PROFILING LAKE SEBU AND THE INDIGENOUS COMMUNITY IN THE VICINITY

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Abstract: The disturbances brought about by different existing biophysical factors comprised by various socio-economic activities of the communities in the vicinity of Lake Sebu in South Cotabato, Philippines threatened its health and state. The focus of the study comprises profiling the current biophysical conditions, socio-economic activities, issues and threats. A transect walk and a combination of different tools in the participatory rural appraisal, the quadrat method, a market survey, and semi-structured interview were utilized in gathering primary data. Secondary data were obtained to further substantiate findings. Two land-use approaches were observed in the vicinity of the lake: agricultural (58.36%) and miscellanea (27.45%). Unsustainable farming practices reduce vegetative ground cover (42.86%). Farming, aquaculture and fishing are the major economic activities, ranking first and second respectively. Corn and rice are the first two major crop types. Aquaculture (90%), fishing (25%) and transport (20%) are the first three major uses of lake water. The coexistence of various land and water resource utilization in Lake Sebu poses different issues and threats affecting the wetland. These are directly or indirectly interrelated with one another. Erosion and soil fertility associated with farming systems and upland degradation, pollution from human settlements, recreational and agricultural activities, and an increasing number of fish cages have continuously imperiled the lake ecosystems. Hence, a need to study these issues quantitatively at different scales is recommended to help in framing a responsive, effective, and sustainable lake management policy.

Keywords: biophysical, economic activities, farming system, issues and threats, land use, profiling, transect

Introduction:

Structures and functions of Lake Sebu are changing due to several biophysical conditions occurring therein. These however are compounded by the different disturbances introduced by the community in the vicinity. Commonly, according to the cited studies, the establishment of human settlements in the catchment areas of lakes and conversion of vast areas of forest into agricultural farmlands (Romshoo and Muslim, in Rashid et al. 2013) were documented and deemed indicative of inflicting stress on aquatic resources. Papa and Briones (2014) highlighted the extensive lake-shore town development and intensive aquaculture as major driving forces causing

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human-induced eutrophication of lakes. Guerrero III (2001) on the other hand, cited a varied degree of sedimentation, pollution and overfishing pressures as indicators affecting the lakes' conditions.

Lake Sebu provides an inherent aesthetic and recreational potential. Not only does it represent the source of water for the different agricultural and aquaculture industries in the vicinity, but the ecotourism industry enhances its progress and thrives as well. However, considering all these conditions and disturbances, the state of Lake Sebu has been affected. Therefore, data on the existing biophysical characteristics and socio-economic activities of the communities in the neighbourhood are vital to be addressed to. These primarily help describe, facilitate the assessment of the current state of the lake and support management initiatives to ensure sustainable provisions and utilization of natural and environmental services in the future.

In this light, the study was undergone with the following objectives: (a) to determine the biophysical profile of Lake Sebu, (b) to establish the baseline data on the major economic activities and crops of indigenous communities in the vicinity, and (c) to identify potential issues and threats affecting the lake ecosystem and the surrounding community.

Materials and methods:

Study site profile and conditions

Lake Sebu is located 6° 10.45' N and 124° 43.95' E (Socio-economic Profile 1995, in Beniga 2001) (Fig. 1). It is 700 m above sea level in the Municipality of Lake Sebu of South Cotabato, Philippines. It covers an area of 354 ha. Featuring a maximum depth of 57 m at the center and 5 m on average near the shoreline, it is fed by several major tributaries from the uphill and various underground springs. Several mountain ranges that store and catch rainwater are located in the surrounding areas. Daguma and Talahik mountain ranges lie in the eastern area, Mt. Busa in the south-eastern, Pitot Kalabao Peak along central and Mt. Talili in the eastern region. The prevailing rainfall conditions of the area belong to the Fourth Type where rainfall is evenly distributed with relatively moderate temperature throughout the year.

