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Application of dominant phytoplankton to assess water quality in small reservoirs

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ABSTRACT

This study focused on the use of dominant phytoplankton species as bioindicators to assess water quality in reservoirs at a university by integrating physical, chemical, and biological parameters. The applied algal research laboratory-phytoplankton (AARL-PP) score was used to classify the water quality from oligotrophic (clean) to hypereutrophic (highly polluted). Before a monitored event, the water quality was moderately polluted, with *Phacus* and *Scenedesmus* species indicating stable ecosystems. After the event, water quality deteriorated, with nutrient levels (NH_3-N and SRP) rising significantly, leading to an increase in pollution-tolerant species like *Oscillatoria* are often linked to harmful algal blooms. These shifts, driven by nutrient influx from human activities, show the rapid response of phytoplankton to environmental changes. This study demonstrates the reliability of the AARL-PP score as a water quality monitoring tool and emphasizes the need for ongoing monitoring to manage the impacts of anthropogenic pollution and preserve the long-term water quality. These results provide critical insights into future water resource management and policy development.

Keywords: AARL-PP score, assessment, bioindicators, phytoplankton, water quality.

INTRODUCTION

The use of the area around the reservoirs often has an impact in many ways, especially water quality. The impacts caused by human activities such as organizing flea markets which may create waste, large amounts of water use, and wastewater from various activities. If not properly managed, it may cause contamination of water sources. Therefore, assessing and monitoring water quality before and after the event is necessary to prevent environmental impacts and maintain water quality in the area. Wastewater analysis can contribute to sustainability and population health, as water is a vital natural resource that affects not only human health, but also ecosystems. Therefore, using water data obtained from regular wastewater monitoring can help many universities to limit the risk of contamination and improve water quality. (Kesari, et al, 2021; McHugh, 2011; Silva, 2023). The accumulation of contaminants such as nutrients, heavy metals, and organic wastes has degraded water quality worldwide, posing a threat to ecosystems and human health (Babuji et al., 2023; Sharma et al., 2024; Zhang et al., 2023). Water quality monitoring is essential for proper water resource management as it allows the identification of pollution sources and corrective actions to be taken. The most common types of analyses are physical, chemical, and biological, and the results are compared with the surface water quality standards set by the Pollution Control Department. Continuous monitoring and management of water resources is essential to prevent further degradation.

Phytoplankton are an important indicator of water quality. Some phytoplankton species, such as *Cyclotella, Dinobryon, Melosira, Pinnularia*, and *Staurastrum*, were found in good water sources. Other phytoplankton species, such as *Euglena* and *Oscillatoria*, are found in polluted water sources or water with high organic matter content (Boonsomsai et al., 2011; Gao et al., 2024; Winder & Sommer, 2012; Zhang, et al., 2021; Zhu, et al., 2021). Studying the dominant phytoplankton species helps us better understand the roles and functions of water sources. In addition, researchers have developed a score for assessing water quality by examining the presence of certain species, called the applied algae research laboratory-phytoplankton (AARL-PP) score was used in Thailand. This study also highlighted the importance of phytoplankton in the aquaculture sector, which is an important part of the economy (Hu et al., 2024; Fai et al., 2023; Sampantamit et al., 2020). The AARL-PP score is used to classify water quality based on the presence and dominance of phytoplankton species, which act as bioindicators of nutrient levels and pollution in aquatic ecosystems. This score system categorizes water bodies on a scale from Oligotrophic (clean, low nutrient levels) to hypereutrophic (highly polluted, excessive nutrient levels). By analyzing the types and abundance of dominant phytoplankton, the AARL-PP score provides a high-resolution classification of water quality and helps assess the degree of nutrient pollution in water bodies.

Owing to its simplicity and effectiveness, the AARL-PP Score has become popular for water quality assessment (Chaipiputnakhajorn & Gunbua, 2023; Enawgaw & Wagaw, 2023; Sakset & Preecha, 2021) and appears to be adaptable to different aquatic environments. This enables the determination of different degrees of water quality from oligotrophic (clear) to hypereutrophic (extremely contaminated) conditions. Due to their short maximum life cycle and strong dependence on nutrient enrichment, phytoplankton can reflect shifts in the quality of water in real time, in response to nutrient pollution by agriculture or wastewater discharge (Ramos et al., 2017; Yang et al., 2022). Near other worldwide water monitoring schemes, this approach presents a universal standard that can be employed internationally. And its popularity comes from its complimentary nature with the traditional approaches of water quality assessments which blends physical, chemical and biological methods into the relevant monitoring tools. The integration of dominant phytoplankton species with water quality monitoring has emerged as an effective tool for combating eutrophication and other aquatic pollutants for policy and management purposes. (Gao et al., 2024; Ernesto and Gabriel, 2019; Zhu et al., 2021)

Through the compilation and synchronization of physical, chemical, and biological studies, the overall purpose of this study is to evaluate water quality in selected water sources. In particular, the AARL-PP score (which rates dominant phytoplankton species according to the degradation resulting from nutrient enrichment) will be used for the research to assess water quality. Linking phytoplankton composition to relevant water quality variables (nutrients, dissolved oxygen, and organic matter) this study aims to uncover the ecological condition behind these water bodies. These findings will provide a better understanding of sustainable management practices of water resources, which can facilitate planning and conservation in the future. This research will be critical in managing sustainable water resources to ensure that water quality monitoring can promote long-term ecological integrity and human well-being.

METHODOLOGY

Study area

The reservoirs at Kasetsart University were selected as the study area because of their diverse uses and the presence of various activities that could significantly impact water quality, particularly during large events such as the Kaset Fair. This location allows for the evaluation of human activities, including water resource usage, wastewater discharge, and nutrient runoff, from activities related to education, research, tourism, and food consumption. Additionally, collecting water samples from various sites with different usage patterns provides a comprehensive assessment of the water quality, covering a wide range of activities within the university. Water sampling in this study was designed to cover various activities across the university that could impact the water quality of the reservoirs. Samples were collected from five sites representing areas with different human activities to ensure comprehensive data on the impact of these activities. Water samples were collected from locations involved in food consumption, education, tourism, and research activities, considering nutrient runoff, wastewater discharge, and other pollutants generated by these activities. Samples representing various human activities and environmental impacts were collected from five sites. S1 (main cafeteria) was selected as the potential nutrient runoff from food waste, whereas S2 (museum) served as a control with minimal disturbance. S3 (co-operation building) captured runoff from foot traffic and landscaping, and S4 (university hotel) assessed the tourism-related wastewater. S5 (building 1) monitored potential pollutants from academic and research activities. Map showing water quality sampling sites (Figure 1).

Water quality assessment

Water samples will be collected before the Kaset Fair in 12–15 January 2024 and after the Kaset Fair in 15–18 February 2024, with water quality parameters being collected from the designated points and analyzed in situ for temperature (°C), dissolved oxygen; DO (mg/L), electrical conductivity; EC (µS/cm), salinity (PSU), and pH using a YSI Multi-Parameter Analyzer (ProQuatro model). Depth (cm) was measured using a portable depth sounder, transparency (cm) with a Secchi disc, and turbidity (NTU) with a turbidity meter. Chemical and biological water quality was further analyzed in the laboratory, including total soluble solid; TSS (mg/L) by the gravimetric method, biochemical oxygen demand; BOD (mg/L) by the azide modification method, chlorophyll-a (µg/L) by the spectrophotometric method, ammonia-nitrogen; NH_3-N (mg/L) by the phenol-hypochlorite method, and soluble reactive phosphorus; SRP (mg/L) by the ascorbic acid method (Washington, 1984).

