

## Climate Change Issues of Paper Manufacturing Production at Phong Khe Craft Village

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### Abstract

Today, the development of industries and rapid urbanization has a profound impact on the human environment. It can be said that the environment in the craft village is most affected. The environment in these areas is severely degraded and depending on the type of production, the environment in the craft villages is different. In Phong Khe ward of Bac Ninh Province, Vietnam, there are over 204 small and large facilities of recycling and producing paper. The paper facilities produce about 200,000 tons of paper each year and the amount of paper produced is not less than 500 tons each day in Phong Khe. They are creating livelihoods for more than 6,000 workers and generating local budgets from VND- 50 billion to VND 60 billion per year. Despite this great contribution, the use of old machines and “backward” modes of production means that paper recycling has caused serious air, soil, and water pollution in the region. The specific objectives of this study were as follows: (1) provide an overview of paper production process in the Phong Khe paper craft village; (2) comprehensive literature review of the current status of water environment, atmosphere environment, soil environment and solid waste; (3) figure out about waste treatment in Phong Khe ward.

**Key words** : Climate change, Phong Khe, environmental pollution, recycling paper

### 1. Introduction

Phong Khe is a ward of Bac Ninh Province, Vietnam and about 32 km northeast of Hanoi capital. Phong Khe economy mainly relies on paper recycling and manufacturing. Since 1995, paper production in Phong Khe has developed vigorously due to the adoption of machinery. In 2015, the capacity of all paper kinds (toilet paper, paper, votive paper, cardboard, etc.) reached about 255,000 tons. In 2016 and the first 6 months of 2017, the production situation is stable and favorable trend, good product consumption. Total capacity of paper in 2016 reaches 262,000 tons and in the first 6 months of 2017

reached 135,000 tons. According to the households, about 500 - 600 kg coal are needed to produce one ton of paper. Thus, the amount of coal and firewood of the paper production facilities used to produce paper up to 400 - 500 tons/day. They also daily dispose of around 5000 m<sup>3</sup> 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 [1-7].

The ambient atmosphere in Phong Khe Commune is smelly and filled with dust and coal smoke. The

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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”. 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 [8-11].

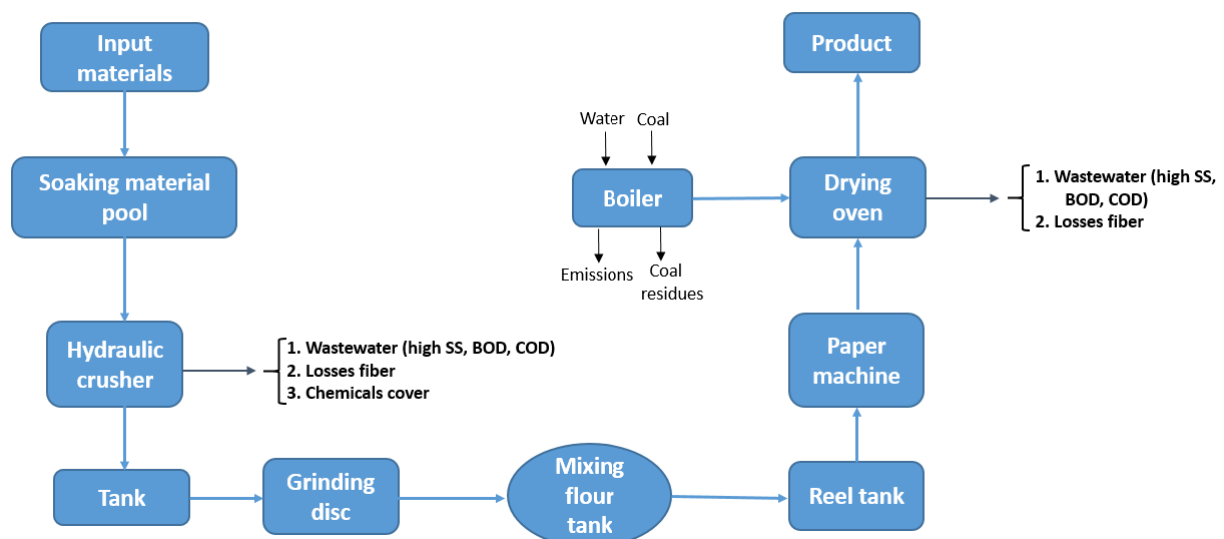
## 2. General paper production process in Phong Khe craft village

Paper manufactures 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 paper production process in Phong Khe is illustrated in Figure 1.