On the other hand, the agricultural activities in the surroundings are intensive. A wide selection of agricultural crops is planted. These crops are the primary sources of income for the community of T'boli and Ilonggo (95.5%) and other tribes (4.5%) (Socio-economic Profile 2010) inhabiting the lake's vicinity.

Methods

The collection of primary data was done by establishing a three-kilometer distance transect route in the vicinity and in the shoreline (2 each Barangay) of Barangay Poblacion and Barangay Bacdulong. This was preliminarily facilitated using the land-use map of the municipality.

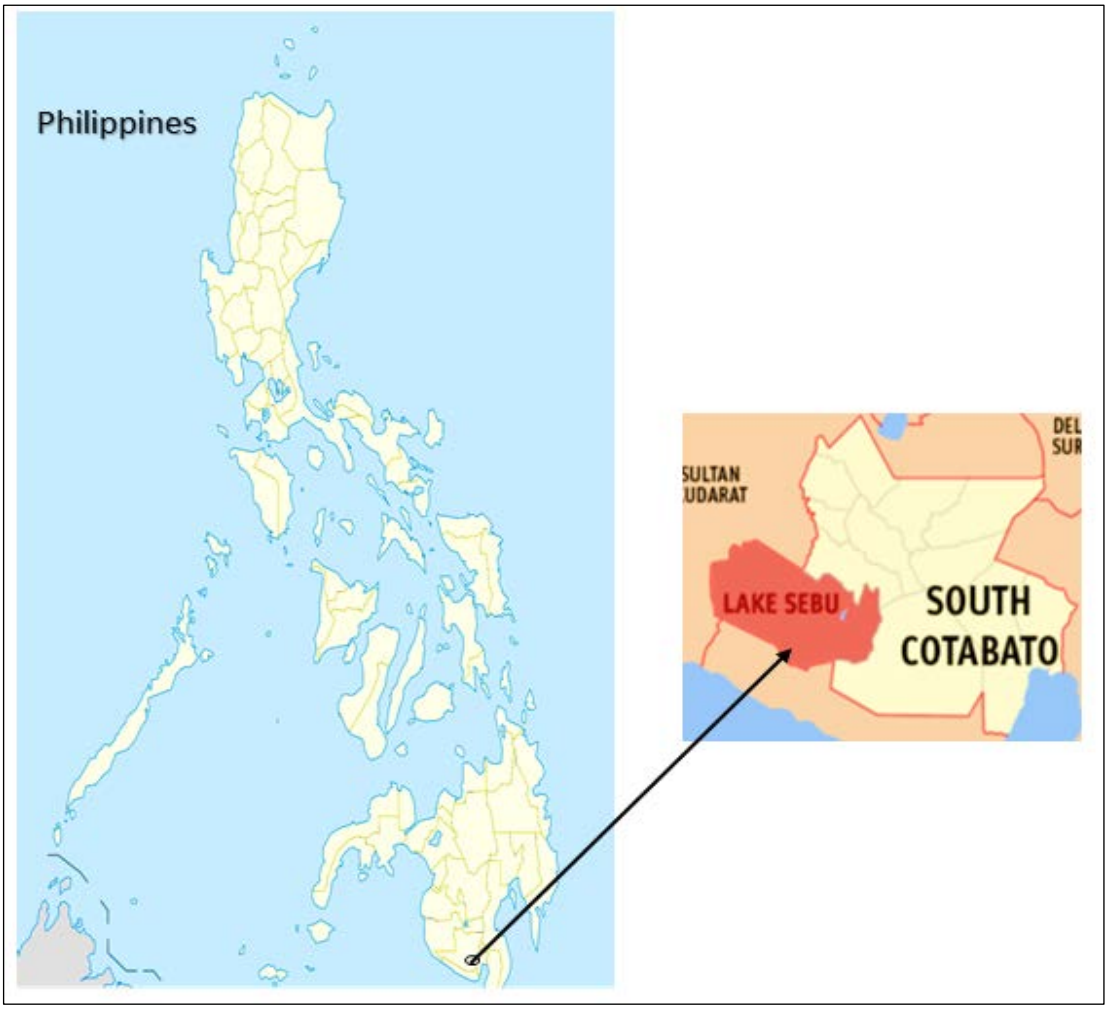
Every 300 m distance was marked up to the end of each transect route. A 10 m x 10 m quadrat diagonally located in every mark was measured and the vegetative ground cover was assessed employing the visual assessment indicators of Meat and Livestock Australia Tool A (2015). Altitude and coordinates were described using a digital GPS-Altimeter and land-use activities, percentage of vegetative and ground cover, water resource utilization within and on the shoreline. On the other hand, an approximate distance of 10 m from the waterline outward and 5 m inward for about a distance of 30 m were noticed in profiling free-floating and attached flora of the lake. This was done with the help of binoculars. Market survey, observations and knowledge of key informants on species of fish and other fauna in the lake were employed.