Phytoplankton sampling

Phytoplankton samples were randomly collected at each site by filtering 20 liters of surface water through a 22 µm mesh phytoplankton net. The filtered water (10 mL) was preserved with 10% formalin and taken to the lab for analysis. Phytoplankton species were identified to the genus level using light microscopy and a Sedgwick-Rafter counting chamber (1 mL capacity). The dominance index (D), species diversity index (H'), evenness index (E), and frequency of occurrence (F%) indices were calculated (Clarke & Warwick, 1994;

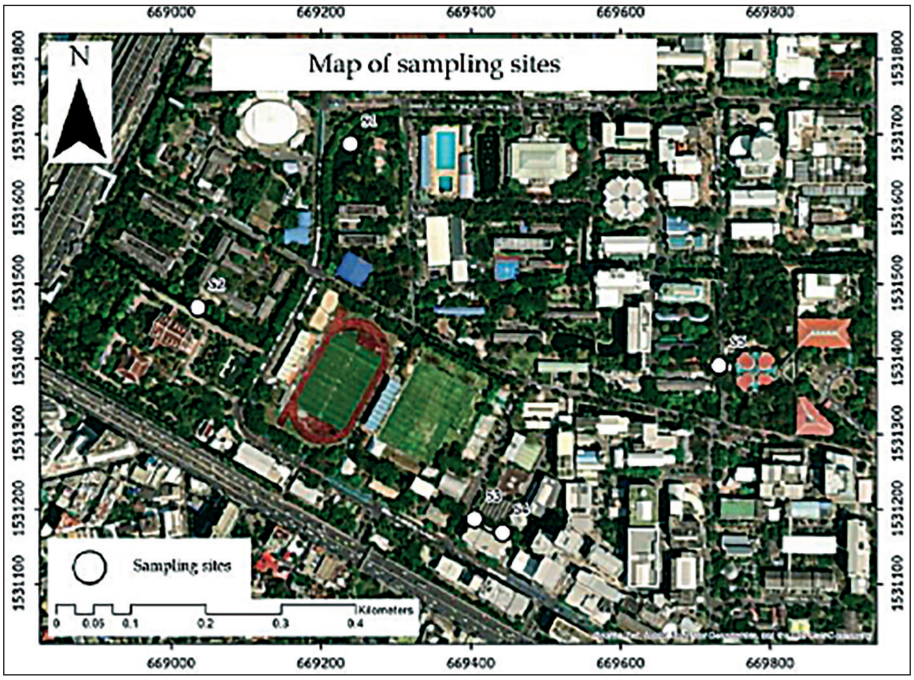

Figure 1 Map of sampling sites, consisting of: S1 (Main Cafeteria), S2 (Museum), S3 (Co-operation Building), S4 (University Hotel), and S5 (Building 1)

Keawkhiew et al., 2013; (Washington, 1984; Wongrat & Boonyapiwat, 2023). The formulae as follows (Evgenia, 2013; Novia, et al., 2016; Pielou, 1975; Strickland and Parsons, 1972):

$$Dominance\ index\ (D) = \sum_{i=1}^{n}(Pi)^2 \quad (1)$$

where: *Sdi* – species diversity index, *Sid* – Shannon index of diversity, *Pi* – relative abundance of species.

Dominance index values range from 0–1, if *D* is close to 1 (one), that means there is a dominant species, whereas if *D* close to 0 (zero), that means no dominant species.

$$Sdi(Sid;\ H') = \sum_{i=1}^{n} Pi\ Ln\ Pi \quad (2)$$

where: *Sdi* – species diversity index, *Sid* – Shannon index of diversity, *Pi* – significance probability for all species (n/N is the proportion of i, expressed as nets.)

$$Evenness\ index\ (E) = \frac{H'}{Hmax} \quad (3)$$

where: *E* – evenness index, *H'* – species diversity index; *Hmax* = *Ln S* (*S* = total number of species).

$$Frequency\ of\ occurrence\ (F\%) = \frac{NOPSS}{NS} \times 100 \quad (4)$$

where: *NOPSS* –number of occurrences of that plankton species in the samples, *NS* – number of samplings.

Data analysis

Water quality parameters, phytoplankton density, species richness, and evenness indices were compared. Dominant phytoplankton species were used as indicators of water quality by comparing their scores with the applied algal research laboratory-phytoplankton (AARL-PP) score, where lower scores indicate better water quality and higher scores indicate poorer quality (Table 1 and Table 2) (Peerapormpisal et al., 2007; Peerapormpisal, 2015). Statistical methods, including stepwise multiple regression (at a 0.05 significance level), were used to determine the relationships between dominant phytoplankton species and physical, chemical, and biological water quality factors. Standardized coefficients (β) were analyzed to identify the influence of these relationships.

RESULTS AND DISCUSSION

Water quality before the Kaset Fair

Before the Kaset Fair, water quality at the five sampling sites (S1–S5) exhibited relatively stable conditions. The average water temperature ranged from 26.2 to 28.6 °C across sites, indicating little variation in thermal profiles. pH levels were relatively consistent, ranging between 7.35 and 7.86, showing neutral to slightly alkaline water conditions. The dissolved oxygen (DO) concentrations varied significantly, with Site S1 recording the lowest value of 1.79 mg/L and Site S5 the highest at 6.69 mg/L, indicating sufficient oxygenation at most sites but potential hypoxic conditions at S1. Salinity values were low at the three sites, ranging from 0.33 to 0.42 PSU, and never showed signs of saltwater intrusion. The turbidity values were moderate, with a maximum range of 9.15 NTU at Site S5 and 34.89 NTU at Site S4, indicating heterogeneity of suspended particulate matter among sites. Sites S3 and S5 had the highest transparency values, corresponding to transparent waters ranging from 20 to 60 cm. Total ammonia-nitrogen (NH_3-N) concentration ranged from 113.38 mg/L at Site S3 to 213.71 mg/L at Site S1, indicative of low to moderate nutrient enrichment. The NH_3-N in natural water is usually below 0.5 mg/l (Notification of the National Environment Board No.4, B.E.2539 (1994)), but nitrogen compounds deposit in water due to the influxes resulting from agricultural practices, the discharge of community unlimited wastewater, and rainfall. Sources of nitrogen compounds Nitrogen compounds are usually in nitrate, nitride, and ammonia forms in water bodies. Phytoplankton can take up nitrate by first reducing it to ammonia before assimilating the latter into different cellular components (Gajaseni, 2001). Except for a high biochemical oxygen demand (BOD) of 12.74 mg/L at site S5 (Table 3) which suggested the localized origin of organic matter, the values of BOD found in surface water quality are acceptable in the regions. The surrounding water body is a relatively still natural earthen pond. Sunlight permeates through the surface, and big trees surrounding the water body shade the ecosystem. It is why several aquatic creatures, reptiles, and other species live in this region. It also pollutes the organic substances and nutrients to enhance the number of phytoplankton. This process can lead to a bloom of phytoplankton as they take advantage of the

Table 1. Dominant phytoplankton genus scores (Peerapornpisal et al., 2007; Peerapornpisal, 2015)

Genus	Score	Genus	Score	Genus	Score	Genus	Score
Actinastrum	5	*Crucigenia*	7	*Gymnodinium*	6	*Phacus*	8
Acanthoceras	5	*Crucigeniella*	7	*Gyrosigma*	7	*Phormidium*	9
Amphora	6	*Cryptomonas*	8	*Isthmochloron*	5	*Pinnularia*	5
Anabaena	8	*Cyclotella*	2	*Kirchneriella*	5	*Planktolyngbya*	7
Ankistrodesmus	7	*Cylindrospermopsis*	7	*Melosiera*	5	*Pseudanabaena*	7
Aphanocapsa	5	*Cymbella*	5	*Merismopedia*	9	*Rhizosolenia*	6
Aphanothece	5	*Dictyosphaerium*	7	*Micractinium*	7	*Rhodomonas*	8
Aulacoseira	6	*Dimorphococcus*	7	*Micrasterias*	2	*Rhopalodia*	5
Bacillaria	7	*Dinobryon*	1	*Microcystis*	8	*Scenedesmus*	8
Botryococcus	4	*Encyonema*	6	*Monoraphidium*	7	*Staurastrum*	3
Centritractus	4	*Epithemia*	6	*Navicula*	5	*Staurodesmus*	3
Ceratium	4	*Euastrum*	3	*Nephrocytium*	5	*Stauroneis*	5
Chlamydomonas	6	*Eudorina*	10	*Nitzschia*	9	*Strombomonas*	8
Chlorella	6	*Euglena*	2	*Oocystis*	6	*Surirella*	6
Chroococcus	6	*Eunotia*	5	*Oscillatoria*	9	*Surirella*	6
Closterium	6	*Fragilaria*	5	*Pandorina*	6	*Synura*	8
Cocconeis	6	*Golenkinia*	6	*Pediastrum*	7	*Tetraedron*	6
Coelastrum	7	*Gomphonema*	6	*Peridiniopsis*	6	*Trachelomonas*	8
Cosmarium	2	*Gonium*	6	*Peridinium*	6	*Volvox*	6

Table 2. Water quality scores followed trophic level and general water quality (Peerapornpisal et al., 2007)

Score	Water quality by trophic level	General water quality
1.0-2.0	Oligotrophic status	Clean
2.1-3.5	Oligo-mesotrophic status	Clean-moderate
3.6-5.5	Mesotrophic status	Moderate
5.6-7.5	Meso-eutrophic status	Moderate-polluted
7.6-9.0	Eutrophic status	Polluted
9.1-10.0	Hypereutrophic status	Very polluted

ready supply of nutrients, a type of process that is known as "eutrophication." This phenomenon can reduce the oxygen levels in the water, causing water quality degradation. The solubility of oxygen in water depends on the temperature; as the temperature decreases, more oxygen can dissolve, while higher temperatures reduce oxygen solubility (Rattanaphani et al., 1990). However, if there is significant photosynthesis by phytoplankton, oxygen levels in the water may increase (Cha-umphol, 1996).

