Leaflet no. 41-2020

The Republic of the Union of Myanmar
Ministry of Natural Resources and Environmental Conservation
Environmental Conservation Department
Union Territory, Nay Pyi Taw
Director Office

Assessment of Water Quality of Streams Affected by Urban Land-Use for Sustainable Green City Development: Case Study in Nay Pyi Taw, Myanmar

Ms. Saint, Staff Officer
Mr. Ye Tun, Director
Mrs. Nwe Ni Win, Staff Officer
Ms. Thae Cho Aye, Staff Officer
Mr. Tint Lwin Tun, Deputy Staff Officer

November, 2020

Table of Contents

Assessment of Water Quality of Streams Affected by Urban Land-Use for Sustainable Green City Development: Case Study in Nay Pyi Taw, Myanmar

Daw Saint, Staff Officer
U Ye Tun, Director
Daw Nwe Ni Win, Staff Officer
Daw Thae Cho Aye, Staff Officer
U Tint Lwin Tun, Deputy Staff Officer
Environmental Conservation Department

Abstract

Water quality assessment for ambient water resources is paramount important in order to control water pollution and impact on human health. This paper aims to assess current situations of water quality of streams affected by urban land use expansion in Nay Pyi Taw and to propose policy suggestion for water quality management related urban area concerning sustainable green city development, Nay Pyi Taw. Primary data of water quality parameters: pH, Temperature, Conductivity, Turbidity, Total Dissolved Solid (TDS), Potassium (K^+), Nitrate (NO_3), Sodium (Na^+), Calcium (Ca^+) were collected by using Multi Parameter Water Quality Meter (Horiba,U-52G) and portable analyzers from six sampling points in two main streams which are flowing through Nay Pyi Taw Union Territory all year round, 2019. Moreover, laboratory experimental results of Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were determined. High pH values were observed in dry season October-December. BOD values were observed higher than the guideline values of EPA and Thailand surface water quality standards. The nitrate value is resulted in seasonal and spatial variation due to the greater agricultural farming practices in the dry and rainy season than in the winter season. These results showed that the water quality of sampling point no.3 of Ngalite stream was polluted due to urban wastewater (Grey water) discharging from market and residential area of Pyinmana Township. Thus, this study revealed that urban and agricultural land-use affected nutrients concentration and water quality parameters seasonally and spatially.

Keywords: Water quality parameters, nutrient concentration, urban landuse, sustainable development

စဉ်ဆက်မပြတ်ဖွံ့ဖြိုးသော အစိမ်းရောင်မြို့တော် ဖြစ်ပေါ်လာစေရန် မြို့ပြမြေအသုံးချမှု ကြောင့် နေပြည်တော်အတွင်း ဖြတ်သန်းစီးဆင်းနေသော ချောင်းများ၏ ရေအရည်အသွေး ထိခိုက်နိုင်မှုအား တိုင်းတာအကဲဖြတ်ခြင်း

စိမ့်၊ ဦးစီးအရာရှိ

ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးဦးစီးဌာန

စာတမ်းအကျဉ်း

ရေထုညစ်ညမ်းမှုနှင့် လူတို့၏ကျန်းမာရေးအပေါ်ထိခိုက်မှုတို့အား ကာကွယ်ထိန်းချုပ်နိုင်ရန်အတွက် ပတ်ဝန်းကျင်ရေထုအရည်အသွေး ဆန်းစစ်အကဲဖြတ်ခြင်းသည် အရေးကြီးသောလုပ်ငန်းတစ်ခု ဖြစ်ပါသည်။ ဤလေ့လာမှုသည် ပြည်ထောင်စုနယ်မြေ၊ နေပြည်တော်အတွင်း မြို့ပြ ဧရိယာဖွံ့ဖြိုးလာမှုကြောင့် နေပြည်တော်အတွင်း ဖြတ်သန်းစီးဆင်းနေသော ချောင်းများ၏ ရေအရည်အသွေး ထိခိုက်နိုင်မှုနှင့် လက်ရှိအခြေအနေအား တိုင်းတာ အကဲဖြတ်ခြင်း၊ စဉ်ဆက် မပြတ် ဖွံ့ဖြိုးသော စိမ်းလန်းသော မြို့တော်ဖြစ်ပေါ်စေရန် စံညွှန်းတစ်ခုဖြစ်သည့် မြို့ပြဧရိယာအတွင်း ရေ အရည်အသွေးစီမံခန့်ခွဲမှုနှင့် စပ်လျဉ်း၍ မူဝါဒဆိုင်ရာ အကြံပြုချက်များအဆိုပြုရန် ရည်ရွယ်ပါသည်။ Study area အနေဖြင့် နေပြည်တော်အတွင်းရှိ မြို့နယ်များဖြစ်သည့် ပျဉ်းမနားမြို့နှင့် လယ်ဝေးမြို့နယ်များအတွင်း ဖြတ်သန်းစီးဆင်းလျက်ရှိသော ငလိုက်ချောင်း၊ ပတ္တာချောင်းနှင့် ဆင်အုံကန်တို့တွင် sampling points (၆) နေရာမှကောက်ယူခဲ့သည့် ရေနမူနာများ၏ ရေအရည်အသွေးအား အကဲဖြတ်ခြင်းဖြစ်ပါသည်။ ၂၀၁၈–၂၀၁၉ ခုနှစ်အတွင်း Multi Parameter Water Quality Meter (Horiba, U–50) နှင့် Portable Analyzers တို့အား အသုံးပြု၍ ငလိုက်ချောင်း၊ ပတ္တာချောင်း နှင့် ဆင်အုံကန်

