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Assessment of Carbon Dioxide Captured in Producer Biomass and Its Influencing Factors in a Tropical Freshwater Reservoir

Bhanupong Phrommarat* & Dirakrit Buawech

Department of Environmental Science, Faculty of Science, Silpakorn University, Nakhon Pathom, 73000 Thailand

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Abstract

Since the impact of global warming and climate change due to emissions of greenhouse gas is increasingly serious, freshwater aquatic ecosystems are considered to be one of the most important natural carbon sinks. The key process of the carbon cycle and energy flow in the system is photosynthesis where CO_2 is fixed to produce organic compounds by aquatic producers or phytoplankton. The concept of net primary productivity (NPP) is generally used to describe the net amount of energy and CO_2 stored in producer biomass. Nonetheless, phytoplankton primary production depends directly on various physicochemical as well as biological factors. This study investigated the variation of NPP to estimate CO_2 absorption in relation to the influence of physicochemical parameters in tropical freshwater ecosystems by using Srakaew reservoir as a case study. Water samples were collected in three consecutive seasons during September 2018 to April 2019. The results revealed that CO_2 captured by phytoplankton in the reservoir to produce their biomass or NPP range from 350 to 5,777 mg m^{-2} day^{-1} (mean = 2,813 mg m^{-2} day^{-1}). CO_2 absorption displayed a significant linear relationship with light intensity and water temperature. Seasonal variation can affect NPP and CO_2 absorption. In the hot season, NPP and CO_2 absorption in the water were significantly higher than the cool season while there was no significant difference in the rainy season compared with the other seasons. According to the trophic state assessment, Srakaew reservoir was classified as eutrophic and hypereutrophic due to its low Secchi transparency coupled with high nutrient levels in the water.

Introduction

The threat of global warming and climate change is increasingly seen as one of if not the primary international environmental concern. The phenomenon is attributed to an increase of greenhouse gas (GHG) emissions to the atmosphere of which carbon dioxide (CO_2) contributes over 65% of total GHG emissions (IPCC, 2014). As the situation of the impact is increasingly severe, it is necessary to seek an appropriate methodology to reduce the emissions and to accumulate CO_2. There are two main approaches of CO_2 sequestration

* Corresponding Author
e-mail: phrommarat_b@su.ac.th

globally adopted, namely physical and biological strategies (Khoo et al., 2011). Nonetheless, due to a number of limitations associated with physical techniques, technical improvements are still under investigation (Bhola et al., 2014). On the other hand, biological CO_2 capture appears to be a more promising technique since the method is normally a part of natural processes in ecosystems and less complicated than the physical techniques (Kumar et al., 2010). The key process is CO_2 fixation during photosynthesis to produce organic compounds by producers including plants and other photosynthetic organisms. Therefore, ecosystems, both terrestrial and aquatic, are considered to be the largest natural carbon sinks.

The concept of primary productivity is normally used to describe the amount of energy and CO_2 fixed by producers. It is also used as a biodiversity index of an ecosystem that is directly or indirectly controlled by the biotic and abiotic factors (Paul et al., 2006). Primary productivity is the rate at which solar energy is converted into chemical energy by photosynthetic (or chemosynthetic) autotrophs in an ecosystem while the accumulation of energy in producers called primary production (Miller & Spoolman, 2009). Primary productivity can be categorized into Gross Primary Productivity (GPP) and Net Primary Productivity (NPP). GPP refers to the total amount of chemical energy produced in the process, whereas NPP is the remaining chemical energy from aerobic respiration of producers and stored in their tissue (biomass). Thus, NPP can be used as an indicator of the capacity of an ecosystem to accumulate carbon (Lin, 2014). There is evidence that changes in NPP directly influence the amount of carbon stored in ecosystems (Reich et al., 2001). In terrestrial ecosystems, plants as producers can sequester a large amount of CO_2 as biomass from the atmosphere. However, previous studies indicated that aquatic producers such as microalgae and cyanobacteria have more rapid growth rates and more efficient CO_2 fixation than terrestrial plants (Costa et al., 2000; Langley et al., 2012). In addition, Sydney (2010) suggested that approximately 513 ton of CO_2 per ha per year can be sequestered in aquatic ecosystems during the process of biomass production of phytoplankton. Studying on primary productivity of producers and its influencing factors in aquatic ecosystems is therefore beneficial to understand natural mechanisms of carbon sequestration.