A combination of transect walk, seasonal calendar, and ranking were utilized to outline socio-economic activities, issues and threats. Actual observations and semi-structured

interviews with 10 chosen local analysts or key informants were as well employed. Secondary sources were obtained from agencies concerned with substantiating findings.

Figure no. 1 Location of the study area (a - Maps from http://en.wikipedia.org/wiki/Lake_Sebu, _South_Cotabato; b - Maps from Municipal Planning and Development Council of Lake Sebu; c- Transect Samples - Photos by R. Porras)

a.



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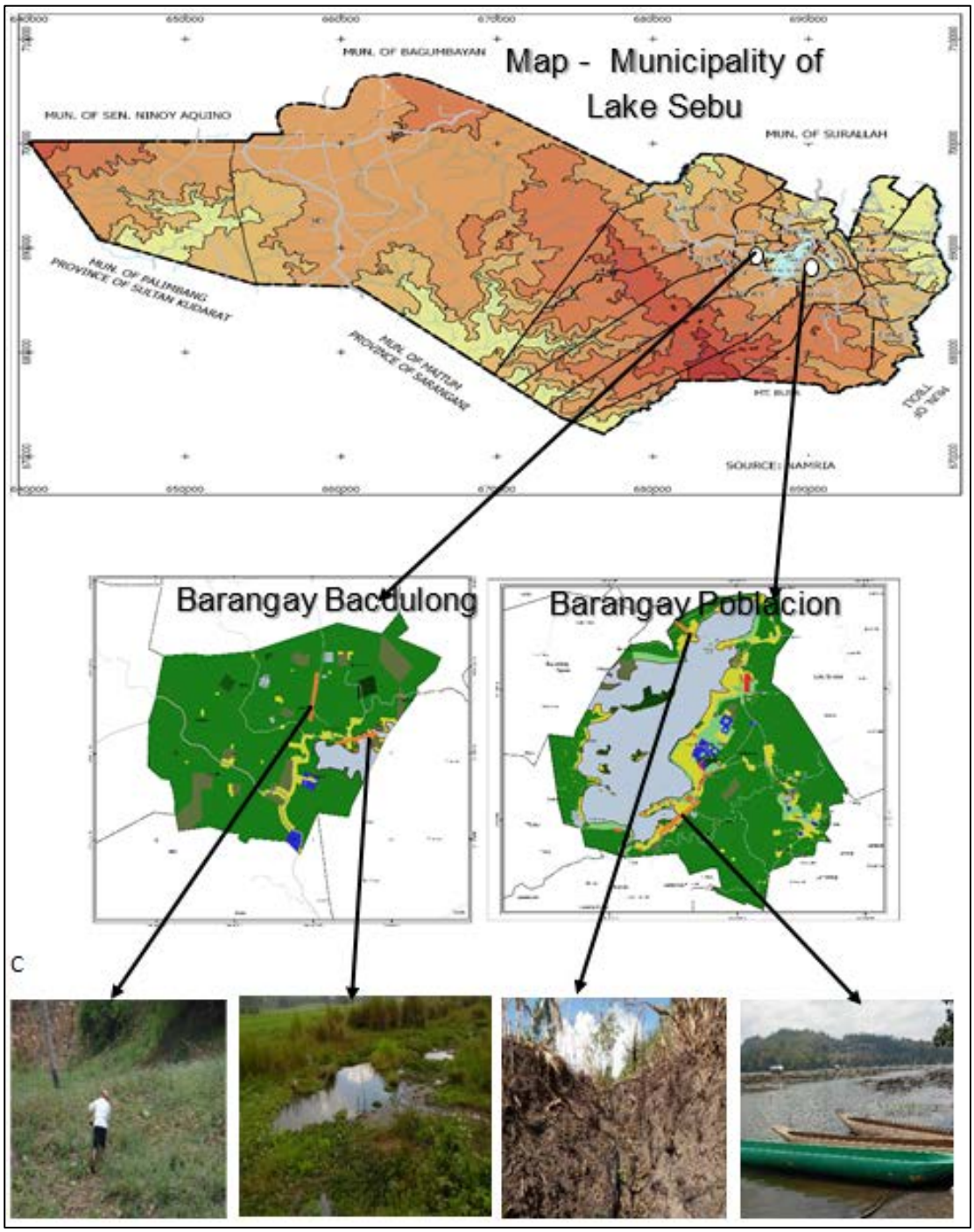

