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RESEARCH REPORT

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Compliance of Paper-Making Plants with Environmental Regulations in Bac Ninh Province, Vietnam

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This study from Vietnam shows that the paper-making industry in Vietnam is the cause of significant environmental pollution that affects the country's wildlife and the health and livelihoods of its people. It finds that there is a general lack of awareness about the environmental impact of the paper-making industry. It also finds that there are many paper-making plants that do not comply with the country's environmental regulations and do not have the necessary pollution clean-up technology.

The study is the work of Nguyen Mau Dung from Hanoi University of Agriculture. It assesses the paper-making plants in Phong Khe Commune of Bac Ninh Province, which is one of the centres of paper production in Vietnam. It recommends a number of key steps that must be taken to improve the environmental performance of the paper-making plants in the area. These include securing the necessary resources to set up pollution treatment systems that can be shared by groups of plants and strengthening the monitoring and enforcement of environmental legislation. It also recommends that more be done to raise awareness of environmental protection among the general population and the plant owners in the province.

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**Compliance of Paper-Making Plants
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May, 2009

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COMPLIANCE OF PAPER-MAKING PLANTS WITH ENVIRONMENTAL REGULATIONS IN BAC NINH PROVINCE, VIETNAM

Nguyen Mau Dung

EXECUTIVE SUMMARY

This study investigated the compliance of paper-making plants in Phong Khe Commune of Bac Ninh Province with environmental regulations. Despite contributing greatly to the economic development of the commune, the paper-making industry has generated a huge amount of waste and is considered as one of the most serious polluters in the region. According to existing regulations, all paper plants in the commune are required to submit an environmental impact assessment (EIA) report, pay the wastewater charges, and establish a wastewater treatment system. Many paper-making plants in the commune have not, however, comply with these regulations. Although fines were imposed for non-compliance, only a few plants have paid the fines due to weak enforcement. As a result, the current costs of compliance of paper-making plants are very small compared with the full costs of compliance. Type of plant, location of the plant, and number of schooling years of the plant owners were found to be significant factors affecting compliance. The main reasons why the plants did not comply with the regulations were the plant owners' inadequate understanding of environmental regulations, their lack of financial resources, limited space for treatment system installation, small fines, and the limited capacity of the local environment authorities in enforcing the regulations. The option of wastewater treatment for a group of paper-making plants located close to one another was widely accepted. The study proposes collective action for the adoption of this treatment option and policy recommendations.

1.0 INTRODUCTION

1.1 Research Problem

Bac Ninh Province is located in the center of the Red River Delta, Vietnam, next to Hanoi City. It lies within the Northern Key Economic Zone, where the economic growth rate is rather high. In recent years, Bac Ninh has achieved significant socio-economic growth. The provincial Gross Domestic Product (GDP) doubled from 1,548.3 billion VND in 1996 to 3,666.9 billion VND in 2003 (estimated at 1994 prices) (Vo et al. 2004), and increased to around 4,657.3 billion VND in 2005 (Bac Ninh Statistical Department 2006). During the period 1996-2005, Bac Ninh's GDP growth rates were stable at around 13.5%, much higher than the national GDP growth rate (Bac Ninh Statistical Department 2006).

Of three sectors (i.e., agriculture, industry, and services), the industrial sector has shown the fastest growth. Its contribution to provincial GDP increased from 372.4 billion VND in 1996 to 2,110 billion VND in 2005. Consequently, the contribution of this sector to provincial GDP rose from 22.3% in 1996 to 45.1% in 2005 (Vo et al. 2004; Bac Ninh Statistical Department 2006).

The paper-making industry in Bac Ninh is among the most significant, making up between 5-6% of the total annual industrial output value from 1996-2005. The industry's output value increased from 24.2 billion VND in 1996 to 157.9 billion VND in 2002 and an estimated 414.3 billion VND in 2006 (at 1994 base year prices, according to Decision No. 192 TCTK-TH of 1995) at a growth rate of 49% per annum (Bac Ninh Statistical Department 2007). As of 2005, paper-making in Bac Ninh accounted for 16.42% of total paper products in the whole country and generated permanent employment for more than 3,000 people in the province (Bac Ninh Statistical Department 2006).

More than 90% of around 190 paper-making plants in Bac Ninh Province are located in Phong Khe Commune. There are around 210 paper-making lines in the commune with the capacity to produce 300–5,000 tonnes/line/year. The main inputs for paper-making here are wastepaper and bamboo. The products include various kinds of paper such as printing paper, writing paper, votive paper, toilet paper, and 'kraft' paper. In 2005, the paper-making industry of the communes produced around 30 thousand tonnes of various kinds of papers each month (Phong Khe Commune People's Committee 2006).

Although the paper-making industry has greatly contributed to economic development in the area, it has also caused serious air and water pollution. According to the Bac Ninh provincial report (DONRE 2007), the paper-making plants in the commune burn more than 200 tonnes of coal/day and use a huge amount of water as one tonne of paper produce needs 50-100 m³ of water. They also daily dispose of around 2,000-2,500 m³ of wastewater containing heavy polluted effluents namely, BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), SS (Suspended Solids), and phenol; around 20 tonnes of coal residue; and big amounts of other solid waste such as pins, pastes, adhesive tapes, and nylon paper. They also emit a lot of dust into the air. The serious pollution in the commune has been highlighted many times by local and national newspapers and other publications.

The ambient atmosphere in Phong Khe Commune is smelly and filled with dust and coal smoke. The water in all the commune canals is black due to wastewater being discharged into them without any treatment and cannot be used for household purposes any longer. Moreover, this wastewater flows freely into the Ngu Huyen Khe River which flows through many other communes in Bac Ninh Province and is the main reason why the local people and officials now call the river "Dead River" (Bac Ninh People's Committee 2005). The pollution in the commune has had negative impacts on the health of its people and its agricultural production. There has been an increase in the incidence of various respiratory and skin diseases and a significant area of land is no longer suitable for cultivation.

Due to the environmental problems caused by the paper-making plants, the Bac Ninh government has issued environmental regulations and made efforts to enforce them. All the paper-making plants have been required to: (a) submit their environmental impact assessment (EIA) reports, (b) fully pay their wastewater fees based on National Decree No. 67/2003/ND-CP, and (c) build preliminary treatment systems for wastewater and waste-air treatment. An environmental inspection team was established to inspect the paper-making plants in Phong Khe Commune. Many of the plants have not complied with the regulations. Fewer than 10% submitted their EIA reports; only half partially paid the wastewater fees; and while several built wastewater treatment tanks, these are not operational. The pollution

caused by these paper-making plants is very serious, resulting in a seminar held by the Bac Ninh Department of Natural Resources and Environment in May 2006 to seek solutions to the problem.

Although past studies have focused on the financial analysis of paper-making plants or tried to address the pollution situation in paper-making communes, there has been no research on current environmental regulations on paper-making plants. Questions that need to be answered are: (a) Are the current regulations suitable and sufficient to control the paper-making plants? (b) How do the current regulations affect paper-making plants in terms of how the plants cope with regulations and how the regulations affect the performance and profitability of the plants? (c) Why do many plants not fully comply with the regulations? and (d) How should the regulations be enforced so as to mitigate pollution in the area? This research was designed to take into account the appropriateness of current regulations and to propose solutions to enforce the regulations effectively, thus mitigating the environmental problems in the commune. The study results are expected to be used by the local authorities and policy-makers to better design and enforce environmental regulations on paper-making plants, and to make plant owners and local residents pay more attention to environmental protection.

1.2 Research Objectives

The overall objective of this research was to investigate the environmental regulations related to paper-making plants and their compliance with such regulations in Bac Ninh Province, Vietnam. The specific objectives of the research were as follows:

- a) To provide an overview of the environmental compliance status of the paper-making industry in Bac Ninh Province;
- b) To investigate the current costs of compliance of paper-making plants vis-à-vis the costs of full compliance;
- c) To analyze the factors affecting the level/extent of compliance of paper-making plants with environmental regulations; and
- d) To draw policy implications for better environmental compliance and pollution mitigation in Bac Ninh Province.

1.3 Research Questions

The study sought to answer the following questions:

- a) What is the status of the paper-making industry in Bac Ninh Province (number of paper-making plants, equipment, labor force, kind of products, product quantity, production cost, selling price, profit, etc.)?
- b) What are characteristics of the local environmental authorities in Bac Ninh Province (the number of staff involved in monitoring and enforcement, the number of inspectors, the number of laboratories for sample analysis, the number of vehicles, the number of inspections, etc.)?

- c) What is the compliance cost for paper-making plants? (the compliance cost that paper-making plants actually incurred in 2006 and the full compliance cost they should have incurred in 2006)
- d) What factors affect the compliance of paper-making plants with the regulations?
- e) What should be done to make paper-making plants comply better with environmental regulations and to mitigate the pollution they cause?

1.4 Scope of the Research

There are around 190 paper-making plants in Bac Ninh Province. About 90% or 175 of those plants are located in Phong Khe Commune. This research therefore focused mainly on the plants in Phong Khe Commune as the representative sample for the paper-making industry in Bac Ninh Province.

There are a number of environmental regulations directly and indirectly affecting the paper-making plants in Bac Ninh Province. However, only those regulations that directly affected the paper-making plants were considered in this study, namely, for the plants to submit their environmental impact assessment (EIA) reports, pay their wastewater fees and build wastewater treatment systems.

The compliance cost refers to the cost that increases or the benefit that decreases when paper-making plants comply with environmental regulations. Thus, the compliance cost could be the cost of establishing and operating a wastewater treatment system to meet the standards, the wastewater fee, and any other environmental fee that paper-making plants have to pay in accordance with the regulations.

2.0 LITERATURE REVIEW

2.1 Environmental Compliance and Enforcement

The Organization for Economic Cooperation and Development (OECD 2004) defines compliance as a behavioral response to regulatory requirements. Similarly, Environment Canada (2003) defines compliance as a state of conformity with the law. Hence, compliance indicators include measurable pieces of information about the regulatees' behavior response to a regulatory requirement. The United States Environmental Protection Agency (USEPA 1992) defines environmental compliance as the full implementation of environmental requirements. Compliance occurs when the requirements are met and desired changes are achieved.

The OECD (2004) defines enforcement as the application of all variable tools to achieve compliance. In a broad sense, the OECD's definition of enforcement includes compliance promotion, compliance monitoring, and non-compliance responses. Enforcement indicators include measurable pieces of information about compliance promotion, compliance monitoring, and non-compliance responses. The USEPA (1992) defines environmental enforcement as the set of actions that governments or others take to

achieve compliance within the regulated community and to correct or halt situations that endanger the environment or public health.

One of the primary goals of an environmental enforcement program is to change human behavior so that environmental requirements are complied with. Achieving this goal involves motivating the regulated community to comply, removing barriers that prevent compliance, and overcoming existing factors that encourage non-compliance. An effective environmental compliance strategy and enforcement program brings many benefits to society. First and most important is the improved environmental quality and public health that results when environmental requirements are complied with. Second, compliance with environmental requirements reinforces the credibility of environmental protection efforts and the legal systems that support them. Third, an effective enforcement program helps ensure fairness to those who willingly comply with environmental requirements. Finally, compliance can bring economic benefits to individual facilities and to society.

However, laws designed to protect the environment are only the first step in an effective environmental policy. If the (local) Environmental Protection Agency (EPA) does not enforce compliance with these laws, or the enforcement effort is ineffective at deterring violations, the laws will come to nothing more than empty words (Nadeau 1997). Securing compliance with environmental standards is therefore a difficult task. According to Laplante and Rilstone (1996), for an approach of monitoring and enforcement to be effective, one must have a clear understanding of a plant's pollution control behavior. Regulator must be able to observe characteristics of plants and industries and from these characteristics, predict which is most likely to be in non-compliance. In particular, one needs to know how current monitoring practices affect pollution behavior and in the light of this knowledge, reallocate, if necessary, monitoring resources more efficiently.

2.2 Factors Affecting Compliance

Many factors affect compliance. Which factors are operating in any particular regulatory situation will vary substantially depending on the economic circumstances of the regulated community, on cultural norms within the community and nation as a whole, and sometimes on the individual personalities and values of managers within the regulated community. These factors can be seen in Table 1.

In any environmental situation, several of the factors described in the table will influence the behavior of the regulated community. For this reason, environmental enforcement programs will generally be most effective if they include a range of approaches to changing human behavior. The approaches fall into two categories: (a) promoting compliance through education and incentives, and (b) identifying and taking action to bring violators into compliance. Different programs will place different emphasis on these two approaches depending on the culture and the particular regulatory situation. However, experience with enforcement programs does suggest that some form of enforcement response may ultimately be essential to achieve widespread compliance (USEPA 1992).

Table 1. Factors affecting compliance

Factors motivating compliance	Barriers to compliance and factors encouraging non-compliance
Economic	
• Desire to avoid a penalty. • Desire to avoid future liability. • Desire to save money by using more cost-efficient and environmentally sound practices.	• Lack of funds. • Greed/desire to achieve competitive advantage. • Competing demands for resources.
Social/Moral	
• Moral and social values for environmental quality. • Societal respect for the law. • Clear government will to enforce environmental laws.	• Lack of social respect for the law. • Lack of public support for environmental concerns. • Lack of government willingness to enforce.
Personal	
• Positive personal relationships between program personnel and facility managers. • Desire on the part of the facility manager to avoid legal process. • Desire to avoid jail, the stigma of enforcement, and adverse publicity.	• Fear of change. • Inertia. • Ignorance about requirements. • Ignorance about how to meet requirements.
Management	
• Jobs and training dedicated to compliance. • Bonuses or salary increases based on environmental compliance.	• Lack of internal accountability for compliance. • Lack of management systems for compliance. • Lack of compliance training for personnel.
Technological	
• Availability of affordable technologies.	• Inability to meet requirements due to lack of appropriate technology. • Technologies that are unreliable

Source: USEPA (1992)

Laplante and Rilstone (1996) measured the impacts of inspections on the self-reported emissions levels of plants in the pulp and paper industry in Quebec, Canada, and suggested that both inspections and the threat of an inspection had a strong impact on reducing pollution emissions. Furthermore, the study found that inspections also induced more frequent self-reporting from the industry. Nadeau (1997) looked at the effectiveness of the EPA in reducing the time that manufacturing plants spent in a state of non-compliance. The study results indicated that a 10% increase in EPA monitoring activities

led to a 0.6–4.2% reduction in violation time. The same increase in enforcement activities resulted in a 4–4.7% reduction in violation time.