Firstly, waste papers collected from various sour-

ces will be the input materials of the paper recycling process. It will be immersed in a soaking material pool containing NaOH (or watered) to soften the paper, and then the paper is crushed by hydraulic crusher together with some whitening chemicals and water. In the factory of low-quality paper, wrapping paper ... the waste paper material can be directly ground by the hydraulic crusher. A huge amount of wastewater with high concentration of SS, BOD, COD, and losing fiber will be discharged after crushing. Then the paper fiber liquid will be transferred to the tank for fiber separation later. Big sized fiber will be crushed again. After that, that liquid will be moved to grinding disc to make better quality. At grinding disc, chemicals, solvents, and additives are supplied to the tank to ensure the requirements and quality of the later product. Then the pulp will be pumped into the mixing flour tank, the pulp is present in the suspension. The mixing flour tank ensures the consistency of the pulp mixed with some chemicals and solvents in the production process before switching to reel tank. The pulp is transferred from reel tank to paper machine by the water wheel. The pulp is dried in the dry oven to make the final paper products [12].

Summary, in all production processes from raw



**Figure 1.** The common Waste Paper Making Process in Phong Khe craft village, Bac Ninh province

**Table 1.** Waste generated in the production process

Producing process	Waste generation	Environment affected
Classification	Solid waste: tape, nylon, pin, dust	Soil, water, air
Soaking material	Waste water and alkaline	Water, air
Bleaching	Water containing chemicals	Water, air
Hydraulic crusher	Noise, solid waste, chemicals	Soil, water, air
Mixing flour	Waste water, chemicals	Soil, water, air
Paper machine	Waste water, noise	Soil, water, air
Dry	Emission, coal residues	Soil, air

materials to processing to waste products are polluting the environment. The continuous discharge of huge waste without planning and management have deprived the natural assimilation of the environment, increasing the risk of contamination (especially the water environment).

Looking at the above statistics, we can see from the classification process to the production process produce huge amount of waste that affects all three types of soil, water, and air environment.

### 3. Environment problem

#### 3.1. Status of water environment

##### Wastewater:

Paper recycling uses and releases large volumes of water. In the production of water used in the input is usually approximately the amount of water is discharged. Wastewater from the process of grinding the pulp and paper, from the soaking process mainly containing fine fiber, additives, alkali, sodium hypochlorite, and coloring. In addition, the wastewater also contains chemicals that fall out. Water pollution is created during the soaking, cleaning, boiling, and grinding of waste paper. Despite being less toxic than emissions from factories using raw material inputs, wastewater is released indiscriminately and without treatment. This causes serious pollution in surface and underground water. While paper recycling activities have made a significant economic

contribution to village households, their environmental impacts have also been costly.

In Phong Khe village, there are more than 100 households which engage in producing more than 200,000 tons of paper per year. Every day, a huge amount of wastewater containing high levels of organic pollutants is emitted. This wastewater then runs directly into domestic canals and Ngu Huyen Khe River, which has a serious impact on the quality of both surface and underground water in Phong Khe. In 2014 alone, the local authorities discovered 383 tons of waste which paper producers planned to use in Phong Khe. A report released by the Bac Ninh provincial authorities showed that Phong Khe discharges over 5,000 m<sup>3</sup> of untreated wastewater to the canals every day [1].

Everyday wastewater has a characteristic color such as pink, yellow, white opaque, black ... There are so many colors because the village produces various types of paper, each type of paper have different color characteristics of wastewater. The composition and characteristics of the wastewater vary according to the characteristics of each production facility. With kraft paper production facilities, the contents of COD and BOD<sub>5</sub> are usually higher than that of votive paper or sanitary napkin production facilities because of differences in type and quality of input materials (toilet paper and sanitary napkin require higher quality of raw materials). However, sanitary napkin production

facilities have a higher content of chlorine, higher turbidity comparing with the votive paper production facilities owing to the use of many bleaching chemicals.