တို့တွင် လစဉ်ကွင်း ဆင်းတိုင်းတာခဲ့သည့် water quality parameters (pH, Temperature, Conductivity, Turbidity, Total Dissolved Solid (TDS), BOD, COD, Potassium (K+), Nitrate (NO3), Sodium (Na+), Calcium (Ca+) ဆိုင်ရာ ကိန်းဂဏန်း အချက်အလက်များအား (U.S.EPA), ASEAN (Thailand, Vietnam) မျက်နှာပြင် ရေထုအရည်အသွေး စံချိန်စံညွှန်းတို့ဖြင့် နှိုင်းယှဉ်အကဲဖြတ်ခြင်း ဖြစ်ပါသည်။ pH, TDS, Dissolved Oxygen (DO) တန်ဖိုးများသည် သတ်မှတ်ထားသော မျက်နှာပြင်ရေထု အရည်အသွေး လမ်းညွှန်ချက် (EPA, ASEAN surface water quality guidelines) တို့နှင့် ကိုက်ညီမှုရှိပြီး BOD နှင့် nutrient တန်ဖိုး NO3 များသည် သတ်မှတ်စံချိန်စံညွှန်းတို့ထက် သိသာစွာ ကျော်လွန်နေပြီး ရာသီဥတုနှင့် နေရာအပေါ်လိုက်ပြီး ပြောင်းလဲမှုရှိကြောင်း လေ့လာတွေ့ရှိရပါသည်။ ရလာဒ်များအပေါ် သုံးသပ်ချက်များအရ sampling point ၆ နေရာအနက် ငလိုက်ချောင်း၏ sampling point no.3 နေရာ(ပျဉ်းမနား မြို့ ဘောဂသီရိကားကွင်းအနီး)သည် အခြားနေရာများထက် ပိုမို ညစ်ညမ်း နေကြောင်း တွေ့ရှိရပါသည်။ နေပြည်တော်(၈)မြို့နယ်မှ လူနေအိမ်ယာများအား အဓိက ရေပေးဝေသည့် အရင်းအမြစ်များမှာ ဆည်များဖြစ်ပြီး အချို့မြို့နယ်များတွင် မြေအောက်ရေ၊ အဝီစိတွင်းရေတို့သုံးစွဲကြသဖြင့် ငလိုက်ချောင်းနှင့် ပတ္တာချောင်းရေသည် စိုက်ပျိုးရေး လုပ်ငန်းများအတွက်သာ အသုံးပြုခြင်း ဖြစ်ပါသည်။ တိုင်းတာရရှိသော ရလဒ်များအရ အဆိုပါ ချောင်းများ၏ ရေအရည်အသွေးသည် စိုက်ပျိုးရေးလုပ်ငန်းများအတွက် သုံးစွဲရန် သင့်တော်သော အခြေအနေတွင်ရှိပါသည်။ အစိုးရအနေဖြင့် စဉ်ဆက်မပြတ် ရေအရည်အသွေး စီမံခန့်ခွဲမှုဆိုင်ရာ မူဝါဒချမှတ်ခြင်း၊ အမျိုးသားအဆင့်၊ တိုင်းဒေသကြီးအဆင့်

လုပ်ငန်းအစီအစဉ်များရေးဆွဲခြင်းတို့ကို ဆောင်ရွက်ထားရှိပြီး ၎င်းအား အကောင်အထည် ဖော်ရာတွင် ဒေသခံပြည်သူ လူထုပူးပေါင်းပါဝင်ရန်မှာအရေးကြီးသော ကဏ္ဍတစ်ခု ဖြစ်ပါသည်။ ဤလေ့လာမှုမှ မြို့ပြဖွံ့ဖြိုးတိုးတက်လာခြင်းသည်ချောင်းများအရ ရေအရည်အသွေးအား ထိခိုက်မှုရှိကြောင်း လေ့လာတွေ့ရှိရသဖြင့် လူနေရပ်ကွက်များမှ စွန့်ပစ်သည့်ရေဆိုးများအား စနစ်တကျ စီမံခန့်ခွဲခြင်း၊ ပြန်လည်သန့်စင်ခြင်း၊ ရပ်ကွက်အလိုက် ရေဆိုးသန့်စင်သည့် ကန်များ တည်ထောင်ပေးခြင်းတို့ကို တိုင်းဒေသကြီးအဆင့် အစိုးရမှ ဆောင်ရွက်ရန် လိုအပ်ပါသည်။ အမျိုးသားအဆင့်အနေဖြင့် စဉ်ဆက်မပြတ် ဖွံ့ဖြိုးတိုးတက်မှု ပန်းတိုင် -၆.၆ (SDG 6.6) အားပြည့်မီရန် ရေချိုဂေဟစနစ် ထိန်းသိမ်းခြင်း၊ ရေချိုရရှိသည့် အရင်းအမြစ်များဖြစ်သည့် သစ်တောများ၊ ရေဝေရေလဲဒေသများနှင့် ဆက်စပ်သည့် ဂေဟစနစ်များ ထိန်းသိမ်းခြင်း လုပ်ငန်းများအား မြို့ပြမြေအသုံးချမှု အစီအစဉ်တွင်ပေါင်းစပ် ဆောင်ရွက်သင့်ပါကြောင်း အကြံပြုထားပါသည်။

Assessment of Water Quality of Streams Affected by Urban Land-Use for Sustainable Green City Development: Case Study in Nay Pyi Taw, Myanmar

1. Introduction

Clean water access is one of the key indicators of environmentally sustainable cities development and identifies as one goal in Sustainable Development Goals (SDGs) as well. Water quality varies significantly according to different ecosystems, land use pattern and human intervention [1]. Water contamination can be caused by human activities in two main ways: point sources and non-point sources [2]. Pollution control requires a better understanding of water quality and the impact by land use particularly during urbanization [3]. Rapid urban development is the main causes of serious environmental degradation related to air and water pollution [4]. In urban areas, the main sources of water pollution are untreated sewage, industrial and household wastes directly discharges into water bodies. Therefore, urban areas development has the potential that can impact on ecology and environment at a great extent.