Kang and Lee (2004) empirically examined the effectiveness of an imposition of higher fines for repeated violations and state-dependent enforcement in terms of the reduction of violation days, by simulating the emitting behavior of 65 sub-industries in the Korean manufacturing industry over the period 1987–1989. State-dependent enforcement in which the regulatory agency's policy depended upon the firm's past performance was found to be more effective than an imposition of higher non-compliance fines for repeated violations in regard to the number of sub-industries exhibiting persistent non-compliance. However, the number of fully complying sub-industries was found to be slightly higher under an imposition of higher non-compliance fines for repeated violations.

Recent research indicates that local communities may exercise considerable leverage to pressure firms to improve their environmental performance (Afsah, Laplante and Wheeler 1996, Blackman and Bannister 1998, and Pargal and Wheeler 1996). Dasgupta et al. (2001) show evidence that capital markets may react negatively to the announcement of adverse environmental incidents (such as violation of permits, spills, court actions, complaints, etc.) or positively to the announcement of superior environmental performance.

Dasgupta and Wheeler (1997) found that the incidence of complaints reflected potential abatement benefits and the intensity of exposure to highly visible pollutants. However, citizen complaints did not seem to be affected by harmful pollutants that were less visible while basic education seemed to have a strong independent effect on the propensity to complain. The researchers concluded that relying on complaints alone would lead to inappropriately low allocation of inspection resources to less-educated, relatively silent regions.

2.3 The Environmental Policy Framework in Vietnam

Vietnam's environment is under considerable stress from rapid economic growth, urbanization, and growing human pressure on relatively scarce natural resources. Based on the environmental changes that have occurred in Vietnam as well as the potential pressure on the environment due to imminent development activities, it can be seen that the key environmental issues in Vietnam at present are the degradation of the following components of the environment: forest, biodiversity, land, water (both inland and sea water), and the air (MONRE 2002).

In an effort to address its environmental challenges, Vietnam has raised the profile of environmental sustainability in its national and international dialogues (World Bank 2007). Since the 1990s, acceleration in building a comprehensive regulatory and institutional framework for environmental management has been witnessed in Vietnam. The first draft of the Law on Environmental Protection (LEP) was written in 1991, submitted to the National Assembly by the National Environment Agency, adopted on 27 December 1993, and enacted in January 1994 under Decision 29L/CTN of the President of the State. The LEP was later revised in 2005. It contains general provisions and describes

measures to prevent and remedy environmental pollution and degradation. It describes the environmental management responsibilities and duties of the Ministry of Science, Technology and Environment (MOSTE) at the central level and the People's Committees at the provincial level. The LEP calls for international collaboration and makes provisions for the implementation of the law and for dealing with violations. It also requires managers of projects which potentially have impacts on environment to submit EIA reports.

A set of national environmental standards and indicators has gradually been developed. In 2002, MOSTE issued Decision No. 35/2002/QĐ-BKHCMNT publicizing a list of Vietnamese Environmental Standards for Compulsory Application. This consists of 12 standards related to air quality, 2 related to noise, 15 related to water quality, 1 related to soil quality, and 1 related to vibration.

In 2003, the Government established the Ministry of Natural Resources and Environment (MONRE), and approved the National Strategy for Environmental Protection (NSEP). Furthermore, in June 2003, the Vietnamese government issued Decree No. 67/2003/ND-CP on environmental protection charges for wastewater. The Decree has been effective since 1 January, 2004. This is the first economics instrument in Vietnam based on the 'polluter pays principle'. The Decree is the result of a continuous study over five to six years which included analyzing the models used in other countries and consultation with local stakeholders. It is a significant step in the control of environmental pollution in Vietnam. The main goals of the decree are: (a) to limit the environmental pollution caused by wastewater, (b) to use "economically clean" water (this means to encourage people to save clean water or to use clean water in an economically efficient way), and (c) to seek funding for the Environmental Protection Fund. Environmental protection charges for waste-air were proposed by MONRE in 2007 and are now being considered by the Vietnamese government. It is expected that a decree on charges for waste-air will be issued and come into effect in the near future.

Despite these signs of progress, there is need for substantial improvement in the policy framework for environmental sustainability and the institutional arrangements to achieve it. Progress has been slow due to weak commitment by sectoral agencies, low awareness of local departments and officials, and capacity challenges at all levels. There is a lack of environmental integration at the planning and programmatic levels, especially in the public investment planning process and in regional plans for land and resource use. In addition, awareness on the expected, negative environmental impacts of sustained economic growth, and the mechanisms for stakeholders to hold government agencies accountable for their performance is weak (World Bank 2007).

3.0 RESEARCH METHODOLOGY

3.1 Data Collection

3.1.1 Secondary data

Secondary data on the paper-making industry in Bac Ninh Province and Phong Khe Commune were gathered from the provincial statistical books and communal reports, related studies, and other reports of various agencies (including the Departments of Natural Resources and Environment, Science and Technology, and Agriculture and Rural Development at the provincial level, and the Departments of Economics at the district level).

The data on environmental regulations, institutional setting and the compliance of paper-making plants was gathered mainly from the Bac Ninh Department of Natural Resources and Environment (DONRE), and Phong Khe Commune authorities.

3.1.2 Primary data

The primary data for the research came from three sources: (a) the field survey of paper-making plants in 2007, (b) the database on paper-making plants from the inspection in 2006, and (c) focus group discussions (FGDs).

(a) Field survey

The main purposes of the field survey were to gather both qualitative and quantitative information on the (a) business situation of the paper-making plants such as kind of papers produced, production scale, inputs, outputs, sales, etc.; (b) environmental performance of the paper-making plants (their compliance with the regulations, inspections, and fines or penalties imposed/paid); and (c) implications for regulation improvement to mitigate the environmental pollution in the area.

Personal interviews with plant owners using a standard questionnaire were conducted. At first, a draft questionnaire was developed. It consisted of four parts. The first part gathered general information on the paper-making plants, including information on location, ownership, and owners. The second part gathered data on plant resources (working areas, production lines, and other assets); production (input use, total production, and trends in production volume); and sales (sale volumes, prices, and buyers).

The third component gathered information on the environmental performance of paper-making plants such as whether the owners submitted their EIA reports, paid their wastewater fees in full, or built the required treatment systems, and why they did or did not do so; also on how much the environmental compliance costs for plants were, how inspections were carried out, and how fines and penalties were imposed on the plants in 2006 and previous years. The final component gathered the respondents' opinions on what

should be done to mitigate the environmental pollution in the area in terms of both the policy and technical aspects. The draft questionnaire was pre-tested through interviews with 10 plant owners for its appropriateness. Then the final questionnaire was developed for the field survey. The interviewers were trained on how to administer the questionnaire and introduced by commune staff to plants owners for direct interviews.

Through discussions with the commune staff and due to limitations of time and financial resources, it was agreed that around 60 plants with different ownership, location, and type of paper products in the commune would be selected as the sample. At first, the 175 paper plants in the commune were divided into two categories of individual households and company plants. Then, each category was further divided into two groups: those located inside and outside the industrial clusters (there are two in Phong Khe Commune).

At first, a list of the plants in each group was prepared. Then plants to be interviewed from each group were randomly selected. In case the interview with one plant in the group could not be conducted, another plant in the same group would be randomly selected instead in order to secure the number of interviewed plants in each group. The number of plants in each group is presented in Table 2.

Table 2. Number of plants surveyed in each group

Group	Plants in the commune		Plants surveyed/ interviewed	
	No.	%	No.	%
Company plants inside the industrial cluster	49	28.0	17	27.4
Company plants outside the industrial cluster	43	24.5	15	24.2
Household plants inside the industrial cluster	15	8.6	5	8.1
Household plants outside the industrial cluster	68	38.9	25	40.3
Total	175	100	62	100

(b) Data from the inspection in 2006

In the middle of 2006, Bac Ninh DONRE in cooperation with Phong Khe Commune People's Committee conducted an inspection on 157 of the 175 paper-making plants in Phong Khe Commune. The inspection team investigated if the plants established and ran a wastewater treatment system, submitted their EIA reports, and paid their wastewater charges. The inspection team decided on the plants to be fined and determined the levels of the fines. The database on the results of the inspection was used to determine the environmental compliance of the paper-making plants.

(c) Focus group discussions

Focus group discussion (FGD) is a technique used to elicit the common understanding of people about the issues being researched and helps to provide some answers to the research questions. Moreover, FGDs among key informants also help to

check the reliability of the answers obtained. In other words, FGD can be used to cross-check the data/information collected through other methods.

In this study, several FGDs were organized. Firstly, FGDs with plant owners and non-paper-making villagers (with different backgrounds in term of age, sex, social position, experience, plant ownership, and scale of operations) were organized to get their opinions on the appropriateness of environmental regulations and their effects on the behavior of paper-making plants, emerging problems in implementing the regulations, and proposed solutions to improving the compliance of paper-making plants with regulations (such as changing regulation contents, institutional settings, environmental awareness improvement, etc.).

Secondly, FGDs with plant owners and communal officials were organized to get a full understanding of compliance costs. The costs of meeting the standards through the installation of mechanical and/or technological pollution abatement measures and the imposition of wastewater fees were discussed. A comparison between these compliance costs and the costs of penalties/fines was made. This helped shed light on why many plants did not comply with the regulations. Thirdly, FGDs with the commune officials and representatives of DONRE were held to get their opinions on environmental regulations and the compliance of paper-making plants.

Fourthly, FGDs with staff in Bac Ninh's DONRE were also held to get information on the characteristics of local environmental authorities such as the number of environmental staff involved in monitoring and enforcement, their capabilities (degrees and special fields of study), the number of inspectors, the number of laboratories for sample analysis, the number of vehicles, the budget available for monitoring and enforcement, the number of inspections per year in the last five years, any difficulties that the local environmental staff were facing in monitoring the paper-making plants, and their opinions on the current regulations and proposed solutions of what should be done to overcome the current difficulties. The situation of wastewater fee collection and use of wastewater fees in the province was also investigated through FGDs with DONRE staff, and through in-depth interviews with the Head of the Environment Section and other key staff of DONRE.

3.2 Analysis

The empirical analyses of this research relied on three main procedures. Initially, descriptive statistics were used to describe the status of the paper-making industry and its impacts on the environment as well as the compliance of paper-making plants with regulations. Next, comparative analyses were used to identify the differences in compliance behavior between paper-making private companies and individual households, between small and large scale plants, and so on. The descriptive statistics and comparative analysis focused on making clear why some paper-making plants complied with environmental regulations while others did not. Finally, the logit regression model was employed to identify the factors affecting the compliance of paper-making plants with environmental regulations.

3.2.1 Descriptive statistics

Descriptive statistics were used to describe the general situation of the paper-making industry in the research site such as the number of paper-making plants by kinds of paper products, total labor force involved in the paper-making plants, the total product volumes of the industry, etc. This method was also used to present the general resources of each plant group (production area, labor resource, capital and assets); the performance of paper-making plants per group (when the plant was established, amount of inputs used, and output volumes); the environmental consequences of paper-making activities; the plants' response to or compliance with environmental regulations including the submission of the EIA reports, payment of wastewater fees and the establishment of treatment systems; and the reasons why the plants did or did not comply with environmental regulations. The method was also used to present the characteristics of the local environmental authorities such as the number of environmental staff involved in monitoring and enforcement, their qualifications, the number of inspectors, the number of laboratories for sample analysis, the number of vehicles as well as the situation of wastewater fee collection under Decree 67 and the use of wastewater fees in Bac Ninh Province.

3.2.2 Comparative analysis

Comparative analyses were made to show the development of the paper-making industry in Phong Khe Commune through comparing by year, the number/ratio of plants by group or labor force engaged in processing activities, and the production of paper products. Comparative analysis was also used to show the differences between the plant groups in terms of productive resources; the performance of the paper-making plants; the wastewater volumes discharged; the attitude of respondents to the environmental consequences and the regulations; and the ratios of plants complying with the regulations. A comparative analysis of two plant groups—those complying with the regulations and those not doing so—was made to highlight the differences between the two groups and the significant reasons for the compliance and non-compliance of plants.

3.2.3 Logit regression model

The data was examined to see if it was possible to run a logit function to identify the factors affecting the compliance of paper-making plants with environmental regulations. The model can be written in a general functional form as follows:

$$COP_i = f(F_i, P_i, e_i)$$

where

i ($i = 1, 2, 3, \dots, N$) stands for the plant;

COP denotes the compliance indicator, equal to 1 if the paper-making plant complied with the regulations and equal to 0 if otherwise;

F is vector of plant owner characteristics, such as age and education level, which were expected to have an impact on the probability of compliance with the regulations;

P is a vector reflecting plant characteristics such as type of ownership, volume of products, and number of labor employed; and

e_i is the error term.

Then, the model was estimated using data analysis and statistical software (STATA). The estimated parameters explained which factors significantly affected the compliance of the paper-making plants with environmental regulations.

4.0 RESULTS AND DISCUSSION

4.1 The Paper Industry in Phong Khe Commune

Phong Khe Commune is situated about 35 kilometers northeast of Hanoi. According to the People's Committee of Phong Khe Commune (2007), the commune has 1,964 households with 8,546 people. The total area of Phong Khe Commune is 548 hectares, of which agricultural land accounts for 56.7% (311 hectares). The commune has four villages: Duong O, Dao Xa, Cham Khe, and Ngo Khe. Of the many traditional paper-making craft villages that have existed in the north of Vietnam for centuries, Duong O has become the most industrialized. In the past, Duong O was known for its production of Do paper. Do paper is an off-white paper produced from the bark of the Do tree. It is silky smooth, flexible, acid-free, mold-resistant, and water-resistant.

The production of traditional Do paper in the village has almost stopped because of the shrinkage of the Do paper market. In the past decade, the village has been transformed from a community of Do paper producers to a community of small industrial paper producers. From six paper mills with six paper production lines in 1992, Duong O had 71 paper mills with more than 100 paper production lines in 2002. Paper mills have also sprung up in neighboring villages in Phong Khe Commune. Phong Khe now has a total of 175 paper mills of which 139 are located in Duong O, 28 in Dao Xa, and 8 in Cham Khe.

The paper industry has created jobs for many people in the commune and attracted around 3,000 people from neighboring communes to participate in production processes, wastepaper trading, and other related services. Total paper production reached around 120,000 tonnes in 2005 and approximately 150,000 tonnes in 2006. The revenue from the paper industry in the commune reached 450 billion VND in 2005 and 540 billion VND in 2006 and is projected to be 600 billion VND in 2007. The industry generates 87% of the total income of the commune and contributes 13 billion VND to the national budget through taxes (Phong Khe Commune People's Committee 2007).