In aquatic ecosystems, the processes of carbon assimilation expressed as primary productivity of producers display complex relationships where solar energy is converted to chemical energy under the influence of other physicochemical factors in water. Light and nutrients are frequently found to be the main limiting factors in freshwater lakes (Guildford & Hecky, 2000; Simmons et al., 2004). Light availability is a factor that determines the vertical distribution of photosynthetic autotrophs and their production rates (Tonetta et al., 2015). Moreover, seasonal variations of light intensity and temperature can also influence on the distribution of phytoplankton (Vaillancourt et al., 2003). In the tropical zone where weather conditions have no obvious pattern like in the temperate zone, weather conditions such as rain and cloud cover can disrupt the intensity of light, temperature and physicochemical properties of water that consequently affect the process of photosynthesis of aquatic producers (Guildford et al., 2007; Omar et al., 2016).

Phytoplankton productivity is sensitive to nutrient availability, particularly phosphorus. In oligotrophic (low-productivity) lakes, the growth of phytoplankton and production are usually constrained by phosphorus limitation (Liboriussen & Jeppesen, 2003). Pollutants from anthropogenic activities such as nutrient leaching from fertilizers, release of washing detergents and other domestic wastes can induce an imbalance of nutrient in water leading to eutrophication (Chaudhuri et al., 2012). Apart from physicochemical factors, lake trophic state or a measure of the productivity of an aquatic ecosystem can be used to describe the potential of lake for primary production. Carlson & Simpson (1996) suggested a production-based trophic state index (TSI) using three index variables (water transparency, total phosphorus and/or chlorophyll a) that are interrelated by linear regression models and should lead to the same index value for a given combination of variable values. As such, any of the three variables can theoretically be used to classify a lake or reservoir. Four states of lake are classified based on TSI value including oligotrophic (low-productivity), mesotrophic (moderate-productivity), eutrophic (high-productivity) and hypereutrophic (very high-productivity) (Carlson & Simpson, 1996). Yet, the state of a freshwater lake can be varied from time to time as a result of changes in temporal and spatial factors (Kuehl & Troelstrup, 2013).

Besides natural aquatic ecosystems, artificial or man-made aquatic ecosystems are likely to be important in terms of the ecological and socio-economic value in urban areas; they play an equivalent role in providing ecosystem services including carbon sequestration (Clifford & Heffernan, 2018). In this study, Srakaew reservoir that is an artificial aquatic ecosystem located in the urban area of Nakhon Pathom province was used as a case study. The reservoir is considered to be a good example of small-scale artificial aquatic ecosystems in urban areas. Additionally, the site can represent a lake that is affected by human activities in both rural and urban communities as it is supplied with a canal flowing from agricultural lands. The study site is situated in Silpakorn University surrounded by urban communities that may discharge pollutants and nutrients into the water. The objectives of this study were to (1) estimate NPP and the trophic state of tropical freshwater ecosystems, (2) assess the potential of CO_2 absorption by calculating CO_2 captured by aquatic producers to produce their biomass or NPP and (3) examine the relationship between CO_2 absorbed in producer biomass and associated physicochemical parameters including water temperature, Secchi transparency, light intensity and total phosphorus.

