Science on Natural Resources and Environment 21 (2019) 39-43

Science on Natural Resources and Environment
Journal homepage: hunre.edu.vn/hre/d16216

IMPACT OF INDUSTRIAL ACTIVITIES ON WATER QUALITY OF THE CAU RIVER SECTION FLOWING THROUGH THAI NGUYEN CITY

Vu Thi Phuong Thao
Hanoi University of Mining and Geology

Received 31 August 2018; Accepted 21 October 2018

Abstract

The main objective of this article is to assess the impact of industrial activities on the water quality of the Cau river and to identify the major industrial sources of pollution and their environmental consequences. The impact of industrial effluents on see earlier correction was investigated on 12th November 2016 by collecting water samples at 4 sites along the Cau river from Son Cam to Cau Tra Vuon in dry seasons. COD, BOD_5, and 6 heavy metal concentration inside these samples including As, Cd, Cu, Fe, Pb, Zn were analyzed. Analyzed results reveal high levels of pollutants when Cau River receives industrial waster water; high levels of COD and BOD_5, at 3 sites (Hoang Van Thu, Cau Gia Bay, Cau Tra Vuon), and high levels of Fe, Pb and Zn at 2 sites (Cau Gia Bay, Cau Tra Vuon). The results show that the Cau river water quality in this section does not meet the standard for aquaculture (A2 limit of 08/2015/BTNMT). The result also shows the negative impacts of industrial wastewater from paper mill, ore mining, Iron and Steel Industrial Park, Lu Xa metallurgical Industrial Park, etc. These sources of wastewater directly pollute the Cau river and change its water quality. Therefore, the protection of the Cau river must include adequate treatment of the wastewater produced in the area, as well as the construction of wastewater treatment plants for major industries in the area.

Keywords: Water quality; Industrial activities; Heavy metal; Wastewater.

Corresponding author. Email: vtpthao1975@gmail.com

1. Introduction

The Cau river originates from the southern tip of Phia Booc (1,578 meters in height) of Van On mountain (Phuong Vien commune, Cho Don district, Bac Kan town). The last of this river is in Pha Lai, Chi Linh, Hai Duong. The total length of the Cau river is 288 km. The Cau river basin is facing serious environmental challenges due to the on going industrialization in Vietnam. In the Thai Nguyen province, there are more than 1,200 production bases with nearly 1,000 bases that have discharged industrial wastewater into the environment. Among them, there are 47 production bases with a discharge capacity of 100m^3 or more directly discharging into the Cau river or tributary level 1, 2 of the Cau river [4]. At discharge points of these production bases, the Cau river water is unusable the even smell the same as in the outlet area of Hoang Van Thu Paper Plant, Cao Ngan Thermal Power Plant, etc.

This paper presents results of assessment effect of industrial wastewater on the Cau river water quality by analyzing the concentration of organic matter and some heavy metal (As, Cd, Cr, Cu, Pb and Zn) in the Cau river water. The study locations consist of locations without industrial

wastewater (Son Cam site) and locations receiving industrial wastewater. These assessments help managers, scientists and the community have general information on the extent of heavy metal contamination in river water to determine the right solutions for environmental protection and management in the study area.

2. Material and method

Sampling sites were selected on the basis of field surveys and information on pollution sources. Mapinfo software version 15.0 and Coreldraw version 10 are used to represent the sampling map based on the actual sampling location coordinates. Water samples are taken at 4 points on the Cau river from Son Cam to Cau Tra Vuon (21 km length). Figure 1 shows the map of the sampling locations at the Cau river. Tab. 1 presents water sampling sites and sampling purposes.

