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# Bakong (*Hanguana malayana*) associated-species and water quality in Laguna De Cagayan Lake, Northern Philippines

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**Key words:** Bakong, Importance value, Laguna de Cagayan Lake, Water quality, Simpson diversity index

**Abstract**

One aquatic plant species are of great interest in the province of Cagayan, Northern Philippines. This is Bakong (*Hanguana malayana*) species that are dominantly found in Laguna de Cagayan formerly known as Bangalao Lake located 18°14' 24" N and 121°54'35" E at Barangay Luga, Sta. Teresita, Cagayan. Bakong is locally used for fiber; its' weaved products being one of the major trade commodity and attraction of *Nammunit* Ecotourism Festival held annually. It is subsumed that problem will emerge if its harvesting rate is greater than its regeneration capacity. This study was conducted to determine the ecology of Bakong, diversity of different Bakong-associated species, and assess the physicochemical water-soil environment of Laguna de Cagayan Lake. The rapid ecological assessment was employed in the study using both descriptive, qualitative research design for on-site parameters and complete random design for laboratory parameters. The study revealed a total of 20 associated species, belonging to sixteen (16) different plant families; importance value of Bakong plants is 55.56% suggesting that Bakong Species is the most dominant aquatic plant in the lake ecosystem with 0.672 Simpson diversity index (SDI). The high diversity index of the lake may be attributed to its geographical location, land topology, and ecotone to the surrounding ecosystem. The results also showed that the physical properties of the lake such as Total Dissolved So; id (<200ppm), temperature (32°C), pH (7.2) and turbidity index (0.35) passed the environmental standard; chemical properties such as iron (<0.2mg/L) and lead content (<0.2mg/L) is within the required, permissible level while the dissolved oxygen (DO > 10 mg/L) content exceeded the desired amount. This implies that the water of Laguna de Cagayan Lake is still in good condition that permits the growth of floral species thriving in the area. These findings show the need for the lake to be maintained and protected for its sustainable viability for economic, social, environmental, aesthetic and for other beneficial purposes.

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**Introduction**

Surface water quality deterioration has become a serious concern worldwide due to increased pollution and climate change (Scanlon *et al*, 2007; Todd *et al.,* 2012) Such deterioration threatens the use of water resources, especially the drinking water supply, and economic development. However, according to UNICEF (2004), improving the water supply remains a challenge, especially in Asia. Poor water quality has been linked to public health concerns, mainly through the transmission of water-borne diseases. Therefore, many countries have implemented water quality protection measures and monitoring regimens (Astel *et al.,* 2007; Behmel *et al.,* 2016; Romero, 2016). Furthermore, to better understand water resource conditions, it is critical to assess water quality, especially the major contributors to its spatial and temporal variations.

Lakes are inland water bodies that neglect clear ocean trade. In these water bodies, lake habitats contain physical, chemical and biological resources. Fresh or salt water can be found in lakes in arid regions. This may be shallow or deep, definite or temporary. Lakes of all kinds share multiple ecological and biogeochemical processes and their analysis is a part of the "limnology" discipline. Lakes are excellent environments for the analysis of ecological dynamics: environmental, chemical and physical process interactions always vary in terms of quantity or consistency from land or air. Since water and land and water and air are separate, certain ecosystem elements are intertwined. The remote lakes become sandy owing to evaporation or the supply of freshwater. A lake can exist anywhere within a river basin, depending on its sources. A headwater lake has nothing but the drainage of many minor tributary streams, direct surface runoff and ground water inflows. It is managed by a headwater dam. These lakes will all have one contribution of the water.

The reservoirs have a major input and a substantial outlet farther downstream in river basins, with the water flow from input to output changing as a result of other water sources. (Wu *et al.,* 2017).

