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**Editors:**

Dr. Thanh Ngoc TONG

Dr. Duong Du BUI

Dr. Cecilia Tortajada

**Associate Editors:**

Van Hong Thi PHAM,

Thinh Duc TRAN,

Hung Van HOANG

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# Current water quality of surface water source in coastal zone of Quang Binh province

Thao Vu Thi Phuong<sup>1</sup>; Duc Thanh Nguyen<sup>2</sup>; Ngoc Thanh Nguyen<sup>2</sup>

<sup>1</sup>- Hanoi University of Mining and Geology, Email: vuthiphuongthao@hmg.edu.vn

<sup>2</sup>- Institute of Geography, Vietnam Academy of Science and Technology

No. 18. Hoang Quoc Viet Road, Cau Giay District, Hanoi, Vietnam

**Abstract:** Densely populated areas, aquaculture areas, agricultural production, tourist areas and industrial clusters in Quang Binh coastal area are contributing to boosting economic development but also causing many environmental consequences, especially surface water environment. 7 locations of surface water have been observed for monitoring and sampling with two times of 2018. Pollutant concentration consist of organic matter, nutrients, heavy metals and coliforms in surface water sources in coastal area of Quang Binh province has been analyzed. The monitoring results in 2018 show that the quality of all river water still meets the permitted standard value B2 QCVN 08-MT:2015/ MONRE but shows signs of decline over time. In general, the water quality of rivers tends to be worse than previous years, especially, concentration of mercury in Gianh River is quite high, higher than limit value of QCVN 08-MT: 2015 / MONRE on surface water quality many times.

## 1. Introduction

Quang Binh is located in the narrowest part according to the East-West direction of Vietnam's S-shaped strip of land (50 km along the shortest path from the Lao border to the East Sea). In the west, Quang Binh shares a border with Laos and in the East is adjacent to the East Sea. 85% of total natural area is mountainous. The mainland part of Quang Binh stretches from 16°55' - 18°05' N and from 105°37' - 107°00' E. In Quang Binh, there are 5 big rivers: Gianh, Roon, Nhat Le (the confluence of Kien Giang river and Long Dai river), Ly Hoa and Dinh with a total flow of 4 billion m<sup>3</sup> / year. These rivers are made up of many basins and all originate from the Truong Son range, flowing into the sea. The coastal area of Quang Binh province occupies a small area (about 335km<sup>2</sup>/8.055km<sup>2</sup>) but it is considered as one of the natural areas with the most specific characteristics, creating many advantages for socio-economic development. Surface water resources are a decisive factor to the sustainable socio-economic development in the coastal area of Quang Binh province.

In recent years, surface water resources in Quang Binh coastal area are suffering from negative impacts from industrial development and people's activities. These activities emit a significant amount of pollutants into surface water sources, which poses many risks to human health and ecosystems. In this study, water quality of surface water in Quang Binh coastal area was investigated to provide positive orientations to protect surface water resources in coastal areas of Quang Binh province.

## 2. Materials and method

### 2.1. Sample location, sampling time.

Quang Binh is located in the monsoon tropics, to be affected by the climate of the North and the South and is divided into two distinct seasons, rainy season and dry season. Therefore, surface water (consist four river water sampling sites is carried out in two times in 2018 year (one time for dry season consist of, one time for rainy season consist of 22<sup>th</sup> May



Figure 1. Sampling location map

and 25<sup>th</sup> September) at (Figure 1). The sampling coordinates are determined by the locating device Global GPS (Table 1). Water samples were collected from five main rivers - Roon River, Gianh River, Ly Hoa River, Dinh River and Nhat Le River and from two important lakes – Bau Tro Lake and Bau Sen Lake. Collected water layer was surface water layer. Selection of sampling sites based on specific environmental conditions of environmental factors, representing environmental factors, is less prone to change according to the observation time, accessible for sampling.