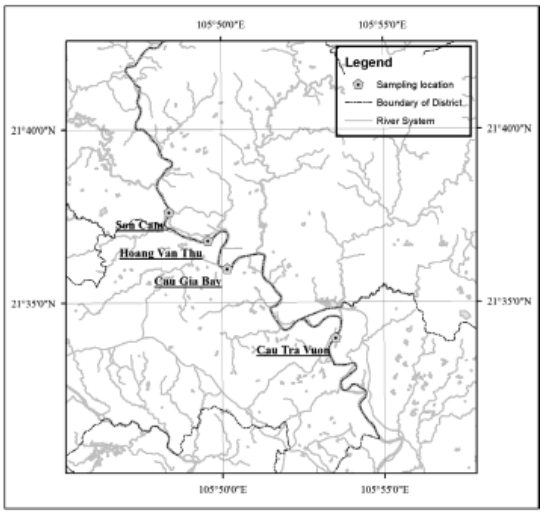

Figure 1: The map of sampling sites along the Cau river

Table 1. Water and plant sampling sites and sampling purposes

No	Study sites	Coordinates		Sampling purposes
		Latitude	Longitude	
1	Son Cam	21° 37' 37"	105° 48' 20"	Assessment of water quality of Cau river before flowing into Thai Nguyen city.
2	Hoang Van Thu	21° 36' 38"	105° 49' 37"	Assessment of water quality of Cau river after receiving wastewater from Hoang Van Thu paper mill and coal company.
3	Cau Gia Bay	21° 35' 51"	105° 50' 14"	Assessment of water quality of Cau river after receiving wastewater from iron mines.
4.	Cau Tra Vuon	21° 33' 52"	105° 53' 38"	Assessment of water quality of Cau river after receiving wastewater from steel processing companies

The samples were taken on 12th November of 2016. After being taken, the water samples were transported immediately to the laboratory and stored at 4^0C. The samples were analyzed in the laboratory of the Vietnam Academy of Science and Technology. Water temperature, pH, electrical conductivity and dissolved oxygen were measured on the spot using WQC-24 / TOA water quality meter. Organic pollutants and heavy metals in water samples were analyzed in the laboratory by flame atomic absorption spectrometry using the Perkin Elme and following the procedure of APHA, AWWA, and WEF [3].

3. Result and discussion

Results of the water analysis reveal that industrial wastewater has a serious impact on Cau River water quality. At Son Cam sites, where the Cau River water has not received industrial wastewater, water quality parameters meet the demand for water supply for living with limit value A2 of QCVN 08-2015/BTNMT. But from Hoang Van Thu site, which receives industrial wastewater from the river basin to the end of river section, the water quality of Cau river was heavily contaminated by organic pollutants and

heavy metals Fe, Pb, Zn. Water quality measurements of these parameters were high and exceeded limit value A2 of QCVN 08-2015/BTNMT and even exceeded limit value B1 of QCVN 08-2015/BTNMT. The concentration of some of the water quality parameters in the Cau river water is presented in Tab. 2.

Table 2. Concentration of some water quality parameters in Cau River water

Unit: mg/l

No	Study sites	pH	DO	COD	BOD_5	As	Cd	Cu	Fe	Pb	Zn
1	Son Cam	7,5	6,1	14,5	5,9	0,003	0,002	0,003	0,9	0,01	0,8
2	Hoang Van Thu	7,3	4,2	29	9,2	0,003	0,002	0,003	2,1	0,02	0,7
3	Cau Gia Bay	7,3	4,5	18	9,0	0,003	0,004	0,004	2,3	0,05	1,3
4	Cau Tra Vuon	7,4	4,9	17	8,8	0,003	0,003	0,003	2,0	0,06	1,1
A2 of QCVN 08-2015/BTNMT		6 ÷ 8,5	≥ 5	15	6,0	0,02	0,005	0,2	1,0	0,02	1,0

