Bangladesh Textile-Clothing Industry: Wastewater Pollutant Review in Gazipur and Dhaka

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Abstract: The textile industry is one of the most critical sectors in Bangladesh, for it depends on the textile industry heavily, which accounts for a considerable portion of its exports and annual GDP. The low cost of the labor force becomes a decisive advantage that attracts Western countries to open factories there, especially around Dhaka areas. However, while earning a profit, Bangladeshi textile industries emit a huge amount of pollutions, devastating the local environment severely. This research paper reveals the value of several discharged wastewater pollution- Biochemical oxygen (BOD), Chemical oxygen demand (COD), Dissolved oxygen (DO), and pH value from the Bangladesh Bureau of Statistics (BBS)- around the blue river's garment factories to find the causes of pollution and evaluate river water quality. The results display that the total amount of water pollution already goes beyond the standard level, meaning that the Bangladesh government should consider the detrimental impact the Bangladesh textile factories cost seriously. Our research paper summarizes several efficacious strategies such as adopting waterless dyeing technology, Pigouvian tax, cap and trade, and more rigorous environmental regulation, thereby enabling Bangladesh to minimize its textile industry's pollutants while developing its economy.

1. Introduction

1.1 Research background and Motivation

Nowadays, the majority of fast-fashion brands assert they are sustainable. Being a developing country, Bangladesh has specialized in ready-made garments (RMG) for decades, which account for 84 percent of Bangladesh’s exports [1]. Given its cheap labor force and convenient location, companies, especially those fast fashion ones, choose Bangladesh to manufacture apparel. Although they allege producing sustainable garments, the water pollution doesn't seem to be effectively controlled. Textile and industrial effluents may cause alteration of the physical, chemical, and biological properties of the aquatic environment by a continuous change in temperature, odor, noise, turbidity, etc. that is harmful to public health, livestock, wildlife, fish, and other biodiversity [2]. The contamination should be regulated strictly. To raise local people's quality of life, this environmental pendulum must be figured out effectively. Thus, conducting thorough research on Bangladesh's environmental situations and then coming up with efficient solutions are necessary.

1.2 Literature Review

In the last seven years, Bangladesh’s garment industry has increased its annual revenue from $19 billion to $34 billion—a 79 percent raise (Fathi, 2021). The textile and Apparel sector contributes around 20% to Bangladesh’s GDP (Stitchdiary, 2018). However, the insurmountable negative externality caused by this industry is terrifying. Bangladesh positions at number 86 among 142 countries concerning drinking water quality (Arefin, 2017). Bourgeoning literature seeks to determine the number of effluents discharged by Bangladesh textile companies with the support of factual data comprehensively. For instance, the average value of TSS of the effluent was found 1,123 mg/L, indicating that the TSS concentration in the effluent sample is about seven times higher than the DOE

standard. TDS in water mainly consists of ammonia, nitrite, nitrate, phosphate, alkalis, some acids, sulfates, metallic ions, etc. (Islam et al., 2011). What's more, the export market of the Bangladesh RMG sector has diversified during 2006 -2016 as the Trade Entropy index increased by more than two times (Hossain et al., 2019). It is also mentioned that women were the primary labor force in the textile industry, for most are illiterate. (Menzel et al., 2019). Thus, their overlook toward effluent control may also lead to excessive pollution discharge to some degree. However, while considering possible solutions, not many articles talk about it with enough evidence or support. Our research paper will then compare strategies developed countries that also devote themselves to textile fields but with effective regulation, thereby harnessing their technology or the essence of the rule to make a radical change.

