การกระจายตัวของคุณภาพน้ำเชิงพื้นที่และแนวทางการจัดการน้ำสำหรับมหาวิทยาลัย

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วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตร
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มหาวิทยาลัยราชภัฏวไลยอลงกรณ์ ในพระบรมราชูปถัมภ์
พ.ศ. 2565

SPATIAL DISTRIBUTION AND WATER QUALITY MANAGEMENT GUIDELINE FOR UNIVERSITY

RASHMI CHETIA

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF SCIENCES
IN INNOVATION OF ENVIRONMENTAL

GRADUATE SCHOOL
VALAYA ALONGKORN RAJABHAT UNIVERSITY
UNDER THE ROYAL PATRONAGE PATHUM THANI
2022

THESIS APPROVAL

GRADUATE SCHOOL

VALAYA ALONGKORN RAJABHAT UNIVERSITY

UNDER THE ROYAL PATRONAGE PATHUM THANI

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รัศมี ไชเดีย. (2565). การกระจายเชิงพื้นที่ของคุณภาพน้ำและแนวทางการจัดการน้ำสำหรับมหาวิทยาลัย. วิทยาศาสตรมหาบัณฑิต สาขาวิชานวัตกรรมการจัดการสิ่งแวดล้อม. อาจารย์ที่ปรึกษา : ผศ.ดร.วนัสพรรัศม์ สวัสดี ผศ.ดร.อนัญญา โพธิ์ประดิษฐ์

บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อ 1) ตรวจสอบสภาพของคุณภาพน้ำในมหาวิทยาลัยราชภัฏวไลยอลงกรณ์ฯ และ 2) ตรวจสอบและประเมินคุณภาพน้ำที่สถานีวิกฤตในมหาวิทยาลัยราชภัฏวไลยอลงกรณ์ฯ เก็บตัวอย่างน้ำทั้งหมด 16 แหล่งน้ำภายในมหาวิทยาลัย ประกอบด้วย รางระบายน้ำ คลองขุด และบ่อขนาดใหญ่ โดยตัวอย่างน้ำจะถูกวิเคราะห์โดยวิธีมาตรฐาน 23rd Edition พารามิเตอร์ตรวจวัดคุณภาพน้ำประกอบด้วย ค่าพีเอช ค่าออกซิเจนละลาย ไนไตรท์ ไนเตรท แอมโมเนีย ฟอสเฟต และไนโตรเจนในรูปทีเคเอ็น ตรวจวัดคุณภาพน้ำเป็น ในช่วงระยะเวลา 4 เดือน คือ เดือนพฤศจิกายน 2563 มกราคม 2564 มีนาคม 2564 และ มิถุนายน 2564 เก็บตัวอย่างเป็นในช่วงเวลาเดียวกัน (10:00-12:00 น.) เพื่อลดความคาดเคลื่อนของชุดข้อมูล

ผลการวิจัยพบว่า 1) คุณภาพน้ำในช่วงปิดทำการเนื่องจากสถานการณ์โควิด-19 พบว่า ค่าพีเอชในแหล่งน้ำทุกสถานีอยู่ในช่วง 7.8-8.7 ค่าออกซิเจนละลายมีค่าผันแปรในช่วงระยะเวลา โดยเดือน มี.ค. 2564 มีค่าออกซิเจนละลายสูงสุด 6.3 ±1.4 มก. ต่อลิตร และในเดือน มิ.ย. 2564 มีค่าออกซิเจนละลายต่ำสุด 4.5 ±1.4 มก. ต่อลิตร นอกจากนี้มีการตรวจพบการแปรผันเชิงพื้นที่ของไนไตรท์ที่มีค่าความเข้มข้นของไนไตรท์สูงบริเวณสถานีใกล้โรงอาหารและหอพัก เมื่อเปรียบเทียบกับสถานีอื่น (F-test: P> 0.05) การแปรผันเชิงเวลาของไนเตรทนั้น พบว่า เดือน ม.ค. 2564 มีค่าสูงสุด 9.8±0.5 มก. ต่อลิตร และในเดือน มิ.ย. 2564 มีค่าต่ำสุด 7.7±0.6 มก. ต่อลิตร และในส่วนฟอตเฟต เดือน มิ.ย. 2564 มีค่าสูงสุด 3.4±1.9 มก.ต่อลิตร เดือนมี.ค. 2564 มีค่าต่ำสุด 1.6±1.0 มก. ต่อลิตร และในส่วนแอมโมเนีย เดือน พ.ย. 2563 มีค่าสูงสุด 2.0±1.6 มก. ต่อลิตร และในเดือน มิ.ย. 2564 นั้น มีค่าน้อยกว่า 0.6 มก. ต่อลิตร 2) การตรวจสอบและประเมินคุณภาพน้ำในสถานีวิกฤติ พบว่า มีการแปรผันเชิงเวลาของคุณภาพน้ำในสถานีที่มีความวิกฤติ ในช่วงปิดทำการเนื่องจากสถานการณ์โควิด-19 นั้นส่งผลดีต่อคุณภาพน้ำ เนื่องจากกิจกรรมการซักล้างต่าง ๆ ลดลง อย่างไรก็ตามยังพบค่าไนโตรเจนในรูปทีเคเอ็นสูงในช่วงการปิดทำการครั้งที่ 1 คือ เดือน พ.ย. 2563 (0.9-26.9 มก.ต่อลิตร) มากกว่าเมื่อเปรียบเทียบกับค่าไนโตรเจนในรูปทีเคเอ็นในเดือน ม.ค. มี.ค. ซึ่งเป็นช่วงเวลาเปิดทำการ และปิดทำการในครั้งที่ 2 ตามลำดับ เนื่องจากก่อนการปิดทำการครั้งแรกนั้นมีการปล่อยมลพิษทางน้ำเป็นเวลานานจึงเกิดการสะสมของมลพิษในแหล่งน้ำอย่างต่อเนื่อง ซึ่งจากการศึกษาการกระจายตัวของคุณภาพน้ำ พบว่า ไนเตรท ไนไตรท์ และฟอตเฟต มีความซับซ้อน อย่างไรก็ตามแหล่งที่มาหลักของสารประกอบฟอสฟอรัสและไนโตรเจนนั้นมาจากกิจกรรมการซักล้างจากโรงอาหารและหอพัก แม้ว่าสารประกอบฟอสฟอรัสและไนโตรเจนเป็นธาตุอาหารสำหรับการเจริญเติบโตของสิ่งมีชีวิตในแหล่งน้ำ แต่สารประกอบเหล่านี้ยังสามารถนำไปสู่การเกิดปรากฏการณ์ยูโทรฟิเคชัน และผลกระทบอื่น ๆ ต่อสภาพแวดล้อมในแหล่งน้ำ ซึ่งอัตราส่วนของสารประกอบไนโตรเจนต่อฟอสฟอรัสในแหล่งน้ำนั้นมีความสำคัญต่อปัจจัยจำกัด และควบคุมการเกิดปรากฏการณ์สาหร่ายเจริญเติบโตมากเกินไป ปรากฏการณ์ต่าง ๆ เหล่านี้แสดงให้เห็นว่าการลดการทำกิจกรรมซักล้างต่าง ๆ ภายในมหาวิทยาลัย สามารถนำไปสู่คุณภาพน้ำที่ดีขึ้นของแหล่งน้ำในมหาวิทยาลัยราชภัฏวไลยอลงกรณ์ฯ

องค์ความรู้ที่ได้จากการวิจัยในครั้งนี้ คือ จากผลการวิจัยทั้งหมดถูกนำมาใช้ในการจัดทำคู่มือแนวทางการจัดการน้ำในมหาวิทยาลัยโดยคู่มือนี้เจ้าหน้าที่ของมหาวิทยาลัยสามารถใช้เป็นแนวทางในการประเมินสถานการณ์น้ำเสียที่จะเกิดขึ้นในแหล่งน้ำของมหาวิทยาลัย และสามารถใช้สำหรับนักศึกษาในรายวิชาสิ่งแวดล้อม อีกทั้งคู่มือนี้ยังเป็นเอกสารที่สามารถนำไปสู่การขับเคลื่อนนโยบายภายในมหาวิทยาลัย โดยเฉพาะอย่างยิ่งในเป้าหมายการพัฒนาที่ยั่งยืนที่ 6 และ 14 ได้อีกด้วย

คำสำคัญ : มลพิษเชิงพื้นที่ คุณภาพน้ำ ปรากฏการณ์ยูโทรฟิเคชัน สถานการณ์โควิด-19

Rashmi Chetia. (2022). Spatial Distribution and Water Quality Management Guideline for University. Master of Science (Innovation of Environmental Management). Advisors: Asst. Prof. Dr.Vanatpornratt Sawasdee, Asst. Prof. Dr.Ananya Propradit

ABSTRACT

The objectives of this research were to 1) examine the state of water quality in VRU, and 2) investigate and assessment of the water quality at the critical stations in VRU. The water samples were collected at 16 water resource stations in VRU including sewerage ditches, excavated canals, and big ponds. The water samples were analyzed according to the Standard Methods Examination Water Wastewater 23rd Edition. The water quality parameters at each sampling station were measured including the pH, dissolved oxygen (DO), nitrite (NO2-), nitrate (NO3-), ammonia (NH3), phosphate (PO4-), and total kjeldahl nitrogen (TKN). Water qualities were conducted for a period of 4 months: November 2020, January 2021, March 2021, and June 2021, approximately the same time (10:00–12:00 am) to minimize the accidental errors.

The results were presented; 1) water quality tests in lockdown periods due to COVID-19 showed that the water at all sampling water resource station was pH values 7.8 to 8.7. The DO values were varied in the sampling period that highest in March 2021 was 6.3 ±1.4 mg L-1 and the lowest in June 2021 was 4.5 ±1.4 mg L-1. Spatial variations were detected for NO2-, which high values of NO2- concentration was found in near canteen and dormitory station when compared with the other station (F-test: P> 0.05). Temporal distribution of NO3- varies were highest in January 2021 was 9.8±0.5 mg L-1 and lowest in June 2021 was 7.7±0.6 mg L-1, and highest phosphate was found in June 2021 was 3.4±1.9 mg L-1 and lowest in March 2021 was 1.6±1.0 mg L-1, and highest NH3 was found in November 2020 was 2.0±1.6 mg L-1 and lowest in June 2021 (lower than 0.6). 2) The investigate and assessment of the water quality at the critical stations was presented in temporal distribution of the water quality has a positive impact due to the COVID-19 lockdown as there were fewer washing activities. However, the highest value of TKN was found during the 1st lockdown in November 2020 (0.9 to 26.9 mg L-1) when compared with TKN values under no lockdown month in January and March 2021, and 2nd lockdown, respectively because a 1st lockdown was occurred after longtime water pollution release in environment. Over the trial of spatiotemporal distribution of the water quality found in this study, the profiles of NO-3, NO-2, PO-4, fractions were complex, however main sources of phosphorus and nitrogen in water at VRU were likely to be attributable to wash off from canteen and dormitory station. Although, P and N considered essential nutrient elements for growth and energy transport of aquatic living organisms, it can also lead to eutrophication and the other water environmental effects in VRU. The ratio of phosphorus and nitrogen compounds in water resources is important to factor that limiting factor and consequently control and reduce algae bloom. This phenomenon revealed that a decrease in washing activities can lead to an improvement in the water quality at VRU.

The body knowledge was obtained from the results were used in optimizing water quality monitoring in the VRU by creating a manual on water quality management guideline, which university staff can use as a guideline to assess the situation of wastewater that will occur in the water resources at the VRU, and for student in environmental subject. The manual can use as a dynamic document that will be periodically reviewed and updated as deemed necessary to transform VRU policy, especially as it concerns objectives number 6 and 14 of sustainable development goals.

Keywords: Spatial pollution; Water quality; Eutrophication phenomenon; COVID-19 circumstances.

ACKNOWLEDGEMENTS

I am honored to be a part of Valaya Alongkorn Rajabhat University under the Royal patronage as a student. I would like to take the opportunity to express my gratitude to the university for funding my education. It is because of your generosity that I am able to focus on my studies. I am very thankful to Assoc. Prof. Dr. Issara Suwanbol, the President of the University Asst. Prof. Dr. Supot Saikaew, the Dean of College of Management Innovation, Asst. Prof. Dr. Nisa Pakwilai accepted me as a student.

I am very thankful to my respected teachers of our Department of Innovation of environment Management that I was very happy to learn with our teachers. In particular, I am indebted to my advisor Asst. Prof. Dr. Vanatpornratt Sawasdee and Co-advisor Asst Prof. Dr. Ananya Popradit for your guidance, discussion with me and help me in my study countless times. I would like to thank Dr. Sasitorn Hasin and Asst Prof. Dr. Suntaree Jeenthamw for teaching and supporting me all the time. I want to tell you that the study periods were valuable for me.

My sincere thanks go to all Assamese and Thai people who help and support me all the time. I am extremely thankful to my father, mother, uncles, aunts, sisters, brothers, and all friends for encouraging and supporting me whenever I needed them.

I shall always remain grateful for all the things I have learned from all of you. My heartfelt gratitude once again to everyone for your help and support. Thank you.

Rashmi Chetia

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CHAPTER 1
INTRODUCTION

1.1 Background and importance of the problem

The present demands of industry, agriculture, and domestics are steadily growing. Several human activities are increasing because of the growing population. These activities discharged many types of wastewaters that contaminated a high amount of toxicity that can affect water quality. Growing modernized agriculture techniques, urbanization, increasing population plays a considerable role in the quality of water and has harmful effects on neighboring watersheds (Popradit, 2017). Nowadays, water resources are being diverted for agricultural, domestics, and industrial uses. Therefore, water resources should be more efficiently used, water-saving efforts should be promoted and water demands should be controlled (Park S. W. 2006). The daily water uses for humans, and the ecosystem also depended on surrounding water quality. Wastewater from community, industry, and agriculture creates a significant problem in the aquatic environment because of the organic loading and nutrients contains. Although organic matter can be a breakdown in water resources, oxygen was depleted (European Environment Agency, 2019). The pollutants concentrations of surface water in the dry season that variations of water quality are mainly influenced by domestic sewage, industrial wastewater, and brine intrusion. In the wet or rainy season, except for the pollution sources, drainages from cultivated land and livestock farm are the main factors influencing water pollution (Fan X. et al. 2012). The excess nutrients and organic matter such as nitrogen and phosphorus compounds from the agricultural area and domestic can cause plant and algae grow excessively that cutting out of light and lowering of dissolved oxygen into water, the aquatic animal cannot respiration and died. Therefore, water pollution has become a challenging problem all over the globe, causing a scarcity of useful water. Therefore, there is a pressing demand to develop an eco-friendly environmental policy. However, higher education institutions are change agents in society, and they require services from their communities and leaders in social responsibility and ecological sustainability (Tangwanichagapong, 2017). Therefore, this research aims to determine the state of the problem investigate the water quality and purpose of the water management guideline for Valaya Alongkorn Rajabhat University under the Royal Patronage. Thus, the spatial distribution and water quality management guideline for the university in each situation was obtained. Finally, the university can be utilized the water quality management guideline from this research.

1.2 Research objectives

1.2.1 To determine the state of water quality in VRU.

1.2.2 To investigate and assessment the water quality at critical station.

1.3 Conceptual framework of the research

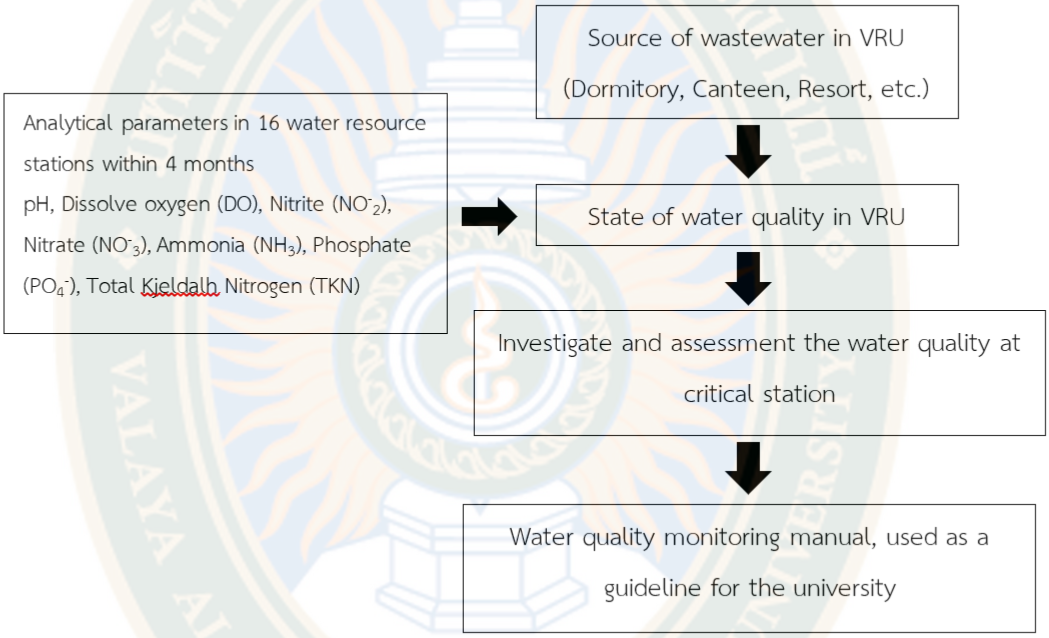

Figure 1 Framework of the study.

1.4 Scope of research

This research is focused on spatial distribution and water quality management guideline for university. The state of water quality will be analyzed with each station of water in VRU. Analytical parameters were consisting of pH, dissolve Oxygen (DO), nitrite (NO_2^-), nitrate (NO_3^-), ammonia (NH_3), phosphate (PO^{3-}_4), and Total Kjeldalh Nitrogen (TKN) in November (Nov) 2020, January (Jan) 2021, March (Mar) 2021 and June 2021. Such measures will be done with analytical methods and will help in the estimation of cumulative pollution. Then, investigate and assessment the water quality at critical station from analytical parameters in objective 1. The water quality at critical station trend is presented. Finally, this study will obtain the water management guideline for university. Therefore, this research can be presented the suggestion of water quality management in university.

1.5 Research Terminology/ Definitions

1.5.1 Water quality

The water quality in Valaya Alongkorn Rajabhat University (VRU) with differences of water station.

1.5.2 Spatial distribution of water quality

Spatial distribution of water quality in VRU is data of water quality in each parameter that distribution in each water station in university.

1.5.3 Water quality management guideline for university

The water quality management guideline will be included of the analysed data of each station and trend of wastewater quality of VRU.

1.6 Expected Benefits

1.6.1 Spatial distribution of water quality data in VRU.

1.6.2 The knowledge of water quality distribution in each water station in university.

1.6.3 Trend of water quality for eutrophication phenomenon.

1.6.4 The water quality management guideline for university.

CHAPTER 2
THEORIES

The theories of “Spatial distribution and water quality management guideline for university” as follow:

2.1 Source of Pollution and Transport Process
2.2 Type of wastewater
2.3 Point source and non-point source
2.4 Water quality
2.5 Water resource and source of wastewater of Valaya Alongkorn Rajabhat University (VRU)
2.6 Related Research

2.1 Source of Pollution and Transport Process

The study of effect of wastewater in environment was considered the source of pollution and transport process. There are 9 sources of pollution that identified with U.S. Environmental Protection Agency (Table 1).

Table 1 Sources of pollution

Sources	Pollution
Agricultural	Chemical solution, Fertilizer, Insecticide, Feed
Chemical Industry	Chemical solution for production process, Electricity, Solvent, Fuel, Insecticide
Mining	Air pollution, Coal, Toxic
Energy Industry	Solvent, Fuel, Waste from Boiler, Radioactive waste
Landfill and hazardous waste	Leachate, Hazardous waste
Medical Industry	Hazardous Waste, Infection Waste, Solvent
Food Industry	Slaughterhouse Wastewater
Domestic Waste/ Municipal Waste	Solvent, Laundry detergent, Fertilizer, Insecticide, Organic Wastewater
Government Waste	Fuel, Radioactive waste

Source: Ashraf et al. (2014)

The sources of pollution were divided into 2 categories: inorganic and organic compounds. The toxic diffusion is dependent on 2 factors: 1) the transport process and 2) transformation process (Bilal & Iqbal, 2020).

1) Transport process

Transportation of toxicity in each phase can be achieved through processes. Transportation of toxicity in water resources can be through several processes such as sorption, volatilization, and bio-uptake. Moreover, the transportation process in soil includes sorption, runoff, and leachate. Therefore, the toxicity can be transferred through several phases that can result in contamination causing damage to human and environmental health.

2) Transformation process

There are several transformation processes that can transform toxic substances. The transformation processes include photolysis, reduction, hydrolysis, oxidation, and microbial degradation. These processes can cause an increase in toxicity resulting in further damage to human and environmental health.

2.2 Types of wastewaters

Wastewater is water whose physical, chemical, and biological properties have been changed as a result of the introduction of certain substances which render it unsafe for some purposes such as drinking (Amoatey & Bani, 2011). The impurities in wastewater are mainly due to the presence of solid (Organic or Inorganic) in wastewater. Mainly wastewater comes from a residential or domestic source, industrial source, and agricultural source. Wastewater release from ordinary living processes such as bathing, toilet, flushing, laundry, dishwashing, using fertilizer, etc. The major type of wastewater can be described in figure 2. The increasing population and industrial growth led to generate a high amount of wastewater channeled to water bodies as raw water (Edokpayi et al. 2017).

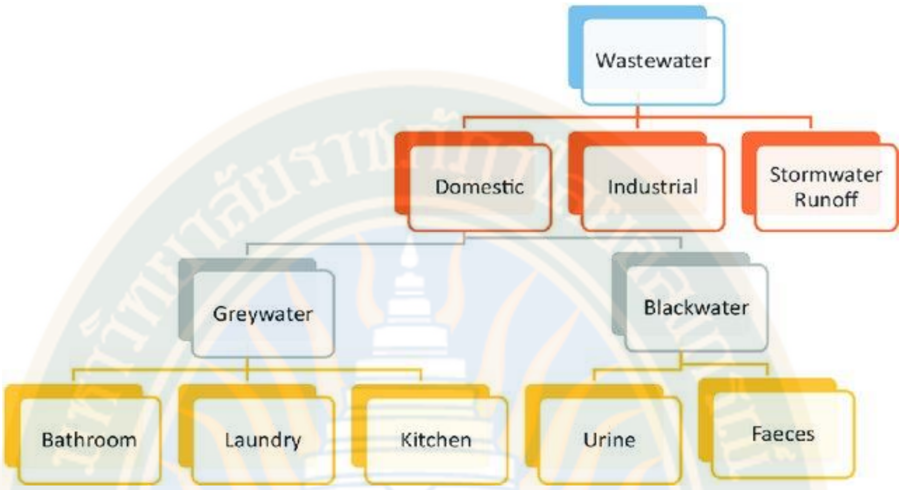

Figure 2 Type of wastewater.
Source: Amoatey & Bani (2011)

Domestic source of wastewater: The wastewater coming from human activities in households such as kitchen waste, dishwashing, garbage disposal, bathing, laundry, washing hands, toilet, household cleaning, private gardening, pet faces, and urine and washing private vehicles, is called domestic wastewater which is consist of high nutrients. The nutrients are nitrogen from those waste and phosphate from detergent or cleaning products. The wastewater discharge from domestic source contaminants pollutants can big impact on groundwater and the environment (Amoatey & Bani 2011).

Industrial source of wastewater: Industrial wastewater is important pollution for the environment. Industrial wastewater is discharged from various industries and contaminates different kinds of pollutants such as chemical industry, food processing industry, mining, textiles, iron, steel industry, etc. Industrial wastewater is released as its own pollutant into rivers, lakes, and coastal areas and resulting in negative effects on the environment and human life (Shi, 2011).

Agricultural source of wastewater: Nutrient from agriculture is a challenging issue for surface water. The growing population has a great impact on agriculture work. Increased nitrogen and phosphorus fertilizer users have the most influence on the environment to change the quality of wastewater and algae growth in freshwater. The high nutrient from agriculture may become more dangerous for the ecosystem and lead to eutrophication (Withers et al. 2014).

