required by LLDA (see also Laguna Lake Development Authority 2019, Bureau of Fisheries and Aquatic Resources 2022). The tilapia floating cages have continually surpassed the 10 percent allowable stipulated by the Philippine Fisheries Code. So, the registered fish cage operators have not yet conformed to the agency's reducing instruction, while the unregistered operators are ongoing and not sanctioned, adhering to the authority's mandate.

In Palakpakin Lake's arrangement, the fish cage belt has been organized but not thoroughly completed by LLDA (see Figure 4, Google Earth 2022b, see also Apple Maps 2022c, Google Maps 2022c). The tilapia floating cages are assembled but not strictly clustered in the lake's structure zone. Overall, the fish cage operators have already adhered to the agency's directive. In the dimension, the fish cage's size and distance are loosely

consistent with the LLDA's regulation. The tilapia floating cages and their intervals are generally proportionate (i.e., the fish enclosures are comparable, and the modules and clusters are parallel) in the aquaculture structure zone. Thus, the fish cage operators are relatively maintaining the authority's requirements. In the navigation and access lane, Palakpakin Lake's corridor is not impeded, and the pathway zone is regularly applied. The water pathway is rudimentary for transport and passageway to be arranged and systematic in the small lake. Hence, the designated zoning map has to be implemented by the authority and accustomed to the populace. In Palakpakin Lake's limitation, the fish cage allocation abides by the allowable limit required by LLDA (see also Memorandum Circular no. 2017-04 2017, Board Resolution no. 544 2018, Bureau of Fisheries and Aquatic Resources 2022). The tilapia floating cages have been able to maintain the 10 percent allowable stipulated by the Philippine Fisheries Code. So, the legitimate fish cage operators have conformed to the agency's reducing instruction, while the illegal operators have been curtailed, adhering to the authority's mandate.

In Calibato Lake's arrangement, the fish cage belt has not been methodically executed and conducted by LLDA (see Figure 5, Apple Maps 2022d, see also Google Earth 2022c, Google Maps 2022d). The tilapia floating cages are noticeably cluttered and scattered in the lake's structure zone. So, the fish cage operators have not yet followed the agency's directive. In the dimension, the fish cage's size and distance are not compatible nor parallel to the LLDA's regulation. The tilapia floating cages and their intervals are not proportional (i.e., the fish enclosures are nonuniform, and the modules and clusters are incompatible) in the aquaculture structure zone. Hence, the fish cage operators still do not comply with the authority's requirements. In the navigation and access lane, Calibato Lake's corridor is constrained, and the pathway zone is less enacted. The water pathway is basic for transport and passageway to be not impeded and assembled in the small lake. Thus, the designated zoning map has to be sanctioned by the authority and recognized by the populace. In Calibato Lake's limitation, the fish cage allocation still surpasses the allowable limit required by LLDA (Apple Maps 2022d, Google Earth 2022c, see also Board Resolution no. 566 2019). The tilapia floating cages have constantly exceeded the 10 percent allowable stipulated by the Philippine Fisheries Code. In other words, the registered fish cage operators have not yet abided by the agency's reducing instruction, while the unregistered operators are occurring and not penalized, conforming to the authority's mandate.

(ii) The Road Infrastructure, as mentioned, refers to the accessibility of the community and tourism development, specifically the established road to crater lake from the urban areas and populations. Remarkably, this pertains to the legal and recognized access for contributing to Bunot Lake, Palakpakin Lake, and Calibato Lake's progress. Here, accessibility means the existence of adequate transportation infrastructure for the lake's populace. The community means a maar lake's inhabitants and fish cage operators; tourism means commercial traveling or visiting a crater lake to serve the local economy; and the established road means the designated route in and out of a small lake.

Bunot Lake's designated route to the maar lake and vice versa to the urban area is well-established. In the accessibility, the crater lake has two proximate roads, one northwest—Werner Schetelig Avenue, a national highway that links to the city proper, and the other southwest—Sabang Road, a barangay road that provides the main entry to Bunot Lake (see Figure 6, Google Earth 2022a, see also Apple Maps 2022b, Google Maps 2022b).