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Results and discussion:

Biophysical Attributes

Land Use Types. Tables 1 and 2 show land use types found in two barangays and their corresponding computed percentage values.

Table no. 1 Existing land use relative to land cover (Poblacion and Barangay Bacdulong) (Source: Socio-economic Profile 2010)

Land use type	Area (ha)	Percent (%)
Agricultural	995	58.36
Built-up	142	8.33
Forest	42	2.46
Grassland	58	3.40
Miscellaneous	468	27.45

Table no. 2 Existing land use relative to land use policy (Poblacion and Bacdulong) (Source: Socio-economic Profile 2010)

Land use type	Area (ha)	Percent (%)
Settlement	91	5.34
Production areas	675	39.59
Protection Areas	851	49.91
Infrastructures	88	5.16

The rapid increase in the population growth puts pressures on agricultural land (Maskey et al. 2003), therefore instilling encroachment of upland areas (Fig. 2) as noted in the vicinity of Lake Sebu. An aspect which is not sustainable. These are the sources of heavy loads of nutrients leaching into the lake (Romshoo and Muslim, in Rashid et al. 2013) during soil erosion.

Figure no. 2 Encroachment noticeded on upland areas (Photos by R. Porras)

Vegetative and Ground Cover. Quadrats samples in the area have revealed that the estimated average vegetative and ground cover reaches 42.86%. Accordingly, ground cover features a critical level if it is lower than 30% (Land Managers Monitoring Guide – Ground Cover Indicator 2010).

Farming systems in the vicinity of the lake, which are attributed to the lower percentage estimate of vegetative ground cover though the impact of dry season, are not discounted. In the case of cornfields for instance, corn stubbles were slashed and burned by many farmers during land preparation. Herbicide was sprayed to kill weeds days after planting. These facilitated loosening and exposure of soil surface, making it less vegetated and susceptible to soil erosion according to key informants. Table 3 shows classifications of soil erosion in the municipality of Lake Sebu.