The key indicators of Sustainable Green City Development are clean air, clean water and clean land. Sustainable management of water and improve water quality by reducing pollution is identified as a goal in Sustainable Development Goals: SDG-6. This study focus on water resources and associated land uses particularly urban area and its impact on water quality. In the context of Nay Pyi Taw, Nay Pyi Taw city has been awarded the Environmentally Sustainable Cities (ESC) award in 2017. In order to maintain this situation, the water quality of two main streams flowing through the Nay Pyi Taw Union Territory will be assessed by comparing with international standards such as WHO drinking water quality and ASEAN (Thailand and Vietnam) surface water quality standards to reveal the current situation and impacts of urban land use. The results will be evidence to support the improvement of sustainable green city development.

The integration of environmental considerations into the development process is the sustainable way to enhance the quality of life of all its citizens (NSDS, 2009) [6]. Sustainable management of water resources has become a major concern in many countries since it can affect human health and the sustainability of agriculture (NSDS, 2009) [6]. Correlation between land use change and water quality has been studied in previous several researches. Thus, this study focuses on water quality management as a key indicator in order to achieve sustainable green city development of Nay Pyi Taw.

At present day, population pressure is leading factor for land use changes such as urban development and agricultural land expansion. As a consequence, environmental quality (air and water) degradation occurs, especially, water pollution is becoming the most important issue for human’s well-being and directly impact on ecosystem health as well. In Nay Pyi Taw, the Ngalite stream provides natural freshwater resource for agricultural purposes and recreation facilities. Thus, water quality assessment, management and monitoring plan are required to conduct by relevant organization in order to control water pollution and specific water quality standards for surface water (ambient) is important to specify in order to support effective management of water resources. This study aims to assess current situations of water quality of streams affected by urban land use in Nay Pyi Taw and to propose policy suggestion for water quality management in urban area concerning sustainable green city development, Nay Pyi Taw.

2. Objectives

- To assess current situations of water quality of streams affected by urban land use in Nay Pyi Taw
- To propose policy suggestion for water quality management in urban area concerning sustainable green city development, Nay Pyi Taw.

3. Materials and Methods

3.1 Study area

Naypyidaw is located between the Bago Yoma and Shan Yoma mountain ranges in central part of Myanmar with a total area of 7,054.37 km^2 (2,723.71 sq mi) and geographic coordinates are 19.75 Latitude and to 96.13 Longitude. The major freshwater resources for residential area receive from the Chaungmagyi Dam which is located to the northern part of Naypyidaw, the Ngalite Dam is at the south and the Yezin Dam in the north-east of Naypyidaw. Average temperature is determined as 36-40 °C in summer (March-May), 30-32 °C in rainy season (June-September), 14-29 °C in winter (November-February). Average rainfall amount are 2-1.3 inches (January-April), 5.2-9.0 inches (May-October), 0.3-1.5 inches (November-February). In residential area, a total population is 1,109,630 in Nay Pyi Taw Union Territory.

The study area is selected six sampling points in two streams namely Ngalite stream and Patta stream which are flowing through Nay Pyi Taw Union Territory and Sin Ohn lake. Three sampling points of Ngalite stream flowing through Pyinmana township and two sampling points of Patta stream flowing through Lawe township are selected to measure water quality because that places located near residential area. The location map of study area is shown in Figure (1).