The university area has mainly domestic sources and agricultural sources of wastewater, but some parts of wastewater come from the laboratory. In university, domestic and agricultural wastewater will be a huge impact on the university water system. In terms of agricultural wastewater in VRU, normally in agriculture areas use organic fertilizer and have poultry farms and animal shelters. The wastewater that comes from domestic, agricultural, and laboratories can highly affect water bodies. The excess nutrient or pollutants come from those sources can lead to the eutrophication phenomenon in wastewater.

2.2.1 Effect of nitrogen form wastewater

Nitrogen compounds such as nitrite, nitrate is present in organic materials, foods, fertilizers, explosives, and poisons. It is an essential component of life, but high levels of nutrition are toxic to the environment. Nitrogen pollution is caused by the excess of nitrogen and mainly comes from fertilizers through runoff, sewage, and mineral deposits (Mihale, 2015). The general response of shallow coastal to excessive nitrogen load was showed in figure 3. Nitrates occur naturally in the soil, either alone or as a compound such as sodium nitrite. Nitrites come from municipal and industrial wastewater, automobile and industrial emissions, decomposition of both plants and animals but agricultural fertilizers application is the largest non-point source of pollution affecting groundwater quality (Zhao Z. 2015). Water pollution caused by nitrogen comes at a high cost for the ecosystems. High concentrations of nitrates in water can cause many problems for aquatic life (Verma et al. 2014). Too much nitrogen and phosphorous in the water causes algae to grow at a rate faster than what the ecosystems can handle and can lead to the severe reduction of dissolved oxygen. In the absence of oxygen, aquatic insects and plants cannot survive (European commission, 2013). Nitrogen-related contamination has become a major environmental problem that poses a threat to human health and the environment in several ways (U.S department of health and human services, 2017).

The general response of shallow coastal to excessive nitrogen load was showed in figure 3. Nitrogen was obtained from various sources of land uses and convene into groundwater, streams, river, and coastal waters. Nitrogen loading to the coastal waters is affected the aquatic ecosystem. Excessive nitrogen loading is contributing to water quality degradation, habitat loss and can cause algae growth. It is responsible for nitrogen enrichment and destroys the aquatic ecosystem (Baron et al. 2013).

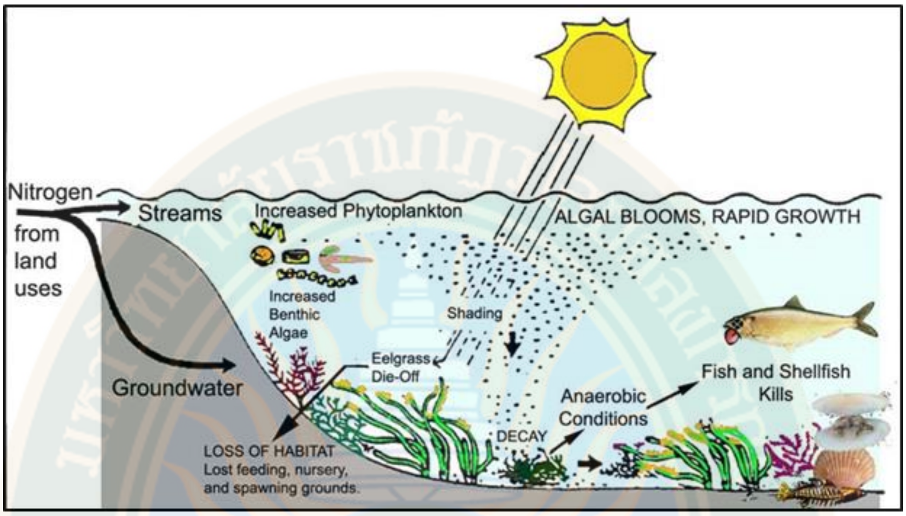

Figure 3 Nitrogen effect on environment.
Source: Modified from U.S. Fish and Wildlife circular, Restore Chesapeake Bay.

2.2.2 Effect of Phosphorus form wastewater

Phosphorus is an essential nutrient in plants and animal growth, but the concentration of phosphorus is generally low in soil (Schulz et al. 2013). That is why farmers usually apply phosphate fertilizers on agricultural land. Phosphorus assimilates in conjunction with vitamin B and is essential for human health to make protein, maintenance, and repair of cells and tissues and helps the body to make ATP (Adenosine triphosphate), a molecule used by the body to store energy and phosphorus also a component of body key's energy source. Plants can absorb phosphate fertilizer through the hair in their roots, which helps in plant growth. Phosphorus mining from phosphate rocks is a cause of water pollution and human health (Reta et al. 2018).

Nowadays, runoff caused by the application of phosphate fertilizer is a common problem for the environment (Figure 4). High concentrations of phosphorus lead to eutrophication of the aquatic ecosystem, impacting both agricultural lands and water resources (Ngatia, et al. 2019). High concentrations of phosphorus and anoxia in surface sediments are the result of decades of high phosphorus loading causing increased settling and decomposition of organic matter (Schelske, 2009). Figure 4 explains high levels of phosphorus in the water causes eutrophication, which is why phosphorus is dangerous for the health of humans as well as the environment (Amann, et al. 2018).

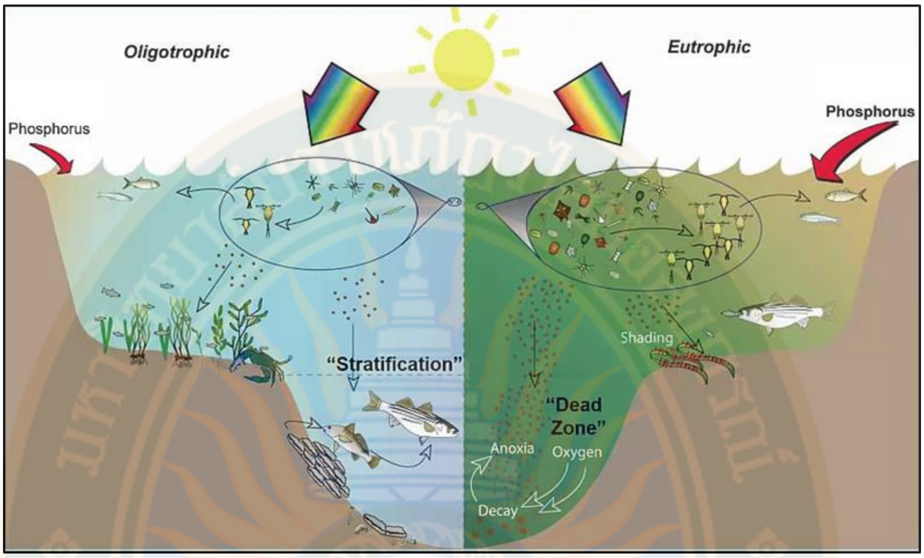

Figure 4 Phosphorus effect on environment.
Source: Walt Boynton (2016)

2.3 Point source and non-point source

Due to human activities, water is polluted, and it is a threat to the environment. Water is a resource that has many uses including recreation, transportation, and electric power generation as well as for domestic, industrial, and commercial uses and release into the environment (Amoo & Komolafe, 2018). Therefore, water pollution can be natural or artificial and it can have permanent, irregular, or accidental effects (Viman, et al. 2010). Regulatory agencies charged with protecting the environment identity two main categories of water pollution: point-source and non-point source pollution (Figure 5).

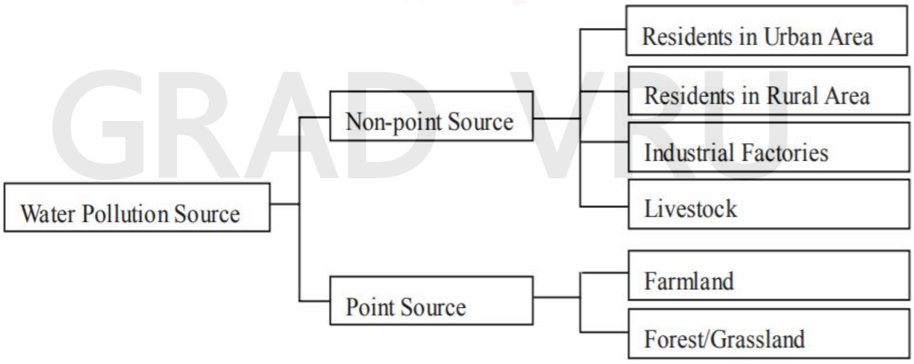

Figure 5 Type of pollution sources (Point source and non-point source)

2.3.1 Point source

Point source pollution is a very easy to identify. This pollution is a single identify localized source. These are easy to quantify and control (Kamarudzaman et al. 2011). The bulk of point source pollution come from wastewater released from power plants, industrial plants, municipal wastewater treatment plants, smokestacks, discharge pipes and drainage ditches (Viman, et al. 2010).

2.3.2 Non-point source

Non-point source pollution is an opposite of point source pollution. These pollutions are released from multiple sources. Non-point source cannot be traced to a single point of discharge, difficult to quantify and control (Kamarudzaman, et al. 2011). Non-point sources pollution occurs when rainfall, snowfall also wastewater come from urban areas, agriculture activities, construction building etc. This pollution also called natural pollution has high impact on water sources such as surface water and underground waters more than point source pollution (Viman, et al. 2010).

Point source and non-point source pollution has following effects on ecosystems (Islam, et al. 2018):

- Point source pollution can be harmful to the aquatic ecosystems and aquatic plant and animal may be killed by mud from construction sites, chemicals which are most harmful for animal and plant species.

- These pollutions also come from industrial plants, agricultural runoff, urban storm water and heavy materials, fertilizer, pesticide can run off into streams or rivers or seep into soil and affect ground water.

- The pollutants can contaminate drinking water sources, reduce oxygen levels, accumulates in the tissues of fish, also its cause damages to forest tree species around water bodies (Islam et al. 2018).

2.4 Water quality

Water is perhaps the most precious and limited natural resource. The quality of water is very important in both environmental and economic aspects. Water ecosystems provide basic products for maintaining human life, production activity, maintains functions of natural ecosystem structure, ecological processes, and ecological environment (Zhang et al. 2018). Thus, managing freshwater ecosystems improperly may cause serious problems in the availability and quality of water but water quality assessment and analysis are also essential for using multiple purposes (Grizzetti et al. 2016). Water quality can be defined as the chemical, physical and biological characteristics of water and these standards are necessary to fulfill the suitability of efficient use of water for a designated purpose. Therefore, water quality analysis is to measure required parameters, following standard methods to monitoring purposes such as to check whether the water quality is suitable or not, to monitor the efficiency of a water system, check-up gradation or change in dry and rainy seasons (Roy, 2019).

The regulation of building and municipal wastewaters is showed in table 2 and 3. There are 5 types of building wastewater in Thailand.

Table 2 Regulation of building wastewater

Parameters	**Regulation**				
	A	B	C	D	E
pH	5-9	5-9	5-9	5-9	5-9
BOD	<20 mg/L	<30 mg/L	<40 mg/L	<50 mg/L	<200mg/L
Suspended solids	<30 mg/L	<40 mg/L	<50 mg/L	<50 mg/L	<60 mg/L
Total nitrogen	<35 mg/L	<35 mg/L	<40 mg/L	<40 mg/L	-
Fat, Oil and Grease	<20 mg/L	<20 mg/L	<20 mg/L	<20 mg/L	<10 mg/L

Source: Notification of the Ministry of Natural Resources and Environment dated Nov 7, B.E.2548 (2005), which was published in the Royal Government Gazette, Vol.122, Part 125D dated December 29, B.E.2548 (2005)

VRU has a residential area, dormitory office, buildings, classrooms, Gym, playground, schools, and the wastewater from those sources are including to regulation of building wastewater. According to the Ministry of Natural Resources and Environment Thailand, the regulation of building wastewater is divided into five types of wastewaters based on area measurement. The using parameters are to measure the regulation of building wastewater. This study needs to follow the standard regulation of building wastewater because of the same category.

Table 3 Regulation of municipal wastewater

Parameters	Regulation
pH	5.5-9.0
BOD	<20 mg/L
Suspended solids	<30 mg/L
Total Nitrogen	<5 mg/L
Total Phosphorus	<2 mg/L
Fat, Oil and Grease	<20 mg/L

Source: Notification of the Ministry of Natural Resources and Environment dated April 7, B.E.2553 (2010) was issued under the Enhancement and Conservation of National Environmental Quality Act, B.E.2535 (1992) and published in the Royal Gazette, Vol. 127, Special Part 69D dated June 2, B.E.2553 (2010).

The VRU area is a very big area with a dormitory, household, canteen, office buildings, agricultural land, and laboratory, etc. Wastewater from agricultural runoff, road runoff, household runoff, runoff after a rainstorm is included in municipal wastewater (Canadian Institute for environmental law and policy 2002). The standard regulation of municipal wastewater is related to the university wastewater quality, which is needed to study most.

2.5 Water resource and source of wastewater of Valaya Alongkorn Rajabhat University (VRU)

Water resource of this university are mostly artificial, and these are big ponds, and canals. Big ponds were dug by human in the university (Figure 6). The ponds are balance the water quantity in university and many aquatic animals live in these ponds.

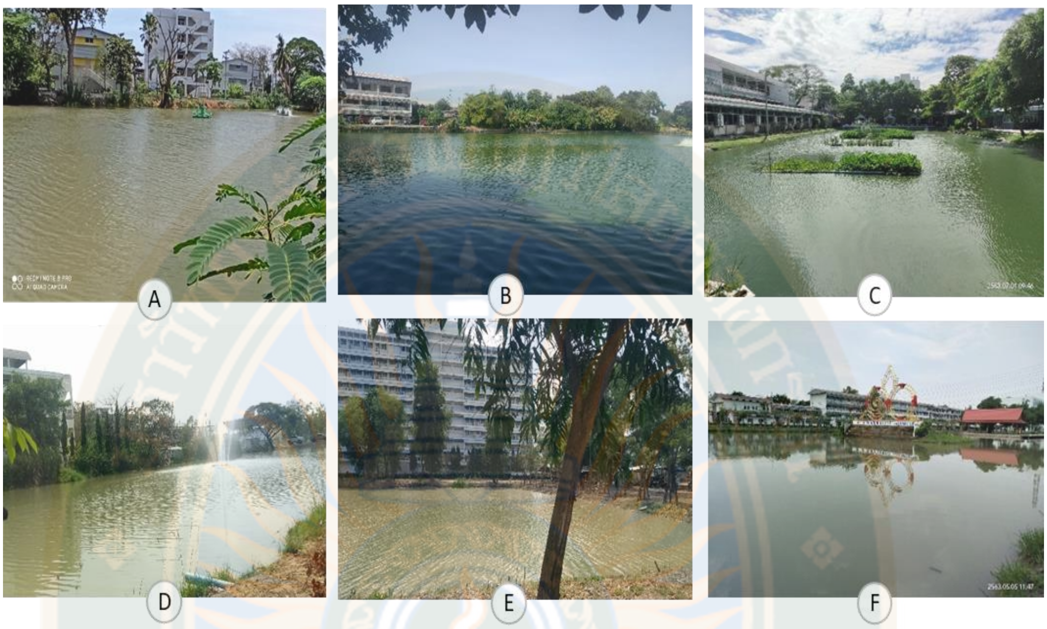

Figure 6 Manmade ponds in the university.

There are many canals in this university (Figure 7). All canals are connected with each other including all buildings canals. The VRU coffee shop (station 5) canal connected to the natural canal outside VRU. Some canals are connected with ponds along agriculture land.

Figure 7 Manmade canals in the university.

The source of wastewater of VRU are domestics or residential area, dormitory, office buildings including laboratory of VRU, canteen or restaurant, and agricultural area including animal shelter (Figure 8).

Figure 8 Source of wastewater in university.

2.6 Related research

This research is following some former studies that are related to the research. Most of the studies indicated the impact of nitrogen and phosphorus-based wastewater toxic for groundwater.

Viman et al. (2010) reported that human settlements have been built behind water resources which help to the development of specific areas and release wastewater from the development area. Water pollution has a negative impact on human health and the surrounding environment. This study about the source of pollution that can change the natural's qualities of water and the inclusion of foreign elements resulted from a series of natural and artificial effects. The sources of wastewater pollution are categorized by two-point- point source and nonpoint source.

Kamarudzaman et al. (2011) reported that water resources in the catchment area come from various sources. This study about the sources of the surrounded area of Timah Tasoh in Malaysia identifies which area source pollutions had the potential to increase the pollution rate. This study was conducted to establish the number of point source and nonpoint sources pollution and while the laboratory study has done to analyse the water quality parameters such as physical, chemical, and biological. The analysis is based on National Water Quality Standard for Malaysia and DOE water Quality Index Classification. These methods can conclude that point source and nonpoint source pollution and found that have the potential to increase pollution rate.

Fan et al. (2012) reported that due to the population increase and growing industrial and urbanization the Pearl River in China water quality deteriorates continually. The study is proposed a water quality management paradigm based on the seasonal variation and it is better exploring the seasonal change of water quality seasonal variation in 2008 and relevant impact factors were analyzed by multivariate statistic methods as a case to make management measures. The results show that the water quality of 2008 significant differences exist between dry and wet seasons using 17 water quality parameters except for TP. In the dry season, the variations of river water quality are mainly influenced by domestic sewage, industrial waste, and saltwater intrusion. In terms of wet season drainages from cultivated land and livestock farm are the main factors for water pollution.

Mihale (2015) reported in this study that the levels of ammonia, nitrate, nitrite, and phosphate compounds in the water of the Great Ruaha River are in response to natural and human pressures. Water samples were collected from Mtera dam, Ruaha Mbuyuni, Mswiswi, and Luwosi of Ruaha River. The water samples were analysed using standard methods. The analysis report indicates that the nitrite and ammonia sources were closely related to nitrate, probably most of the nitrites can nitrification from ammonium than denitrification of nitrate, nitrate and phosphate were indicate the same source that could be fertilizer from agricultural fields. So, increasing agricultural, and household activities is a threat to the future dynamics of nitrogen and phosphorus pollution in the area.

Popradit (2017) reported that agriculture activities and human wastes are the main factors that can affect the water ecosystem. The survey study found that 100% of households have disposed of domestic waste near their resident without treatment in a protected area in Thailand. The waste can cause the decrease of oxygen from the water column which is affected to the BOD and can be harmful to the water ecosystem. This study was used to measure physical, chemical, and biological parameters. The study found that in Nov the amount of nitrogen was highest while the phosphorus was over the standard measurement at every site.

Va et al. (2018) reported that domestic wastewater generated from various types of buildings has been recognized to be different to some extent. This study aimed to know the quality, quantity, fluctuation of the quantity of domestic wastewater released from office buildings in Bandung of Indonesia. Blackwater, greywater, and mixed water were taken from two buildings and measured every hour 7 am until 4 pm during working time. The samples were measured by parameters following the standard method. This study suggests that domestic wastewater from buildings has specific characteristics, and it contains a high concentration of the nutrient.

Roy (2019) reported that water is a precious natural resource that is required for a different purpose, but the suitability of water must be checked before use. Poor quality of water is a threat to the water ecosystem and may cause hazards and severe economic loss. Water quality analysis is essential for using any purpose this analysis consists of some standard protocols. This study provides guidelines for sampling, preservation, and analysis of the samples, and a standard chain of action is discussed briefly that can help analysts.

Ngatia et al. (2019) in this research study that eutrophication can occur from nitrogen and phosphorus in marine ecosystems. It is a worldwide problem. Eutrophication has a negative impact on the ecosystem, food security, health issue, tourism disruption economy, acid rain, and climate change. The study focused on the management of nitrogen and phosphorus pollution includes leaching from farms, fertilizer, wetlands, animal waste, fossil fuel, mitigating N and P from urban sources, and restoration of an aquatic ecosystem. Mitigation measures need to be a focus on dual nutrient strategy for nitrogen and phosphorus pollution reduction.

Dong et al. (2018) reported that multiple types of water resources in the western mining area in China. This study investigates the protection of water resources in the process of coal mining includes mainly three methods for achieving effective utilization of mine water: water conservation mining, underground reservoir storing, and simultaneous exploitation of coal and groundwater as resources. The research is proposed a multi-objective programming model for water resources allocation and using the model can coordinated development for mining safety, mine water utilization, and remediation and control of the water environment is achieved.

Zhang et al. (2018) reported that the issue of water resources has become a bottleneck that limits its development in the river basin of China. This study systematically analyzed different classification methods of the service functions of water ecosystems as well as factors that affect them. The research study about water resources protection, allocation, utilization, and the impacts of water resources management on land in China. The study result showed that climate, land cover, human activities were the main factors affecting the service functions of the water ecosystem.

Amoo and Komolafe (2018), this is a baseline study on the physical and chemical conditions of water in an artificial lake in Nigeria. The study was carried out between Nov 2013 and October 2014 with both wet and dry seasons that assessing the water quality status of the lake. This research used a total of nineteen parameters, among the parameters analyzed, only transparency and sodium showed significant seasonal variations within the acceptable limits of NIS, USEPA, and WHO except turbidity and phosphate. The result of the study is that the lake has not yet been highly impacted by anthropogenic activities.

The research that related to this study forwarded that domestic wastewater, industrial wastewater, agriculture runoff can highly affect ground and surface water or natural resources of water. The source of wastewater is divided into two category point source and nonpoint source. Most of the studies reported that nitrogen and phosphorus come from domestic sources and that have a high concentration of nutrients to increase pollution in the water ecosystem. Nowadays, growing population, agricultural activities and growing industry is the main factor of nitrogen and phosphorus pollution. Increasing N and P pollution are affecting the marine ecosystem too. The high nutrient in water can cause decrease oxygen and BOD will cause harm to the aquatic animal. The high nutrient can help to grow algae in an uncontrolled manner and eutrophication is lead in the water. A study reported that domestic wastewater is a high contaminate nutrient water and nutrient ratio that led to eutrophication. Nitrogen and phosphorus pollution can affect the surrounding environment, human health, animal health, climate change with the eutrophication phenomenon. Thus, the spatial distribution and water quality management guideline for the university in each situation was analysed. Finally, the university can be utilized the water quality management guideline from this research.

CHAPTER 3
RESEARCH METHODOLOGY

This research is focused on spatial distribution and water quality management guideline for university. It was determining the state of the problem of water quality in VRU, and then investigate and assessment the water quality at the critical in VRU. The water samples were collected in sixteen water sampling stations at the VRU including 3 sewerage ditches, 3 excavated canals, 5 sedimentation ponds, 5 big ponds. The water samples were analyzed according to the Standard Methods Examination Water Wastewater 23rd Edition. Water quality parameters at each sampling station were measured including the pH, dissolved oxygen (DO), nitrite (NO_2^-), nitrate (NO_3^-), ammonia (NH_3), phosphate (PO_4^-), and total kjeldahl nitrogen (TKN). Water qualities were conducted for a period of 4 months (Nov 2020, Jan 2021, Mar 2021 and June 2021), and approximately the same time (10:00–12:00 a.m) to minimize the accidental errors. The water quality at critical station trend was presented. Finally, this study was obtained the water quality management guideline follow sustainable development goals (SDGs) for university. Therefore, this research can be presented the suggestion of water quality management in university.

3.1 Research Methodology Design

The wastewater monitoring with each parameter. Parameters are recorded in the table (Table 4) every examine times. Overall, of research methodology design flow chart was showed in table 4. Then, correlation graph will be showed in this research.

Table 4 Analytical parameters in this research

Parameters	Unit	Method
pH	-	APHA, 23nd edition
DO	mg L^{-1}	APHA, 23nd edition
Nitrite (NO^-_2)	mg L^{-1}	APHA, 23nd edition
Nitrate (NO^-_3)	mg L^{-1}	APHA, 23nd edition
Ammonia (NH_3)	mg L^{-1}	APHA, 23nd edition
Phosphate (PO_4^-)	mg L^{-1}	APHA, 23nd edition
Total Kjeldahl Nitrogen (TKN)	mg L^{-1}	APHA, 23nd edition

3.2 Analytical parameters

3.2.1 pH

This research was measured pH with pH meter (Version of pH meter: DIGICON WA-48SD).