Water quality after the Kaset Fair

After the Kaset Fair, all sampling sites experienced a marked deterioration in water quality. Water temperatures dropped a few tenths of a degree across all regions, from 23.7 to 27.3 °C, likely due to seasonal or atmospheric phenomena. But the more worrying changes were in chemistry and biology. Total ammonia-nitrogen (NH_3-N) levels were also dramatically elevated, especially at Site S4, where ammonium concentrations peaked at 4,161.37 mg/L after the event – an environmentally alarming total representing extremely high levels of nitrogen loading from runoff or waste. Similarly, the other sites had also high NH_3-N concentrations varying from 1,597.30 to 3,071.00 mg/L, which may be harmful to aquatic organisms due to its toxicity. The levels of BOD also were highly elevated at all sites, with Site S4 having the highest difference, increasing from 9.82 mg/L before to 23.07 mg/L after the event. This indicates an influx of organic matter likely due to waste, decomposing organic debris. In contrast, DO levels plummeted significantly at some sites, the lowest being 0.52

Table 3. Physical, chemical and biological water quality before the Kaset Fair

Parameter	Sampling sites									
	S1		S2		S3		S4		S5	
	P.1	P.2	P.1	P.2	P.1	P.2	P.1	P.2	P.1	P.2
Water Temperature (°C)	28.0	28.1	28.6	28.6	26.4	26.6	26.9	26.2	27.6	27.6
pH	7.46	7.38	7.50	7.53	7.56	7.35	7.48	7.86	7.85	7.86
Transparency (cm)	40	40	60	30	40	20	40	20	60	30
Depth (cm)	60	50	90	60	60	40	70	30	100	100
Salinity (PSU)	0.37	0.38	0.42	0.41	0.33	0.33	0.42	0.33	0.39	0.39
Turbidity (NTU)	14.14	11.51	20.45	17.39	12.93	9.40	34.89	27.55	9.15	10.28
EC (µS/cm)	0.81	0.82	0.91	0.89	0.69	0.71	0.88	0.69	0.83	0.84
DO (mg/l)	1.79	4.41	4.15	1.67	4.43	0.27	0.13	6.69	5.32	5.67
TSS (mg/l)	0.02	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.02
Chlorophyll *a* (µg/l)	0.07	0.03	0.14	0.16	0.01	0.01	0.01	0.01	0.02	0.05
NH_3-N (mg/l)	213.71	141.92	177.38	156.29	113.38	120.33	150.21	115.33	141.71	119.67
SRP (mg/l)	1,429.71	1,174.52	798.05	1,004.76	628.38	694.90	1,683.38	638.95	1,024.29	1,117.14
BOD (mg/l)	7.35	7.50	6.65	8.44	5.29	5.81	9.82	10.73	12.29	12.74

mg/L (Site S4), indicating that increased organic matter resulted in oxygen depletion, which may create an anoxic environment fatal for aquatic organisms. This may be a possible salinity increase at some sites, especially at Sites S3 and S4, with salinity values in 0.64 PSU, due to the entering of salts or dissolved solids from runoff. Turbidity also increased in both periods, with a range of 10.57 to 38.46 NTU, indicating more suspended solids, likely by sediment suspension and river pollution. It also supports increasing the amount of particulate matter in the water where transparency levels decrease in almost all the sites (Table 4).

Phytoplankton diversity

This event also affected phytoplankton diversity. Before the event, the phytoplankton

Table 4. Physical, chemical and biological water quality after the Kaset Fair

Parameter	Sampling sites									
	S1		S2		S3		S4		S5	
	P.1	P.2	P.1	P.2	P.1	P.2	P.1	P.2	P.1	P.2
Water Temperature (°C)	27.8	27.3	27.1	26.3	24.9	25.7	24.6	23.7	26.8	27.1
pH	7.59	7.69	7.89	7.54	7.82	7.46	7.71	8.02	7.77	7.67
Transparency (cm)	40	40	50	30	40	20	30	40	60	40
Depth (cm)	60	60	90	60	60	40	70	60	100	100
Salinity (PSU)	0.31	0.46	0.23	0.45	0.48	0.48	0.64	0.63	0.45	0.44
Turbidity (NTU)	15.21	13.34	23.47	21.59	14.81	11.23	38.46	31.54	10.57	13.30
EC (µS/cm)	0.67	0.99	0.49	0.93	0.96	1.00	1.28	1.23	0.96	0.93
DO (mg/l)	1.01	2.77	4.03	1.13	3.57	1.45	0.52	4.95	3.69	2.90
TSS (mg/l)	0.04	0.03	0.02	0.03	0.02	0.03	0.03	0.03	0.02	0.02
Chlorophyll *a* (µg/l)	0.17	0.07	0.06	0.04	0.03	0.04	0.01	0.01	0.04	0.03
NH_3-N (mg/l)	2,205.07	2,941.37	3,071.00	3,007.30	1,886.93	2,080.26	4,161.37	3,905.81	2,098.04	1,597.30
SRP (mg/l)	1,875.89	1,755.89	1,235.89	1,599.78	1,618.67	1,510.33	2,130.89	2,115.33	1,793.67	1,853.11
BOD (mg/l)	11.27	7.60	14.13	19.47	6.53	7.13	22.67	23.07	12.40	12.93

community was dominated by species indicative of mesotrophic conditions such as *Cyclotella* and *Scenedesmus*, suggesting intermediate nutrient levels with stable ecosystems. The species richness and evenness indices were calculated before the event, indicating a more stable and diverse aquatic system. After the event, there was a distinct transition to eutrophic and hypereutrophic signals (*Microcystis* and *Oscillatoria*), characteristic of dominance in highly eutrophic and polluted waters. These organisms are sometimes linked to harmful algal blooms, which lead to toxin production and additional degradation of the water quality. The relative abundance of *Oscillatoria* highlights an increase in organic matter and nutrients because this genus dominates at high phosphorus and nitrogen concentrations. Mean annual indices of species diversity were lower as overall phytoplankton species richness declined and dominance of pollution-tolerant species increased. Such a change is symptomatic of declining water quality, which, if it continues, may cause permanent changes in ecosystems. (Archilla et al., 2004; Fernandez et al., 2012).

The dominant phytoplankton species across sampling sites before the Kaset Fair gives some indication of the general quality of the water. Over all sites, the most abundant species was *Phacus*, especially abundant at S4 (9.499 units/L) and S5 (5.833 units/L); *Phacus* is regularly linked to nutrient-rich conditions and characterized meso-eutrophic status, indicating mild pollution levels. Likewise, *Chlorella* barely exceeded the 2001 unit/L threshold and, at 3,333 units/L at S1 and 2,000 units/L at S2, can be considered abundant, also confirming the meso-eutrophic state. Additionally, *Scenedesmus* was found in high densities, with 6.499 units/L at S3 and 3.166 units/L at S5, reflecting moderate nutrient levels in these areas (Table 5). After the Kaset Fair, there were noticeable shifts in the composition and abundance of dominant phytoplankton species, pointing to a decline in water quality. *Phacus* continued to dominate several sites, with densities of 6.499 units/L at S1 and 5.333 units/L at S5, indicating that nutrient levels remained relatively high. However, the most significant change was the increase in *Oscillatoria*, particularly at S3 levels at 8.499 units/L and at S5 levels at 1,000 units/L. *Oscillatoria* is known to thrive in eutrophic and polluted waters with high nutrient concentrations, particularly phosphorus and nitrogen, often associated with organic pollution and runoff. The predominance of *Oscillatoria* indicates that water quality has shifted from moderately eutrophic to eutrophic in some areas, indicating higher pollution levels and excess nutrient loading following such events (Figure 2).

The analysis of phytoplankton diversity presented in Table 2 (before the event) and Table 3 (after the event) demonstrates notable variations in the phytoplankton density across the sampled sites. In Table 6, before the Kaset Fair, genera such as *Chlorella*, *Phacus*, and *Scenedesmus* exhibited higher densities across multiple locations. The dominance index (D) values ranged from 6.895 to 21.904, while the species diversity index (H') varied between 1.300 and 2.463, indicating moderate diversity levels at certain sites. The Evenness Index (E) values remained relatively stable, ranging from 0.668 to 0.803, suggesting a balanced distribution of species at most sampling points. In Table 3, following the event, there were some shifts in phytoplankton densities, with *Phacus* and *Oscillatoria* continuing to dominate across different sites. The dominance index (D) remained within a comparable range, from 7.895 to 19.903, while the species diversity index (H') showed a slight decrease, ranging between 1.435 and 2.411. The Evenness Index (E), like the pre-event results, exhibited consistent values across sites, ranging from 0.690 to 0.812. Overall, the comparison between the two tables illustrates the stability and moderate diversity within the phytoplankton communities before and after the Kaset Fair.