Land Slope Characteristics. The average altitude computed using a digital GPS. The altimeter in the study area revealed 733 m. These areas are characterized by flat (0-3%) and gently sloping to undulating (3-8%)

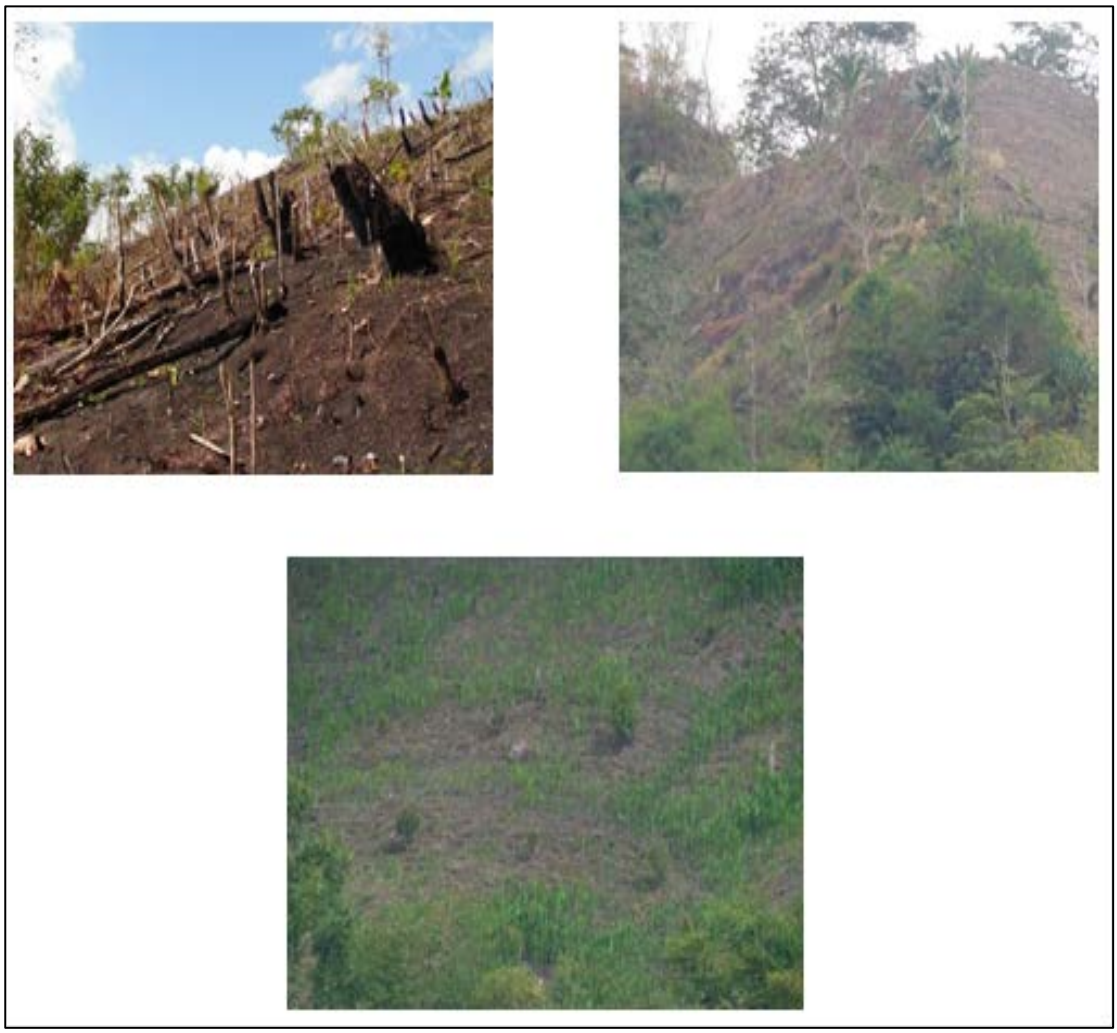
slope classification (Socio-economic Profile 2010).

Areas of different slope types in the vicinity are used by the communities for different land use activities. However, a similar observation was noticed concerning what is pointed by Maskey et al. (2003) in their study. Some marginal and steep slope areas (Fig. 3) were encroached, cleared out trees, burned and utilized them for different agricultural crops.