Materials and Methods

1. Site description

The study was conducted in Sakaew, a small man-made reservoir situated in Silpakorn university Sanamchandra palace campus, that is located at the central areas of Nakhon Pathom province, Thailand (latitude 13°48' to 13°49' N; longitude 100°02' to 100°03' E) (Fig. 1). The reservoir covering a total area of 17,700 m^2 with mean depth of 3 m was constructed in 1903; at the same time that Sanamchandra palace was built in the reign of king Rama VI. It is currently used for recreational purposes, fish species conservation and as a shelter for some migratory birds. The reservoir is supplied with water by rainfall as well as from Chedi Bucha canal flowing from the north-west of the province through community areas and agricultural lands before filling the reservoir and then running eastward to meet the Tha Chin River at Nakhon Chaisi district. The reservoir is currently under control of the university; and fishing activity is not allowed. No floating plants exist in the area. Emergent plants in the littoral zone are sparse and, therefore, not taken into account in this study. It is noted that the period of the hot (pre-monsoon) season of Thailand is normally from March to May, June to October for the rainy (monsoon) season and November to February for the cool (post-monsoon) season (TMD, 2018).

2. Field measurements

A 7-month study was undertaken during the period of September 2018 to April 2019 to assess net primary productivity and related physicochemical parameters. Five points of sample collection were defined across the reservoir as depicted in Fig. 1. Samples were collected once a week between 11.00 am and 02.00 pm. Secchi transparency, which determines the depth of photic zone, was measured at each point of collection by a Secchi disk. Average solar radiation of the day was recorded by an ambient air monitoring station, AQM model 65 (Aeroqual, Auckland, NZ), located adjacent to the collection points as exhibited in Fig. 1. Dissolved oxygen (DO) before and after incubation as well as water temperature were measured in situ by YSI model 54A dissolved oxygen meter (Yellow Spring Instruments, Ohio, US).

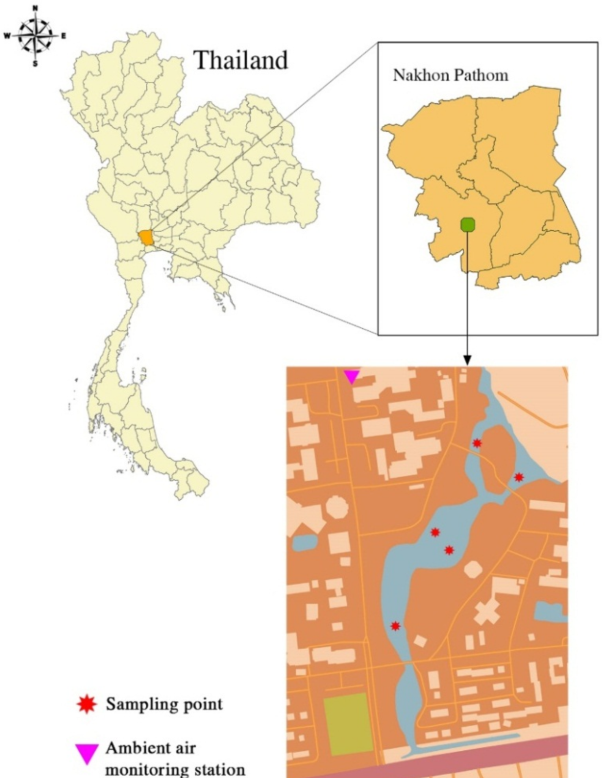

Fig. 1 Map of the study area: Srakaew reservoir, Nakhon Pathom, Thailand

3. Laboratory analysis

Water samples for total phosphorus analysis were collected from each point each testing day at the midpoint of the Secchi depth. The samples were subsequently combined following the spatial composite sampling method. The method accounts for horizontal spatial heterogeneity that provides an estimate of average water quality (Alberta Environment, 2006). Then, the water samples were brought to the laboratory for the analysis. Total phosphorus was determined by the ascorbic acid method following APHA, AWWA and WEF (2012) (Rice et al., 2012).