1.3 Research Contents and Framework

From a minimizing-loss perspective, this article estimates the data of pollution index from the effluents in Bangladesh located around rivers to evaluate their pollution level. After comparing the actual and required values, if the result is much higher than the standard value, this paper advocates specific mitigation related to technological innovation and implement rigorous environmental protection policies. Combining Cape and Trade, externality, and cost and benefit analysis, we prefer to solve the effluent problem from both macro and microeconomic levels, thus accomplishing the mentioned loss-minimizing goal. The structure of this research consists of four parts. This first part is the methodology, which utilizes pollution data and maps and certain theoretical models. The second part is about results and discussion, where we analyze the data to conclude the impact of Bangladesh textile industry pollution. The last part is about a conclusion. While concluding the whole paper, we also present tactics to help Bangladesh mitigate and alleviate its severe pollution problem and minimize its side effect while making a profit.

2. Research process

2.1 Method

We used maps and tables to display the amount of wastewater, distribution of the factories in Bangladesh. And we studied the case of the Balu River in Dhaka, the area with the majority of RMG factories, by using Biochemical oxygen (BOD), Chemical oxygen demand (COD), Dissolved oxygen (DO), and pH value to evaluate the pollution caused by the factories.

2.2 Wastewater amount

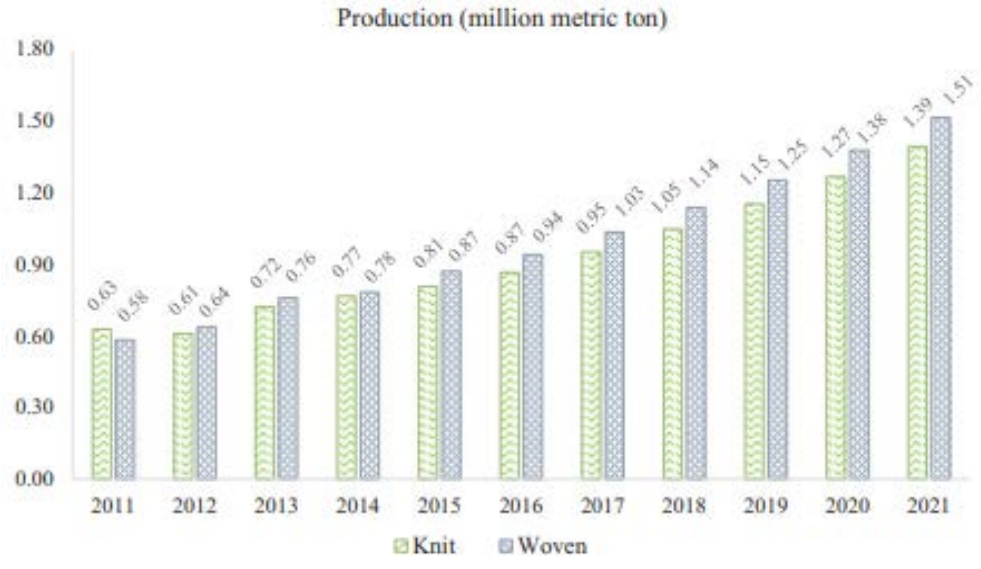

Figure 1. Trend analysis of annual textile production in Bangladesh
*Source from Evaluation of presemt and future wastewater impacts of textile dyeing industries in Bangladesh

Fig.1 predicts that by 2021, there are around 2.9 million metric tons of fabric is going to produce, the sum of the production of Knit and Woven. And it is about 2.40 times larger than the production in 2011 (1.21 million metric tons). The huge amount of production will lead to enormous quantities of wastewater. By using the water Key performance indicator (KPI, 0.12 m^3/kg fabric), there will be 348 million metrics of wastewater be produced by 2021. Compared with the wastewater amount in 2011 (145.2 million metrics), the amount of wastewater will increase by 202.8 million metrics [3]. The enormous amount of wastewater does not have proper methods to be disposed and most of them are directly drained in the surrounding channel, which will lead to severe water pollution [4]. Thus, it is critical to analyze the water pollution caused by the Garment factories in surrounding water bodies.