The Laguna de Cagayan, locally known as Bangalao Lake of Sta. Teresita, Cagayan, Northern Philippines offer a good eco-tourism potential and economic activities. Bangalao Lake is located in the heart or center of Sta. Teresita, Cagayan, originally covering a total of 224 hectares. It is located adjacent to the Northern Range of Sierra Madre which houses several caves that makes it one of the major tourist attractions in the province of Cagayan. If given a chance to be developed in a sustainable, eco-friendly manner, this can give a boost to local tourism benefiting the local community, the municipality of Sta. Teresita, as well as the entire province of Cagayan.

The town of Sta. Teresita is a small municipality in the province of Cagayan. It is sandwiched between the town of Buguey and Gonzaga. It consists of only nine (9) barangays (NSO, 2010). It is semi-coastal area. Majority of land is covered with swamps, mangroves and unwanted grasses (e.g. Bakong species). Majority of the people are farmer and fisher folks with minimal income. They have good ecotourism with mountainous areas having numerous cave system and open lake (Laguna de Cagayan).

Not much known to the public, it is also home and the haven of the Philippine wild ducks. Likewise Bakong (*Hanguana malayana*) plants thrive in the lake that gave its natural vegetation because its leaves can grow up to two meters in length (Aribal & Fernando, 2018; Carag & Buot Jr, 2017). This plant dominates the lake vegetation (Padilla, *et al*., 2015). It is a natural lake which also caters different fishes and different floras Binaday *et al.*, 2017). The lake also offers good panoramic views for nature photographers. It also offers potential for local boating, and spelunking in the vicinity area. (Chong, 2019) (Mohammadpour *et al.,* 2015). The lake provides sufficient water as habitat for the different organisms as well as sources of foods for the growth and survival of aquatic organisms (Martin & McCutcheon, 2018; Moriasi *et al.,* 2015). With the present anthropogenic activities such as utilization of Bakong as raw material in their local weaving industry and daily fishing, the water condition of the lake is affected; it gives us

assumption that there is a rapid reduction of aquatic life in the lake since these living species can hardly reproduce, grow, and survive with unfavorable disturbing environment (Amarathunga, *et al.,* 2016; (Sudrajat & SALEH, 2019). Also the lake, serves as flood basin absorbing much of the eroded soil, fertilizer and pesticide residues of farmers from adjacent agriculture (Siev *et al.,* 2018; Kropáček, 2015; Carle, Sasser, & Roberts, 2015). In addition, waste and water pollution from nearby residences are being absorbed by the lake in Sta. Teresita.

It is therefore imperative to conduct a study on the ecology, floral diversity and physico-chemical characteristic of Laguna de Cagayan Lake in Sta. Teresita, Cagayan relative to the continues existence of Bakong in the lake, prior to sustainable development of its eco-tourism potential and biodiversity conservation. (Boley & Green, 2016; Massenssini at al. 2015).

Generally, this study aimed to determine the ecology, floral diversity of Bakong-associated species and physico-chemical characteristic of Laguna de Cagayan lake relative to the existence of Bakong (*Hanguana malayana).*

Specifically, this study aimed to:

a. Determine the ecology of Bakong;
b. Determine the floral composition of the lake associated to Bakong;
c. Determine the Importance Value (IV) of each floral specimen;
d. Determine the floral diversity in terms of Simpson Index; and
e. Determine the physico-chemical property of the lake; and

**Materials and methods**

*Study Site*

Laguna de Cagayan lake at Barangay Luga, Sta. Teresita, Cagayan with coordinates 18°14' 24" N 121°54'35" E. Barangay Sta. Teresita is a sixth Class municipality of Cagayan dependent on its rice land and native crafts. It is 113.7 kilometers away from Tuguegarao. The Lake is predominantly covered with Bakong plants that are the main source of fibers for the Laguna de Cagayan weavers in the municipality. Likewise, Bangalao Lake is being promoted as the major tourist destination of the municipality by celebrating the Bangalao Ecotourism Festival annually.

*Plant materials*

*Bakong Plant* (*Hanguana malayana*)

Bakong is an example of hydrophytes found in Laguna de Cagayan or Bangalao Lake. It is a rare type of aquatic plant. It was subjected to various studies and research because of its potentials.