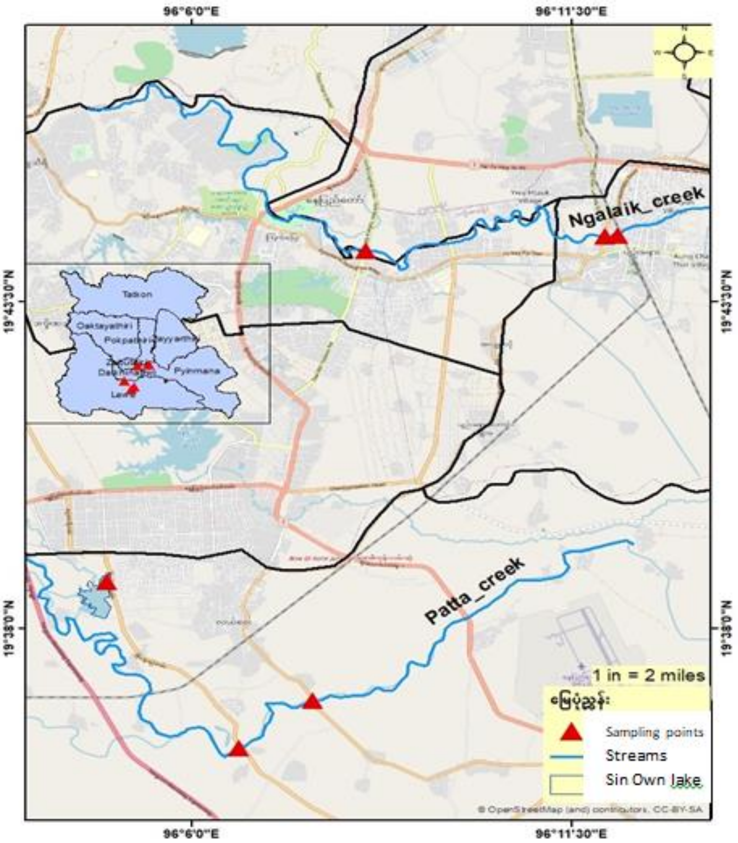

Figure 1. Location map of study area

3.2 Data collection

Desk study conducted to collect baseline information of water quality management and policy from various resources such as scientific records, academic research papers, and article in the study area. Quantitative Methods was applied for data collection. Primary data of water quality were collected from six sampling points in two main streams flowing through Nay Pyi Taw Union Territory all year round (2019). Multi Parameter Water Quality Meter (Horiba, U-52G) and portable analyzers were applied to measure water quality parameters: pH, Temperature, Conductivity, Turbidity, Total Dissolved Solid (TDS) and nutrients level: Potassium (K), Nitrate (NO_3), Sodium (Na^+), Calcium (Ca^+). Moreover, experimental results of Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) in laboratory were statistically analyzed to assess amount of oxygen available in water for survival of aquatic organisms.

3.3 Data analysis

The descriptive statistics was used to reveal the seasonal and spatial variation of the values of water quality parameters, and analyze the collected water quality data by comparing the standard values of EPA and ASEAN surface water quality as an assessment strategy. The results are interpreted through percentages, text, graphs and figures.

4. Results and Discussion

4.1 Seasonal and spatial variation of water quality of Ngalite and Patta streams

The pH value of water body is an important indicator to assess water quality because it can determine the solubility, nutrients (phosphorus, nitrogen, and carbon) and heavy metals [7]. For example, metals tend to be more toxic at lower pH because they are more soluble [7]. In this study, the pH value of water samples in six sampling points was determined by seasonally. The pH value of water samples of two streams were observed 8.00 - 8.34 in October to December, 7.17 - 7.74 in June to September, 7.02 – 7.65 in February to May (Figure 2). High pH values were observed in dry season whereas pH values were stable in rainy season. These results showed that the water quality of the two streams was slightly alkaline in winter season. However, the average annual value of pH is being within the optimum range of EPA (6.5-8.5) and ASEAN (5.5-9) surface water quality standards.

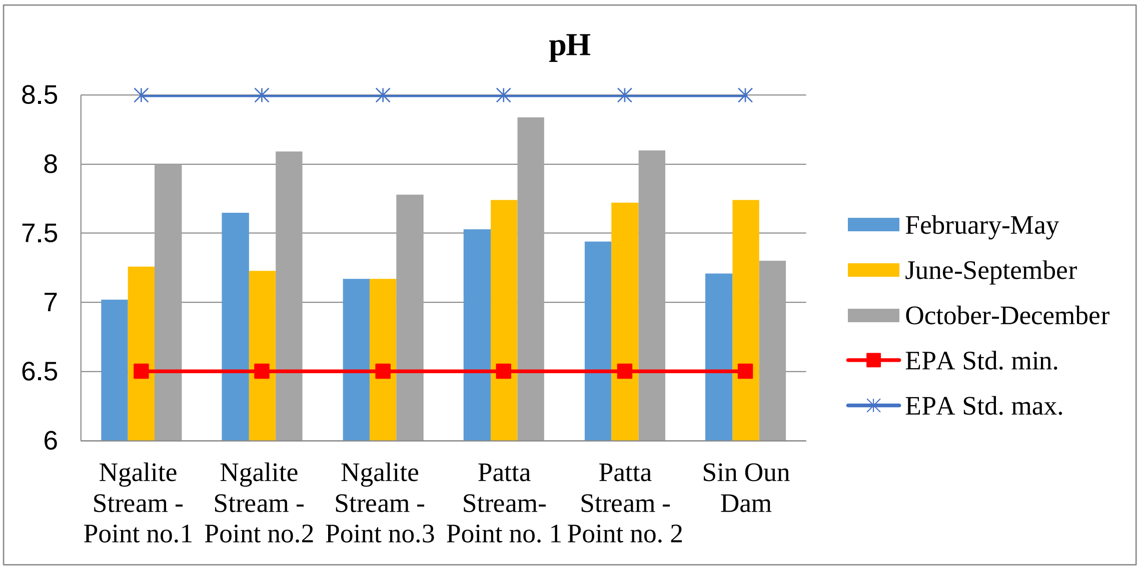

Figure 2. Seasonal variation of pH value in Ngalite and Patta streams

Average annual values of Total Dissolved Solids (TDS) in six sampling points, 243.42 mg/L, 290.27 mg/L, 310.18 mg/L, 191.36 mg/L, 245.73 mg/L, 125.91 mg/L respectively, were determined under the guideline value of EPA standard ($\leq$ 500 mg/L). However, in Ngalite stream, the TDS value was higher in March than other months and it exceeded the guideline value of EPA standard in March.