2.3 Distribution of RMG factories and analysis areas

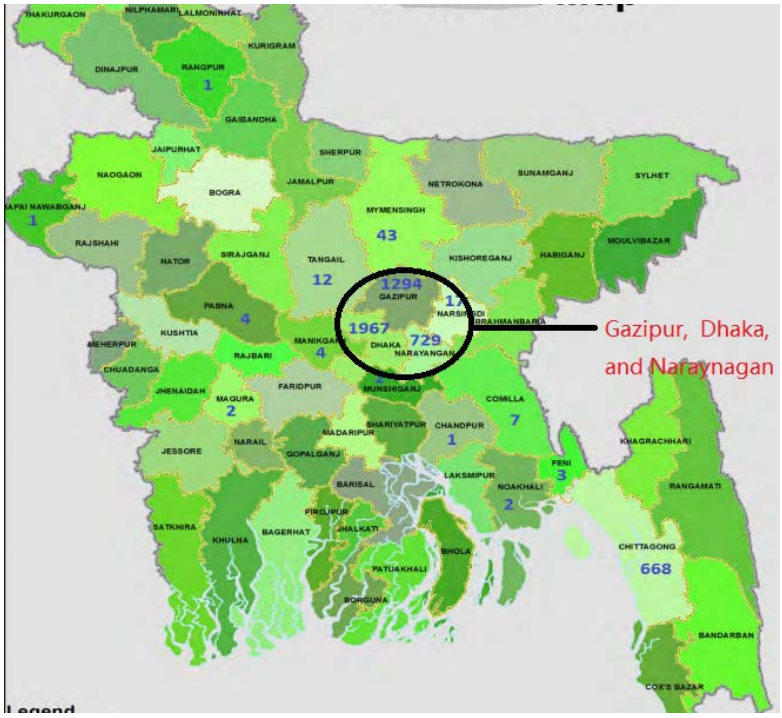

Figure 2. Bangladesh Garments distribution map
*Source from Living Wage Report Dhaka, Bangladesh, and Satellite Cities

According to figure 2, it can be found that most factories are founded in the Dhaka area, and most of them are around the city of Dhaka, Gazipur, and Narayanganj. There are 4787 Garments on the map, and about 83 percent of Garments, 3990 garments, are in these areas. Thus, we decided to choose the case of the Balu River to analyze the water pollution caused by the textile and dyeing factories.

The Balu River is a tributary of the Shitalakshya River in Bangladesh. Before joining the Shitalakshya at Demra, it flows through the marshes of Beel Belai and Dhaka. The rivers of Dhaka City, Bangladesh, are highly influenced by the extent and intensity of economic expansion, like other fast industrializing emerging countries' urban river systems. While Greater Dhaka is the country's economic engine, accounting for 40% of GDP, the Turag-Tongi-Balu River system in central Dhaka gets a massive load of household and industrial effluent due to high levels of pollution, over-abstraction of groundwater, and inefficient usage [6]. Therefore, using BOD, COD, pH value, and DO can analyze the effect of textile and dyeing factories in the Balu River.

3. Result and discussion

3.1 General analysis of Balu rivers water quality

According to figure3, except for the area near the Fulpukuria Dyeing Ltd., the areas near the dyeing and fabric factories have high BOD and COD, and the area near the South Side of Tongi Rail Bridge

has the highest conservation of BOD and COD. The pH value is similar in six areas and is closed to 7, which shows that the pH value of the Balu River is neutral. And in the perspective of the DO value, only the area near the Fulpukuria Dyeing Ltd. Pagar, Tongi, which has the lowest values in the other three parameters, has a relatively high DO value.