Table no. 3 Classification of Soil Erosion (Source: Socio-economic Profile 2010)

Degree of erosion	Location
No apparent erosion	Lower portion of Ned, T'konel, Lake Seloton and Lamlahak
Slight erosion	Portions of Bacdulong, Ned, Lake Lahit, Poblacion, Luhib, T'konel, Lamlahak and Talisay
Moderate erosion	Portions of Barangay Denlag, Halilan, Hanoon, Tasiman, Ned and Lamdalag
Severe erosion	Portions Of Barangay Ned, Lamdalag, Lamfugon and Lower Maculan

Figure no. 3 Marginal areas employed for agricultural activities (Photos by R. Porras)



Aquatic Biota. Various exotic species of fish like Mozambique tilapia (Beniga 2001) and other aquatic biota were introduced in the lake's ecosystem. Table 4 shows the following species of fish present in the lake.

Table no. 4 Fish Species in Lake Sebu

Species Local Name	Scientific Name	Remarks
Tilapia	*Oreochromis* sp.	Collected through Market Survey
Ayungin	*Leiopotherapon plumbeus*	Collected through Market Survey
Bagtis (Bonol)	*Glossogobius circumspectus*	Collected through Market Survey
Gourami	*Osphronemus* sp.	Collected through Market Survey
Paitan (Hait)	*Puntius* sp.	Reported by the Key Informants
Haluan (Halo)	*Channa striata*	Reported by the Key Informants
Korean Fish (Bighead Carp)	*Hypophthalmichthys nobilis*	Reported by the Key Informants
Hito	*Clarias batrachus*	Reported by the Key Informants

Native fish species in the lake like Paitan (*Puntius*) have dwindled to such an extent that it can only be seen and caught in some parts of the lake as reported by key informants. Araullo (2001) highlighted that alteration of the existing fish population brought by interbreeding, predation and competition for food, space, and habitat was due to the introduction of exotic species. Lake Buhi, the home of 'sinarapan' *Mistichthys luzonensis***,** the world's smallest commercial fish, is now dominated by tilapia. The population of *Mirogobius lacustris* in Laguna de Bay, *Sardinella tawilis* in Taal Lake, and the small cyprinids in Lake Lanao and Lake Sebu which has been reported to have declined greatly after the introduction of some exotic species (Araullo 2001) are some cited examples. Moreover, other groups of animals were observed, such as frogs, clams and snails, crustaceans, waterfowls and different species of birds, among which herons and egrets were constantly seen present in the lake.

A mix of grasses and water lettuce are plants commonly found along the shoreline. Water lilies of two species (white and red) and water hyacinth are common free - floating plants. However, considering the lake's outlet in Pagasa (6.21 latitude, 124.70 longitude at an altitude of 709 m) , located in Poblacion, an abundant mix of grasses and wide cover of free-floating water hyacinth and water lilies is present (Fig. 4).

Socio-economic profile and lake resources utilization

Major economic activities and crop types have been ranked (Tab. 5) in order of their importance based on the key informant's participatory value judgement.

Agricultural farming and aquaculture stood for the first two major economic activities in the communities. These were similar to the findings of Macandog et al. (2014) in their study of Taal Lake. The sampled communities appeared as dependent in agricultural farming and fish-based activities in Taal Lake for their livelihood.

Planting of major crops such as corn and rice (upland) has been based on the rainfall pattern. Commercial fertilizers, herbicides and pesticides were used to improve production yield. Usually there were used 8-10 bags of fertilizers and a gallon of herbicides – considering the need per hectare in the case of corn land. Aquaculture on the other hand, would employ 30 bags of commercial feeds or more depending on the desired sizes of *Tilapia* in a fish cage of about 200 square meters (Beniga 2001) for a period of more or less than 6 months.