According to analysis results of wastewaters in Table 2, we find that the quality of wastewater samples in Phong Khe village have concentrations of polluted substances exceeded many times comparing with the established standards. In the two wastewater samples, they exceeded the Vietnam permission standards 16.6 and 21 times for the concentration of BOD<sub>5</sub> (20°C), 20 and 27.2 times for COD, 14.6 and 21 times for TSS, respectively. The concentration of chromium (VI) was 1.54 times higher than Vietnam standard, the iron concentration was 4.9 and 5.88 times higher than permit level, the content of ammonium exceeded 1.05 times, the sulfide content exceeded respectively 19.35 and 81.9 times, the

coliform scores were 3 and 5.3 times higher than permission standard respectively. Other heavy metal elements such as lead and copper are still within the allowable limits. Comparative Standard is QCVN 40:2011/BTNMT Column A - National Technical Regulation on industrial wastewater [13].

Due to the high content of organic materials in wastewater, the dissolved oxygen in the effluent ditches is almost nonexistent and wastewater is in an exhaustion leading to anaerobic degradation of organic compounds and makes a foul odor (H<sub>2</sub>S). In addition, the level of wastewater pollution depends on the technology of paper production, the source of recycled materials and the level of wastewater treatment.

Surface water:

Surface water pollution is a consequence of untreated wastewater generated by producers in recy-

**Table 2.** Results of waste water quality analysis in Phong Khe paper craft village

No.	Parameter	Unit	QCVN 40: 2011/ BTNMT (A)	Result
1	Temperature	oC	40	28.5 - 34.2
2	Color	Pt/Co	50	85 - 140
3	pH	-	6 - 9	6.2 - 7,55
5	TSS	mg/l	50	730 - 1050
6	COD	mg/l	75	1500 - 2050
7	BOD <sub>5</sub> (20o)	mg/l	30	500 - 630
8	Asen	mg/l	0.05	0.032 - 0.045
9	Mercury	mg/l	0.005	0.003 - 0.0045
10	Lead	mg/l	0,1	0,08 - 0,09
11	Amoni	mg/l	5	4.3 - 5.25
12	Copper	mg/l	2	1.2 - 1.7
13	Iron	mg/l	1	3.5 - 5.88
14	Sunfua	mg/l	0.2	3.78 - 16.39
15	Crom (IV)	mg/l	0.05	0,041 - 0,077
16	Total Nitrogen	mg/l	20	18
17	Total Phosphorus	mg/l	4	3.26 - 3.95
18	Coliform	Bacteria/100 ml	5000	15,000 - 26,500

Source: Results of environmental observation report of Phong Khe craft village in the first quarter of 2016 by the Bac Ninh Center for Natural Resources and Environment Monitoring.



**Figure 2.** Untreated wastewater from the paper productions directly to the Ngu Huyen Khe River.

pled paper craft villages discharged directly into the receiving source. Therefore, wastewater with high concentration of color chemicals and other smelly substances are freely discharging into the river and residential drainage system. Paper, tars, pulp, and chemicals used in production have directly affected local people's health. Over 5,000 m<sup>3</sup> untreated wastewater with heavy effluents of COD, BOD and SS from residual chemicals, pulp, fibers with high levels of organic are discharged from this village every day, running directly to the canals and Ngu Huyen Khe River. As a result, Ngu Huyen Khe River, once clean enough for agriculture purposes, has become "Dead River" due to its smelly, black water.

According to monitoring results of the first quarter of 2016 by the Center for Monitoring Natural Resources and Environment, the quality of surface water in the village shows that the BOD<sub>5</sub> content exceeds the Vietnam standard allowed 144.13 times, the content of COD was 108.53 times higher than standard, the content of TSS exceeded the allowed standard

27.42 times, the coliform content exceeded the permit level 1.2 times, iron content exceeded the standard 4.82 times. The benchmark is QCVN 08-MT: 2015/BTNMT, Column B1 - National Technical Regulation on surface water quality (Table 3).