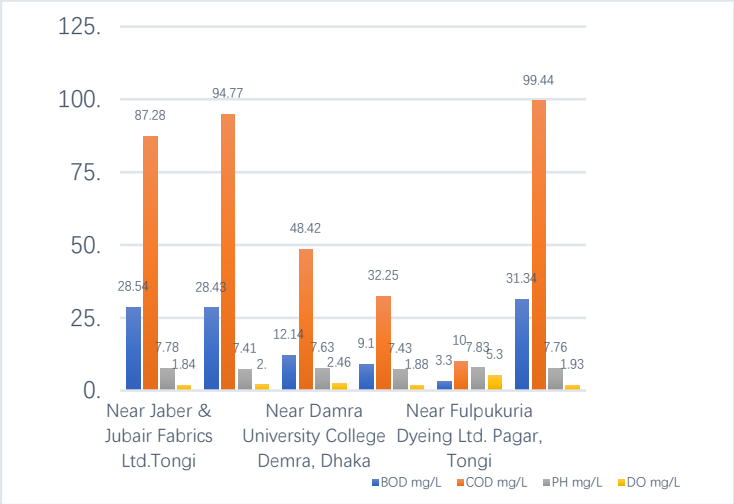

Figure 3. Balu River Water Quality 2018
*Data from Bangladesh Environment statistics 2020

3.2 Data analysis of Balu rivers water quality

According to the Bangladesh and U.S. surface water criteria & TableI, the BOD of surface water that uses for irrigation should be 10mg or less, which is the lowest standard for surface water. However, according to the table, the mean value of the Balu river's concentration of BOD,18.81mg/L, is almost two times larger than the standard. Although the value in the region near Fulpukuria Dyeing Ltd. Pagar, Tongi, 3.3mg/L, and the value in the region near Balu Bridge, 300 feet Road, Dhaka, 9.1mg/L, has reached the standard, The value of the concentration of the BOD in the region near Jaber&Jubair fabrics Ltd. Tongi, 28.54mg/L; the region near Hossain Dyeing Ltd. Pagar Tongi, 28.43mg/L; and the region near Side of Tongi Rail Bridge, Paga, Tongi, 31.34mg/L, are close to or even larger than the three times of the standard.

In the perspective of COD, Bangladesh does not have a clear standard in The Environment Conservation Rules, 1997. Whereas according to the standard of US (40mg or less), the mean value of COD concentration, 62.02, is also higher than the standard. In addition, the area near Hossain Dyeing Ltd. Pagar Tongi; the area near Hossain Dyeing Ltd. Pagar Tongi; and the area near Side of Tongi Rail Bridge, Paga, Tongi, are also exceed standard a lot- 87.28mg/L, 94.77mg/L, and 99.44mg/L. they are all two times larger than the standard. And only the value in the region near Fulpukuria Dyeing Ltd. Pagar, Tongi, 10mg/L, and the value in the region near Balu Bridge, 300 feet Road, Dhaka, 32.25mg/L below the standard.

In the perspective of DO, only the value in the area near Fulpukuria Dyeing Ltd. Pagar, Tongi, 5.3 mg/L, reach the standard of Bangladesh,5 mg/L. In pH value, all areas reach the criteria.

In the five regions, only the region near Fulpukuria Dyeing Ltd. Pagar, Tongi reach all the criteria. The regions near Jaber&Jubair fabrics Ltd. Tongi, Hossain Dyeing Ltd. Pagar Tongir, and Side of Tongi Rail Bridge, Paga, Tongi show high BOD and COD value which fatherly exceed the standards.

Table 1. Balu River's Walter Quality Analysis

Name/region	BOD	COD	PH	DO
standard in irrigation water (Bangladesh/us)	10 or less/10	-/40	6.5-8.5	5 or more
Near Jaber & Jubair Fabrics Ltd.Tongi	28.54	87.28	7.78	1.84
Near Hossain Dyeing Ltd. Pagar Tongi	28.43	94.77	7.41	2
Near Damra University College Demra, Dhaka	12.14	48.42	7.63	2.46
Near Balu Bridge, 300 feet Road, Dhaka	9.1	32.25	7.43	1.88
Near Fulpukuria Dyeing Ltd. Pagar, Tongi	3.3	10	7.83	5.3
South Side of Tongi Rail Bridge, Pagar, Tongi	31.34	99.44	7.76	1.93
mean	18.80833333	62.02666667	7.64	2.568333333

