AIM INTERNATIONAL LLC Publisher
Frontiers in Applied Engineering and Technology, 2024;1(01): 84-104
Website:https:/journal.aimintlllc.com/index.php/FAET

# ENVIRONMENTAL IMPACT AND MANAGEMENT IN THE FACE OF INDUSTRIAL GROWTH: A STUDY OF NOAPARA MUNICIPAL AREA, JESSORE, BANGLADESH

**Shishir Kumar Das**[1]
[1]Graduate Assistant, Environmental science, Southeast Missouri State University, Cape Girardeau, MO, USA
Email: shishir.semo@gmail.com

**Mohammad Moniruzzaman**[2]
[2]Independent Researcher, Bangladesh
Email: monirnstu0321@gmail.com

Keywords

*Industrial Development*
*Types of Industry*
*Waste*
*Environment Impact*
*Municipality*
*Environmental Management*
*Sustainability*

ABSTRACT

***The rapid growth of Bangladesh's population and labor force has made industrialization essential, as agriculture alone cannot sustain the increasing workforce. Industrial development, while driving urbanization and economic growth, often results in unplanned and uncontrolled expansion, posing significant threats to the surrounding built environment. This study focuses on the environmental management practices in industrial zones within Noapara municipality, a Class-A municipality in Bangladesh. The research reveals that industries in Noapara fail to adopt scientific methods for waste management, contributing to environmental degradation. Moreover, agencies responsible for managing industrial waste face severe challenges, including insufficient technical and non-technical manpower, lack of facilities and equipment, and inadequate budgetary support. Compounding these issues, residents in industrial and surrounding areas are largely unaware of the detrimental effects of improper waste management. The study also explores the municipality's role in granting No Objection Certificates (NOCs) for industrial setups, analyzing data from the NOC register to classify industries established between 2000 and 2016. Findings highlight critical gaps in current practices and emphasize the urgent need for enhanced waste management strategies, institutional capacity building, and community awareness to promote sustainable industrial development and environmental protection.***

## 1 INTRODUCTION

### *1.1 Background*

The period of transformation from an agricultural economy to an urban, mass-producing economy has accompanied every period of sustained per capita gross domestic product (GDP) growth in recorded history. Less than 20% of the world's populations live in industrialized nations, yet they account for more than 70% of world output (R. sean, 2015.) Industrialization is generally believed to be the key to economic development for the developing countries like Bangladesh (Haq A I, 2008). The country of Bangladesh's surroundings is already very dangerous and its degradation keeps unabated. One of the predominant motives for environmental degradation in Bangladesh is behavioral which encompass deforestation, pollutants of air, water, and land thru

**Received**: 10th October, 2024 **Accepted**: 12th December,2024 **Published**: 15rd December,2024

deposition of business effluent (Planning Commission, 2010). In the past few years, the gross domestic product (GDP) of Bangladesh has been growing at an average of 5.5%. In 2005, GDP growth rate was 5.8% and the industry sector showed the highest growth at 8.5% (ADB, 2006). The country's population and labor force are growing rapidly every year, and it is impossible that the growing labor force can ever be absorbed in the agriculture sector unless employment opportunities can be created by rapidly expanding the country's industry sector (Haq A I, 2008). Industrialization has the potentials to help achieve a variety of social objectives such as employment, poverty reduction, labor standards and greater access to education and healthcare (European Commission, 2006). Thus, industrial development is encouraged in all types of urban areas across the country to achieve the development vision by 2021. In a word, the industry is the most potential sector for socio-economic development in Bangladesh.

In contrast, there are a number of environmental concerns with industrial development in emerging nations. With increased manufacturing and other industrial processes come the need for more energy and the potential for more pollution. As emerging nations grow, they become responsible for increased greenhouse gas emissions. A greenhouse gas is an atmospheric gas that holds the sun's heat and may contribute to global climate change. In addition to the global atmospheric impact of industrialization, there is the threat of damage to the emerging countries' domestic environments. Industrialization spikes the need for resources, such as lumber, fossil fuels, fertile soil, and water. It can cause climate change, loss of natural resources, air and water pollution, and extinction of species. Apparently, unplanned and uncontrolled industrial development has great influence changing the surrounding built environment causing serious environmental degradation in the urban area. So, the control of environmental degradation in an urban area is a very burning issue for both national and local government context. Hence, the industrial policy must have the endorsement of some strategies regarding environmental management to set up environment-friendly industry in any area.

According to the industrial policy of Bangladesh, a number of permissions from the national government and local government are mandatory while setting industry. On behalf of the national government, the 'Department of Environment' under the 'Ministry of Environment and Forest' is the concerned department to provide the 'Environmental Clearance Certificate (ECC)' for industry setting across the country. Alternatively, the municipality under the 'Ministry of Local Government Rural Development and Cooperatives' is concerned agency to preserve the built environment sound for urban citizens ensuring sustainable urban development. The goal of this research is to evaluate the practices of environmental management in response to industrial development within the Noapara Municipal area: a. to analyze the types, distribution and development trend of existing industries; b. to identify the environmental impact of industrial development, and c. to investigate the present environmental management system of industry & the role of municipal authorities.

## 2 LITERATURE REVIEW

Research works relevant to industrial development and its effect on environment has been explored here. This chapter made the compilation of the works carried out by various researchers. Reviewed literature relevant to this research work has been systematically cited. Moreover this chapter aims at presenting results of different works to have clear idea and better understanding over research topic and understanding in wider dimension.

### *2.1 Industrialization and Regional Growth*

Industrialization is a part of wider modernization process, where social change and economic development are closely related with technological innovation, particularly with the development of large-scale energy and metallurgy production (Sullivan, Steven, 2003). According to the original sector classification of Jean Fourastie (1954), an economy consists of a "Primary sector" of commodity production (farming, livestock breeding, exploitation of mineral resources), a "secondary sector" of manufacturing and processing (as paid work), and a "Tertiary Sector" of service industries. The industrialization process is historically based on the expansion of the secondary sector in an economy dominated by primary activities (Jean Fourastie, (1954).

The first transformation to an industrial economy from an agricultural one is called the industrial revolution and took place from the mid-18th to early 19th century in certain areas in Western Europe and

North America, starting in Great Britain Derby, followed by Germany, and France. This now is called the first industrial revolution (Pollard, 1981). The Second industrial revolution describes the later changes that came about in the mid19th century after the invention of steam engine, internal combustion engine,

### *2.2 Industrial Development and Environment*

Industrialization to achieve economic development has resulted in global environmental degradation. The developing world is often seen as having a high percentage of heavily polluting activities within its industrial sector. This, combined with a substantial agricultural sector, which contributes to deforestation, the erosion of the top soil and desertification, has lead to extreme pressures on the environment. This crisis suggests that the sound development and management of natural resources and the adoption of low- waste or environmentally clean technologies (Se Hark, Walter, 2011). Industrialization has spawned its own health problems. Modern stressors include noise, air, water pollution, poor nutrition, dangerous machinery, impersonal work, isolation, poverty, homelessness, and substance abuse. Health problems in industrial nations are as much caused by economic, social, political, and cultural factors as by pathogens. Industrialization has become a major medical issue worldwide (Hopke, 2011). According to published report of European Commission reveals that sustainable industrial growth is benefit for the country's economy but on the other hand, industrial development is coupled with environmental degradation and resources depletion, societal exploitation and economic recklessness, the associated benefits, if any, will not last (European Commission, 2006)

### *2.3 Industrial Location Choice*

The space of industrialization depends upon a large number of factors such as resource, size, location, environment etc. the location of industries is the main determinant for sustainability of industrial development. The industrial location theory has three approaches which are *the least cost approach, market area analysis and the profit maximization approach* (Glasson, 1968).These three 'umbrella' approach provide a useful framework for the analysis of the theoretical approach to industrial location and also identify transport, labor, agglomeration and market as the key elements in location theory. The theory does not consider the environmental impact to choice location for industrial development. But, industrial development is recognized as driving force of structural change in nature for economic development which has huge impact to the surrounding built environment (Haq, 2008).

