

# The database management framework for combined sewerage system of Phu Loc river basin in Danang city by GIS

*Ha Quan Tran*<sup>1\*</sup>, *Van Quang Tran*<sup>1</sup>, *Thi Kim Thuy Phan*<sup>1</sup> and *Elena Gogina*<sup>2</sup>

<sup>1</sup>University of Science and Technology, The University of Danang, 550000, 54 Nguyen Luong Bang, Da Nang, Vietnam

<sup>2</sup>Moscow State University of Civil Engineering, Yaroslavskoye Shosse, 26, Moscow, Russia

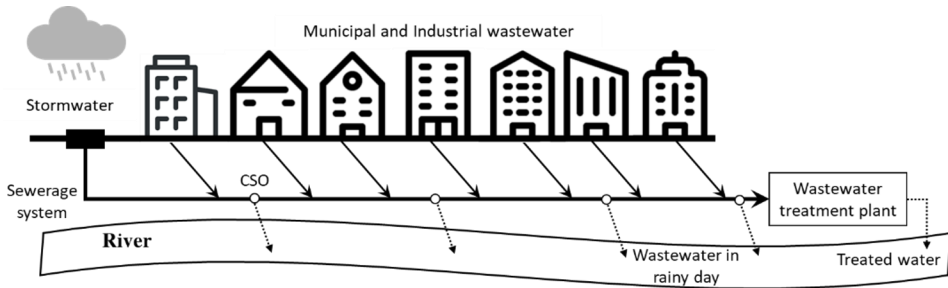
**Abstract.** Nowadays, Geographic Information Systems (GIS) applications have provided tools to integrate information, visualize scenarios, present powerful ideas, and develop effective solutions like never before so that it supports strategic decision making. Based on the advantages of GIS applications, the main goal of database management framework is simulation and visualization combined sewerage system and water quality data of Phu Loc river, Da Nang city via QGIS software. Although the length of the river is only 1.9 km, the Phu Loc river was discharge point of drainage basin in the northwest area of Da Nang city with a total area of more than 3500 hectares, which included 5 urban lakes, the municipal wastewater treatment plant with capacity over 40000 m<sup>3</sup>/d. After transform and organize data from other source to QGIS, the researchers created a database management framework for sewerage system with relation model for each group of data. Based on process digitalization data of water quality, QGIS software should presented type of digital map of Phuloc basin area with construction of combined sewerage system for basin area and water quality index for river and urban lakes.

## 1 Introduction

Based on urbanization and economy, Danang city is the third largest city in Vietnam, located on the coast in the central region and on the North – South transportation axis. Similar to major cities in a developing country, the Ministry of Construction in Vietnam and the government of Danang city have focused to infrastructure development as a key to economic growth [1]. Therefore, the sewerage system should be guaranteed in terms of design, construction, operation and maintenance not only to serve the strengths of city such as services and tourism but also to ensure the sustainable development. However, the combined sewage system still has been applied in Danang city, and the database management on collected wastewater system and water quality still fragmented and lacks linkage due to the domestic wastewater from households has been mixed with rain water and industrial wastewater in local area before being treated in wastewater treatment plants.

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\* Corresponding author: [thquan@dut.udn.vn](mailto:thquan@dut.udn.vn)



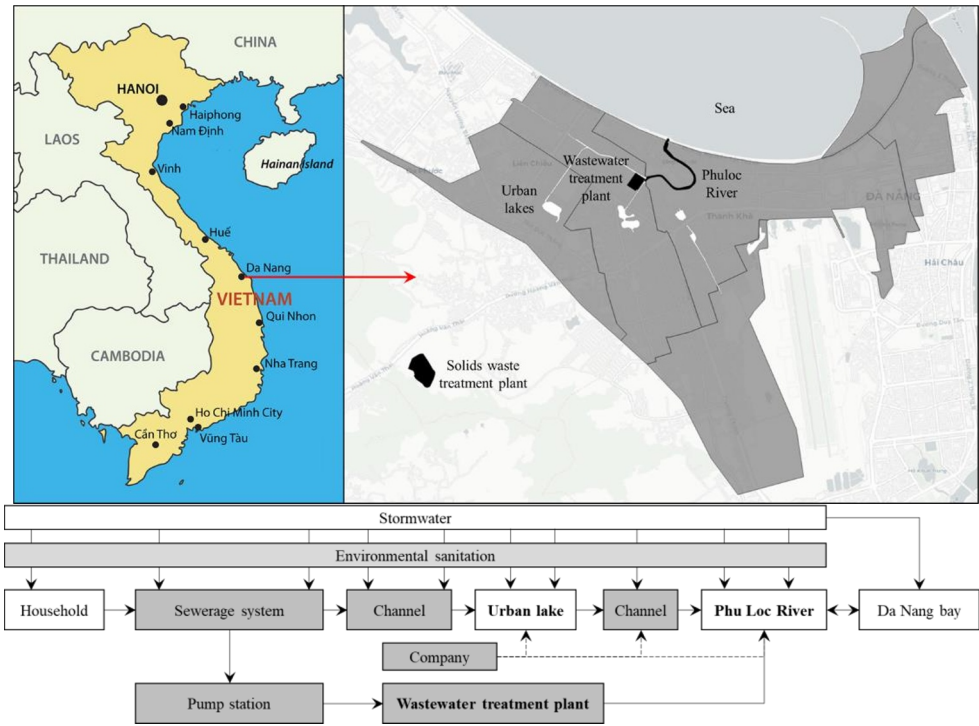
**Fig. 1.** Combined sewerage system in Danang city

