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The wastewater quality from several industrial production branches and traditional production villages in the Day-Nhue river basin, North Vietnam

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Abstract. The Day-Nhue river system, which locates in the important economic region of the northern plains, covers a natural surface of 7949 km². The pollution of the Day-Nhue river system was mainly due to receiving untreated/ ineffective untreated wastewater discharges from the different sources in the basin. This paper focused on the industrial wastewater sources. Our purposes are to i) collect information about the number and sizes of industrial production factories and traditional production villages; ii) establish the database of wastewater quality released from six main industrial production branches in the basin. The results obtained from our investigation during 1/2007–12/2009 showed that the total wastewater discharge from industrial production factories and traditional production villages reached to 100,000 m^3/day and 45,000-60,000 m^3/day, respectively. The wastewater quality of some industrial production branches exceeded the *National technical regulation on industrial wastewater* QCVN 24:2009/BTNMT. Most traditional production villages caused serious organic pollution.

Keywords: wastewater quality, industrial production, traditional production villages, Day- Nhue River.

1. Introduction

Recently, in Vietnam, the operation and function of many industrial zones in different cities and provinces where there were not efficient wastewater treatment systems have led to the serious water pollution. These point sources not only pollute the surface water and disrupt biogeochemical cycles in hydrosystem but also affect the underground water quality and human health.

The Day-Nhue river basin (7949 km^2) locates in the Red River Delta, covering partly 5 Vietnamese provinces such as Hanoi, Nam Dinh, Ha Nam, Ninh Binh and Hoa Binh. The results from different previous projects reveal that the water quality of the Day-Nhue river has seriously declined: low value of dissolved oxygen, high value of ammonium and organic

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matters [1]. The causes of river water pollution are direct wastewater discharges without treatment or ineffective treatment [1,2]. Presently, the Day-Nhue river is utilized to provide water for agricultural and industrial activities, and notably used as domestic water for the many inhabitants in its basin. Therefore, the urgent needs are to reduce and eliminate the water pollution. To fulfill these requirements, in the first step, we have to investigate the pollution sources both quantitatively and qualitatively in order to give the best solutions for ameliorating the water quality in this basin.

In this study, we i) collected information about the number and sizes of industrial production factories and traditional production villages; ii) established the database of wastewater quality released from six main industrial production branches in the Day-Nhue river basin. The results could contribute to the database construction, attending to the environment protection, management and sustainable development in Vietnam in general and especially in the Dayr-Nhue river basin.

2. Methods

A database of industrial factories and traditional production villages was built using MS Excel software. All information concerning the factories such as production, wastewater discharge, wastewater quality, water volume utilization, wastewater treatment system, etc ... was drawn from different documentation sources (Reports on environmental statement from DOSTs of different provinces in the basin; reports from previous projects on the Day river basin ...). About 600 factories, (among approximately 4113 factories in the whole Day river basin [2]) in the five provinces mentioned above, were selected to establish the necessary database. 600 questionnaires were sent directly to the factories, which locate in the Day-Nhue river basin, for information.

Parallel with the documentation process, the wastewater samplings were conducted from April to December 2007 in Hanoi, Ha Nam, Hoa Binh and Ninh Binh provinces. The physicochemical variables were directly measured in-situ by the Water Quality Checker equipment WQC-22A (TOA, Japan). The wastewater sampling procedure observes to the Vietnamese Standards TCVN 5999-1995. The analytical methods were based on the American Standards [3].

3. Results and discussion

3.1. Development of industrial production in the Day-Nhue river basin

3.1.1. Development of industrial factories:

Along with the agricultural development, the manufacturing industry in the Day-Nhue basin in recent years has rapidly increased; both in scales and diversity.

The percentage of different industrial branches in the Day-Nhue river basin were shown in the table 1 [4].

Table 1. Percentage (%) of some main industrial branches in the basin

STT	Industrial branches	Ratio (%)
1	Mechanics	32.1
2	Food processing	15.1
3	Textile	13.3
4	Chemicals	8.3
5	Construction materials	12.8
6	Others	18.3

According to the 2006 national report of the Environmental state [2], in the Day-Nhue river basin, there were about 4113 factories (data recorded in 2004), distributed unevenly in 5 provinces. About 79% of the factories locate in Hanoi, 10% in Nam Dinh, 5% in Ninh Binh,

4% in Ha Nam and 2% in Hoa Binh province [5]. Important industrial zones in this basin are Thuong Dinh, Vinh Tuy, Cau Dien, Cau Buou, Van Dien, Phu Xuyen, Thuong Tin, Ha Dong…

3.1.2. Development of traditional production villages

In recent years, the traditional production villages have been revived and enhanced. The Ministry of Science and Technology [2] reports that there were 458 traditional production villages in the Day-Nhue river basin, and 936 traditional production villages in all five provinces (Table 2).