Table 3. Paper production industry in Phong Khe Commune (2006)

Items	Unit	Quantity
1. Number of paper mills	mill	175
2. Number of paper production lines	line	210
3. Production capacity per mill	kg/day	300-5,000
4. Total paper production	tons	150,000
5. Revenue from paper production	billion VND	540

Source: Phong Khe Commune People's Committee (2007)

Paper-making plants in Phong Khe produce different kinds of paper such as votive paper, kraft paper, wrapping paper, tissue paper, and toilet paper. These products are sold throughout Vietnam. The equipment used in the paper production lines is old, mainly imported from China with some parts made in Vietnam.

The major input for paper production in Phong Khe is wastepaper. However, wastepaper has different categories and each category is used for producing different kinds of paper. Pine resin is used to make the pulp more luminous in the case of wrapping paper, votive paper, and tissue and toilet paper. Javen is used to bleach the pulp in the making of votive paper, and tissue and toilet paper. Pigment is used to create desired colors for the paper. Paper production requires huge volumes of water—50-150 m³ of water is needed to produce one tonne of paper products. It also consumes a lot of electricity (280-300 Kwh/tonne of paper products). Coal is also used to create the steam which is necessary for the production process.

The paper production process as practised in Phong Khe is illustrated in Figure 1. In the first stage, solid waste such as paste, pins, and nylon are removed from the wastepaper. At the same time, bamboo canes are soaked with water, soda and steam until they become decomposed and ready for milling. The mixture of cleaned wastepaper and decomposed bamboo is then milled and washed and put into a tank of water to dilute it. The fiber mixture, with more than 90% water at this point, is sprayed onto a moving screen and water is drawn off at high speed in the paper machine, leaving behind paper. The paper is then dried, refined, and cut for shipment or conversion into consumer products.

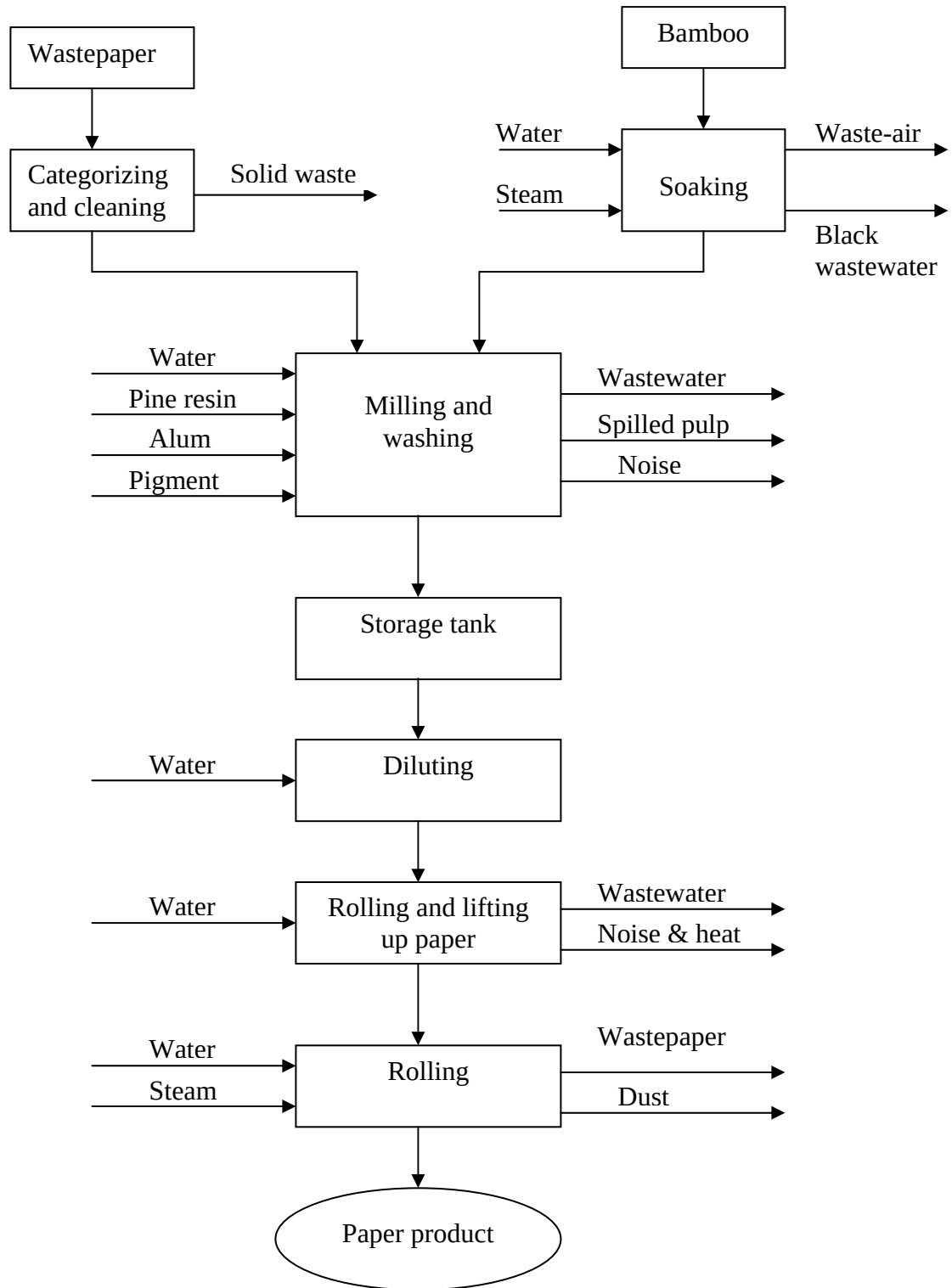


Figure 1. The paper production process

However, for specific categories of paper and paper quality, the producers will use more or less bamboo material, pine resin, and pigment. Table 4 shows the inputs for paper production in Phong Khe Commune.

Table 4. Inputs for paper production in Phong Khe Commune

(Average for 1 tonne of paper products)

Input	Unit	Wrapping paper	Votive paper	Kraft paper	Tissue and toilet paper
1. Wastepaper (& bamboo)	tonne	1.2-1.3	1.2-1.3	1.2-1.3	1.2-1.3
2. Pine resin	kg	30-40	30-40	0	50-60
3. Javen (sodium hypochloride)	liter	0	15-30	0	20-50
4. Alum	kg	40-50	40-50	40-50	40-50
5. Pigment	kg	0	3-5	0	3-7
6. Sodium hydroxide (NaOH)	kg	5-6	5-6	5-6	6-8
7. Coal	kg	500	600	700	600
8. Water	m ³	50-100	60-120	50-100	75-150
9. Electricity	kw	280-300	280-300	280-300	280-300

Source: survey 2007

Although the paper-making industry has contributed greatly to economic development in the commune, it causes serious environmental pollution in the area due to the discharge of huge wastewater volumes containing COD, BOD, SS, and phenol effluents, and great amounts of solid waste and waste-air from coal burning. The air in the commune is filled with dust and smoke, and smells bad. According to a survey in 2003 by the Institute of Environment, Science and Technology, University of Technology, the content of COD in the wastewater in Phong Khe Commune is from 630–1,260 mg/l, 6–12 times higher than the standard.

Table 5. Effluents in wastewater from paper-making

	COD (mg/l)	BOD₅ (mg/l)	SS (mg/l)	Phenol (mg/l)
1. Wastewater from paper production	1,260	402	1282	0.2
2. Wastewater from the canal in Duong O	630	105	200	0.11
3. Wastewater at a discharge point of the canal	380	64	210	0.05
TCVN 5945 -1995	100	50	100	0.05

Source: University of Technology (2003) in Dang 2004.

The serious pollution has degraded the agricultural land in the commune, making more than 15 hectares uncultivable. It has also negatively impacted the health of the local people. The incidence of skin and respiratory diseases is high and has increased significantly in recent years (Table 6).

Table 6. Disease incidence in Phong Khe Commune

Diseases and symptoms	Incidence in 2001 (%)	Incidence in 2005 (%)
Problems with ear, nose & throat		
Stuffy nose	40.0	42.0
Runny nose	37.3	40.0
Hoarse voice	38.7	39.0
Dry throat	45.7	47.5
Sore throat	32.0	32.6
Respiratory problems		
Cough	36.0	37.0
Phlegm	39.7	40.0
Tightness in the chest	29.7	31.0
Suffocation	31.3	33.3
Difficulty in breathing	26.7	35.0
Wheezing	11.0	14.0
Eye problems		
Itchy eyes	45.0	47.0
Tearing	32.3	35.0
Blurred vision	34.3	35.0
Sore eyes	40.7	42.0
Dermatological problems		
Itch	42.3	45.0
Rash	39.0	42.0
Xeroderma	14.7	21.0
Skin ulcers	30.7	31.0
Boils	9.0	-
Neurological disease		
Insomnia	44.7	43.0
Dizzy spells	53.0	55.0
Headaches	53.7	54.0
Decreased concentration	25.7	26.0
Amnesia	31.0	31.0
Diminished hearing	33.7	34.7
Muscle fatigue	52.3	53.0
Digestive problems		
No appetite	43.7	40.0
Nausea	10.3	10.0
Indigestion	12.0	13.0
Stomachache	24.0	28.0
Others		
Fever	18.3	15.7

Source: report on the environmental situation in Bac Ninh (Bac Ninh DONRE 2006)

4.2 Environmental Regulations and the Compliance of Paper-making Plants

Deeply concerned about the environmental problems in Bac Ninh Province in general and in the paper-making communes in particular, the Bac Ninh government has issued environmental regulations in order to try to resolve the problems. These regulations mainly include submitting the EIA reports, building preliminary treatment systems for wastewater, and paying the wastewater charges.

Although the above regulations have been imposed on paper-making plants as well as on other craft industries, the pollution in the region and in Phong Khe Commune have become worse. The Ngu Huyen Khe River that flows through the commune is considered as a “dead river” as the river water cannot be used for irrigation and other purposes, especially in the dry season. Faced with such serious pollution, the Bac Ninh People’s Committee ordered the Bac Ninh DONRE to conduct environmental inspections in mid-2006 on craft villages that discharged their waste into the river and propose relevant measures to improve their environmental compliance. Phong Khe Commune was inspected as it was considered to be a serious polluter in the region. The inspection team inspected almost all the paper-making plants in the commune (157 out of 175), imposed fines on the plants which did not comply with the regulations and threatened the firms with closure if they failed to pay the fines.

4.2.1 EIA report submission

On 6 September, 1997, the Bac Ninh People’s Committee issued Decision No. 203/QD-UB on environmental impact assessments of socio-economic development projects in Bac Ninh Province. This requires all socio-economic development projects in Bac Ninh to submit EIA reports to the Environmental Protection Agency for evaluation. For paper-making plants, this decision has been effective from 2004. However, very few of them have complied with this regulation. An inspection in September 2006 by the Bac Ninh DONRE showed that only five paper-making plants in Phong Khe Commune had submitted their EIA reports while 152 plants (96.8%) had not. The five plants which had submitted the reports were all companies. Of the 152 plants not submitting the EIA reports, 66 (100% of the total number of household plants) were individual households and 86 (94.5% of the total number of company plants) were companies. By location, 95.3% of the plants inside the industrial zone and 97.8% of the plants outside it had not submitted their EIA reports.

Table 7. EIA report submission by paper-making plants as at September 2006

	EIA submitted		EIA not yet submitted	
	No. of plants	Percentage	No. of plants	Percentage
1. By ownership	5	3.2	152	96.8
- Enterprises/Companies	5	5.5	86	94.5
- Individual households	0	0	66	100.0
2. By location	5	3.2	152	96.8
- Inside industrial zone	3	4.7	61	95.3
- Outside industrial zone	2	2.2	91	97.8

Source: DONRE inspection database (2006)

After the inspection in September 2006, 132 out of the 152 paper-making plants which had not submitted the EIA report were fined, the average fine being 3 million VND per household and 4 million VND per company. All the plants which had not submitted their EIA reports were required to do so before 31 December 2006. However, of the 132 plants were fined, only 16 (15 companies and one individual household) paid the fine. Up to end of 2007, only 14 more plants had submitted their EIA reports while the others still had not. Figure 2 refers.

It therefore seems that inspections and fines create incentives to comply with regulations. Between 2004 (when Decision No. 203 was adopted) and 2006, only five enterprises had done their EIAs, while after the inspection and the introduction of fines in mid-2006, 14 more did their EIA reports. Stronger enforcement of regulations can therefore probably induce paper-making plants to comply with environmental regulations.

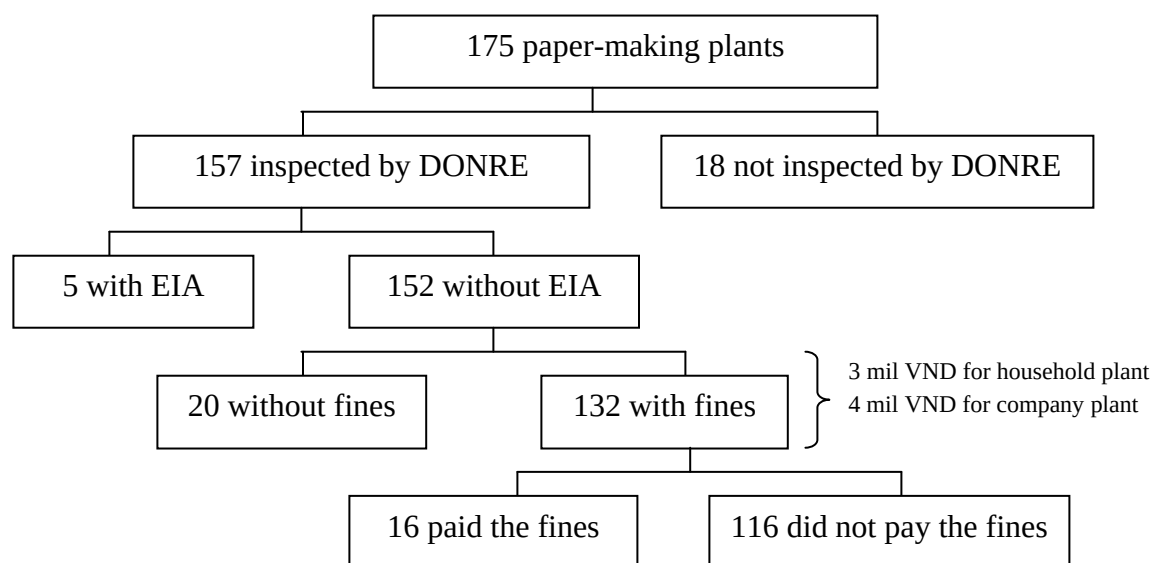


Figure 2. Compliance of paper-making plants with EIA report submission regulations

This study discovered that the plant owners could not do the EIA report themselves as it required a lot of complicated technical information. They had to hire consulting agencies, usually the Environmental Monitoring and Analysis Station of Bac Ninh DONRE. The cost of preparing the EIA report is regulated from 0.01–0.05% of the total plant investment cost. For paper plants in Phong Khe, it is between 20-35 million VND depending on the plant's scale of operation and the negotiation between the plant owner and the agency. This is equivalent to the full costs of compliance. However, the costs of non-compliance were much lower. For such a reason, the current costs and full costs of complying with EIA report requirements are the same for plants which submitted the report, but different for plants which have not submitted the report. By the end of 2007, only 19 plants (10.9%) had submitted their EIA reports while 156 (89.1%, comprising 73 companies and 83 individual households) had not (Table 8).