Bakong (*Hanguana malayana*) is an evergreen herb with large coated bulb (5 to 10cm diameters). Its leaves are crowded (6 to 12 leaves per plant). Its leaves apex is long (90 to 150cm) and wide (12 to 15cm)(Niissalo & Leong-Škorničková,2017). It is widely distributed throughout the Philippines along sandy seashores but sometimes planted inland. Its distant relative (*Crinum asiaticum*) is ornamentally cultivated. It is not endemic. It is also found in China, India, South Korea, Myanmar, Japan and Sri Lanka. (MOHD-AZLAN; Zakeyuddin, *et al.* 2016; Leong-Škorničková, & Niissalo,2017).

Bakong is a versatile plant native to the Philippines and some parts of Southeast Asia and thrives in wetlands and terrestrial habitats. So versatile is the plant that it even surprised the DTI- Design Center of the Philippines in 2013 when it was discovered for its many uses. The Bakong plant calls the Laguna De Cagayan (Bangalao Lake) in Barangay Luga its home for as long as the residents can remember.

Recent developments on Bakong species include its leaves that are rich in cellulosic fiber good for weaving industry. Local people began to explore Bakong leaves as source of natural fiber. It is substitute to Nipa and coconut leaves.

They harvested Bakong leaves, weaved mat and other raw products (Leatemia,Pattinama & Luhukay, 2019). LGU Sta Teresita recognized this potential and they

want to establish an organized local weaving industry to become alternative livelihood for local men and women. There are scientific gaps on Bakong species. At present time, there is no baseline information nor much research conducted on Bakong species. Not even habitat assessment of the species in the local setting.

Before the development and commercial utilization of Bakong species in Sta. Teresita, Cagayan, there is need to conduct a study dealing with ecological and bio-physical assessment of its habitat. There is a need for basis for determining its feasibility, viability and sustainability of a proposed Bakong weaving industry.

In fact, undergraduate study on a machine to extract bakong fiber was one of the most applauded theses for the degree of Bachelor of Fine Arts major in industrial design at the University of Santo Tomas on March 2015. Researcher Nino Christopher D. Garcia successfully defended his project project called "Design and Development of Bakong Plant Fiber Extracting Machine for Sta. Teresita." It was the first of its kind as it is exclusively for Bakong fiber only. From the stem, the machine can extract fiber measuring 1.2 to 1.4 meters long.

The sight of massive vegetation of Bakong which can reach as high as 1.5 meters highlighted the lake. Until 2012, the Bakong has always been unwanted in the area. Most of the fish farmers occasionally trim them down or eradicate them totally because "it has no value" to them. Not anymore.

The water pest have dramatically transformed into a potential industrial gold mine. It can now be an alternative raw material for elegant and sophisticated furniture designs never before seen in any industrial exposition. MOHD-AZLAN & DAS).

*Operational Materials*

The following materials were used during the collection of samples: 1 liter sterilized containers (5), pH meter, thermometer, pencil, paper, TDS meter, and Secchi disk (to measure the depth and turbidity of water).

*Research Design*

The study employs descriptive and qualitative design using ecological parameters.

*Collection of plant samples and diversity study*

Collection of floral species were based on the on the works of Aguilar, (1987). Diversity Index Study utilized the DENR Manual for Biodiversity Assessment (2002).

*Data gathering and analysis of the physico-chemical characteristic of Bangalao Lake*

Data gathered from the on-site physical measurement of the different water parameter was recorded monthly. Results of chemical test from the DOST Regional Standard Laboratory were also recorded and tabled. Mean of every parameters were compared to the Standard Permissible Values set by DAO 35, Series of 2005 for water quality, while lead was compared with the WHO permissible level for water, soil and plant tissues.

**Results and discussions**

*Bakong and Its Associated Flora Species*

The Bakong species found in Laguna de Cagayan Lake of Sta. Teresita, Cagayan was confirmed by the researchers to be of *Hanguana malayana* (Jack) Merr. belonging to family Hanguanaceae.