4. Measurement of primary production

Net primary production (NPP) was estimated according to the light/dark bottle method (Vollenweider, 1969). In the measurement, the decline of oxygen in the dark bottle that has been incubated for a period of time reflects the amount of respiration by consumers and producers whereas the oxygen change in the light bottle indicates the net result of oxygen produced and oxygen utilized by respiration. However, as the current study was focused on estimating NPP, only light bottles were used. Water samples were collected at the midpoint of the Secchi depth. An initial value of dissolved oxygen (DO) of light bottles was measured prior to the bottles being sealed and suspended at the midpoint of the Secchi depth and incubated for three hours (from 11.00 am to 02.00 pm). After the incubation, the bottles were collected and final DO concentrations were measured. NPP was estimated by dividing the change in dissolved oxygen (final-initial) by the incubation period and then multiplying by the number of daylight hours of each testing day. Nevertheless, due to lack of data, the number of daylight hours in this study was assumed to be 12 hours. In addition, as Thailand is located close to the equator, daylight hours are likely to be less variable compared to those countries located in temperate zone. The unit of NPP was converted from per volume to per area by multiplying the value by the Secchi depth. Finally, daily NPP was identified in carbon units per square meter following the unit conversion that 1 mg C is equal to 2.67 mg O_2 (Lind, 1985). The calculation is explained in equation (1).

In terms of CO_2 absorption, the net use of CO_2 by producers for biomass production can also be converted from NPP since 1 mgC of NPP is produced from 3.67 mg CO_2 according to the photosynthesis equation.

5. Trophic state index

Trophic state is a measurement of the productivity of a water body associated with correlated criteria. The trophic state of the reservoir was assessed by the Carlson Trophic State Index (TSI) considering measurements of Secchi transparency, total phosphorus, and/or chlorophyll a by applying the equations below (Carlson & Simpson, 1996):

$$\text{TSI Total Phosphorus} = 14.42 * \ln(\text{TP}, \mu g\ l^{-1}) + 4.15 \tag{2}$$

$$\text{TSI Secchi transparency} = 60 - 14.41 * \ln(\text{Secchi transparency, m}) \tag{3}$$

$$\text{TSI Chlorophyll a} = 9.81 * \ln(\text{chlorophyll a}, \mu g\ l^{-1}) + 30.6 \tag{4}$$

However, only two types of TSI calculated from total phosphorus or TSI (TP) and transparency or TSI (SD) were taken into account in this study. The Trophic State Index ranges from 0 to 100. Different index ranges indicate one of the following trophic categories: oligotrophy (less than 30), mesotrophy (30 to 49), eutrophy (50 to 70) and hypereutrophy (more than 70). It is noted that TSI calculated from different parameters are considered separately (not in average value) as individual surrogate indicators (Kuehl & Troelstrup, 2013).

6. Statistical analysis

The results of physicochemical parameters and NPP of each day of study represented an average of 5 samples collected from 5 points of the reservoir. Comparison of parameters in different seasons was analyzed using one-way ANOVA and multi-pairwise comparisons by Tukey's Honestly Significant Difference (HSD) post hoc test under 5% significance level. In addition, linear regression with $\log_e$ transformations was conducted in order to evaluate relationships of the variables by using the Statistical Package for the Social Sciences (SPSS, version 24) software. The results were expressed as differences between the groups considered statistically significant at $p < 0.05$ and highly significant at $p < 0.01$.

$$\text{NPP (mg C. m}^{-2}\text{.day}^{-1}) = \frac{\Delta\text{DO (mg. l}^{-1}\text{ day}^{-1}) * 1000 \text{ (l. m}^{-3}) * \text{Secchi depth (m)}}{2.67 \text{ mg O}_2\text{. mg C}^{-1}} \tag{1}$$

Results and discussion

1. Physicochemical parameters

Average water temperature of the reservoir throughout the period of study was 28.1°C. The lowest temperature was recorded in the winter month of January (23.9°C) and the highest temperature was found in March (32.3°C) demonstrated in Table 1. Table 2 shows seasonal average values of different parameters indicating that the average temperature and light intensity in the hot season was significantly different from those in the rainy and cool seasons. Light intensity highly depends on weather conditions, particularly cloud cover, in each day. In a cloudy, rainy day such as on October 26, average light intensity was recorded as low as 53.2 W. m^{-2}; whereas in a sunny day of summer on March 29, it reached 225.8 W. m^{-2}. The light penetration depth or transparency measured by Secchi disk is likely to be varied from day to day ranging from 24.3 cm to 34.3 cm. However, the transparency tends to be high from the end of rainy season (October) until the end of winter (February) with an average of 28.8 cm when the value tends to be low in the early summer from March onwards with an average of 25.8 cm. Total phosphorus concentrations ranged between 90 to 280 μg. l^{-1}. Although there is no significant difference influenced by seasonal variation, the overall trend of TP concentration was relatively high in the middle of the cool season in December. It can be as a result of high precipitation in the rainy season leading to elevating reservoir water volume and diluting TP in the water body (Ling et al., 2017).

