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SPATIAL-TEMPORAL VARIATIONS OF NITRATE CONCENTRATION IN YOM RIVER

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ABSTRACT

This research has been performed using surface water quality data, nitrate-N concentrations (NO_3-N) discharging along Yom River, to assess the relative impact of point source and non-point sources, such as agricultural activities and urbanization, causing eutrophication on surface waters, together with many adversely effects on aquatic ecosystems and human health. Water samples have been collected during 2005 - 2012 twice a year -- in May (summer), and in August (rainy season) -- from 13 stations starting from the north of the Yom River (Yo.13), located in Chiangmuan District, Phayao Province to the south (Yo.01), located in Photalay District, Phichit Province. Results revealed that slightly increasing of NO_3-N and higher NO_3-N levels occurred in downstream than those observed in upstream part of Yom river. Moreover, NO_3-N levels presented higher concentration in rainy season than those in summer season. The measurement showed such NO_3-N leaching in Yom river resulting in eutrophication in downstream of Yo.01 to Yo.04. The concentrations of NO_3-N ranged between 0.38 to 0.50 mg/l. Maximum and minimum for average monthly concentrations during 2005 – 2012 of NO_3-N were 0.91 and 0.02 mg/L at Yo.02 and Yo.13, respectively. In conclusion, the nitrate situation in the Yom river tends to be eutrophication, which implications to decreasing nitrate is urgently required.

Keywords: Eutrophication, Nitrate, Yom River

INTRODUCTION

Nitrate is an important nutrient in the water. It is the primary factors that control the growth of aquatic plants and plankton as the primary producer in the food chain (Fogg, 1971). If nitrate flow into water sources It may add nutrients to the water source and certain extent to the phenomenon of the proliferation of algae or phytoplankton called Plankton bloom, aquatic plants and algae grow rapidly and death to become organic resulting in a lack of oxygen in the water and causing harm to organisms in the water. Such general phenomena called eutrophication (Committee on Water Quality Criteria,1972).

Nitrate (NO_3) is a naturally occurring form of nitrogen found in soil. Nitrogen is essential to all life. Most crop plants require large quantities to sustain high yields. The formation of nitrates is an integral part of the nitrogen cycle in our environment. In moderate amounts, nitrate is a harmless constituent of food and water. Plants use nitrates from the soil to satisfy nutrient requirements and may

accumulate nitrate in their leaves and stems. Due to its high mobility, nitrate also can leach into surface water and groundwater. If people or animals drink water high in nitrate, it may cause methemoglobinemia, an illness found especially in infants.

Nitrates form when microorganisms break down fertilizers, decaying plants, manures or other organic residues. Usually plants take up these nitrates, but sometimes rain or irrigation water can leach them into groundwater. Although nitrate occurs naturally in some groundwater, in most cases higher levels are thought to result from human activities. Common sources of nitrate include fertilizers and manure, animal feedlots, municipal wastewater and sludge, septic systems, and N-fixation from atmosphere by legumes, bacteria and lightning (Metcalf and Eddy, 1991).

Amount of nitrate 0.3 mg/l resulted in the eutrophication, which affect the quality of water resources and water supply, including harmful organisms in the water (Stensel and Horne, 2000). In surface water nitrate found in small amounts, usually less than 1 mg/l and not exceeding 5 mg/l. However, groundwater may have high nitrate from 0 to 1000 mg/l. The concentration of nitrate in the surface water of the Pollution Control Department stated that the amount of nitrate nitrogen should not exceed 5 mg/l. Moreover, high nitrate levels in water can cause methemoglobinemia or blue baby syndrome, a condition found especially in infants under six months. The stomach acid of an infant is not as strong as in older children and adults. This consequently cause an increase in bacteria that can readily convert nitrate to nitrite (NO_2); therefore, we should not give infants drink water that exceeds 10 mg/l NO_3-N. Nitrite is absorbed in the blood, and hemoglobin (the oxygen-carrying component of blood) is converted to methemoglobin, which does not carry oxygen efficiently. This results in a reduced oxygen supply to vital tissues such as the brain. Methemoglobin in infant blood cannot change back to hemoglobin, which normally occurs in adults. Severe methemoglobinemia can cause brain damage and finally brain death. In animals, it is difficult to determine the toxicity of nitrate in animals because it depends on the rate at which the substance is consumed. A few hundred milligrams of nitrate may cause poisoning if consumed in a few hours spreads over a whole day approx.1,000mg, nitrate may cause no signs of toxicity (Holland et al. 1990). Common symptoms include abdominal pain, diarrhea, muscular weakness or poor coordination. Affected animals will have blood that is a chocolate-brown color. If the problem is diagnosed in time, they can fully recover with a treatment of methylene blue. Pregnant animals may abort within a few days. Nitrate also exists in animal feeds and fodder. Drought-stressed forage plants commonly have high nitrate levels. These feeds can have an additive effect when consumed with high nitrate drinking water (Self-J.R., 1998).