Table 6 shows the following water resource utilization of Lake Sebu. A fish cage for aquaculture (Fig. 5) occurs with a relative frequency of 19.3 per kilometer and covers a great area. Thus on March 24, 2015, the Municipal Agriculture Office recorded 3.193 installed fish cages. This is consistent with the findings of several studies conducted in the Philippines. Taal Lake for example, has been predominantly used for the aquaculture of tilapia (*Oreochromis* sp.) and bangus or milkfish (*Chanos chanos*) since 1975 (Macandog et al. 2014). In the case of Laguna de Bay, one of the main uses of the lake includes fishery for both open fishing and aquaculture (Barril n.d.). However, fish cage culture has a harmful impact on the quality of the lake (particularly the sediment phase) as singled - out and concluded by Hallare et al. (2009). Aside from this use, utilization of lake water varies from transporting, recreational and domestic uses which include site for hook and line fishing, bathing, washing and drinking.

Figure no. 4 Abundant mix of grasses and free-floating plants in the lake outlet (Photos by R. Porras)

Table no. 5 Ranking of major economic activities, crop types, and issues and threats involved

Rank	Economic activities	Crop types	Issues and threats involved
1	Agricultural farming	Corn	Soil erosion
2	Fishing/Aquaculture	Rice	Pollution
3	Business	Banana	Unsustainable farming system
4	Paid labour	Vegetables	Loss of soil fertility
5	Backyard raising (livestock)	Bamboo	Increasing number of fish cages
6		Root crops	Encroachment of lake shoreline
7			Upland degradation

Table no. 6 Lake water resource utilization

Water resource utilization	Percent (%)
Aquaculture	90
Fishing (Net and Hook and Line)	25
Transport	20
Recreational	15
Domestic	10
Irrigation	5

Figure no. 5 Fish cages – Lake Sebu (Photos by the Authors)

Issues and threats

There are several major interrelated issues and threats (Tab. 7) that continuously threaten the state of Lake Sebu. These led to the gradual dwindling of its aesthetic, recreational and economic values.

Soil erosion and loss of soil fertility compounded by upland degradations are evident identified issues. These are associated with unsustainable farming systems according to key informants. Paragas et al. (n.d.) has pointed that soil erosion is now the most serious problem in the Philippines.

Pollutants loaded to the lake from agricultural fertilizers and pesticides, wastes from human settlements, recreational facilities and overfeeding of fish in the aquaculture are issues critically pointed out by key informants. The establishment of unpaved roads close to the perimeter of the lake was also identified and stressed to add the level of silts and sediments reaching the lake waters.

Table no. 7 Issues and threats identified

No.	Issues and Threats
1	Soil erosion
2	Pollution
3	Unsustainable farming system
4	Loss of soil fertility
5	Increasing number of fish cages
6	Encroachment of Lake Shoreline
7	Upland degradation

On the other hand, the presence of many floating and deteriorating bamboo materials, nets and floaters were observed on the water surface of Lake Sebu. These increase the possibility of lake shallowing according to

Araullo (2001) as this debris is allowed to deteriorate and stay uncollected, which impedes water circulation and flow. Araullo (2001) further highlighted that overfeeding fishes from the fish cages enriched water with organic phosphorus, nitrite, ammonia, and other toxic substances. These are detrimental to fishes during upwelling. Bottom water loaded with toxic substances, such as hydrogen sulphides and ammonia, is brought up to the surface that results in fish death (Tab. 8).

Table no. 8 Recorded fish kill occurrence (August 2010 – March 2014) (Source: Lake Sebu, Municipal Agriculture Office - 2015)

Date of Occurrence	Location
August 1-2, 2010	Lot 70, Tukufol, Lemsufo
July 24-27, 2011	Lot 70, Tebenwu
Dec. 7-9, 2011	Lemsufo
Jan. 26-29, 2012	Lot. 70, Purok Rosas, Tukufol, S'bu Udi, Tabite, Outlet (Pagasa)
May 2-4, 2012	Lemsufo
July 29-August 2, 2012	Lemsufo, Tebenwu, Lot 70, T'bowow, Tukufol
September 23-27, 2012	Lot 70, Tukufol
Oct. 6-16, 2013	Lot 70, Pag-asa, Tebenwu, T'bowow, Tukufol
Jan. 28-29, 2014	T'bowow, Lot 70, Purok Rosas, Bakikot, Tebenwu
March 12-13, 2014	Lemsufo, Lot 70