3.1. Impact of organic pollutants in industrial wastewater to Cau river water quality

At the beginning of the river section, at the Son Cam site, pH was 7,5, DO was 6,1 mg/l, BOD_5 was 5,9 mg/l, and COD was 14,5 mg/l. In this site, on the whole, water quality parameters meet limit value A2 of QCVN 08-2015/BTNMT [8] for water supply for living. At Hoang Van Thu site, where Cau river has received wastewater from the Hoang Van Thu paper mill, river water quality was severely polluted. Most water quality parameters were higher than the A2 permitted standards. Specifically, DO was 4,2, BOD_5 was 9,2 mg/l, COD was 29 mg/l. DO was low with high organic pollutants in the Cau river water which not only affects the habitat of aquatic organisms but also indirectly the health of the people in this area due to the smell from organic aerobic decay. However, at this location, concentration of heavy metals was low and satisfies the A2 allowable value of QCVN 08-2015/BTNMT. From this site to the end of river section, DO was in range 4,2 ÷ 4,9 mg/l, BOD_5 and COD always exceed the allowable limit A2 of QCVN 08-2015/BTNMT, indicating that a large amount of organic matter exists in the river section.

Every day, Hoang Van Thu paper mill discharges 300 m^3 of waste water into the Cau river. The toxicity of these effluents is due to the presence of a complex mixture of extracts in the trunk including resins, fatty acids, lignin, and some decomposition products of chlorinated lignin. The concentration of these substances can potentially inhibit fish and the other organisms living in the river [6].

3.2. Impact of heavy metal pollutants in industrial wastewater to Cau river water quality

In locations receiving wastewater of metal mining such as the Cau Gia Bay site (which receives wastewater from the Trai Cau iron mine), the Cau Tra Vuon site (which receives wastewater from Thai Nguyen Iron and Steel Industrial Park and Luu Xa Industrial Park) river water quality was seriously impacted by the presence of organic pollutants and heavy metals.

Heavy metal is a collective term which applies to the group of metals and metalloids with an atomic density greater than 4 g/cm^3 or 5 g/cm^3 [6]. The overall results reveal that the Cau River from the Cau Gia Bay site to the Cau Tra Vuon site has been polluted by heavy metals.

The available data revealed that the river after receiving industrial wastewater contains a large quantity of heavy metal [2]. The analyzed data confirmed the presence of high concentration of iron, lead and zinc in all samples collected from both the Cau Gia Bay and the Cau Tra

Vuon sites. The concentration of heavy metals in the Cau river water at study sites varied markedly in other studied sites, tended to increase along the river section and the overall concentration of heavy metals in the water showed the trend: Fe > Zn >Pb. At the Son Cam site, heavy metal concentration was very low, satisfying the A2 allowable value of QCVN 08-2015/ BTNMT [8]. While in other locations, a higher concentration of lead, iron, zinc was detected. Analytical results revealed the highest iron concentration (2,3mg/l) and highest zinc concentration (1,3 µg/l) at the Cau Gia Bay site, with the highest lead concentration 0,06 mg/l at the Cau Tra Vuon sites. The high heavy metal concentration in the water downgrades the water quality of these sites to class 5 of the EPA; heavy metal contamination is not a modern problem arising out of industrialization - it began when humans started processing ores [1]. Since then the use of metals and their impacts on the environment have accelerated [7]. Generally, most of the heavy metals enter the river from different sources, it can be either natural by erosion and weathering and or anthropogenic. In view of the intense human activity, natural sources of heavy metals from leaching and weathering of rocks in the environment are usually of little importance. The most important anthropogenic sources of heavy metal are various industries and domestic sewage. The practice of discharging waste from industries and untreated domestic sewage into the aquatic ecosystem has led to an increase in concentration of heavy metals in river water [2]. The Cau river water quality is not an exception. The reason for the degradation of water quality of the Cau river water is due to waste water from a series of lead slag factories from the river basin, from the mining areas (specially Pb-Zn ore mining), Thai Nguyen Iron and Steel Industrial Park and Lu Xa metallurgical area,... which all discharge directly into the Cau river. These sources of waste directly pollute the Cau river.

The steel industry is one of the most impactful to the water quality of the Cau river. Wastewater of this type contains many dissolved substances and chemicals. The development of innovative technologies for the treatment of wastewaters from steel industries is of vital importance the country. Although many research papers have been reported on wastewater pollution control studies, very limited research work is carried out for the treatment of wastewater of steel industries. Currently, the following treatment methods are available: addition of sodium chloride for breaking up the emulsion, the addition of calcium hydroxide for saponification of the grease and oil, and the addition of aluminum sulfate as a flocculation agent. Calcium carbonate is used for neutralization. The Ruthner process has been developed for treating pickling wastewater [9, 10].