Table 1. Location of water sampling

o	Sites sampling	Sample symbol	S	Coordinates	
				Latitude	Longitude
	Roon River at Roon Bridge, Quang Trach District	M1	Q 45"	17 <sup>0</sup> 52' 39"	106 <sup>0</sup> 26'
	Gianh River at Gianh River Bridge, Hạ Trách commune, Bo Trach District	M2	Q 40"	17 <sup>0</sup> 42' 28,6"	106 <sup>0</sup> 26'
	Ly Hoa River at Hai Trach commune, Bo Trach District	M3	Q 35,5"	17 <sup>0</sup> 38' 15"	106 <sup>0</sup> 31'
	Dinh River at Dai Bridge, Dong Hoi City	M4	Q 35"	17 <sup>0</sup> 27' 35"	106 <sup>0</sup> 37'
	Nhat Le River at Chanh Hoa Bridge, Nam Trach commune, Bo Trach District	M5	Q 54,6"	17 <sup>0</sup> 32' 44,6"	106 <sup>0</sup> 32'
	Bau Tro Lake at Quan Hau town, Quang Ninh District	M6	Q 06,7"	17 <sup>0</sup> 24' 19,5"	106 <sup>0</sup> 38'
	Bau Sen Lake at Sen Thuy Commune, Le Thuy District	M7	Q 29,2"	17 <sup>0</sup> 10' 21,3"	106 <sup>0</sup> 54'

## 2.2. Methods of collecting and analyzing water samples

Sampling procedures are in accordance with sampling standards in the "Guidelines for Sampling in Rivers and Streams-TCVN 6663-6: 2008" [4]. Samples were transported immediately to the laboratory of General analysis, Institute of Geography, Vietnam Academy of Science and Technology, stored at 4<sup>0</sup>C and conformed to TCVN 6663-1995. Samples were analyzed in laboratory with the criteria and methods in Table 2 and refer the procedure of APHA, AWWA, and WEF [1].

Table 2. Water samples and analytical methods

o	Parameters	Units	Method of analysis	Parameters	Units	Method of analysis
	pH	-	Quick test by TOA	PO <sub>4</sub>	g/l	TCVN 6202:2008
	Turbidity	TU	WQC -22A	CN <sup>-</sup>	g/l	SMEW W 4500CN <sup>-</sup> E
+	NH <sub>4</sub>	g/l	SME WW 4500-NH <sub>3</sub> : F	As	g/l	SMEW W 3111-As:2012

	<b>NO<sub>2</sub></b>	m	SME				SMEW
-	g/l	WW	4500-		<b>Hg</b>	g/l	W 3112-
		NO <sub>2</sub> B					Hg:2012
	<b>NO<sub>3</sub></b>	m	TCV				
-	g/l	N 6180:1996					

### 3. Results And Discussion

Rivers and streams in the coastal districts of Quang Binh mostly originate in the territory of the province and pour directly into the East Sea. Due to the narrow and steep topography, rivers and streams here are often short and steep, the density of rivers and streams is quite high [2].

The river flow is relatively large. The total flow in the flood season (September to November) accounts for 60-80% of the total flow of the year. Low flow lasts for 8 months, but during this period, there is usually sub-tropical rain that can increase the total flow [3].

**Roon River System:** The Roon River with length of 30 km, originates from the southern slope of Hoanh Son mountain range, in the north of Quang Trach district, flows with Northwest - Southeast direction, flows into the East Sea at Bac Ha mouth. The river has a basin area of 261km<sup>2</sup>. Monitoring results showed that the quality of Roon river water meet demand for water supply for waterway and other purposes with low water quality requirements with limit value B2 of QCVN 08-2015 / MONRE [5]. TSS is approximately 30 mg/l in both monitoring times; COD was in range of 21÷26mg/l; BOD<sub>5</sub> in range of 14÷20mg/l; NH<sub>4</sub><sup>+</sup> in range of 0,3 ÷ 0,6 mg/l; PO<sub>4</sub><sup>3-</sup> in range of 0,01÷0,1mg/l; iron in range of 0,1÷1,8mg/l with high value at the second monitoring time. The concentration of pollutants in Roon river surface water between the monitoring times is relatively stable, except iron, the level of fluctuation is not much. Some parameters such as organic matter, coliform and iron are high of value at the time of monitoring in the second times. Pb, Hg only detected in trace form and little variation between monitoring times in the year. Comparison of monitoring results of water quality in Roon river in the period of 2011 – 2015 [3] shows that the quality of Roon river water fluctuates not much over the years, particularly iron content tends to increase compared to previous years.