This result was verified and certified by the National Museum. Field survey conducted by the team also identified twenty (20) Bakong associated species within the habitat of Laguna de Cagayan Lake, belonging to sixteen (16) different plant families (Table 1).

The associated species includes *Cyclosorus interruptus* (Willd.) *H. Ito, Stenochlaena* sp., *Nephrolepis* sp., *Cayratia triflolia* (L.) *Domin, Mikania cordata* (Burm. f.) B.L.R., *Persicaria barbata* (L.) *H. Hara., Premna* sp., *Scleria* sp., *Phragmites karka* (Retz.) Trin. ex Steud., *Breynia cernua* (Poir.) Mull. Arg., *Gonostegia hirta* (Blume ex Hassk.) Miq., *Alpinia* sp., *Ficus* sp., *Passiflora foetida L., Dinochloa* sp., *Ficus nota* (Blanco) Merr., and *Ludwigia hyssopifolia* (G. Don) Exell, respectively.

**Table 1.** Bakong associated species in Bangalao Lake.

| Specimen No. | Family | Scientific Name |
|---|---|---|
| S01 | Thelypteridaceae | *Cyclosorus interruptus* (Willd.) *H. Ito* |
| S02 | Vitaceae | *Cayratia trifolia* (L.) Domin. |
| S03 | Blechnaceae | *Stenochlaena* sp. |
| S04 | Asteraceae/ Compositae | *Mikania cordata* (Burm.f.) B.L.R. |
| S05 | Polygonaceae | *Persicaria barbata* (L.) *H.Hara.* *(Syn: Polygonum barbatum* L*)* |
| S06 | Lamiaceae | *Premna* sp. |
| S07 | Cyperaceae | *Scleria* sp. |
| S08 | Nephrolepidaceae | *Nephrolepis* sp. |
| S09 | Poaceae/gramineae | *Phragmites karka* (Retz.) *Trin. ex Steud.* *(Syn: Phragmites vallatorius* (Pluk. Ex L.) Veldkamp) |
| S10 | Phyllanthaceae | *Breynia cernua (Poir.)* Mull. Arg. |
| S11 | Vitaceae | *Cayratia trifolia* (L.) Domin |
| S12 | Urticaceae | *Gonostegia hirta (Blume ex Hassk.)* Miq. |
| S13 | Zingiberaceae | *Alpinia* sp. |
| S14 | Moraceae | *Ficus* sp. |
| S15 | Passifloraceae | *Passiflora foetida* L. |
| S16 | Polygonaceae | *Persicaria barbata* (L.) *H. Hara.* *(Syn: Polygonum barbatum L.)* |
| S17 | Poaceae/ Gramineae | *Dinochloa* sp. |
| S18 | Moraceae | *Ficus nota* (Blanco) Merr. |
| S19 | Asteraceae/ Compositae | *Mikania cordata* (Burm.f.) B.L.R |
| S20 | Hanguanaceae | *Hanguana malayana* (Jack) Merr. |
| S21 | Onagraceae | *Ludwigia hyssopifolia* (G.Don) Exell |

Table 2 reveals that the plant species identified belong to family of Thelypteridaceae, Blechnaceae, Nephrolepidaceae, Vitaceae, Asteraceae/Compositae, Polygonaceae, Lamiaceae, Cyperaceae, Poaceae/Gramineae (2), Phyllanthaceae, Urticaceae, Zingiberaceae, Moraceae (2), Passifloraceae, and Onagraceae, respectively.

*Importance Value*

It was found out that out of 92.5 ha bathymetric area of Laguna de Cagayan lake, Bakong plants predominantly covered approximately 62% of the total area favorably occupying riparian edge to shallow water (<1m depth) profile, its vegetation coverage is more than enough to be considered *healthy* ecosystem (>50% vegetation cover index).