### 3.2. Status of atmosphere environment

Phong Khe is now listed as one of the most seriously polluted localities in Bac Ninh province. The latest Bac Ninh Provincial Department of Natural Resources and Environment survey on environmental pollution revealed that the province is suffering from alarming levels of air, water, noise and soil pollution. During the paper production process, due to the use of chemicals such as NaOH, sodium hypochlorite in the process of bleaching raw materials should at this stage exhaust emissions amount of toxic gas such as H<sub>2</sub>SO<sub>3</sub>, Cl<sub>2</sub>, H<sub>2</sub>S, etc [14].

The dust content in the air is almost 2 to 2.5 times higher than Vietnam standards and especially in production areas. Due to the operation of recycled

**Table 3.** Results of surface water quality analysis in Phong Khe paper craft village

No.	Parameter	Unit	QCVN 08-MT:2015/ BTNMT (B1)	Result
1	pH	-	5,5-9	6,2-7,55
2	TSS	mg/l	50	1370
3	COD	mg/l	30	3256
5	BOD <sub>5</sub> (20o)	mg/l	15	2160
6	Asen	mg/l	0,05	0,035
7	Mercury	mg/l	0,001	0,00075
8	Lead	mg/l	0,05	0,045
9	Copper	mg/l	0,5	0,35
10	Iron	mg/l	1,5	7,23
11	Crom (IV)	mg/l	0.04	0,032
12	Total Phosphorus	mg/l	4	3,7
13	Coliform	Bacteria/100 ml	5000	6000

Source: Results of environmental observation report of Phong Khe craft village in the first quarter of 2016 by the Bac Ninh Center for Natural Resources and Environment Monitoring

**Figure 3.** Black smoke from a base production in Phong Khe

paper production facilities, the use of heaters for paper machines consumes a large amount of coal

(about 500 tons of coal per day) which produces a large amount of dust, on the other hand, number of

establishments also uses fuelwood, which impacts deforestation. Emissions from non-treated fuel combustion (containing toxic gases such as  $\text{SO}_2$ ,  $\text{CO}$ ,  $\text{NO}_x$ , etc.) are discharged directly into the environment, causing the atmosphere of the village to be seriously polluted.

Moreover, transportation of raw materials, as well as consumption of products, also affect the quality of air. Duong O also produces sanitary paper, napkins so the air is polluted by chlorine from bleach 3 times higher than Vietnam standard. The large country lanes in Phong Khe alternate with pitch-dark sewers which produce bad odors and make sick people suffer. The canals there have turned dull red because the water has been dyed with the cleansing chemicals from paper workshops. Wastewater from production household is discharged directly into the sewerage system, as the anaerobic digestion of paper fiber in the canals as well as in the landfill contaminates air by  $\text{H}_2\text{S}$ . At the survey point of Duong O village, the content of  $\text{H}_2\text{S}$  exceeds Vietnam standards 3

times.

In addition, the noise in the production area exceeds the permissible standard of 10 dBA - 20 dBA which is mainly due to the operation of the machinery system. Besides, we have to mention a type of noise due to the large volume of traffic that transports materials and products that affect the surrounding population [14]. Phong Khe is always noisy because of the trucks going in and out from the morning till evening which produce noise, and smoke and kick up dust. While adults work at workshops, children play around the piles of scrap paper. Pham Xuan Vu, 54, a local resident, said he has been living in Phong Khe since the day he was born, but now does not want to live there anymore. "The environment is getting more and more serious. It is hot and muggy on sunny days and smells on rainy days," Vu said. "Instead of using charcoal and firewood as fuel, a lot of households here burn garbage and rags to optimize their profits," he complained. Vu is a member of the craft village's



**Figure 4.** Solid waste and soil pollution in Phong Khe

supervisory board. His duty is to find the people who burn rags and garbage illegally at midnight and fine them. Though culprits have been found and punished, the problem still cannot be stopped [1].

### 3.3. Status of soil environment and solid waste

Waste generated in the production process is not collected and arbitrarily poured into the system of village roads, rivers, and canals. As a result of the survey, the amount of solid waste generated from production, business, service, and activities of local people is about 60 - 65 tons of waste per day. In addition, rainwater flows over the surface that has been swept away by oil, grease, heavy metals, chemicals to ponds and lands surrounding the production area, which directly affects agricultural production [5].