3.2.2 Dissolve Oxygen (DO)

This research was measured dissolve oxygen with DO meter (Version of DO meter: DIGICON WA-48SD)

3.2.3 Nitrate (NO^-_3)

Nitrate (NO^{-3}) is an important nitrogen compound that plants used to produce protein for growth. Nitrate (NO^{-3}) is occurring from organism release wastes that consist of nitrogen compound. The high nitrate (NO^{-3}) can be occurred Methemoglobinemia in baby, therefore standard of nitrate (NO^{-3}) was lower than 10 mg L^{-1} (APHA Standard Methods for the Examination of Water and Wastewater, 23rd edition).

3.2.4 Nitrites (NO^-_2)

Nitrite (NO_2) is not found in high concentrations in either surface water or groundwater, but it can be present as an intermediate step in the oxidation of ammonia or reduction of nitrate (NO_3). Nitrite is present in samples from biological processes such as nitrification, denitrification (APHA Standard Methods for the Examination of Water and Wastewater, 23rd edition).

3.2.5 Ammonia (NH_3)

There are two types of ammonia (NH_3 or NH_4). When the pH of the wastewater is acidic or neutral, the mostly of the nitrogen is ammonium ion (NH_4^+). When the pH increases over 8.0, the nitrogen is mostly ammonia (NH_3). The ammonia-N was analyzed by condensation and titration (APHA Standard Methods for the Examination of Water and Wastewater, 23rd edition).

3.2.6 Total Kjeldahl Nitrogen

Total kjeldahl nitrogen is the total of organic nitrogen. Organic nitrogen is degradation to ammonia by sulfuric acid oxidizing. Carbon and hydrogen are oxidizing to CO_2 and H_2O. Then condense to take ammonia ion in boric acid and examine ammonia by titration with strong acid (APHA Standard Methods for the Examination of Water and Wastewater, 23rd edition).

3.2.7 Phosphate (PO_4^{3-})

The orthophosphate level in mg L^{-1} (or ppm) is determined by a colorimetric method. Ammonium molybdate and potassium antimony tartrate react in acid medium with orthophosphate to form a phosphomolybdate complex that is reduced to intensely colored molybdenum blue by ascorbic acid. The color intensity of the solution determines the phosphate concentration (APHA Standard Methods for the Examination of Water and Wastewater, 23rd edition).

3.2.8 Eutrophication phenomenon analysis

This research was calculated cumulative of N and P with mass balance calculation. The ratio of N and P accumulation showed the water resource was occurred the eutrophication phenomenon from N or P. The equation for calculation as follows Equation 1:

$$R = \frac{[TN]}{[OPO_4P]} \qquad \text{Eq. 1}$$

Where: [TN] is TN in water resource (mg L^{-1})

[OPO_4 P] is ortho P level in water resource (mg L^{-1})

$R > 10$: High N, P is limiting factor for the eutrophication phenomenon.

$R < 5$: High P, N is limiting factor for the eutrophication phenomenon.

The eutrophication phenomenon is occurred with high N or high P in water resource. N and P are high nutrient that release from human activities. High levels of N and P are harmful and nutrient runoff causes overgrowth of algae or microorganisms. The ratio of N to P compounds in water resource is important factor that limiting factor and consequently that controlled to reduce algae bloom. Moreover, the ratio of N to P and algae cell can be predicted the eutrophication phenomenon. The N to P ratio was 7:1 and algae cell (Table 5) that can result to eutrophication phenomenon occurred.

Table 5 Eutrophication phenomenon from nutrient concentration

P (mg L^{-1})	N (mg L^{-1})	Dry algae cell (mg L^{-1})	Significant
0.013	0.092	1.45	Problem threshold
0.13	0.92	14.50	Problem likely to exist
1.30	9.20	745	Severe problems possible

Source: EPA (1985; 2001)

3.3 The study area of research

The research areas are the surrounding area of Valaya Alongkorn Rajabhat University, under the Royal Patronage located at Khlong Luang district, Pathum Thani province, within Nov 2020, Jan 2021, Mar 2021, and June 2021 (Figure 9).

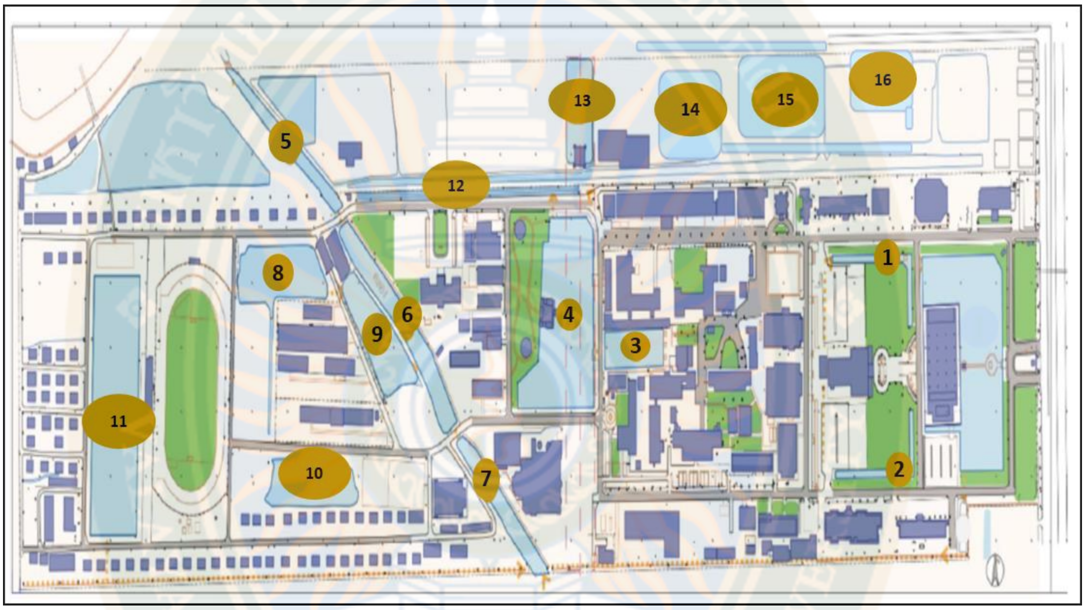

Figure 9 Area points for monitoring

A rough detailed description of each station as follows (Figure 10).

Station 1 Sewerage ditch from office building related to university restaurant.

Station 2 Sewerage ditch from an office building that is connected to the university Science center building.

Station 3 Sedimentation Pond around the demonstration school.

Station 4 Big Pond in front of Thai traditional house connected to the office building, demonstration school.

Station 5 Excavated canal connected to VRU coffee shop; it connects to the natural canal outside VRU.

Station 6 Excavated canal around university dormitory; obtains wastewater from the dormitory.

Station 7 Excavated canal around demonstration school; it connects to the natural canal outside VRU.

Station 8 and 9 Sedimentation ponds behind and in front of the university dormitory.

Station 10 Sedimentation Pond opposite to dormitory and canteen.

Station 11 Sedimentation Pond behind football field and connected to university personnel housing.

Station 12 Sewerage ditch connected to agricultural demonstration area of VRU.

Station 13 Big Pond close to agricultural demonstration area of VRU.

Station 14 Big Pond behind the faculty building.

Station 15 Big Pond behind the faculty building.

Station 16 Big Pond that nearly the buffalo shelter.

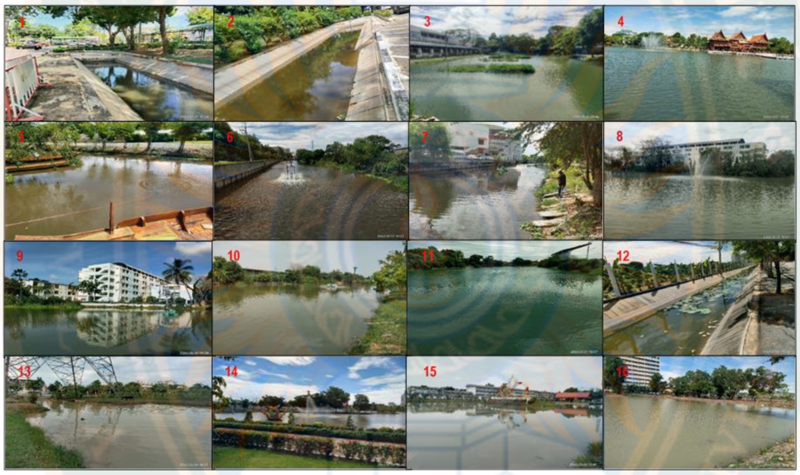

Figure 10 The stations of water resources in the university.

3.4 Water quality management guideline for university

The water management guideline was obtained from the spatial distribution of water quality in each water station. The data of water quality in each water station will be analyzed and presented with the trend of water quality. Moreover, the trend of water quality can be predicted the type of water quality that can be occurred the eutrophication phenomenon. It was used to publicize VRU that can create knowledge and awareness of the effect of nitrogen and phosphorus in wastewater. The data in the guidebook consist of the effect of wastewater from the household, industrial, and agriculture works can highly impact surface water and affected the health of animals and humans. This study is focused on monitoring the effect of nitrogen and phosphorus pollution in wastewater. The study is monitoring wastewater pollution in water resources for the water ecosystem of VRU. The data in the guidebook was consist of:

1. The source of wastewater and land uses effect on water in VRU.

2. Effect of nitrogen and phosphorus pollution that led to eutrophication phenomenon.

3. Awareness and activities in VRU and effect on water.

3.5 Data analysis

Comparison of the water parameters between difference study area and sampling period were test by One-way analysis of variance (ANOVA) with Least-Significant Different test. Normality and homoscedasticity of the data were confirmed prior to the analyses using the Shapiro-Wilk and Levene tests, respectively. All data were log-transformed to reduce heteroscedasticity prior to analysis.

All univariate statistical analyses were performed with the PAST: Paleontological Statistics Software Package for Education and Data Analysis version 4.04.

CHAPTER 4
RESULTS AND DISCUSSIONS

This research study is the spatial distribution and water quality management guideline for the university. It was determining the state of the problem of water quality in VRU, and then investigate and assessment the water quality at the critical in VRU. The water samples were collected in sixteen water sampling stations at the VRU including 3 sewerage ditches, 3 excavated canals, 5 sedimentation ponds, 5 big ponds. The water samples were analyzed according to the Standard Methods Examination Water Wastewater 23rd Edition. Finally, this research can be presented the suggestion of water quality management in university

4.1 Determine the state of water quality in VRU:

Spatial analysis of each station in four months. The 1st month is Nov 2020, 2nd month is Jan 2021, 3rd month is Mar 2021 and 4th month is June 2021.

A rough detailed description of each station as follows (Figure 11).

Station 1 Sewerage ditch from office building related to university restaurant.

Station 2 Sewerage ditch from an office building that is connected to the university Science centre building.

Station 3 Sedimentation Pond around the demonstration school.

Station 4 Big Pond in front of Thai traditional house connected to the office building, demonstration school.

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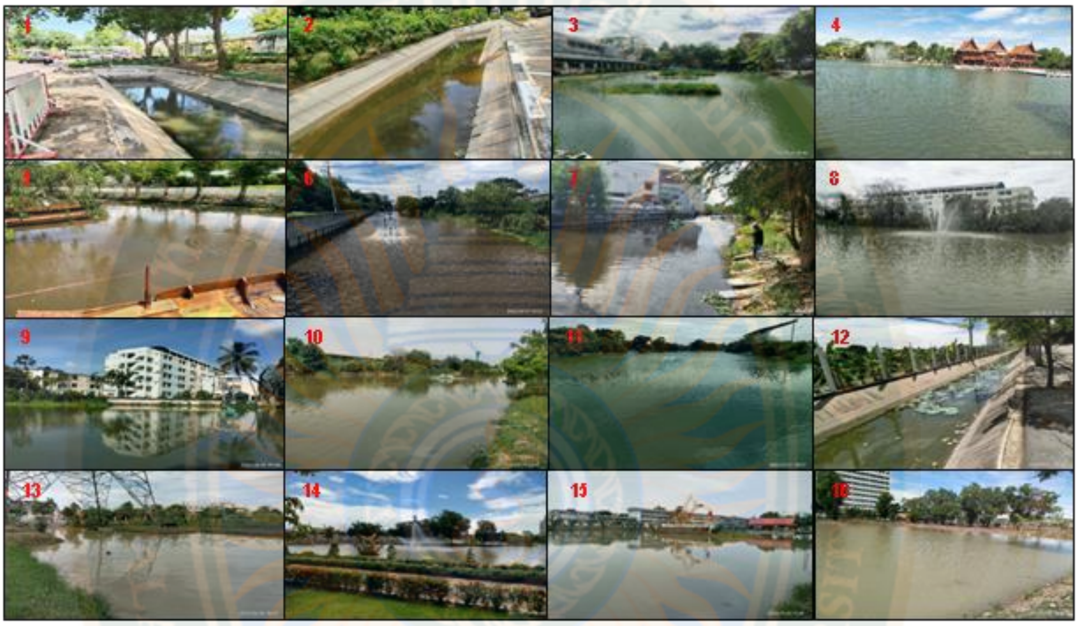


Figure 11 The stations of water resources in the university.

Station 1 – This station was showed highest value of NH_3 in Mar 2021 was 5.27 mg L^{-1}, and NH_3 in Nov 2020 and Jan 2021 was 3.5 mg L^{-1} NH_3 is 0.03 mg L^{-1} in June 2021, respectively. Comparatively, NO^-_2 and NO^-_3 were low in the Nov 2020 and Mar 2021, but the Jan 2021, and June 2021 nitrite was higher than the Nov 2020 and Mar 2021. In the Nov 2020, total nitrogen was higher than the Jan 2021, Mar 2021, and June 2021 and the concentration was higher than municipal wastewater standard regulation. The Jan 2021 was lockdown, the activities of the university were less than Nov 2020 and Mar 2021 and NO^-_3 was low, and nitrite was high in June 2021. In June, the classes were started after lockdown, but it was online classes and work from home. Station 1 is beside of office building and related to a canteen. This building has many types of activities such as students, lecturers, and office workers use the toilet, small kitchen, bathroom, and that toilet. Therefore, the wastewater release from this building has high nitrogen. In the Nov 2020, total nitrogen was higher than the Jan 2021, and Mar 2021, and the concentration was higher than municipal wastewater standard regulation. In term of phosphate was higher than municipal wastewater standard regulation in June month. pH was between 7.0-8.5 in four-month and the DO was similar in the Nov 2020 and Mar 2021 (6.7 mg L^{-1}) but in the

Jan 2021 DO was 4.5 mg L^{-1} and June 2021 it was very low (2 mg L^{-1}). In the June 2021 DO was in sensitive situation for aquatic animals because below 3.5 mg L^{-1} DO is not safe for coastal fish or aquatic animals (Camargo et al. 2005). The N:P ratio in Nov 2020 was 8.3, Jan 2021 was 1.84, Mar 2021 was 6.6 and June 2021 was 2.2, respectively. The ratio shows that in Jan 2021, Mar 2021, and June 2021 phosphorus is the factor of the eutrophication phenomenon. In this situation, the water cannot continue the nitrogen cycle. Nitrogen and phosphorus will because of growing algae and BOD increase. It will be led to the eutrophication phenomenon. The nutrients (N:P) ratio in the Nov 2020 was 8.3, in the Jan 2021 1.84, Mar 2021 was 2.7 and June 2021 was 2.26. The ratio shows that in the Jan 2021, Mar 2021, and June 2021, phosphorus is the factor of the eutrophication phenomenon. Cause of high nutrients and low dissolved oxygen, the water will become wastewater. It will be led to the eutrophication phenomenon. Eutrophication has been regarded as the direct environmental consequence of the widespread usage of phosphorus (Kundu et al. 2015).

Station 2 – This station is beside of office building, opposite station 1. In station 2, NH_3 was 4.5 mg L^{-1}, NO^{-}_2 was lower than NH_3 in the Nov 2020 due to the transformation of nitrogen compound was not occurred (Self-purification). In term of NH_3, NO^{-}_2, and NO^{-}_3 value in Jan 2021 and June 2021 were lower than Nov 2020 and 3rd month. Phosphate was showed 2.0 mg L^{-1} in the Nov 2020, Jan 2021 (4.6 mg L^{-1}), and June 2021 was 4.3 mg L^{-1}, it was more than Nov 2020 and in the Mar 2021 (3.0 mg L^{-1}) and it was more than municipal standard regulation. The pH was between 7.0- 8.4 in each month. The optimum condition pH for the aquatic animals was 6.5 to 8.5. DO was similar in Nov 2020 and Jan 2021 that was 5.3 mg L^{-1}, but in Mar 2021, and June 2021 was 7 mg L^{-1} and 6 mg L^{-1}, respectively. The amount of DO needs for aquatic animals is in different rang. Bottom feeders, crabs oysters, and worms need 1-6 mg L^{-1}, and shallow water fish need 4-15 mg L^{-1} (Camargo et al. 2005). In this station DO rang is very good for the aquatic animal. The source of wastewater of this station is the same as in station 1. Although the total nitrogen was high in Nov 2020 and phosphorus was 2 mg L^{-1}, there was no problem in the water of this station. However, the result shows that eutrophication can occur cause of high phosphorus in the Jan 2021 (3.2 mg L^{-1}) and Mar 2021 (2.4 mg L^{-1}). The result shows that eutrophication can occur cause of high phosphorus in the 4th month. Phosphorus is the essential nutrient for an aquatic plant, the total nitrogen is very low in this station. Therefore, nitrogen is the limiting factor in this station. When the nutrients have increased in the water body, which helps to grow algal biomass and is the cause of low dissolved oxygen. That is considered the main responsible for the eutrophication process (Environment Agency 2019). However, the result shows that eutrophication can occur cause of high phosphorus in the Jan 2021 (3.2 mg L^{-1}), Mar 2021 (2.4 mg L^{-1}), and June 2021 (0.2 mg L^{-1}).

Station 3 – The station is situated near a secondary school in the university. The school activities such as use toilet, bathroom, classroom activities (Art class, and Science work) and the school canteen, that release wastewater to this station. In this station, NH_3, NO^-_2, and NO^-_3 concentrations were low. The result of the Nov 2020, Jan 2021, and Mar 2021 shows that NH_3 was high in the Nov 2020, NO^-_2 and NO^-_3 were low, but nitrite was high in the Jan 2021, and Mar 2021. The June 2021 NH_3, NO^-_2, and NO^-_3 were lower than the Nov 2020, Jan 2021, and Mar 2021. However, the total nitrogen is higher than municipal standard regulation in the Nov 2020, Jan 2021, and Mar 2021 but very low in the June 2021. The phosphate was lower than municipal wastewater standard regulation in Nov 2020, total phosphorus was higher than municipal standard regulation in Jan 2021, total phosphate was low in Mar 2021, and it was 2 mg L^{-1} in June 2021, it was lower than municipal wastewater standard regulation. DO concentration was normal 6.9 mg L^{-1} in Nov 2020, 6 mg L^{-1} Jan 2021, and 7 mg L^{-1} in June 2021 and it was higher than other months in Mar 2021 (9 mg L^{-1}). The DO range is very good for the aquatic animal. Although the station is near school, the school has no activities because of Covid-19. The result shows that phosphate is the limiting factor that can lead to the eutrophication phenomenon in the June 2021. The pH was between 7.5 and 8.5 and DO was 6.0 and 9.0 mg L^{-1} in four months but Jan 2021 was very higher than the other three months. However, the total nitrogen is higher than municipal standard regulation in Nov 2020, Jan 2021, Mar 2021, Phosphate was lower than municipal wastewater standard regulation but in the June 2021 it was like municipal wastewater standard regulation. The result shows that nitrogen is the factor that can lead to the eutrophication phenomenon in the Nov 2020 and Mar 2021, and phosphorus can lead the eutrophication in the Jan 2021, and June 2021. The total phosphate was low than municipal standard regulation. However, the DO was high but it was good for the aquatic animal, and pH was under municipal standard regulation. There is a possible lead to eutrophication by nitrogen. The DO will help to do the nitrification process. On the other hand, nitrogen is an essential nutrient for the plant. Nitrogen can be converted to other forms by nitrifying bacteria and turn into its consumable form of nitrates (NO^-_3) that can be taken by plants. Most of the time at the stage of nitrates the runoff water takes the nitrogen into water bodies, which is the cause of the growth of algae blooms. In terms of algae bloom (Eutrophication), aquatic animals and plants can die because of low dissolved oxygen and no sunlight bottom of the water body. BOD will be increasing in the water. That water becomes wastewater and leads to the eutrophication phenomenon (Dodds & Smith, 2016).

Station 4 – The station is situated middle of the university near a Thai traditional house. The wastewater is release to this station from an office building, school, and dormitory area. In terms of nitrogen, the NH_3 in the Nov 2020 was higher than Mar 2021, and June 2021. In the Nov 2020, the NO^-_2 was 0.6 mg L^{-1} but Jan 2021, Mar 2021, and June 2021 it was low. NO^-_3 was low and almost the same in four months. The total nitrogen in three months was more than municipal standard regulation, but it was low in the June 2021. In terms of phosphorus, it was almost the same in four months, Nov 2020 was 3 mg L^{-1}, Jan 2021 was 3 mg L^{-1}, Mar 2021 was same and the phosphorus, 3.67 mg L^{-1} in June 2021 but it was higher than municipal standard. The DO was perfect, between 6.0 and 7.0 mg L^{-1} in four months. Nov 2020 and June 2021 were similar, but the Jan 2021, and Mar 2021 were a little bit low. pH was between 8.0 and 9, under municipal wastewater standard regulation in each month. In this condition, the NH_3 can be converted into NO^-_2, and it will be converted to NO^-_3. The concentration of nitrogen and phosphorus is shown that phosphorus can cause algae bloom and it will lead to eutrophication.

Station 5 – The station is a cannel that is related to VRU hut (canteen) and the cannel also links to outside of the university. In this station, NH_3 in wastewater was high in the Nov 2020 and the Jan 2021, Mar 2021, and June 2021 were very low. The NO^-_2 was high in Nov 2020, in Jan 2021 was lower than Nov 2020, in Mar 2021, and June 2021 it was lower than Jan 2021. In terms of NO^-_3 was high in Nov 2020 than Jan 2021, Mar 2021, and June 2021. The total nitrogen is high in Nov 2020 according to municipal wastewater standard regulation. In terms of phosphate, Nov 2020 was 5.6 mg L^{-1}. It was very higher than Jan 2021, Mar 2021, and June 2021, in Mar 2021, and June 2021 was almost same but in Jan 2021, it was slightly low. DO was a little bit similar in four-month (4.0 mg L^{-1}-6.0 mg L^{-1}) and the pH was under municipal standard regulation (7.0-8.5). In this condition, nitrite can be converted by nitrifying bacteria to nitrate and ammonia. It can cause the growth of algae. Although the total nitrogen was higher than municipal standard regulation comparatively phosphate was very high that can lead to eutrophication. The phosphorus nutrient come from P-based detergents, population growth, P- fertilizer, and phosphorus is the most common cause of water quality failures (Environment Agency, 2019). The result shows that nitrogen was the limiting factor of eutrophication.

Station 6 – Station 6 is near the university dormitory and release wastewater from the dormitory that is related to many activities such as bathing, toilet, washing cloth and dishes, cleaning the house, and cooking. In station 6, NH_3 concentration was high in the Nov 2020 and Jan 2021 but it was low in the Mar 2021 and June 2021. NO^{-}_{3} concentrations were low in each month, but the NO^{-}_{2} was 0.7 mg L^{-1} in Nov 2020, and it was very low in Jan 2021 but in Mar 2021 and June 2021 it was very high (1.1 mg L^{-1}). The DO value was similar Nov 2020, Jan 2021, and Mar 2021 (5.9 mg L^{-1}- 6.4 mg L^{-1}) but it was very low in the June 2021 3.67 mg L^{-1}. The DO below 3 mg L^{-1} in water it can cause aquatic animal die. The pH was between 7.5 and 8.5 each month. In terms of phosphorus in each month, it was high. The Nov 2020 was very higher than the other three months, it was 6.13 mg L^{-1}, and the June 2021 was 5.1 mg L^{-1}. In Jan 2021 and Mar 2021 was between 2 to 4 mg L^{-1}. According to the result, the phosphorus is higher than municipal wastewater standard regulation and that is the cause of eutrophication in this station. The main sources of phosphate in water are household sewage water containing detergents, soap base water, cleaning preparations, and human excreta (Kundu et al. 2015).

