

Assessment of the water quality status in dry season of some lakes within Hanoi inner city

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Abstract

The lake system in Hanoi plays an important role in community life such as: entertainment, culture and tourist, water supply and drainage, environmental regulation... However, the increase in urbanization process coupled with collection, discharge and untreated wastewater, the amount of pollutants discharged directly into the lake increases rapidly, causing the water quality of the lakes to be seriously affected. The purpose of this paper is to assess the water quality of some lakes in the inner city of Hanoi in the dry season of 2018. The analysis results showed that most of the water quality in the lakes is polluted. Many indicators exceeded the Vietnamese standard QCVN 08: 2015/MONRE - National technical standards on surface water quality, in which the organic pollution (COD, BOD₅, NH₄⁺, PO₄³⁻) is mainly, then the microbial contamination. The population growth and urbanization pressures are one of the main reasons for causing serious pollution of surface water in the lakes within inner city.

Keywords: Hanoi city, organic pollution, lake system, treatment, water quality.

1. Introduction

A lake is an area filled with water, localized in a basin, that is surrounded by land (Esko Kuusisto and Veli Hyvärinen, 2000), lie on land and are not part of the ocean (Esko Kuusisto and Veli Hyvärinen, 2000). It plays an important role in receiving and regulating water and climate, creating landscapes and the entertainment place of the community. The total area of the lake in the world is about 2.7×10^6 km², accounting for 1.8% of the continental area. Where the lake derived from is important because it affects the chemical composition of the lake water. In addition to the ions usually in natural water such as HCO₃⁻, CO₂, SO₄²⁻, Cl⁻, Ca²⁺, Mg²⁺, Na⁺, K⁺... the lake water have some compounds of N, P, Si, sometimes contain of Fe and some gases such as CO₂, O₂... and organic compounds are resolved by organisms (Vo, 2004). The science of

lakes in Vietnam and the world is rather limited, it has got many shortcomings and just concentrated on statistics, classification of the lake or preliminary survey. In Vietnam, the lakes are used for many purposes such as: aquaculture, hydropower, flood control, irrigation... When the environmental pollution is increasing so the amount of mud is thickening and making the depth of the lake water is decreasing, while the amount of water supplied to lakes is only rainwater and domestic wastewater has turned lakes into places to store waste water and seriously effected the environment (Dang, 2009).

Hanoi is located in a low topographic area of the Red river delta (Vo, 2004) and has a hydrological network and the system of river and lake is very variety, including of large rivers such as Day River, Duong River, Cau River, Ca Lo River... and the small rivers flowing in the inner area such as To Lich River, Kim Nguu River... has become the drainage routes of the city (Vo, 2004; Dang, 2009). There are 111 large and small lakes densely distributed in the city area, with surface water area reaching 2,180 ha, the largest is West Lake with an area of 516 ha (Dang, 2009; Nguyen, 2009). In recent years, with the speed of urbanization and industrialization rapidly, Hanoi is facing serious environmental pollution and degradation, especially the water environment. Both the groundwater and the surface water in Hanoi is also on contaminated status. Some previous researchs showed that the concentration of nutrients in the lakes of Hanoi city is very high such as (NH₄⁺; NO₃⁻; PO₄³⁻) in Ba Mau lake is 8 - 10; 3 - 5; 7.3 - 10 mg/L, Giang Vo lake is 7 - 10; 2 - 10mg/L; Ngoc Khanh lake is 8 - 9; 30 - 40; 3.2 - 5 mg / L (Le, 2009; Nguyen et al, 2017). The BOD, COD, Total P, NH₄⁺-N; NO₂⁻-N in Thien Quang lake is higher than the allowable value of Vietnamese standard 08:2015/MONRE, column B1 (Do, 2010). Therefore, the purpose of this study is to evaluate the water quality of some main lakes within Hanoi inner city in the dry season of 2018. The analysis results provided information on the lake quality in Hanoi city and propose some contribution about using management measures of lake water in Hanoi capital.

2. Material and method

2.1. Research subjects

Sample of lake water was collected at 10 lakes within Hanoi inner city, every lake takes samples at 3 points, then 3 samples are mixed together into 1 sample and analyzed for water quality. Lake water samples are taken monthly during the experimental period from June 2018 to December 2018 with sample codes are as follows: Gia Lam Lake (GL), West Lake (HT), Hoan Kiem (HK), Nghia Tan (NT), Ha Dinh (HD), Thanh Cong (TC), Nam Dong (ND), Van Quan (VQ), Kim Dong (KD) and Bay Mau Lake (BM).