Table 3 shows the Importance Value (IV) of each species in Laguna de Cagayan lake, Sta. Teresita, Cagayan. Bakong rank 1 with IV of 55.560% followed by Scleria 18.883% (2), Cyclorus 8.574% (3), Ficus 4.672% (4) and Water Hyacinth 2.882% (5). These were also the top five dominant species in the lake. On the other hand, Water Lily, *Persicaria* and *Nephrolepis* were the least in terms of IV with 0.206%, 0.376% and 0.4672%, respectively. Bakong plant also shows the highest relative frequency, relative percentage cover and relative diversity.

The importance value of Bakong plants suggest that Laguna de Cagayan Lake vegetation is suited for Bakong stand that may cover the entire Lake.

However, the occurrence of Scleria which is a grass species indicates that their presence as the second dominant species may attribute to the shallow areas where Bakong vegetation occurs. Continues siltation of the lake is one of the major causes of making the Laguna de Cagayan Lake shallow. Likewise, the presence of *Cyclorus* a fern species in the clear areas where Bakong are few is a suggestive effect of species invasion. Another kind of grass the Graminae are also dominant in the peripheral portions of the lake adjacent to the farmlands. It serves as an ecotone of the Lake with the farmland. This Graminae are also invasive species.

**Table 2.** Flora diversity at Bangalao Lake by Family Group.

| Plants (N=21) | Family | Group (N =16) |
|---|---|---|
| Ferns (3) | Thelypteridaceae | 3 |
| | Blechnaceae | |
| | Nephrolepidaceae | |
| Trees (2) | Moraceae | 1 |
| | Moraceae* | |
| Grass (16) | Vitaceae | 12 |
| | Asteraceae/compositae | |
| | Polygonaceae | |
| | Lamiaceae | |
| | Cyperaceae | |
| | Poaceae/gramineae | |
| | Phyllanthaceae | |
| | Vitaceae* | |
| | Urticaceae | |
| | Zingiberaceae | |
| | Passifloraceae | |
| | Polygonaceae* | |
| | Poaceae/gramineae* | |
| | Asteraceae/compositae* | |
| | Hanguanaceae | |
| | Onagraceae | |

**Table 3.** Bakong and Associated Species Importance Value and Rank.

| Species | Frequency | Relative Frequency | Relative Density | Relative Dominance (% Cover) | Importance Value (IV) | Rank |
|---|---|---|---|---|---|---|
| Stenochaena (F1) | 8 | 0.30 | 0.0219 | 2.3710 | 2.693 | 6 |
| Cyclosorus (F2) | 46 | 0.55 | 0.1260 | 7.8980 | 8.574 | 3 |
| Scleria (G1) | 92 | 1.00 | 0.2521 | 18.883 | 20.14 | 2 |
| Bakong | 182 | 1.00 | 0.4986 | 54.061 | 55.56 | 1 |
| Graminae (G2) | 7 | 0.15 | 0.0191 | 1.0376 | 1.207 | 11 |
| Cayratia (V1) | 3 | 0.05 | 0.0082 | 0.4845 | 0.543 | 12 |
| Mikania (V2) | 5 | 0.20 | 0.0137 | 2.2768 | 2.491 | 7 |
| Kangkong (H1) | 4 | 0.15 | 0.0109 | 2.2939 | 2.455 | 8 |
| Ficus (S1) | 4 | 0.15 | 0.0109 | 4.5107 | 4.672 | 4 |
| Water Hyacint (H2) | 5 | 0.15 | 0.0137 | 2.7184 | 2.882 | 5 |
| Water Lily (H3) | 2 | 0.10 | 0.0055 | 0.1501 | 0.206 | 15 |
| Nephrolepis (H3) | 2 | 0.10 | 0.0055 | 0.3473 | 0.453 | 13 |
| Lotus (H4) | 2 | 0.10 | 0.0055 | 1.3463 | 1.452 | 9 |
| Bamboo (G3) | 1 | 0.05 | 0.0027 | 1.3506 | 1.403 | 10 |
| Persicaria (W1) | 2 | 0.10 | 0.0055 | 0.2701 | 0.376 | 14 |

*Index of Diversity*

Table 4 shows that the Simpson Index Diversity of Laguna de Cagayan Lake was 0.672 which shows a high diversity index. The high diversity index of the lake may be attributed to its geographical location, land topology, and ecotone to surrounding ecosystem.