Table 8. Current costs versus full costs of compliance with EIA report submission regulations

	No. of plants	Current costs incurred	Full costs of compliance
Plants which have submitted their EIA reports	19	20-35 mil VND	20-35 mil VND
Plants which have not submitted their EIA reports	156	0 mil VND for EIA writing; 3-4 mil VND for fines (16 plants)	20-35 mil VND

Source: FGDs (2007)

4.2.2 Payment of wastewater charges

Decree No. 67/2003/ND-CP on environmental protection charges for wastewater was implemented in Bac Ninh on August 1, 2004. According to this decree, all production and business units, including the paper-making plants in Phong Khe Commune, that discharge industrial wastewater must pay a wastewater charge. Every quarter, DONRE calculates charges for all paper plants. At the beginning of the quarter, it issues an announcement to the plants on the total charges including the charges for the last quarter and for previous (unpaid) quarters. The plants are required to pay the charges to the Bac Ninh Treasurer within 20 days of the announcement and to report their wastewater volumes at the end of the quarter to DONRE.

According to the inspection results in September 2006, the total wastewater charges that all the paper plants in Phong Khe had to pay up to September 2006 was 198.92 million VND. However, only 74 paid (charges of 55.8 million VND or 28%) while the rest (83 plants) did not pay the wastewater charges (Table 9). This situation coincided with the general situation in Bac Ninh Province. According to Bac Ninh DONRE, the total wastewater charges from August 2004 to March 2007 due from all production and business units in Bac Ninh was 1.38 billion VND, but DONRE only received 365 million VND

(26.3 %). Around half of the units in Bac Ninh have not paid their wastewater charges and many have not paid in full.

Table 9. Payment of wastewater charges by paper-making plants as at September 2006

	Wastewater charges paid		Wastewater charges not paid	
	No. of plants	Percentage	No. of plants	Percentage
1. By ownership	74	47.1	83	52.9
- Enterprise	53	58.2	38	41.8
- Individual households	21	31.8	45	68.2
2. By location	74	47.1	83	52.9
- Inside industrial zone	46	71.9	18	28.1
- Outside industrial zone	28	30.1	65	69.9

Source: DONRE inspection database (2006)

Non-compliance fines were imposed on 77 plants (out of the 83 which did not pay their wastewater fees). These comprised 35 enterprises and 42 individual households; 17 plants were located inside the industrial zone and 60 outside it. The individual households were fined with 500,000 VND per plant while the companies were fined 700,000 VND each. However, only two plants have paid the fine. See Figure 3.

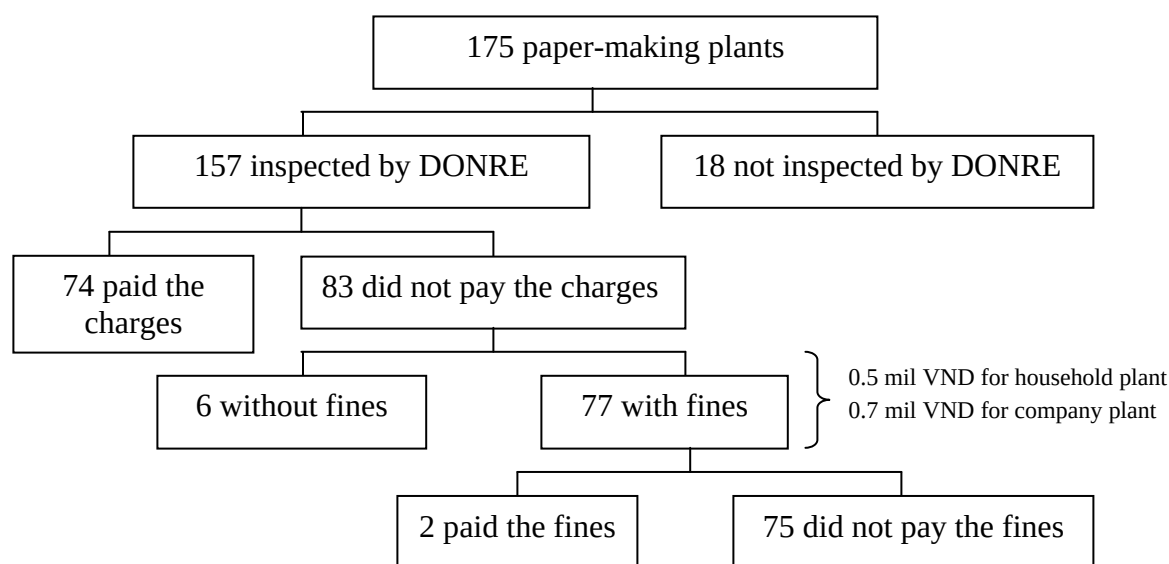


Figure 3. Compliance of paper-making plants with wastewater charge payment regulations

According to DONRE, after the inspection and introduction of the non-compliance fines on unpaid wastewater charges, more paper plants in Phong Khe complied with this regulation, but only for Quarters 3 and 4 of 2006 (right after the inspection). The total

collected charges of these two quarters increased, accounting for more than 90% of the total collected charges for the whole year. However, in the year 2007, when no inspection was done in Phong Khe, the total collected payments decreased sharply in comparison with 2006. Regular inspection could therefore be an effective measure to make plants comply with the regulation.

As required by Bac Ninh DONRE, each paper-making plant has to pay the wastewater fee quarterly since Quarter 3 of 2004. The wastewater charge is calculated by DONRE based on the wastewater volumes and effluents of each plant. Most plants were established before 2004, therefore, they should have paid the fees 11 times from Quarter 3/2004 to Quarter 1/2007. However, as shown in Table 10, they paid only 1.1 times on average. Many plants (89/175) did not pay at all, 31 paid only two times, and 33 plants paid only one time. Only two plants paid seven times while two others paid six times. The average quarterly fee was 185,000 VND/plant in 2006. However, it ranged from 6,000–825,000 VND/plant (Table 10).

Table 10. Current wastewater charges versus total charges (Q3/2004 – Q1/2007)

Type of plant		Total wastewater charge ('000 VND)	Total payment ('000 VND)	Total debt ('000 VND)	No. of times of payment	Wastewater charge for one quarter ('000 VND)
Companies	Mean	2,536	695	1,818	1.8	174
	Maximum	22,480	4,694	22,000	7.0	825
	Minimum	256	0	0	0	18
	Std. Dev.	3,135	976	2,936	1.7	162
Individual households	Mean	1,530	129	1,401	0.4	198
	Maximum	6,883	4,597	4,032	3.0	762
	Minimum	64	0	64	0	6
	Std. Dev.	1,102	542	966	0.7	162
Total	Mean	2,059	427	1,620	1.1	185
	Maximum	22,480	4,694	22,000	7.0	825
	Minimum	64	0	0	0	6
	Std. Dev.	2,443	846	2,234	1.4	162

Source: calculated from DONRE data records (2007)

As shown in Table 10, the average wastewater fee a plant had to pay from Quarter 3/2004 to Quarter 1/2007 was 2.06 million VND. However, each plant actually paid only 0.43 million VND or just about one fifth of the charges: 89 plants (or 50.9% of the total number) paid nothing, 24 (13.7%) paid less than 20%, 15 (8.6%) paid between 20–40%, 24 (13.7%) paid from above 40% to 60%, 17 plants (9.7%) paid from above 60% to 80%, and 6 (3.43%) plants paid more than 80% of which only one paid the wastewater charge in full (Figure 4). The maximum charge for a single plant up to Quarter 1/2007 was 22.5 million VND while the maximum payment was only 4.7 million VND. The outstanding payment of the paper-making plants ranged from 0–22 million VND, averaging at 1.8 million VND.

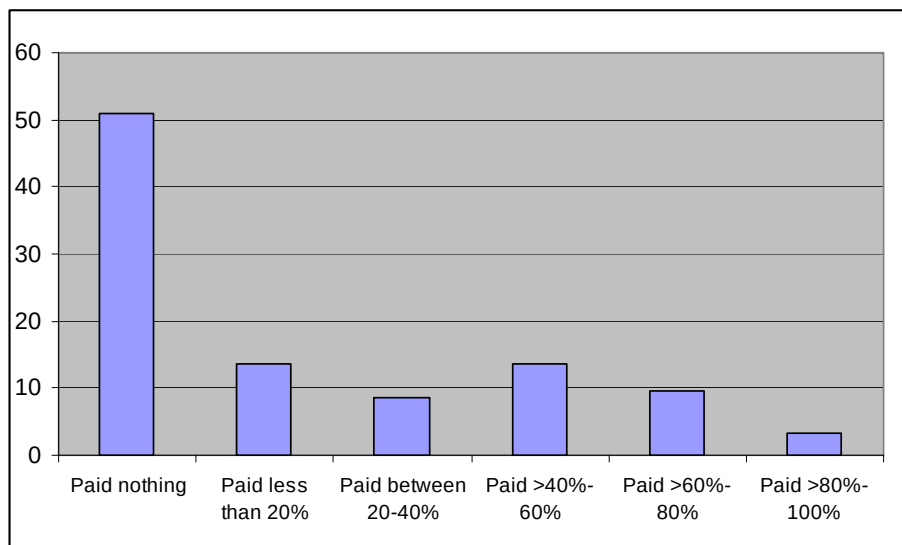


Figure 4. Percentage of plants that paid their wastewater charges (Q3/2004 – Q1/2007)

In general, the companies better complied with the regulation on wastewater charge payments than individual household producers. While the number of times from Q3/2004 to Q1/2007 that a company paid the wastewater charge was 1.8 on average, the figure for an individual households was just 0.4. While a company paid 27.4% of the wastewater charges on average, an individual household paid only 8.4%. This is probably because the management of individual household plants is more difficult than that of company plants since the latter officially follow the enterprise laws of Vietnam while individual household plants do not.

4.2.3 Installation of wastewater treatment systems

On July 26, 2000, the President of Bac Ninh People's Committee issued Decision No. 76/2000/QD-UB on environmental protection regulations for Bac Ninh Province. With nine chapters and 35 articles, these regulations embody the Environmental Protection Law of Vietnam (1993). The regulations specify that paper-making plants must establish wastewater treatment systems to treat their wastewater before disposing it into the environment¹.

In accordance with Decision No. 76/2000/QD-UB, all paper-making plants in Phong Khe are required to establish a treatment system to treat their wastewater up to the TCVN (government) standards before discharging it into the environment. However, up to

¹ Article 17: All production and business units which emit waste into the environment have to implement measures to prevent or mitigate environmental pollution, and to invest in equipment and waste treatment systems to meet the TCVN standards before discharge.

now, very few plants in the commune have done so. They only have a water circulation tank to reuse the wastewater. Each paper-making plant discharges around 5–15 m³ of untreated wastewater into the environment every day. Only four plants (Hien Hoa, Long Khanh, Duc Huynh, and Nguyen Van Thang) that had received funds from the demonstration project funded by the Vietnam Chemistry Association and Bac Ninh DONRE established their own systems. Unfortunately, when the project ended, these treatment systems also stopped operating due to lack of funds. Other than these, only the five plants which had submitted EIA reports had established wastewater treatment systems as at September 2006.

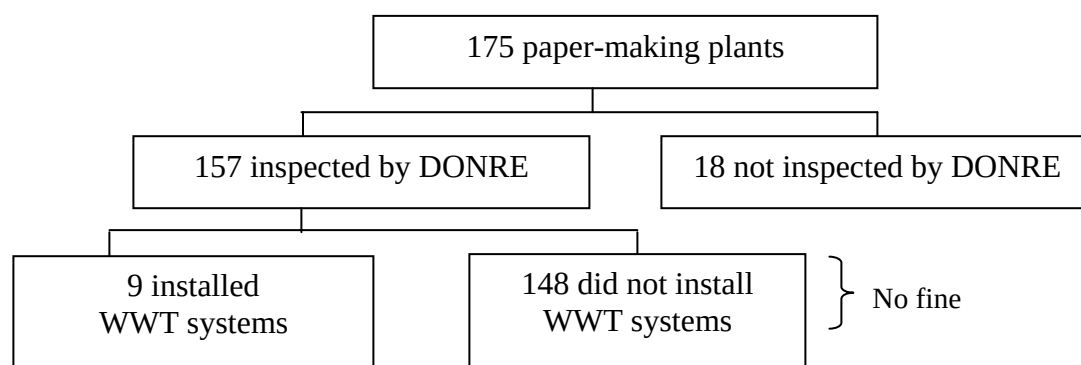


Figure 5. Compliance of paper-making plants with wastewater treatment system installation regulations

Note: WWT = wastewater treatment

The wastewater treatment system includes a tank and other facilities. The cost of system establishment depends on the tank capacity, but is estimated at about 25–50 million VND per plant. Moreover, the operational cost for electricity, chemicals, and other items, is about 0.3–0.8 million VND per month. Only 9 plants (or 5.1%) established wastewater treatment systems while the remaining 94.9% did not. However, these systems are not operational, the reason being that operating them would mean additional costs for the plants. Also, there is no action taken for non-operation so there is no incentive to operate the systems. The current compliance costs and the full compliance costs of installing a treatment system are shown in Table 11. All plants have also been required to establish waste-air treatment systems, but none have done so.

Table 11. Current costs versus full costs of compliance with treatment system installation regulations

Type of plant	Current costs incurred	Full costs of compliance
Plants with treatment system (9 plants)		
- Establishment cost	25-50 mil VND	25-50 mil VND
- Operational cost	0	0.3-0.8 mil VND/month
Plants without treatment system (166 plants)		
- Establishment cost	0	25-50 mil
- Operational cost	0	0.3-0.8 mil VND/month

Source: FGDs (2007)

4.3 Factors Affecting the Compliance of Paper-making Plants with Environmental Regulations

4.3.1 Capacity of local environmental authorities in Bac Ninh Province

This section will describe the local environmental management system, including its resources and facilities, and analyze local enforcement action.