2.2. The analysis methods

2.2.1. *Sampling and preservation:* Samples are taken monthly during the experimental period from the month 6/2018 to 12/2018 according to TCVN 5994: 1995.

2.2.2. *Quickly test in the field:* Indicators are quickly measured in the field by WQC-24A (TOA, Japan) includes: temperature ($^{\circ}\text{C}$), pH, conductivity ($\mu\text{S}/\text{cm}$), total dissolved solids (mg/L).

2.2.3. *Sample analysis in the laboratory:* Indicators such as NH_4^+ (mg/L), PO_4^{3-} (mg/L) are determined by colorimetric method on the OPTIMA SP-300 (Japan); COD, TSS (total suspended solids) and chloride (Cl^-) are analyzed according to Vietnamese standard such as: 6491:1999; 6625:2000; 6194:1996. Two microbiological criteria of *E. coli* and *coliform* were analyzed according to Vietnamese standard 6846-2007 and 4882-2007.

2.3. Statistical analysis

All experiments were done in triplicate and the data were calculated and drawn by the software GrapPad Primse 6 (one way ANOVA). Statistical significance was accepted at a level of $p < 0.05$.

3. Results and discussion

3.1. Results analysis of physical and chemical parameters

The results analysis of physical and chemical parameters are shown in Table 1. In Table 1, the average pH value ranges from 6.51 to 7.06, the change of pH in Hanoi lakes is not clear and there are mild acidity in the dry season. The average pH value of Van Quan Lake is the highest (7.06), the Tay Lake is the smallest (6.51) and is within the allowable limits of Vietnamese standard 08:2015/MONRE (Column A2).

Table 1. The monitoring value of physical and chemical parameters of ten lakes within Hanoi inner city

Lakes	G	H	H	N	H	T	N	V	K	B	Vietnamese standard 08:2015/ MONRE (A2)
	L	T	K	T	Đ	C	Đ	Q	Đ	M	
Parameters											
pH	.92	.51	.73	.82	.53	.87	.79	.06	.76	.81	6 - 8.5

T^oC	5.7	5	5.6	5.5	5.4	5	5.7	6	5.7	5.4	-
TD S (mg/L)	5	41.5	0	75	79.4	15	17	54	01.5	50.3	-
EC (μS/cm)	1.5	19	50.5	74.2	60.5	80.9	50.8	15	95.8	00	-
TSS (mg/L)	4	.5	4	1	2	1	6	.8	.6	5	30
Cl⁻ (mg/L)	5.44	6.33	6.98	4.61	1.06	7.04	4.79	3.78	9.17	8.51	350

Total dissolved solids (TDS) and electrical conductivity (EC) in every lakes varied from 45 - 301.5 mg/L and 91.5 - 495.8 μS/cm. Similarly, the total suspended solids (TSS) varied from 11 - 64 mg/L, in which the average TSS value of Gia Lam Lake was the highest with 64 mg/L and the second is Hoan Kiem Lake with value of 54 mg/L and both of these lakes exceeds the allowable limits of Vietnamese standard 08:2015/MONRE (Column A2). TSS value in Nghia Tan Lake has the lowest value with 11mg/L. The content of clorua is change slightly, varied from 31.06 to 83.78 mg/L and all of the clorua content is lower than the allowable limits of Vietnamese standard 08:2015/MONRE (Column A2). The data in Table 2 showed that the physical and chemical parameters of 10 monitoring lakes varied within wide range, only the salt concentration and pH value are not significantly changed.

3.2. Results analysis of organic and microbiological parameters

The results analysis of organic and microbiological parameters are shown in Table 2 as follows:

Table 2. The monitoring value of organic and microbiological parameters within Hanoi inner city

Lakes											Vietna mese standard 08:2015/ MONR E (A2)
	GL	HT	H K	N T	H Đ	TC	N Đ	V Q	K Đ	B M	
Para- meters											
NH₄⁺	3	2				9					0.3

(mg/L)	2.9	.47	.46	.56	.88	.25	.08	.7	.66	.66	
PO₄³⁻	3	0				1					0.2
(mg/L)	.39	.25	.49	.15	.13	.07	.56	.65	.27	.18	
COD	2	8				1					15
(mg/L)	2.4	.64	.6	1.2	.8	1.2	.4	.2	.6	4.4	
<i>E. coli</i>	9	7				6					50
(CFU/100 mL)	00	00	50	5	5	50	50	20	5	00	
Colifo											5.00
rm	1	1				1					
(MPN/100 mL)	10.10 ²	10.10 ²	600	100	40	10.10 ²	600	30	200	900	0