Station 7 – Station 7 is near a primary school in university that is connected to the school and outside of the university. The primary school has many types of activities such as toilet, cleaning, an organic farm, school canteen, etc. In the wastewater of this station, the NH_3 concentration was 2.7 mg L^{-1} in Nov 2020 that similar with Jan 2021 but in the Mar 2021 and June 2021, it was very low. The NO^{-}_{2} was 0.0 mg L^{-1} in Nov 2020 and Mar 2021 it was a slight high (0.2 mg L^{-1}) but in Jan 2021 and June 2021 it was very high (1.1 mg L^{-1}) and the NO^{-}_{3} was low in Nov 2020, Jan 2021, Mar 2021 and June 2021. The total nitrogen is almost similar in the Nov 2020, Jan 2021, and Mar 2021 but higher than municipal wastewater standard regulation. In the June 2021, the total nitrogen was lower than municipal wastewater standard regulation. The phosphate was high each month, it was higher than municipal wastewater standard regulation. In the Nov 2020, Jan 2021, and June 2021 it was 5 mg L^{-1} and the Mar 2021 was lower than another month (1 mg L^{-1}). The Mar 2021 was lockdown time. The DO of Nov 2020, Jan 2021, and Mar 2021 were normal, the value was between 4.9 and 6.1 mg L^{-1} in three months. Although the DO in the June 2021 was low 4 mg L^{-1}, it is normal for the aquatic animal, they can survive. The pH was under the municipal wastewater standard regulation. The result is that phosphorus concentration is the cause of the eutrophication phenomenon. The sources of the phosphate are P containing detergents, cleaning, farming, or agricultural activities, which dominated the sources for influencing the phosphorus contain water environmental problems of this station (Kundu et al 2015).

Station 8 – The station is located behind the university dormitory. Station 8 was low NH_3, NO^-_2, and NO^-_3 in each month, Nov 2020, Jan 2021, and Mar 2021, and June 2021. In term of total nitrogen was also low. Comparatively, the phosphate was low each month. The phosphate was 1 mg L^{-1} Nov 2020 and Jan 2021, it was 2 mg L^{-1} in the Mar 2021 and June 2021. It was similar to municipal wastewater standard regulation. The DO was similar in the Nov 2020 and Jan 2021, 6.9 and 6.5 mg L^{-1} and it was a little bit low in the Mar 2021 and June 2021 5 and 4 mg L^{-1}, but it cannot affect wastewater. The pH range was 7.4- 8.5 in four months. Resulting the phosphorus is the limiting factor of eutrophication. The source of phosphorus is food waste, drink, toilet, detergent, etc. It will be dangerous for aquatic animals such as fish, turtles also lizards. Eutrophication restricts water use for the aquatic animal otherwise, increased algae and oxygen shortages may cause serious health problem to aquatic animals and death (Khan and Mohammad, 2014).

Station 9 – Station 9 is situated in front of the university dorm. The station is related to a dormitory and an office building where has an herb and some small plant garden. The NH3 concentration was 2.5 mg L^{-1} in Nov 2020, and Jan 2021 but it was low in Mar 2021 and June 2021 and the NO^-_3 cannot detect in Nov 2020, in Jan 2021, Mar 2021, and June 2021 it can detect but it was low, 0.9 mg L^{-1} in each month but the NO^-_2 was high in Nov 2020, Mar 2021, and June 2021 but in Jan 2021, it was very low. The NO^-_2 was very high in the June 2021, 1.1 mg L^{-1}. In term of phosphate concentration was 3 mg L^{-1} in Nov 2020, in Jan 2021 and 3rd month was higher than Nov 2020 but in June 2021 it was very high (5 mg L^{-1}). It is higher than municipal wastewater standard regulation. DO was normal in each month (6-9.5 mg L^{-1}) and the pH was under municipal wastewater standard regulation (8.0-8.8). Although in this condition the total nitrogen is low, it can be high by nitrifying bacteria (Selman & Greenhalgh, 2010). The ratio shows that in this station phosphorus is the cause of eutrophication.

Station 10 – This station 10 is located opposite of university dorm and the canteen of a dorm, and it is related to the university household. The wastewater release from these areas, the NH_3 was 2 mg L^{-1} in Nov 2020 and Jan 2021 but in the Mar 2021 and June 2021, it was low. The NO^-_2 was very high in 3rd month and very low in the Jan 2021 and June 2021 and NO^-_3 was very low in each month. Although the different concentrations of nitrogen form in each month compared to the total nitrogen was lower than municipal standard regulation of wastewater in four months.

In term of phosphorus, in the Nov 2020 and Mar 2021 was high and Jan 2021 was according to municipal standard regulation but the June 2021 phosphorus was very high according to the municipal standard regulation of wastewater. The DO was perfect in Nov 2020, Jan 2021, and Mar 2021 (5-5.5 mg L^{-1}) but in the June 2021, it was low (3 mg L^{-1}). In the June 2021 in this station the DO was not good, it was difficult for the aquatic animal to live here. The pH was normal, it was between 6.9 and 8.5. That indicates that the wastewater is a serious condition, and the phosphorus is the cause of the eutrophication phenomenon.

Station 11 – Station 11 is behind the university playground and related to university households. In this station normally wastewater comes from the household area. The NH_3, NO^-_2, and NO^-_3 concentrations were low in the months that was sampling. According to the result, phosphorus was normal in four months. It was less than municipal wastewater standard regulation. The DO was normal in the Nov 2020, Jan 2021, Mar 2021, and June 2021 (5-8 mg L^{-1}). It was perfect for the aquatic living organism. The pH is under the municipal standard regulation. The concentration of wastewater of this station seems very normal. In this station, phosphorus will be responsible for the eutrophication process.

Station 12 – Station 12 is the long cannel near the agricultural area and it is linked to the area. In this station, the NH_3 concentration of wastewater was very low each month. The concentration of NO^-_2 was high in Nov 2020 but it was low in the Jan 2021, Mar 2021, and June 2021. The NO^-_3 was low each month. The phosphate was 1.3 mg L^{-1} in Nov 2020 but in the Jan 2021 and Mar 2021, it was not detected. In the June 2021, the phosphate was 4.3 mg L^{-1}, however, the data is according to the municipal wastewater standard regulation. The DO and pH were normal this month. Resulting, the limiting factor of eutrophication and phosphorus is the cause of the eutrophication problem.

Station 13 – Station 13 is a big pond located in an agriculture area. In this station, the NH_3, and NO^-_3 was very low. NO^-_2 were high in the Nov 2020 than the Jan 2021, Mar 2021, and June 2021. In term of phosphorus was very low in the Nov 2020 but in the Jan 2021, Mar 2021, and June 2021, it was 1 mg L^{-1}, it is low according to municipal wastewater standard regulation. The DO was normal in the Nov 2020, Jan 2021, and Mar 2021 (5-6 mg L^{-1}) but it was low in the June 2021 (3.3 mg L^{-1}). The pH was normal in four months. According to the municipal wastewater standard regulation, the total nitrogen and phosphorus were low in the Nov 2020 and June 2021, in the Jan 2021 total nitrogen was high and phosphorus was low but in Mar 2021 both were high, but the concentration of DO can cause problems in the wastewater. The wastewater will be going worst condition. In this condition, BOD can occur in water bodies and the aquatic animal will die and the wastewater of this station will occur eutrophication phenomenon but nitrogen will be a limiting factor. Runoff from agricultural fields, manure from concentrated livestock operations, and aquaculture are the largest agricultural nutrients sources. The excess nutrients are a cause of algae bloom and low dissolved oxygen in the water and being wastewater (Selman & Greenhalgh, 2010).

Station 14 – The station is a big pond that is related to the science building and canteen. The water of this station, NH_3 was low in the Nov 2020, Jan 2021, and June 2021 but it was high in the Mar 2021. The NO^-_2 concentration in the Nov 2020 was higher than Mar 2021 but in the Jan 2021 and June 2021 it was low than Nov 2020 and Jan 2021. NO^-_3 concentration was very low in four months. The phosphorus concentration in the Nov 2020 and Mar 2021 was similar but it was very low in the Jan 2021 and June 2021. The DO was normal, and the pH was under municipal wastewater standard regulation. The DO was normal in four-month and the pH was similar in four months. According to the municipal standard regulation, the Nov 2020 total nitrogen was high, but phosphorus was the limiting factor, in the Jan 2021 and Mar 2021 nitrogen was high and the cause of eutrophication. In this condition, the nitrogen cycle can occur. The wastewater seems normal, but the ratio shows that total nitrogen can cause a factor for the eutrophication phenomenon. It might be an effect of increasing organic waste, detergents, foods waste that end up in produce high nutrients and minerals (Peppa et al. 2020).

Station 15 – Station 15 is a big pond behind the faculty building of the university. In this station, NH_3 was very low concentration Nov 2020, Jan 2021, Mar 2021, and June 2021. The NO^-_2 concentration was similar Nov 2020 and Mar 2021; the Jan 2021 and June 2021 NO^-_2 was low. In terms of NO^-_3 in Mar 2021 was 10 mg L^{-1} but Nov 2020, Jan 2021, and June 2021 it was very low. The phosphate of this station was low in Nov 2020 but Jan 2021, Mar 2021 was similar to municipal standard regulation but in June 2021 phosphorus was very high in this station, it was 4.3 mg L^{-1}. Comparatively the total nitrogen is lower than municipal wastewater standard regulation. The phosphate of this station was higher than municipal wastewater standard regulation. DO was between 5.4 and 6.6 mg $L^{-1}$and pH was 6.9 and 8.5 in each month, under municipal standard regulation. Although the result shows that the wastewater of this station is very normal in four months, phosphorus can cause lead to eutrophication problems.

Station 16 – Station 16 is near the buffalo shelter of the university. The NH_3 concentration was similar Nov 2020, Jan 2021, Mar 2021, and June 2021. The NO^-_2 was very high in Nov 2020 (1.7 mg L^{-1}), Jan 2021, Mar 2021, and June 2021 were low. The NO^-_3 was very low in the station in four months (<10 mg L^{-1}). The phosphate was lower than municipal wastewater standard regulation. The DO was 7 mg L^{-1} in the Nov 2020 and Jan 2021, the Mar 2021 was 5 and the June 2021 was 4 mg L^{-1}. pH was the same in Nov 2020, Jan 2021, Mar 2021, and June 2021 it was 7. It was under municipal wastewater standard regulation. Although the station seems stable, phosphorus can affect water bodies. The water quality impacts of nitrogen loading may increase in the frequency of the eutrophication phenomenon (Sinha et al. 2017). The concentration of each parameter is showing in figure 12.

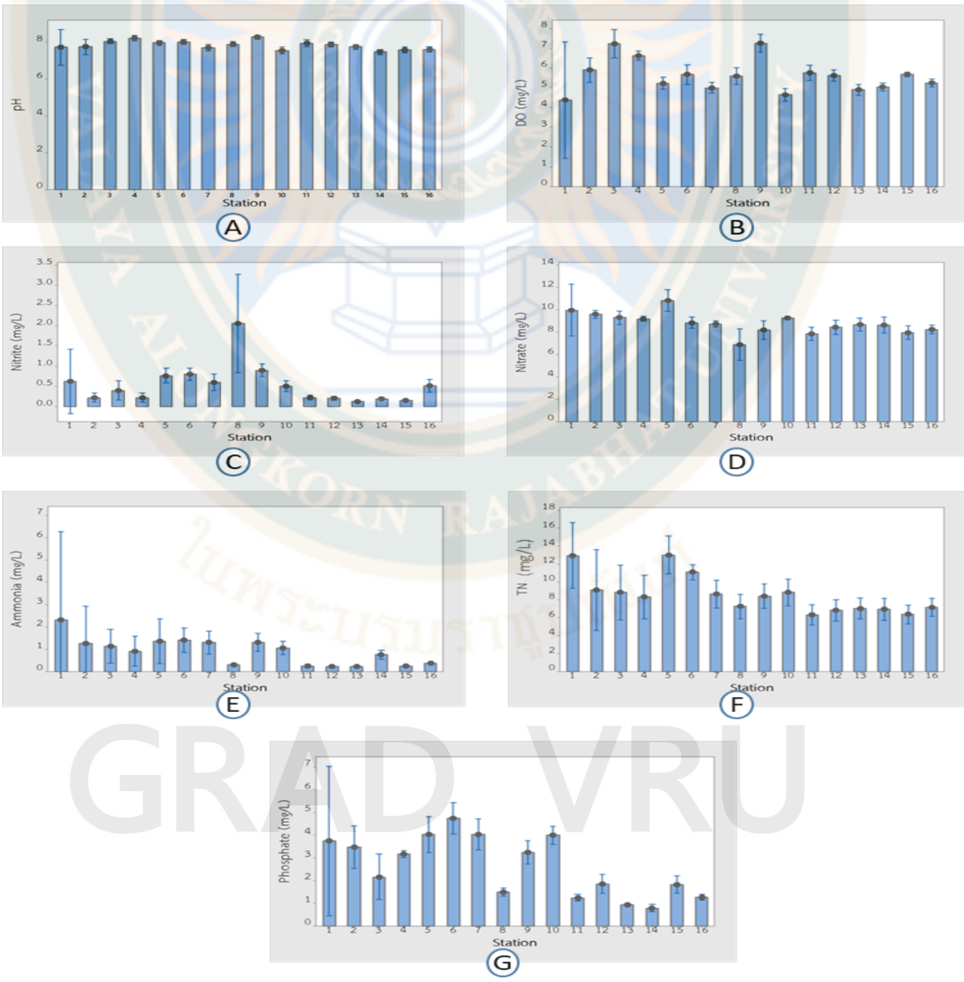


Figure 112 Concentration of parameters in each station within four months; pH (A), DO (mg L^{-1}) (B), nitrite (mg L^{-1}) (C), nitrate (mg L^{-1}) (D), ammonia (mg L^{-1}) (E), Total nitrogen (mg L^{-1}) (F), phosphate (mg L^{-1}) (G).

4.1.1 Eutrophication phenomenon analysis.

The eutrophication phenomenon can be occurs with high N or high P in water resources. N and P are the high nutrients that release from human activities. High levels of N and P are harmful and nutrient runoff causes overgrowth of algae or microorganisms. The ratio of N to P compounds in water resources is an important factor that limiting factor and consequently that controlled to reduce algae bloom. Moreover, the ratio of N to P and algae cells can be predicted the eutrophication phenomenon.

There are several water resource stations in this university. Each water resource obtained wastewater from each building, canteen, and a small community (Household, and apartment) in the university. Generally, the characteristics of the wastewater in VRU are similar to municipal wastewater, especially the N and P content. The nitrification and denitrification processes can convert the N compound into ammonia, nitrite, and nitrate. Thus, nitrification and denitrification processes can help reduce N compounds, leading to a decrease in the eutrophication phenomenon in water resources. There are 2 steps of the nitrification process: *Nitrosomonas* sp converts NH_3 into nitrite, and then *Nitrobacter sp* oxidizes NO_2^- into NO_3^- as follow:

This equation of *Nitrosomonas* sp. convert NH_3 into NO_2^-;

$$NH_3 + O_2 \longrightarrow NO_2^- + H_2O + H^+ \qquad \text{Eq 2.}$$

This equation of *Nitrobacter* sp. oxidize NO_2^- into NO_3^-;

$$NO_2^- + O_2 \longrightarrow NO_3^- \qquad \text{Eq 3.}$$

The denitrification process is the opposite of the nitrification process. This process is a reduction process. It occurs under anaerobic conditions when oxygen levels are depleted. The nitrate becomes the primary oxygen source for microorganisms. Nitrate is converted into gaseous N compounds, such as N_2O, NO, and N_2, by different bacteria, such as *Bacilius* sp., *pseudomonas* sp., *clostridium* sp. In this process, nous compounds follow the chain of equation 4.

$$NO_3^- \longrightarrow NO_2^- \longrightarrow NO \longrightarrow N_2O \longrightarrow N_2 \qquad \text{Eq 4.}$$

DO is another factor that affects the nitrification and denitrification processes because the nitrification process occurs in aerobic conditions (Equation 2–3). When nitrification can not happen, it leads to the accumulation of N compounds in water resources. N compound and also P compound are nutrients for plant and algae growth. A high amount of nutrients results in excessive plant and algae growth, covering the top of water resources. As a result, oxygen cannot be dissolved into the water bodies. DO affects aquatic animals because they use gills for breathing. If oxygen cannot be dissolved into the water body, the aquatic animals face shortness of breath and death. The bottom feeders, crabs, oysters and worms need minimal amounts of oxygen (1-6 mg L^{-1}), while shallow water fish need higher levels (4-15 mg L^{-1}). The concentration of DO is below 3.7 mg L^{-1}, which effect to fish survive (Camargo et al. 2005).

4.2 Investigate the water quality in VRU:

The study investigates the water quality of each station according to parameters in four months. The concentration of each parameter will be referred to the quality of the wastewater of VRU. The wastewater in this area was mainly from local pollutants release. The wastewater of VRU is similar to municipal wastewater standard regulation. Generally, the cause of eutrophication is the presence of a high amount of nitrogen and phosphorus nutrients can lead to algae blooms. The contaminants in wastewater are categorized into physical, chemical, and biological. The water quality of VRU was monitor by 8 physio-chemical parameters according to the municipal wastewater standard regulation. The parameters are pH, DO, NO^{-}_{2}, NO^{-}_{3}, NH_3, TKN, TN, PO_4^{-}, and COD.

4.2.1. Total Nitrogen (TN)

TN in Nov 2020 was 7.9 to 20.5 mg L^{-1} (Figure 13); .6 to 12.4 mg L^{-1} in Jan 2021 (Figure 13); 4.7 to 13.9 mg L^{-1} in Mar 2021 (Figure 13); and 1.0 to 11.13 mg L^{-1} in June 2021 (Figure 13). The average data in four months were, 11.9 mg L^{-1} in Nov 2020, 11.0 mg L^{-1} in Jan 2021, 8.8 mg L^{-1} in Mar, and 2.8 mg L^{-1} in June 2021 (Figure 13). In Nov 2020, TN was maximum because it was the so-called ‘normal situation’ (no lockdown) when students, officers, lecturers, and government visitors came to use the university facilities. Jan 2021 marked the beginning of the lockdown period under the COVID-19 crisis, and Mar 2021 represented the period when the university opened with ‘new normal’ protocols. June 2021 was a lockdown period, everyone did work from home.

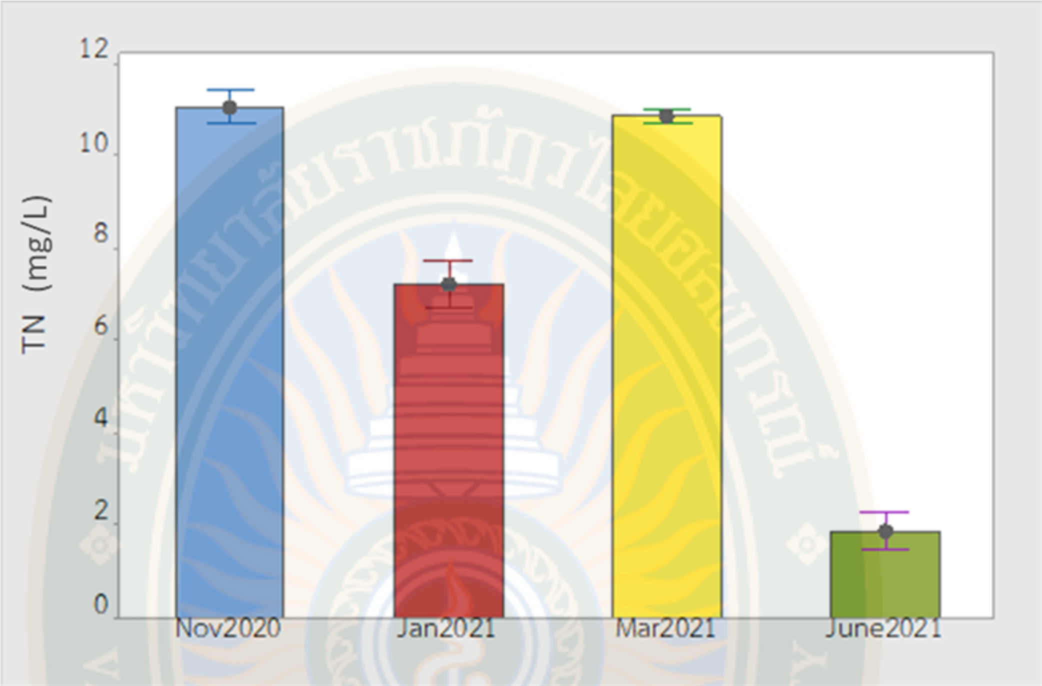


Figure 123 Average of total nitrogen in four month, Nov 2020 (SD = ±3.0), Jan 2021 (SD = ±0.9), Mar 2021 (SD = ±3.0), and June 2021 (SD = ±3.7).

4.2.2 Ammonia (NH_3),

Ammonia (NH_3) in Nov 2020 was between 0.4 mg L^{-1} to 5.0 mg L^{-1}. In Jan 2021 0.4 mg L^{-1} to 2.7 mg L^{-1}, in Mar 2021 0 – 5.3 mg L^{-1} and in June 2021 was 0-0.03 mg L^{-1} (Figure 14). The average data in four months were, 2.0 mg L^{-1} in Nov 2020, 1.0 mg L^{-1} in Jan 2021, 0.6 mg L^{-1} in Mar 2021, and 0.0 mg L^{-1} in June 2021 (Figure 14). The result shows that in lockdown periods the ammonia was low. In Nov 2020, there was no lockdown, the university was open, in Mar was the university was half open but in Jan and June was lockdown periods. The people were working from home. In Jan 2021 and June 2021 month ammonia was low in each station (Figure 14).

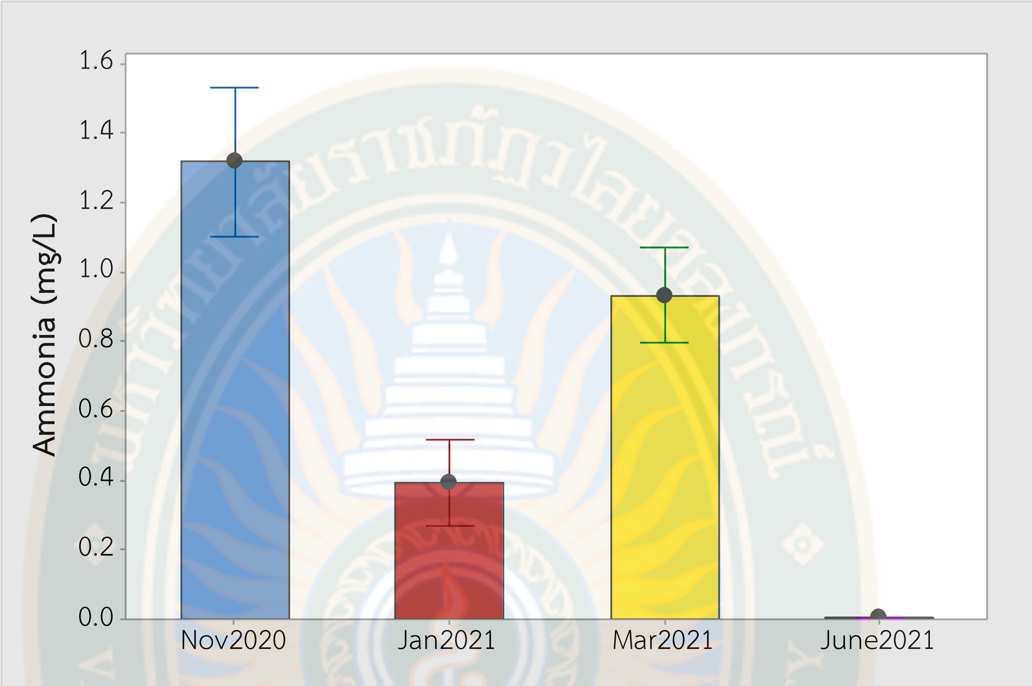


Figure 13 Average of ammonia in four month, Nov 2020 (SD = ±1.6), Jan 2021 (SD = ±0.8), Mar 2021 (SD = ±1.3), and June 2021 (SD = ±3.6).