### *2.4 Industrial Development: Bangladesh Perspective*

Industrial development in Bangladesh, during the post-independence period, both in terms of its growth rate as well as the structural changes, has been rather modest. Between 1983-eighty four and 2005-06, its proportion in GDP multiplied from approximately 10 percentage to 17 percentage, and the percentage of employment rose from nine percentage to eleven percentage (CPD, 2005). However, the dynamism of the economic region is meditated with inside the sectorial proportion to GDP and especially in the percentage of incremental GDP price addition. On the vulnerable side, the enterprise region is slim primarily based totally best 5 industries (readymade clothes and textiles, fish and seafood, leather, fertilizer and pharmaceuticals) accounted for eighty one percentage of the boom executed in the course of the 1980s.After the trade liberalization of the 1990s, between 1992 and 2000, the number of large and medium enterprises in the industry sector increased than small enterprises. At present, the textile and readymade garment sector employs about 6.5 million people (Planning Commission, 2010).

Industrial policy of Bangladesh has changed by every new government within its period. The author has r

1. Industrial Investment Policy, 1973
2. New Industrial Investment Policy, 1974
3. Revised Investment Policy, December 1975
4. New Industrial Policy (NIP), June 1982
5. Revised Industrial Policy (RIP), July 1986
6. Industrial Policy, July 1991
7. Industrial Policy, 1999
8. Industrial Policy-2005 (IP 2005)
9. Industrial Policy 2010 (IP 2010)

The most common objectives in these policies are as

follows;

- Environment-friendly industrial development
- Create employment opportunity and Poverty reduction
- Increasing annual GDP growth rate
- Small and medium scale industrial development
- Export-orientated industrial development
- Local level industrial development.

According to the review of industrial policies in Bangladesh, it is clear to understand that among nine industrial policies, last two industrial policies are the most feasible regarding environment safety. In the latest Industrial Policy 2010 (IP 2010), there is an inclusion of important part regarding establishment of environment-friendly industry. But, in the list of stakeholder for preparation, monitoring and implementation of industrial policy, the role of local government does not exist. Consequently, local government organization at local level is neither aware about the National Industrial Policy nor liable for following the National Industrial Policy. So, the findings from this research will create a sense to knock at the policy maker for updating the industrial policy regarding environmental management practices at local level (Haq, 2008).

### *2.5 Industrial Development and Environmental Management Practices*

Environmental and herbal assets are the closing base of financial improvement. Also, with bushes being the supply of oxygen and the sink for carbon dioxide and water being important for existence, human existence itself is depending on the surroundings. Environmentally sound improvement requires movements to repair and keep environmental fitness at the same time as pursuing socio-financial improvement (Planning Commission, 2010). The country of Bangladesh's surroundings is already very bad and its degradation keeps unabated. One of main motives for environmental degradation in Bangladesh is behavioral which encompass deforestation, pollutants of air, water, and land through deposition of business effluent. Industrialization is the root causes of today's vulnerability of the global environment resulting in global warming The adverse impacts of global warming are going to spread along the shoreline of countries like Bangladesh affecting their overall socio-economic condition (NEMPCP, 2012). The Growth rate of industry in Noapara municipal area is very high. Especially red and orange category are growing rapidly. Besides such type of industry generate huge amount of industrial waste which are directly discharge or emitted to the environment. The existing management system of this area is not satisfactory. Most the industrial authority has no perfect waste management system. There need a sustainable management as early as possible to protect the environment and living people (Karim, 2011). The first environmental activities in Bangladesh were taken soon after the Stockholm Conference on Human Environment in 1972. The DoE is responsible to oversee the environmental management aspects across the whole country. The DoE has published some legal bases; The National Environment Policy-1992, The Environmental Conservation Act-1995, The Environmental Conservation Rules-1997. Based on the above legal bases, the government took some initiatives to control of industrial pollution across the country. According to the Environment Conservation Act, 1995 and the Environment Conservation Rule, 1997, the mechanism for issuance of environmental clearance certificate has been introduced for the new industries or projects after assessing project area and pollutants to be emitted or discharged by the industries or projects to be set up. For the highly polluting industries, environmental clearance is given after setting up effluent treatment plant.

## 3 STUDY AREA PROFILE

In this section, a brief description of the study area with necessary maps and figures has been given. Besides some socio-economic information about inhabitants of Noapara municipal area which are relevant for the present study have also been analyzed in this chapter. This chapter reflects location, relevant history, demographic profile, topography, climate and land use at a glance.

### *3.1 Location*

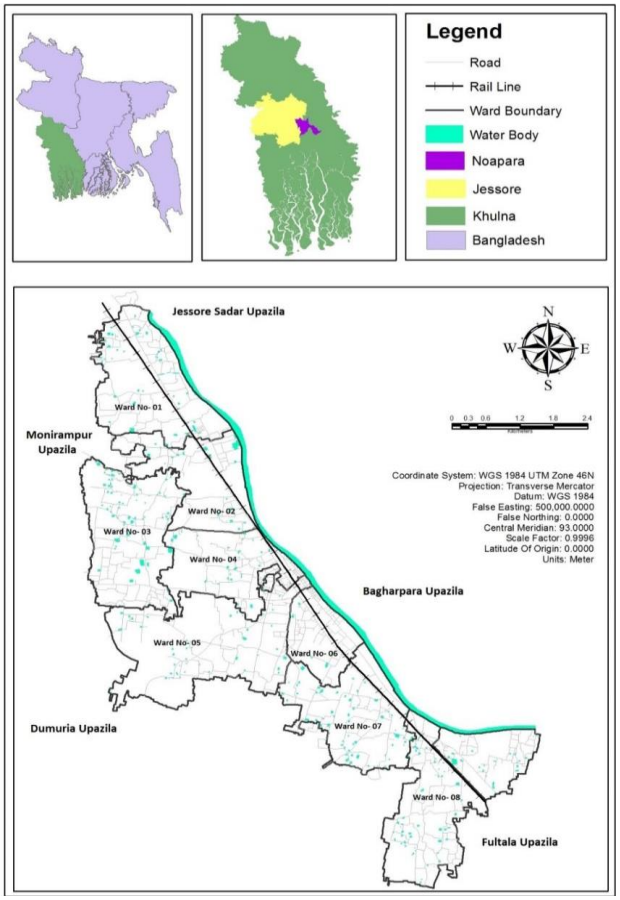
Noapara municipal area is selected for this study which is under abhaynagar Upazila and district of Jessore. Noapara paurashava is situated just beside the river Bhairav. Noapara municipal Area is located between 23°50' north latitudes and between 90°25' and 90°30'

east longitudes. This municipality is bounded by Bhairav river at the side of north-east, Chalisa union on the side of the south-west, on the east Fultala Upazila under the district of Khulna and at west Prembag union. The paurashava is 30 kilometers away from the Jessore district. The total area of the municipality is 25.12 square kilometer. The total population of this paurashava is 85856. Among them 60.14 percent people are literate. Here the population density is 3314 per square kilometer, which is comparatively higher than surrounding area. Under this municipality, there are 8 wards and 20 mahallas (BBS- 2011). Location map of Noapara municipal area are given below figure 3.1

### *3.2 Land Use*

Land use of the study area is divided into different categories such as industrial, commercial, residential, transportation, water bodies, open space etc. As a municipal area industrial land use is high enough than the others municipality of Jessore. Because of a good transportation system, available labors, and raw materials the land use of this area dramatically change in a recent couple of year. The change of land use mainly converted into the industrial land from agricultural land. Because of the business economic hub as a growth center, it pressures on its land use and decreasing the open vacant land and agricultural land. Land use map of Noapara municipal area are given below figure 3.1.