(a) The environmental management system in Bac Ninh

The environmental management system in Bac Ninh operates at three levels: provincial, district and communal. At the provincial level, Bac Ninh DONRE is responsible for the natural resource and environmental management of the whole province. Bac Ninh DONRE manages eight DONREs in Bac Ninh City and the districts of Gia Binh, Luong Tai, Que Vo, Thuan Thanh, Tien Du, Tu Son, and Yen Phong. The DONRE of each city/district manages its own natural resources and environment issues under the guidance of Bac Ninh DONRE. At the commune level, there is one staff responsible for natural resource and environment management in each commune.

Bac Ninh DONRE has eight functional units (the Land Management Unit, Planning Unit, Secretarial Office, Inspection Unit, Environmental Management Unit (EMU), Water and Mineral Unit, Mapping Unit, and Accounting Unit) and four centers/offices (the Land Fund Development Center, Land Use Rights Registration Office, Environmental Monitoring and Analysis Station, and Natural Resources Technique Center).

EMU is primarily responsible for environmental management in the province. Its major tasks are: (i) to help the Bac Ninh People's Committee in designing legislation relating to environmental protection in Bac Ninh Province; (ii) to coordinate with other departments in Bac Ninh Province for formulating the annual plan, medium-term plan and long-term plan on environmental protection, submitting these to the Bac Ninh People's Committee for approval, and monitoring the plan implementation; (iii) to guide, inspect, and monitor the implementation of environmental regulations in Bac Ninh Province, and to address disputes, appeals or complaints on environmental issues; (iv) to monitor

environmental quality and to write annual reports on the state of environment in Bac Ninh; (v) to appraise the EIA reports of investment projects, and production and business units in Bac Ninh Province; (vi) to conduct activities to educate and raise environmental awareness of the people and organizations in Bac Ninh Province; and (vii) to coordinate with the city/district environmental management units in organizing environmental inspections/checks and guiding the implementation of environmental protection laws and regulations.

In addition to EMU, the Environmental Monitoring and Analysis Station (EMAS) and Inspection Unit (IU) provide support services to EMU such as sampling and measuring wastewater and waste-air effluents while IU also organizes inspections on land use and environmental problems in the province.

(b) Environmental management staff in Bac Ninh

The Environmental Management Team of Bac Ninh Province has been established since 1994 following the Environmental Protection Law of 1993. At the beginning, there was only one staff who graduated from the University of Agriculture. He first worked in the Product Quality Measurement Department before moving on to the Environmental Management Team in the Bac Ninh Department of Science, Technology and Environment. In August 2002, following the establishment of the Ministry of Natural Resources and Environment (MONRE), EMU was set up under Bac Ninh DONRE. At present, EMU has only 6 staff comprising an EMU head, a secretary, and four technical staff (3 men and one woman) each responsible for different areas: waste management; appraising the EIA reports; inspecting production and business units; and responding to petitions, complaints, etc. All the technical staff are quite young (below 35 years old) and university graduates in environmental chemistry or environmental technology.

The IU has the task of organizing and implementing inspections on land use, and environmental issues. The unit has only four staff, including the head. In recent years, there have been many problems on land use, therefore the unit has paid much more attention to settling these than to environmental issues. Only when the pollution in Ngu Huyen Khe River became very serious was an inspection on the business units in the craft villages along the river organized by the IU from July to September 2006. The inspection team is usually composed of staff from the IU, EMU, and the Environmental Monitoring and Analysis Station (EMAS). When conducting inspections on craft villages, the inspection team coordinates with the staff from DONRE at the district level, the President and Vice-President of the commune, and commune environmental staff.

EMAS in Bac Ninh DONRE was established in 2004 to help manage the environment more effectively. The station has 16 staff. The station staff also participate in the environmental inspections, and give advice on or write EIA reports for investment projects and production/business units in Bac Ninh Province and also in the neighboring province of Bac Giang.

At the district level, there is only one or two staff responsible for environmental management per district (12–23 communes/district). However, they generally do not have

expertise in environmental management but in irrigation management and agricultural economics instead. In each commune, one staff is appointed to be responsible for environmental management as well as many other tasks such as land, irrigation, and transportation management. Most environmental staff at the commune level are high school graduates and do not have expertise in environmental management.

(c) Facilities for environmental management

The facilities for environmental management at EMU and IU in Bac Ninh DONRE include just several computers, a telephone, and a facsimile machine. However, EMAS has three testing and analysis rooms for water, air and soil samples. The facilities are quite modern with a total value of around 2.7 billion VND (as at 2006)². At the district level, the staff are equipped with a telephone and computers. Environmental management staff at the commune level, however, have to share a telephone with other commune staff. Environmental staff at all levels usually use their own motorbikes to carry out inspections or other work and are paid for petrol costs in addition to being given a small allowance. Bac Ninh DONRE has only two cars, reserved for the Director and Vice-Director.

EMU of Bac Ninh DONRE, with support from the district and commune environmental staff, EMAS, and IU, has to do a huge amount of work. It currently oversees more than 1,000 enterprises, several industrial zones, and around 60 craft villages in the province. With only six people, a limited budget for implementing its activities, and limited transportation means, it is very hard for EMU to fulfill its responsibilities.

(d) Local enforcement action

In order to ensure the compliance of the paper-making plants in Phong Khe Commune, DONRE, in cooperation with other stakeholders, implemented several measures as follows:

(i) Enhancing the environmental education of local staff

DONRE annually organizes a training course to raise the awareness of its staff and village heads on environmental issues. The local staff in Phong Khe have also been also invited to participate in such training courses. However, due to the limited fund, the course is often very short in duration (only a day) and caters to a large number of participants (between 100–350 participants/course). The effectiveness of the course is thus not very high.

(ii) Conducting inspections on production units/firms

Annually, Bac Ninh DONRE implements checks and/or inspections on production firms in the province. However, with its limited budget and manpower, DONRE can only

² Two billion VND was donated under a Canadian project.

check and inspect a limited number of units each year³. Although there are about a thousand firms outside the craft villages and many small firms in 62 craft villages in the province, DONRE could only check 28 firms (including 15 units in the craft villages) in 2005, 30 firms (including 11 in craft villages) in 2006, and 55 firms (including 17 in craft villages) in 2007. In 2005, DONRE did not implement any inspection. Only under special instructions from the Bac Ninh People's Committee and with additional funds, did DONRE inspect 169 firms in craft villages in 2006 (157 in Phong Khe Commune and 12 in Phu Lam Village), and 127 firms in Chau Khe craft village in 2007.

For Phong Khe Commune, in the period 2002–2007, Bac Ninh DONRE could organize only one inspection on paper plants in 2006 to discover which plants had violated environmental regulations and land use laws. The paper-making plants were inspected without concern as to location, plant type, product type, etc. Although the inspection in 2006 found that paper-making plants were very serious polluters, and fines/penalties were imposed on those which did not submit their EIA reports or pay their wastewater charges (Table 12), no further action has been taken. There has been no re-inspection to check if the plants have taken any measures to mitigate their pollution. Many plants have also not paid the fine, with no action being taken against them for this.

Table 12. Enforcement action after the 2006 inspection

Nature of non-compliance	After inspection	Additional penalty
1. Non-submission of EIA reports	- To be fined 4 mil VND/ company & 3 mil VND/ household - Required to submit EIA before 30 Dec 2006	If plants do not pay the fine, the DONRE will not certify their loan applications.
2. Non-payment of wastewater charges	- To be fined 0.7 mil VND/company & 0.5 mil VND/ household - Required to pay in full before 30 Dec 2006 - Strictly required to pay quarterly charges	If plants do not pay the fine and charges, DONRE will not certify their loan applications.
3. Non-establishment of wastewater treatment systems	- Required to establish a primary wastewater treatment system, but no specific time given	Nothing.

Source: FGDs (2007)

³ An environmental check usually refers to a random check to see if firms are complying with environmental regulations. It may be carried out by environmental staff without the accompaniment of local government staff. An environmental inspection, however, needs to be conducted in accordance with national decrees/ordinances by a formal inspection team which must include an expert and local government staff (commune staff in the case of Phong Khe). It is usually carried out on firms suspected of causing environmental pollution.

- (iii) Making the environmental compliance of firms a necessary condition for firm certification

Although some firms were fined after the inspection for non-compliance of environmental regulations, many did not pay fines or their outstanding wastewater charges. However, many paper firms need to take loans from banks for their business. In order to get the loans, these firms need to offer collateral. Land use rights is generally considered as good collateral but the firms need to get certification from DONRE to verify their land use rights and that their land is not collateral for other purposes. In such cases, DONRE will require firm to pay up all outstanding fines and wastewater charges before providing such certification.

- (iv) Seeking the cooperation of other stakeholders

In order to force firms to comply with the environmental regulations, DONRE has also sought the cooperation of other stakeholders, especially the commune authorities, electricity supply company, and banks. DONRE requires the commune authorities to better manage the production situation of paper-making plants and keep DONRE informed regarding the compliance of firms with the regulations as well as help DONRE collect the wastewater fees from the firms. For firms which fail to pay the fines, DONRE has sought the help of the local electricity supply company and the banks. It wants the electricity supply company to temporarily stop providing electricity to non-complying firms until they pay up their fines. DONRE also wants the banks to withhold and withdraw loans from non-complying firms. However, these stakeholders do not support DONRE much. In order to force them to cooperate more, DONRE proposed the Environmental Protection Rules for Craft Villages and Small and Medium Industrial Clusters in Bac Ninh Province and submitted them to the provincial People's Committee for certification in 2008. These rules specify the responsibility of DONRE, other departments (police, investment and planning departments, banks, electricity supply company, etc.), and district and commune authorities in environmental protection, and require all stakeholders to cooperate with DONRE in addressing environmental problems.

(e) Reasons for weak enforcement

As proposed in the 2006 inspection report, if a firm did not pay its fines and wastewater charges and/or establish a treatment system by 30 December 2006, it would be temporarily closed until it had done so. However, DONRE has not been able to enforce this. There are several reasons for this.

- (i) Manpower problems

Although Bac Ninh Province has more than 1,000 firms, 62 craft villages, and many industrial clusters, there are not enough staff working on environmental protection. At the provincial level, only five staff at EMU and 16 staff at EMAS are doing environmental work. At the district level, there is only one to two staff doing so.

In addition, each commune has only one staff responsible for environmental work. However, the person is responsible not only for environmental management but also for many other duties such as managing the transportation and irrigation systems in the commune. Inadequate manpower results in weak enforcement.

In Phong Khe, although the deadline set for the firms to establish their treatment systems and pay their fines and outstanding wastewater charges was 30 December, 2006, DONRE could not ascertain which firms complied or did not comply with this regulation. This is because the firms did not have to report to DONRE if they had done so. So if DONRE wanted to know the status of compliance (after the inspection), it would have to visit the firms again, but this would be difficult due to lack of human and financial resources

Another problem with the human resources of DONRE is the qualifications of the staff. Although the younger and newer staff may have degrees in environmental management and technology, they lack experience while the older ones are qualified in other disciplines like agriculture. At the district level, most of the environmental staff are qualified in land management because most of them were transferred from the land management section to the environmental management section which was newly created under the Department of Land Management and Environment. In the commune, most of the staff responsible for environmental issues are only high school graduates with little understanding of environmental management.

Finally, another constraint with manpower is that the staff are not motivated to do their jobs well because they find it difficult to live on just their low salaries. In fact, they usually have to devote time and effort to earning extra income.

(ii) Inadequate facilities and working conditions

In the whole of Bac Ninh Province, there are only three analysis rooms in EMAS while there is none at the district level. DONRE also does not have a car for its inspection staff to visit the plants—they have to use their own motorbikes. Therefore, the environmental staff of the commune and district find it hard to conduct inspections, collect wastewater samples and measure wastewater volumes. They have to call upon the staff of EMAS to accompany them on an inspection to do the sampling and testing.

(iii) Lack of funds for enforcement

The annual budget for all the environmental work done by DONRE is very small, only 1.5 billion VND (or around 90,000 USD⁴). The budget for enforcement action accounts for around 20% of the total funds—this money is used for environmental education and inspections/checks (including all costs for sampling, analysis, travel, etc.) With such limited finances, DONRE can only do inspections for one craft village with a small number of plants each year. If they want to implement large inspections in one or several craft villages, they need to get additional funds from the provincial committee.

⁴ 1 USD = 15,900 VND as at 2007.

However, the provincial committee will only provide this support if DONRE can prove that the inspection is absolutely necessary.

(iv) Poor cooperation from the commune authorities

In order to enforce the regulations, DONRE needs the help and cooperation of various stakeholders, especially the commune authorities which directly oversee the plant owners. However, sometimes the commune authorities do not strongly support the implementation of environmental regulations such as imposing fines or penalties for non-compliance. This is because of several reasons: (a) the firm owners and commune staff are usually relatives, friends or acquaintances; (b) the paper-making industry plays a very important role in providing employment and income for the local residents; and (c) the cooperation mechanism between DONRE and the commune authorities is unclear. For example, DONRE requires the commune authorities to collect the wastewater charges from the paper-making plants but it does not make clear how much of this should go to the commune authorities to cover the cost of collection. Another complaint is that DONRE makes decisions to fine non-complying plants without consulting the commune authorities.

(v) Poor cooperation from other stakeholders

DONRE has sought the cooperation of the electricity supply company and the banks in closing down non-complying plants. However, the electricity company refuses to be involved because the electricity supply contract does not cover a plant's violation of environmental regulations. The electricity company can only stop providing power to a client when the client violates the contract, for example, by not paying the electricity bill on time. Moreover, cooperating with DONRE to close down non-complying firms will cost the company time and resources, and also reduce its revenues/profits. Similarly, banks do not want to be involved with DONRE to close down plants.

4.3.2 The effect of plant characteristics on compliance

The characteristics of paper-making plants such type of plant, location, type of products, and scale of plant have impacts on their environmental compliance.

(a) Type of plant

Company plants are registered and must manage their operations in accordance with the enterprise laws of Vietnam while individual household plants are not registered and have quite a free hand in running their business. As presented in Table 13, there are differences between companies and household plants in complying with environmental regulations. While 5.5% of the companies did submit EIA reports and establish wastewater treatment systems, none of the individual households did so. Only 31.8% of the households paid their wastewater charges while the figure for companies was 58.2%. The percentages of company plants being fined for non-compliance with environmental laws were smaller

than for individual households. Meanwhile, the proportion of company plants paying their fines and the percentage of additional company plants complying with the regulations after inspection were also higher than for household plants.