To solve the above problems, the Geographical Decision Support System has been widely applied in Environmental Assessment and Planning. Among them, Geographic Information Systems (GIS) applications have provided tools to integrate information, visualize scenarios, present powerful ideas, and develop effective solutions like never before so that it supports strategic decision making. From 2010 to Onward, besides providing tools for data creation and storage, the range of commercial GIS software products out there seems endless with the open source [2-5]. Based on the advantages of GIS applications, the main goal of database management framework is simulation and visualization combined sewerage system and water quality data of Phu Loc river, Da Nang city via QGIS software [6-8].

The main purpose of developing database management framework for combined sewerage system of Phu Loc river basin in Danang city is to improve the management efficiency through the value of the available data. For simulating and visualization water quality data, the research has been performed in Phuloc basin area, based on the scientific recommendations of Danang University of Science and Technology, faculty of Environment and Center for Environment and Community research of Vietnam. In details, the water quality database will also support the retrieval and sharing of information on the water quality of the Phu Loc River and the regulating reservoirs in the river basin for the community as well as organizations and Environmental Protection Agency of local government.

## 2 Study area, Material and Method

The research has been proceeded in sewerage system around Phuloc river in Danang city. This case study was the main drainage basin in the northwest area of Da Nang city with a total area of more than 3500 hectares, which included 5 urban lakes, the municipal wastewater treatment plant with capacity over 40000 m<sup>3</sup>/d. Moreover, in this area, the treated water from plant mix with storm and ground water and pours into Danang bay through Phuloc river. The schema of combine sewerage system and relationship between component objects has been presented in Figure 2.



**Fig. 2.** Research area and objectives of database management framework

According components in Figure 2, basic data of database management framework for combined sewerage system is divided into 3 main groups: surface water quality of Phuloc river and urbanlake, construction of sewerage system related to water quality, and general information on Phu Loc river basin. Therefore, the database management framework has been proceeded through process digitalization information or data, which included (i) Digitization data of water quality and sewerage system around Phuloc basin river, drainage system which collected stormwater and municipal wastewater around urban lakes; and (ii) Digitalization data to visualizing water quality of urban lake, drain, channel and river through database. Based on process digitization data and relational model of database management framework has been determined [9-15].

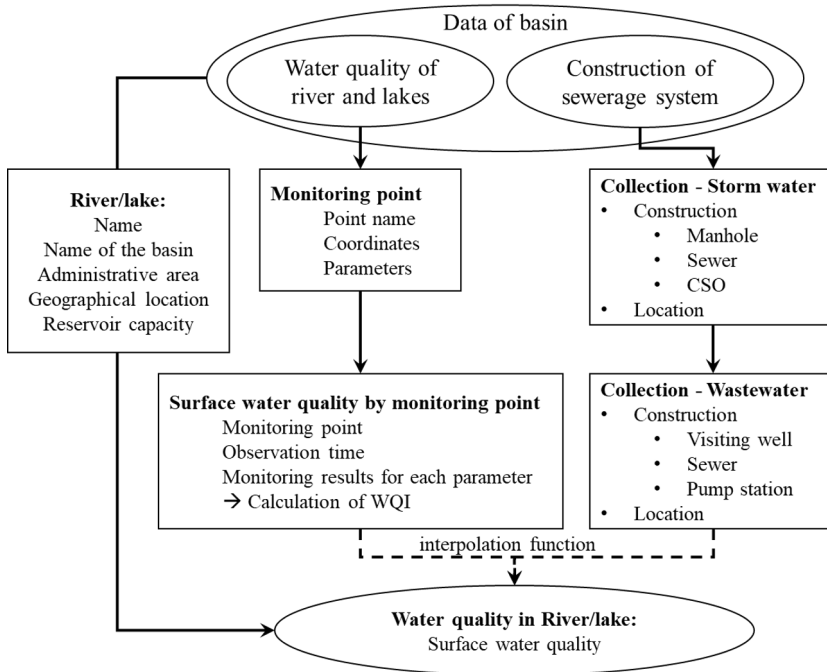
Finally, in order to ensure the visualization of the water quality data in database management framework, the Water Quality Index (WQI) was applied to the calculation and display of water quality in Phu Loc River and urban lakes. Basically, the water quality index (WQI) model is a popular tool for evaluating surface water quality. It uses aggregation techniques that allow conversion of extensive water quality data into a single value or index. Globally, the WQI model has been applied to evaluate water quality based on local water quality criteria such as turbidity, dissolved oxygen, oxygen demand, nutrients and bacteria [16 , 17]. According to the color-corresponding interpolation method of the WQI value, the water quality change is shown by the color band in Table 1 [18].