**Table 4.** Simpson's Index of Diversity of Laguna de Cagayan Lake.

| Species | Plant Type | Number (n) | n(n-1n) | Simpson's Index of Diversity (1-D) |
|---|---|---|---|---|
| Stenochaena (F1) | Fern | 8 | 56 | |
| Cyclosorus (F2) | Fern | 46 | 2070 | |
| Scleria (G1) | Grass | 92 | 8372 | |
| Bakong (H1) | Hydrophytes | 182 | 32942 | |
| Graminae (G2) | Grass | 7 | 42 | |
| Cayratia (V1) | Vines | 3 | 6 | |
| Mikania (V2) | Vines | 5 | 20 | 0.672 |
| Kangkong (H2) | Hydrophytes | 4 | 12 | |
| Ficus (S1) | Shrub | 4 | 12 | |
| Water Hyacint (H3) | Hydrophytes | 5 | 20 | |
| Water Lily (H4) | Hydrophytes | 2 | 2 | |
| Nephrolepis (F3) | Fern | 2 | 2 | |
| Lotus (H5) | Hydrophytes | 2 | 2 | |
| Bamboo (G1) | Grass | 1 | 0 | |
| Persicaria (W1) | Grass | 2 | 2 | |
| Total Count | | 365 | 43560 | |

*Ecological and Habitat Assessment*

The basic ecological and habitat assessment was shown in Table 6 about Bangalao Lake, the main habitat of Bakong species.

**Table 6.** Basic Ecological and Habitat Observations in Bangalao Lake.

| Parameter | Description | Remarks |
|---|---|---|
| Elevation | Average Elevation of the Lake | 15 masl |
| Fauna | Snail, Golden Kuhol (Bisukol) | Prolific in adjacent ricefield |
| | Snail, Freshwater Clam (Bennek) | Within sandy substrate area |
| | Bird, Philippine Wild Duck (Papan) | Transitional Habitat (few months) |
| Flora | Freshwater hydrophytes (Bakong) | On the Northern part of the Lake |
| Water Source | Spring, Spring Lake Type (Bukal) | Flowing and recharging all year round |
| Outlet Tributary | Connected to the Buguey Lagoon | Via a small creek |
| Water Use | Irrigation to adjacent rice and corn field; flood and drainage basin | Via irrigation pump |
| Adjacent Ecosystem | Agriculture (Corn and Rice Field) | Northern and Eastern part is cornfield; Southern and Western part is ricefield |
| Special Features | Bangalao Lake is adjacent to different Cave system (Eco-tourism potential) | The eastern side is mountainous where the different cave system is located |
| Flora | Medicinal plants, Maratabako | Found in the Lake vicinity |
| | Tree, Narek (adjacent areas) | Provincial tree of Cagayan |

*Rapid Water Quality Assessment*

Table 7 shows the water quality assessment of Bangalao Lake, the ecosystem where the Bakong strive the most and well adapted. Four (4) sampling sites were established to describe the lake and its relationship to adjacent ecosystem.

**Table 7.** On-site Water Quality Assessment (Bangalao Lake).

| Sampling Site | Parameter | Value |
|---|---|---|
| Station 1 (S1): West Side | TDS | 167 ppm |
| - Prone to Erosion | Temp | 24.3 deg C |
| - Adjacent to Cornfield | pH | 6.6 |
| | Depth | 59cm |
| | Turbidity | 8cm |
| Station 2 (S2): South Side | TDS | 148 ppm |
| - Wetland area | Temp | 24.3 deg C |
| - Sediments from Decomposed plants | pH | 6.7 |
| | Depth | 28cm |
| | Turbidity | 28cm |
| Station 3 (S3): East Side | TDS | 270 ppm |
| - Wetland area, Open water | Temp | 26.0 deg C |
| - Full of Decomposed plants | pH | 5.3 |
| | Depth | 25cm |
| | Turbidity | 25cm |
| Station 4 (S4): Northern Side | TDS | 173 ppm |
| - Adjacent to ricefield | Temp | 25.9 deg C |
| | pH | 5.1 |
| | Depth | 60cm |
| | Turbidity | 16cm |