Water Quality Indication: The high densities of *Oscillatoria* after the event are particularly concerning for members of this genus, which frequently form harmful algal blooms that consume dissolved oxygen and/or produce toxins that degrade water quality even further. The transition to the dominance of *Oscillatoria* in conjunction with the consistent presence of *Phacus* reflects high nutrient loads from runoff and other pollutants from activities related to the event. At sites such as S3 and S5, the dominance of pollution-tolerant species indicated that water quality had been impaired even further, suggesting the presence of eutrophic conditions. Eutrophication affects phytoplankton diversity; for example, in Mexican water bodies such as Lake Patzcuaro (Tomasini et al., 2012) and the Valle de Bravo reservoir (Figueroa-Sanchez et al., 2014), it has been documented that through nutrient overload, the increased

Table 5. Density of phytoplankton before the Kaset Fair in sampling sites

Genus	Density of phytoplankton (unit/L)										
	S1		S2		S3		S4		S5		F %
	P.1	P.2	P.1	P.2	P.1	P.2	P.1	P.2	P.1	P.2	
Actinastrum	0	0	833	500	0	0	0	0	0	0	20
Ankistrodesmus	0	0	500	667	0	0	0	0	0	0	20
Chilomonas	167	0	0	0	0	0	0	0	0	0	10
Chlorella	3,333	2,500	2,000	1,667	500	333	0	0	0	0	60
Closteriopsis	0	0	0	0	667	500	500	333	167	0	50
Chroococcus	0	0	333	500	0	0	0	0	0	0	20
Closterium	0	0	0	333	0	0	0	0	0	0	10
Coelastrum	0	0	1,167	1,000	0	0	0	0	0	0	20
Coelomoron	0	0	333	0	0	0	0	0	0	0	10
Coelosphaerium	0	0	167	167	0	0	0	0	0	0	20
Cosmarium	667	1,000	1,833	2,333	0	0	0	0	0	0	40
Crucigenia	0	0	167	0	0	0	0	0	0	0	10
Diatoms	0	0	0	0	8,999	8,166	7,999	5,999	5,499	11,499	60
Didymocystis	0	0	0	0	0	0	0	0	0	333	10
Eudorina	0	0	2,000	1,667	1,500	1,667	333	500	0	333	70
Euglena	167	167	2,000	2,166	1,667	1,833	0	0	333	667	80
Microcystis	1,333	1,500	0	0	0	0	0	0	0	0	20
Oscillatoria	1,000	1,167	2,500	1,500	1,167	833	500	667	1,000	1,333	100
Paranema	333	500	0	0	0	0	0	0	0	0	20
Pediastrum	0	0	2,333	2,000	0	0	0	167	1,000	833	50
Pendoria	0	0	0	0	0	0	0	0	500	333	20
Peridinium	500	1,167	0	0	0	0	0	0	0	0	20
Phacus	5,333	5,999	9,166	9,499	6,666	7,499	2,333	2,666	4,333	5,833	100
Polycystis	0	0	667	667	0	0	0	0	0	0	20
Porphyridium	0	0	667	833	0	0	0	0	0	0	20
Protococcus	1,000	500	500	333	1,833	1,333	1,333	1,167	1,167	1,333	100
Scenedesmus	0	167	6,499	5,833	1,500	1,167	500	333	3,000	3,166	90
Staurastrum	0	0	333	333	0	0	0	0	0	0	20
Trinema	0	333	0	0	0	0	0	0	0	0	10
Triptastrum	0	0	167	333	0	0	0	0	0	0	20
Volvox	333	0	167	167	0	0	0	0	167	167	50
Zygnema	0	0	667	500	0	0	0	0	0	0	20
Total	14,166	15,000	34,999	32,998	24,499	23,331	13,498	11,832	17,166	25,830	
Dominance index (D)	10.895	10.896	21.904	20.904	8.901	8.901	6.895	7.893	9.897	10.902	
Species diversity Index (H')	1.848	1.885	2.463	2.429	1.763	1.696	1.300	1.465	1.800	1.666	
Evenness index (E)	0.771	0.786	0.797	0.798	0.803	0.772	0.668	0.705	0.782	0.695	

species of *Microcystis* and *Oscillatoria*, a typical species for water bodies with eutrophic conditions (Ernesto & Gabriel, 2019). Typically, thriving in nutrient-rich waters exacerbates the degradation of water quality through harmful algal blooms.

Similarly, studies around the Yuqiao Reservoir in China, which explores phytoplankton dynamics, show that, depending on nutrient loads, excessive nutrients move communities toward cyanobacteria dominance, especially under warm conditions (Zhang et al., 2024).

Table 6. Density of phytoplankton after the Kaset Fair in sampling sites

Genus	Density of phytoplankton (unit/L)										F %
	S1		S2		S3		S4		S5		
	P.1	P.2	P.1	P.2	P.1	P.2	P.1	P.2	P.1	P.2	
Actinastrum	0	0	667	333	0	0	0	0	0	0	20
Ankistrodesmus	0	0	500	667	0	0	0	0	0	0	20
Chilomonas	500	0	0	0	0	0	0	0	0	0	10
Chlorella	4,000	2,833	1,667	1,333	667	667	0	0	0	0	60
Closteriopsis	0	0	0	0	1,000	500	833	500	333	0	50
Chroococcus	0	0	333	333	0	0	0	0	167	0	30
Closterium	0	0	0	167	0	0	0	0	0	0	20
Coelastrum	0	0	1,000	667	0	0	0	0	0	0	10
Coelomoron	0	0	500	0	0	0	0	0	0	0	10
Cosmarium	833	1,333	0	2,000	0	0	0	0	0	0	30
Crucigenia	0	0	167	0	0	0	0	0	0	0	10
Diatoms	0	0	0	0	9,499	8,499	8,499	6,166	5,833	10,666	60
Didymocystis	0	0	0	0	0	0	0	0	0	167	10
Eudorina	0	0	1,667	1,833	1,333	2,166	500	500	0	0	60
Euglena	333	167	1,500	2,000	2,000	2,000	0	0	500	833	80
Microcystis	1,167	1,833	0	0	0	0	0	0	0	0	20
Oscillatoria	1,167	1,333	2,166	1,000	1,167	1,167	667	1,000	1,167	1,000	100
Paranema	333	333	0	0	0	0	0	0	0	0	20
Pediastrum	0	0	2,000	1,667	0	0	167	333	1,000	833	60
Pendoria	0	0	0	0	0	0	0	0	833	500	20
Peridinium	667	833	0	0	0	0	0	0	0	0	20
Phacus	5,833	6,499	8,666	9,166	7,166	7,999	2,666	3,000	4,666	5,333	100
Polycystis	0	0	500	500	0	0	0	0	0	0	20
Porphyridium	0	0	333	333	0	0	0	0	0	0	20
Protococcus	1,000	667	667	333	2,000	1,500	1,667	1,500	1,500	1,000	100
Scenedesmus	0	833	6,166	5,333	1,500	1,000	500	667	3,333	2,500	90
Staurastrum	0	0	500	333	0	0	0	0	0	0	20
Trinema	167	333	0	0	0	0	0	0	0	0	20
Volvox	167	0	167	167	0	0	0	0	167	167	50
Zygnema	0	0	667	500	0	0	0	0	0	0	20
Total	16,167	**16,997**	29,833	28,665	26,332	25,498	15,499	13,666	19,499	22,999	20
Dominance Index (D)	11.897	10.897	19.903	18.903	8.902	8.901	7.896	7.895	10.899	10.902	20
Species diversity Index (H’)	1.911	1.928	2.411	2.285	1.783	1.746	1.435	1.606	1.903	1.666	
Evenness index (E)	0.769	0.804	0.805	0.776	0.812	0.795	0.690	0.772	0.794	0.695	

This has an adverse impact on species variety and increases the chance of toxic algal blooms. In conclusion, before the event, the water quality was meso-eutrophic, which rated it as a moderate nutrient and pollution level. The excessive dominance of *Oscillatoria* at certain sites after the event suggests eutrophication, and these sites showed the most extreme increase in biomass. This also suggests that the event enhanced nutrient loading and decreased water quality, particularly at sites dominated by pollution-tolerant species. Long-term monitoring is required to properly assess the potential ecological impact and persistence of these degraded conditions.