4.2.3 Nitrite (NO_2), and Nitrate (NO_3).

Nitrite (NO_2) and Nitrate (NO_3) in Nov 2020 were very high. Nitrate (NO_3) was between 4.0 and 14.3 mg L^{-1} in Nov 2020, 9.0 and 10.1 mg L^{-1} in Jan 2021, 4.0 and 10.5 mg L^{-1} in Mar, and 6.9 and 10.0 mg L^{-1} in June 2021 (Figure 15). The average data in four months were, 9.3 mg L^{-1} in Nov 2020, 9.8 mg L^{-1} in Jan 2021, 9.0 mg L^{-1} in Mar 2021, and 7.7 mg L^{-1} in June 2021 (Figure 15).

In Nov 2020, nitrite was between 0 and 1.6 mg L^{-1}, 0.1 and 1.0 mg L^{-1} in Jan 2021, 0.1 and 1.1 mg L^{-1} in Mar 2021, and 0.1 and 1.1 mg L^{-1} in June 2021 (Figure 16). The average data in four months were, 0.6 mg L^{-1} in Nov 2020, 0.2 mg L^{-1} in Jan 2021, 0.4 mg L^{-1} in Mar 2021, and 0.4 mg L^{-1} in June 2021 (Figure 16). Resulting in that nitrite and nitrate were high in Nov 2020, that time was a very normal situation. In Jan 2021 was lockdown period and in Mar was half lockdown period. Office and some workers could come to the office for work but in June started for full lockdown. Surprisingly nitrogen form is low in Jan 2021 and very low in June 2021. In Mar 2021, nitrate was high, but nitrite was very low (Figure 15) (Figure 16).

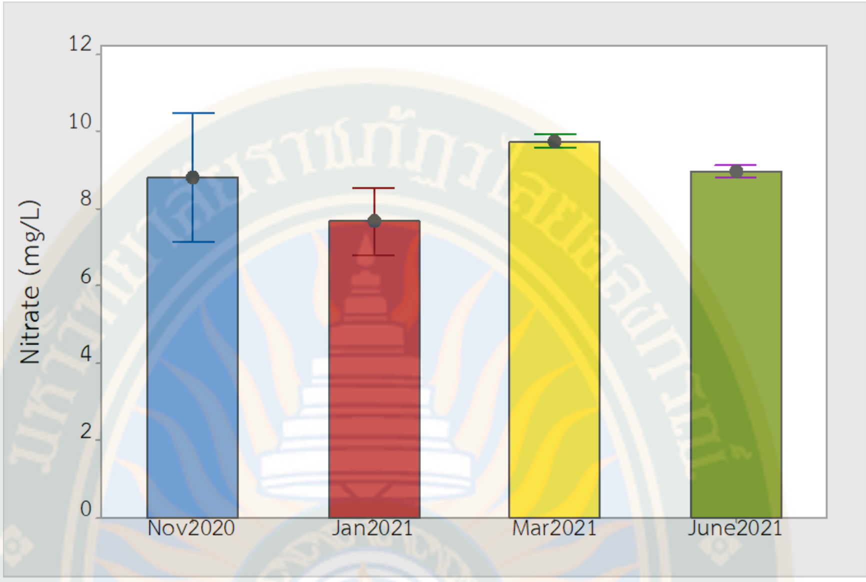


Figure 14 Average of nitrate in four month, Nov 2020 (SD = ±2.1), Jan 2021 (SD = ±0.5), Mar 2021 (SD = ±2.4), and June 2021 (SD = ±0.6).

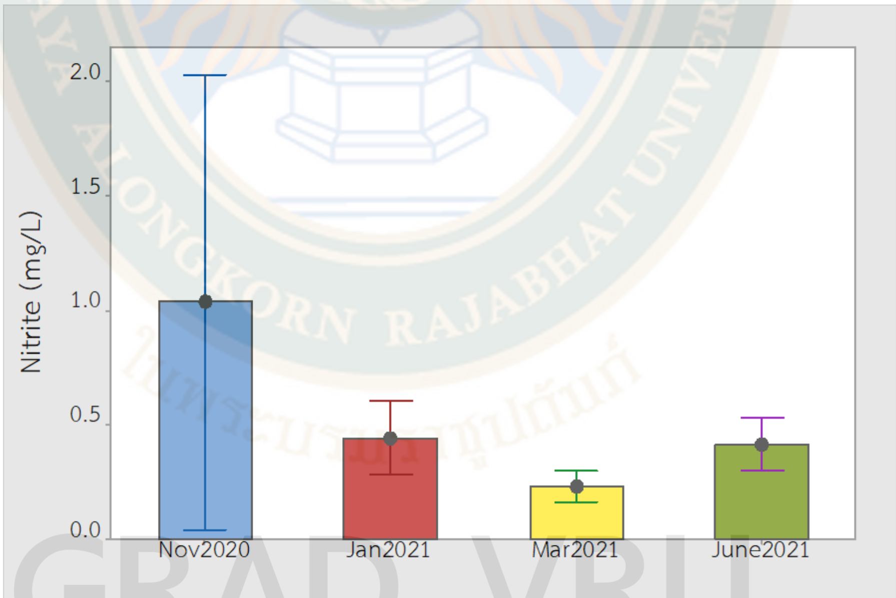


Figure 15 Average of nitrite in four month, Nov 2020 (SD = ±0.4), Jan 2021 (SD = ±0.2), Mar 2021 (SD = ±0.4), and June 2021 (SD = ±0.4).

4.2.4 Phosphate

Phosphate was 0.9 to 6.1 mg L^{-1} in Nov 2020, 0.9 to 6.0 mg L^{-1} in Jan 2021, 0.3 and 3.0 mg L^{-1} in Mar 2021, and 0 to 5.1 mg L^{-1} in June 2021 (Figure 17). The average data in four months were, 2.7 mg L^{-1} in Nov 2020, 2.9 mg L^{-1} in Jan 2021, 1.6 mg L^{-1} in Mar 2021, and 3.4 mg L^{-1} in June 2021 (Figure 17). Comparatively In Jan 2021 was low in four months. In Nov 2020 was normal but in June 2021 was very high. Most station phosphorus can lead to the eutrophication phenomenon in June month 2021. This month was a lockdown and every people stay at the dormitory and work from the dorm. Normally, people using phosphate-based detergent or cleaning products. This is the cause of high phosphate in June month 2021.

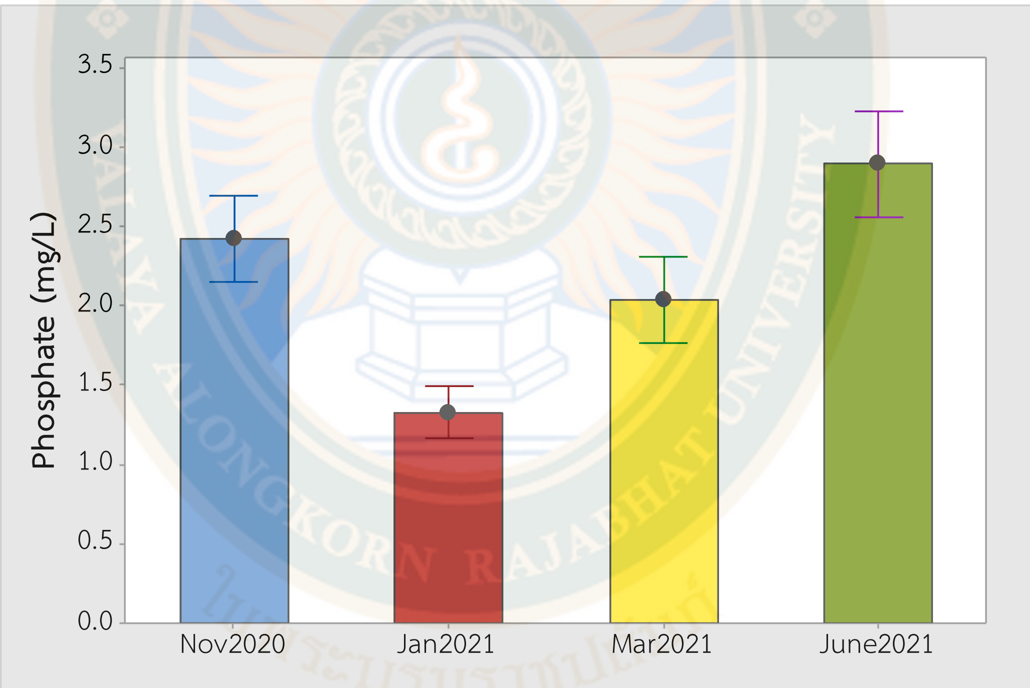


Figure 16 Average of phosphate in four month, Nov 2020 (SD = ±1.8), Jan 2021 (SD = ±1.9), Mar 2021 (SD = ±1.0), and June 2021 (SD = ±1.9).

4.2.5 pH

The pH, in Nov 2020 range was 7.8 to 8.8, in Jan 2021 7.5 to 8.3, in Mar 2021 7.0 to 8.0, and in June 2021 7.0 to 8.0. The pH average data in four months were, 8.3 mg L^{-1} in Nov 2020, 8.1 mg L^{-1} in Jan 2021, 7.6 mg L^{-1} in Mar 2021, and 7.4 mg L^{-1} in June 2021 (Figure 18). The range was normal in each month (Figure 18). In Jan 2021 and June 2021 was comparatively low than Nov 2020 and Mar 2021 because of lockdown (Figure 18).

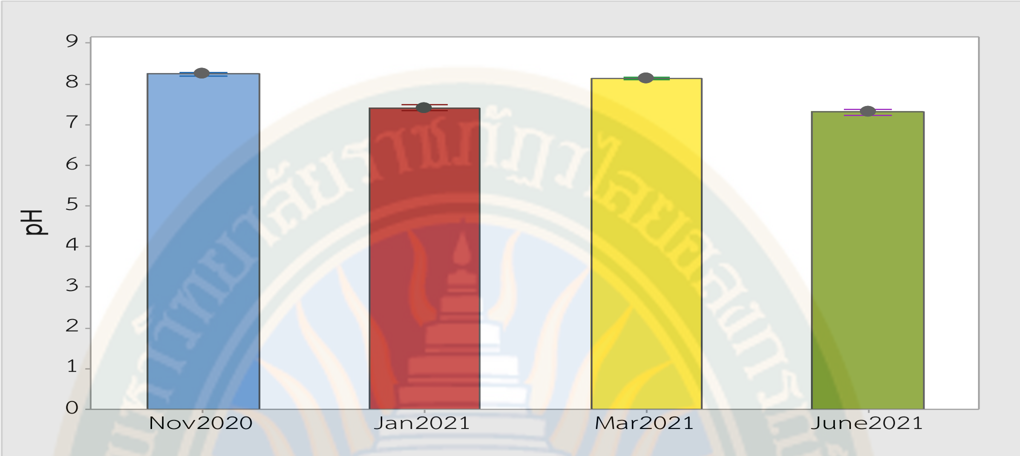


Figure 17 Average of pH in four month, Nov 2020 (SD = ±0.2), Jan 2021 (SD = ±0.2), Mar 2021 (SD = ±0.4), and June 2021 (SD = ±0.4).

4.2.6 DO

This research measured DO in water resources within the four-month study period (Nov 2020, Jan 2021, Mar 2021, June 2021) (Figure 19). The DO average data in four months were, 6.0 mg L^{-1} in Nov 2020, 5.7 mg L^{-1} in Jan 2021, 6.3 mg L^{-1} in Mar 2021, and 4.5 mg L^{-1} in June 2021 (Figure 19). The Nov 2020 data show DO range was between 4.5 and 7.0 mg L^{-1}, while DO in Jan 2021 was between 4.5 and 6.5 mg L^{-1}. The DO of Mar 2021 was within the range of 5.0 and 9.5 mg L^{-1} because of the increase in the number of people. The DO of June was between 2.0 and 7.0 mg L^{-1}.

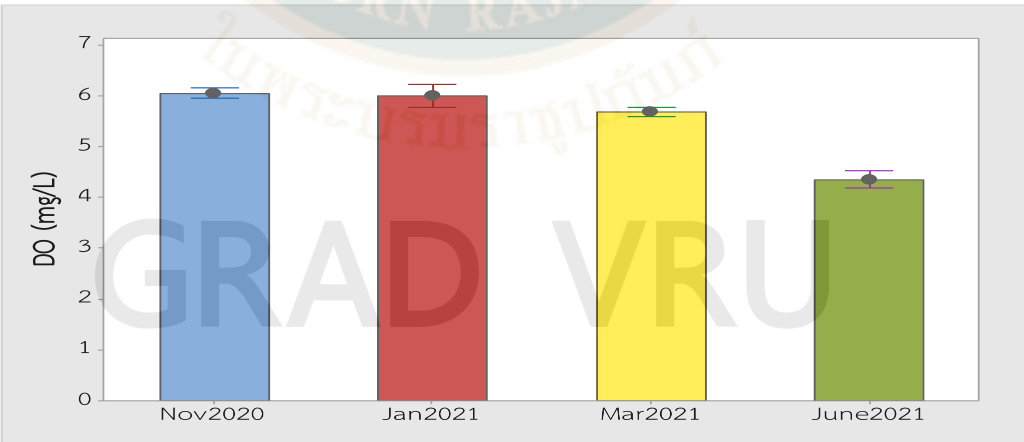


Figure 18 Average of DO in four month, Nov 2020 (SD = ±0.7), Jan 2021 (SD = ±0.6), Mar 2021 (SD = ±1.4), and June 2021 (SD = ±1.4).

4.3 Alteration of Spatial Pollution Compounds to Eutrophication Phenomenon of VRU Area in three months of closing and opening under Corona Virus Disease Circumstances:

This part discussing the TKN and phosphate parameters only 1^{st} month, 2^{nd} month, and 3^{rd} month. The 1^{st} month Nov 2020 was a normal situation (no COVID-19), in Jan 2021 was a lockdown and again Mar 2021 was open (no lockdown). This was the right time to compare in these three stations the normal-lockdown-after lockdown period. The result shows many things in these three months that related to the eutrophication phenomenon.

TKN is organic N in the water bodies. TKN in Nov 2020 was from 0.9 to 26.9 mg L^{-1}. It was 1.0 to 12.0 mg L^{-1} in Jan 2021, and 0.3 to 16.0 mg L^{-1} in Mar 2021. The results show that TKN was in a high range during the working period (Figure 21). P in Nov 2020 was 0.9 to 6.1 mg L^{-1} (Figure 17); in Jan 2021, it was 0.9 to 6.0 mg L^{-1} (Figure 17); in Mar 2021, it stood somewhere between 0.3 and 3.0 mg L^{-1} (Figure 17); and in June 2021, it was 0.0 to 5.1 mg L^{-1} (Figure 17). P is a component in found detergent and cleaning agents that are released into water bodies. It is hard for ordinary wastewater systems to break it down. Therefore, P has appeared in the water bodies. For this situation, P in Jan 2021 is lower than those of Nov 2020 and Mar 2021.

Average and standard deviation of Total nitrogen and phosphate were significantly high between the months (Figure 20). TN was particularly high in Nov 2020 and Mar 2021, while very low in Jan 2021 and June 2021. Figure 21 shows that P and TKN were significantly high between months, especially in station1 (Figure 21).

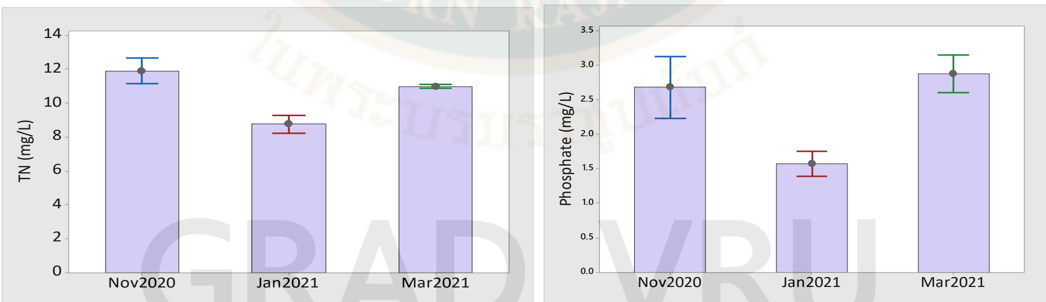


Figure 19 Average of total nitrogen in three month, Nov 2020 (SD = ±3.0), Jan 2021 (SD = ±0.9), Mar 2021 (SD = ±3.0), and phosphate in three month, Nov 2020 (SD = ±1.8), Jan 2021 (SD = ±1.9), Mar 2021 (SD = ±1.8).

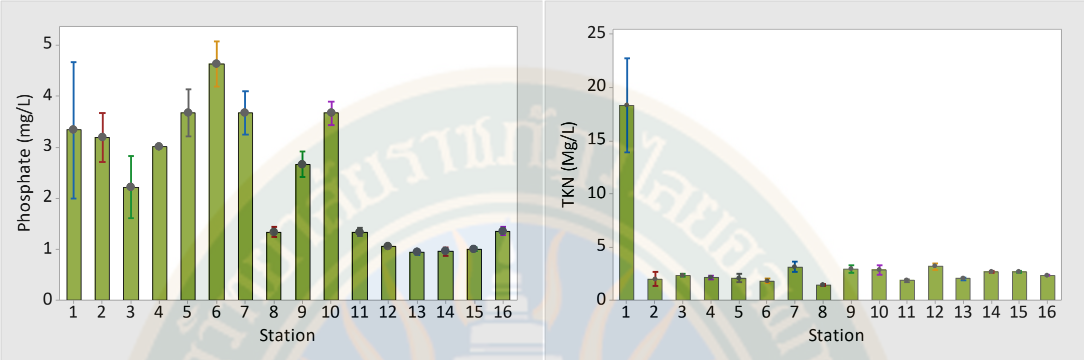


Figure 20 Average of phosphate in sixteen station of three month, Station 1 (SD = ±1.8), Station 2 (SD = ±1.5), Station 3 (SD = ±1.7), Station 4 (SD = ±1.2), Station 5 (SD = ±0.7), Station 6 (SD = ±0.5), Station 7 (SD = ±0), Station 8 (SD = ±1), Station 9 (SD = ±1.0), Station 10 (SD = ±1.0), Station 11 (SD = ±0.6), Station 12 (SD = ±1.6), Station 13 (SD = ±0.2), Station 14 (SD = ±0.7), Station 15 (SD = ±1.5), Station 16 (SD = ±0.0), and TKN in sixteen station of three month, Station 1 (SD = ±7.7), Station 2 (SD = ±1.8), Station 3 (SD = ±0.6), Station 4 (SD = ±0.8), Station 5 (SD = ±0.8), Station 6 (SD = ±1.9), Station 7 (SD = ±1.3), Station 8 (SD = ±2.6), Station 9 (SD = ±0.5), Station 10 (SD = ±2.2), Station 11 (SD = ±2.8), Station 12 (SD = ±0.9), Station 13 (SD = ±1.0), Station 14 (SD = ±0.6), Station 15 (SD = ±0.6), Station 16 (SD = ±0.6).

The eutrophication phenomenon occurred in Nov 2020 at 7 stations and in Mar 2021 at 6 stations during normal situations (no lockdown). We found that only 4 stations had eutrophication phenomenon during Jan 2021. In stations 12, 13, 14, the ratio of N: P was consistently high during the experimental period. It could be concluded that VRU should be concerned with the water quality of those stations (Figure 23).

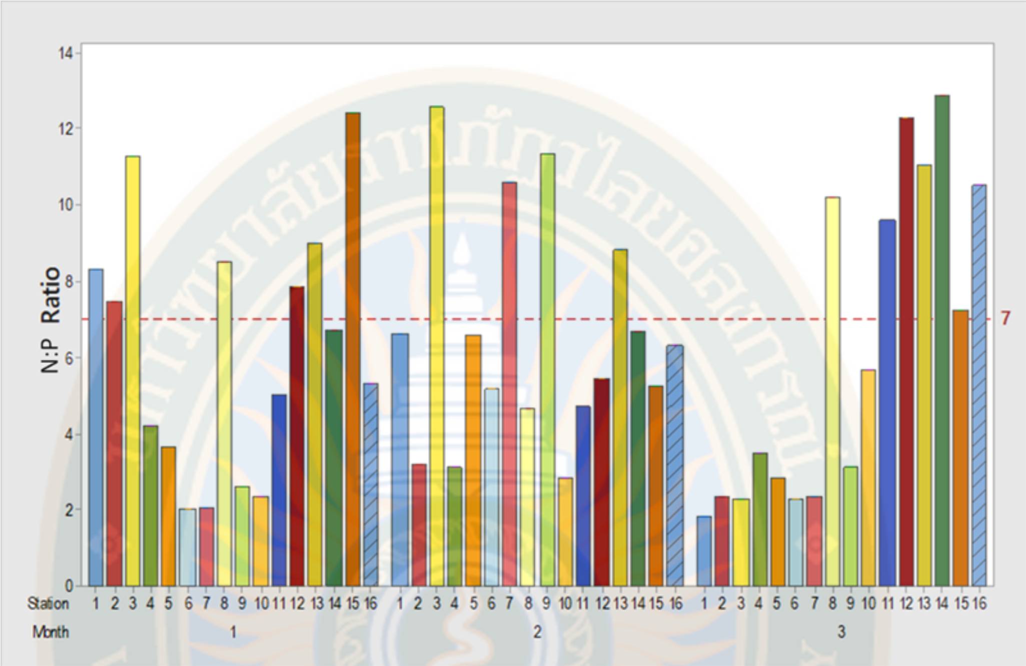


Figure 21 The N: P ratio with reference line (7:1) in each station, the probability of eutrophication phenomenon nutrient concentration in VRU.

In station 12, the sewerage ditch is related to the agricultural demonstration area of VRU. There are many types of agricultural activities. The N: P ratio in Mar 2021 was as high as 12.30:1, and N was the limiting factor. Station 13 is a big pond close to the agricultural demonstration area of VRU. The ratio was high every month, N was the limiting factor. Station 14 is a big pond behind the faculty building. It had a very high N: P ratio and these 3 stations are 1 sewerage ditch and 2 big ponds. DO and light are important factors to the eutrophication phenomenon. The light and DO conditions should be suitable for eutrophication. VRU should be more concerned with these 3 stations as much as we are.

Chemical Oxygen Demand (COD) is a parameter that estimating how much oxygen would be required for the portion of organic matter in wastewater. COD is water quality measured by the active substances and biologically inactive organic matter in water (Khan S. & Ali J. 2018). In the university, the COD was between 83 mg L^{-1} and 30 mg L^{-1} in Nov 2020, in Jan 2021 was 70 mg L^{-1} to 23 mg L^{-1} and in Mar 2021 was 76 mg L^{-1} to 29 mg L^{-1}.