At present, waste of handicraft villages is concentrated and piles are not regulated according to technical regulations, in the tropical conditions of Vietnam (sunny and heavy rain), the organic components of garbage disintegration create a stench, affecting the air environment and people's life. The paper industry (excluding the facilities located in the craft village) generated in the village is estimated at over 60 tons/day (2017). Currently, it is difficult to treat this waste and the method being used is burning, but this is also the cause of environmental pollution.

Dust, emissions, wastewater, and solid waste generated from paper production process can cause soil pollution and affect plant growth and development. The area of agricultural land has significantly decreased because of the development of the industry, and the production facilities have encroached. The main cause of the agricultural area lost due to pollution. The rice fields and fish farms were covered by waste, they were too polluted to be cultivated so they had to be abandoned and now farmers have no land fit for cultivation. The agricultural land surrounding the production sites, water and garbage has turned the area into the abandoned land, an estimated one-third of the total agricultural land. The remaining land is also contaminated at a smaller rate be-

cause the canal system has become the main source of wastewater, which is being supplied to the agricultural life that causes soil pollution. In addition, soil pollution has to mention another cause that is waste of the production process and a huge amount of unused coal residues are indiscriminately thrown away. Long-term accumulation of these waste sources has a lasting effect on the soil environment, which directly affects the soil's ability to cultivate [14].