These issues are not unique to Lake Sebu. Sharma and Chouhan (2008) in their study of Lake Budha Pushkar of India and Barill and the study of Laguna Lake in the Philippines have enumerated issues which are similarly observed in Lake Sebu as well.

Conclusions:

The current alterations observed in the ecological structure of Lake Sebu are attributed to the different existing biophysical and socio-economic factors therein. It is conspicuous that these alterations are compounded and enhanced by different socio-economic activities employed by the communities in the vicinity. Land use activities practised by the people in various communities highly contribute to the continued lake degradation. These aspects bring various negative consequences that outweigh the benefits it provides to the communities in reference to the lake degradations it inflicts. Practices like unsustainable farming adopted in the surroundings and aquaculture have contributed and complicated issues and threats affecting the lake's ecosystem.

The causes of lake degradation are diverse and interrelated. Continued practice of unsustainable farming, deforestation, utilization of lake water resource beyond its carrying capacity, encroachment of shoreline of the different agricultural activities and human settlement augment the number of threats to the resource base of the lake. Pollution, soil erosion, siltation and sedimentation represent issues arising out that need to be studied quantitatively. Baseline data on these on different scales should be established. Further, crafting of effective and responsive management policy to protect and save threatened ecosystems of the lake should be anchored on it.

Rezumat:

PROFILUL LACULUI SEBU
ȘI COMUNITATEA INDIGENĂ
DIN VECINĂTATE

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Perturbările cauzate de diverşi factori bio-fizici ca urmare a activităţilor socio-economice din cadrul comunităţilor umane din vecinătatea Lacului Sebu, din zona Cotabato de Sud, Filipine, au dus la periclitarea stării de sănătate a ecosistemelor din zonă. Studiul nostru a urmărit prezentarea aspectelor privind profilul condiţiilor bio-fizice actuale, al activităţilor socio-economice, al problemelor şi ameninţărilor existente. O rută de studiu şi o combinaţie a diferite unelte de evaluare rurală, metoda pătratelor, un sondaj de piaţă şi un interviu semi-structurat au fost folosite în colectarea informaţiilor primare. Datele secundare au fost obţinute din concluziile descoperirilor ulterioare. Două tipuri de folosinţă a terenului au fost observate în vecinătatea lacului: agricol (58.36%) şi alte utilizări (27.45%). Practicile nesustenabile ale fermierilor reduc acoperirea cu vegetaţie a terenului (42.86%). Acvacultura şi pescuitul sunt principalele activităţi economice, situându-se pe primul, respectiv al doilea loc. Porumbul şi orezul sunt primele două mari tipuri de culturi. Acvacultura (90%), pescuitul (25%) şi transportul (20%) sunt primele trei utilizări majore ale apei lacului. Utilizarea concomitentă a diverselor resurse din apă şi sol de la Lacul Sebu generează diverse probleme şi ameninţări care afectează ecosistemul acvatic. Acestea sunt direct sau indirect interrelaţionate unele cu celelalte. Eroziunea şi fertilitatea solului, asociate cu sistemele de ferme agro-zootehnice, cu degradarea zonelor de podiş, poluarea datorată aşezărilor umane, activităţile agricole şi recreaţionale, precum şi un număr crescând de cuşti pentru peşti, au pus continuu în pericol ecosistemul lacului. De aceea, necesitatea de a studia aceste aspecte în mod cantitativ, la diferite niveluri, este recomandabilă pentru a ajuta la conturarea unei politici de management sustenabilă şi eficientă a lacului.

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