2. NPP and CO_2 absorption

Phytoplankton biomass in the form of NPP within Srakaew reservoir reflected seasonal variation since there was a statistical difference between groups determined by one-way ANOVA ($F(2,22) = 8.487$, $p < 0.01$). As shown in Table 2, the results from Tukey post hoc test revealed that NPP in the hot season was statistically significantly higher than that in the cool season while no significant difference was observed for NPP in the rainy season compared with the other seasons. Seasonal trends in NPP follow the pattern reported in other tropical lakes located in the monsoon-influenced countries that NPP tends to be low in the monsoon and cool seasons and highest in the hot season (Chaudhuri et al., 2012; Sontakke & Mokashe, 2014; Kumar, 2015). The high NPP of lakes in the monsoon-influence zone in the hot season could be due to greater light intensity coupled with high temperature that increase photosynthetic production of phytoplankton, while the low in the monsoon and cool seasons could be due to low temperature and poor light intensity (Singh et al., 2018). The average NPP throughout the collecting period was 767 mgC. m^{-2}. day^{-1} that ranged from 96 to 1,576 mgC. m^{-2}. day^{-1}. Compared the results to previous studies, it appears that NPP of Srakaew reservoir showed a higher value than temperate lakes such as in Sweden (5-192 mgC. m^{-2}.day^{-1}) (Ask et al., 2009) and in South Dakota, USA (average 245 mgC. m^{-2}.day^{-1}) (Kuehl & Troelstrup, 2013). As for the other lakes located in the same climate zone, NPP of a lake in Assam varied from 110–1,750 mgC m^{-2}.day^{-1} (Sugunan & Bhattacharjya, 2000). Mean NPP of a lake located in Brahmaputra floodplain was 548 ± 87 mgC. m^{-2}. day^{-1} (Baruah, 2003). Moreover, compared with Tonle Sap, a large-scale tropical lake located in Cambodia, the range of NPP is likely to be approximate to the current study, which is 1,700–2,400 mgC. m^{-2}. day^{-1} (Holtgrieve et al., 2013). However, in some tropical eutrophic lakes such as Patna Pond in India where nutrients and light are abundant, the value of NPP can be as high as 5,469–9,964 mgC. m^{-2}.day^{-1} (Verma & Srivastava, 2016).

Table 1 Mean value of physicochemical parameters and NPP in Srakaew reservoir recorded in each collecting date