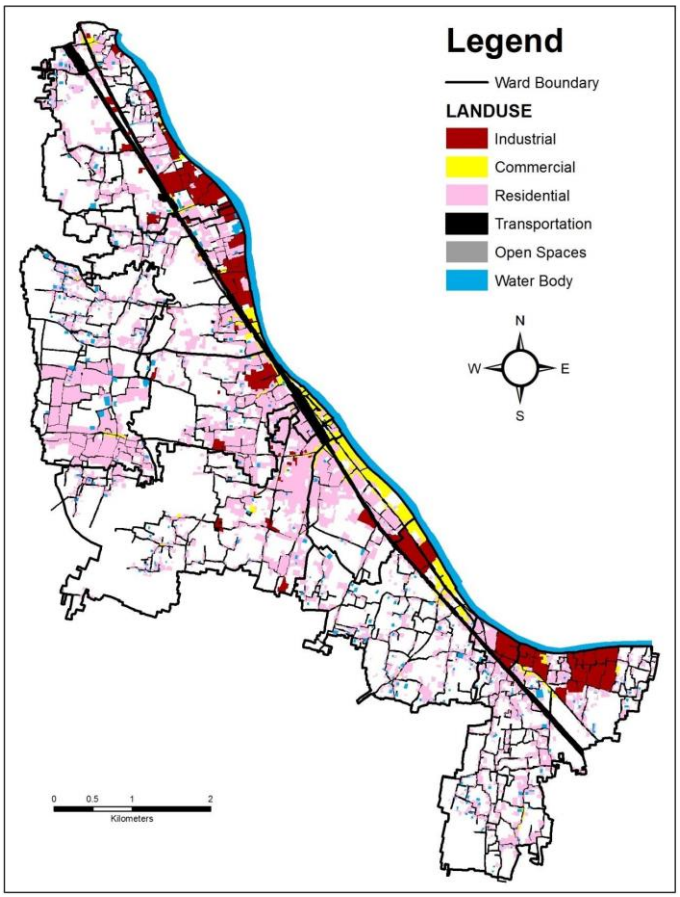
***Figure 3.1: Location map of Noapara municipal area***




### *3.3 Micro Climatic Condition*

Direction and speed of the wind and rainfall patterns have major implications for industrial waste management.

***Figure 3.2: Land use map of Noapara municipality area***




**i) Speed and Direction of wind:** The dominant wind direction in the study area is from the North and North West in the months between October to February and from south to south-west in the months between March to September. Average wind speed in the study area from October to February is 2.79 km/hr and from the March to September it is 3.42 Km/hr.(Source: Meteorological department)

**ii) Rainfall pattern:** Maximum rainfall in the study area occurs in the month of June which is about 399 mm and minimum rainfall occurs in the December which is 30 mm. The study area experiences a typical monsoon climate with high rainfall in the months from June to September and is relatively dry at other times of the year. (Source: Meteorological department)

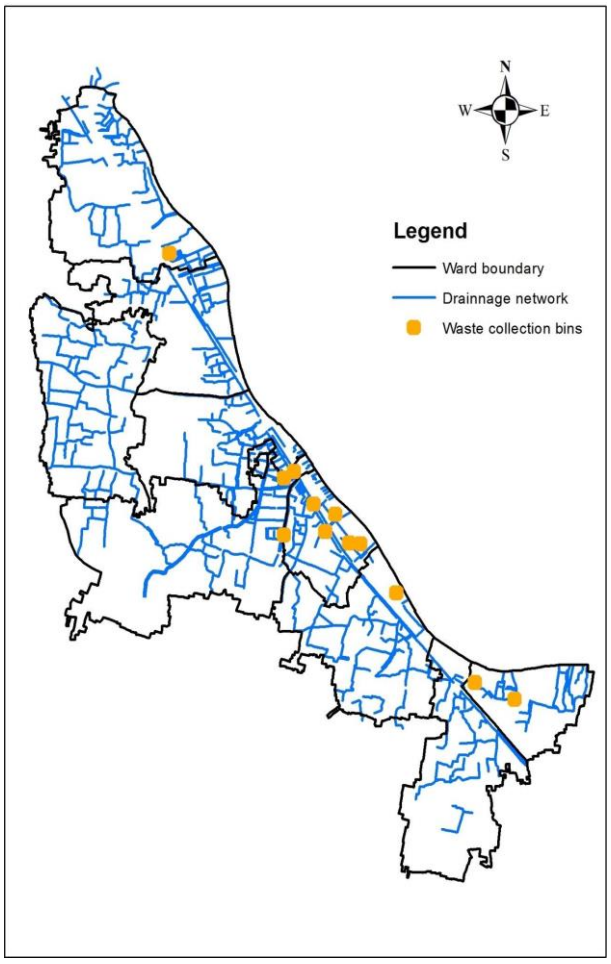
**iii) Temperature:** April-May month was very hot and sunny day and the monsoon season was June to October. Climate condition is warm-humid weather where average temperature $27^0$c. (Source: Meteorological department)

### *3.4 Physical Infrastructures*

**i)Roads:**

Jessore-Khulna highway is the major arterial road in the study area. The study area possesses a well-connected road network throughout the entire area.

***Figure 3.3: Map of Drainage network with location of waste collection bin***




***ii) Storm Sewerage System***

According to Noapara municipality, very few have sanitary sewerage connection with 2.4." diameter main lines under almost all the major roads sewerage network of both brick sewer and pipe sewer of varying diameters ranging from 18" to 48". Main storm sewerage line in the area is the line under Bengal-Taltola secondary road. The line has varying diameters at different sections ranging from 24" two 48". There are two out falls of this storm sewerage network at Noapara municipality one at Bhairav river another is Amdanga Khal near Chengutia. (Noapara municipality)

***iii) Dustbins***

According to Noapara municipality, there are approximately 12 dustbins in the study area. The average capacity of each dustbin is 5.5 m3. (Noapara Municipality). Location of dustbin and drainage network is shown in figure 3.3.

## 4 METHOD

The methodology is the science of method; the science dealing with principles of procedure in research work. The methodology of the research is a strategic or scientific approach to organize and analyze the scattered ideas and views of the study. It also expresses some techniques of collecting, processing and analyzing the data and information. So, the methodology is very crucial for data collection and data processing from every angle and makes a right decision. As a proper working procedure helps to accomplish the study smoothly, this study has maintained a systematically arranged methodology for the achievement of desired output and illustrates in this chapter.

In the recent years, the industrial sector is increasingly contributing to the local economic development of Bangladesh. A major source of revenue earning for several municipalities of Bangladesh is the industrial sector. Industrial development becomes a threat to the urban citizens for the living if the municipality has no effective environmental management practices in the process of providing 'NOC'. Consequently, citizens of industrial dominating municipalities face serious environmental threat due to haphazard development of the industries. Day by day, environmental degradation like water pollution, air pollution and sound pollution is increasing in those urban areas. Most of the municipalities in Bangladesh have no strategic base to

control the environmental degradation in the urban area through environmental management practices as well as citizens are not aware enough about the environmental impact on the surrounding built environment for industrial development.

In the last few years, Noapara paurashava become familiar with its huge industrial development and its economic importance. Most of the surrounding people are largely economically dependent on those industrial activities. In spite of its economic benefit industrial activity negatively impact on the environment. Besides, the existing environmental management system is not satisfactory, that's why this area is selected as study area of this research.

### *4.1 Sample Size Determination (community perception)*

Simple random sampling method has been selected for determining the sample size to analyze the community perception about the different socio-economic impact of industries. The following formula is used to calculate the sample size.

$$\text{Sample size} = \frac{\frac{z^2 * p\,(1-p)}{e^2}}{1+\left(\frac{z^2 * p(1-p)}{e^2 n}\right)}$$

Here,

N = population size e = margin of error z = z-score
p = population proportion

Considering 95% confidence level, the sample size is determined 43. The calculation of sample size determination has been added in appendix E.

Data Collection

The primary data has been collected by field survey through FGD, KII, GPS survey, questionnaire survey and industrial survey. Before this survey checklist and different questionnaire has been prepared.