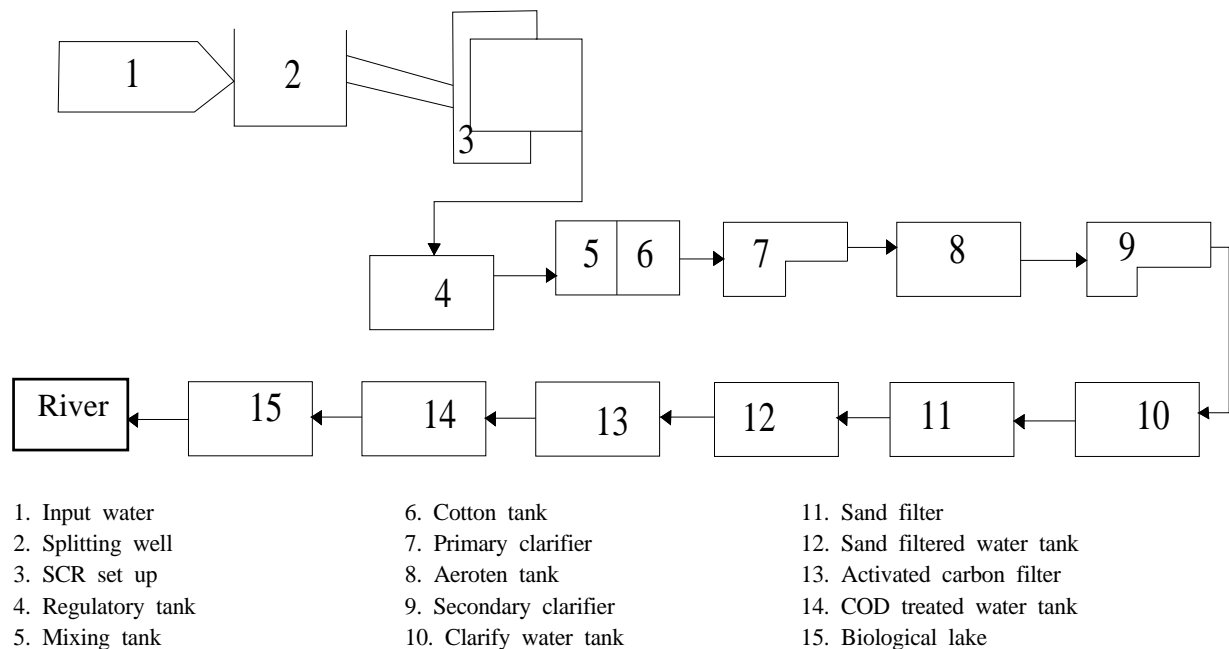
## 4. Waste treatment

### 4.1. Wastewater

Wastewater from paper production facilities is discharged directly into Ngu Huyen Khue river via village's canal, which seriously affects to surface water and groundwater. At present, the amount of waste water from the village is estimated at 12,000 m<sup>3</sup>/day. Faced with that situation, Bac Ninh province government have built Phong Khe wastewater treatment plant with investing VND 156 billion. The plant built on a total area of nearly 4 hectares with designed capacity of 5000 m<sup>3</sup>/day that will ensure thorough treatment of wastewater from factories, paper factories. According to the report of Bac Ninh province, total wastewater treatment of the plant was over 241,000 m<sup>3</sup> by the end of July 2017. The average daily discharge of sewage is over 1800 m<sup>3</sup>/day, only reached under 20% total amount of wastewater [15]. This shows that currently wastewater in Phong Khe has not been thoroughly treated causing direct pollution to surface water and underground water. The aeroten treatment system is used for wastewater treatment at Phong Khe wastewater treatment plant (Figure 5).

Moreover, many projects on environment protection were implemented, for example: "Improving of wastewater treatment in Dao Xa, Viet Nam". The project improved quality of surface and irrigation water in Dao Xa using traditional agricultural methods and enhanced environmental awareness of inhabitants, local authorities and experts. Bac Ninh Province also implementing the project of renova-





**Figure 5.** Diagram of wastewater treatment system at Phong Khe treatment plant

ting, dredging and upgrading Ngu Huyen Khe river with the total investment of VND 2,000 billion in 2016. The project has completed the dredging stage and now embankments are being constructing.

#### 4.2. Gaseous waste

Currently, recycled paper production facilities in Phong Khe ward do not have any solutions for storage as well as treating gaseous waste. The emissions from boiler flue tubes and during production processes of paper in facilities release directly to the environment cause bad odors as well as affect public health [13].

#### 4.3. Solid waste

Solid waste were partially transported to gathering points, partly piled by the roadside, the rest was burned to destroy. In general, solid waste in recycled paper production craft villages has not been thoroughly collected and treated. Solid waste, including hazardous waste is collected and dumped in low lying areas such as ponds, lakes, riversides, etc., is then naturally burned, polluting the surface water, groundwater, soil and air environment. At present,

the waste from the Duong O and Dao Xa villages flows to the Ngu Huyen Khe River. It pollutes the water source, affecting the safety of dyke in rainy season. On the other hand, the burning of industrial waste under normal temperature conditions can often produce dioxin/furan that seriously affects to people health in the surrounding area [13].

In recent years, Phong Khe Ward government has actively propagated and disseminated legal knowledge on environmental protection to enterprises and production establishments. They also have mobilized people to raise their awareness and responsibility, contributing to ensuring the handling of pollution in production activities to avoid causing harms to the environment. At the same time, companies and enterprises are required to perform a contract to connect the waste water pipeline to the Phong Khe wastewater treatment plant in order to minimize the pollution of the environment. In 2016, in order to prevent the use of industrial waste as fuel for boilers, the local authorities in collaboration with the Department of Natural Resources and Environment, Environmental Police, Police of Bac Ninh city... inspected 6 cars, seized 40 tons of waste, inspected 26 produc-



**Figure 6.** Discharge and burning garbage in Phong Khe paper recycling village

tion facilities, seized and destroyed 190 tons of waste, and police in Phong Khe ward regularly patrol, they detected and punished 26 cases of violation, recovered and destroyed 41 tons of waste. According to a report by the People's Committee of Phong Khe ward, in 2016, the number of people who burned waste of boiler, was reduced but some households still surreptitiously violated affecting the living environment [16].

## 5. Conclusion

Summary, Phong Khe is facing with environmental challenges such as air, water, noise and soil pollution. Due to undeveloped manufacturing equipment, insufficient paper waste, and wastewater treatment, serious environmental contamination is happening around the production area with a high emission of GHGs and risk of fire incidents. The problem of pollution in the paper recycling village especially

water pollution if the government doesn't treat well, it will cause seriously affecting on surrounding environment, quality of life of people. Since Vietnam does not have yet the policies and guidelines that encourage the wastepaper collection for paper recycling, paper craft villages are an emerging focus of national and local environmental concern, with new laws and policies to match. Whereas the key solution in need - an appropriate green technology for sustainable, cost-effective manufacture and recycle of paper for this paper craft village, need be determined and invested for research to transferred to production facilities.

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