Pohlert et al.(2005) have used the Soil and Water Assessment Tool (SWAT) to simulate the release of pollutants, nitrates and where to source the exact point of unknown origin, the exact (point and non-point source) to the Dill catchment area of central Hesse in Germany which geological features included coal and sand. The data from the point of origin to the point is that there are four sources of municipal waste water consisting of 1 treatment plant and 3 steel mill sources, which they used nitric acid in the smelting process. Most of the crops grown in such agricultural areas are oats and barley. The calibrated model years have been done 2000 to 2002, and verified during 2002 to 2003. The results showed that the simulation of monthly nitrate load was quite well with model efficiency of 0.66 to 0.77. Moreover, there are many researchers (Kamwaree, 2012; Wongsasri, 2012) who have corried out hydrological SWAT to evaluate the amount of nitrate that affects the water quality for rivers, for examples, Hu et al. (2007) used hydrological SWAT to predict the amount of nitrate affecting onupstream of the River Embarras in the eastern state of Illinois United States. Determination of runoff associated with amounts of nitrate is released from the agricultural areas, which is mostly corn and soybeans ~ 97 percent. A fertilizer and tillage causes a release of nitrate fertilizer into rivers. the coefficient of determination of nitrate is in the range of 0.36 to 0.74, which showed that the model can predict the change of nitrate in this river basin.

This paper aims to perform using surface water quality data, nitrate-N concentrations (NO_3-N) discharging along Yom River to assess the relative impact of point source and non-point sources, such

as agricultural activities and urbanization, causing eutrophication on surface waters, together with many adversely effects on aquatic ecosystems and human health.

MATRIALS AND METHODS

Study area

Yom River (Fig.1), one of the major watersheds of the Chao Phraya River, is located in the north of Thailand. Latitude location is 14°50' N to 18°25' N and between longitude 99°16' E to 100°40' E. The border has contract with other four major rivers. In the north border on Mekong River. In the south border on Ping River. In the west border on Wang and Ping River. And the east border on Nan River. The Yom river basin covers the provinces of Phayao, Nan, Phrae, Sukhothai, Lampang, Tak, Phitsanulok, Phichit, Kamphaengphet with a catchment area of 23,616 square kilometers. It has a total length of 735 kilometers and an average runoff to 3683.63 million cubic meters per year. The river area cover mostly forest area ~ 44 percent, ~ 35.9 percent of paddy field and ~ 14.8 percent of others agricultural plants (Hydro and Agro Informatics Institute, 2012).

Most people living lower in the Yom river are farmers. When the population increased with the decline of water quality in the river below. The current count is even more severe due to the runoff from various agricultural activities and waste water discharging from industries, which has been so much more than the ability to handle of the river specially in the lower area

Analysis of nitrate in Yom River

This research collected data on the water quality of all surface water samples collected at 13 stations as shown in Table 1:

Station	Location
Station YO.01	Phothale District, Phijit Province
Station YO.02	Phopratubchang District, Phijit Province
Station YO.03	Samngam District, Phijit Province
Station YO.04	Bangrakam District, Phitsanulok Province
Station YO.05	Meuang District, Sukothai Province
Station YO.06	Tumbon Pakquare Meuang District, Sukothai Province
Station YO.07	Sawankalok District, Sukothai Province
Station YO.08	Srisatchanalai District, Sukothai Province
Station YO.09	Wangching District, Phrae Province
Station YO.10	Meuang District, Phrae Province
Station YO.11	Tumbon Banklongpho Meuang District, Phrae Province
Station YO.12	Song District, Phrae Province
Station YO.13	Chingmon District, Phrae Province

Table 1. Location of surface water stations

Samples have been collected during 2005 - 2012 twice a year -- in May (summer), and in August (rainy season). The water samples collected using water samples vertically type and collected at mid-depth at the center of the width of the river. Water samples store in a plastic bottle HDPE volume 1 liter is 1 per bottle for the parameters of the analysis nitrate (NO_3-N) to maintain water samples by sulfuric acid (H_2SO_4) to pH less than 2. All samples were labelle station name , packed in foam boxes and kept at 4 °C to reduce the bacteria and physical and chemical processes. Then samples were taken to the laboratory for further analysis at department of environmental science, Chulalongkorn University. The analysis for nitrate in water samples by Brucine Method, which is according to the standards set forth in Standard Methods for the Examination of Water and Wastewater (APPHA, AWWA and WEF, 2005).