### *4.2 Focus Group Discussion (FGD)*

Focus group discussions have been done in all eight wards due to identifying the potential impacts of existing industrial activities from the community people. Focus group discussions are done by some target group of people such as industry worker, community people to pick out problems, their reasons and results associated with the influences of commercial sports with inside the vicinity. The scopes of the FGD are shared amongst the local community all through the discussions. From the FGD especially distance & impact level data have been collected for the correlation coefficient analysis. Checklist of FGD has been added an appendix A.

### *4.3 Key Informant Interview (KII)*

The interviews with key informants were performed separately. The key informants concerned with inside the discussions have been farmers; people dwelling with inside the industries; teachers; neighborhood leaders; social workers; experts; journalists; owner & employee of industries; municipal corporation. The view of the stakeholders at the problems of current commercial effects on exclusive sectors which includes physical, biological, socio-political environments etc., were accrued in the course of those consultations. Additionally, the cause of the discussions is to familiarize the stakeholders with the problems of the study. From the KII mainly different qualitative data have been collected. Checklist of KII has been added an appendix A.

### *4.4 Questionnaire survey*

Three types of the questionnaire have been formulated for this research, one for municipal authority, one for industry owner & other for local people, industry worker etc. The questionnaire for municipal authority contains four parts. Part 1 for the desk of the surveyor (surveyor is responsible to verify the documents of land ownership in the process of 'NOC' providing). Part 2 for the desk of sub-assistant engineer (sub-assistant Engineer is responsible to confirm the specific documents regarding environmental management aspect in the process of 'NOC' providing). Part 3 for the desk of assistant engineer (assistant engineer is responsible to justify the specific documents regarding environmental management practices in the process of 'NOC' providing for industry set up in the municipal area). And part 4 for the desk of the mayor (mayor approved the application form for providing 'NOC'). By the questionnaire survey of the industry owner different types of data about industries general information, production process, waste generation, waste management system has been collected. The general perception of the socio-economic condition has been analysis by the data of another questionnaire which is for local people, industry worker, students etc. Questionnaire for municipal staff, industry owner and community people have been added an appendix A.

### 4.5 Industrial survey

From the industrial survey, the data has been collected which include industrial production process, raw materials, and the final product, by product, flow diagram, type of waste generation, effluent treatment plan, environment management system etc. Those data have been collected from industry owner, staff, production manager & worker.

### 4.6 Secondary Data Collection

The secondary data has been collected through literature reviews, information about industrial profiles, and socio-economic status of the study area. Different types of geographic and demographic data have been collected from municipal authority different organizations and reports. In table 4.1, all needed data and their sources have been described.

**Table 4.1: Secondary data & its source**

| Data Type | Data source | Data format | Year |
|---|---|---|---|
| GIS data | Municipality | Shapefile | 2016 |
| Demographic data | BBS | PDF | 2011 |
| Sample data (air) | NEMPCP | PDF | 2012 |
| Sample data (water) | Journal paper | PDF | 2011 |
| Sample data (soil) | Journal paper | PDF | 2014 |
| Statistical data | Municipal authority | PDF | 2016 |

### 4.7 Data Analysis

Both qualitative and quantitative data from primary and secondary sources were analyzed by using different analytical tools and approaches. The variable of the qualitative data was converted into quantitative value for analysis.

### 4.8 Types and Distribution Mapping

Types and distribution mapping have been done by using Arc GIS 10.1 with the secondary data (shapefile) from municipal authority and primary data (location) by GPS, types of industry from field survey. All existing industries have been categories in four class such as green, orange A, orange B & red. Industries also have been categories by its production capacity as the small, medium and large industry.

### 4.9 Existing Environment Management System Analysis

Environment management practice has been investigated by two authority such as municipal authority and industry authority. In municipal authority, four municipal stuffs has been selected for the municipal survey to collect secondary data about NOC process and tread license. The weakness of municipality on environment management practice also investigated in this section. The management system of industrial authority has been analyzed through a questionnaire survey. From the questionnaire survey data about waste generation, handling of waste, treatment of waste, recycling reuse of waste, waste disposal has been collected. Information about environmental management plan, effluent treatment plan, site clearance, location clearance of the industry has been collected to find out the condition of the present management system.

## 5 FINDINGS

The social and environmental impacts for industrial development largely depend on their classification and spatial location of industries in urban area. Any structural change has either positive or negative influence on its surroundings social environment as well as on built environment. Apparently, large structural change of industrial development generates more environmental impacts on surroundings. Therefore, types of industries are important factor for environmental management. It seems that high concentration of industries makes more structural change in surrounding built environment that creates additional sufferings for human being. So, spatial distribution of industries is another vital feature to control the environmental degradation. During 2000 - 2016, a number of industries have been established in Noapara municipality which has significant impact on the surrounding built environment (Karim, 2011). The types and spatial location of existing industries in Noapara municipal area are stated in the following paragraphs.

According to Noapara municipality register, 48 industries of different types have been established within the jurisdiction of municipal area during 2000

to 2016. Among these, about 10 less polluting and small sized industries like sow mill and husking mill as well as handicraft and cottage industries have received trade license from the municipality during the started period. It was observed that these industries do not require 'No Objection Certificate (NOC)' from the municipality for their operation in the municipal area and thus do not appear in the register of industries which have applied for 'NOC' as environmental clearance to the municipal authority. However, other 38 industries are found which presumably more polluting and large industries are. These industries were asked for environmental clearance along with the trade license from the municipality prior to their establishment in the municipal area.While providing the trade license, Noapara municipality segregates the industries into two categories such as limited company or proprietor based on ownership status. In case of limited company, there is a requirement of submission the company's memorandum for 'Trade License'. From the company's memorandum, Noapara municipality knows the investment amount of industry. Noapara municipality has 'by-laws' to define the industries into three types (i.e. small, medium and large) based on the investment amount and charges the fee accordingly for the TL'. The different types of existing industries in Noapara municipal area are given (Appendix - B)

**Table 5.1: Distribution of industries according to ownership status and investment type in Noapara municipality**

| Ownership pattern of industries | Number of industry (%) | Number of industry (%) | Typology of industries based on investment | Investment Amount (Taka) |
|---|---|---|---|---|
| Proprietor | 14(29.17) | 10(20.83) | Small | Up to 100,000 |
| | | 4(8.33) | Medium | 100,001-10,000,000 |
| Limited company | 34(70.83) | 10(20.83) | | |
| | | 24(50) | Large | Above 10,000,000 |
| Total | 48(100) | | | |

*Source: Noapara municipality office*

From the above table 5.1, it is found that 34 out of 48 industries have limited company ownership status. Among these 34 industries, 24 industries are large and rest 10 industries are medium. Almost all large and medium industries are limited company and small industries are proprietor. Although, industry category based on input materials and output materials is more important than other typology regarding environmental management issue, but Noapara municipality does not take consideration of this typology while providing 'NOC' for setting industry. The national agency DoE is more concerned about input materials and output materials based typology while provide ECC for industrial development. DoE classification of industries helps the urban authority to take decision properly for providing the 'NOC' as 'environmental clearance' and also charging fee rationally for that. In practical, proper classification makes easy for the concerned authority to overcome the problem of environmental degradation with limited resources at municipal level. The author has stated in details this typology in the following paragraph. The DoE follows the 'Environmental Conservation Rule, 1997' to categorize the industry based on location and environmental impact. Environmental impact is determined by input materials and output materials. According to the schedule -1 of the 'Environmental Conservation Rule, 1997', industries are classified into four types such as Green, Orange- A, Orange-B and Red.

