RESEARCH PROPOSAL

GROUP 1 WATER RESOURCE QUALITY ASSESSMENT

<u>Group Members</u>

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Chapter 1
Introduction

The Dong Nai river basin is located in the Central Highlands of Vietnam and connects to the Saigon river, which is near the Northern part of Ho Chi Minh City (Figure 1). It covers around 49,600 square kilometers, which include 11 provinces of Vietnam. The population in that area is around 3.47 million. The tropical climate experiences both a rainy season (May – November) and a dry season (December – April). Problems in the area for both water quantity and water quality are different in the different seasons. In the rainy season, flooding is the main issue. On the other hand, drought and water pollution are prevalent problems during the dry season. The Dong Nai river basin provides great benefits to Ho Chi Minh City and the surrounding provinces. For example, the irrigation water for rice cultivation is primarily from the river. It also generates a substantial amount of electricity for Ho Chi Minh City through hydropower dams. The dams also create water reservoirs or water storage in order to maintain water levels during the dry season and reduce sea water intrusion in the area. Moreover, the river basin is considered as the main source for drinking water in Ho Chi Minh City. However, the river basin has been facing numerous challenges with deforestation, rapid urbanization, industrial growth, and economic growth. The potential pollution sources are from several different sources, including industrial and processing zones, industrial clusters, landfills and solid waste processing sites, outlets and confluences of canals, as well as deforestation. These driving forces might have impacts on the water quality scenario in this area. In addition, climate change will also impact the river basin, which will affect both human life and ecosystem services, including water quality. Therefore, an integrated water quality assessment of the upperstream of the Dong Nai river basin is needed for this area. Moreover, an integrated water quality dataset is believed to be a beneficial resource for the water resource managers in the area.

