Академическая наука - проблемы и достижения

Academic science - problems and achievements XXXV

spc Academic

Материалы XXXV международной научно-практической конференции

Академическая наука - проблемы и достижения

15-16 июля 2024 г.

Bengaluru, India

УДК 4+37+51+53+54+55+57+91+61+159.9+316+62+101+330

ББК 72

ISBN: 9781445247809

В сборнике опубликованы материалы докладов XXXV международной научно-практической конференции " Академическая наука - проблемы и достижения ".

Все статьи представлены в авторской редакции.

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ASSESS THE CURRENT STATUS AND LOAD-BEARING CAPACITY IN THE BUI RIVER BASIN IN BAC NINH PROVINCE

Abstract

Bac Ninh province has a relatively thick river density, with many large rivers and inter-provincial rivers flowing through, such as the Duong River, Cau River, Thai Binh River, and Bui River. According to the results of an investigation and assessment of surface water quality on many rivers in Bac Ninh province, there are signs of mild to severe pollution in many places that do not meet the quality of water used for exploitation. The most commonly used is to collect water for domestic purposes. The article evaluates the current status of direct and indirect discharge sources into the Bui River basin with 94 points and a total flow of 1,026.5 m^3/day. According to the results of the water sample analysis, surface water quality in the Bui River basin in Bac Ninh province tends to be slightly polluted, especially the river section flowing through urban areas, industrial parks, and craft villages. Directly receive wastewater from these areas. Pollution parameters include BOD_5 , COD, TSS, NH^{4+}. At the same time, the article conducted calculations to evaluate the carrying capacity of the Bui River. The calculation results show that Bui River water can be assessed as slightly polluted; section 1 of Bui River can receive additional pollution load. However, in section 2 of the Bui River, the organic group, including BOD_5, COD, TSS, NH^{4+} , can no longer accept the remaining indicators; other pollutants, such as Fe and Pb, can still accept additional loads but at modest values.

Keywords: Water quality, Bui River, Bac Ninh province

1. Introduction

Bac Ninh is a province influenced by the critical economic development region of the Northern region, especially in the area directly influenced by the capital, Hanoi. Therefore, the urban system of Bac Ninh province must create close links to meet and serve the common socio-economic development goals in the entire Northern region, especially the area around Hanoi. Bac Ninh Province has a quite dense system of rivers and canals with high river network density, on average from 1-1.2 km/km^2 Almost 4 sides have rivers as boundaries with

provinces: the North has the Cau River, the boundary with Bac Giang province; to the south, there is the Bui River, which is the boundary with Cam Giang district, Hai Duong province; to the east there is Thai Binh river which is the boundary with Nam Sach district, Hai Duong province, to the northwest there is Ca Lo river is the boundary with Soc Son district, Hanoi city [3,5,6].

With industrial development potentials, such as abundant, qualified labour, abundant raw materials, and a convenient transportation system, Bac Ninh has gradually promoted the development of industries in recent years. Currently, Bac Ninh has 33 industrial zones and clusters with a discharge flow of 64,080.5 m^3/day; typical operations such as Que Vo Industrial Park, Thuan Thanh III Industrial Park, Tien Son Industrial Park, Dai Dong - Hoan Son Industrial Park, Yen Phong Industrial Park... industrial parks and industrial clusters have had their development planning approved. Special production wastewater is relatively large in industry groups such as food processing, wood production, electronic components, and construction materials production,... With the rapid increase in both the number and scale of wastewater treatment plants. Such industrial parks and industrial clusters will lead to negative aspects associated with development, such as a rapid increase in the amount of waste in general and industrial wastewater in particular. Waste discharge sources will increase many times compared to the present.