From the above table 5.2, it is seemed that about 50% industries are large and among large industries 20.8% are orange-B and 41.7% are red. Table 5.2 also illustrated that 22.9% industries are orange-B and 27.1% industries are red and only 18.8% industries are

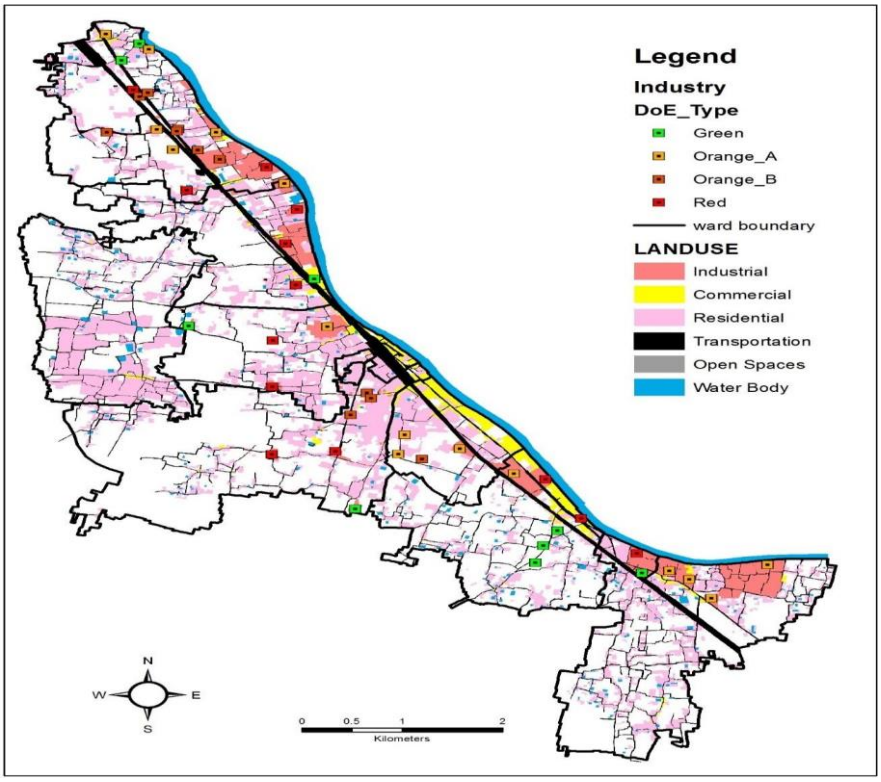
identified as green that indicate the vulnerability of the built environment in Noapara municipality.

**Table 5.2: Distribution of industries in Noapara municipality according to DoE classification and investment**

| DoE Type | Investment Type | | | Total |
|---|---|---|---|---|
| | Small | Medium | Large | |
| Green | 5 | 3 | 1 | 9 |
| Orange A | 2 | 5 | 8 | 15 |
| Orange B | 1 | 5 | 5 | 11 |
| Red | 2 | 1 | 10 | 13 |
| **Total** | **10(20.83%)** | **14(29.17%)** | **24(50%)** | **48(100%)** |
| | | | | |
| Percentage | (%) | (%) | (%) | (%) |
| Green | 50 | 21.4 | 4.2 | 18.8 |
| Orange A | 20 | 35.7 | 33.3 | 31.3 |
| Orange B | 10 | 35.7 | 20.8 | 22.9 |
| Red | 20 | 7.1 | 41.7 | 27.1 |
| **Total** | **100** | **100** | **100** | **100** |

From the figure 5.1, it is illustrated that all red and Orange-B types industries are located in ward no-1, 2, 4, 6 and 8. For better scope of employment opportunity, people from other districts migrate to Noapara municipality and settle themselves in the ward no-1, 2, 4, 6 and 8. As a result, the population densities of these wards are also higher than other wards in noapara municipality (Noapara municipality, 2010). So, ward no-1, 2, 4, 6 and 8 are getting more urban characteristics due to rapid structural changes in built environment. Therefore, ward no-1, 2, 4, 6 and 8 are more vulnerable than other wards in Noapara municipal area. Noapara municipality should give more attention as early as possible to reduce the environmental degradation in these wards through proper management practices.

***Figure 5.1: The distribution of existing industries in Noapara municipal area based on DoE category***




*(Source: Noapara municipality)*

### 5.1 Spatial Distribution of Existing Industries

Spatial distribution analysis has been done by using nearest neighborhood method. In the study area there are 8 wards. From the spatial distribution analysis it is shown that the industrial spatial distributions are dispersed, clustered or random in different ward. From the table 5.3 shown that maximum industries are in ward number one which are dispersed. In the ward 3, there is no industry.

**Table 5.3: Spatial Distribution Of Existing Industries**

| Ward no | Number of Industry | Spatial distribution |
|---|---|---|
| 01 | 17 | Dispersed |
| 02 | 5 | Random |
| 03 | 0 | ~ |
| 04 | 4 | Dispersed |
| 05 | 6 | Random |
| 06 | 4 | Clustered |
| 07 | 6 | Random |
| 08 | 6 | Clustered |

From this chapter it can be concluded that the types & distribution of industries in this study area is different in various ward. In some ward there are compact and some are disperse in character distribution of industry. The existing industry is also categories according to DoE type (Green, Orange A, Orange B, Red).

### 5.2 Industrial Waste & Impact on Environment

To develop a suitable Industrial waste management (IWM) system it is necessary to have a clear idea about the meaning of environment and industrial waste. Pollution potential and effect on environment by different types of industrial waste also bear a great significance in developing a suitable IWM system. This chapter intends to discuss these issues.

### 5.3 Industrial Waste

Wastes generated from different processes of industrial activity may be termed as industrial waste. Manufacturing process in any industrial enterprise is a compilation of a number of activities. It varies from industry to industry and even from plant to plant producing similar products (Chhatwal, 1992).

#### 5.3.1 Types of Industrial Waste

Industrial wastes can be categorized into four basic types depending upon their physical nature. These are

- Solid.
- Semi solids.
- Liquid.
- Gaseous. (Chhatwal, 1992).

## 6 ENVIRONMENTAL IMPACT ASSESSMENT OF THE STUDY AREA

### 6.1 Physical Environment

Primary affects because of commercial sports cognizance on bodily functions which include air, water, and soil. As said withinside the predicament of this take a look at, getting clinical records and facts to finish the effect tests is a chief challenge. However, the take a look at attempts as a good deal as viable to expose the number one affects with the aid of using reviewing the clinical literature, and additionally with the aid of using comparing the nearby community's notion approximately the commercial affects.

### 6.2 Impacts on Air

#### 6.2.1 Science-based discussions

Some factories which includes Ahad Cement, Himalay Cement, Karim Cement (to a few extent) produced fugitive emissions, in particular in substances handling, crushing, switch factors of substances, packing of merchandise and transportation. Most of the cement factories have now no longer followed the greenbelt and normal water sprinkling to lessen the effect of fugitive emissions (Karim, 2011). Different types of parameter such as $SO_2$, $NO_x$, CO, PM etc. are responsible for the

air pollution of the study area. From the previous literature review it was shown that $PM_{10}$ causes sever pollution and $NO_x$, $PM_{2.5}$ was also very harmful in the study area. On the other hand CO, $SO_2$ was less harmful for the environment.

**Table 6.1: Different parameter and their impact level of Air pollution**

| Parameters | Range | | | | | | Desirable limit For residential and sensitive region | Unit | Study area quantity |
|---|---|---|---|---|---|---|---|---|---|
| | Good | Satisfactory | Moderately polluted | poor | Very poor | severe | | | |
| $So_2$ | 0-20 | 21-40 | 41-80 | 81-180 | 180-400 | 400+ | 80 | micro gram/meter cube | 30-120 |
| $No_x$ | 0-40 | 41-80 | 81-180 | 181-280 | 281-400 | 400+ | 80 | micro gram/meter cube | 55-195 |
| CO | 0-1 | 1.1-2 | 2.1-10 | 10-17 | 17-30 | 34+ | 2.1-10 | micro gram/meter cube | 1-5 |
| $PM_{2.5}$ | 0-30 | 31-60 | 61-90 | 91-120 | 121-250 | 250+ | 61-90 | micro gram/meter cube | 40-155 |
| $PM_{10}$ | 0-50 | 51-100 | 101-250 | 251-350 | 351-430 | 430+ | 101-250 | micro gram/meter cube | 125-478 |