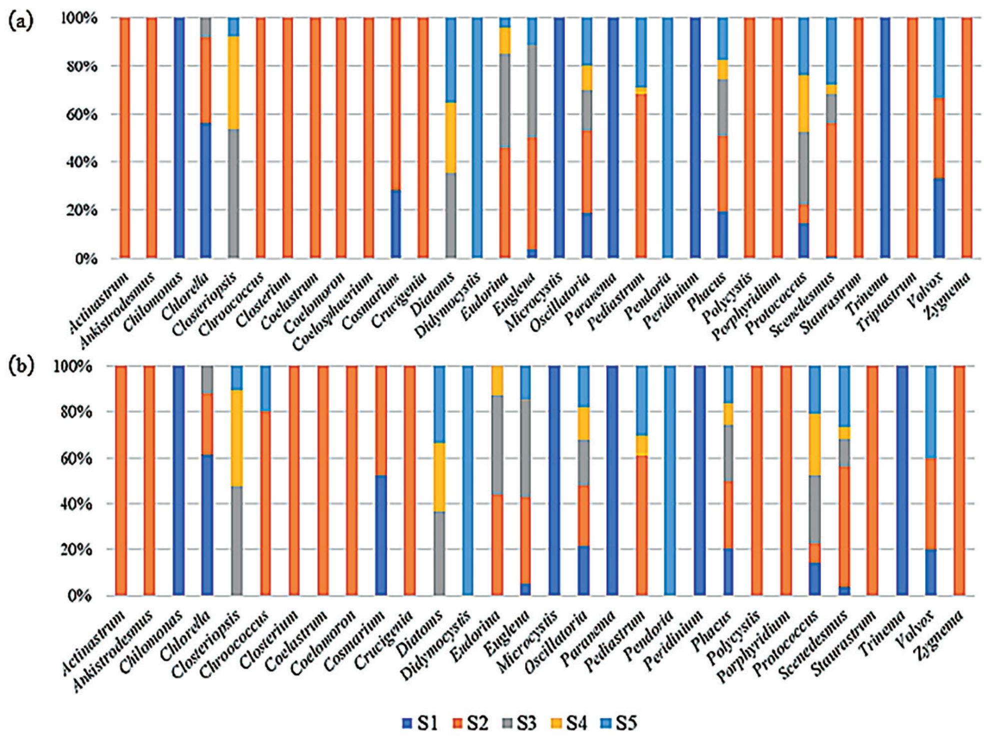

Figure 2. Sorting the density of phytoplankton by genus: (a) before the Kaset Fair, (b) after the Kaset Fair

Evaluation of water quality levels by AARL-PP score method

This distinction is more evident than that in phytoplankton species associated with polluted waters, such as Oscillatoria and Microcystis, including artificial eutrophication. The AARL-PP Score is highly reliable, with a 95% accuracy rate compared to traditional chemical methods, and therefore serves as a practical tool for environmental monitoring. Table 7 shows the trophic status water quality assessment using the AARL-PP score following pre-event sampling across five sampling sites (S1-S5) based on the dominant phytoplankton genera at each site (Pinmongkhonkul et al., 2022; Sarunya, 2018) As in Table 1.

The predominant genera at Site S1 were *Phacus*, *Chlorella*, and *Microcystis*, and the resulting score revealed a meso-eutrophic average of 7.3, demonstrating that Site S1 was moderately polluted. For example, site S2 varied between the two sampling periods, the average score from the first was 8.3, dominated by the taxa *Phacus*, *Scenedesmus*, and *Oscillatoria*, indicating that the conditions were eutrophic (polluted). In contrast, the average score in the second period was 6.0, indicating a meso-eutrophic status. Similar to Site S2, Site S3 fell in the meso-eutrophic range, representing moderate nutrient enrichment, with dominant genera being *Phacus*, *Euglena*, and *Eudorina*, with of 6.7 as an average score. In particular, the average scores were between 8.3 and 9.0 at sites S4 and S5, reflecting eutrophication with a phytoplankton community dominated by *Oscillatoria* and *Scenedesmus*. These genera are often linked to nutrient-rich and polluted environments, indicating that these sites were considerably nutrient-loaded, possibly because of anthropogenic factors. Evaluation of trophic status using the AARL-PP score based on dominant phytoplankton genera at the same five sampling sites after the Kaset Fair. Results indicate that Site S1 sustained a mean score of 7.3 and dominant genera (*Phacus*, *Chlorella*, and *Microcystis*), classifying it as meso-eutrophic, suggesting moderate nutrient levels with little change in nutrient levels post-event. As for the S2 area, there was a similarity of the pattern before the Kaset Fair, where the first sampling (average 8.3) was dominated by *Phacus*, *Scenedesmus*, and *Oscillatoria,* suggesting eutrophic conditions and the first period diminished to 6.0, suggesting meso-eutrophic conditions (Table 7). Site S3 recorded a small drop in the mean score (6.3), with dominant genera (*Phacus*, *Euglena*, and *Oscillatoria*) staying in the meso-eutrophic range, indicating moderate pollution. The overall indication of significant environmental pressure due to nitrate and increases in ammonium concentrations was site and time-specific, with sites S4 and S5 recording consistent highs of 8.3 to 9.0 by pollution-tolerant genera such as *Oscillatoria* and *Scenedesmus* – an indication of long-term persistence of eutrophication. These genera indicate extended nutrient enrichment and pollution, likely driven by runoff and organic matter inputs associated with the event. Based on reports from 165 authors, pollution-tolerant algal genera and species form a stable series, with diatoms, pigmented flagellates, and green and blue-green algae being prominent. The top eight genera included *Euglena*, *Oscillatoria*, *Chlamydomonas*, *Scenedesmus*, *Chlorella*, *Nitzschia*, *Navicula*, and *Stigeoclonium*, whereas the top five species were *Euglena viridis*, *Nitzschia palea*, *Oscillatoria limosa*, *Scenedesmus quadricauda*, and *Oscillatoria tennis*. In some genera, such as *Euglena*, a single species is more pollution-tolerant than others, whereas in others, such as *Oscillatoria*, multiple species show similar tolerance levels. Pollution indices for these algal genera and species are useful for evaluating water samples with high levels of organic pollution (Mervin Palmer, 2007). The use of the AARL-PP score for water quality assessment has been discussed in numerous publications, revealing major results. Phytoplankton communities are responsive to differences in nutrient and pollution status in a range of environments, as exemplified by phytoplankton diversity-based water quality assessment and the distribution of dominant phytoplankton genera in Phayao Lake, Thailand, such as *Cyclotella* and *Microcystis* (Pinmongkhonkul et al., 2022). Other river studies, such as those of Elbe in Germany, indicate that phytoplankton such as *Cyclotella* act as key bioindicators of water quality, in addition to other groups such as *Microcystis*. Studies on aquatic health indicators such as dissolved oxygen saturation (DO) and pH have shown that water parameters, especially DO and pH, that are important for evaluating aquatic ecosystems' health status are directly driven by phytoplankton activity, particularly in nutrient-rich environments. Results from these studies have shown an association between increased nutrient levels and the predominance of eutrophication-related species, indicating a trend of decreasing water quality. They also noted that

Table 7. Water quality assessment using dominant genus of phytoplankton

Sampling sites		Dominant genus of phytoplankton	Average score	Trophic level	Water quality
Before the Kaset Fair					
S1	P.1	*Phacus* (8) *Chlorella* (6) *Microcystis* (8)	7.3	Meso-Eutrophic Status	Moderate-Polluted
	P.2	*Phacus* (8) *Chlorella* (6) *Microcystis* (8)	7.3	Meso-Eutrophic Status	Moderate-Polluted
S2	P.1	*Phacus* (8) *Scenedesmus* (8) *Oscillatoria* (9)	8.3	Eutrophic Status	Polluted
	P.2	*Phacus* (8) *Scenedesmus* (8) *Cosmarium* (2)	6.0	Meso-Eutrophic Status	Moderate-Polluted
S3	P.1	*Phacus* (8) *Euglena* (2) *Eudorina* (10)	6.7	Meso-Eutrophic Status	Moderate-Polluted
	P.2	*Phacus* (8) *Euglena* (2) *Eudorina* (10)	6.7	Meso-Eutrophic Status	Moderate-Polluted
S4	P.1	*Phacus* (8) *Oscillatoria* (9) *Scenedesmus* (8)	8.3	Eutrophic Status	Polluted
	P.2	*Phacus* (8) *Oscillatoria* (9) *Oscillatoria* (10)	9.0	Eutrophic Status	Polluted
S5	P.1	*Phacus* (8) *Scenedesmus* (8) *Oscillatoria* (9)	8.3	Eutrophic Status	Polluted
	P.2	*Phacus* (8) *Scenedesmus* (8) *Oscillatoria* (9)	8.3	Eutrophic Status	Polluted
After the Kaset Fair					
S1	P.1	*Phacus* (8) *Chlorella* (6) *Microcystis* (8)	7.3	Meso-Eutrophic Status	Moderate-Polluted
	P.2	*Phacus* (8) *Chlorella* (6) *Microcystis* (8)	7.3	Meso-Eutrophic Status	Moderate-Polluted
S2	P.1	*Phacus* (8) *Scenedesmus* (8) *Oscillatoria* (9)	8.3	Eutrophic Status	Polluted
	P.2	*Phacus* (8) *Scenedesmus* (8) *Euglena* (2)	6.0	Meso-Eutrophic Status	Moderate-Polluted
S3	P.1	*Phacus* (8) *Euglena* (2) *Oscillatoria* (9)	6.3	Meso-Eutrophic Status	Moderate-Polluted
	P.2	*Phacus* (8) *Euglena* (2) *Oscillatoria* (9)	6.3	Meso-Eutrophic Status	Moderate-Polluted
S4	P.1	*Phacus* (8) *Oscillatoria* (9) *Eudorina* (10)	9.0	Eutrophic Status	Polluted
	P.2	*Phacus* (8) *Oscillatoria* (9) *Eudorina* (10)	9.0	Eutrophic Status	Polluted
S5	P.1	*Phacus* (8) *Scenedesmus* (8) *Oscillatoria* (9)	8.3	Eutrophic Status	Polluted
	P.2	*Phacus* (8) *Scenedesmus* (8) *Oscillatoria* (9)	8.3	Eutrophic Status	Polluted