Table 8 shows the physical properties of Bangalao Lake for the period November 2016 to February 2017. The Total Suspended Solids (TDS) has an average of 189.5mg/L has passed the DAO 35 standard for class C water, its temperature averaged 25.12°C also passed the DAO 35 requirement of 25-32 and its pH averaging to six (6) also passed DAO 35 standard. Turbidity averaging 20.25 did not pass the DAO 35 of 40-60mg/L.

The major reasons that cause the turbidity of the lake not to passed the standard and was very low is due to the dominance of hydrophytes Bakong plant that covers almost 50 percent of the lake surface area.

These hydrophytes plant has the ability to reduce siltation of the river due to its big branching rhizomes that protects the river when run-off water cascade to the lake.

The average depth of the lake in the five sites tested was 66.75cm. The depth was very shallow since the sampling area was within 2 meters from the edge of the lakeshore. However, LGU Sta. Teresita claims that the lagoon area has a depth 8 -12 meters.

**Table 8.** On- site Testing of Physical Properties of Water in Bangalao Lake.

| Parameters | Nov | Dec | Jan | Feb | TOTAL | Average | DAO 35 | Remarks |
|---|---|---|---|---|---|---|---|---|
| TDS | 167 | 148 | 270 | 173 | 758 | 189.5 | >500 | Passed |
| Temp | 24.3 | 24.3 | 26.0 | 25.9 | 100.5 | 25.12 | 25-31/25-32 | Passed |
| pH | 6.6 | 6.7 | 5.3 | 5.1 | 23.7 | 6 | 6.5-9.0/6.0-9.0 | Passed |
| Depth | 59 | 60 | 28 | 120 | 267 | 66.75 | No Available Data | - |
| Turbidity | 16 | 28 | 8 | 29 | 81 | 20.25 | 40-60 | Passed |

Fig. 2 shows the comparative measurement of the different parameters for the monthly monitoring. The graph shows that during the month of January the TDS was on its peak with the value of 270 mg/L. Water depth during the month of February was the highest at mean of 120cm.

It was noted that during this month, continuous rain was observed in the area; in fact even during their Bakong Festival last February 24 to 28, 2016 continues rain perils the activity. The pH of Bangalao Lake was slightly acidic with a mean of 6. While the temperature ranges from 24.3° C to 25.9° C. On the other hand, February and December registered the highest turbidity of 29 mg/L and 28 mg/L respectively. February and December months were a rainy months compared to November and January during the course of the study.

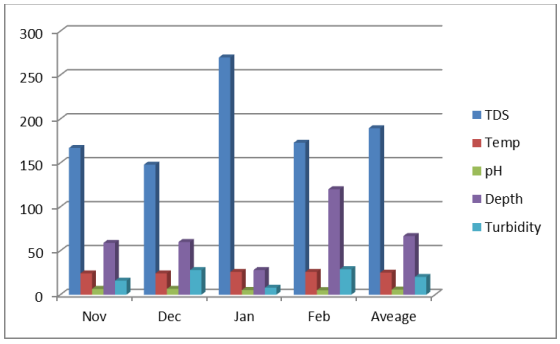


**Fig. 2.** Monthly comparison of the physical properties of Bangalao Lake water.

Table 9 and Fig. 3 shows the chemical properties of Bangalao Lake water for Iron and dissolved oxygen. The table shows that iron with average of 2.62mg/L have passed the DAO 35 requirement. However, dissolved oxygen averaging 6.68mg/L exceeded the DAO 35 requirement of 3-5mg/L. The high amount of dissolved oxygen was due to the numerous Bakong plants that covers the lake.