In addition to industrial parks and industrial clusters, Bac Ninh currently has about 62 traditional craft villages with a discharge volume of 12,487.7 m^3/day, focusing on the fields of paper production and delicate wooden furniture technology, ceramics, glass, bamboo and rattan, bronze casting, recycled iron and steel... The discharge flow of specific craft villages is as follows: Da Hoi iron and steel smelting craft village (120 m^3/day), Phong Khe paper craft village (5,000 m^3/day), Tien Ngoai vermicelli craft village (3,500 m^3/day), Dai Lam rice wine craft village (2,500 m^3/day), Dai Bai bronze casting craft village (130 m^3/day), Quang Bo bronze casting village (300 m^3/day). Raw materials for craft villages are mainly sourced locally. Most production facilities are located in narrow residential areas, which limits the construction of wastewater treatment systems. Untreated wastewater is discharged directly into ponds, lakes, and rivers near the production site, water-receiving systems, irrigation canals, and receiving rivers [1]. This process seriously affects water quality in the area, especially currently. There are some craft villages that are the most worrying threat in Bac Ninh Province in terms of environmental quality, such as Phong Khe paper craft village, carpentry villages, and wooden handicrafts...

Bui River is the southern boundary of Bac Ninh province with Hung Yen province; the 14.5 km long river connects the Cam Giang River with the Thai Binh River; this is the main drainage river of two districts, Gia Binh and Luong Tai [2], which are also under construction is a river basin heavily affected by wastewater sources from that industrialization process. Therefore, assessing the

current state of water quality and carrying capacity in the main river basins in Bac Ninh province, including the Bui River, is extremely necessary to propose measures to minimize the possibility of source pollution surface water and help managers control wastewater sources discharged into the above river basin.

2. Research methods

The following research methods are used to carry out the content of the article's work:

**** Data collection methods***: Collecting research data is a very important step in scientific research. To obtain accurate, complete data and meet the requirements of research objectives, researchers must choose methods, techniques and data collection tools to suit the research question and target audience. Research objectives, research design and resources available to carry out the research.

**** Methods of synthesizing and processing documents***: Assessing the reliability of document information; Synthesize information, data, and documents about receiving sources and waste sources, including: location, water quality, flow, and factors affecting receiving sources and waste sources; Analysing and processing information, data, and documents on receiving sources, waste sources, factors affecting receiving sources and waste sources.

**** Method for assessing the ability to receive wastewater and carrying capacity of river water sources using the indirect assessment method***: assessment of the ability to receive wastewater and carrying capacity of the river is done based on minimum limits. The range of each parameter is evaluated according to technical regulations on surface water quality and flow, as well as the analysis results of river water quality and flow and analysis results of wastewater sources discharged into the river section.

**** Water quality index (WQI) calculation method***

The water quality index to evaluate regional surface water quality is calculated according to the value VN_WQI according to Decision No.1460/QD-TCMT on November 12 2019, issued by the General Department of Environment [4].

The water quality values are evaluated on a scale of 100 and represent water quality from very severely polluted to very good water quality specifically, the water quality assessment scales according to the WQI index are shown in

Table 1.

Table 1. WQI water quality assessment index table

WQI value	Water quality assessment level	Color
91 - 100	Good for domestic water supply purposes	Blue
76 - 90	Used for domestic water supply purposes but requires appropriate treatment measures	Green
51 - 75	Use for irrigation and other similar purposes	Yellow
26 - 50	Used for water transportation and other similar purposes	Orange
0 - 25	The water is heavily polluted and needs treatment measures in the future	Red

3. Results and discussion

3.1 Results of analyzing surface water quality in the Bui River basin

Bui River is the main drainage river for the Gia Binh and Luong Tai districts of Bac Ninh province and is also the primary source of wastewater from domestic and agricultural activities in the area. Based on the type of wastewater discharge on the Bui River water body analyzed above, the report selects parameters to evaluate the ability to receive wastewater and the carrying capacity of the Bui River water source, including COD, BOD_5, NH_4^+, TSS, Pb, Fe.