4.3.1 Effect of eutrophication

Due to increasing population, economic development, and increase human activities such as fertilization and agricultural activities, sewage and industrial runoff that challenge water quality (Sinha E. et al. 2017). The process of eutrophication can be greatly accelerated by human activities. The two most acute phenomena of eutrophication are lack of oxygen and algal blooms that produce harmful toxins, processes that can destroy an aquatic ecosystem. Where the eutrophication occurs, the chemical composition of the water such as the excessive alkalinity that occurs during intense photosynthesis. Ammonia toxicity in fish for example is much higher in alkaline waters (Ansari & Gill, 2014). During the later stages of eutrophication, the water body is supported by abundant plant life due to higher levels of nutrients such as nitrogen and phosphorous (Khan & Mohammad. 2014). The environment is faced short-term problems such as effects on aquatic animals, algal growth because of eutrophication. Mostly, in the long-term effect, the environment got climate change, ocean warming, acidification, and major ecological impacts on the aquatic ecosystem and surface water (Jia, et al. 2019). Management should focus on increasing the concentration of nutrients released from human activities (Jessen et al. 2015). The analysis of each station was in three months; the second month (Mar) was lockdown for COVID- 19. The university was closed, the students have chosen to remain in their homes, avoiding public activities and classes in university. Therefore, the results show differences in three months.

4.3.2 Effect of covid-19 on wastewater

The whole world comes to a standstill as many countries shut themselves off from the work due to the novel coronavirus disease pandemic (COVID-19) that hit the world. The impact of covid-19 on the environment is not seen to be direct but is related to human activities (Lim et al. 2021). The virus spread in a short time has brought a decrease in industrial activities, road traffic, and tourism. Restricted human interaction with nature during this crisis time has appeared as a blessing for nature and the environment (Lokhandwala & Gautam, 2020). Due to the pandemic situation, most of the countries of the world are in lockdown. In this period, dramatically change the environment such as climate change, decrease the temperature, carbon emissions have dropped, improvement air pollution, and a reduction in water pollution in many cities (Rupani et al. 2020). However, ecosystems are changing dramatically due to climate change. The restriction of lockdown plays a positive role in recovering the health of the environment. In the megacities, the particulate matter (PM) concentration map shows that the pre lockdown phase indicated a decreased PM concentration but lockdown time a higher decrease in PM concentration (Ghos et al. 2020). These changes directly affect the environment were restricted to interact species from different habitats and thereby it is fully conceivable that climate change can affect air quality. During this periods water pollution is decreased in several cities around the world. Oil and coal are the source of NO_2 pollution and particulate matter. For COVID-19 37% decrease in coal production and a 1/3 reduction in oil consumption (Rupani et al. 2020). The lockdown is likely to help marine life because of the noise and activities on the water stop. The water has become clear. In the presence of mammals, dolphins and seals have been seen in areas where they had not been seen (Lombrana, 2020). When the lockdown started, people are beginning work from home. Fewer people producing less pollution and water quality also recover as well. Balamurugan et al. (2021) reported that due to lockdown the water quality and quantity in many rivers have consequently improved. The COVID-19 pandemic situation is having a major impact on the wastewater treatment plants system. In river Ganga (India), the DO is increasing and BOD, NO^{-}_{3} concentration is decreasing because of close industries, offices, and gathering people (Dutta et al. 2020). The analyzed periods indicate that water consumption drop in industrial and public categories but an increase in residential category in Southern Brazil (Kalbusch et al. 2020). The Yamuna River, of India, has improved significantly since the enforcement of the lockdown that has led to a reduction in the dumping of industrial waste into it (India Water Portal, 2020). Nitrate and phosphate inputs are predominantly derived from agricultural runoff and domestic sewage into the river. The sudden lockdown resulted in the industrial, agricultural discharge usually ends up, and the result shows that the NO^{-}_{3} and PO_4^{2-} ironically decrease as well as DO (Shukla et al. 2021). The spatial variation of the pollutants indicates that industrial effluents are the major source of pollution. The longest freshwater lake in India estimated suspended particulate matter based on an established turbidity algorithm that showed that the SPM concentration decreased an average of 15% on the lockdown period compared to the pre- lockdown period. The maximum value of decreased suspended particulate matter is 8 mg L^{-1} (Yunus et al. 2020).

The Covid -19 was impact to the university. The lockdown is the effect in the university working situation, many classes and offices are closed. The lockdown had many positive impacts on the environment as well as on other areas. At this time the result shows that the nitrogen concentration is decreased and the environment has a positive vibe during the lockdown period. In this period, the gathering of people is prohibited and the classes and office were work from home. Therefore, the concentration of all parameters is a huge difference from Nov 2020 to June 2021.

4.4 Water quality management guideline for university

In guideline was include the activities of each station and the effect of each activity. Such household activities that release wastewater contaminates nitrogen and phosphorus pollution. That can be badly affected by the surface water of VRU. The sources of VRU discharge a huge amount of wastewater into the surface water. All the wastewater come from different sources such as office building, school, canteen laboratory, small health care center, dormitory, etc. The wastewater carrying N and P-based wastewater. The consist amount of N and P can be decreased by taking care of each activity. Moreover, guideline was present how to decrease the pollution of each station and how to protect the water quality of the university. It was showed the pollutant decrease method by taking care of people's activities. People should avoid some product which is bad for the environment such as do not use chemical fertilizer, avoid phosphorus-based cleaning product for cloth or dish, avoid plastics that effect on water and aquatic animal. People can use eco-based products such as cloth bags, eco-based cleaning products for dish wash, cloth wash, and use organic fertilizer etc. It will help the environment.

The land uses and distribution of VRU and the sources of wastewater was presented in guidebook. It was included all sources of wastewater in the university. The land of the university is used for different purposes such as agriculture, dormitory, canteen, buildings, and big ponds. Each land can release wastewater with specific characteristics such as fertilizer contaminate wastewater from agricultural land, chemical contaminate from laboratory or office buildings, phosphorus consists wastewater from the household area, nitrogen contaminates from the canteen or school area. The different sources of the university discharge different types of pollutants from each source. People can easily identify the pollution related to the source in the university. The guideline will provide the knowledge and awareness of using eco-friendly products and the harm of nitrogen and phosphorus toxicity that can lead to eutrophication. People will get more knowledge of their activities in daily life, and they can get more concerned about their product which is using in their life. People should focus on reuse, recycle, and reduce methods to keep clean and safe the environment.

Moreover, this study was discussed the sustainable development goals (SDGs) with VRU conditions. The SDG is accepted by all countries of the world. This is an agenda for peace and prosperity for people and the planet, present and into the future. The development of all countries, ending poverty, improve health education, economic growth reduce inequality are including in SDGs. It is a global partnership for a better world. VRU is concern about SDGs and contributes to a better future. VRU contributes to education, good health, clean water, equality, etc. This contribution will show in the guideline. Finally, this research can be obtained the water management guideline for university (Figure 23).

Figure 22 Cover page and QR code (E-book) of guideline for university.

4.4.1 Sustainable Development Goals

The Sustainable Development Goals (SDG) were set up in 2015 by the United Nations General Assembly, what is known as Agenda 2030. The SDG is a future global development agenda, which is included 17 goals. The SDG goals were accepted by 193 countries under UN resolution (Reference). The 17 goals are:

1. No Poverty,
2. Zero Hunger,
3. Good Health and Well-being,
4. Quality Education,
5. Gender Equality,
6. Clean Water and Sanitation,
7. Affordable and Clean Energy,
8. Decent Work and Economic Growth,
9. Industry, Innovation, and Infrastructure,
10. Reducing Inequality,
11. Sustainable Cities and Communities,
12. Responsible Consumption and Production,
13. Climate Action,
14. Life Below Water,
15. Life on Land,
16. Peace, Justice, and Strong Institutions,
17. Partnership for the Goals.

The SDGs are link related to the university show in Figure 24. Especially the SDG 6 is the main purpose of according to this study and the SDGs 3, 12, and 17 are link to the university to develop in future goals.

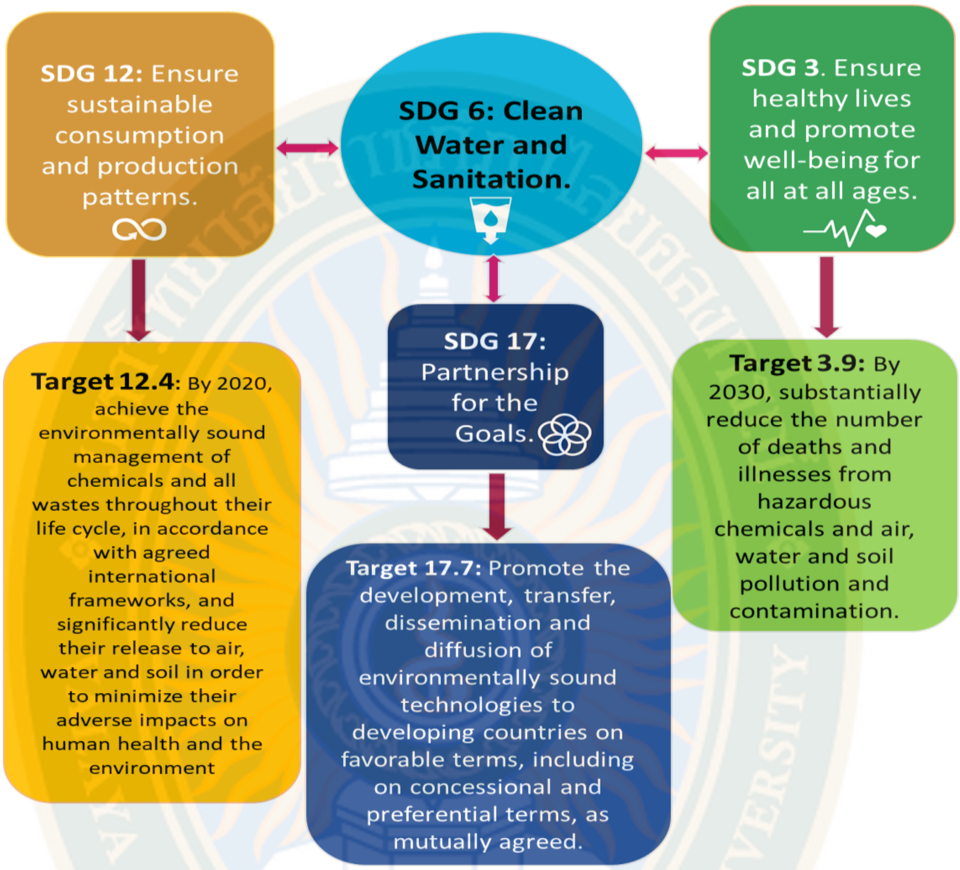


Figure 23 Sustainable Development Goals (SDG) link to water resource in VRU.

The study focused on wastewater monitoring for sustainable development. In the covid-19 circumstances, the result shows that different results at different times. SDG goal 6 is linked to this study. Goal 6 is to ensure availability and sustainable management of water and sanitation for all. The goal has eight targets and eleven indicators for achieving the goal. SDG goal 6 targets and indicators are included improve drinking water quality, wastewater treatment, hygiene improve water quality, restore water-related ecosystems. VRU focused on SDG goal 6. VRU has a wastewater treatment plant, provided good water for drinking, it is safe and hygienic (Figure 25). VRU is more concerned about the safe and reuse of waste and develops the water ecosystem of VRU. This is a track to contribute to SDG goals.

Figure 24 Fresh water ecosystem, wastewater treatment, water ecosystem, safe-hygiene drinking in VRU.

SDG goals 3 is link to VRU. SDG goal 3 is to ensure healthy lives and promote well-being for all of all ages. Goal 3 is targeted to improved health service, increase funding and support to medical research and basic health in developing countries. The 3.9 target is by 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination. VRU has done a lot of planning to reduce household pollution, water pollution, and increase water quality, safe and hygienic environment in VRU. In the Covid-19 pandemic, situation VRU take initiative to help people, provide food and support to recover the country.

VRU follows the SDG of goals 12. According to the 11 targets of SDG 12, use natural resources, reduce food waste, use eco-friendly production, reduce plastic and other waste, focus on recycling and reuse methods. Target 12.4 is referred to achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, reduce hazardous waste release to air, water, and soil in order to impact human health and the environment. VRU has arranged many programs for students to teach reuse and recycling methods, using dustbin follow the rules of reducing, reuse, and recycle. VRU has implemented reduce plastic use and increase the use of more eco-friendly products. VRU is more concerned about rural development, education, innovative management, and environment study (Figure 26). That will help to contribute the goal 12 of SDG.

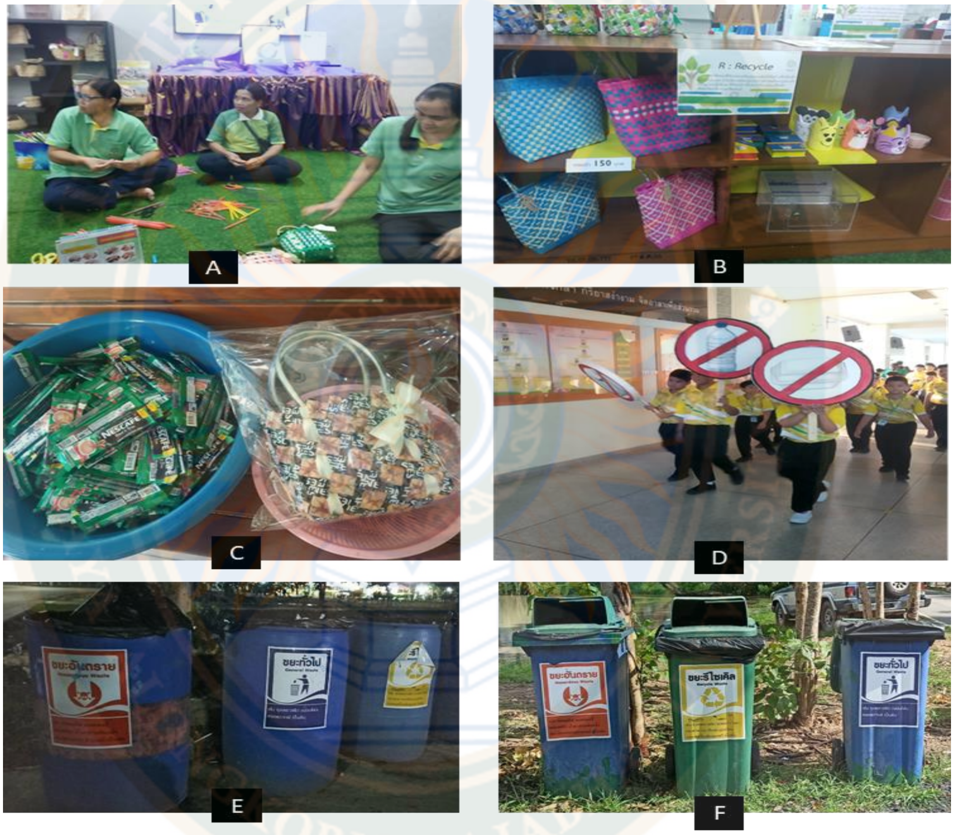


Figure 25 Reuse, recycle and reduce activities in VRU.

VRU has followed SDGs 17, the SDG 17 is strengthening the means of implementation and revitalize the global partnership for sustainable development. VRU helps to promote the development, transfer, dissemination, and diffusion of environmentally sound technologies for development (United Nation Sustainable Goals 17, 5th September 2021).

CHAPTER 5
CONCLUSION

The study focused on state of water quality, investigate and assessment of the water quality at the critical stations, and water management guideline for university, respectively. The growing population, agriculture techniques, modernization are discharging many types of wastewaters. The study prefers to discuss the wastewater concentration and problem of nitrogen and phosphorus pollution of VRU. In background study of this study added that nitrogen and phosphorus pollution can lead to the eutrophication phenomenon. The activities of households, office buildings, canteens, agriculture release high nutrients such as detergent, dishwashing that included phosphorus, and the waste from canteen households included nitrogen. The agriculture of VRU does not use chemical fertilizer in agricultural activities. However, the daily water uses for humans, and the ecosystem depended on surrounding water quality, therefore water resources should be more efficiently used. The conceptual framework of the research was found out the problem and investigate the water quality in VRU by using analytical parameters based on a quantitative analysis of this research, the study's purpose is to make a pocketbook for university. The expected benefits of the research were spatial distribution of water quality data of VRU; the knowledge of water quality distribution in each water station in university; the trend of water quality and eutrophication phenomenon and make a water management pocketbook for university.

The theories of the research discussed the source of pollution and transport process; type of wastewater; point source and non-point source; water quality; standard of wastewater and related research. On the other hand, the research study about the effect of nitrogen and phosphorus on humans and the environment. The quality of water is very important in the environmental and economic aspects. Water quality should be defined as the chemical and biological characteristics of water. The standard of water is necessary to fulfil the suitability of efficient use of water for the designated purpose. This chapter discusses the water quality to measure water in VRU by using parameters as the regulation of building and municipal wastewater standards.

The research investigated four months separately collected the samples and examine water resources in university. The COVID-19 crisis is an important factor for wastewater during the monitoring periods. Because of the COVID-19 crisis, the university follow the guideline and closed in lockdown periods. This is a great impact on the VRU wastewater system. The activities of the university were less than before lockdown periods. Many official workers, students, and professors work from their homes. Therefore, the result shows that the pollution decreased in the lockdown situation. The investigated results were the Nov 2020 data show DO range was between 4.0 and 9.0 mg L^{-1} in Nov 2020, Jan 2021, Mar 2021, and June. But the station 6, 10 and 13 was 3 mg L^{-1} and station 1 was 2 mg L^{-1} in June 2021. Nov 2020, TN was maximum because it was the 'normal situation' (no lockdown). The results show that TKN was in a high range during the working period. Phosphorus in Jan 2021 was lower than those of Nov 2020, Mar 2021, and June because of the COVID-19 lockdown.

Over the trial of spatiotemporal distribution of the water quality found in this study, the profiles of NO^{-}_{3}, NO^{-}_{2}, PO^{-}_{4}, fractions were complex, however main sources of P and N in water at VRU were likely to be attributable to wash off from canteen and dormitory station. Although, P and N considered essential nutrient elements for growth and energy transport of aquatic living organisms. While, it can be lead to eutrophication and the other water environmental effects in VRU. The ratio of N and P compounds in water resources is important to factor that limiting factor and consequently controlled to reduce algae bloom. These phenomenal revealed that COVID-19 lockdown might probably lead to an improvement in the water quality at VRU. It can be concluded that the eutrophication phenomenon can occur with high phosphorus in VRU. The result shows that nitrogen is the limiting factor in most of the stations in VRU. Basically, the sources of households, agriculture activities, dormitories, and office buildings release wastewater containing phosphorus. The ratio of N:P was high during the working period. pH was normal each month. Based on these conclusions, practitioners should consider about activities of VRU and water management policy. Increasing pollution could be an effect on the VRU environment. This research can be found the error of water quality of each station and maintaining the point and non-point sources of wastewater. The present efforts to control eutrophication focus on fixing the past damage with a more effective plan. People should avoid use phosphorus base product, N-P base fertilizer, and make policies to reduce nitrogen and phosphorus uses. This research will recommend that the management of green organizations positively impact their journey towards a sustainable environment. The research suggests that VRU should do further study on increasing the concentration of nutrients released from human activities in the university and the change of environment, aquatic animal, and human health due to eutrophication. Some research needs to do a study about the wastewater treatment plan for new development. VRU should research on target of SDGs that are related to the university. All of results were summarized and created a water quality monitoring manual, which can be used as a guideline for the university to be aware of the wastewater situation in VRU, and for student in environmental class. The manual can use as a dynamic document that will be periodically reviewed and updated as deemed necessary to transform of the VRU policy, especially in gold 6 and 14 of sustainable development goals.

REFERENCES

Ansari, A. A., & Gill, S. S. (2014). **Eutrophication: Causes, consequences and control**. 2.

Amanna, A., Zobolia, O., Krampea, J., Rechbergera, H., Zessnera, M., & Eglea, L. (2018). Environmental impacts of phosphorus recovery from municipal wastewater resources. **Conservation & Recycling**. 130, 127–139.

American Public Health Association-American Water Works Association-Water Pollution Control Federation (APHA-AWWA-WPCF), (2017). **Standard Methods for the Examination of Water and Wastewater, 23rd ed**. APHA, Washington, DC.

Amoatey, P., & Bani, R. (2011). **Wastewater Management, Wastewater Water-Evaluation and Management,** 379-398.

Amoo, T. O., & Komolafe, O. O. (2018). Assessment of water quality parameters in an Artificial Lake, Shouthwestern Nigeria. **Tropical Freshwater Biology**, 27(2), 43-55.

Ashraf, A. M., Mahh, J. M., & Yusoff, I. (2014). **Soil Contamination, Risk Assessment and Remediation**. Retrieved from http://dx.doi.org/10.5772/57287.

Balmurugan, M., Kasiviswanathan, K. S., Ilampooranan, I., & Soundharajan, B. S. (2021). COVID-19 lockdown disruptions on water resources, wastewater and agriculture in India. **Frontiers in Water**, 3, 603531.

Baron, J. S., Hall, E. K., Nolan, B. T., Finlay, J. C., Bernhardt, E. S., Harrison, J. A., Chan, F., & Boyer, E. W. (2013). The interactive effects of excess reactive nitrogen and climate change on aquatic ecosystems and water resources of the United States. **Biogeochemistry,** 114, 71-92.

Buzzards Bay, (1990). National estuary program, Modified from U.S. Fish and Wildlife circular, Restore Chesapeake Bay.

Bilal, M., & Iqbal, M. N. H. (10^{th} June, 2020). Transportation fate and removal of micro plastic pollution- A perspective on environmental pollution. Case Studies in Chemical and Environmental Engineering, in press. **Journal Pre-Proof.** Retrieved from https://doi.org/10.1016/j.cscee.2020100015.

Biondo, A. E., and Bonaventura, L. (2021). Agricultural resources allocation and environmental sustainability. **Journal of Environmental Management and Tourism**, 1(49), 105-113.

Boynton, W., (2016). **Impact of phosphorus on estuarine water quality**. University of Maryland.

Canadian Institute for environmental law and policy, (2002). **Spotlight on sustainability: Managing source of municipal wastewater.**

Camarago, J. A., Alonso, A., & Salamanca, A. (2005). Nitrate toxicity to aquatic animals: A review with new data for freshwater invertebrates. **Chemosphere,** 58, 1255-1267.

Dong, S., Xu, B., Yin S., Han, Y., Zhang, X., & Dai, Z. (2018). Water Resource Utilization and Protection in the Coal Mining Area of Northern China. **Scientific Reports.** 9, 1214.

Dodds, W. K., & Smith, V. H. (2016). Nitrogen, phosphorus, and eutrophication in streams. **Inland Waters,** 6, 155-164.

Dutta, V., Dubey, D., & Kumar, S. (2020). Cleaning the river Ganga: Impact of lockdown on water quality and future implications on river rejuvenation strategies. **Science of the Total Environment**, 743, 140756.

Edokpayai, J. N., Odiyo, J. O., & Durowoju, O. S. (2017). **Chapter 18 Impact of Wastewater on Surface Water Quality in Developing Countries: A Case Study of South Africa.** Intech Open Science. Retrieved from http://dx.doi.org/10.5772/66561.

Environment Agency, (2019). **Phosphorus and freshwater eutrophication pressure narrative.**

European commission, Science for environment policy in depth report, (2013). **Nitrogen Pollution and the European Environment**.

Fan, X., Cui, B., Zhang, K., Zhang, Z., & Shao, H. (2012). Water Quality Management Based on Division of Dry and Wet Seasons in Pearl River Delta, China. **Clean – soil, Air, Water**, 40(4), 381-393.

Ghosh, S., Das, A., Hembram, T. K., Saha, S., Pradhan, B., & Alamri, A. M. (2020). Impact of COVID-19 induced lockdown on environmental quality in four Indian megacities using landsat 8 OLI and TIRS-derived data and mamdani fuzzy logic modelling approach. **Sustainability.** 12(13), 5464.

Grizzetti, B., Lanzanova, D., Liquete, C., Reynaud, A., & Cardoso, A. C. (2016). Assessing water ecosystem service for water resource management. **Environment Science and Policy.** 62, 194-203.

India Water Portal, (2020). **COVID-19 lockdown: Health of Ganga and Yamuna rivers improves.** Retrieved from https://www.indiawaterportal.org/articles/covid-19-lockdown-health-ganga-and-yamuna-rivers-improve.

Islam, F., Lian, Q., Ahmad, Z. U., Zappi, M. E., Yao, L., & Gang, D. D. (2018). Nonpoint Source Pollution. **Water Environment Research**. 90(10), 1872-1898.