The traditional production villages are distributed unevenly in five provinces. About 67% of traditional production villages locate in Hanoi, 19.7% in Nam Dinh, 8.7% in Ha Nam, 3.7% in Ninh Binh, and 0.9% in Hoa Binh province.

Table 2. Distribution of traditional production villages by the industrial production branches in five provinces

Province	Number of villages	Textile - dyeing	Food process.	Solid waste recycle	Handicrafts	Construction materials	Other
Ha Noi	328	27	48	12	183	4	54
Ha Nam	17	2	2	1	9	-	3
Nam Dinh	90	12	21	10	20	-	27
Ninh Binh	17	1	11	7	-	-	-
Hoa Binh	15	14	1	-	-	-	-

3.2. Wastewater discharge and its quality

3.2.1. Wastewater quality from industrial production

According to reports from the Provincial People Committees [5], Hanoi city discharges the highest volume of industrial wastewater (76.000 m^3/d, about 76% of the total wastewater releases in the Day-Nhue river basin), and about 8% from the Ha Nam province; 7% from the Nam Dinh, 7% from the Ninh Binh province and 2% from the Hoa Binh province.

The wastewater quality of six industrial branches in this basin was summarized from literature data, from the questionnaire results and also from our real sampled and analytical results.

Physicochemical variables: The results of physicochemical variables which were summarized from literature data and also from our real analysis were shown in the table 3. The results revealed that the mean pH values of wastewater discharged from six industrial branches were from neutral to alkaline (6.7 – 8.1). The pH values of wastewater from the mechanics and textile are the highest (8.4 and 8.1 respectively) while the lowest from food processing (6.7). The mean conductivity reached the lowest value (365.5 μS/cm) in wastewater from the construction materials and the highest value (1028.2 μS/cm) from the mechanics. The suspended solids (SS) is an important factor which impacts development of aquatic organisms [7]. The mean SS concentrations from almost industrial branches exceeded the National technical regulation on industrial wastewater QCVN 24:2009/BTNMT column B (Table 3). Note that the SS contents in wastewater from the papers, chemicals, construction materials and food processing were 4.6, 2.8, 1.8, and 1.2 times higher, respectively, than the QCVN 24:2009/BTNMT, column B.

Table 3. Mean values of some physicochemical variables of wastewater from six industrial branches

Branches	pH	TDS (mg/l)	Conductivity (μS/cm)	SS (mg/l)	DO (mg/l)
Mechanic	8.4	630.0	1028.2	125.7	3.50
Food processing	6.7	402.4	880.8	384.5	1.56
Chemicals	7.5	490.5	530.6	2511.8	2.91
Papers	7.4	223.0	462.8	1233.8	1.82
Textile-dyeing	8.1	852.6	827.0	551.9	2.01
Construction materials	7.6	125.6	365.5	177.9	3.90

Nitrogen and phosphorus contents: In water environment, nitrogen and phosphorus are two indispensable elements for the aquatic organism development but when their concentrations in water are so high, they could cause eutrophication, and break the ecological balance in hydrosystem [7]. The N and P contents in industrial wastewater were quite different. The results showed that the mean nitrate concentration in wastewater from six industrial branches varied from 0.31 – 2.71 mgN/l, with the highest value obtained from textile and the lowest value obtained from construction materials. The mean ammonium values in wastewater from six industrial branches varied from 1.02 to 6.39 mgN/L, with the highest value obtained from mechanics and the lowest value obtained from construction materials. The Center of Environment and Applied Geology [8] reported that wastewater from the chemicals, bating and alcohol–beer production often released a larger amount of ammonium than the other industrial productions. The total phosphorus contents in wastewater from the mechanics, textile and food processing were higher than ones from the paper, chemicals and construction materials. Note that the mean value of total phosphorus in wastewater from the mechanics exceeded the National technical regulation on industrial wastewater QCVN 24:2009/BTNMT, column A.

Organic matter concentrations

Information from literature data and from the questionnaire results showed that the mean COD values in wastewater from six industrial branches exceeded the National technical regulation on industrial wastewater QCVN 24:2009/BTNMT column B (100mg COD/l). Especially, the mean COD values from the paper and food processing branches were very high (901.4 and 417.5 mg/l respectively). Most of the mean BOD_5 values in wastewater from 6 industrial branches exceeded the National technical regulation on industrial wastewater QCVN 24:2009/BTNMT column A (30 mg/l). The mean BOD_5 content in wastewater from the paper production and food processing are the highest (238.1 mg/l and 174.4 mg/l respectively), about 4.8 and 3.5 times higher, respectively than the QCVN 24:2009/BTNMT column B (50mg/l). The lowest value was recorded from the textile production (24.2 mg/l) (Figure 1).