**Table 1.** WQI value and their visualization based on regulation documents

Value of WQI in point					
< 10	10 – 25	26 – 50	51 – 75	76 – 90	91 – 100
Polluted	Poor	Bad	Average	Good	Very good
WQI for area					

### 3 Results and Discussion

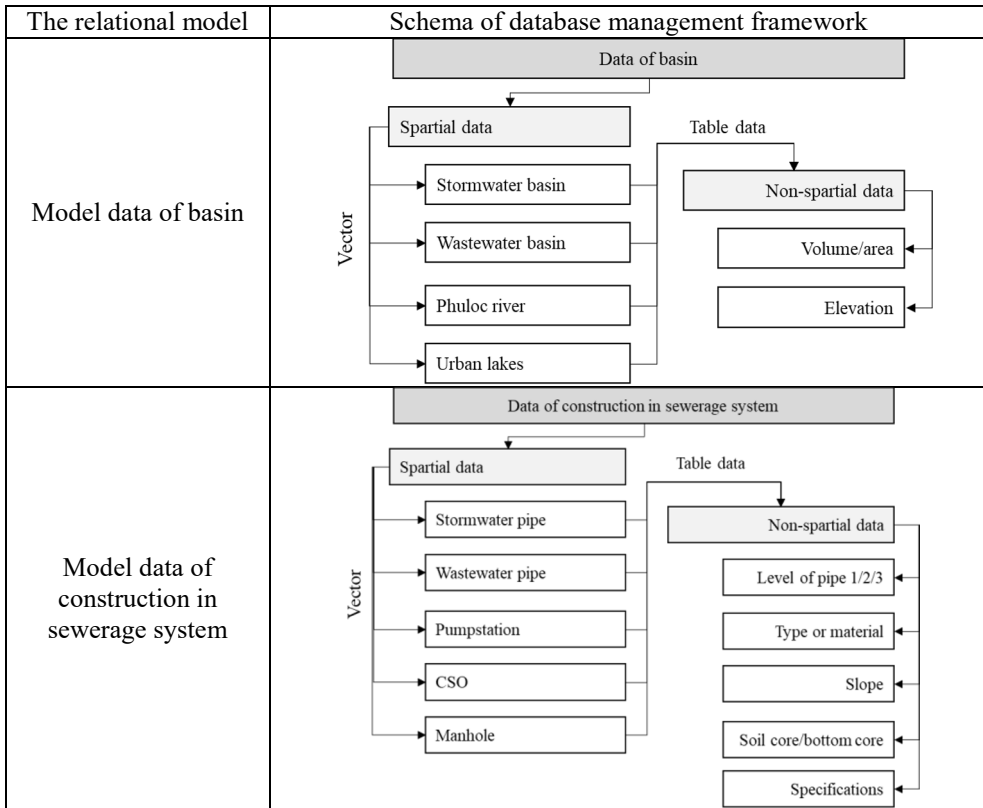
The Phu Loc basin database management framework is the result of systematizing groups of river basin data, factors/buildings related to water quality and water quality in rivers and lakes according to the prescribed monitoring point. The composition of the data groups and the relationships between the components are shown in Figure 3.



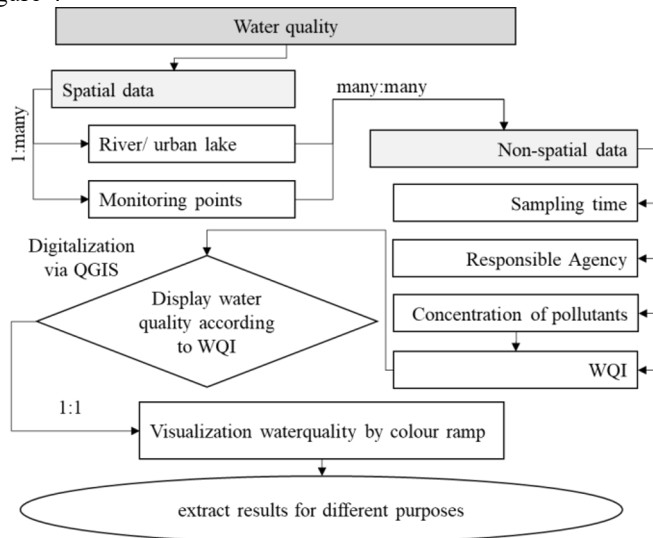
**Fig. 3.** The data groups and the relationships between the components in GIS