3.3. Water quality monitoring and environmental law enforcement in study area

Statistical work and survey of liquid waste discharge directly into the Cau river basin has been implemented. However, this is not usually done annually, largely due to limited budgets [4]; Therefore, the environmental database should be built into system and information should be updated regularly; this wwill help, management and control of effluents.

Violation of the law on environmental protection in the Cau river basin is still complicated. Although businesses are fully aware of the harmful effects of environmental pollution as well as legal liability companies are still willing to find ways to evade the obligation to process environment due to economic profit. Some localities lack attention; have not fulfilled

their responsibilities in the management and protection of mineral resources.

The protection of the Cau river water quality must, therefore, include adequate treatment of the septage produced in the area, as well as the construction of wastewater treatment plants for the major industries of the area.

4. Conclusions

The analyzed result shows the industrial wastewater from Hoang Van Thu paper mill, Thai Nguyen Iron and Steel Industrial Park, Lu Xa metallurgical area, etc. Negatively impacted the water quality of the Cau river in a river section from Hoang Van Thu to Cau Tra Vuon. This river section does not meet standards for aquaculture by both Vietnamese governmental standard and also EPA standards. Industrial activities annually discharge a large volume of waste water containing remarkable amounts of organic pollutants, iron, lead, and zinc into the river. These sources of waste directly pollute the Cau river. This pollution may bring serious effects for the health of organisms living in and using the Cau river water in life.

It is therefore recommended that a regular and continuous monitoring scheme should be developed for the Cau river system. Environmental law should be enforced to prohibit the discharge of industrial wastewater to Cau River system.

REFERENCES

[1]. A. Kabata-Pendias & H. Pendias (2001). *Trace elements in soils and plants*. London: CRC.

[2]. A.B. Yılmaz, A. Yanar, E.N. Alkan (2017). *Review of heavy metal accumulation on aquatic environment in Northern East Mediterranean Sea part I: some essential metals*. Rev Environ Health, 32(1-2), pp.119-163.

[3]. APHA, AWWA, and WEF (1998). *Standard methods for the examination of water and wastewater*. 20th edition, America Public Health Association, American Water Works Association and Water and Environment Federation, Washington DC, USA.

[4]. Department of Waste Management and Environmental Improvement - Department of Environmental Protection in Cau River Basin (2015). Report: *Situation of water environment and major sources of water environmental pollution in the river basin - Causes and solutions*.

[5]. Helle Marcussen & Karin Joergensen & Peter E. Holm & Daniela Brocca & Robert W. Simmons & Anders Dalsgaard (2008). *Element contents and food safety of water spinach (Ipomoea aquatica Forssk.) cultivated with wastewater in Hanoi, Vietnam.* Environmental Monitor Assess.

[6]. J.S. Hawkes (1997). *What is heavy metal*? J. Chem. Educ. 74, 1374.

[7]. P. E. Holm, H. Rootzén, O. K. Borggaard, J. P. Moberg, & T. H. Christensen (2003). *Correlation of cadmium distribution coefficients to soil characteristics*. Journal of Environmental Quality, 32, pp.138 - 145.

[8]. Ministry of Natural Resources and Environment (2015). *QCVN 08:2015/ BTNMT - National Technical Regulation on surface water quality*.

[9]. Sanjeev Kumar Sinha, Vikas Kumar Sinha, Samir Kr. Pandey, Anup Tiwari (2014). *A Study on the Waste Water Treatment Technology for Steel Industry: Recycle And Reuse*. American Journal of Engineering Research (AJER), Volume-03, Issue-04, pp-309 - 315.

[10]. U.S. Environmental protection Agency (1974). *Waste Management Strategies for industries*. Design criteria for Mechanical, Electric and Fluid system and Washington, D. C.