Table 13. Compliance of paper-making plants with regulations by type of plant

Categories	EIA report submission		Payment of wastewater charges		Establishment of wastewater treatment system	
	Co.	HH	Co.	HH	Co.	HH
% of plants that complied with the respective regulation	5.5	0	58.2	31.8	5.5	0
% of plants fined	83.5	84.8	38.5	63.6	0	0
% of fined plants that paid the fine	19.7	1.8	5.7	0	-	-
% of additional plants that complied after inspection (compared to the total no. of plants in the commune)	15.2	0	12.0	10.6	-	-

Source: DONRE inspection database (2006)

Note: Co. = company and HH = household

(b) Plant location

The industrial zone in Phong Khe Commune was established in 2003 over an area of 12.7 hectares. The purpose was to move the paper-making plants from the residential areas to the industrial zone in order to better manage the environmental pollution caused by the plants and to mitigate the pollution in the residential areas. Around 80 paper-making plants are located inside the industrial zone now.

Table 14 shows that the plants located inside the industrial zone seem to comply better with environmental regulations than the ones located outside the zone. While 71.9% of the plants inside the zone paid the wastewater charges, the figure for the plants outside the zone was only 30.1%. The proportion of plants inside the industrial zone paying a fine was significantly higher than that of plants outside the zone, especially for EIA report submission.

Table 14. Compliance of paper-making plants with regulations by location of plant

Categories	EIA report submission		Payment of wastewater charges		Establishment of treatment system	
	Inside zone	Outside zone	Inside zone	Outside zone	Inside zone	Outside zone
% of plants that complied with the respective regulation	4.7	2.2	71.9	30.1	4.7	2.2
% of plants fined	87.5	81.7	30.4	80.0	0	0
% of fined plants that paid the fine	23.2	4.0	1.8	1.3	-	-
% of additional plants that complied after inspection (compared to the total no. of plants in the commune)	-	-	14.3	14.7	na	na

Source: DONRE inspection database (2006)

(c) Type of products

The main products of paper-making plants in Phong Khe are votive and toilet paper. However, no votive and toilet paper plants submitted any EIA reports before the inspection in 2006. The number of plants producing votive and toilet paper that paid wastewater charges are also smaller than for the kraft and wrapping paper plants. The rate at which plants were fined due to non-submission of their EIA reports was similar among the plants producing the same type of products. However, the proportion of votive paper plants fined for not paying wastewater charges was the highest (88.2%) while the figures for toilet, kraft, and wrapping paper plants were 48.4%, 44.2%, and 22.2%, respectively (Table 15). Plants producing kraft paper and wrapping paper were also found to be more compliant with the regulation to submit EIA reports than votive and toilet paper plants.

Table 15. Compliance of paper-making plants with regulations by type of products

Categories	EIA report submission	Payment of wastewater charges	Establishment of treatment system
1. % of plants which complied			
- Votive paper	0	27.3	0
- Toilet paper	0	51.4	0
- Kraft paper	6.0	60.0	6.0
- Wrapping paper	10.0	80.0	10.0
- Other	14.3	42.9	14.3
2. % of plants fined			
- Votive paper	78.2	88.2	0
- Toilet paper	88.6	48.4	0
- Kraft paper	86.0	44.2	0
- Wrapping paper	90.0	22.2	0
- Other	85.7	66.7	0
3. % of plants which paid the fine			
- Votive paper	3.6	0	-
- Toilet paper	0	0	-
- Kraft paper	22.0	2.0	-
- Wrapping paper	20.0	0	-
- Other	14.3	14.3	-

Source: DONRE inspection database (2006)

(d) Scale of plant

The paper plants are divided into large-scale and small-scale groups. It appears that the large-scale plants complied a bit better with environmental regulations than the small-scale ones. A higher number of large-scale plants submitted their EIA reports and paid their wastewater charges. Although more large-scale plants were fined due to non-submission of their EIA reports, a higher percentage of them paid the fine (20.9%) while only 3.1% of the small-scale plants did so. Meanwhile, 53% of the large-scale plants were fined due to not paying their wastewater charges while the figure for small-scale plants was higher at 64.6%. Table 16 refers.

Table 16. Compliance of paper-making plants with regulations by scale of plant

Categories	EIA report submission		Payment of wastewater charges		Establishment of treatment system	
	Small-scale	Large-scale	Small-scale	Large-scale	Small-scale	Large-scale
% of plants that complied with the respective regulation	1.3	5.1	41.8	52.6	1.3	5.1
% of plants fined	82.3	85.9	64.6	53.0	0	0
% of plants that paid the fine	3.1	20.9	0	5.7	-	-

Source: DONRE inspection database (2006)

4.3.3 Determinants of compliance of paper-making plants with environmental regulations

In order to ascertain the determinants of environmental compliance of paper-making plants, a logit function was used. Since there was a very small number of plants which had submitted their EIA reports, the dependent variable could not be the EIA report submission. So the dependent variable was the payment of wastewater charges (wwc_payment). The dependent and independent variables were defined as follows:

- a) wwc_payment: equal to 1 for a plant which paid the charge, 0 for otherwise
- b) plant_type: equal to 1 for a company plant and 0 for a household plant
- c) location: equal to 1 for a plant inside the industrial zone, 0 for otherwise
- d) plant_scale: equal to 1 for a large-scale plant, 0 for otherwise
- e) wwc_level: quarterly wastewater charge for the plant ('000 VND)
- f) age: age of the plant owner (years)
- g) school_year: the plant owner's number of years in school

The results of the logit regression model are presented in Table 17. The location of the plant as a determinant of wastewater charge payment was significant at the 1% level. Plants inside the industrial zone complied better with the wastewater charge payment regulation than plants outside the zone. A possible explanation is that there exists a management unit of the industrial zone which is responsible for encouraging firms inside the zone to comply with environmental regulations through education programs, meetings, or visits to plants by the management staff. The plant owner's number of years in school was also found to be a significant factor affecting the decision to pay the wastewater charge. A higher number of years in school probably helps the owners better understand

legislation issues and environmental problems, and thus, facilitates better compliance with regulations.

Table 17. Logit regression model results

Variable	Coefficient	Std. Err	P> z
Constant	-5.943	1.588	0
Plant_type	0.436	0.436	0.318
Location	1.666	0.439	0
Wwc_level	0	0	0.469
Plant_scale	0.029	0.577	0.959
School_year	0.355	0.093	0
Age	0.043	0.024	0.079
Number of observations			157
LR chi ² (8)			36.04
Prob > chi ²			0
Log likelihood			-90.545
Pseudo R ²			0.1660

4.3.4 Opinions of plant owners on compliance

One objective of our study was to investigate the determinants of environmental behavior of the paper-making plants. Direct interviews with the 62 paper-making plant owners were carried out to understand the reasons why they did or did not comply with the regulations.

(a) Submitting the EIA reports

Of the 62 interviewed paper-making plant owners, 56 reported that they had still not submitted their EIA reports. Over 85% of the latter did not know what contents were to be included in the reports. When they were required to provide reasons why they did not submit the EIA reports to Bac Ninh DONRE, 35.7% of them reported that they did not know that it was compulsory to submit EIA reports, 57.1% revealed that it would cost them too much, 33.9% thought there would be no problem if they did not submit the reports, and 17.9% were afraid that they would be required to pay more environmental charges or fees if they submitted the reports. Table 18 refers.

Table 18. Reasons for not submitting EIA reports

Reasons	Percentage
1. Do not know that it is compulsory to submit EIA report.	35.7
2. Submitting EIA reports is costly.	57.1
3. Afraid that the EIA report will be used for computing and collecting more fees (wastewater and other fees).	17.9
4. No problems in not submitting the EIA report (no fine or enforcement).	33.9
5. Have good relations with the local officials.	3.6

Source: survey (2007)

Discussions with the local people and DONRE staff revealed that their perception of the main underlying reason for non-submission of the EIA reports was that report preparation was costly. As the plant owners could not write the reports, they had to hire environmental agencies (usually DONRE) at the cost of 20-35 million VND—this was quite a big amount for them. The second underlying reason was that up to the current time, nothing happened even if plant owners did not submit the EIA reports. Although in principle, non-complying plants had to pay a fine of 3-4 million VND, DONRE was unable to enforce this.

Only six of the interviewed plants (9.67%) had submitted EIA reports, mostly in recent years (2006 and 2007). Most of them said that they submitted the report to comply with the regulation, or because it would be a basis for calculating the charges or fees for their plants, help them avoid being fined, or help them to improve their business reputation. However, according to DONRE staff, of the 19 plants that submitted their EIA reports, very few actually did so voluntarily. The main reason why they submitted the reports was because some plants imported wastepaper from other countries and they had to submit EIA reports to customs offices in order to get approval for their wastepaper to come in through the port. Another reason was that since 2006, if a firm wanted to rent land for doing business, submitting the EIA report was one condition for this.

(b) Paying the wastewater charges

Wastewater charges for paper-making plants are collected quarterly. While most plant owners reported that they were informed of the charges quarterly, 19% said they were not aware of this practice. This reflects the fact that some plant owners do not pay much attention to wastewater charges. Furthermore, only one (1.6%) owner revealed that he clearly understood how to calculate the wastewater charges while 32.2% said that they knew how only to some extent and 66.6% admitted that they did not know how to calculate the charges at all. Among the interviewees, 66.1% paid the charges while 33.9% did not pay in 2006.

The reasons for not paying the wastewater charges are presented in Table 19. The first reason was that many owners (75%) did not know why they should pay the

wastewater charge. A significant number did not know what the collected charges would be used for as they did not see any investment in environmental improvement made from the money collected. Meanwhile, the owners who discharged wastewater into the common pools or rivers in the area thought that their wastewater was harmless so they refused to pay the wastewater charges. More than half of the owners who did not pay the charges thought that there would not be a problem if they did not pay. Apparently, they were inspected once before and fined a very small amount (300,000-400,000 VND). Sixty per cent of the owners said they did not pay the charges because many others also did not pay. Some people said they did not pay as they thought that the charges were wrongly calculated. These people compared their production volumes and wastewater charges with those of others and felt that they were overcharged. As the quarterly wastewater charge was not big, financial limitations were not considered as a key reason.

Table 19. Reasons for not paying wastewater charges

Reasons	Percentage
1. Do not know why they have to pay the wastewater fee.	75.0
2. Do not have enough financial resources to pay.	10.0
3. Nothing will happen if they do not pay (no fine or only a small fine).	55.0
4. Many other people also do not pay.	60.0
5. The wastewater fee of the plant is wrongly calculated (too high).	60.0
6. Have good relations with the local officials.	5.0

Source: survey (2007)

More than half of the interviewed owners paid the wastewater charges. The reasons why they paid are presented in Table 20. Around 84% of these owners reported that they felt it necessary to comply with the regulations as their wastewater discharges harmed the environment. A significant proportion (27.7%) reported that they paid the charges because they were quite small compared with their business profits. Accuracy in the calculation of the wastewater charges, the improved reputation of the plants, and willingness to contribute to environmental protection were also reasons for paying up. Several owners said that they paid the wastewater charges because they did not want to get into trouble with the local authorities.

Table 20. Reasons for paying wastewater charges

Reasons	Percentage
1. It is a regulation that should be followed.	84.4
2. The wastewater fee is accurately calculated.	13.8
3. The fee is small compared to the plant's profits.	27.7
4. The payment would be useful for environmental protection in the commune.	16.6
5. Improvement in the reputation of the plant.	22.2
6. Others	8.3

Source: survey (2007)

(c) Establishing a wastewater treatment system

As the wastewater from paper-making plants is considered to be one of the main sources of environmental pollution in the commune, a wastewater treatment system is required by law to be installed in every plant. Bac Ninh DONRE, in cooperation with the commune's People's Committee announced this regulation to the paper-making plants and tried to persuade them to comply but only very few plants have done so.

The questionnaire was designed to investigate why plants did not install the wastewater treatment system. The reasons are given in Table 21. The highest percentage of plant owners (84.2%) reported that the treatment system was quite costly and they could not afford it. From FGDs with the local people and officials, a treatment system would cost quite a big amount (30–50 million VND) to install and the monthly operation cost (electricity, chemical agents, and labor) would be significant (around 0.5–0.8 million VND). For plants with an annual production volume of less than 500 tonnes (45% of the surveyed plants), these costs would amount to around half their annual profits. So they tried to save by not installing the system.

Table 21. Reasons for not installing a wastewater treatment system

Reasons	Percentage
1. Not enough space for the installation.	47.4
2. Not enough money for the installation.	84.2
3. Only a small fine or no fine for not installing the system.	78.9
4. No one pays the fine although they are required to pay (and nothing happens to them)—there is no enforcement.	68.4
5. Have good relations with the local officials.	0
6. No support for treatment system installation.	73.9
7. Others	52.6

Source: survey (2007)

DONRE and the commune's People's Committee tried to encourage the plant owners to install the treatment systems, but did not fine them if they failed to do so—this reason was reported by nearly 80% of the plant owners. Since almost all the plants in the commune had not yet installed the system, it was difficult to persuade a plant owner to do so. Many plant owners expected that some project by the government or international donors would support the treatment of wastewater in the commune. In fact, some demonstrations had been done in several plants in the commune with outside support.

Some plants located near to the river and lake in the commune refused to install the treatment system as they discharged their wastewater into these water bodies. The owners thought that their wastewater did not affect any households in the villages; that it would only affect the water in the river, but then the water would flow away and there would not be any negative effects. Thus, these owners believed that it was not necessary for them to treat their wastewater or install any treatment system.

4.4 Collective Action for Pollution Mitigation and Compliance Improvement

4.4.1 Opinions on environmental compliance and pollution mitigation

The environmental regulations in Bac Ninh were issued in order to mitigate the pollution situation in the province as well as in the paper-making communes. However, in Phong Khe Commune, this objective could not be achieved as many paper-making plants did not comply with the regulations. Although fines have been imposed for non-compliance, these have not been effective. Many plants continue to pollute the environment and disregard the law.

Under such a situation, we sought the opinions of stakeholders on how to resolve the problem. Different stakeholders had different opinions as reported below.

- **EMU and DONRE:** EMU and DONRE believe that if they have more power and get better cooperation from other related agencies, the compliance of paper-making plants could be improved and the pollution situation, mitigated. Bac Ninh DONRE recently designed the Environmental Protection Rules for Craft Villages and Small and Medium Industrial Clusters in Bac Ninh Province and submitted these to the provincial People's Committee for adoption. According to the rules, Bac Ninh DONRE will: (a) raise the awareness of plant owners on environmental issues through dissemination of information and education and encourage them to comply with the regulations; (b) inspect and classify the plants as non-polluters, light polluters, serious polluters, or very serious polluters and publicize their names; (c) for plants which are considered as serious or very serious polluters but which do not take any action to lessen their pollution emissions, Bac Ninh DONRE will inform the Bac Ninh Department of Investment and Planning to revoke their business licenses, inform the electricity supply company to stop providing the power to the plants, and also inform the State Bank in Bac Ninh to suspend any loan applications or withdraw any loans given until the plants take mitigation measures (this must be certified by DONRE); (d) reward plants that act to mitigate

pollution. However, with the shortage of resources (staff, facilities, and finance), poor cooperation from the other agencies, and having a huge area and number of plants to monitor, whether DONRE can do all this is another matter.