**Gianh river system:** Gianh river system with a total length of 158 km. Gianh River water quality analysis results show that TSS is in range of 25 ÷31mg/l; COD was in range of 20÷29mg/l; BOD<sub>5</sub> in range of 15÷21mg/l; NH<sub>4</sub><sup>+</sup> in range of 0,2 ÷ 0,7 mg/l; PO<sub>4</sub><sup>3-</sup> in range of 0,1÷0,2 mg/l; Coliform in range of 2500÷4000MPN/100ml; iron in range of 0,3÷0,6mg/l, mercury in range of 0,03 to 0,215mg/l . Comparing the analysis results between two time of the year realize that the content of pollutants in Gianh river is relatively stable between the periods of the year. Concentrations of organic matter, nutrients and coliforms tend to increase slightly in the second times, heavy metal concentration are quite low at the monitoring times and are quite stable between two times, except Hg is 0,215mg/l at the second monitoring time.



In the year, As and Cd are smaller than the detection limit of the analytical method. Gianh River flows through many different areas, residential areas, industrial zones in many districts, so the quality of river water must be worst than other rivers in coastal zone of Quang Binh.

**Ly Hoa River:** Ly Hoa River originates from coordinates  $17^{\circ} 31'30''$  North latitude,  $106^{\circ} 26'50''$  East longitude (the western edge of Bo Trach district) with a height of 400m, flows in the Southwest - Northeast direction Go to Ray village, then meander in the east to Ly Hoa mouth. The river basin has an area of 177 km. Ly Hoa River passes through Phuc Trach, Dong Trach, Duc Trach and Hai Trach communes before pouring into the sea, so the water quality of Ly Hoa River is directly affected by the discharge of craft villages as well as activities of people living on both sides of the river. The analyses results of water quality of Ly Hoa River show that the river water quality meets the purpose of navigation and other purposes with low water quality requirements. TSS is in range of  $16 \div 29$  mg/l; COD was in range of  $20 \div 32$  mg/l; BOD<sub>5</sub> in range of  $14 \div 23$  mg/l; NH<sub>4</sub><sup>+</sup> in range of  $0,2 \div 0,8$  mg/l; PO<sub>4</sub><sup>3-</sup> in range of  $0,1 \div 0,18$  mg/l; Coliform in range of  $3000 \div 7000$  MPN/100ml; iron in range of  $0,2 \div 0,3$  mg/l.

It is easy to realize that water quality in Ly Hoa river over 2 monitoring times in 2018 changes slightly. The concentration of organic matter, nutrients and coliforms tends to increase at the time of the second monitoring. The cause of the increase in the content of these substances is due to in dry season, with low river flow, self-cleaning of the river also low making concentration of pollutants in the river decreases. The content of heavy metals does not fluctuate greatly and is relatively stable between the monitoring periods in the year. The monitoring results in 2018 show that the quality of Ly Hoa river water still meets the permitted standard but shows signs of decline over time. In general, the water quality of Ly Hoa river tends to be worse than previous years.