Dissolved oxygen enters the water from the atmosphere and through the photosynthesis by aquatic plants, and is depleted through chemical oxidation and respiration by aquatic animals and microorganisms, especially during the decomposition of plant biomass and other organic material [9]. Dissolved oxygen (DO) and pH are the critical indicators of water quality for the survival of aquatic plants and animals. The DO values of stream water were examined in the range of 5.2 - 6.25 in March and April. These values are > 4 which is acceptable level of EPA standard and Thailand surface water quality standard.

The amount of dissolved oxygen in water can vary seasonally, and decreases with higher temperature, salinity, and depth. The maximum solubility of oxygen in water at 1 atm pressure (standard air pressure at sea level) ranges from about 15 mg/L at 0°C to 8 mg/L at 30°C, that is, ice-cold water can hold twice as much dissolved oxygen as warm water [9]. Warm water is less capable of holding dissolved oxygen. For this reason, temperature should be measured at the same place within the stream at which dissolved oxygen is measured. This allows the correlation between the two parameters to be observed. The problem of low dissolved oxygen levels is caused by increasing the metabolic rates of aquatic plants as water temperature rises, thus increasing their biochemical oxygen demand.

Biochemical oxygen demand (BOD) means the amount of oxygen consumed by bacteria and other microorganisms while they decompose organic matter under aerobic (oxygen is present) conditions at a specified temperature [7]. BOD is a measure of the amount of oxygen required to remove waste organic matter from water in the process of decomposition by aerobic bacteria. High level of BOD value indicates the high amount of organic matter present in water. High BOD levels affect dissolved oxygen (DO) levels by decreasing the oxygen available in water is consumed by the bacteria. Then less dissolved oxygen available in water can impact the survival of aquatic organisms. The causes of high BOD value are related to high level of nitrate present, organic pollution and untreated wastewater discharged.

In the study area, the average annual value of BOD in Nalite stream was examined as 9.50 mg/l of sampling point no.1, 13.50 mg/l of sampling point no.2, 15.45 mg/l of sampling point no.3 and 6.14 mg/l of sampling point no.1 and 9.29 mg/l of sampling point no.2 in Patta stream. These amounts of BOD were observed higher than the guideline values of EPA and Thailand surface water quality standards (Figure 3). The sampling point no.3 of Ngalite stream was determined the highest average annual value of BOD than other places and the high level of nitrate value as well. The reason could be wastewater (Grey water) from market and residential area of Pyinmana township discharging into the Ngalite stream, the sampling point no.3, located in that area. Therefore, the water quality of sampling point no.3 of Ngalite stream was assessed as pollution occurred.

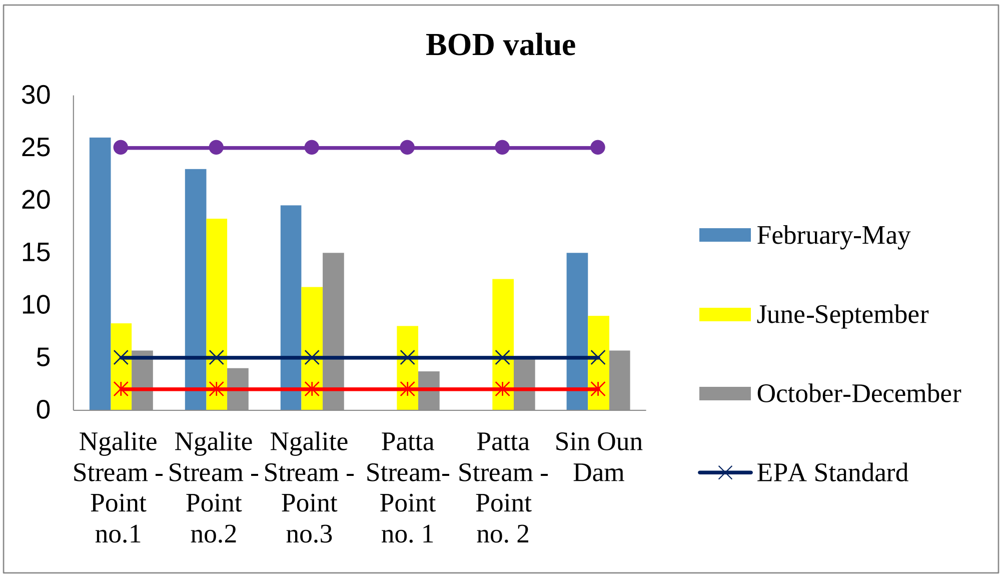

Figure 3. Seasonal variation of BOD value in study area

COD is normally higher than BOD because more organic compounds can be chemically oxidized than biologically oxidized [10]. In the study area, the highest value of COD was observed 119.2 mg/l in February to May for sampling points in Ngalite stream. The highest average annual value of COD was examined 105.69 mg/l for sampling point no.2 in Ngalite stream. There was bridge construction site at sampling site no. 2, Pyinmana township. It could be the reason of higher COD level in water sample of that sampling point. All COD values of water samples were exceeding the standard of 10 mg/l of EPA standard.