In details, the database management must be holds and creates the relationship between spatial and non-spatial data. The spatial data reflects the geometric representation of the graphic features on the maps such as location of sewerage, Combined Sewer Overflows or pump station. On the back side, the non-spatial information compiles the attributed data about water quality that is attached to the geographic features as tabular data. Moreover, it also contains information about the spatial relationship among different geographic objects which is called topographical relationships; and such relationships are: Sharing relation, connectivity relation and adjacency relation. Therefore, the relational model of each group has been showed in table 2 [19].

**Table 2.** The relational model of each group

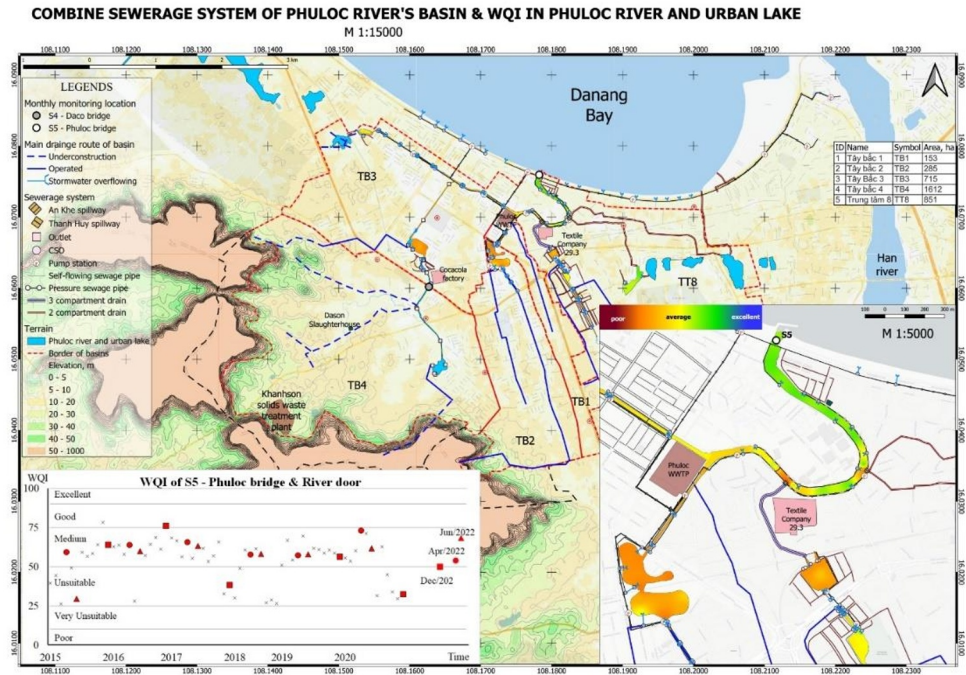


After Digitization data of water quality and sewerage system around Phuloc basin river, the water quality of Phuloc river and urban lake has been performed and visualized via process digitalization data. The block diagram of digitalization water quality will be presented in Figure 4



**Fig. 4.** The block diagram of digitalization water quality

Based on process digitalization data of water quality, QGIS software should presented type of digital map of Phuloc basin area in Figure 5



**Fig. 5.** Layout digital map via QGIS based on database management framework

According process digitalization data of water quality, the digital map has been printed. In this map, all information of basin area has been presented such as area and elevation of each basin. After that, the main sewerage system has been divided to underconstruction or operated with type: pressure sewer or gravity sewer. Moreover, the water quality of urban lakes and Phuloc river has been showed via colour ramp from polluted – red to good – green. At least, for future forecasting, the graphic of water quality from 5 years ago has been added to layout (for high quality of map, should be loading form this link: [https://drive.google.com/file/d/1rHQ05HaZyV21tEyhzrCowBxCamwEailr/view?usp=share\\_link](https://drive.google.com/file/d/1rHQ05HaZyV21tEyhzrCowBxCamwEailr/view?usp=share_link))

## 4 Conclusion

Summarize, the major challenger of wastewater management in Danang city today is improving management capacity for sewerage system and water quality. Process digitization and digitalization wastewater collected system data ensures the orientation of infrastructure development of Danang city through the unification of database in space (location) and time (past, present and future).

However, it is nessecery to ensure data and information security when establish database management framework and database management. Currently, QGIS cannot classify and define access rights for different user objects such as: local government, drainage infrastructure management agency, researchers or community in basin area. Based on database management framework, the administration of database management to look into this problem when creating, design and extract results.

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