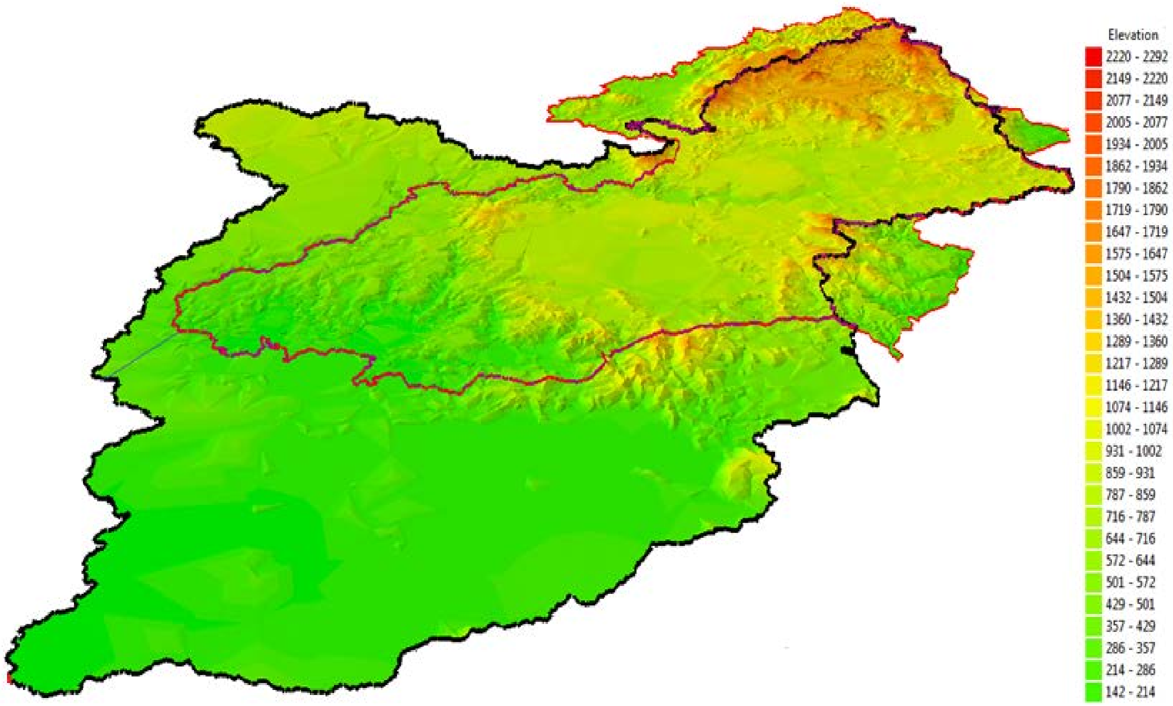

Figure 1 Study Area of the Dong Nai River Basin

Chapter 2
Statement of the problem

2.1 Statement of the problem

The water quality of the Dong Nai river basin needs to be studied comprehensively because of the area's importance as a drinking water supply for Ho Chi Minh City. Therefore, water quality should be ensured so that no contaminants exceed levels that would affect human health. However, this study area has had limited research conducted about its water quality, including by regulatory bodies charged with the control of the water quality. In addition, pollution sources need to be identified and a map created to illustrate the contaminated sites. Finally, this study will be able to be used in the Master Plan of Vietnam.

2. 2 Objectives

1. To characterize the surface water in the dry season and in the rainy season of the study area based on three water quality parameters (e.g. physical, chemical, and biological).
2. To construct a water quality index (WQI) for the river basin based on the studied water quality parameters and compare the WQI with the existing water quality standard in Vietnam and other countries
3. To prepare spatio-temporal maps for the critical pollutants using advanced GIS tools to visualize pollution dissemination patterns in the study area
4. To propose solutions to support the master Plan of the local/state government regarding water resources management issues in changing climate

Chapter 3
Methodology

3.1 Water quality parameters

The Dong-Nai river basin is the source of drinking water forHo Chi Minh City, Vietnam; therefore, water the quality of in the area should be considered of paramount importance.

3.1.1 Parameters

All parameters that will be covered in this study are included: physical (temperature, conductivity/salinity, turbidity, and TDS), chemical (pH, as well as concentrations of PO_4^{3-}, NH_4^+, DO, BOD_5, COD, and heavy metals such as Pb, Hg, Cd, Cu, Cr, Mn, etc.), and biological (*E.coli* and *coliform*)

3.1.2 Monitoring time and frequency

The sampling frequency will be every month for 21 months. Samples will be taken on the 15^{th} of each month. Moreover, during each sampling occasion, samples will be taken twice a day corresponding to the highest and lowest water level.

3.1.3 Sampling methodology, preservation, and analytical method

Samples will be taken in the middle of the river, 30mm below the surface. Techniques for sample collection and preservation of water will be adapted from the U. S. Environmental Protection Agency (1983) as showed in **Table 1.**

Table 1: Sampling methodology and preservation

Parameters	Containers	Preservation Conditions	Volume (mL)	Maximum preservation duration
pH	Plastic or Glass	-	25	Analyze immediately
Temperature	Plastic or Glass	-	1000	Analyze immediately
Turbidity	Plastic or Glass	4 °C	100	48 hours
TDS	Plastic or Glass	-	1000	28 days
DO	Glass	-	300	Analyze immediately
BOD_5	Plastic or Glass	4 °C	1000	48 hours
COD	Plastic or Glass	4 °C	50	28 days
NH_4^+	Plastic or Glass	4 °C and H_2SO_4 @pH < 2	400	28 days
PO_4^{3-}	Plastic or Glass	4 °C and H_2SO_4 @pH < 2	50	28 days
Cl^-	Plastic or Glass	-	50	28 days
Pb	Plastic or Glass	HNO_3 @ pH<2	100	6 months
Cd	Plastic or Glass	HNO_3 @ pH<2	100	6 months

Cu	Plastic or Glass	HNO_3 @ pH<2	100	6 months
Cr	Plastic or Glass	HNO_3 @ pH<2	100	6 months
Mn	Plastic or Glass	HNO_3 @ pH<2	100	6 months
E. Coli	Plastic or Glass	4 °C, Dark	300	48 hours
Coliform	Plastic or Glass	4 °C, Dark	300	48 hours
Oil & Grease	Glass	4 °C	1000	28 days

The analytical methods for identifying pollutants are demonstrated in **Table 2.**