Date	Temperature (°C)	Transparency (cm)	Light intensity (W. m^{-2})	Total P (μg/l)	NPP (mg C. m^{-2}. day^{-1})
20-Sep	27.7 ± 0.3	27.2 ± 1.5	53.2	175	202 ± 210
28-Sep	29.0 ± 0.6	32.0 ± 1.0	166.3	280	1,047 ± 250
08-Oct	28.0 ± 0.5	25.6 ± 4.3	166.9	140	1,025 ± 374
15-Oct	28.2 ± 0.6	28.0 ± 2.9	157.2	130	1,333 ± 541
22-Oct	27.5 ± 0.5	29.9 ± 5.6	119.2	90	665 ± 231
29-Oct	27.6 ± 0.4	29.3 ± 6.4	112.3	90	547 ± 231
05-Nov	27.8 ± 0.4	25.9 ± 2.6	86.8	145	323 ± 131
17-Nov	28.9 ± 0.3	27.0 ± 3.8	135.5	160	802 ± 150
22-Nov	27.8 ± 0.7	28.0 ± 1.8	70.1	175	258 ± 184
27-Nov	27.4 ± 0.5	29.5 ± 3.3	141.2	150	785 ± 131
06-Dec	27.1 ± 0.4	29.3 ± 3.1	109.0	260	532 ± 164
13-Dec	25.8 ± 0.4	28.3 ± 2.3	138.0	240	346 ± 46
20-Dec	25.7 ± 0.6	25.6 ± 2.7	133.5	240	374 ± 143
04-Jan	23.9 ± 0.2	29.6 ± 4.5	75.9	190	193 ± 135
11-Jan	26.3 ± 0.4	27.6 ± 4.4	105.7	130	96 ± 48
18-Jan	25.9 ± 0.1	33.1 ± 1.7	88.8	155	272 ± 218
08-Feb	26.7 ± 0.5	27.0 ± 2.6	143.0	110	748 ± 147
15-Feb	29.6 ± 1.0	30.0 ± 1.7	125.7	200	1,427 ± 515
22-Feb	28.7 ± 0.6	34.3 ± 0.9	173.9	180	745 ± 306
01-Mar	31.0 ± 1.0	28.3 ± 2.0	164.2	180	1,156 ± 452
15-Mar	32.3 ± 0.4	24.3 ± 3.3	177.4	185	840 ± 277
22-Mar	30.0 ± 0.6	26.0 ± 2.8	189.2	185	1,341 ± 351
29-Mar	30.0 ± 0.5	25.2 ± 3.2	225.8	165	1,576 ± 94
05-Apr	30.1 ± 0.3	25.1 ± 1.9	222.7	205	1,337 ± 166
10-Apr	30.5 ± 0.6	25.6 ± 2.1	218.6	165	1,212 ± 74
Average	**28.2 ± 1.9**	**28.1 ± 2.5**	**140.0 ± 47.1**	**173.0 ± 46.9**	**767 ± 448**

Table 2 Seasonal variation of physicochemical parameters and NPP in Srakaew reservoir

Parameter	Unit	Rainy season[1]	Cool season[2]	Hot season[3]
No. of sample (n)		6	13	6
Temperature	°C	28.0 ± 0.5[a]	27.1 ± 1.6[a]	30.7 ± 0.9[b]
Transparency	cm	28.7 ± 2.2[ab]	28.9 ± 2.6[a]	25.8 ± 1.4[b]
TP	$\mu g\ l^{-1}$	150.0 ± 71.0[a]	179.6 ± 45.3[a]	180.8 ± 15.0[a]
Light intensity	$W\ m^{-2}$	129.2 ± 44.1[a]	117.5 ± 30.8[a]	199.7 ± 26.2[b]
NPP	$mgC.\ m.^{-2}\ day^{-1}$	803 ± 409[ab]	530 ± 363[a]	1,244 ± 245[b]

Remark: [a-c] different letters in the same row represent statistical differences ($p<0.05$, Tukey's HSD test).
[1] data collection period: September 20, 2018 to October 29, 2018.
[2] data collection period: November 5, 2018 to February 22, 2019.
[3] data collection period: March 1, 2019 to April 12, 2019.

As far as CO_2 absorption is concerned, the amount of CO_2 absorbed in phytoplankton biomass is directly positively related to NPP and thus, it showed the same trend to NPP results. Fig. 2 illustrates average carbon absorption of the reservoir on the day of sample collection (with a 95% confidence interval). The highest CO_2 absorption (5,777±346 $mg.m^{-2}.day^{-1}$) was observed in the same day of the highest NPP on March 29, 2019, while the lowest value (350±175 $mg.m^{-2}.day^{-1}$) was recorded on January 11, 2019. It appears that eutrophication or phytoplankton blooms in aquatic ecosystems can decrease the amount of CO_2 emitted into the atmosphere, and in turn, increase carbon sequestration in waters (Pacheco et al., 2013; Weinke et al., 2014). However, once these phytoplankton decay, the process of decomposition may deplete the concentration of dissolved oxygen above lake beds and provoke the anaerobic activity of microbes that subsequently generates greenhouse gases such as methane (Borges et al., 2015).