*Source: Agrawal, 1983(desirable limit) and NEMPCP, 2012*

### 6.2.2 People perception-based discussion

Industrial sports and their influences on herbal air are mentioned with the area people as a way to discover the mind-set of nearby human beings toward air pollutants issues. For this, matrix questions containing statements (Appendix A) is given to nearby human beings, manufacturing facility employees and students. Likewise, the connection among the diploma of air pollutants and distance from business regions is analyzed through the usage of correlation regression coefficient. In the field, its miles observed that the diploma of air pollutants differed in step with the distances from the commercial region. So to degree this dating, a correlation among the effect degree and distances from the commercial region is calculated. Here the rating for air pollutants effect is acquired through the usage of weights of three, and one to the responses of high, medium and coffee respectively given through the respondents of FGD. From this it is able to be finish that there's a terrible dating among the effect of air pollutants and distance from business region. This suggests that human beings with inside the take a look at region trust that the air pollutants degree is better close to the commercial region. The nearby groups make a few conclusions which can be given as follows: approximately 500m distance from the commercial regions, the air pollutants offer the very best effect; from approximately 1.5km distance it precipitated medium influences with inside the region; and in from a distance of more than 2km from business regions, the effect is the lowest. The calculation of the analysis has been given in (Appendix C). The recreational value of any area is hampered by the air pollution. In this study area it is shown that most of the people think that air pollution impacts on human health, animal, soil and also the recreational value. 58% people strongly agreed that air pollution caused by the industry are responsible for the health damage of factory worker.

## *6.3 Impacts on water*

### 6.3.1 Science-based discussions

Surface water source of the study area such as Voirav river, Amdanga canal and different types of pond and water bodies polluted by waste from the industry such as leather, textile, paper mill, chemical industry. Various types of parameter were selected for the estimation of impact level on surface water such as BOD, PH, DO, TDS, COD, Nitrate, phosphate, turbidity etc. In the study area from the previous study it was shown that turbidity, COD, TDS condition is very poor, that's means those are the main causes of water pollution on this area. On the other hand nitrate,

total ammonia as N condition is in a good level.

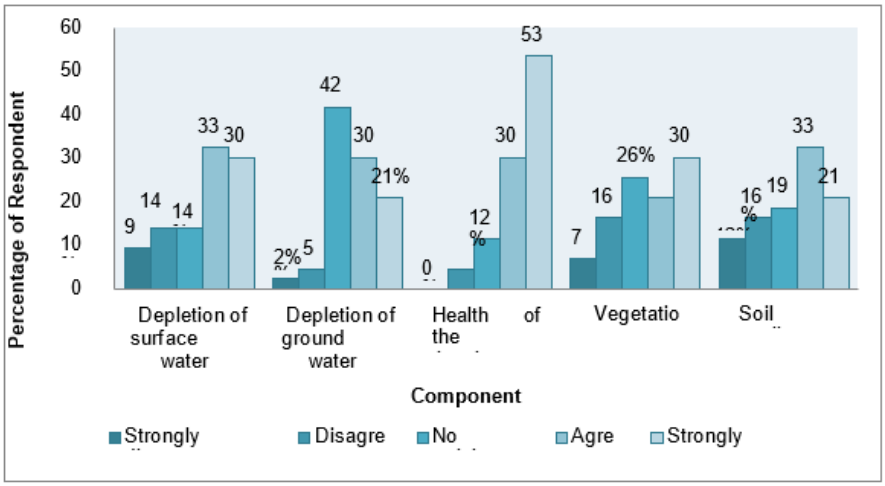
### 6.3.2 People perception-based discussion

In order to discover the mind-set of neighborhood human beings in the direction of the water pollutants issues, matrix, questions containing ten statements is given to neighborhood human beings manufacturing facility employee and students. The acquired reaction is analyzed with the aid of using the use of Likert's model. Likewise the diploma of water pollutants effect with recognize to distance from business location is likewise mentioned with the network all through the sector survey. In the sector it's miles observed that the diploma of water pollutants differs from vicinity to vicinity. The dating among the effect stage and distance from the economic location is classified with the aid of using the use of correlation regression coefficient. Since the fee of correlation coefficient is -0.38987, it could be finish that there may be a poor dating among the effect of water pollutants and distance from the economic location. The neighborhood network showed an immoderate withdrawal of floor water all through the operation of industries which has induced a drop with inside the stage of water to be had with inside the region. The calculation of the analysis has been given in (Appendix C).

**Table 6.2: Different parameter and their impact level of water pollution**

| Parameters | Desirable Limit | unit | Dry season | Wet season | Impact |
|---|---|---|---|---|---|
| **Biological Oxygen Demand (BOD)** | 3 | mg/L | 3.7 | 2.1 | poor |
| **pH** | 6.5-8.5 | - | 7.6 | 8.9 | Moderately polluted |
| **Dissolve Oxygen (Saturation)** | >5 | % | NIL | NIL | - |
| **Total Dissolved Solid )TDS)** | 500 | mg/L | 538 | 600 | Very poor |
| **COD** | <20 | mg/L | 740 | 960 | severe |
| **Nitrate (NO3)** | 0.5 | mg/L | 0.58 | 0.25 | satisfactory |
| **Phosphate (PO4)** | - | mg/L | 0.02 | 0.01 | - |
| **Turbidity** | 5 | NTU | 53 | 37 | severe |
| **Total Ammonia as N** | 1.5 | mg/l | 0.5 | 0.2 | satisfactory |

***Figure 6.2: Impact on environment due to water pollution***



Water pollution causes negative impact on surface water, ground water, health of local people vegetation and soil quality. This negative impact hampers the biodiversity of local ecology. Within those five components local people think that water pollution causes serious impact on human health through surface water.

### *6.4 Impacts on Soil*

In the previous study during the field survey soil sample was taken from two different points: crop land and land where industrial sledges were disposed. The result of that sample test is presented in bellow table.

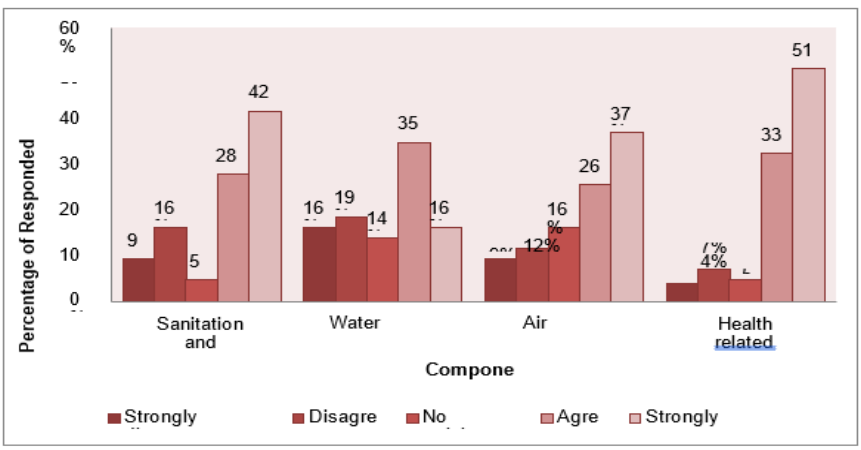
**Table 6.3: Different parameter and their impact level of soil pollution**

| Parameters | Soil Test | | Reference Range | Impact |
|---|---|---|---|---|
| | Sample-01 | Sample-02 | | |
| **pH** | 7.7 | 7.7 | | - |
| **Total Nitrogen(N %)** | 0.12 | 0.11 | Low (L): <0.1; Medium 0.1-0.2; High(H): >0.21 | medium |
| **Available Phosphorous (Kg/ha)** | 30.25 | 24.75 | Low(L): <30; MEDIUM: 31-55; High (H): >55 | medium |
| **Available potassium (Kg/ha)** | 384.0 | 369.6 | Low (L): <110; Medium: 111-280; High (H): >280 | high |
| **Organic matter N)%** | 2.40 | 2.27 | Low (L): <2.5; Medium: 2.6-5.0; High (H): >5.1 | low |