Table 2: Analytical methods form U. S. Environmental Protection Agency

Parameters	Analytical methods
pH	150.2 Continuous Monitoring (Electrometric) by pH Meter
Temperature	-
Turbidity	180.1 Turbidity by Nephelometry Revision 2.0
TDS	160.1 Gravimetric, Dried at 180 degrees C
DO	-
BOD_5	405.1 Biochemical Oxygen Demand
COD	410.3 Chemical Oxygen Demand (Titrimetric, High Level for Saline Waters) by Titration
NH_4^+	350.1 Ammonia Nitrogen by Semi-Automated Colorimetry Revision 2.0
PO_4^{3-}	365.1 Phosphorus by Semi-Automated Colorimetry Revision 2.0
Cl^-	300.0: Determination of Inorganic Anions by Ion Chromatography Reversion 2.1
Pb	200.7 Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry Revision 4.4

Cd	200.7 Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry Revision 4.4
Cu	200.7 Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry Revision 4.4
Cr	200.7 Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry Revision 4.4
Mn	200.7 Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry Revision 4.4
E. Coli	1604 Total Coliforms and *Escherichia coli* in Water by Membrane Filtration Using a Simultaneous Detection Technique
Coliform	1604 Total Coliforms and *Escherichia coli* in Water by Membrane Filtration Using a Simultaneous Detection Technique

3.2 Water quality standard and water quality index preparation

A water quality standard can be used to define the designated beneficial uses of water be defining water quality that is needed to support those uses. The minimum beneficial uses to be considered in order to establish the standards which are assigned different purposes; for example, drinking water supplies, recreation, agricultural uses, industrial uses, and navigation. Moreover, a requirement specifies the standards have to protect public health and welfare. The water quality standard which as reported by the U.S. EPA on selected parameters is show in **Table 3**

Table 3: Water quality standard on selected parameters (U. S. Environmental Protection Agency, 2001)

Parameters	Value	Unit
pH	5.5 – 9	-

Temperature	-	-
Turbidity	-	-
TDS	-	-
DO	>50%	%saturation O_2
BOD_5	5	mg/L O_2
COD	40	mg/L O_2
NH_4^+	1.5	mg/L
PO_4^{3-}	0.7	mg/L
Cl^-	250	mg/L
Pb	0.05	mg/L
Cd	0.005	mg/L
Cu	0.1	mg/L
Cr	0.05	mg/L
Mn	0.3	mg/L
E. Coli	-	-
Coliform	5000	no/100mL

Comparing water quality standards may not make people clearly understand the complexity of the water situation. In this kind of evaluation, individual parameters are compared with standards. Hence, a water quality index should be created in order to give information to the public in an easier manner.

A water quality index is defined as a weighted average of selected ambient concentrations of pollutants, usually linked to water quality classes. It can be used as an indicator for a water body's given situation, in which several parameters will be used for evaluating the quality and expressed as numeric results. It can help government officers or managers to regulate the water quality with more ease and provide understandable information to the public. Several countries have established a water quality index that focuses on different parameters in order to make it suitable for their situation. For example, RPI, which is the water quality index of Taiwan, evaluates 4 parameters that consists of DO, BOD_5, suspended solids, and ammonium. For Malaysia, the water quality index based on 6 main parameters as follows: concentrations of BOD, COD, ammonium, pH, DO, and suspended solid. In addition, Thailand also has an index for water quality that considers 4 parameters: concentrations of DO, total coliform bacteria, fecal coliform bacteria, and BOD.

According to the purposes of water uses in Dong Nai river basin, any water quality index used should emphasize the problems in that area, which will be based on diverse parameters. Therefore, the water quality index will be developed in 3 steps as follows (Thi Minh Hanh, Sthiannopkao, The Ba, & Kim, 2010):

1. Parameter selection

The water quality parameters will be set by these criteria. The parameter should represent overall water quality status and reflect each impairment category for a water system, including physical characteristics, oxygen content, nitrogen content, and human health aspects. In addition, parameters that are often monitored and have known key effects on water quality should also be selected.

2. Rating curves method application

This method will help to transform the concentrations of water quality variables into a quality score

3. Hybrid aggregation function and multiplicative forms

The water quality index will be performed by aggregating all parameters to produce a final index score.

Once all information about the situation of the water body, water usage purposes, and other the key factors of this area are obtained, an appropriate water quality index will be selected for the water quality parameters evaluated in the study.