Table 1. Water Quality Parameters of Six Sampling Sites in Nay Pyi Taw (2019)

Parameters	**Sampling Sites**	**Season**			**Standard**	
		Feb.-May	June-Sept.	Oct.-Dec.	**EPA**	**ASEAN**
pH (Mean± SD)	Point 1	7.02±0.49	7.26±0.45	7.96±0.25	6.5–8.5	5-9 (Thai) 5.5-9 (Vietnam)
	Point 2	7.65±0.79	7.23±0.46	8.09±0.05		
	Point 3	7.17±0.61	7.17±0.52	7.78±0.27		
	Point 4	7.53±0.72	7.74±0.22	8.34±0.40		
	Point 5	7.44±0.83	7.72±0.13	8.10±0.06		
	Point 6	7.21±1.06	7.74 ± 0.44	7.30±0.27		
Temperature	Point 1	32.55	25.34	30.2	NC	NC
	Point 2	32.31	24.81	31.73		
	Point 3	33.64	25.89	28.63		
	Point 4	31.34	24.65	31.22		
	Point 5	31.50	24.03	30.12		
	Point 6	30.64	23.79	30.23		
Total	Point 1	312.5±197.45	188±73.26	230±15.52	≤500	

Dissolved Soilds (mg/l) (Mean±SD)	Point 2	430.25±216.89	190±59.2	237±10.97		
	Point 3	445	210±76.68	264±2		
	Point 4	131±89.5	180±55.98	288±10.6		
	Point 5	272	190±48.67	285±16.37		
	Point 6	93.26	108±52.69	194±14.73		
Oxidation Reduction Potential (ORP)	Point 1	289	314	376.33	**NC**	**NC**
	Point 2	272.75	322.5	373.33		
	Point 3	227.25	307.5	366.67		
	Point 4	226.5	338.75	405.67		
	Point 5	181	329	377.33		
	Point 6	154	281	254.67		
Turbidity (NTU) (Mean±SD)	Point 1	22±5.31	169.75±7.37	43.67±4.51	<700	15
	Point 2	46.45±22.54	137.25±18.08	89.17±2.61		
	Point 3	64.95±26.13	92.13±5.75	87.1±5.21		
	Point 4	78.95±28.43	870.5±44.28	333±321.05		
	Point 5	102.5±14.18	900.5±132.57	336±130.22		
	Point 6	20.5±2.29	84.1±3.72	30.03±1.16		
Salinity (ppt) (Mean±SD)	Point 1	0.25±0.17	0.55±0.77	0.63±0.75	NC	NC
	Point 2	0.26±0.15	0.5±0.67	0.77±0.98		
	Point 3	0.33±0.19	0.48±0.55	0.83±1.09		
	Point 4	0.3±0.12	0.5±0.73	0.73±0.92		
	Point 5	0.3±0.12	0.55±0.77	0.73±0.92		
	Point 6	0.1±0.05	0.33±0.52	0.47±0.64		
BOD (mg/l) (Mean±SD)	Point 1	26	8.25±1.89	5.67±0.57	5	2 (Thai) <25 (Vietnam)
	Point 2	23	18.25±12.45	4±3.36		
	Point 3	19.5	11.75±9.18	15±6.93		
	Point 4		8±2.94	3.67±0.58		
	Point 5		12.5±6.95	5±1.73		
	Point 6	15	9±2.94	5.67±2.89		
COD (mg/l) (Mean±SD)	Point 1	118.4	75.85±21.05	96±36.37	10	40 (Thai) <35 (Vietnam)
	Point 2	119.2	118.83±93.72	83.67±56.58		
	Point 3	116	50.23±26.04	105.6±85.91		
	Point 4		49.8±18.20	115±67.55		
	Point 5	20.64	27.38±21.41	71.67		
	Point 6	25.32	28.33±19.30	58		

Point 1, 2, 3: Ngalite stream, Point 4, 5: Patta stream, Point 6: Sin Oun Lake

NC= Not of concern

4.2 Nutrients concentration of water samples

Nutrients concentration in water body is influenced by the land-use pattern in surrounding area. Nitrate (NO_3) and potassium (K^+) are the nutrient parameters of water quality particularly derived from agricultural farming by using chemical fertilizer. According to the results, the nitrate concentration in water sample exceeds the guideline value of EPA and ASEAN standards. In seasonally, the nitrate value in two streams were higher in dry season and monsoon (February to September) than winter (October to December). In this study, average nitrate values were observed to be 27.5 -75.5 ppm in hot season, 38.25- 59.25 ppm in rainy season and 5.67-6.67 ppm in cold season (Figure 2). This study showed that nitrate level is higher in dry season and rainy season than the cold season. This could be attributed to the greater agricultural farming practices in the dry and rainy season than in the winter season.