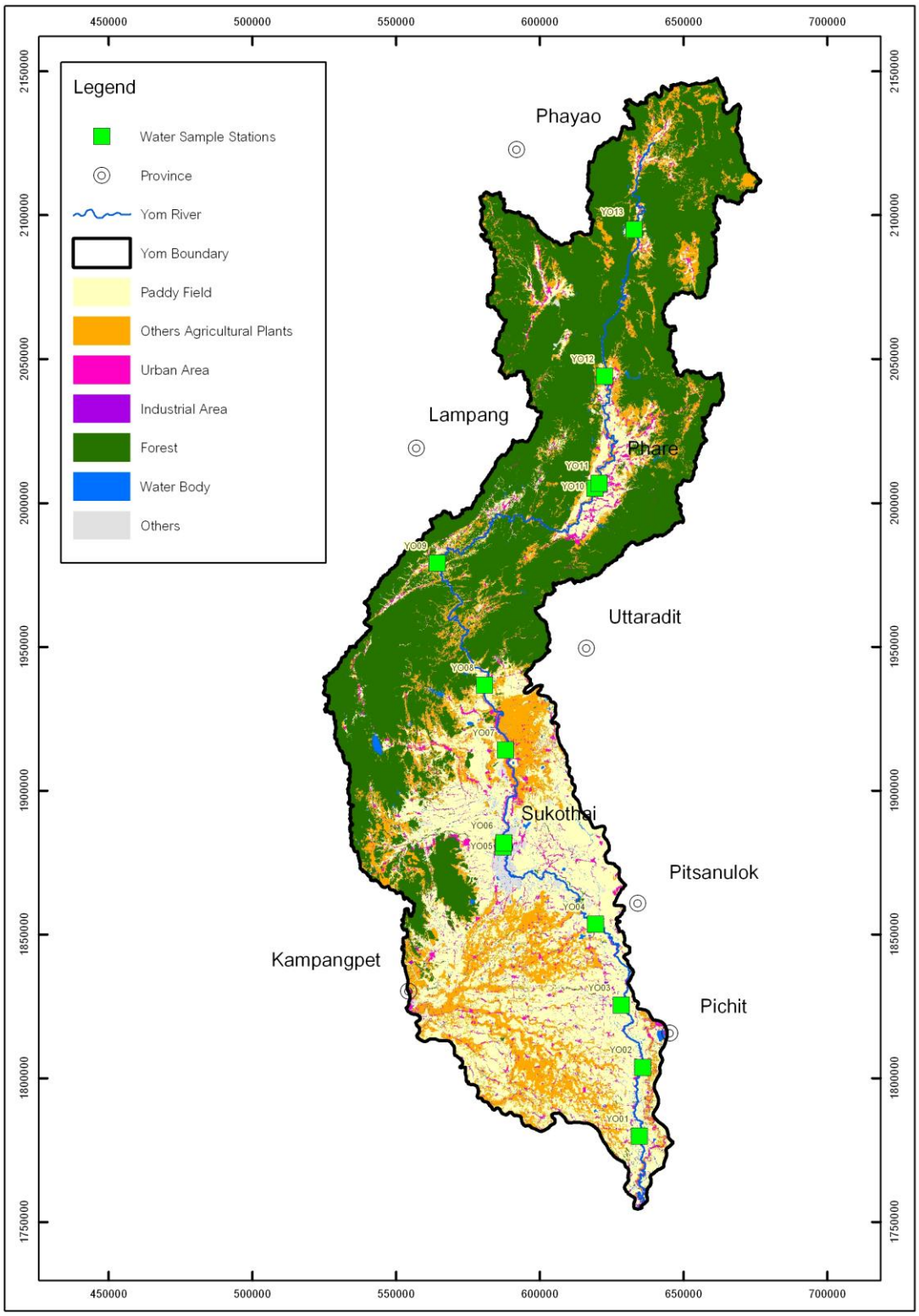

Figure 1. Stations of surface water sample and land use map in Yom river

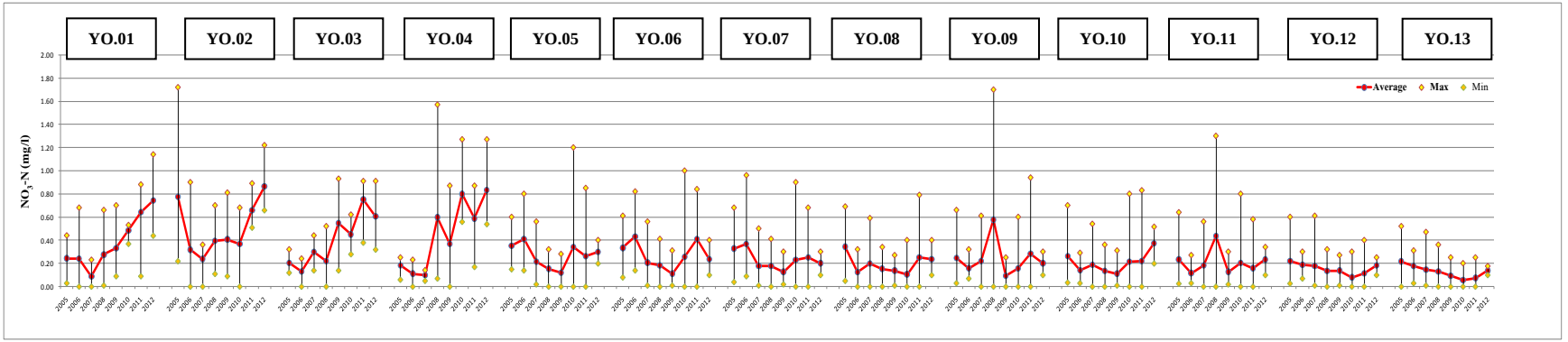

Figure 2. Average, maximum and minimum concentrations of NO_3-N during 2005 – 2012 in Yom river.