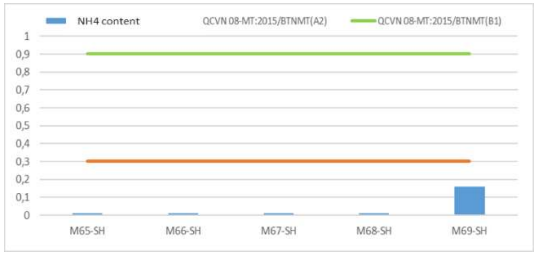
Results of analysis of 05 water samples on Bui River in November 2022 are as follows: Ammonium content (NH_4^+) in all samples has values ranging from 0.01 - 0.16 mg/l, within the allowable limit for comparison with QCVN 08 standards (column A2).

The BOD_5 content in all samples ranged from 14.35 to 57.41 mg/l, 2.4 to 9.6 times higher than QCVN 08 standards (column A2).

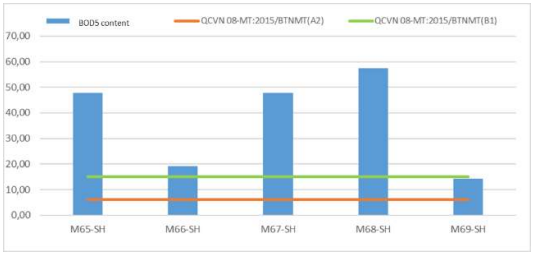
The COD content in all samples ranged from 24.0 to 96.0 mg/l, 1.6 to 6.4 times higher than QCVN 08 standards (column A2).

The NO_3^- content in all samples ranged from 0.415 to 0.714 mg/l, within the allowable limit compared to QCVN 08 standards (column A2).

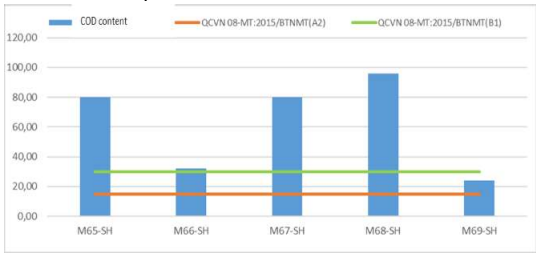
The content of heavy metals such as Pb, Cd, As, Cu, Mn in all samples QCVN 08 standards (column A2). Only the Fe content in all samples has values ranging from 2.28 - 2.56 mg/l, 2.3 - 2.6 times higher than QCVN 08 (column A2).



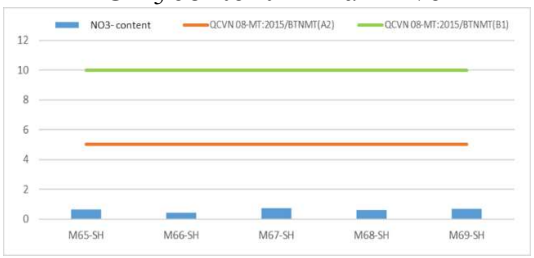
NH_4^+ content in Bui River



BOD_5 content in Bui River



COD content in Bui River



NO_3^- content in Bui River

Figure 1. Results of analysis of water sample on Bui River

3.2 Results of calculating the WQI index to evaluate surface water quality at Bui River basin

WQI water quality parameters are calculated according to Decision No.1460/QD-TCMT dated November 12 2019, of the General Department of Environment on promulgating Technical Instructions for calculating and announcing Vietnam's water quality parameters (VN_WQI). In particular, WQI is calculated from water quality monitoring parameters, used to quantitatively describe water quality and the ability to use that water source and expressed through a scale.