*Data from Bangladesh Environment statistics 2020, the environment conservation rules, 1997, and Technical and Economic Evaluation of WWTP Renovation Based on Applying Ultrafiltration Membrane

4. Discussion

The process of RMG industries will lead water to high BOD and COD, such as Sizing, Desizing, dyeing, and printing. Discharge of high-BOD wastes can result in water quality issues such as dissolved oxygen depletion and fish deaths in receiving water bodies [10]. However, as Dyeing Ltd., Fulpukuria Dyeing Ltd. reach all criteria, which shows that there are some technologies to dispose of the wastewater produced by the Dyeing process to make it harmless. And Fulpukuria Dyeing Ltd. spent money on disposing of the wastewater. It sacrifices its utility to make the production process socially efficient and environmentally friendly.

Thus, to solve the water pollution caused by RMG Industries, from a governmental perspective, imposing Pigouvian taxes or tradable pollution licenses are necessary. Those help to narrow the gap between marginal social cost and marginal private cost. If Pigouvian taxes are higher than the cost of disposing of wastewater, the factories will consider making wastewater harmless or producing less wastewater rather than discharge it directly. The negative social externality will decrease, and the production will be more efficient. Besides, if the government uses tradable pollution licenses, it gives the property right of the wastewater to the RMG factories themselves. The restricted amount of pollution a company can release is regulated. Factories need to buy more pollution licenses from other factories to increase the amount of wastewater that they can discharge, otherwise, once they exceed the stipulated amount, they are forced to pay hefty fines. Through the tradable license, it can provide financial support for the companies possibly to improve their technology to gain more benefit and make factories that need to buy a lot license to use new technology to reduce pollution, which is conducive to environmental protection.

From a personal perspective, individuals' incentive on green and environmental protection needs to be raised to a higher level. Basically, lecturing workers how severe is the condition after discharging tons of effluents to rivers directly could urge them to be concerned about the emitted pollution the factories they work in seriously, which is meant to pave the road for further practical application [1].

From a technical perspective, Bangladeshi textile factories could adopt waterless dyeing techniques. On the ground that waterless dyeing utilizes Carbon Dioxide to produce dyeing polyester fabrics, the pollution discharged after the whole process can be lowered. In fact, pivotal companies

such as DyeCoo in Dutch have done a great job in waterless dyeing, which can effectively save 32 million liters of water and recycle 95% of the CO2 back into the process [11]. Hence, textile factories located in Buriganga or Shitalakhma river should study DyeCoo's technology, thereby being able to minimize the contamination brought in water. Nonetheless, while employing waterless dyeing technology, factories have to evaluate whether the financial spending is affordable because the investment cost of the machines is $2.5 to 4 million (U.S.). In this way, factories have to analyze the cost and benefit profoundly, thereby deciding the application of waterless dyeing technologyIn addition, a strict and thorough regulation system needs to be constructed. The latest regulation of wastewater and surface water standards in Bangladesh is The Environment Conservation Rules, 1997, and many regulations are ambiguous or defective. For example, there is no COD standard for surface water that can be used for irrigation. In the Bangladesh Bureau of Statistics (BBS) and department of environment (DoE), there is little data about the pollution of the surface water without precise parameters. A vague criterion will make industries have chance to reduce their cost in the perspective of wastewater treatment to increase profit.