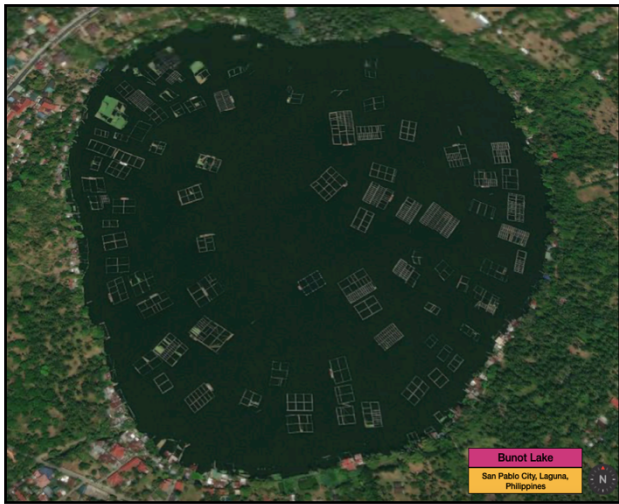


Figure 3: Bunot Lake (Apple Maps 2022b)



Figure 4: Palakpakin Lake (Google Earth 2022b)

Both are concrete roads adjacent to Bunot Lake, making it essential to pave the way for the community and tourism development. In the community, Sabang Road is the primary designated route in and out of a small lake and the center of the inhabitants, fish cage operators, and tourism stakeholders. In tourism, Sabang Road is typically the focal point of development, so it ought to expand the barangay road and institute commercial facilities (such as from the direction sign and parking area to the restroom and lodge). Thus, the road infrastructure exists in Bunot Lake, but the organizational structures of the populace and tourism development are still emerging overall.

Palakpakin Lake's designated course to the crater lake and vice versa to the urban area is markedly recognized. In the accessibility, the maar lake has one proximate road, the San Lorenzo Road, a barangay road, along the northern fringe (see Figure 7, Google Earth 2022b, see also Apple Maps 2022c, Google Maps 2022c). This barangay road is a paved road near Palakpakin Lake, making it advantageous in preparing the community and tourism development. In the community, San Lorenzo Road is the principal designated course that accesses a small lake and is intrinsic to the inhabitants, fish cage operators, and tourism stakeholders. In tourism, San Lorenzo Roads is generally the center of development, but the rudimentary commercial amenities and activities are less instituted. Consequently, the road infrastructure is present in Palakpakin Lake, but the subsidized organizational structures of the tourism development are still less materialized overall.

Calibato Lake's designated path to the small lake and vice versa to the urban area is within the vicinity. In the accessibility, the



Figure 5: Calibato Lake (Apple Maps 2022d)

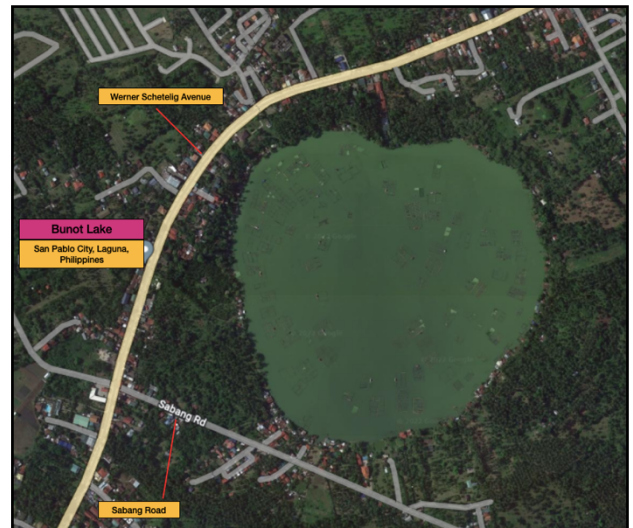


Figure 6: Bunot Lake, Werner Schetelig Avenue, and Sabang Road (Google Earth 2022a)

crater lake has one proximate road, San Pablo-Rizal-Nagcarlan Road, a provincial road, along the northwest perimeter (see Figure 8, Google Earth 2022c, see also Google Maps 2022d, Apple Maps 2022d). This provincial road is the concrete road approaching Calibato Lake, making it the groundwork for community and tourism development. In the community, San Pablo-Rizal-Nagcarlan Road is the main designated route to enter this maar lake, but the passage road to Calibato Lake is lacking; thus, the inhabitants, fish cage operators, and tourism stakeholders have ramifications. In tourism, San Pablo-Rizal-Nagcarlan Road is anchored principally on development, but the necessary components, particularly the direct road and commercial facilities, are absent. The road infrastructure is not starting in Calibato Lake; hence, the requisite road and the organizational structures of the community and tourism development are crucial and pressing.