Table 2. The WQI value corresponds to the water quality assessment level

No.	Model number	Coordinates (VN2000 system KTT $105^0 30'$ projection zone 3^0)		Sampling locations	WQI index	Comparison of WQI and water use regulations
		X	Y			
1	M65-SH	2320330	569655	Lam Thao commune, Luong Tai district	50	Not achieved
2	M66-SH	2320922	571512	Lam Thao commune, Luong Tai district	62	Obtain
3	M67-SH	2321657	573855	Phu Luong commune, Luong Tai district	47	Not achieved
4	M68-SH	2322355	574650	Phu Luong commune, Luong Tai district	54	Obtain
5	M69-SH	2322544	575565	Trung Chinh commune, Luong Tai district	55	Obtain

3.3 Results of assessing the bearing capacity of the Bui River basin in Bac Ninh province

To evaluate the resilience of the Bui River basin in Bac Ninh province, the authors divided the above river basin into 2 sections as a basis for calculation as follows:

a. Section 1 (Bu-1): Bui River, from the water intake point from Thai Binh River to Bui River in Huong Trai, Minh Tan commune, Luong Tai district to before Dong Khoi River flows into Bui River, Lai Te area, commune Trung Chinh, Luong Tai district. Bu-1 river section: assessed according to QCVN 08 (column B1). The 3-month average flow rate of the Bu-1 section is 0.09 m^3/s.

On this section of the river, the main types of distributed emissions are concentrated in the two main types: residential activities and livestock farming, with 15 waste sources, and the total discharge flow is 104 m^3/day. The point source of waste agriculture has 02 waste sources, and the discharge flow is 0.036 m^3/day.

Table 3. Summary of waste sources in section 1 of Bui River

Unit: m^3/day

Type of waste source	Emission type	Number of waste sources	The discharge flow is investigated
Distributed waste sources (surface waste sources)	Living	12	93.5
	Breed	3	10.5
Concentrated waste sources	Industrial cluster/zone	-	-

Type of waste source	Emission type	Number of waste sources	The discharge flow is investigated
(point waste sources)	Villages, production and services	-	-
	Medical	-	-
	Agriculture	2	0.036

Table 4. Wastewater receiving capacity, river carrying capacity

Unit: kg/day

Quality wastewater	Load max	Current load	Load in the waste stream	Load capacity
BOD_5	129.6	95.0	11.8	11.4
COD	259.2	164.2	21.5	36.8
TSS	432.0	190.1	4,3	118.8
NH_4^+	7.8	3.2	3.9	0.3
Pb	0.4	0.1	0.0	0.2
Fe	13.0	4.5	0.1	4.2

Water quality parameters such as organic parameters: BOD_5, COD, TSS parameters, NH_4^+, Pb, Fe are completely capable of receiving their additional load. BOD5 can also receive an additional 13.2 kg/day, COD can also receive about 40.8 kg/day, TSS can also receive about 119.5 kg/day; NH_4^+ can also receive an additional 0.4kg/day; Fe can also absorb 1.6 kg/day, Pb can also absorb 0.2 kg/day.

b. Section 2 (Bu-2) : Bui River section before Dong Khoi River flows into Bui River, Lai Te area, Trung Chinh commune, Luong Tai district to Ngoc Quan pumping station area, Ngoc Quan village, Lam Thao commune, district Luong Tai. The bu-2 river section is evaluated according to QCVN 08 (column B1). The 3-month average flow rate of the Bu-2 section is 0.09 m^3/s.

In this section of the river, the main types of distributed emissions are concentrated in residential activities and livestock farming, with 16 waste sources. The total discharge flow is 122 m^3/day. The point source of waste is agriculture, with 01 waste source, and the discharge flow is 4.8 m^3/day.