*Source: JICA (1987), Karim (2011)*

The trouble of business effects on soil is mentioned with the neighborhood communities. As according to the local community's notion, maximum of the factories produce a massive quantity of dirt due to the fact the factories do now no longer have dirt amassing equipment. Dust generated with the aid of using the cement production vegetation is composed normally of alkaline particulates from the uncooked and completed products. According to the locals, because of an accumulation of dirt with inside the neighborhood environment, crop cultivation close to the commercial regions reduced in contrast to the pre-enterprise era. Likewise, in the course of the flowering periods, the photosynthesis and pollination methods are disturbed due to dirt accumulation on vegetation and soil and the local community shared their reviews concerning this trouble. Qualitative data approximately the feelings, reviews, thoughts and perspectives of neighborhood people at the sensitization of soil pollutants has been assessed with the aid of using the use of Likert's Model. Further evaluation concerning neighborhood people's notion approximately the soil affects is achieved with inside the study. The diploma of soil-land pollutants capability and distance from business regions is in particular mentioned. In the field, it's far observed that the diploma of land pollutants differed in line with

**Figure 6.3: Impact on environment due to soil pollution**



distances from the commercial area. So a correlation coefficient approach is used to degree this correlation courting among the effect degree and distances from the commercial area. The rating for land pollutants capability is acquired with the aid of using the use of weights of three, and one and represents high, medium and occasional respectively given with the aid of using the respondents of a Focus Group Discussion. From the calculation, it's far acquired that the cost of correlation coefficient is-0.1894. This terrible signal confirmed that there's a terrible courting among the effect of land pollutants capability and distance from the commercial area.

### *6.5 Noise pollution*

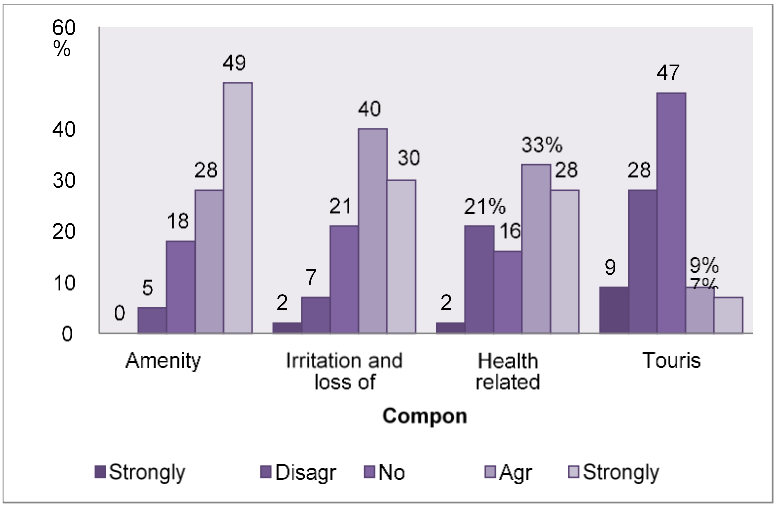
Cement production plants, electricity plants includes some of heavy device which include heavy engines, generator, cement grinding equipment etc. Adding to the severity of the noise pollution, cement plants with inside the examine vicinity are positioned adjoining to residential, institutional and academic areas.The evaluation approximately the connection among stages of noise pollutants with recognize to distance from the economic place is carried out. In the sector visits, its miles be aware that the diploma of noise pollutants relies upon on the gap from the economic place. So to degree this courting the correlation among the effect stage and distance from the economic place is classed the usage of correlation coefficient.

**Table 6.4: world Bank guideline on noise level for cement plants**

| Area | Maximum allowable (hourly measurement) in dB | | Remarks |
|---|---|---|---|
| | 7am-10pm | 10pm-7am | |
| Residential, Institutional, Educational | 55 | 45 | Residential, Educational institution need to away from industrial area |
| Industrial, Commercial | 70 | 70 | Industrial area should be far away from residential area |

Analyzed the acquired statistics the rating fee of noise pollutants capability is reap through the usage of weights of three, two, and one to the reaction of excessive, medium, low respectively given through the answered of FGD. Since the fee of correlation is -0.170461389, It may be finish that the effect of noise pollutants growth as the gap lower at a decrease rate. According to neighborhood network notion at the gap

**Figure 6.4: Impact on environment due to noise pollution**



of 200m distance it brought about a excessive effect. The calculation of the analysis has been given in (Appendix C)

From the correlation coefficient analysis it is found that all kind of pollution is increased as the distance from the industry decrease. That's means near to the industry there is high impact of pollution. Among air, water, soil, noise pollution there are different rate of pollution increasing towards the industry.

**Table 6.5: Results of correlation coefficient according to distance and pollution**

| Pollution | Correlation coefficient value (r) | Impact | Rank |
|---|---|---|---|
| **Air pollution** | **-0.282311527** | **Negative** | **02** |
| **Water pollution** | **-0.38987** | **Negative** | **01** |
| **Soil pollution** | **-0.1894** | **Negative** | **03** |
| **Noise pollution** | **-0.170461389** | **Negative** | **04** |

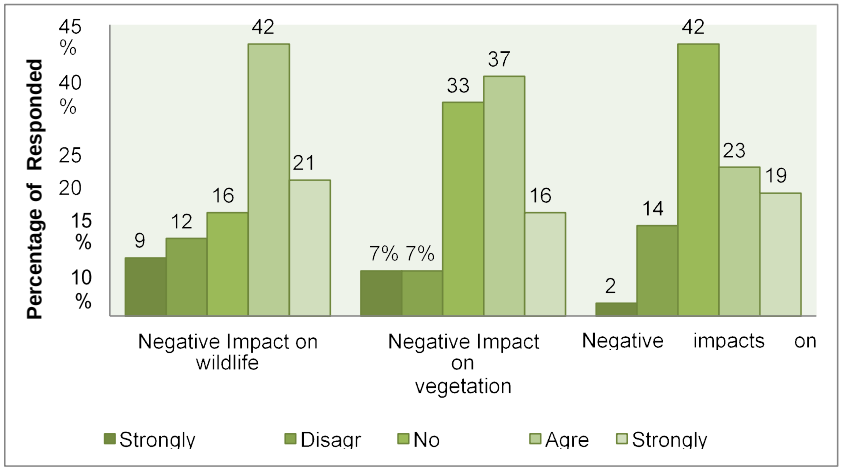
*Source: Field survey*

### *6.6 Biological Environment:*

The destructive outcomes of business sports have brought about a negative effect on plants, Wildlife and Habitats, Rare/Endangered/Endemic flora and fauna etc. According to the nearby communities, dirt debris usually collect over plant surfaces and as a result, the boom of the plant is suppressed main to a lower with inside the yield. Most of the humans agreed that poor effect on flora and fauna & its habitat and poor effect on plants because of business improvement may be very high. On the opposite hand humans are much less situation approximately the effect on livestock.

As said with inside the above sections, air, water, soil, and noise were adversely affected because of business sports with inside the region. As a result, the outcomes of such negative influences have additionally been located in extraordinary sectors particularly in socio-monetary, way of life and health. In this regard, the questionnaires concerning the economic influences on social, monetary and cultural surroundings have been offer to the nearby groups to decide their belief approximately the influences.

**Figure 6.5: Impact on Biological environment due to industrial development**



## 7 DISCUSSION

For a happy and prosperous nation, need addressing environmental degradation issues and effectively meeting the challenges arising from the climate change for sustainable economic development. In this chapter, based on the findings some recommendations have been provided to overcome the drawbacks in environmental management practices in Noapara municipality. Finally, some concrete statements have been included as concluding remarks. Important findings regarding environmental management practices which are outcomes from the analysis of industry type and distribution, environmental impact assessment, existing management system of municipality and industry investigation the 'NOC' process and direct interview of municipal and industrial staff, case study in the study area. The summary of these findings are stated briefly in the following paragraphs. From the types and distribution analysis of industry it is found that there are 48 industries in the study area within those some are proprietor and some are limited company. According to investment type industries are also categories as small, medium and large within 50% industries are large and among large industries 20.8% are orange-B and 41.7% are red, that indicate the vulnerability of the built environment in Noapara municipality. From the trend analysis it is found that private ownership industries are growing rapidly than the government ownership industry. Besides according to DOE category of industry, such as orange A, orange B and Red category industries are increasing day by day. That means more outputs produce more wastes which create more threat to environment.