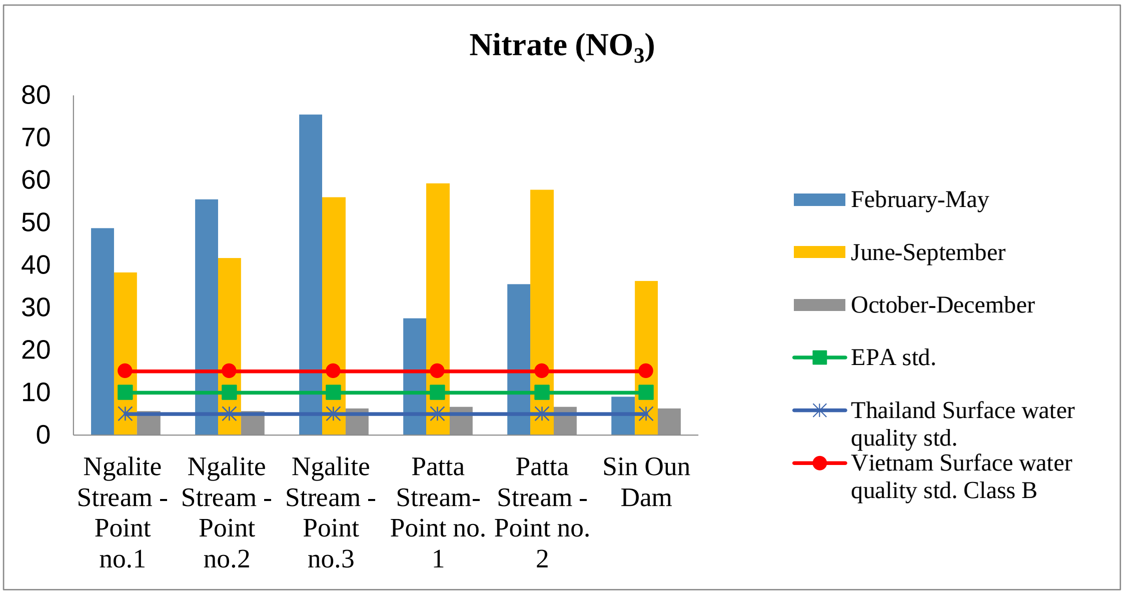

Figure 4. Seasonal and spatial variation of nitrate value in study area

Moreover, the nitrate value in the two streams, Ngalite and Patta, were higher than the Sin Oun lake because there are agricultural farming surrounding these two streams. It means that the nitrate value is resulted in seasonal and spatial variation. The highest nitrate concentrations were observed in sampling point no.3, Ngalite stream flowing through Pyinmana township. Discharging wastewater including large amount of organic wastes, and other wastes like sewage disposal from market and residential area could be the reason of the higher results in the sampling point no.3 comparing with other places.

An excess amount of nitrogen in a waterway may lead to low levels of dissolved oxygen and negatively alter various plant life and organisms. Nitrate pollution in water often impacts aquatic ecosystems and the causes are due to natural and/or human intervention such as discharged wastewater waste: septic tank systems and landfills, intensive husbandry, agricultural farming practices with nitrate over application of manure, chemical fertilizers [11,12]. Nitrate guideline value for drinking water established by the World Health Organization (WHO, 2006) is 50 mg/L, EPA standard recommends 10 mg/L in drinking water, and ASEAN standards set 5 mg/L in Thailand and 15 mg/L in Vietnam in surface water. Nitrate levels from 0 – 40 ppm are generally safe for fish but it can be toxic if it will be greater than 80 ppm.

When a significant rainwater component was present; relatively high concentrations were measured in waters draining cultivated and farmed areas and were associated to relatively high potassium (K^+) contents [12]. Nutrient parameters correlate directly with rainfall due to water runoff [13]. Heavy rainfall can cause nutrient loads in water bodies by runoff from residential and agriculture area, as a result it affected on water quality [14]. These observations prove that there is seasonal variation of nitrate transport in surface water.

Higher concentration of nitrate in water body occurs due to draining mostly from agricultural and farming practices in surrounding areas. Therefore, appropriate management of livestock manure and suitable use of fertilizers will help for controlling nitrate accumulation in the soil, and also reducing its transport by leaching. Supply of Nitrogen may be restricted for agriculture activity where the high concentrated aquifer water is found [15].

Sodium (Na^+) concentration was observed that it exceeded the acceptable level of EPA drinking water standard. The average annual values of sodium were examined of 214.5 ppm, 232.78 ppm, 237.44 ppm, 181.86 ppm, 180.71 ppm, 120.29 ppm in six sampling points respectively. These values are higher than 30 to 60 mg/L of EPA drinking water standard. Hence, the water quality of sampling area was not suitable for drinking without specific treatment.

Calcium carbonate concentrations in water body below 60 mg/l is generally considered as soft; 60–120 mg/l, moderately hard; 120–180 mg/l, hard; and more than 180 mg/l, very hard (McGowan, 2000). The maximum and minimum levels of calcium (Ca^+) are 40–80 ppm (WHO, 2003). The average annual values of calcium were examined of 33.56 ppm, 33.11 ppm, 35.11 ppm, 35.43 ppm, 33.29 ppm, 20.71 ppm in six sampling points respectively. Hence, these values were under the range of acceptable level of EPA and WHO standard.

Table 2. Nutrient Parameters of Six Sampling Sites in Nay Pyi Taw (2019)

Parameters	Sampling Sites	Season			Standard	
		February-May	June-September	October-December	EPA	ASEAN
Calcium (Ca^+)	Point 1	14.75	54	17.33	NC	NC
	Point 2	18	51.5	18.33		
	Point 3	22.25	52.5	20		
	Point 4		46.75	20.33		
	Point 5		43.75	19.33		
	Point 6		25.5	14.33		
Potassium (K^+)	Point 1	2	295.25	12.67	NC	NC
	Point 2	1.5	234.75	12.33		
	Point 3	2.5	424	20		
	Point 4		327.5	12.33		
	Point 5		284.5	21.67		
	Point 6		237.75	11.67		
Nitrate (NO_3) (Mean±SD)	Point 1	48.75±1.5	38.25±30.51	5.67±0.58	10	5 (Thai)
	Point 2	55.5±6.35	41.75±29.97	5.67±0.58		15
	Point 3	75.5±10.97	56±58.23	6.33±0.58		(Vietnum)
	Point 4	27.5±27.14	59.25±36.12	6.67±1.53		
	Point 5	35.5±35.22	57.75±33.17	6.67±1.15		
	Point 6	9±2.31	36.25±29.51	6.33±0.58		
Sodium (Na^+)	Point 1	300	244.5	119.33	NC	NC
	Point 2	280	270.5	121		
	Point 3	315	291	147.67		
	Point 4		222.5	127.67		
	Point 5		221.25	126.67		
	Point 6		154	75.33		