5. Conclusion

The main sites we choose are cities in which the textile factories are in clusters, which could be treated as an epitome to estimate Bangladesh's whole textile pollution situation. Since the environmental problem is a long-existing issue, it is indispensable to raise individuals' awareness toward this topic, especially the ones related to the ignorance of the detrimental impact of pollution. Our research shows that the pollution discharged by near-river textile factories already goes beyond the standard score. Textile production is one of the determinants in Bangladesh. Undoubtedly, the profit and money brought by these dyeing companies are considerable. Therefore, it is very important to protect the environment while making a profit for those textile factories. If companies ignore the pollution, the damage and irrevocable problems would be waiting in the future. Developed countries are therefore able to get contact with the circumstances of those developing countries, which enables them to provide help while they need to reduce pollution. Other developing countries could also adopt those advanced technologies, if effective, thereby constructing a benign circulation and better our whole world constantly. One of the drawbacks of this research paper is that the data are all not surveyed and gained directly from Bangladesh local factories, given the condition is not permitted. If improving, we would like to visit certain textile factories in Bangladesh for a while and gain reliable data to conduct a more precise and accurate report, thus finding a direct relationship between the number of factories and the number of pollutions they discharge. Also, when data are available, we would choose to investigate the relationship between the number of textiles Bangladesh exports annually and the amount of pollution produced by those leading textile manufacturers, thereby finding the correlation between them indirectly.

Author Contribution

Zihang Wang conducted the research, analyzed the data, and wrote the discussion part of the paper; Sicheng Xu wrote the abstract, introduction, and conclusion parts of the paper; all authors had approved the final version.

References

[1] A. Berg, H. Chhaparia, S. Hedrich, and K.-H. Magnus, “What's next for Bangladesh's garment industry, after a decade of growth?” *McKinsey & Company*, 25-Mar-2021. [Online]. Available: https://www.mckinsey.com/industries/retail/our-insights/whats-next-for-bangladeshs-garment-industry-after-a-decade-of-growth. [Accessed: 01-Nov-2021].

[2] A. Munnaf, M. S. Islam, T. R. Tusher, M. H. Kabir, and M. A. H. Molla, “Investigation of water quality parameters discharged from textile dyeing industries,” *Journal of Environmental Science and Natural Resources*, vol. 7, no. 1, pp. 257–263, 2015.

[3] L. Hossain, S. K. Sarker, and M. S. Khan, “Evaluation of present and future wastewater impacts of textile dyeing industries in Bangladesh,” *Environmental Development*, vol. 26, pp. 23–33, 2018.

[4] M. M. Islam, K. Mahmud, O. Faruk, and M. S. Billah, “Textile Dyeing Industries in Bangladesh for sustainable development,” *International Journal of Environmental Science and Development*. pp. 428–436, 2011.

[5] Khan, D. M., Anker, D. R., Anker, M. M., & Barge, D. S. (2016). Living Wage Report: Dhaka, Bangladesh, and Satellite Cities. Context: The Garment Industry.

[6] P. Whitehead, G. Bussi, M. A. Hossain, M. Dolk, P. Das, S. Comber, R. Peters, K. J. Charles, R. Hope, and M. S. Hossain, “Restoring water quality in the polluted turag-tongi-balu river system, Dhaka: Modelling nutrient and total coliform intervention strategies,” *Science of The Total* Environment, vol. 631-632, pp. 223–232, 2018.

[7] Bangladesh Environment statistics 2020. Department of Environment and M. R. Islam, FA & MIS Wing, BBS, 2021, pp. 363–364.

[8] Standard, B. (1997). The environment conservation rules 1997. *Government of the People’s Republic of Bangladesh, Dhaka*.

[9] Bai, H., Lin, Y., Qu, H., Zhang, J., Zheng, X., & Tang, Y. (2020). Technical and economic evaluation of WWTP renovation based on applying ultrafiltration membrane. *Membranes*, *10*(8), 180.

[10] M. R. Penn, J. J. Pauer, and J. R. Mihelcic, “Biochemical Oxygen Demand,” *Environmental and ecological chemistry*, vol. 2, pp. 278–297, 2009.

[11] “Dyeing without water,” *Eco-innovation Action Plan - European Commission*, 11-Feb-2019. [Online]. Available: https://ec.europa.eu/environment/ecoap/about-eco-innovation/experts-interviews/tintura-senza-acqua_en. [Accessed: 01-Nov-2021].