processes such as nutrient loading and pollution, as well as the hydrological regime, affect the cyanobacterial dominance of species such as *Microcystis*, which is common in eutrophic conditions and is regarded as a harmful algal bloom. In particular, the diversity of phytoplankton biomass is largely responsible for changes in water quality, often related to past pollution and improved watershed management (Wilhelms et al., 2022). The study assessed organic pollution levels in lakes using the Pollution Index and evaluated their trophic status based on dominant phytoplankton (AARL-PP Score). Eighty morphospecies from 25 genera, 16 families, and 8 classes were identified, with the Bacillariophyceae class being the most diverse. The genera *Synedra*, *Chlorella*, and *Cosmarium* were the most abundant, indicating moderate organic pollution and mesotrophic state. Key physicochemical parameters, such as temperature, pH, dissolved oxygen, and electrical conductivity, were found to be similar in both the lakes (Delgado-Fernandez et al., 2025).

Evaluation of water quality and dominant genus of phytoplankton

Before the Kaset Fair, the water quality parameters were closely linked to the composition of dominant phytoplankton species at the sampling sites. At Sites S3, S4, and S5, *Scenedesmus* was the dominant genus, with water transparency values of 0.843, reflecting mesotrophic conditions. The association of *Scenedesmus* and transparency was high ($\beta = 0.843$, $R^2 = 0.710$). This means that higher values of transparency here due to the clear waters enhanced the growth of *Scenedesmus*, which prefers moderate nutrient levels and good light penetration. The maximum depth at these sites values of 60 to 100 cm was also likely suitable for *Scenedesmus* as deeper waters provide stable thermal conditions and light diffusion, which further favor its growth. At Site S1, the major genus was *Volvox*, which prospered in the relatively high-water temperature of 28 °C and pH 7.46. The water temperature had a moderately positive association with *Volvox* abundance ($\beta = 0.152$, $R^2 = 0.023$), suggesting that warmer water temperatures promoted *Volvox* proliferation in moderately nutrient-rich conditions. As for Site S2, pH had more acidic values of 6.38 and transparency was lower ($R^2 = 0.710$), which thus favored *Zygnema*. The negative relationship between *Zygnema* abundance and water transparency ($\beta = -0.324$, $R^2 = 0.105$) indicated that transparency decreased, such as higher organic matter, which likely contributed to the proliferation of *Zygnema* within oxygen-depleted habitats (Boonsomsai, 2011; Rungnapa et al., 2003).

After the Kaset Fair, the composition of dominant phytoplankton shifted significantly, which was strongly mirrored in the worsening water quality, where the dominant phytoplankton changed dramatically. In addition to the increased nutrient states at Sites S3 and S5, *Oscillatoria* also became the dominant genus, responding positively to the ecosystem nutrient levels, especially NH_3-N and SRP. NH_3-N concentrations rose sharply, peaking at > 3.000 mg/L at several sites. For example, NH_3-N was positively correlated with *Oscillatoria* abundance ($\beta = 0.483$, $R^2 = 0.233$), suggesting that Oscillatoria was more abundant in water samples with higher nutrient levels during the study, a finding consistent with the preference of *Oscillatoria* for nutrient-rich, eutrophic environments. Finally, the negative factors contributing to the deterioration of water quality were turbidity and lower transparency ($\beta = -0.802$, $R^2 = 0.643$). Such increases in turbidity associated with suspended organic matter favored the genus *Oscillatoria*, water with high nutrient concentrations and low light penetration. *Phacus* continued to dominate at Site S1 (Figure 2), an indication of the apparent robustness of the species to nutrient enrichment at low to intermediate concentrations. NH_3-N and *Phacus* were comparatively less abundant ($\beta = 0.052$, $R^2 = 0.003$), even though NH_3-N and BOD values at this site were enhanced after the event. This suggests that *Phacus* can withstand modest levels of nutrient enrichment without exhibiting the sharp increase observed in *Oscillatoria*. The fact that *Phacus* was still present at S1 indicates that it can survive in conditions with somewhat higher nutrient concentrations (Table 8).

The event has a strong effect on the species composition of phytoplankton and water quality before and after the Kaset Fair, reflected by lower water clarity and fertilizer levels as a result of the event. During mesotrophic conditions, characterized by the relative stability of transparency and nutrient levels before the incident, *Scenedesmus*, and *Phacus* were the dominant. Statistical analyses revealed strong positive correlations between transparency and *Scenedesmus* abundance ($\beta = 0.843$, $R^2 = 0.710$), suggesting that before the

Table 8 Evaluation of water quality and dominant genus of phytoplankton

Parameters/ Sampling Sites	Genus (β, R^2)				
	S1 (*Volvox*)	S2 (*Zygnema*)	S3 (*Scenedesmus*)	S4 (*Scenedesmus*)	S5 (*Scenedesmus*)
Before the Kaset Fair					
Water Temperature	(-0.056, 0.003)	(0.083, 0.007)	(0.152, 0.023)	(0.151, 0.023)	(0.041, 0.022)
pH	(0.568, 0.323)	(-0.215, 0.046)	(-0.146, 0.021)	(-0.506, 0.060)	(-0.035, 0.001)
Transparency	(0.687, 0.472)*	(0.843, 0.710)*	(0.843, 0.710)*	(0.687, 0.472)*	(-0.802, 0.643)
Depth	(0.655, 0.429)	(0.769, 0.591)	(0.372, 0.138)	(0.328, 0.107)	(-0.324, 0.105)
Salinity	NA	(0.383, 0.147)	(0.412, 0.170)	(0.492, 0.424)	NA
Turbidity	(0.418, 0.175)	(0.269, 0.072)	(0.161, 0.026)	(0.151, 0.023)	(-0.190, 0.036)
EC	(-0.020, 0.020)	(0.320, 0.102)	(0.034, 0.116)	(0.483, 0.233)	NA
DO	(0.413, 0.171)	(0.006, 0.000)	(-0.176, 0.031)	(-0.069, 0.476)	(0.052, 0.003)
TSS	(0.333, 0.111)	NA	(-0.333, 0.111)	NA	NA
Chlorophyll *a*	(0.055, 0.003)	(-0.050, 0.003)	(-0.342, 0.117)	(0.076, 0.006)	(0.031, 0.001)
NH_3-N	(0.418, 0.175)	(0.340, 0.116)	(0.595, 0.354)	(0.664, 0.441)	(-0.634, 0.402)
SRP	(-0.011, 0.011)	(0.348, 0.121)	(0.395, 0.156)	(0.617, 0.381)	(0.039, 0.001)
BOD	(-0.386, 0.149)	(-0.265, 0.070)	(-0.107, 0.012	(-0.120, 0.014)	(0.164, 0.027)*
After the Kaset Fair					
Water Temperature	(0.084, 0.007)	(0.134, 0.018)	(-0.028, 0.001)	(-0.121, 0.015)	(0.365, 0.133)
pH	(0.669, 0.448)	(0.343, 0.118)	(0.149, 0.022)	(0.381, 0.145)	(0.507, 0.258)
Transparency	(0.707, 0.500)*	(0.522, 0.273)	(0.412, 0.170)*	(-0.186, 0.034)	(0.707, 0.500)*
Depth	(0.570, 0.325)	(0.671, 0.450)*	(0.128, 0.052)	(-0.092, 0.009)	(0.268, 0.072)
Salinity	(-0.639, 0.408)	(-0.257, 0.066)	(0.040, 0.002)	(0.188, 0.035)	(-0.681, 0.464)
Turbidity	(0.277, 0.077)	(0.222, 0.049)	(0.119, 0.014)	(-0.095, 0.009)	(0.036, 0.001)
EC	(-0.693, 0.480)	(-0.279, 0.078)	(0.048, 0.002)	(0.197, 0.039)	(-0.660, 0.436)
DO	(0.454, 0.206)	(0.060, 0.004)	(-0.172, 0.030)	(0.596, 0.355)*	(0.278, 0.077)
TSS	(-0.243, 0.059)	(-0.707, 0.500)	(-0.333, 0.111)	(-0.243, 0.059)	(0.278, 0.077)
Chlorophyll *a*	(0.387, 0.150)	(0.094, 0.009)	NA	(-0.332, 0.110)	NA
NH_3-N	(-0.298, 0.089)	(0.025, 0.001)	(0.092, 0.009)	(-0.004, 0.000)	(0.457, 0.209)
SRP	(-0.113, 0.013)	(-0.124, 0.015)	(0.046, 0.002)	(-0.086, 0.007)	(-0.230, 0.053)
BOD	(-0.082, 0.007)	(-0.156, 0.024)	(-0.038, 0.001)	(-0.078, 0.006)	(-0.103, 0.011)