Jessen, C., Bednarz, N., V., Rix, L., Teichberg, M., & Wild, C. (2014). Marine Eutrophication. **Environmental Indicators,** 27, 177–203.

Jia, Y., Schmid, C., Shuliakevich, A., Wirtz, H., M., Gottschlich, A., Beek, T., Yin, D., Qin, B., Zou, H., Dopp, E., & Hollert, H. (2019). Toxicological and ecotoxicological evaluation of the water quality in a large and eutrophic freshwater Lake of China. **Science of the Total Environment**, 667, 809-820.

Jung, H. B., Richards, J., & Fitzgerald, A. (2021). Temporal and spatial variations of water quality in the Newark Bay Estuary. **Regional Studies in Marine Science.** 41, 101589.

Kalbusch, A., Elisa, H., Brikalski, M. P., Luca, F. V., & Konrath, A. C., (2020). Impact of coronavirus (COVID-19) spread-prevention actions on urban water consumption. **Resources Conservation and Recycling,** 163-105098.

Kamarudzaman, A., N., Feng, V. K., Azizi, R. A., & Jalil, M. F. A. (2011). Study of Point Sources Pollution- A Case Study of Timah Tasoh Lake in Perlis, Malaysia. **International conference on Environmental and computer Science**. 19, 84-88.

Khan, N. M., & Mohammad, F. (2014). **Eutrophication: Challenges and Solutions.** Eutrophication: Cause, Consequences and Control, 1-15.

Khan, S., & Ali, J. (2018). **Chemical analysis of air and water.** Bioassays, 21-39

Kundu, S., Coumar, M. V., Rajendiran, S., Ajay, & Rao, A. S. (2015). Phosphates from detergents and eutrophication of surface water ecosystem in India. **Current Science,** 108(7).

Li, Y., Shang, J., Zhang, C., Zhang, W., Niu, L., Wang, L., & Zhang, H. (2021). The role of freshwater eutrophication in greenhouse gas emissions: A review. **Science of the Total Environment**, 768, 144582.

Lim, Y. K., Kweon, J. O., Kim, R. H., Kim, K. T., & Lee, K. M. (2021). The impact of environmental variables on the spread of COVID-19 in the Republic of Korea. **Scientific Reports**, 11, 5977.

Lokhandwala, S., & Gautam, P. (2020). Indirect impact of COVID-19 on environment: A brief study in Indian context. **Environmental Research.** 188, 109807.

Lombrana, L. M. (17^{th} April, 2020). **With fishing fleets tied up, marine life has a chance to recover**. The Indian Express.

Mihale, J. M. (2015). Nitrogen and Phosphorus Dynamics in the Water of the Great Ruaha River, Tanzania. **Journal of Water Resources and Ocean science**. 4(5), 59-71.

Ministry of Natural Resources and Environment dated April 7, B.E.2553. (2010). **was issued under the Enhancement and Conservation of National Environmental Quality Act, B.E.2535 (1992).**

Ngatia, L., Grace, M. J., Moriasi, D., & Taylor, R. (2019). **Nitrogen and Phosphorus Eutrophication in Marine Ecosystems. Monitoring of Marine Pollution,** Retrieved from http://dx.doi.org/10.5772/intechopen.81869.

Park, S. W. (2006). **The Sustainable Utilization of Water Resources for a Bio-productive Environment and the Role of Agro-Environmental Education in Korea.**

Peppa, M., Vasilakos, C., & Kavroudakis, D. (2020). Eutrophication monitoring for Lake Pamvotis, Greece, using sentinel-2 data. **International Journal of Geo-Information**, 9, 143.

Popradit, A. (2017). **Effect of community and their Inhabitant Activity on Water Quality in Protected Area in Thailand.**

Qiao, X., Schmidt, A. H., Xu, Y., Zhang, H., Chen, X., Xiang, R., Tang, Y., & Wang, W. (2021). Surface water quality in the upstream-most megacity of the Yang River Basin (Chengdu):2000-2019 trends, the COVID-19 lockdown effects, and water governance implications. **Environmental and Sustainability Indicators**, 10, 100118.

Reta, G., Dong, X., Li, Z., Su, B., Hu, X., Bo, H., Yu, D., Wan, H., Liu, J., Li, Y., Xu, G., Wang, K., & Xu, S. (2018). Environmental impact of phosphate mining and beneficiation: Review. **International Journal of Hydrology**, 2(4), 424-431.

Rodger, B. B., Andrew, D. E., & Eugene, W. R. (2017). **Standard Methods for the Examination of Water and Wastewater, American Public Health Association 23rd edition.**

Roy, R. (2019). An Introduction to Water Quality Analysis. **International Research Journal of Engineering and Technology,** 06(1), 201-205.

Rupani, P. F., Nilashi, M., Abumalloh, R. A., Asadi, S., & Wang, S. (2020). Coronavirus pandemic (COVID-19) and its natural environmental impacts. **International Journal of Environmental Science and Technology,** 17, 4655-4666.

Schelske, C. L. (2009). Eutrophication: Focus on phosphorus. **Science**. 324(5928), 722.

Schulz, W. R., Ulrich, E. A., Elite, M., & Roy, A. (2013). Sustainable use of phosphorus: A finite resource. **Science of the Total Environment,** 461-462.

Selman, M., & Greenhalgh, S. (2010). Eutrophication: Sources and drivers of nutrient pollution. **Renewable Resources Journal.** 26(4):19-26.

Shi, H. (2011). Industrial wastewater – types, amount and effect. **Point sources of pollution: Local effects and its control**, 1.

Shukla, T., Sen, T. S., Boral, S., & Sharma, S. (2021). A time-series record during COVID-19 lockdown shows the high resilience of dissolved heavy metals in the Ganga

River. **Environmental Science & Technology Letters,** 8, 301-306.

Spangberg, J., Tidaker, P., & Jonsson, H. (2014). Environmental impact of recycling nutrients in human excreta to agriculture compared with enhanced wastewater treatment. **Science of the Total Environment,** 493, 209-219.

Sinha, E., Michalak, A. M., & Balaji, V. (2017). Eutrophication will increase during the 21st century as a result of precipitation changes. **Science,** 357, 405-407.

Tangwanichagapong, S., Nitivattananon, V., Mohanty, B., & Visvanathan, C. (2017). Greening of a campus through waste management initiatives: Experience from a higher education, Thailand. **International Journal of Sustainability in Higher Education**, 18(2), 203-207.

U.S department of health and human services public health service, Agency for toxic substances and disease registry, (2017). **Toxicological Profile for Nitrite and Nitrate.**

Va, V., Setiyawn, A. S., Soewondo, P., & Putri, D. W. (2018). The Characteristics of Domestic Wastewater from Office Buildings in Badung, West Java, Indonesia. Indonesian Journal of Urban and Environmental Technology, 1(2), 199-214.

Verma, A., Rawat, K. A., & More, N. (2014). Extent of Nitrate and Nitrite Pollution in Ground Water of Rural Areas of Lucknow, U.P. India. **Current world environment,** 9(1), 114-122.

Viman, O. V., Oroian, I., & Fleseriu, A. (2010). Types of water pollution: point source and non-point source. Aquaculture, Aquarium, Conservation & Legislation. **International Journal of the Bio flux Society,** 3(5), 393-397.

Wang, J., Wang, Q., Hu, J., Yu, H., Liu, C., & Yu, D. (2021). The influence of small-scale resource heterogeneity caused by human activities on the growth phenotype of invasive aquatic plants. **Ecological Indicators**, 125, 107504.

Withers, P. J. A., Neal, C., Jarvie, H. P., & Doody, D. G. (2014). Agriculture and eutrophication: Where do we go from here? **Sustainability**, 6, 5853-5875.

Yan, Q., Cheng, T., Song, J., Zhou, J., Hung, C. C., & Cai, Z. (2021). Internal nutrient loading is a potential source of eutrophication in Shenzhen Bay, Chania. **Ecological Indicators,** 127, 107736.

Yang, S., Liang, M., Qin, Z., Qian, Y., Li, M., & Cao, Y., (2021). A novel assessment considering spatial and temporal variations of water quality to identify pollution sources in urban rivers. **Scientific Reports**, 11(1), 8714.

Yunus, A. P., Masago, Y., & Hijioka, Y. (2020). COVID-19 and surface water quality: Improved lake water quality during the lockdown. **Science of the Total Environment**, 731, 139012.

Zhang, H., Jin, G., & Yu, Y. (2018). Review of River Basin Water Resource Management in China. **Water,** 10(425).

Zhou, Z. (2015). **A global assessment of nitrate contamination in groundwater.** International Groundwater Resources Assessment Center.

APPENDIX

APPENDIX A

RAW DATA OF VRU WASTEWATER CONCENTRATION

NO	Month	Station	pH	DO (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ammonia (mg/L)	TN	Phosphate (mg/L)	N:P Ratio	COD	TKN
1	1	1	8.4	4.5	12.0±0.3	0.3	3.5	15.8±6.0	1.9	8.3	67	26.9
2	1	2	7.8	5.3	10.0±	0.4	4.5	14.9±4.8	2.0±0.0	7.5	30	0.9
3	1	3	8.4	6.9	8.0±0.1	0.3	3.0±	11.3±3.9	1.0±0.0	11.3	66	3
4	1	4	8.7	7	9.0±0.0	0.6	3.0±	12.6±4.3	3.0±0.0	4.2	41	1.4
5	1	5	8.3	5.8	14.3±0.5	1.1±0.0	5.0±0.0	20.5±6.8	5.6±0.1	3.6	68	1.9
6	1	6	8.4	6.5	9.0±0.2	0.7±0.0	2.7±0.2	12.5±4.4	6.1±	2.0	58	1.9
7	1	7	8	5	7.5±0.2	0.0±0.0	2.7±0.2	10.3±3.8	5.0±0.0	2.1	83	6.1
8	1	8	8.4	6.9	7.8±0.1	0.1±0.0	0.5±0.0	8.5±4.3	1.0±0.0	8.5	35	1.4
9	1	9	8.8	7	4.06±0.1	1.3±0.2	2.5±0.0	7.9±1.4	3.0±0.0	2.6	82	5.4
10	1	10	8.3	5.3	9.0±0.0	0.7	2.0±0.0	11.7±4.5	5.0±0.0	2.3	39	1
11	1	11	8.6	5	8.96±0.4	0.6±0.1	0.5±0.0	10.1±4.9	2.0±0.0	5.0	76	2.9
12	1	12	8.3	6.5	9.5±0.2	0.5±0.0	0.4±0.1	10.4±5.2	1.3±0.6	7.8	55	3
13	1	13	8.2	5.8	10.2±0.2	0.1±0.0	0.5±0.1	10.8±5.7	1.2±0.9	9.0	67	3
14	1	14	7.8	6.2	10.5±0.1	0.1±0.0	0.5±0.0	11.2±5.9	1.7±0.6	6.7	45	3
15	1	15	8.1	6.2	10.0±0.0	0.2±0.0	0.5±0.0	10.7±5.6	0.9±0.1	12.4	34	3
16	1	16	8.1	6	9.0±0.0	1.6±0.2	0.5	11.2±4.6	2.1±0.1	5.3	79	3
17	2	1	7.5	4.5	9.5±0.3	1.0±0.0	0.5	11.0±5.1	6	1.8	41	12

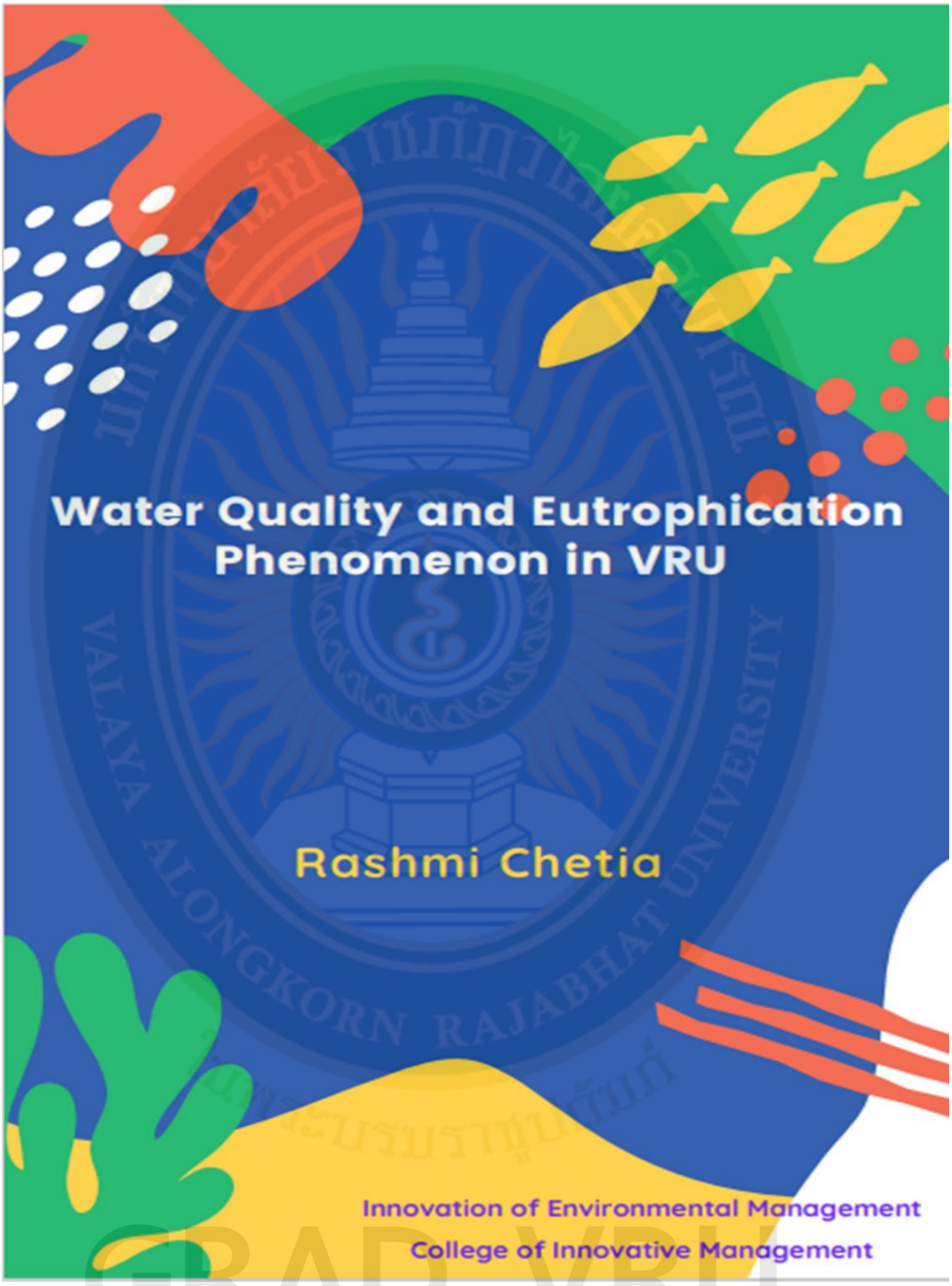
NO	Month	Station	pH	DO (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ammonia (mg/L)	TN	Phosphate (mg/L)	N:P Ratio	COD	TKN
18	2	2	8.2	5.3	10.0±0.0	0.3±0.0	0.5	10.8±5.5	4.6±0.5	2.4	66	1
19	2	3	7.8	6	9.8	0.2±0.0	0.5	10.6±5.5	4.7±0.5	2.3	51	2
20	2	4	8.2	6.5	9.8	0.1±0.0	0.5	10.5±5.5	3.0±0.0	3.5	43	2
21	2	5	8.1	5.8	10.1	0.6±0.0	0.5±0.0	11.3±5.5	4.0±0.0	2.8	38	4
22	2	6	8.2	6.5	10±0.0	0.3±0.0	2.7	13.0±5.1	5.7±0.5	2.3	70	3
23	2	7	8.3	5	9.0±0.0	0.2±0.0	2.5	11.7±4.6	5.0±0.0	2.3	29	2
24	2	8	8.2	6.5	9.5	0.2±0.0	0.5	10.2±5.3	1.0±0.0	10.2	54	1
25	2	9	8.3	6.5	9.8	0.1±0.0	2.5	12.4±5.1	4.0±0.0	3.1	29	1.5
26	2	10	7.9	5.3	9.2	0.1±	2.0±0.0	11.3±4.8	2.0±0.0	5.7	76	1.4
27	2	11	8.2	5	9.0±0.0	0.1	0.5	9.6±5.0	1.0±0.0	9.6	57	1.2
28	2	12	8.2	6	10.5±0.1	0.1	0.45	11.1±5.9	0.9±0.0	12.3	67	1.1
29	2	13	7.8	5.5	10.5±0.1	0.1	0.46	11.1±5.9	1.0±0.0	11.1	45	2
30	2	14	8.1	5	11.0±	0.1	0.5	11.6±6.2	0.9±0.0	12.9	45	2
31	2	15	8.2	5.5	9.0±0.0	0.1	0.5	9.6±5.0	1.3±0.5	7.2	23	2
32	2	16	8.3	6	9.5±0.5	0.1	0.5	10.1±5.3	1.0±0.0	10.5	46	2
33	3	1	8.0±0.0	6.5	8.5	0.1	5.3	13.9±4.2	2.1	6.6	34	16
34	3	2	8.0±0.0	7	9.5	0.1	0	9.6±5.5	3	3.2	40	4

NO	Month	Station	pH	DO (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ammonia (mg/L)	TN	Phosphate (mg/L)	N:P Ratio	COD	TKN
35	3	3	8.0±0.0	9	10.5	1	1.1	12.6±5.5	1	12.6	38	2
36	3	4	8.0±0.0	6	9.0±0.0	0.1	0.2	9.3±5.1	3	3.1	53	3
37	3	5	7.5±0.5	5	9.0±0.0	0.2	0	9.2±5.1	1.4	6.6	29	0.3
38	3	6	8.0±0.0	6	9.5	1.1	0.25	10.9±5.1	2.1	5.2	45	0.5
39	3	7	7.0±0.0	6	9.5	1.1	0	10.6±5.2	1	10.6	29	1.2
40	3	8	7.5±0.5	5	9.0±0.0	0.1	0.25	9.3±5.1	2	4.7	76	1.9
41	3	9	8.0±0.0	9.5	10.0±0.0	1.1	0.25	11.4±5.4	1	11.4	55	1.8
42	3	10	7.0±0.0	5.0±0.0	10.0±0.0	1.1	0.25	11.4±5.4	4	2.8	67	6.1
43	3	11	7.0±0.0	8.0±0.0	4.6	0.1	0	4.7±2.6	1	4.7	41	1.4
44	3	12	8.0±0.0	6.0±0.0	4.8	0.1	0	4.9±2.7	0.9	5.4	39	5.4
45	3	13	8.0±0.0	5.0±0.0	5.2	0.1	0	5.3±3.0	0.6	8.8	32	1
46	3	14	7.0±0.0	5.0±0.0	4.2	0.4	2	6.6±1.9	0.3	22.0	41	3
47	3	15	7.0±0.0	6.0±0.0	4.0±0.0	0.2	0	4.2±2.3	0.8	5.3	32	3
48	3	16	7.0±0.0	5.0±0.0	5.6	0.2	0.5	6.3±3.0	1	6.3	28	2
49	4	1	7.0±0.0	2.0±0.0	10.0±0.0	1.1±0.0	0.03±0.0	11.1±5.5	5.0±0.0	2.2		
50	4	2	7.0±0.0	6.0±0.0	9.0±0.0	0.1	0.0±0.0	9.1±5.2	4.3±0.5	2.1		
51	4	3	80.±0.0	7.0±0.0	9.0±0.0	0.1	0.0±0.0	9.1±5.2	2.0±0.0	4.5		

NO	Month	Station	pH	DO (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ammonia (mg/L)	TN	Phosphate (mg/L)	N:P Ratio	COD	TKN
52	4	4	8.0±0.0	7.0±0.0	9.0±0.0	0.1	0.0±0.0	9.1±5.2	3.7±0.5	2.4		
53	4	5	8.0±0.0	4.3±0.5	10.0±0.0	1.1±0.0	0.0±0.0	11.1±5.5	5.1±0.0	2.1		
54	4	6	7.5±0.5	3.6±0.5	6.9±1.0	1.1±0.0	0.0±0.0	8.0±3.7	5.1±0.0	1.5		
55	4	7	7.5±0.0	4.0±0.0	9.0±0.0	1.1±0.0	0.02±0.0	10.1±4.9	5.1±0.0	1.9		
56	4	8	7.5±0.0	4.0±0.0	9.0±0.0	0.1	0.0±0.0	9.1±5.2	2.0±0.0	4.5		
57	4	9	8.0±0.0	6.0±0.0	9.0±0.0	1.1±0.0	0.03±0.0	10.1±4.9	5.0±0.0	2.0		
58	4	10	7.0±0.0	3.0±0.0	9.0±0.0	0.1	0.0±0.0	9.1±5.2	5.0±0.0	1.8		
59	4	11	8.0±0.0	5.0±0.0	9.0±0.0	0.1	0.0±0.0	9.1±5.2	1.0±0.0	9.1		
60	4	12	7.0±0.0	4.0±0.0	9.0±0.0	0.1	0.0±0.0	9.1±5.2	4.3±0.5	2.1		
61	4	13	7.0±0.0	3.3±0.5	9.0±0.0	0.1	0.0±0.0	9.1±5.2	1.0±0.0	9.1		
62	4	14	7.0±0.0	4.0±0.0	9.0±0.0	0.1	0.0±0.0	9.1±5.2	0.0±0.0	0.0		
63	4	15	7.0±0.0	5.0±0.0	9.0±0.0	0.1	0.0±0.0	9.1±5.2	4.3±0.5	2.1		
64	4	16	7.0±0.0	4.0±0.0	9.0±0.0	0.1	0.0±0.0	9.1±5.2	1.0±0.0	9.1		

APPENDIX B

WATER QUALITY GUIDELINE FOR VRU


Water Quality and Eutrophication
Phenomenon in VRU
Rashmi Chetia
Innovation of Environmental Management
College of Innovative Management

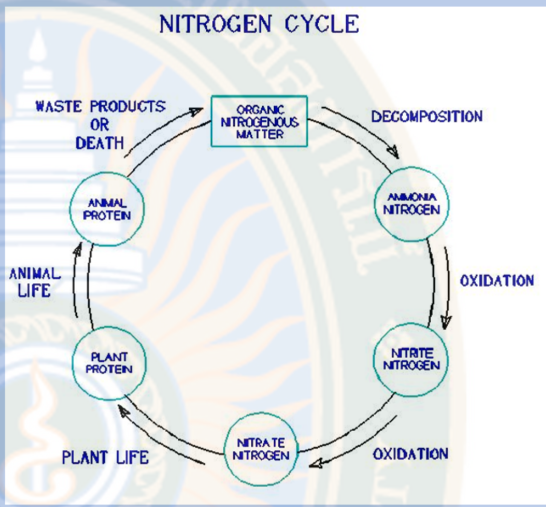
Content

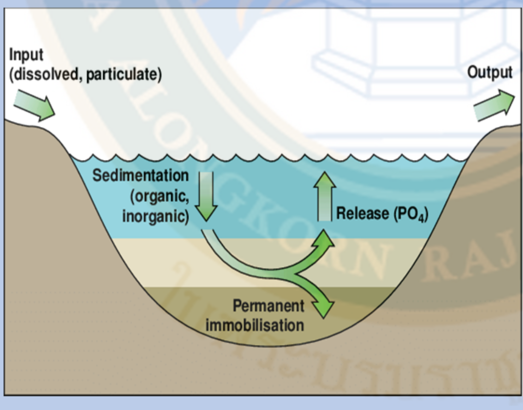
Introduction

The daily water used by humans and in the ecosystem depends on surrounding water quality. The growing modernized agriculture techniques, urbanization, and increasing population play a considerable role in the quality of water and having harmful effects on neighboring watersheds. Although water is considered a renewable resource, it is affected by crops and livestock, agricultural production and use of chemical fertilizers, the high nutrients in urine and faces or household activities, hazardous and industrial waste. The wastewater discharge from those activities contains a high amount of nitrogen (N) and phosphorus (P) toxicity that affects the freshwater quality.