(iii) The Legal Easement, as mentioned, refers to the regulation of the littoral zone, particularly the right for public use and preservation on the lake's shoreline. This pertains to the illegitimate utilization of the land along the lake's margins, especially in conserving Bunot Lake, Palakpakin Lake, and Calibato Lake. Here, the littoral zone means the area situated on the edge of a crater lake, while the illegitimate utilization means the unauthorized structure or construction within the stretch of the lake's bank. In the three small lakes, the legal easement enforces the 20 meters clearing—an open space for public use within the littoral zone abiding by the Forestry Reform Code of the Philippines and the Water Code of the Philippines (see Presidential Decree no. 705 1975, Presidential Decree no. 1067 1976, Department of Environment and Natural Resources Administrative Order no. 2021-07 2021).



Figure 7: Palakpakin Lake and San Lorenzo Road (Google Earth 2022b)



Figure 8: Calibato Lake and San Pablo-Rizal-Nagcarlan Road (Google Earth 2022c)



Figure 9: Bunot Lake and Littoral Zone (Google Earth 2022a)

Bunot Lake’s littoral zone has not been regulated up to the present time. The maar lake’s shoreline has continuously existed with illegitimate utilization, explicitly the prohibition of constructions and habitations (see Figure 9, Google Earth 2022a, see also Google Maps 2022b, Apple Maps 2022b). In other words, the 20 meters open space has not been enforced as the unlawful establishments remain around the lake’s bank. With this, the unresolvedness is implementing the legal easement, specifically abolishing the illegal structures and resettling the informal settlers surrounding the crater lake. Removing these are critical in advancing the community and tourism development and, more importantly, resolving the overlong problem—relocating the informal settlers by providing them a decent abode (via the Local Government and LLDA) and preserving the small lake.



Figure 10: Palakpakin Lake and Littoral Zone (Google Earth 2022b)



Figure 11: Calibato Lake and Littoral Zone (Apple Maps 2022d)

Palakpakin Lake’s littoral zone has not been managed up to the present moment. The crater lake’s shoreline has been regularly maintained by illegitimate utilization, particularly forbidding the structures and dwellings (see Figure 10, Google Earth 2022b, see also Apple Maps 2022c, Google Maps 2022c). So, the 20 meters clearing has not been imposed as the restricted premises persist through the lake’s easement. Thus, this unsettledness is executing the bank’s easement, especially removing the banned constructions and transferring the informal settlers around the small lake. These measures are vital in initiating the locality and tourism development, addressing this prolonged issue of rehabilitating Palakpakin Lake (being the “shallowest” among the Seven Crater Lakes), and resettling a suitable abode for the informal inhabitants.

Calibato Lake’s littoral zone has not been tackled up to this time. The maar lake’s shoreline has been steadily sustained by illegitimate utilization, specifically preventing the establishments and occupancies (see Figure 11, Apple Maps 2022d, see also Google Earth 2022c, Google Maps 2022d). Suitably, the 20 meters open area has not been carried out as the prohibited structures continue surrounding the lake’s margin. Hence, the indecisiveness is prioritizing the legal easement, particularly withdrawing the barred constructions and resolving the informal settlers in the small lake’s fringe. Enacting these are crucial in forwarding the habitation and tourism development, transferring a befitting abode for the informal inhabitants, and dealing with the drawn-out issue of protecting Calibato Lake—the deepest and most enormous capacity of freshwater volume among the Seven Crater Lakes.

Concluding Remarks

The article examines Bunot Lake, Palakpakin Lake, and Calibato Lake and comprehends the Aquaculture Structure, Road Infrastructure, and Legal Easement concepts. The Bunot Lake, Palakpakin Lake, and Calibato Lake are the most problematic issues among the Seven Crater Lakes, and the

Aquaculture Structure, Road Infrastructure, and Legal Easement are the most fundamental requirements between the small lakes. Specifically, the three crater lakes are lesser in the conservation and tourism development, while the three essential factors are indispensable in directionally improving the small lake's conditions. The association between the three maar lakes and their three necessary conditions is complemented, reciprocated, and supplemented by the small lake's restoration and the aquaculture-tourism nexus.