Note: NA – not available, * Correlation at the 0.01 level of significance, ** Correlation at the 0.05 level of significance.

incident, *Scenedesmus* proliferated in the clear waters. In contrast, *Oscillatoria* was the major genus in the post-event periods at the higher phosphorus and NH_3-N locations. The association of *Oscillatoria* with NH_3-N was even greater (β = 0.492, R^2 = 0.424), which further substantiated the argument that nutrient-rich environments following the event were conducive for *Oscillatoria* growth, a genus that is often successful in nutrient-enriched habitats. The negative correlation (β = −0.802, R^2 = 0.643), indicating lower water transparency after the Kaset Fair than before, also reinforced the shift to eutrophic conditions and *Oscillatoria* dominance. *Phacus* and *Scenedesmus* were dominant at sites with moderate increases in nutrient levels. For example, at site S1, with a moderate increase in NH_3-N, *Phacus* had a relatively low correlation (β = 0.052, R^2 = 0.003) with nutrient levels. Collectively, these sampling point-based statistics corroborated with the observed functional transition reformation in phytoplankton community structure from *Scenedesmus* and *Phacus* to *Oscillatoria*, and the driving increase in responsive parameters (ammonia nitrogen) and decrease (transparency) pointed out a typical situation of lettuce in eutrophication systems. It found a greater expressive power of *Oscillatoria* and NH_3-N, with R^2 = 0.424

compared with other genera such as *Phacus* (R^2 = 0.003), tolerant to moderate changes in nutrient concentrations, which appears to be more evident in several situations of nutrient enrichment. Our results demonstrate that phytoplankton is a bioindicator of turnover events, with implications for water quality and ecosystem health (Audomlak and Sangdao, 2013; Beyhan, 2012).

CONCLUSIONS

This study was aimed at using dominant phytoplankton as bioindicators of water quality in several water bodies situated within the university as reflected by physical, chemical, and biological assessments of the water quality. In this work, we investigate the degree to which varying phytoplankton species may indicate levels of nutrient pollution in their aquatic ecosystem. Using the AARL-PP score, the research offers a high-resolution classification of water quality ranging from oligotrophic (clean) to hypereutrophic (highly polluted) based on the presence and dominance of indicator phytoplankton. The hydrobiological status before the monitored event was mostly about meso-eutrophy, and the water sources were characterized by moderate pollution with a predominance of *Phacus* and *Scenedesmus,* indicating moderate nutrient levels and relatively stable ecosystems.

Particularly following the event, water quality experienced a dramatic change. The study indicates the marked increase of nutrients (NH_3-N and SRP) and that the presence of pollution-tolerant species such as *Oscillatoria* dominates in the eutrophic and hypereutrophic conditions. Those species, commonly related to harmful algal blooms, indicated a deterioration in water quality, corroborated by increasing BOD and falling DO levels. Suspended organic matter in water also increased turbidity significantly, lowered water transparency, and subsequently promoted the growth of *Oscillatoria*.

This study found strong correlations between phytoplankton species and water quality indicators. Pre-event conditions favored *Scenedesmus*, indicating moderate nutrient levels, while post-event data showed a shift to pollution-tolerant species, such as *Oscillatoria*, due to nutrient influx from human activities. This highlights the rapid response of phytoplankton to environmental changes, which makes them effective bioindicators. The AARL-PP score method reliably reflects water quality across ecosystems. These findings emphasize the need for ongoing water quality monitoring and the use of phytoplankton as an early warning signal to manage pollution and support sustainable water resource management. The study only covered a limited number of sampling sites within the university, which may not represent the broader environmental impact across the region. The analysis focused on a single event, and long-term data are required to better understand water quality trends. Future studies should include more diverse aquatic ecosystems to evaluate the applicability of the AARL-PP scoring method on a larger scale. The potential effects of different anthropogenic activities on phytoplankton diversity and water quality over long periods were investigated.

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REFERENCES

1. Archilla, A. I. L, Moreira, D., Garcia, P. L., & Guerrero, C. (2004). Phytoplankton diversity and cyanobacterial dominance in a hypereutrophic shallow lake with biologically produced alkaline pH. Extremophiles, 8, 109–115. https://doi.org/10.1007/s00792-003-0369-9
2. Khongsang, A., Wongsal, S. (2013). Phytoplankton indicators in the ban Thai reservoir, Phuket province, Thailand. *Proceedings of the 1st Annual PSU Phuket International Conference 2012*, 10–12 January, 2013, Phuket, Thailand.
3. Babuji, P., Thirumalaisamy, S., Duraisamy, K., & Periyasamy, G. (2023). Human health risks due to exposure to water pollution: A review. *Water, 15*(14), 2532. https://doi.org/10.3390/w15142532
4. Tas, B. (2012). Diversity of phytoplankton and trophic status in the Gaga Lake, Turkey, Energy Education Science and Technology Part A: *Energy Science and Research, 30*(1): 33–44.
5. Boonsomsai, S. (2011). *Phytoplankton Diversity Associated Kudmuangham Reservior Water Quality in Sisaket Province.* Thesis of Master in Science

Education, Ubon Ratchathani Rajabhat University.