**Table 9.** Laboratory Testing of Chemical Properties of Bangalao Lake Water.

| Parameters | R1 | R2 | R3 | R4 | R5 | TOTAL | Average | DAO 35 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Iron | 1.9 | 1.9 | 1.9 | 2.5 | 4.9 | 13.1 | 2.62 | 1.5-7.5 | Passed |
| DO | 7.2 | 6.2 | 6.9 | 6.3 | 6.8 | 33.4 | 6.68 | 3-5 | Passed |

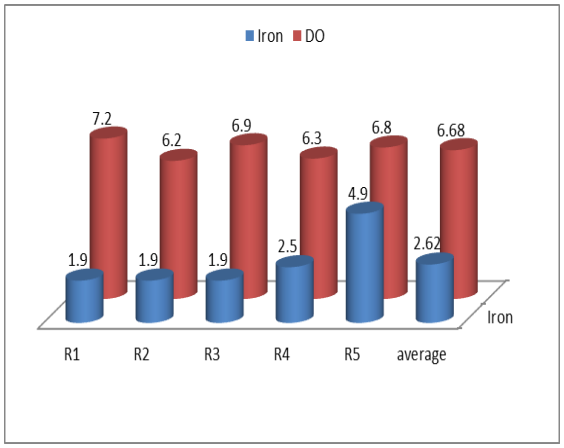


**Fig. 3** Graphical representation of iron and dissolve oxygen on the five replicates representing the five sites of water collection.

**Table 10.** Lead Concentration (mg/L) of water, soil and Bakong plant in Bangalao Lake.

| Parameters | R1 | R2 | R3 | R4 | R5 | Total | Average | Standard | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Water | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.8 | <0.2 | 0.5 | Passed |
| Soil | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.8 | <0.2 | 600 | Passed |
| Plant Tissue | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.8 | <0.2 | 10 | Passed |

Table 10 shows the Lead concentration present in Bangalao Lake. The table shows that the water, soil and Bakong plant sample has an average of <0.2 mg/L. The result of the study suggest that the lake is safe from lead concentration since it was very low in terms of the set permissible level standard of 0.5 mg/L for water (Standard Drinking Water) , 600 mg/L for soil (EPA) and 10 mg/L (WHO) respectively.

## Conclusion

Based from the result of the study, the following were concluded:

1. The results showed that the there were twenty (20) Bakong associated species identified within the habitat of Bangalao Lake, belonging to sixteen (16) different plant families.
2. The importance value of Bakong plants with 55.56% suggest that Bakong Species is the most dominant plant in Bangalao Lake vegetation.
3. The Simpson Index Diversity of Bungalao Lake was 0.672 which shows a high diversity index. The high diversity index of the lake may be attributed to its geographical location, land topology, and ecotone to surrounding ecosystem.
4. The results showed that the physical properties TDS, Temperature and pH content of the lake has passed the DAO 35. The turbidity however did not pass the required average of DAO 35.
5. The chemical properties showed that the iron content passed the required permissible level while the Dissolved oxygen content exceeded the desired amount.
6. Bangalao Lake is found negative with Lead.

**Recommendations**

Based from the result of the study, the following were being recommended:

1. These findings show the need for the lake to be maintained and protected for its sustainable viability for economic, social, environmental, aesthetic and for other beneficial purposes.
2. Longer study period should be conducted to account the overall condition of the lake and include other parameters not mentioned in the study.
3. One of the main targets of the policy makers should be the protection and sustainable usage of the lake that retained their integrity through advocacies for the future generations and before it will result in serious damage to the natural habitat of Bakong.
4. Conservation of the lake and all its habitat types included that maintains valuable populations, particularly the endemic Bakong species that are dominant in the area should given priority.
5. Intensive survey should be continuously conducted to document all the species present especially endemics in the area as well as in other areas that are least protected.

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