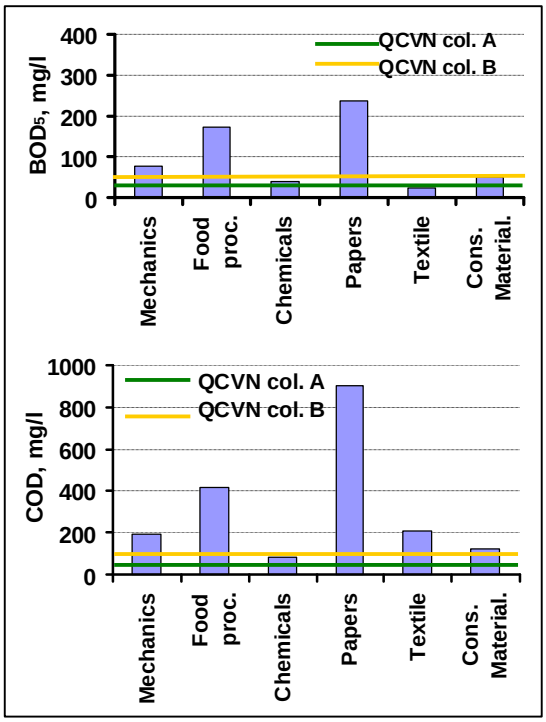

Figure 1. COD and BOD_5 values in wastewater from six industrial branches.

3.2.2. Wastewater quality from traditional production villages

In the one hand, the traditional production villages increase the production of goods and to create jobs for local inhabitants. In other hand, they release chemical contaminants and seriously cause surface water pollution because of the lack of wastewater treatment facilities. Presently, in the basin, the traditional production villages discharge about 45,000 - 60,000 m^3 wastewater/day. Note that wastewater from the traditional production villages in Ha Tay province (now included in Hanoi city) accounts for 40% [2].

The results from the previous investigations [2,4,6] focusing on traditional production village environment indicated that the wastewater quality from the food processing was the worst (table 4). Several variables such as SS, COD, BOD, N, P concentrations in wastewater from food processing far exceeded the QCVN 24:2009/BTNMT, column B. Regarding to the paper mills, wastewater from the paper processing and recycling also impact significantly surface water quality.

Table 4. Wastewater quality from traditional production villages in the Day-Nhue river basin

Production	pH -	SS (mg/l)	BOD (mg/l)	COD (mg/l)	NH_4 mgN/l	N total mgN/L	P total mgP/l
Foods	6.1	1634	1265	1841	44.0	156.1	17.0
Papers	7.0	204.5	297	544.7	30.3	34.3	0.5
Plastic recycling	6.9	340.4	109	189.2	14.2	17.0	0.2
Metal recycling	6.1	30.0	114	72.0	1.5	4.7	0.2
Textile	6.6	135.0	135	172.2	1.5	3.4	0.2
Chemicals	6.6	183.0	125	345.0	1.5	8.8	0.4
QCVN 24:2009/BTNMT, column B	*5.5- 9.0*	*100*	*50*	*100*	*10*	*30*	*6*

4. Conclusions and Petition

4.1. Conclusions

In recent years, in the Day-Nhue river basin, the industry has been developed quickly and contributed significantly to the economic-social development. However, the industrial production activities have also impacted notably the environment. Considering the six main industrial production branches (mechanics, food processing, chemicals, papers, textile – dyeing and construction materials) in

the basin, the factories/traditional production villages distributes unevenly: most of them locate in Hanoi agglomeration.

Many industrial production factories/ traditional production villages have no wastewater treatment system or ineffective treatment facilities and released directly wastewater to surface water bodies, leading to serious water pollution. The data which were synthesized from the literature and also from our sampled and analyzed results indicated that the wastewater variables (SS, nutrients and organic matters) of some industrial factories in the Day-Nhue river basin exceeded the QCVN 24:2009/BTNMT. Note that the COD and BOD values in wastewater far exceeded the *National technical regulation on industrial wastewater* QCVN 24:2009/BTNMT. Considering the traditional production villages, wastewater has been serious polluted, notably from food processing and paper recycling. In addition, total that wastewater discharges of industrial production factories and of traditional production villages reached about 100,000 m^3/day and 45,000 - 60,000 m^3/day respectively. Therefore, effective and urgent measures must be applied in order to ameliorate the environmental state of the Day-Nhue river basin.

4.2. Petition

Some measures are proposed:

- Regularly monitor wastewater quality of the industrial factories. Thoroughly treat wastewater of factories in all provinces of the Day-Nhue River basin.

- Encourage industrial companies in the basin to improve production technologies and to ameliorate the wastewater treatment system in order to observe the Vietnamese standards. The new investment projects could be accepted if they could have environment impact assessment reports.

- Enhancing the activities of communication and education in order to raise the awareness about environmental protection of the factories and local people.

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