The analysis results showed that almost organic and microorganism parameters exceeded the allowable limits of Vietnamese standard 08:2015/MONRE (Column A2). The content of organic ammonium, phosphorus and COD parameters were analyzed at Gia Lam lake is the highest (32.9 - 3.39 - 22.4 mg/L) and the lowest value is Hoan Kiem lake (0.46 mg/L of ammonium), Nghia Tan lake (0.15 mg/L of phosphate) and Nam Dong lake (6.4 mg/L of COD). The *E. coli* microbiological parameter exceeded the allowable limit of 1.5 to 18 times, the highest value was in the Gia Lam Lake (900 CFU/100 mL) and the lowest value was in the Nghia Tan Lake (75 CFU/100 mL). Particularly, coliform parameter has only three lakes exceeding the allowable limits, including of Gia Lam Lake, West Lake and Thanh Cong Lake.

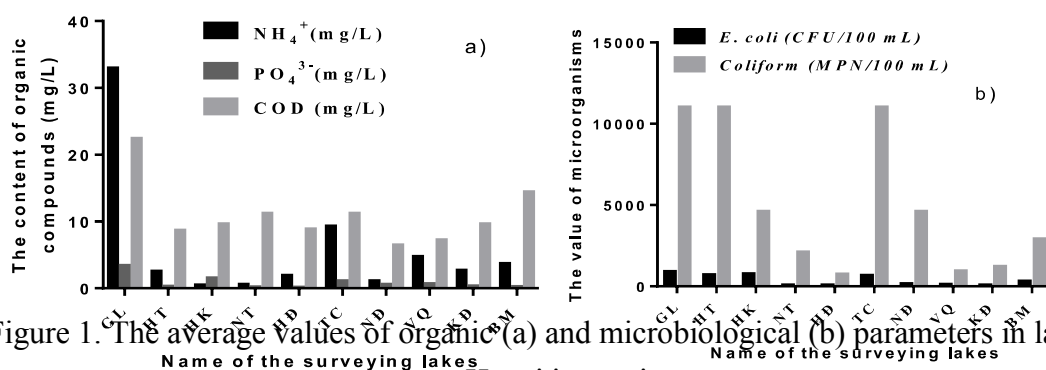


Figure 1. The average values of organic (a) and microbiological (b) parameters in lakes within Hanoi inner city

This monitoring result is similar to some previous studies (Le, 2009; Do, 2010; Nguyen et al, 2017). Because the sampling time is dry season, the water level is low, the weather is not complement of aquatic plants growing and the decomposition processing is slow. According to Le (2009), lakes within Hanoi inner city are greatly effected by domestic wastewater, Nguyen et

al (2017) showed that almost the lakes in Hanoi are eutrophic pollution at different levels. In the world, the study of water quality in lakes is still much discussion and received much attention (Mahakhant et al, 1998; Kazuhito et al, 1996; Norio Hayashi, 2010). Results of monitoring the water quality parameters in some lakes in Thailand showed that the concentration of organic compounds depended on the season, the dry season is always higher than the rainy season (Mahakhant et al, 1998), or the serious organic pollution occurred Dianchi Lake in the urbanization period of Tay An City (China) (Norio Hayashi, 2010), Kojima Lake (Japan) also appeared organic and eutrophic pollution due to the blooming of some algae such as *Microcystis aeruginosa* and *Anabaena* (Kazuhito et al, 1996). Therefore, the population growth and urbanization pressures are one of the main reasons for increasing domestic wastewater discharged into the environment and cause serious pollution of surface water, especially the lakes within inner city.

4. Conclusion

The monitoring results of water environment in the ten lakes within Hanoi inner city from 6/2018 to 12/2018 recorded the average values of chemical and physical parameters as follows: pH (6.51 - 7.06) and mildly acidic; Total dissolved solids (TDS), suspended solids (TSS) and electrical conductivity (EC) in Hanoi lakes varied from 11 - 64 mg/L; 45 - 301.5 mg/L and 91.5 - 495.8 $\mu\text{S}/\text{cm}$; The organic and microbiological parameters are higher many times than the allowable limits of Vietnamese standard 08:2015/MONRE (Column A2). The population growth and urbanization pressures are one of the main reasons for causing serious pollution of surface water in the lakes within inner city.

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