Point 1, 2, 3: Ngalite stream, Point 4, 5: Patta stream, Point 6: Sin Oun Lake
NC= Not of concern

5. Limitation

To collect water quality data, only two streams (Ngalite and Patta streams) was selected to study among three main streams and one river because of limitation of staff, and transportation facility. Water quality parameters (pH, Temperature, Conductivity, Turbidity, TDS, DO and nutrients level: Potassium (K), Nitrate (NO_3), Sodium (Na^+), Calcium (Ca^+)) were assessed by using only portable devices: Multi Parameter Water Quality Meter (Horiba U-52G, Japan) and portable nutrient analyzer equipment and there was no laboratory experiment. Only BOD and COD parameters were experimented in laboratory. Heavy metal cannot be measured by these portable devices. In EPA and ASEAN guidelines, there is no standard value for some nutrient parameters such as Calcium (Ca^+), Potassium (K^+), Sodium (Na^+), thus, it can be assessed with acceptable level. Water depth may slightly affect the value of water quality parameters. In the field work, we can collect water sample data in shallow part of the streams because of limitation of transportation facility.

6. Conclusion and recommendations

This study revealed that the average annual values of pH in six sampling points are being within the optimum range of EPA (6.5-8.5) and ASEAN (5.5-9) surface water quality standards and suitable for irrigation and aquatic life. The amount of BOD values were observed higher than the guideline values of EPA and Thailand surface water quality standards. All COD values of water samples were above the standard of 10 mg/l of EPA standard. The nitrate (NO_3) value is resulted in seasonal and spatial variation. The highest nitrate (NO_3) concentrations were observed in sampling point no.3, Ngalite stream flowing through Pyinmana township. These results showed that urban and agricultural land use affect nutrients concentration and water quality parameters seasonally and spatially. Therefore, this study suggests that the stream water is suitable condition for agriculture and irrigation purpose but it could not be used for drinking purpose.

The regional government should implement domestic wastewater management and build wastewater treatment systems for residential area in Pyinmana township. The National level government should implement integrated urban management including protection and restoration of water-related ecosystems, including forests, wetlands, rivers, aquifers and lakes in order to fulfill SDG – 6.6.

7. Acknowledgements

We would like to express sincere gratitude to U Hla Maung Thein, Director General of Environmental Conservation Department, Ministry of Natural Resources and Environmental Conservation for giving an opportunity to conduct this research. Furthermore, we also deeply appreciate our colleagues and staff for supporting information and facilitating during data collection period.

8. References

(1) L.L. Xia, R.Z. Liu∗ , Y.W. Zao. Correlation Analysis of Landscape Pattern and Water Quality in Baiyangdian Watershed. The 18th Biennial Conference of International Society for Ecological Modeling. Procedia Environmental Sciences 13 (2012) 2188 – 2196

(2) Saroj Gyawalia, Kuaanan Techatoa, Chumpol Yuangyaib, Charongpun Musikavongc. Assessment of relationship between land uses of riparian zone and water quality of river for sustainable development of river basin, A case study of U-Tapao river basin, Thailand. 2012

(3) Li S, Gu S, Tan X, Zhang Q. Water quality in the upper Han River basin, China: The impacts of land use/land cover in riparian buffer zone, Journal of Hazardous Materials 2009;165:317-324.

(4) Rashid, M., M. Manzoor, and S. Mukhtar, *Urbanization and Its Effects on Water Resources: An Exploratory Analysis.* Asian Journal of Water, Environment and Pollution, 2018. **15**: p. 67-74.

(5) Gyawali, S., et al., *Integrating land use and water quality for environmental based land use planning for U-tapao river basin, Thailand.* Procedia-Social and Behavioral Sciences, 2013. **91**: p. 556-563.

(6) National Sustainble Development Strategy (NSDS), Ministry of Natural Resources and Environmental Conservation, 2009

(7) The United States Geological Survey (USGS). pH and water. https://www.usgs.gov/special-topic/water-science-school/science/ph-and-water?qt-science_center_objects=0#qt-science_center_objects

(8) *United States. Environmental Protection Agency. Office of Water. (1994). Water quality standards handbook : appendixes. U.S. Environmental Protection Agency, Office of Water. OCLC 32672770.*

(9) Wetzel, R.G. (2001) Limnology: Lake and River Ecosystems. Third Edition, Academic Press, San Diego, 1006 p.

(10) https://www.butlerms.com/faq-items/what-is-the-difference-between-cod-and-bod/

(11) Canter L.W. Nitrates in groundwater. CRC Press, (1997) Lewis Publishers, London.

(12) KJ, R. K., & Prasad, T. R. (2014). Seasonal variation of nitrate in natural water of bangalore north. *International Journal*, *2*(11), 1120-1122.

(13) Prathumratana, L., Sthiannopkao, S. and Kim, W. K. (2008). The relationship of climatic and hydrological parameters to surface water quality in the lower Mekong River. Journal of Environmental International, 34, 6, 860-866.

(14) Qian, Y., Migliaccio, K. W., Wan, Y., and Li, Y. (2007). Trend analysis of nutrient concentration and loads in selected canal for the southern Indian River lagoon, Florida. Journal of Water, Air and Soil Pollution, 186, 1-4, 195-208

(15) Hooda, P.S., A.C. Edwards, H.A. Anderson, A. Miller,(2000) A review of water quality concerns in livestock farming areas. Science Total Environment 250, 143-167,