6. Chaipiputnakhajorn, T., & Gunbua, V. (2023). The use of phytoplankton as water quality indicator together with basic water quality for reservoirs of eastern Thailand. *Burapha Science Journal*, 913–928.
7. Cha-umphol, P. (1996). *Relation between phytoplankton and some nutrients in Huay Tung Tao reservoir [Dissertation]*. Chiang Mai University, Chiang Mai. [Thailand]
8. Clarke K, Warwick R. (1994). *Change in marine communities: an approach to statistical analysis and interpretation*. Plymouth Marine Laboratory. Plymouth, UK, 144.
9. Delgado-Fernandez, E., Cruz, D., Ayavaca, R., Benitez, A., Hernandez, B. (2025). Microalgal diversity as bioindicators for assessing and sustaining water quality in the High Mountain Lakes of Quimsacocha, Azuay, Ecuador. *Sustainability, 17*,1620. https://doi.org/10.3390/ su17041620
10. Enawgaw Y, & Wagaw S. (2023). Phytoplankton communities and environmental variables as indicators of ecosystem productivity in a shallow tropical lake. *Journal of Freshwater Ecology, 38*(1), 2216244. https://doi.org/10.1080/02705060.2023.2216244
11. Ernesto, J. G., & Gabriel, R. (2019). Eutrophication and Phytoplankton: Some Generalities from Lakes and Reservoirs of the Americas. In V. Milada (Ed.), Microalgae. https://doi.org/10.5772/intechopen.89010
12. Evgenia K. L. (2013). Changes in roach (*Rutilus rutilus* (L.)) diet and growth in relation to river water quality. *Ekologija, 59*(3), 123–130.
13. Fai, P. B. A., Kenko, D. B. N., Tchamadeu, N. N., Mbida, M., Korejs, K., & Riegert, J. (2023). Use of multivariate analysis to identify phytoplankton bioindicators of stream water quality in the monomodal equatorial agroecological zone of Cameroon. *Environmental Monitoring and Assessment, 195*(6), 788. https://doi.org/10.1007/s10661-023-11390-8
14. Fernandez, C., Parodi, E. R., & Caceres, E. J. (2012). Phytoplankton structure and diversity in the eutrophic hypereutrophic reservoir Paso de las Piedras, Argentina. *Limnology, 13*(1), 13–25. https://doi.org/10.1007/s10201-011-0347-3
15. Figueroa-Sanchez, M. A., Sarma, N., Sarma, S. S. S. (2014). Zooplankton community structure in the presence of low levels of cyanotoxins: A case study in a high altitude tropical reservoir (Valle de Bravo, Mexico). *Journal of Limnology. 73*, 157–176. https://doi.org/10.4081/jlimnol.2014.784
16. Gajaseni, N. (2001). *Manual of freshwater ecology laboratory*. Bangkok, Thailand.
17. Gao, W., Xiong, F., Lu, Y., Xin, W., Wang, H., Feng, G., Kong, C., Fang, L., Gao, X., & Chen, Y. (2024). Water quality and habitat drive phytoplankton taxonomic and functional group patterns in the Yangtze River. *Ecological Processes, 13*(1), 11. https://doi.org/10.1186/s13717-024-00489-6
18. Hu, C., Xie, C., Yang, W., Liu, Q., Gao, Y., Zeng, Y., Li, H., Sun, J., & Wang, C. (2024). Function rather than structure of phytoplankton community reveals changes of water quality in an ecological restored lake. *Environmental Monitoring and Assessment, 196*(3), 274. https://doi.org/10.1007/s10661-024-12398-4
19. Keawkhiew, P., Keawtip, S., Seetakroses, P., & Montien-art, B. (2013). Biodiversity of fish in Maesaw Creek at the initiative highland agricultural development station project, Ban Santisuk, Khunkual Subdistrict, Phong District, Phayao Province. *Journal of Fisheries Technology Research, 7*(1), 70–81.
20. Kesari, K. K., Soni, R., Jamal, Q. M. S., Tripathi, P., Lal, J. A., Jha, N. K., Siddiqui, M. H., Kumar, P., Tripathi, V., & Ruokolainen, J. (2021). Wastewater treatment and reuse: a review of its applications and health implications. *Water, Air, & Soil Pollution, 232*(5), 208. https://doi.org/10.1007/s11270-021-05154-8
21. McHugh, A. N. (2011). *An assessment of sustainable water management at university campuses [Dissertation]*. Duke University, Durham. [Thailand]
22. Palmer, M. (2007). Composite rating of algae tolerating organic pollution. *Journal of Phycology 5*(1):78 – 82. https://doi.org/10.1111/j.1529-8817.1969.tb02581.x
23. Notification of Ministry of Science, Technology and Environment No.4, B.E.2539 (1996) dated January 3, B.E.2539 (1996), which was published in the Royal Government Gazette, Vol.113, Part 13D, dated February 13, B.E.2539 (1996).
24. Novia, R., Adnan, & Ritonga, I. R. (2016). Hubungan parameter fisika-kimia perairan dengan kelimpahan plankton di Samudera Hindia bagian barat daya. *Depik, 5*(2), 67–76. https://doi.org/10.13170/depik.5.2.4912
25. Peerapormpisal, Y. (2015). *Freshwater algae in Thailand*. Chiang Mai, Thailand.
26. Peerapormpisal, Y., Pekkoh, J., Powangprasit, D., Tonkhamdee, T., Hongsirichat, A., & Kunpradid, T. (2007). Assessment of water quality in standing water by using dominant phytoplankton (AARL-PP Score). *Journal of Fisheries Technology Research, 1*(1), 71–81.
27. Pielou, E. C. (1975). *Ecological diversity*. New York, NY: John Wiley & Sons.
28. Pinmongkhonkul, S., Prommana, R., Khamkhunmuang, T., Singkurt, S., Sukcharoen, A., & Madhyamapurush, W. (2022). The water quality assessment and biodiversity of phytoplankton in Phayao Lake, Phayao Province, Thailand. *AgBioForum,*

24(1), 65–72.

29. Ramos, J. B., Schulz, K. G., Voss, M., Narciso, A., Muller, M. N., Reis, F. V., Cachao, M., & Azevedo, E. B. (2017). Nutrient-specific responses of a phytoplankton community: A case study of the North Atlantic Gyre, Azores. *Journal of Plankton Research, 39*(4), 744–761. https://doi.org/10.1093/plankt/fbx025
30. Rattanaphani, W., Liawruangrath, S., & Rattanaphani, S. (1990). *Water quality research and analysis from Mae Ping*. Water Resources.
31. Rungnapa, P., Ladda, W. & Sombun, T. (2003). Diversity of fresh water algae in eutrophication condition and suitable for growth of Microcystis aeruginosa. (in Thai).
32. Sakset, A., & Preecha, C. (2021). Variations of phytoplankton in the lower part of the Tapee River Basin (TRB), Surat Thani province, Thailand. *Khon Kaen Agriculture Journal, 49*, 763–778.
33. Sampantamit, T., Ho, L., Lachat, C., Sutummawong, N., Sorgeloos, P., & Goethals, P. (2020). Aquaculture production and its environmental sustainability in Thailand: Challenges and Potential Solutions. *Sustainability, 12*(5), 2010. https://doi.org/10.3390/su12052010
34. Sarunya, Y. (2018). Bioindicators for indicating quality of freshwater ecosystem. *KKU Science Journal, 46*(4), 408–417.
35. Sharma, M., Kant, R., Sharma, A. K., & Sharma, A. K. (2024). Exploring the impact of heavy metals toxicity in the aquatic ecosystem. *International Journal of Energy and Water Resources*. *9*, 267–280. https://doi.org/10.1007/s42108-024-00284-1
36. Silva, J. A. (2023). Wastewater Treatment and Reuse for Sustainable Water Resources Management: A Systematic Literature Review. *Sustainability, 15*(14), 10940. https://doi.org/10.3390/su151410940
37. Strickland, J. D. H., & Parsons, T. R. (1972). *A practical handbook of seawater analysis*. Canada: Fisheries Research Board of Canada.
38. Tomasini-Ortiz, A. C., Moellez-Chavez, G., Sanchez Chavez, J. J., Bravo Inclan, L. A. (2012). Cianobacterias ycianotoxinas en el Lago de Pátzcuaro, Michoacán, México. Revista AIDIS de Ingeniería y Ciencias Ambientales: Investigación, *Desarrollo y Práctica. 5*, 93–101.
39. Washington, H. G. (1984). Diversity, biotic and similarity indices: A review with special relevance to aquatic ecosystems. *Water Research, 18*(6), 653–694. https://doi.org/10.1016/0043-1354(84)90164-7
40. Wilhelms, A., Borsig, N., Yang, J., Holbach, A., & Norra, S. (2022). Insights into phytoplankton dynamics and water quality monitoring with the BIOFISH at the Elbe River, Germany. *Water, 14*(14), 2078. https://doi.org/10.3390/w14132078
41. Winder, M., & Sommer, U. (2012). Phytoplankton response to a changing climate. *Hydrobiologia, 698*(1), 5-16. https://doi.org/10.1007/s10750-012-1149-2
42. Wongrat, L., & Boonyapiwat, S. (2003). *Manual of sampling and analytical methods of plankton*. Bangkok: Kasetsart University.
43. Yang, J., Pei, H., Lu, J., Liu, Q., Nan, F., Liu, X., Xie, S., & Feng, J. (2022). Effects of phytoplankton community and interaction between environmental variables on nitrogen uptake and transformations in an urban river. *Journal of Oceanology and Limnology, 40*(3), 1012–1026.
44. Zhang, P., Yang, M., Lan, J., Huang, Y., Zhang, J., Huang, S., Yang, Y., & Ru J. (2023). Water quality degradation due to heavy metal contamination: Health impacts and eco-friendly approaches for heavy metal remediation. *Toxics, 11*(10), 828. https://doi.org/10.3390/toxics11100828
45. Zhang, Y., Gao, W., Li, Y., Jiang, Y., Chen, X., Yao, Y., Messyasz, B., Yin, K., He, W., & Chen, Y. (2021). Characteristics of the phytoplankton community structure and water quality evaluation in autumn in the Huaihe River (China). *International Journal of Environmental Research and Public Health, 18*(22), 12092. https://doi.org/10.3390/ijerph182212092
46. Zhang, Y., Yang, J., Lin, X., Tian, B., Zhang, T., & Ye, S. (2024). Phytoplankton community dynamics in ponds with diverse biomanipulation approaches. *Diversity, 16*(1), 75. https://doi.org/10.3390/d16020075
47. Zhu, H., Liu, X. G., & Cheng, S. P. (2021). Phytoplankton community structure and water quality assessment in an ecological restoration area of Baiyangdian Lake, China. *International Journal of Environmental Science and Technology, 18*(6), 1529–1536. https://doi.org/10.1007/s13762-020-02911-7