In terms of relationships between CO_2 absorption in biomass and physicochemical variables, there were significant positive linear relationships between log-transformed CO_2 absorption and temperature ($r^2 = 0.514$, $p < 0.01$) as well as light intensity ($r^2 = 0.652$, $p < 0.01$) (Fig. 3 and 4). Light and temperature are known to be important abiotic drivers of algal growth and accordingly photosynthesis (Wetzel, 2001). On the other hand, neither transparency nor total phosphorus showed a significant relationship with CO_2 absorption ($p > 0.05$). This is attributed to an abundance of total phosphorus that could appear in the form of colloidal particles in the reservoir (Heathwaite et al., 2005). As a result, the increase of non-algal turbidity reduces water transparency without a corresponding relationship with NPP. A multiple regression equation using log-transformed variables was derived to describe the influence of temperature and light intensity on CO_2 absorption as follows:

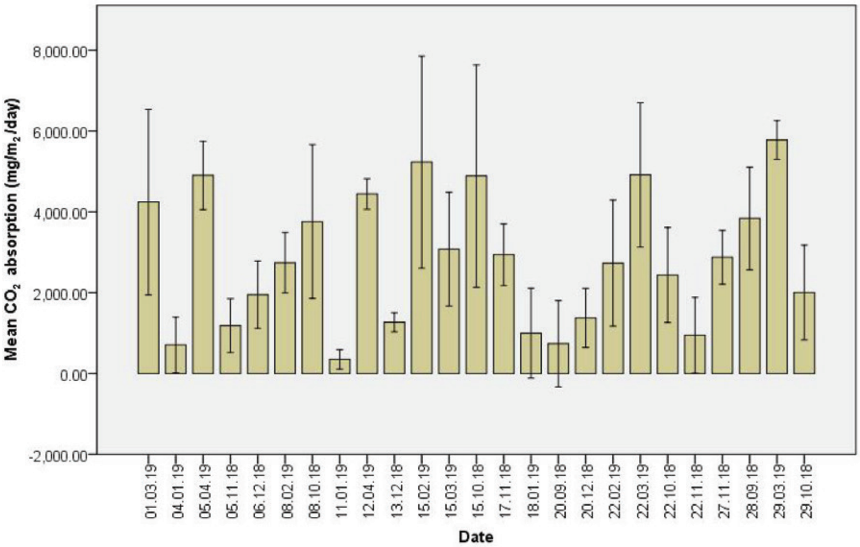

Fig. 2 Variations of CO_2 absorption ($mg.\ m^{-2}.\ d^{-1}$) during the period of study (Error bars represent the 95% confident interval (CI))

$$\ln(CO_2 abs) = -11.347 + 1.197*\ln(Light) + 3.965*\ln(Temp) \quad (5)$$

where ln = Natural logarithm;
CO_2 abs = CO_2 absorption (mg. m^{-2}. day^{-1});
Light = Average daily light intensity (W. m^{-2})
Temp = Water temperature (°C)

The coefficient of determination ($r^2 = 0.734$) was relatively high implying that the equation can explain 73.4% of the variation of CO_2 absorption as phytoplankton biomass. The relationship described by the equation was highly significant ($p < 0.01$).

TSI calculated from total phosphorus ranged between 69.0 and 85.4 while TSI from Secchi transparency ranged from 75.4 to 80.4. The results of TSI as individual surrogate indicators categorized the reservoir as eutrophic (50≤TSI≤70) to hypertrophic (TSI>70). The high index value of total phosphorus indicated that the Sakaew reservoir is enriched by the nutrient; and thus, the growth of phytoplankton in the reservoir is not limited by phosphorus. It is consistent with Tonetta et al. (2015) suggesting that there is no significant correlation between nutrients (nitrogen and phosphorus) and NPP in nutrient rich tropical lakes. By contrast, other factors, such as water temperature and light intensity, tend to play more important roles. In addition, the values of TSI where TSI (TP) is close to TSI (SD) indicate that non-algal particulates or dissolved color may dominate light attenuation (Carlson, 1992). The reason is that, in most turbid lakes, a close relationship between TSI (TP) and TSI (SD) results from clay particles that contain phosphorus while the phytoplankton are unable to utilized all the phosphorus and play a less significant role in contributing to the light attenuation (Carlson & Simpson, 1996). In other words, not all the measured phosphorus is utilized by the phytoplankton.