Table 5. Summary of waste sources in section 2 of Bui River

Unit: m^3/day

Type of waste source	Emission type	Number of waste sources	The discharge flow is investigated
Distributed waste sources (surface waste sources)	Living	14	111.6
	Breed	2	10.40

Type of waste source	Emission type	Number of waste sources	The discharge flow is investigated
Concentrated waste sources (point waste sources)	Industrial cluster/zone	-	-
	villages, production and services	-	-
	Medical	-	-
	Agriculture	first	4.8

Table 6. Waste water receiving capacity and carrying capacity on section 2

Unit: kg/day

Quality Waste water	Load max	Current load	Load in the waste stream	Load capacity
BOD_5	129.6	103.7	12,067.1	-6,020.6
COD	259.2	164.2	20,181.6	-10,043.3
TSS	432.0	190.1	2,545.8	-1,151.9
NH^{4+}	7.8	0.3	7.8	-0.2
Pb	0.4	0.1	0.2	0.1
Fe	21.6	0.0	15.6	3.0

The water quality of the Bui River in this section can be assessed as slightly polluted. The existing group of organic indicators are all larger than the allowed standards according to QCVN 08 (Column B1); the load of pollutants in the input waste source has yet to be considered, so it is no longer capable of receiving additional loads on the river. For heavy metal indicators, only Fe can receive Fe can receive 3 kg/day, and Pb can also receive 0.1 kg/day.

Table 7. Summary of assessment of the carrying capacity

Unit: kg/day

No.	River section	BOD_5	COD	TSS	NH^{4+}	Pb	Fe
1	Paragraph 1	11.39	36.77	118.80	0.34	0.15	4.19
2	Paragraph 2	-6,020.58	-10,043.28	-1,151.93	-0.18	0.08	3.0

Table 7 shows that section 1 of the Bui River can receive more pollution load. However, by section 2, most indicators can no longer receive more pollution load. Specifically, the wastewater receiving capacity of each water quality parameter is shown in the charts below:

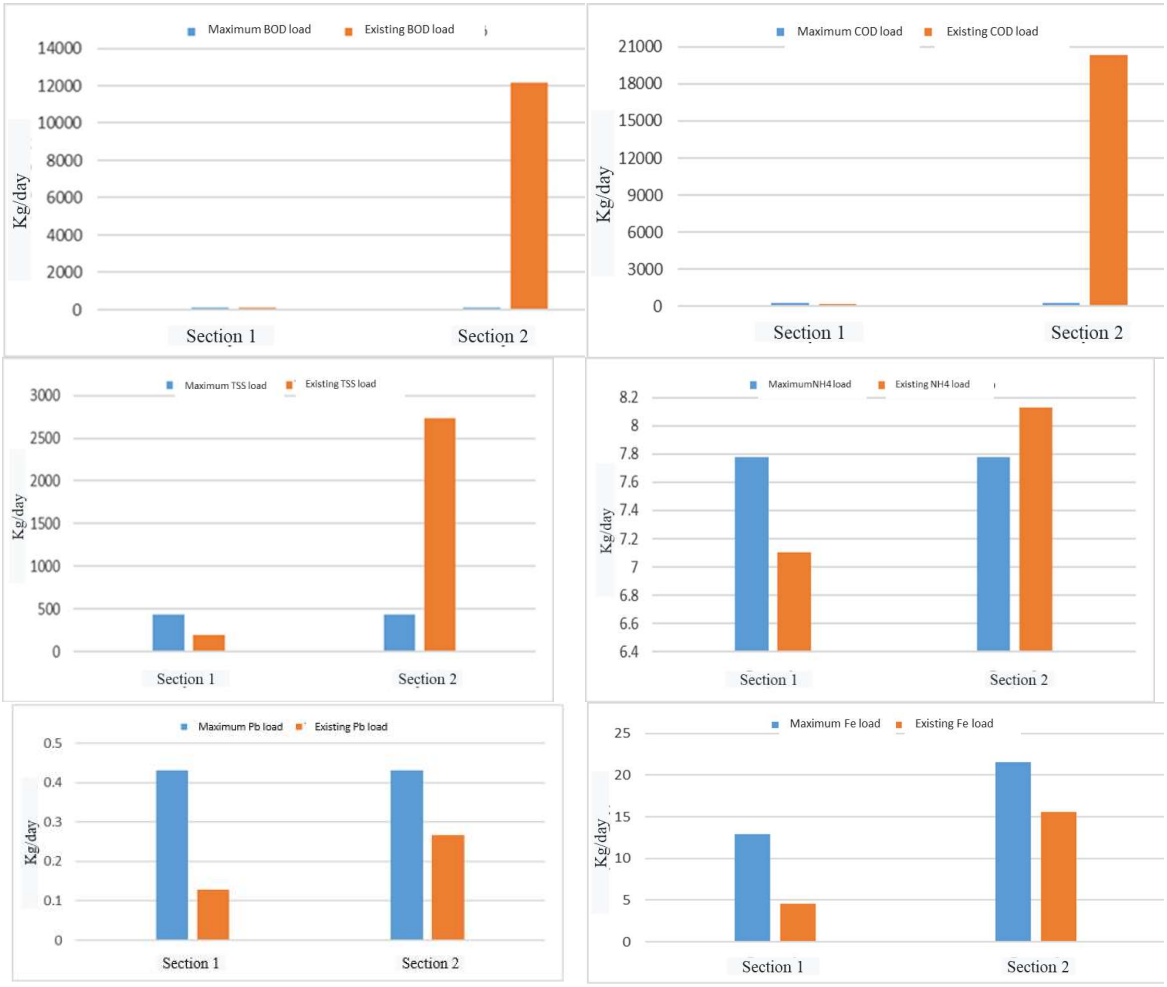


Figure 2. Bui River's load capacity

Survey and research results show that Bui River is receiving 94 points with a total flow of 1,026.5m^3/day, specifically:

Section 1: Bui River, from the water intake point from Thai Binh River to Bui River in Huong Trai, Minh Tan commune, Luong Tai district to before Dong Khoi River flows into Bui River, Lai Te area, Trung Chinh commune, Luong district Finance. In this section of the river, the main types of distributed emissions are concentrated in the two main types: residential activities and livestock farming, with 15 waste sources, and the total discharge flow is 104 m^3/day. Organic parameters BOD_5, COD, TSS parameters, NH_4^+, Pb, Fe are completely capable of receiving their additional load.

Section 2: Bui River, the section before Dong Khoi River flows into Bui River, Lai Te area, Trung Chinh commune, Luong Tai district to Ngoc Quan pumping station area, Ngoc Quan village, Lam Thao commune, Luong Tai district. In this section of the river, the main types of distributed emissions are concentrated in residential activities and livestock farming, with 16 waste sources. The total discharge flow is 122 m^3/day. The water quality of this river

section is slightly polluted. Parameters: BOD_5, COD, TSS, NH_4^+, and metal parameters Fe, Pb are still capable of receiving additional loads but are quite modest. It is necessary to reduce and control the load of all load parameters, especially the parameters BOD_5, COD, TSS, NH_4^+.

4. Conclusions

1. The article evaluates the current status of direct and indirect waste discharge sources into the Bui River basin, identifying 94 points with a total flow of 1,026.5 m^3/day.

2. According to the results of the water sample analysis, the surface water quality in the Bui River basin in Bac Ninh province tends to be slightly polluted, particularly in the river sections flowing through urban areas, industrial parks, and craft villages that directly receive wastewater from these areas. Pollution parameters include: BOD_5, COD, TSS, NH_4^+. The cause of pollution is the impact of human activities, agricultural production, manufacturing, and business, especially industrial activities and craft villages. This pollution increases the concentration of substances beyond the self-cleaning ability of rivers and streams, leading to the deterioration of water quality.

3. Regarding carrying capacity, Bui River water quality can be assessed as slightly polluted. Section 1 of the Bui River can receive an additional pollution load, but in Section 2, the organic group parameters, including BOD_5, COD, TSS, NH_4^+, are already affected. The remaining indicators, Fe and Pb, still have the ability to receive additional loads, but only at modest values.

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