**Dinh River:** Dinh River is one of 5 main rivers of Quang Binh province. The river originates from Ba Roi - Bo Trach mountain area, with coordinates  $17^{\circ} 31'30''$  North latitude,  $106^{\circ} 25'20''$  East longitude. Dinh river has a total length of 37 km with river basin about 212 km<sup>2</sup> This is a irrigation dam that irrigates the rice fields in the south of Bo Trach district and north of Dong Hoi city. Water quality of Dinh river is assessed according to limit values B1 of QCVN 08/ 2015/ MONRE- Used for irrigation or other purposes with similar water quality requirements or use purposes as B2. Monitoring results show that water quality of Dinh river has shown signs of organic pollution, nutrients , iron in dry season. TSS is in range of  $18 \div 31$  mg/l; COD was in range of  $18 \div 20$  mg/l; BOD<sub>5</sub> in range of  $10 \div 14$  mg/l; NH<sub>4</sub><sup>+</sup> in range of  $0,02 \div 0,03$  mg/l; PO<sub>4</sub><sup>3-</sup> in range of  $0,08 \div 0,18$  mg/l; Coliform in range of  $600 \div 1000$  MPN/100ml; iron in range of  $0,1 \div 0,5$  mg/l. The concentration of nutrients is relatively stable and less volatile between two monitoring times in the year, Lead and Mercury are only detected in stain form, Asen and Cadmium have a content smaller than the emission limit of existing analysis method.

**Nhat Le River:** Nhat Le River is the second largest river system of Quang Binh province, behind Gianh river system with 96km long. Nhat Le river system has a basin of 2,647 km<sup>2</sup>. Nhat Le River flowing through many trade zones, industrial and urban clusters should receive a lot of polluting agents from these areas such as production wastewater processing seafood, waste water from urban centers such as Quan Hau town and especially Dong Hoi city must have different water quality.

Water quality monitoring results of Nhat Le river are shown that Nhat Le river water only be able to used for navigation purposes and other purposes with low water quality requirements. All monitoring parameters have reached the limit value of B2 of QCVN 08/2015 /MONRE. TSS is in range of 18 ÷22mg/l; COD was in range of 18÷22mg/l; BOD<sub>5</sub> in range of 12÷16mg/l; NH<sub>4</sub><sup>+</sup> in range of 0,1 ÷ 0,12 mg/l; PO<sub>4</sub><sup>3-</sup> in range of 0,2÷0,6 mg/l; Coliform in range of 1500÷3000MPN/100ml; iron in range of 0,2÷0,7mg/l.

The concentration of organic substances and coliforms tends to increase in dry season due to wastewater from Quang Binh agricultural fish meal processing factories and Nhat Le fishing ports operating with the largest capacity of the year. On the other hand, in the dry season, the river water flow is low, the self-cleaning ability of the river is low. Fe, Pb and Hg concentrations are relatively stable and less fluctuating through monitoring periods in 2018. Arsenic and Cadmium are smaller than the detection limit of the analytical method.

**Bau Tro Lake and Bau Sen Lake:** Bau Tro Lake - an important lake of Dong Hoi City, with an area of 24ha, a capacity of 3.6 million m<sup>3</sup>, is a source of fresh water for domestic use in the past up to now. Bau Sen lake is a freshwater lake with a relatively large a capacity of 1,25 million m<sup>3</sup>, and important for landscape, environment and economy. Currently, the water quality of these lakes has been negatively affected, the content of organic substances, suspended solids, Coliform, N, P, ... exceeds the permitted standard value A2 of QCVN 08-MT:2015/ MONRE used as water supply for drinking and living. The situation of free-grazing cattle is growing in large numbers along with agricultural production activities of people who abuse fertilizers to affect water quality of these lakes, making the content of organic matter, suspended solids, Coliform, N, P ... increase significantly.

#### 4. Conclusion

Most of surface water sources in Quang Binh coastal area have not shown signs of heavy pollution by organic matter, nutrients, heavy metals and coliforms. Almost water monitoring parameters are within the allowable limit B2 of QCVN 08-MT:2015/ MONRE. Water quality tends to be worse in all main rivers, main lake, especially rivers flowing through areas receiving industrial wastewater, densely populated areas, aquaculture areas and agricultural production such as Nhat Le River, Dinh River and Ly Hoa river. Concentrations of organic matter, nutrients and coliforms are higher at the second monitoring, heavy metals in general are very low and are not large fluctuations between the two monitoring times in 2018 year.

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