3.3 Study maps of water pollution in the Dong-Nai river basin

Maps of water pollution in Dong-Nai river basin will be adapted from ArcGIS. Maps assist in selecting areas for sampling and application of mathematical models to predict boundaries of water pollution.

ArcGis is a geographic information system (GIS) for working with maps and geographic information. GIS has played a major role in the development of distributed hydrologic models and in improving our understanding of the spatial aspects of the distribution and movement of water in various landscapes

GIS Data is an important part of a GID project. The data sources include primary data (such as data from surveys, field data collection, and remote sensing) as well as secondary data from other data sources. The sampling density and approaches to sampling depend on the area and objective.

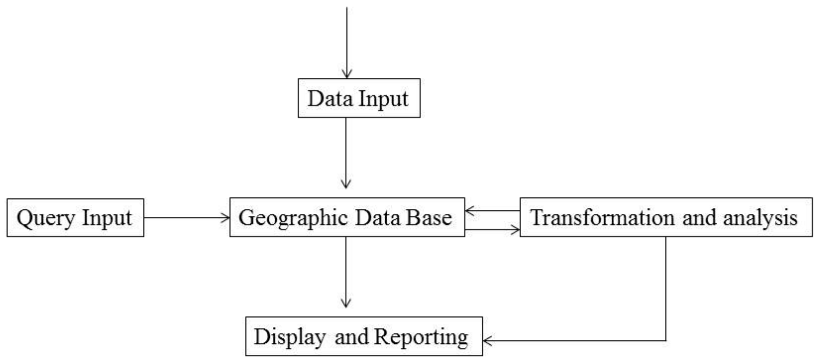

Figure 2 Components of computer-based GIS (ESRI, 2017)

3.4 Propose the study to the government

The water quality assessment study will be very important to assess the overall water resources management issues in the Dong Nai river basin. The water quality is a dynamic phenomenon. The proposed study will be a possible way of water quality monitoring activities for the development master plan of the country. This study can be able to establish some key issues of water quality that can be very useful to design the water management plan for the Mekong delta. We will establish a complete water quality dataset which is believe to become a suitable baseline setup to model the water resources supply and managements by the government and other organizations. This study will set a suitable monitoring pathway for the regular checkup of water quality in Vietnam.

Chapter 4

Limitation and Boundary

To ensure representative water sampling and subsequent quality analysis this project has some challenges to maintain the procedures and spatiality. This project will consider all such difficulties for quality assurances. Our considerations are as following table;

Table 4: Summary study's limitations and overcome methods

SL. No	Assumptions	Overcome
1.	a. Sampling point selection and maintaining sampling throughout the year. b. Administrative difficulties in point sources of pollution.	a. Alternative representative sampling points b. Discussion with stakeholders before implementation.
2.	a. Sample quantity and preservation: handling huge amounts of water samples	a. Ensure backup storage of samples with analysis facilities.
3.	a. Correlation between diverse factors like point and nonpoint pollution sources	a. We will select the best tools for data analysis, including the best models for correlations
4.	a. Logistics during rainy seasons and skilled personnel	a. We will ensure suitable logistics and prior training for the personnel during project implementation.
5.	a. Technical difficulties in studying metal enrichment in river waters	a. We have planned to collect river sediment samples where necessary.

Chapter 5

Expected outcomes and timeline

1. Identification of possible sources of contamination in the water resources and contamination percentage for individual pollutants per unit of water.
2. Propose a water quality index for Dong Nai river basin for the people in the study area as well as for those charged with managing the basin
3. Draw spatial distribution maps for major pollutants of the study area to facilitate understanding of pollution sources
4. Provide suggestions to water resource management planners regarding the usability of the water in the study area in terms of quality

Timeline

Planned submission:3 months		Expected time to complete the project:30 months									
Project component	**Time (e.g. month)**	3	6	9	12	15	18	21	24	27	30
Literature review			15								
Data collection					21						
Data analysis/ model development					24						
Policy recommendation											6
Write up											12

References

Thi Minh Hanh, P., Sthiannopkao, S., The Ba, D., & Kim, K.-W. (2010). Development of water quality indexes to identify pollutants in Vietnam's surface water. *Journal of Environmental Engineering, 137*(4), 273-283.

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