- **Phong Khe Commune:** According to Phong Khe Commune People's Committee, the paper-making industry has played a very important role in the economic development of the commune. Thanks to the paper-making industry, the people have stable jobs with quite high incomes and the local budget has significantly increased from year to year. However, the pollution caused by paper plants is now serious and should be controlled. Finding a balance between economic development and environmental protection is a challenge for the commune. To mitigate the pollution situation in the commune, the People's Committee is prepared to (a) improve the awareness of plant owners on environmental protection through dissemination of information and education; (b) call for projects to support environmental protection in the commune; (c) set up an environmental sanitation team in the commune to see to garbage collection and cleaning the sewerage system in all the villages; and (d) cooperate with DONRE to collect wastewater fees; however, the arrangement should be made clear, for example, how much the commune authorities should be compensated for collection should be determined beforehand.
- **Paper-making plants:** A FGD with plant owners was organized in order to understand why the plants did not comply with the environmental regulations and discuss how to improve the situation. Lack of financial resources, no space for system installation, small fines, and requirement ignorance were found to be the main reasons. An additional reason given was that the people were not sure that pollution in the commune would be mitigated if they complied with the regulations. They did not see how submitting the EIA report would lessen pollution and they doubted that DONRE could monitor that the plants effectively in this respect. They also did not see the value of paying wastewater fees as they did not know what the money collected was used for. As for the establishment of wastewater treatment systems, although the plant owners agreed that this could help mitigate the pollution in the commune, they said this would only happen when most of the plants established and ran the system. If only a few plants did so, then it would not be effective. The paper-making plant owners, however, agreed to pay the wastewater charges voluntarily if the fees were reinvested in wastewater treatment system installation, and to contribute to wastewater treatment system establishment. However, the authorities should ensure that all plants contributed so as to be fair to all.

Although the opinions on regulation compliance were different among the various stakeholders, all agreed that it was necessary to mitigate the pollution caused by wastewater. Thus, how to mitigate the pollution caused by wastewater from paper-making

plants was the main issue discussed in subsequent FGDs. The plant owners and staff agreed that it was highly necessary to treat the wastewater before discharging it into the environment. However, what treatment technology should be applied, how the treatment plant should be designed, and where the money for treatment system establishment should come from were questions that had to be addressed.

4.4.2 Options for wastewater treatment

Based on the available treatment technologies for wastewater from paper-making plants and the opinions from technical experts on wastewater treatment, two options to treat the wastewater were proposed. The first one was to treat the wastewater through individual plants as required by DONRE regulations. The second was to establish treatment systems for groups of plants located close to one another. In the second option, the wastewater from the group will be collected and then treated before disposal.

Option 1: Individual treatment systems for individual plants

The average wastewater volume for one plant in Phong Khe Commune is around 5-15 m³/day as per the survey results. Based on the volumes and contents of wastewater from the paper-making plants, a treatment system using an anaerobic tank was proposed. The treatment process is presented in Figure 6.

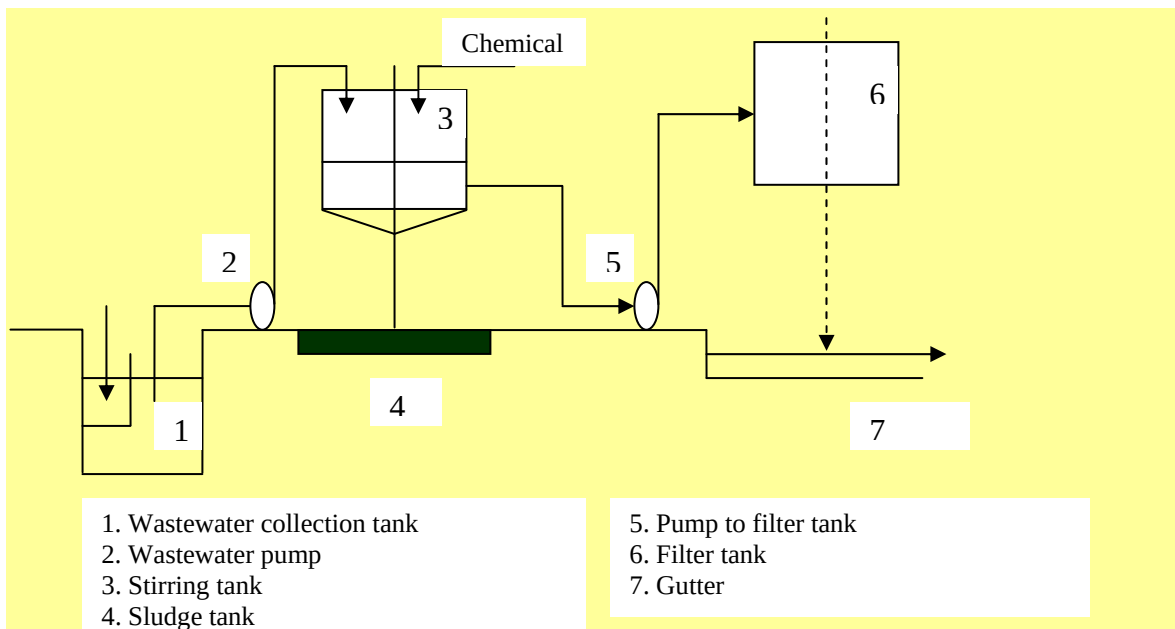


Figure 6. The wastewater treatment system for an individual plant (Option 1)

At first, the wastewater is collected in the wastewater collection tank. The wastewater is then pumped into the stirring tank that contains activated sludge. In the stirring tank, the wastewater and activated sludge are stirred. The organic matter (in the wastewater) will be absorbed by the sludge and settle into the sludge tank. The remaining water in the stirring tank will be pumped into a filter tank to filter the water. The treated water will then flow out through a gutter.

Option 2: Establishment of treatment systems for groups of plants

Based on the locations of the paper-making plants, six plant groups were identified (Table 22).

Table 22. Location and wastewater volumes of plant groups in Phong Khe Commune

Locations	Number of paper-making plants	Estimated wastewater volume (m³/day)
1. Phong Khe Industrial Cluster	52	600
2. Ben Hamlet - Duong O Village	43	450
3. Cau Tien Industrial Cluster	12	75
4. Dao Xa Village	28	150
5. Cham Khe Village	8	50
6. So and Sau Dong Hamlets	32	180

Source: FGDs (2008)

Based on the kind of pollutants and wastewater volumes, the floatation technique was suggested by the technical experts. The treatment process is illustrated in Figure 7.

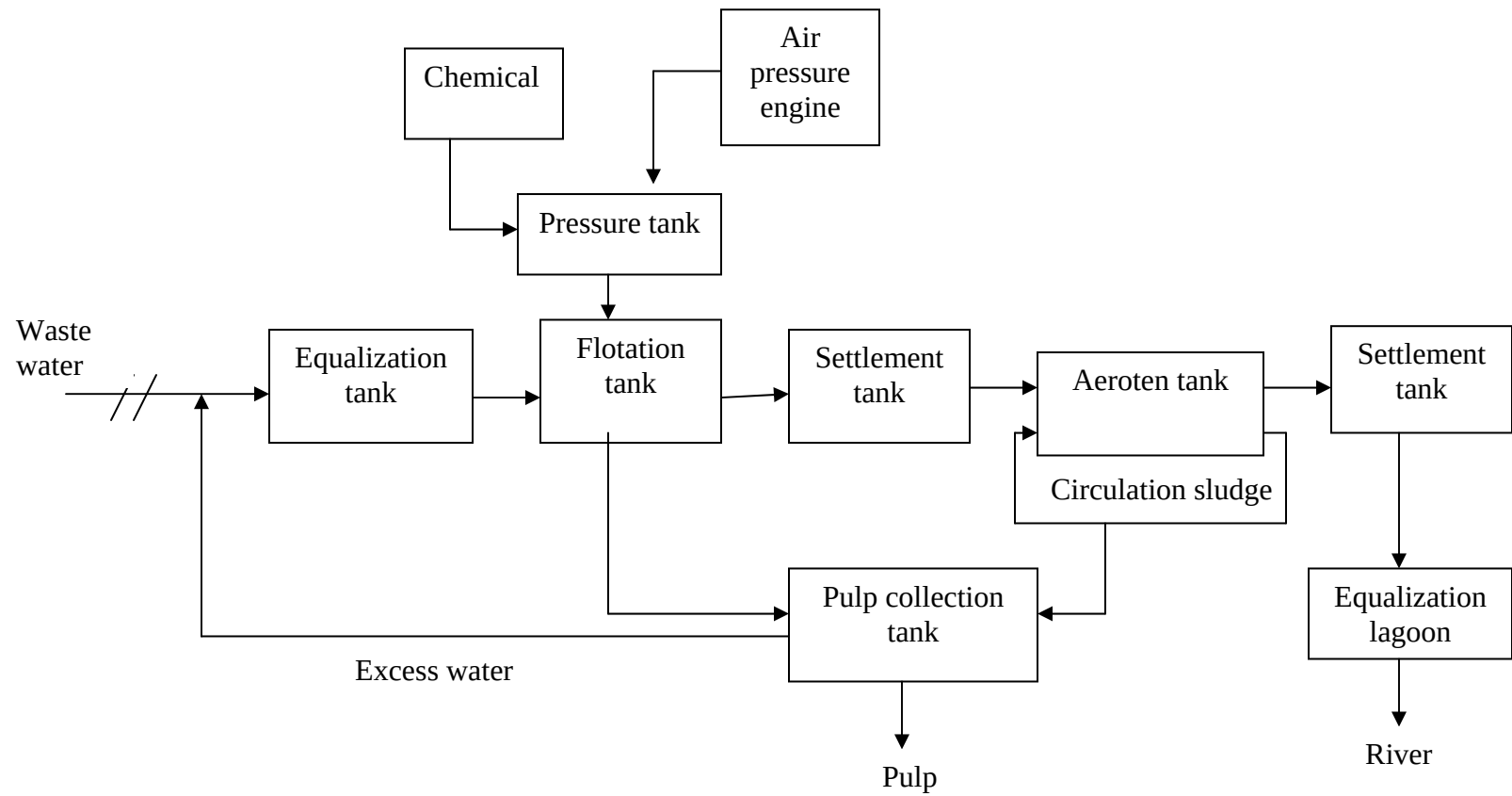


Figure 7. The wastewater treatment system for a group of plants (Option 2)

Note: The two slashes // next to wastewater in the figure denote the rubbish screen

At first, the wastewater passes through a screen to separate large items of rubbish. Then the water flows through a pipe into an equalization tank. In the equalization tank, the water flow is stabilized (not too fast), and then the water is pumped into a flotation tank. At the same time, some of the treated wastewater is pumped into a pressure tank by a high pressure pump to get a saturated air-water mixture at 4-5 atm pressure before flowing into the flotation tank. This will suddenly decompress the saturated air-water flow and foam will form on the water surface. The foam will adhere to fibers or pulp in the water and make these float as well. The pulp is then taken into a pulp collection tank by a moving gutter. The wastewater from the flotation tank then flows to a settlement tank where remaining impurities will be removed. Next, the water goes to the aeroten tank. Here, the wastewater and activated sludge are stirred so that the micro-organisms in the activated sludge will absorb organic matter from the wastewater to form biological floccules and respiration products (carbon dioxide and water). The mixture of wastewater and biological floccules then flows to another settlement tank. After settling, the water flows into a lagoon.

4.4.3 Social acceptability and option selection

In order to decide which treatment option should be selected for application, the social acceptability of the two options was ascertained. The concept of social acceptability can be traced back to the work of rural sociologist, Firey (1960), who was interested in understanding why certain resource practices and prescriptions in different societies persisted while others did not. He concluded that the adoption and retention of any particular resource program or action depended on the extent to which that activity satisfied three key requirements: (a) they were physically possible i.e., they were practices that were consistent with ecological processes, (b) they were economically feasible i.e., they were practices that generated revenue in excess of costs, and (c) they were culturally acceptable i.e., they were practices that were consistent with prevailing social customs and norms. Clawson (1975) introduced a similar premise focused directly on forest environments but provided a more detailed set of criteria than Firey by arguing that successful policies must meet five conditions: (a) biological and physical feasibility, (b) economic efficiency, (c) economic welfare or equity, (d) social or cultural acceptability, and (e) operational or administrative practicality. Both frameworks acknowledge and agree on one fundamental notion: policies and practices lacking societal acceptance and approval will ultimately fail. This will occur even if these decisions and actions are supported by sound science (physically possible) and are profitable (economically feasible).

Wastewater treatment involves the construction of facilities for long-term use and is costly. In this study, the social acceptability of wastewater treatment options was considered in terms of physical feasibility, financing feasibility, economic efficiency, social or cultural acceptability, and operational or administrative practicality. A FGD with local staff, researchers, and villagers was held to ascertain the social acceptability of wastewater treatment options in Phong Khe Commune. Each option was discussed in detail. Then a “voting game” was conducted with the local people in which each individual had the right to select his/her favorite option from his/her own point of view. The social acceptability of each option was then assessed by the sum of individual choices.

(a) Physical feasibility

From the discussions, several problems on the physical feasibility of the options were revealed. In Option 1, three tanks (wastewater collection, stirring, and filter tanks) would have to be constructed for treating wastewater in individual plants. The volume and size of the tanks would have to be larger if the wastewater volume was greater. However, the residential area of household plants was very small. The impossibility of tank establishment in most plants will certainly result in non-homogeneity in wastewater treatment in the commune. Consequently, Option 1 would not be physically feasible. In Option 2, treatment plants would be constructed for treating wastewater from groups of plants. As there was available common land and ponds in the villages, these could be used to set up the treatment plants, subject to the approval of the commune and village authorities, of course.

(b) Financing feasibility

It was clear that the treatment plants in both options could not be established based totally on the contributions of the paper-making plants in Phong Khe because the construction and operational costs were huge, beyond the capacity of the individual plants. Financial support from the local governments and other donors was thus essential. As the environmental pollution in craft villages was an issue of great concern, a pilot wastewater treatment project in a craft village could have a high possibility of receiving financial support from the local government and donors. Therefore, projects based on the proposed options should be designed to solicit such support. According to the participants, Option 2 was more convincing than Option 1, especially in terms of investment management. They felt that Option 1 was more difficult to manage in terms of having to allocate the funds to individual households as well as to control the quality of the treatment systems. On the other hand, in Option 2, the whole investment budget was used for only a number of large treatment systems under the supervision of construction experts. The quality of the constructed plants and use of the investment budget were thus perceived as much easier to control.