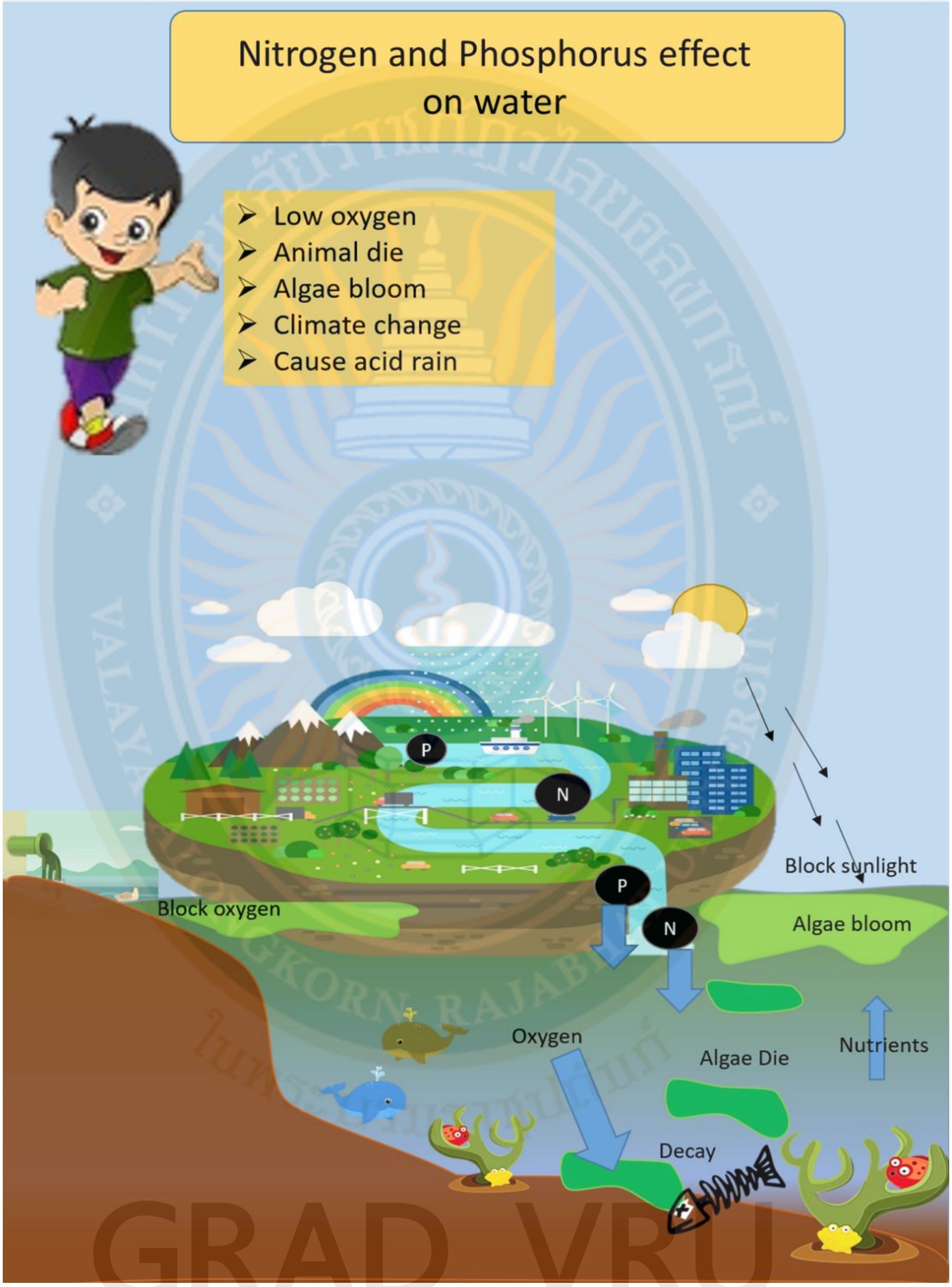
Nitrogen compound and Phosphorus compound in water

Nitrogen compounds: Ammonia (NH_3), Nitrite (NO^-_2), Nitrate (NO^-_3). Nitrogen forms are converted into others compound by nitrification and denitrification process through nitrogen cycle.



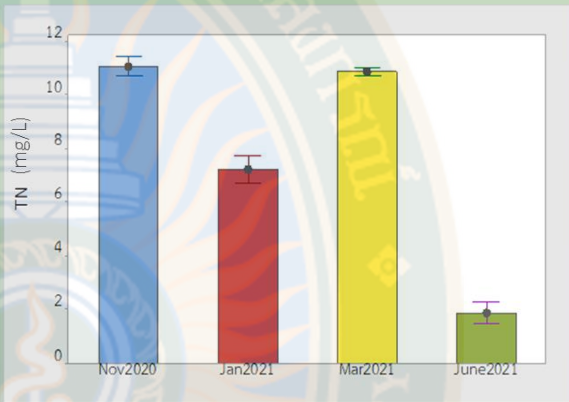


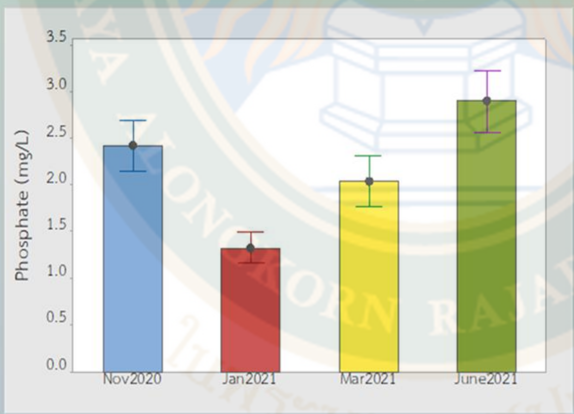
Phosphorus compound: Phosphate (PO_4^-). Phosphorus compounds occur naturally with some common forms, such as phosphate rocks, minerals, bones teeth.


Nitrogen and Phosphorus effect on water
Low oxygen
Animal die
Algae bloom
Climate change
Cause acid rain
P
N
P
N
Block sunlight
Algae bloom
Block oxygen
Oxygen
Algae Die
Nutrients
Decay

Investigate Nitrogen and Phosphorus in VRU

Total Nitrogen and Phosphorus investigated in four month.
1st- November 2020.
2nd- January 2021.
3rd- March 2021
4th- June 2021.





The N and P concentration was different in each month because of Covid-19:
1st month- Normal period.
2nd month- Lockdown period.
3rd month- No lockdown.
4th month- Lockdown.




Land utilization of VRU

The Valaya Alongkorn Rajabhat University under the Royal Patronage has big land. The land is useing for different activities, for example, school, agriculture, big pond, office buildings, dormitory, household, restaurant, cafe, big canteen, etc. In these area has a lot of activities and release a different kind of waste. The study would like to make different groups according to activities.

Group 1: Dormitory and household area.

Station 6, Station 7, Station 8, Station 9, Station 10, Station 11.

Group 2: Office building area.

Station 1, station 2, station 3, station 4.

Group 3: Agriculture area.

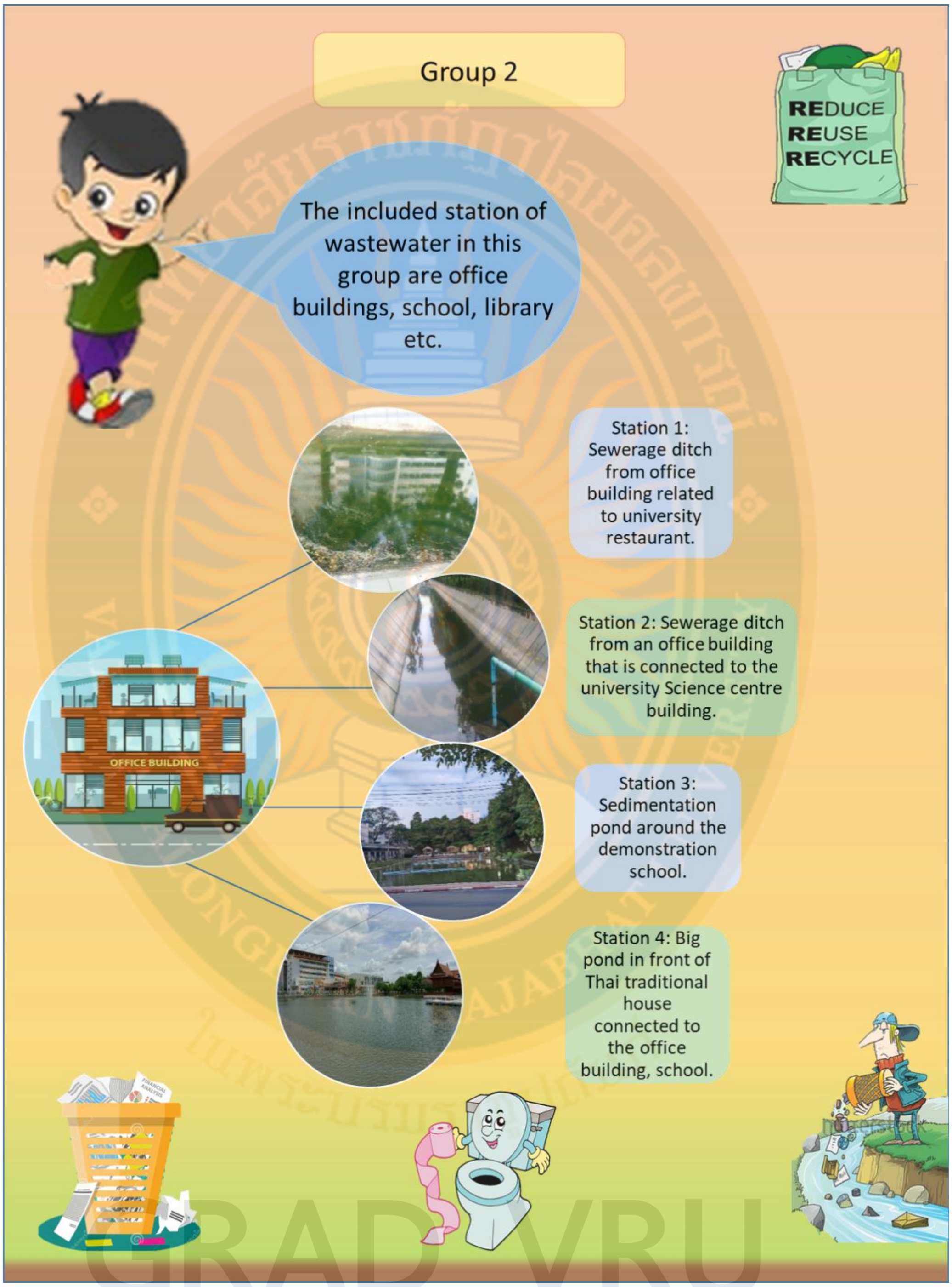
Station 12, station 13, station 14, station 15, station 16

Group 4: Canteen and restaurant area.

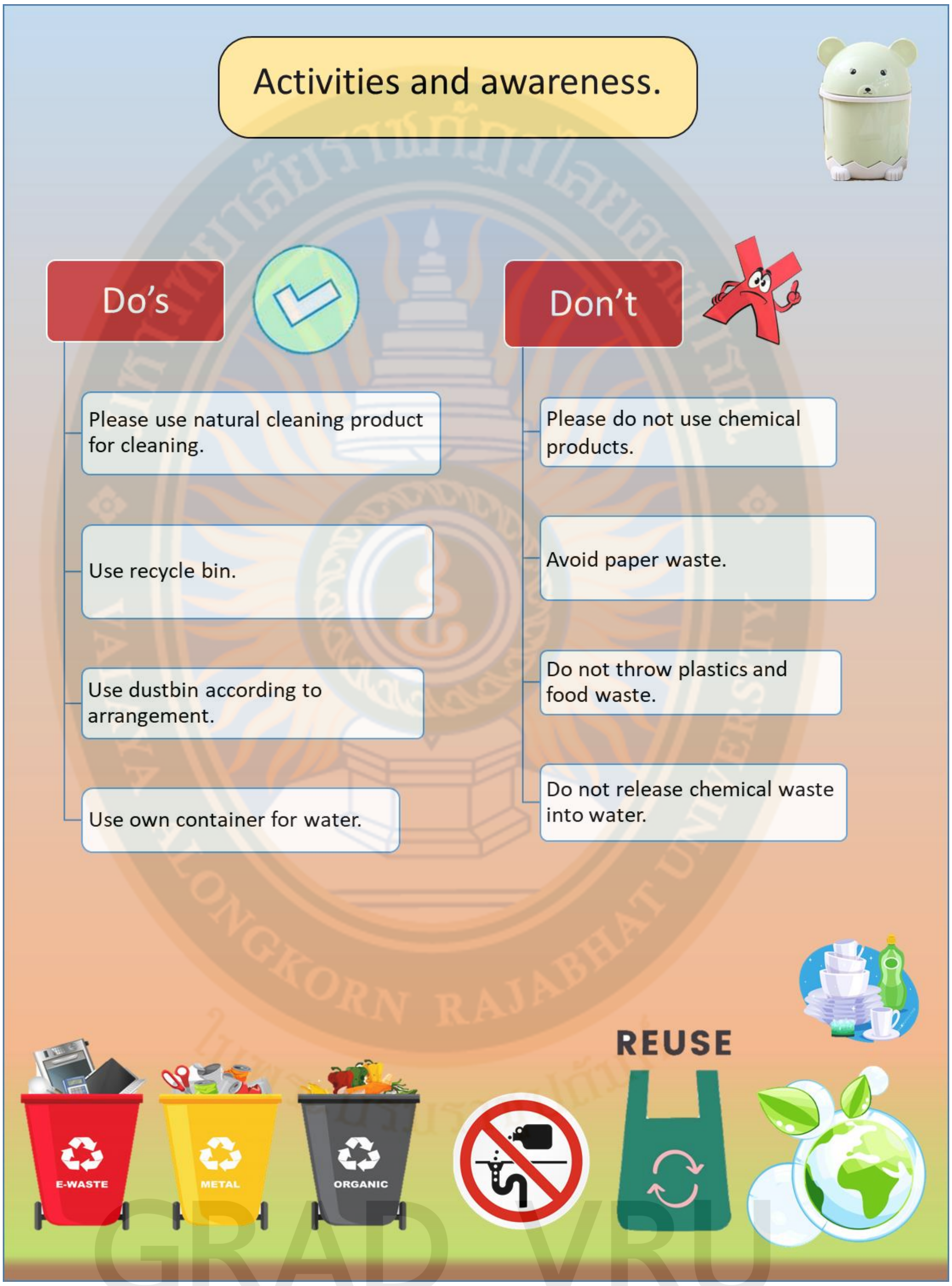
Station 5, station 1


Group 1
Group 1: Dorm and household area.
These stations are normally related to household activities.
Generally, household activities release nitrogen and phosphorus pollution from there solid waste.
Station 6: Near dorm
Station 7: Near school and household area
Station 8: Back of dorm
Station 9: In front of dorm
Station 10: Back of household area
Station 11: In front of household and back of play ground.


Activities and awareness.
Clothe washing and cleaning
The activities of dormitory and household area:
Dish washing and kitchen work.
Toilet, bathroom activities, cleaning and moping.
Do's
Please use organic product for clothes washing.
Use natural cleaning product for cleaning dish. Ex: lemon.
Use dustbin according to arrangement.
Use less water.
Don't
Please do not use more chemical add products.
Avoid using big amount of detergent, liquid dish wash.
Do not throw plastics waste into water.
Do not throw food waste into water.


Group 2
REDUCE
REUSE
RECYCLE
The included station of wastewater in this group are office buildings, school, library etc.
Station 1: Sewerage ditch from office building related to university restaurant.
Station 2: Sewerage ditch from an office building that is connected to the university Science centre building.
OFFICE BUILDING
Station 3: Sedimentation pond around the demonstration school.
Station 4: Big pond in front of Thai traditional house connected to the office building, school.


Activities and awareness.
Many waste from office buildings, school including laboratory and library.
Paper waste
Moping and cleaning
Plastics waste and food waste
Wastewater from toilets and bathroom
Chemical waste from laboratory
1. Wipe
2. Flush
3. Wash


Activities and awareness.
Do's
Please use natural cleaning product for cleaning.
Use recycle bin.
Use dustbin according to arrangement.
Use own container for water.
Don't
Please do not use chemical products.
Avoid paper waste.
Do not throw plastics and food waste.
Do not release chemical waste into water.
E-WASTE
METAL
ORGANIC
REUSE


Group 3
Agriculture area: In this are included 5 stations. VRU concern about agriculture area. Chemical fertiliser not allowed to use in agriculture. Normally use organic fertiliser.
Station 12: Sewerage ditch connected to agricultural demonstration area of VRU.
Station 13: Big pond close to agricultural demonstration area of VRU.
Station 14: Big pond behind the faculty building.
Station 15: Big pond behind the faculty building.
Station 16: Big pond that nearly the buffalo shelter.


Activities and awareness.
Cultivate and harvesting
Plantation
Poultry farm
Fertilizer
Do's
Please use organic compost.
Use organic pesticides.
Use food waste as fertilizer.
Do organic farming.
Don't
Please do not use chemical fertilizer.
No chemical pesticides.
Do not throw plastics and no insecticides.
No more waste and no chemical solution.
ORGANIC
PESTICIDE
FERTILIZER

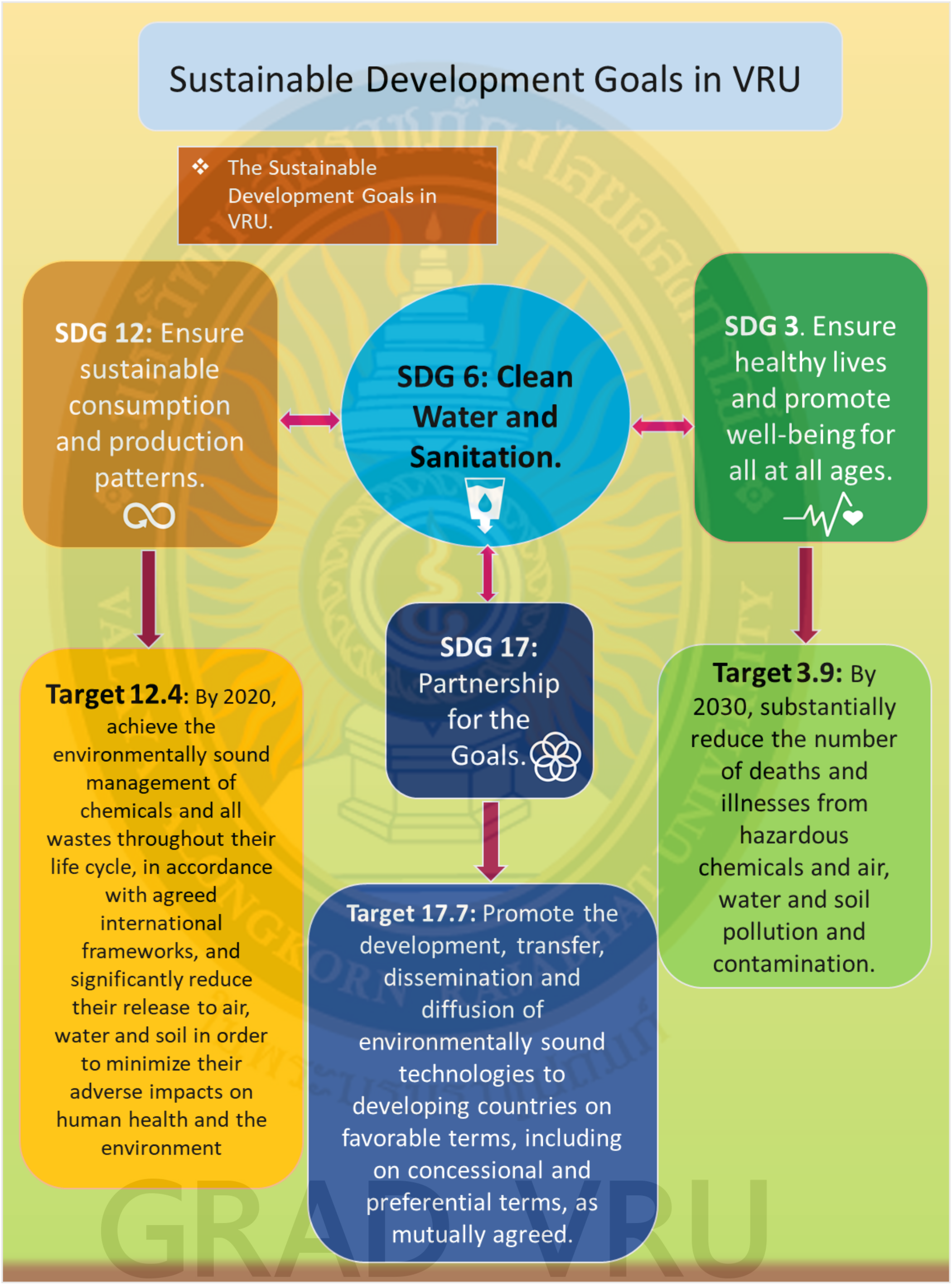

Group 4
Group 4: In this group included canteen and restaurant area. The station 5 is a most visited area for people.
Station 1: Sewerage ditch from office building related to university restaurant
Station 5: Excavated canal connected to VRU coffee shop; it connects to the natural canal outside VRU.
Activities:
Eating, drinking.
cooking
cleaning
Use toilet and hand wash
washing
Boating


Awareness.
Please save our water.
Do's
Please use dustbin.
Use cloths and paper bags.
Bring your own spoon and stick.
Use eco friendly water battle.
Don't
Do not throw garbage.
No plastics bags.
No disposal.
No food waste.
use paper bags


Sustainable Development Goals in VRU
SDG 6 target in VRU:
• Good drinking water quality
• Wastewater treatment plant
• Good water ecosystem
• Safe and hygiene water
6 CLEAN WATER AND SANITATION
Purified
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
SDG 12 target in VRU:
• Use natural resources
• Use eco-friendly products
• Reduce food waste
• Reduce plastics
• Reuse methods
• Recycling methods


Sustainable Development Goals in VRU
SDG 3 target in VRU:
• Help to improve health service in Covid-19 pandemic situation.
• Increase water quality to safe and hygiene.
• Work to reduce hazardous, air, water and soil pollution.
3 GOOD HEALTH AND WELL-BEING
17 PARTNERSHIPS FOR THE GOALS
SDG 17 target in VRU:
• VRU helps to promote environmentally sound technologies for development.


Sustainable Development Goals in VRU
➢ Collecting to analyze the wastewater in VRU to protect human health and environment.
➢ Collecting sample from each station.
➢ Sampling wastewater of each station.
➢ Monitoring the quality of wastewater discharge from canteen and household area of VRU.
➢ Measuring the concentration of wastewater by using test kit.
➢ Measuring DO concentration by DO meter.
GRAD VRU


Sustainable Development Goals in VRU
The Sustainable Development Goals in VRU.
SDG 12: Ensure sustainable consumption and production patterns.
SDG 6: Clean Water and Sanitation.
SDG 3. Ensure healthy lives and promote well-being for all at all ages.
SDG 17: Partnership for the Goals.
Target 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
Target 17.7: Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favorable terms, including on concessional and preferential terms, as mutually agreed.
Target 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
GRAD VRU

Reference

1. Ansari, A. A., & Gill, S. S. (2014). *Eutrophication: Causes, consequences and control*, vol-2.
2. Dodds, W. K., & Smith, V. H. (2016). Nitrogen, phosphorus, and eutrophication in streams. *Inland Waters,* vol-6:155-164.
3. Environment Agency, (2019). *Phosphorus and freshwater eutrophication pressure narrative.*
4. United Nation Sustainable Goals 17
5. https://www.un.org/sustainabledevelopment/

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