Environmental impact assessment has been done by physical environment impact analysis, biological environment analysis & socio-economic environment. The physical environment analysis has been assessed through air, water, soil & noise quality analysis. From the air quality analysis it is found that in this study area $PM_{10}$ causes sever pollution and $NO_x$, $PM_{2.5}$ was also very harmful for the environment. Most of the community people agreed that air pollution impact on their heath seriously, it also decrease the recreational value of the area. From the Likert's model correlation coefficient value is **-0.282311527.** That's means impact of air pollution increase as the decrease of distance. From the water quality analysis it is found that turbidity, COD, TDS condition is very poor, that's means those are the main causes of water pollution on this area. On the other hand nitrate, total ammonia as N condition is in a good level. Most of the community people agreed that water pollution impact on their heath, surface water and vegetation seriously. From the Likert's model correlation coefficient value is **-0.38987.** That's means impact of water pollution increase rapidly as the decrease of distance. From the water quality analysis it's far observed that soil became barely alkaline; but there has been no toxicity with inside the soil. From the Likert's model correlation coefficient value is **- 0.1894.** That's means impact of soil pollution increase slowly as the decrease of distance. Community people agreed that soil pollution impact on surface water, sanitation and drainage. In the study area there are many industry close the school and residential area, which makes serious noise pollution for the surrounding people. From the Likert's model value of correlation is **-0.170461389,** which means the impact of noise pollution increase as the distance decrease at a lower rate. Noise pollution causes impact on amenity losses, loss of concentration, health related problem and tourism sector.

From the organic surroundings evaluation it's far located that, in step with the neighborhood groups, dirt debris normally gather over plant surfaces and as a result, the increase of the plant is suppressed main to a lower with inside the yield. Most of the humans agreed that bad effect on wildlife & its habitat and bad effect on flowers because of business improvement may be very high. The questionnaires concerning the commercial influences on social, monetary and cultural surroundings had been supplying to the neighborhood groups to decide their belief approximately the influences. Socio-monetary problems such as business activities, alternatives of livelihoods for the locals, employment possibility are growing hastily because of business improvement. On the alternative hand city populace growths, bad effect on socio-cultural activities, bad effect on tourism also is due to business improvement.

Industrial development significantly generates the wastes to the surrounding built environment in the

urban area. In this section, find out the existing environment management system of municipality and industry.

From the municipal survey and analysis it is found that municipal management system are establish through providing NOC and business trade license. It also minimizes the environmental impact through waste management by establishing waste collection bins at different location of industry. The main problem of the municipal management system is the NOC process of municipality only checks the land ownership, kharij parcha, mouza map, clearance from surrounding land owners etc. This process is primitive and lack of transparency. Besides the municipality cannot check the Site Plan, IEE & EIA report, ETP Layout & EMP, DoE type various important environmental issues. They have no communication with the department of environment. The main drawback of this management system are lack of public participation, lack of co-ordination between central level, lack of capacity development , lack of skill manpower in the municipality and the most important one authority is not regularly follow the master plan before provide NOC. The master plan has been added in appendix D. During the industrial survey it was found that only 13.15%out of 38 inspected industries were equipped with safe storage facilities for their generated solid and/or liquid wastes. It also observed that only 23.68% industrial authority provide necessary safety arrangement to their workers and 71% industrial units which have no have any kind of treatment facility. Besides most of the industry have no 3R system, have no suitable dumping and disposal site. Because of lack of such facility the industry of Noapara municipality dump the waste directly to the nearest river. Some main drawback of industrial authority are the lack of monitoring, lack of mechanical waste processing, have no ETP and EMP, poor condition of waste disposal system that's why the industrial units continuously hamper the green environment.

Two case studies were conducted during the field survey. One is Karim cement industry and another one is SAF leather industry. After the two red category industries case study it is found that Karim cement industry generate different types of air pollutant such as dust, NOx, SOx $CO_2$ and also causes noise in the manufacturing process. Existing waste management system of Karim cement industry is very poor. By-product solid waste is used for landfill and emitted gas is directly incinerated in the air. Besides, there has no waste treatment plant, laboratory, and resource recovery system. On the other hand SAF leather industry generate different types of water pollutant such as BOD, COD, SS, DS, TDS, organic N, sulfides, ammoniacal and also causes some extent air and soil pollution in the manufacturing process. Existing waste management system of SAF leather industry is not satisfactory. The authority of this industry directly discharges the wastewater to the nearest Bhairav River. Besides, there has no waste treatment plant, laboratory, and resource recovery system.

## 8 RECOMMENDATION

To improve environmental management practices in the Noapara municipal area, several recommendations have been proposed. The municipality should adhere to Schedule-1 of the Environmental Conservation Rule 1997, published by the Department of Environment, to classify industries based on location and environmental impact while issuing No Objection Certificates (NOCs). It should also require Initial Environmental Examination (IEE) reports alongside applications to better understand industry types and impacts. The municipality must enforce zoning regulations to prevent industrial developments in non-industrial zones, relocate non-compliant industries, and ensure strict adherence to the master plan through regular monitoring. Transparency in the NOC process is crucial, with public participation and community consultation integrated into the decision-making process. Strategic initiatives, such as budget allocations for capacity building and logistic support, are needed to strengthen municipal staff and organizational efficiency. Measures include field visits, training sessions, and seminars on environmental management. Additionally, improved infrastructure, such as constructing or cleaning drains to enhance wastewater discharge capacity and maintaining canals, should be prioritized. Increased availability of dustbins and regular waste management at disposal sites, combined with penalties for non-compliance, are

essential. Industrial units should quantify and manage their waste responsibly, implement small-scale treatment units, recycle waste, and invest in technologies that minimize waste production. Safety measures for workers, tree plantation, and training on waste management are also recommended. The Department of Environment (DOE) should collaborate with the municipality and industries to enhance waste management, increase technical capacity, monitor emissions, and develop an Industrial Pollution Projection System. Public awareness campaigns and updated databases on industrial waste are vital, alongside regular environmental impact assessments (EIAs). Inhabitants can raise awareness and pressure industries to adopt environmentally friendly practices through public demonstrations and community initiatives. Finally, the mass media should play a significant role in spreading awareness through radio, television, newspapers, and advertisements, highlighting the harmful effects of industrial pollution to foster collective action for a sustainable environment in Noapara.

## 9 CONCLUSION

For increasing national GDP growth and achieving the long term national strategic goal 'vision 2021' for transforming the country into middle income level, industrial development is the important issue in Bangladesh. The environment friendly industrial development in local area will make sure comprehensive and sustainable economic development across the country. Hence, environmental management practices in municipality level are very much important issues to conserve the built environment for comfortable and sound living of the urban citizens. Industrial waste management is a very vast and complex phenomenon involving a number of issues. Almost all the related issues and their present status in Noapara municipal area are discussed in the present study. Most of the industries of this study area are large and Red category. Besides distribution pattern of the existing industries are dispersed in character. So it causes significant impact on surrounding environment. From the environmental impact analysis it is found that existing industries negatively impact on built environment especially local community and environmental components such as air, water, soil etc. At the same time the role of Noapara municipality and individual industrial authority is not satisfactory level. They are not fully careful about the sustainable environment management system. Industrial waste management in Noapara municipal area, as per the recommendations of the present study, if practiced in future the industrial area inside the municipality, will not be a danger to the living environment surrounding areas and the findings of the research can be used for other industrial zones which are very close to the municipality. Though scope of this study had to be reduced for some inevitable constraints, nevertheless this study can help initiating further studies in this regard.

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