(i) In the Aquaculture Structure, Bunot Lake's arrangement has not been completely executed and regulated in the fish cage belt, and its limitation has continually surpassed the allowable limit in the fish cage allocation. The fish cage operators have not entirely complied with the dimension and the navigation-access lane, nor fully conformed to the reduction and sanctions (i.e., registered and unregistered operators) on the fish structure zone. Palakpakin Lake's arrangement has been organized but not thoroughly completed in the fish cage area, and its limitation has satisfied the allowable stipulated of the fish cage proportion. The fish cage operators have relatively maintained the dimension and the navigation-access lane, and abide by the restriction and curtailment (i.e., legitimate and illegitimate operators) of the fish structure area. Calibato Lake's arrangement has not been methodically implemented and conducted in the fish cage belt, and its limitation has still exceeded the allowable limit in the fish cage allotment. The fish cage operators have not yet abided by the dimension and the navigation-access lane, nor wholly carried out in lowering the fish cage operators and penalizing the illegal fish cage operators.

(ii) In the Road Infrastructure, Bunot Lake's accessibility has existed, but its designated route structures of the community and tourism establishment are still emerging. Palakpakin Lake's accessibility is present, but its designated course structures of tourism development are still subsidized and less materialized. Calibato Lake's accessibility has not started, so the designated path structures for the inhabitants, fish cage operators, and tourism stakeholders are crucial and pressing. (iii) In the Legal Easement, Bunot Lake's littoral zone has not been regulated to date, as the shoreline has continuously existed with illegitimate utilization, particularly the prohibition of constructions and habitations. Palakpakin Lake's littoral zone has not been managed up to the present, as the shoreline has been regularly maintained by illegitimate utilization, specifically forbidding the structures and dwellings. Calibato Lake's littoral zone has not been tackled up to this time, as the shoreline has been steadily sustained by illegitimate utilization, explicitly preventing the establishments and occupancies.

The fish cage limitation of the small lakes requires delving into. The Aquaculture Structure has a long-standing regulation of a 10 percent allowable ceiling on the total lake area, as prescribed by the Philippine Fisheries Code (or a 5 percent acceptable limit to some small lakes via LLDA, e.g., Pandin Lake and Yambo Lake). The current LLDA's requirement in Bunot Lake, Palakpakin Lake, and Calibato Lake are the same— 10 percent permissible. This stipulation, however, needs to look into since the three maar lakes have distinctiveness. For instance, in surface area, Bunot Lake is only 305,000 square meters, while Palakpakin Lake and Calibato Lake are bigger, 479,800 square meters and 430,000 square meters, respectively. In depth, Palakpakin Lake and Bunot Lake are shallow, 7.5 meters and 23 meters, respectively, while Calibato Lake is deepest at 156 meters. In calculating the volume of water, Palakpakin Lake and Bunot Lake have lower storage, approximately 1.6 million cubic meters, and 3.38 million cubic meters, respectively, while Calibato Lake has the highest storage, roughly 29.6 million cubic meters. With these figures, Calibato Lake is suitable to follow the allowable 10 percent limit on fish cages— it has a

bigger water capacity to absorb the environmental expenditures. But Palakpakin Lake and Bunot cannot bear that— probably proper to embrace a 5 percent ceiling only. Thus, the underlying issue here is the small lake's carrying capacity— it should not just focus solely on the water's surface area, but the lake's depth and the water's volume storage are also crucial.

Overall, Bunot Lake, Palakpakin Lake, and Calibato Lake vis-a-vis Aquaculture Structure, Road Infrastructure, and Legal Easement are imperative currently. These three focal-point factors are supposedly known in the past— yet they are still elusive. Although the three small lakes situations have a couple of differences, the Aquaculture Structure, Road Infrastructure, and Legal Easement issues are almost identical. The arrangement and limitation, accessibility, and littoral zone's unresolved obstacles of the three maar lakes are comparable and ongoing from the aquaculture-tourism development, the restoration of the small lake, and the contribution of the local populace. In essence, these central factors are about balancing the aquaculture over-expansion and tourism augmentation on the three crater lakes. Aquaculture, particularly the fish floating cages, has long been dominated, while tourism has incrementally instituted for the most part. Both are vital— aquaculture and tourism development are crucial in advancing the local economy and lake conservation. In addressing this, it does not mean opposing (or even eradicating) the tilapia floating cages but merely equipoising aquaculture and tourism. In other words, the small lake's fish cages have long been tolerated, so it is due time to curtail them in a suitable manner. As the aquaculture's hurdles are tackled (starting with the three essential factors), would tourism can gain ground. Thus, urgent to respond, the government agencies, the city government, the communities, and the stakeholders must immediately match the responsibilities. In the end, the only way to do this in the three maar lakes is to embrace, confront, and materialize— promptly implement them and be effective.

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Conflict of Interest

The authors have no conflict of interests to declare.

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