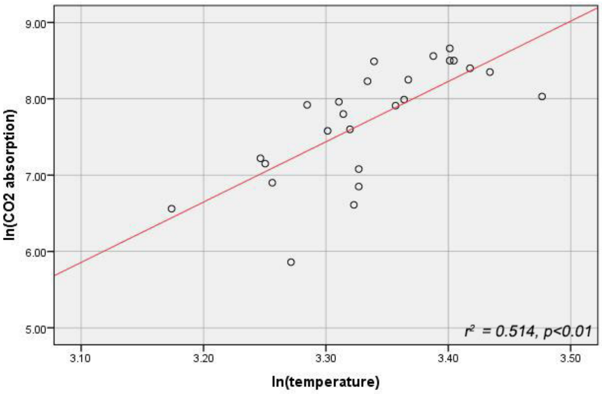

Fig. 3 Relationship between $\log_e$-transformed CO_2 absorption and water temperature

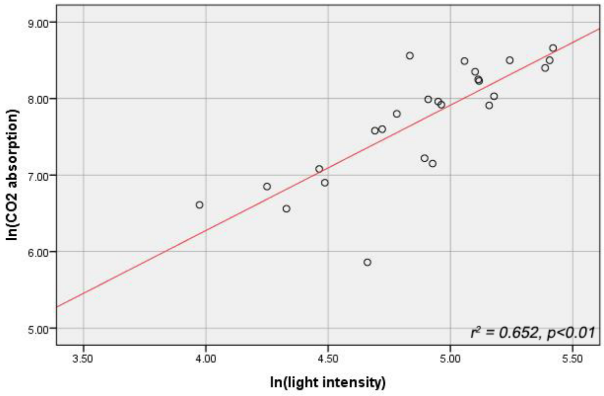

Fig. 4 Relationship between $\log_e$-transformed CO_2 absorption and light intensity

Conclusion

Even though freshwater ecosystems constitute a small fraction of the earth in terms of surface area, they play a crucial role in the global carbon cycle and can be regarded as a potential and promising solution for CO_2 capture and storage. Phytoplankton as the major producers in aquatic ecosystems fix CO_2 via photosynthesis to produce their biomass or NPP. Therefore, the measurement of primary productivity is essential to understand energy and nutrient flows as well as the carbon cycle in the systems. The findings from the present study reaffirmed the importance of aquatic ecosystems. The results indicated that CO_2 captured by phytoplankton in Srakaew reservoir ranged from 350 to 5,777 mg.m^{-2}.day^{-1} (mean = 2,813 mg.m^{-2}.day^{-1}). CO_2 absorption displayed a significant linear relationship with light intensity and water temperature. Likewise, seasonal variation can affect NPP and CO_2 absorption. In the hot season, NPP and CO_2 absorption showed a significantly higher value than the cool season while there was no significant difference in the rainy season compared the other seasons. According to the trophic state assessment, Srakaew reservoir was classified as eutrophic and hypereutrophic due to its low Secchi transparency coupled with high nutrient levels in the water. However, although NPP can roughly estimate CO_2 captured in an ecosystem in the form of producer biomass, it may not usually be a good index to identify the carbon sequestration in the whole system since heterotrophic respiration, namely carbon losses by herbivory and the decomposition of dead organic matter, is not yet considered. Therefore, additional studies associated with heterotrophic respiration are required to fulfill the gap. As the present study was conducted under a limited period of time, temporal variation in production in a longer scale of time should be evaluated. Where possible, other parameters that were excluded from this study, for instance, chlorophyll a, nitrogen content and species composition of phytoplankton should be taken into consideration.

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