(c) Economic efficiency

The investment and operational costs for the two treatment options were estimated by the group of technical experts (Table 23). Based on these costs as well as the average wastewater volumes and expected lifespans of the treatment plants, the average treatment cost for one cubic meter of wastewater in each option was calculated. Option 2 was found to be more cost-effective than Option 1 with a treatment cost of 2.6 thousand VND/m³ compared with 3.1 thousand VND for Option 1.

Table 23. Estimates of wastewater treatment costs for Options 1 and 2

Unit: '000 VND

Costs	Option 1 (individual plant with 7.5 m ³ /day)	Option 2 (plant group with 250 m ³ /day)
A. Investment costs (to last 20 years)	40,100	1,235,932.5
1. Construction cost	21,600	580,500
2. Facility cost	17,500	580,000
3. Other costs	1,000	75,432.5
B. Operational costs (per day)	18	488
C. Cost of treatment of 1 m ³ wastewater	3.1	2.6

Source: estimated by technical experts

(d) Cultural acceptability

Many participants expressed the view that it would be difficult to persuade the households to establish treatment systems in their backyards. The first reason was that for most of the households, the residential area was very small and many people believed the establishment of a wide, deep earthen ditch very close to their homes would bring them bad luck in their life and business. The second reason was the fear of bad smell emanating from the sludge created by the treatment system. Therefore, Option 1 was not really culturally appropriate for household plants with small residential areas. Option 2 was preferred by the participants because the treatment system would be located a little further away from their homes and they would not have to suffer bad luck or bad smell.

(e) Operational or administrative practicality

The treatment technique in Option 1 was perceived as simple and easily transferable to the paper plants. Although the households could manage the technique without difficulty, it would be quite difficult to investigate whether they would follow all the technical guidelines and be able to control the quality of water outflow. The treatment techniques in Option 2, however, were complicated and sophisticated, but the systems and quality of water outflow would be managed by technicians. Therefore, there would be no problems with the operation.

The results of the social acceptability assessment are shown in Table 24. The reasons why participants selected or did not select an option are also given in the table. The majority of the participants (91.67%) were keen on Option 2, the establishment of treatment systems for groups of plants. The advantages of Option 2 included low treatment cost, available space for system establishment, high cultural acceptability, and greater ease of getting and managing financial support. The main disadvantage of the system was the high technical requirement for system implementation and management. However, this was not an insurmountable problem because technicians would be hired to operate the system.

Table 24. Social acceptability assessment of the wastewater treatment options

Option	Agreed with/Accepted		Disagreed with/Not Accepted	
	(%)	Reasons	(%)	Reasons
Option 1	8.33%	- The equipment, reagent, electricity and labor costs are low. - Easy to manage and operate by individual households.	91.67%	- The space for construction is limited in each household. - Not all households in the village can afford this system. - Difficult to get financial support for every plant and to manage the support. - Not culturally accepted. - The treatment cost is high.
Option 2	91.67%	- Low cost of treatment per m³. - Available space (common pool) for treatment plant establishment. - Easier to get financial support. - Culturally accepted. - Salvaging of the present sewerage, canal and common pool system in the village.	8.33%	- Requires high technical expertise for implementation and management.

Source: FGDs (2008)

4.4.4 Collective action for wastewater treatment

From the social acceptability assessment, it became clear that treatment systems for groups of paper-making plants should be the chosen option. However, in order to establish such treatment systems, many issues had to be addressed and this needed the collective action of the various stakeholders, namely, EMU of Bac Ninh DONRE, the Phong Khe Commune People's Committee, and the paper-making plant owners.

Meetings with representatives from DONRE, Phong Khe Commune staff, and paper-making owners were held to discuss the related issues and collective action to deal with any problems that would arise if and when Option 2 was applied. The issues discussed included who would write the project, where to submit the project proposal (asking for support), how the plant owners would contribute to the project, and who would monitor the project when executed. The roles and responsibilities of the stakeholders were identified.

(a) Responsibilities of EMU and DONRE

EMU and DONRE would be mainly responsible for formulating the project and managing and monitoring it if it is implemented. As proposed in the Environmental Protection Rules for Craft Villages, DONRE will have the responsibility of investigating and assessing the environmental situation, formulating environmental projects to mitigate pollution, and selecting applicable models for wastewater treatment in craft villages. EMU

would probably formulate the project in cooperation with another technical partner as it could not fulfill the task alone due to its staff limitations and huge workload. The staff of EMU and the selected partner would then go to Phong Khe Commune to determine the wastewater volumes and contents discharged by paper-making plants. Based on available information on the paper-making plants (namely, secondary data such as previous research reports on wastewater contents, production technology, treatment technology, etc.), the information provided by Phong Khe Commune staff, and survey data, EMU and its partner would then design the wastewater treatment project for Phong Khe.

EMU and DONRE would seek funding for the project. The project proposal would be submitted to the Department of Planning and Investment for consideration and funding support. DONRE would also work with the Department of Science and Technology (DOST) as well as the Provincial People's Committee (PPC) so that the proposed wastewater treatment project in Phong Khe would be ranked as a priority activity, and DOST and PPC of Bac Ninh Province would also seek international support where possible. DONRE would also submit the project to the Vietnam Environmental Protection Fund (VEPF) for support as VEPF can provide loans at preferential interest rates, provide lending interest rate support (i.e., pay part of the interest rate charged), guarantee environmental project loans from credit organizations, and provide loans for environmental projects.

(b) Responsibilities of the Phong Khe People's Committee

At first, the commune's People's Committee will disseminate information (through the loudspeaker system in the commune) to raise awareness of the pollution caused by the paper-making industry and call for pollution mitigation action from all the people in the commune to reduce the negative impacts of pollution on human health.

The People's Committee will mobilize all paper-making plants to participate in the proposed project, require them to cooperate, and provide data on their plants to project staff so that the project staff will have accurate data for project formulation. It will also provide the available data on land, the sewerage system, and ponds in the locality that could be relevant to project formulation. Then the committee will determine, with project staff and village leaders, suitable project sites for establishing the treatment plants in each village. Finally, the committee and village leaders will also appoint one village staff to collect wastewater treatment fees from the paper-making plants.

(c) Responsibilities of the paper-making plants

The paper-making plants will have the responsibility of participating in the project to mitigate the pollution situation in the commune. The wastewater charges that paper-making plants have to currently pay will be replaced by wastewater treatment fees based on their electricity bills. As discussed and agreed by the paper-making plant owners, the payment for wastewater treatment will be 150 VND per kilowatt of electricity. This amount will be used to cover the operational costs of the wastewater treatment system.

The project will install pipelines from the paper-making plants to the common piping system. Plants located along the same roads will work together to install the pipeline for those areas. The investment cost for the wastewater treatment system is considerable. Thus initial contributions from the paper-making plants are necessary. This will also be good for the project because sponsors/donors view contributions from the beneficiaries of a project as an indicator of its sustainability. The plant owners agreed to contribute to the initial investment outlay according to their production scale: 10 million VND for plants with a production volume of less than 30 tonnes per month, 20 million VND for plants with a production volume of 30–100 tonnes per month, and 30 million VND for plants with more than 100 tonnes produced per month.

5.0 CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Conclusions

The paper-making industry has made great contributions to the economic development of Bac Ninh Province in general and Phong Khe Commune in particular. Thanks to it, many more jobs have been generated and the incomes of the people, significantly improved. However, the paper-making plants generate a huge amount of waste and are considered as serious polluters in the area. Although environmental regulations have been issued and implemented in order to mitigate the pollution, many plants have not complied and pollution in the commune is still a problem. This study was therefore designed to provide an overview of the environmental compliance of paper-making plants, investigate the current costs of compliance of the paper-making plants, analyze factors affecting such compliance, and draw policy implications and recommendations to mitigate pollution in the commune. Secondary data on environmental regulations, the paper-making industry, and environmental problems in Phong Khe Commune were gathered from available reports of various agencies. In addition, primary data on paper-making activities, the environmental compliance of plants, and plant owners' opinions about compliance was collected through direct interviews with 62 plant owners and through FGDs. Descriptive statistics, comparative analysis, and social acceptability analysis were used in this research.

Phong Khe currently has 175 paper-making plants producing different types of paper, including votive paper, kraft paper, wrapping paper, and tissue and toilet paper which are distributed throughout Vietnam. In 2006, the commune's paper industry reached a volume of 150,000 tonnes of products with a revenue of 540 billion VND (around 36 million USD), contributing 13 billion VND to the national budget through taxes. However, as paper production lines in the commune are quite old, paper plants cause serious environmental pollution in the area due to the discharge of huge volumes of wastewater with heavy polluted effluents of COD, BOD, SS, and phenol, and great amounts of solid and waste-air from coal burning. This has degraded the agricultural land in the commune as well as the nearby river.

To mitigate the pollution in the region, Bac Ninh authorities have imposed environmental regulations on paper-making plants. All paper-making plants in the commune have been required to submit their EIA reports for assessment, pay their wastewater charges, and establish a wastewater treatment system. However, many paper-making plants have not complied with these regulations. Around 90% of the paper plants have still not submitted their EIA reports, 50.9% have not paid their wastewater charges, and 94.9% have not established wastewater treatment systems as required. Fines have been imposed on non-complying plants, but only a few plants have paid the fines while most have not. More than 60% of the plants in the commune were ranked as serious polluters in the inspection exercise conducted in 2006.

Since many plants have not complied with the regulations, their current cost of compliance is very small compared with the full cost of compliance. While the full cost of submitting an EIA report is between 20-35 million VND, the plants that did not do so were forced to pay a fine of only 3-4 million VND. The average wastewater fee paid was just 0.43 million while the full charge was 2.06 million VND per plant.

Factors affecting the compliance of the plants including type of plant, location of plant, scale of plant, and type of products were considered. Company plants located inside the industrial zone were found to comply better with the regulations than those outside it. The plants producing kraft and wrapping paper also complied better with the regulations than those making votive or toilet paper. The reasons why the plants did not comply with the regulations were also investigated through direct interviews with the plant owners and FGDs. Inadequate understanding of environmental regulations, lack of financial resources, limited space for system installation, and lack of threat of enforcement by the local environmental authorities (due to lack of capacity for enforcement) were found to be the main reasons for non-compliance.

The opinions of different stakeholders on environmental compliance and pollution mitigation were also sought. While EMU would like to have more power, capacity and cooperation with other agencies such as the local electricity company and banks to enforce the regulations, the plant owners wanted measures that would directly mitigate the pollution in the commune. In any event, all stakeholders agreed that it was necessary to mitigate the pollution caused by wastewater from the paper-making plants. Two options for wastewater treatment were proposed: (1) establishing individual treatment systems and (2) establishing treatment systems for groups of plants located close to one another.

An analysis of the social acceptability of these two options was made based on their physical feasibility, financing feasibility, economic efficiency, cultural acceptability, and operational or administrative practicality through FGDs. The results showed that Option 2 was much more widely accepted than Option 1 because it had a lower treatment cost per cubic meter of wastewater, available space for treatment plant establishment, was more likely to get financial support, and was more culturally acceptable. Collective action for applying the selected option was then discussed. DONRE would formulate the project and look for financial support. All the paper-making plants had to participate in the project, pay for wastewater treatment based on their electricity bills, establish pipelines from their plants to the common pipeline system, and make initial contributions based on their monthly product volumes. In addition, the commune's People's Committee would raise

awareness of the dangers of pollution among the owners of the paper-making plants through information dissemination and education, mobilize all paper plants to participate in the project, and provide available data for project formulation.

5.2 Policy Implications and Recommendations

Several policy implications can be drawn from this study and some recommendations made for the better compliance of paper-making plants with environmental regulations and for pollution mitigation in the commune.

(a) Follow-up activities for wastewater treatment adoption

The results of the social acceptability assessment showed that the establishment of treatment systems for groups of plants would be the more viable option for wastewater treatment and the resolution of pollution problems in Phong Khe Commune. However, the initial investment costs including the construction and equipment costs are considerable and beyond the contribution capacity of the paper-making plants although they are willing to contribute a part of their earnings. Financial support from the government or foreign sponsors is thus necessary. Therefore, the wastewater treatment project based on Option 2 should first be designed by the Bac Ninh DONRE in consultation with technical experts. In the project proposal to local/foreign sponsors, the detailed design of the proposed wastewater treatment plant (for each group) and a description of its operation should be made. The contributions from the paper-making plants in the commune and the remaining financial support required from the donors should also be shown. In addition, a cost-benefit analysis should be made to convince donors to support the project. The proposal should be sent to the Department of Science and Technology in Bac Ninh Province so that it may help source for both domestic and international donors.

(b) Raising the villagers' and paper-making plant owners' awareness of the need for environmental protection

Although the people in Phong Khe Commune perceive wastewater and solid waste as environmental health hazards that need to be addressed, their awareness of environmental protection is still low. Many owners do not pay any attention to the contents of the EIA report and do not know the usefulness of submitting the report or paying the wastewater charges. They usually do not voluntarily comply with the regulations. Raising the awareness of environmental protection among the villagers, especially the plant owners, is therefore very necessary. Environmental education programs should be set up and implemented to raise the villagers' understanding of environmental problems and solutions, especially regarding wastewater. Information on the negative effects of environmental pollution on human health should be disseminated to the people in the commune with comparative data on the incidence of disease in Phong Khe and other communes in the region so that the plant owners will understand and pay more attention to pollution mitigation measures to protect their own selves and the community. Training on pollution prevention and treatment should also be done for plant owners and staff.

(c) Improving the capacity of the local environmental authorities

One of the reasons for the non-compliance of paper-making plants is weak monitoring and enforcement action by the local environmental authorities. While the responsibility for environmental protection is huge, the number of environmental management staff and the availability of other resources for environmental management in Bac Ninh Province are very limited. Enforcement activities including compliance promotion, compliance monitoring, and non-compliance penalties have therefore not been implemented regularly and effectively, thus generating a situation of ignorance and apathy among plant owners. Improvement in the capacity of the local environmental authorities is very crucial for better compliance and pollution mitigation. The number of environmental staff in DONRE both at the provincial and district level should be increased. Each craft village should have one staff specializing in environmental management, with adequate knowledge and experience in the field. Furthermore, the local authorities at provincial, district and communal levels should mobilize more funds for implementing environmental work from financial sources such as local authority budgets, credit organizations, and companies and business units in the province (for contributions).

(d) Building more industrial zones

More than half the paper-making plants in Phong Khe are still located in residential areas. The wastewater and solid waste from these plants are the main sources of serious pollution in the commune. Moving these plants to the industrial clusters and building more industrial zones will help mitigate the pollution situation in the commune.

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