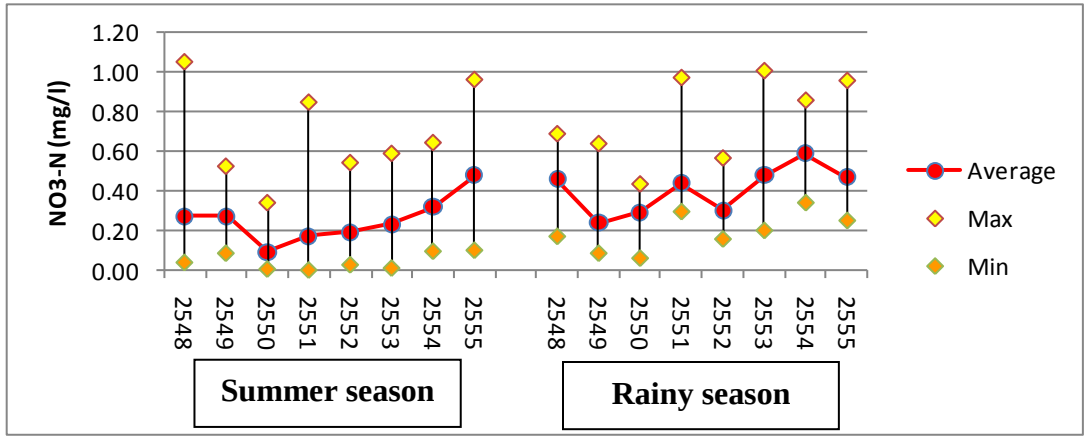

Figure 3. concentrations of NO_3-N on seasonal during 2005 – 2012 in Yom river

RESULTS AND DISCUSSION

The analytical water quality situation of the Yom River during the past eight years (2005-2012) was shown in Fig. 2. Considering the amount of nitrate (NO3-N) measurements with a secondary data in the year 2005 to the year 2011, derived from the Region 2 office environment, Lampang and the region 3 office environment, Pitsanulok and gather together with results conducted by this study in 2012, covering all 13 stations from Phayao province through Wang Chin Phrae province to the Sawankhalok district, Sukhothai and Photalae district in Phijit province.

The concentrations of NO_3-N ranged between 0.38 to 0.50 mg/l. Average maximum and minimum concentrations during 2005 – 2012 of NO_3-N were 0.91 and 0.02 mg/L in Yo.02 (Phopratubchang District, Phijit Province) and Yo.13 (Chingmon District, Phrae Province), respectively. Amount of nitrate concentrations (Figs.2-3) appeared to be clearly increased clearly since Bangrakam District, Phitsanulok Province (YO.04) through Samngam District, Phijit Province (YO.03) Phopratubchang District, Phijit Province (YO.02) to Phothale District, Phijit Province (YO.01)and such nitrate concentration has increasing steadily every year. Unlike the early days of the Yom River (YO.05 to YO.13) to nitrate with similar average 0.21 mg/l. The district is bounded from Chiang Muan, Phayao through down Meuang District, Sukothai However, the amount of nitrate that such analysis is not exceed the surface water quality standards that the criteria should not be more than 5 mg/l.

It was found that there was higher concentration of nitrate in rainy season than in summer. The average nitrate concentration in rainy season was around 0.19 to 0.77 mg/l, while those in summer were around 0.05 to 0.69 mg/l. It should be caused from nitrogen-rich fertilizer, highly used in the beginning of rainy season for productive agriculture (Mishra, A. and Kar, S. 2012.). Nitrates on soil surface may be leached to the river, as well as nitrates from wastewater. The river's high nitrate concentration is harmful to human health through water consumption. As the southern parts of Yom river are agricultural areas such as rice and other crops, surrounded with a number of houses, there is a high increasing tendency of nitrate concentration in the river, which may lead to eutrophication in the foreseeable future (Ratkrow. 2004). According with the amount of nitrate and phosphate in the Kosynthos in the north of Greece with the long river ~ 52 km and catchment area ~ 440 square kilometers, it tended to be occurred eutrophication due to agricultural community and wastewater industry released into the water resources (Vassilios et al. 2009). The overwhelming plants from eutrophication may impede infrastructure systems such as municipal water and transportation on water surface. It may also exploit dissolved oxygen level that affected aquatic ecosystem. For better long-term water quality, it was highly recommended that there must be effective regulations in wastewater management both from agricultural and from households.

CONCLUSION

The average of nitrate found in the lower Yom river were higher than those detected in the upper Yom river and average nitrate concentration in rainy season was higher than that in dry season. This may cause from leaching of fertilizer residues from the two sides of the lower Yom river, which most areas are agricultural areas. Furthermore, most of the cultivation of perennial crops, including the waste water plants in the urbanized areas, situated along the two sides of the lower Yom river, released directly runoff into river. As a result, average nitrate tend to be higher than those in the past and also higher in the lower than those in the upstream river. Therefore, people should concern about water quility and treat waste water before discharging into the river. Furthermore, to appropriately management of landuse plan in the future, the numerical modeling regarding land use management model would be applied.

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