

Dissertation
On
OF
“Seasonal variation in air quality: A case study in
the Ward No-26 of Haldia Municipality”

M.Sc. Semester-IV Examination-2023



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SUBMITTED BY

SHUVANKAR GAYEN

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REG NO.- 1160620 of 2018-19

SUPERVISED BY

MR. PRANAY SANTRA

ASSISTANT PROFESSOR

DEPT.OF GEOGRAPHY

HALDIA GOVERNMENT COLLEGE

VIDYASAGAR UNIVERSITY



HALDIA GOVERNMENT COLLEGE

DEPARTMENT OF GEOGRAPHY (UG & PG)

Debhog, Purba Medinipur

CERTIFICATE

This is to certify that **MR. SHUVANKAR GAYEN**, Roll- **PG/VUEGG19/GEO-IVS No. - 005** has prepared a dissertation work on "*Seasonal variation air quality: A case study from Port Area of Haldia Municipality, Ward No-26, Purba Medinipur, West Bengal*" for M.Sc. Semester-IV, Examination in Geography, 2023 as a partial fulfilment of the curriculum of Vidyasagar University in Geography paper GEO496.2. It is further certified that this is his original work and no part of this work has been submitted elsewhere before for the awardment of any degree.



Signature 17.8.2023

Signature of the Supervisor
Assistant Professor
Dept. of Geography
Haldia Government College

Assistant Professor, WBES
Department of Geography
Haldia Government College

CHAPTER-1

Introduction

1.0 Introduction:

Air is a fundamental element crucial for sustaining life. Optimal air quality positively impacts our health and overall well-being. Nonetheless, diverse sources, particularly those originating from human activities, pose a substantial peril to the quality of air. To assess the state of the air, the Air Quality Index (AQI), a numerical gauge, is utilized. This index provides daily updates on air quality's effects on human health and the environment. Its results are instrumental in conveying estimated levels of air pollution to the public. Elevated AQI values indicate escalated air pollution, which in turn endangers human health significantly. Most significantly, AQI offers insights into the cleanliness or contamination of the air in our surroundings, in addition to the potential health risks it might entail. This index is primarily focused on the health repercussions that could manifest within hours or days of exposure to polluted air. It hinges upon the measurement of major air pollutants, encompassing particulate matter, ground-level ozone, sulphur dioxide (SO₂), nitrogen dioxide (NO₂), and carbon monoxide (CO). Among these pollutants, particulate matter and ozone present the most substantial threats to both human health and the environment.

Distinct countries establish their own unique air quality indices that correlate with nationally defined air quality standards, designed to safeguard public health. On an hourly basis, the concentration of each air pollutant is gauged and transformed into a numerical value within a standardized index or scale. These individual values for pollutants are denoted as sub-indices. The highest sub-index for a given hour is then designated as the AQI for that particular hour. Essentially, the AQI functions as a measuring tool that spans a range from zero to five hundred (0-500).

Haldia, located in the Purba Medinipur district of West Bengal, India, is an industrial port city. Positioned approximately 124 km (77 mi) southwest of Kolkata, near the mouth of the Hooghly River – one of the Ganges' distributaries – Haldia boasts a significant river port and an industrial complex. It is home to numerous petrochemical enterprises and is being developed as a pivotal trade port for Kolkata. Unfortunately, due to its industrial nature, Haldia faces substantial air pollution challenges.

1.2 Objectives:

The core objectives of the field study revolve around unveiling concealed truths. These objectives encompass various dimensions:

1. The study aims to analyse the physical characteristics of the study area.
2. The study seeks to investigate the dynamics of land use and land cover within the study area (Ward No-26) during the period 2000-2020.
3. Aiming to elucidate the demographic attributes that define the study area.
4. The study aims to analyse the seasonal variation of air quality.
5. Analysing trends related to different air pollutants.
6. The study also scrutinizes the interplay between pollution and health within the study area.

1.3 Importance of the Study:

Studying air quality in Haldia Municipality Ward No. 26 is of paramount importance due to its far-reaching implications for public health, the environment, and sustainable development. Firstly, understanding the air quality in this specific area helps safeguard the health of its residents. Poor air quality, characterized by elevated levels of pollutants like particulate matter, ozone, and nitrogen dioxide, can lead to a range of respiratory and cardiovascular ailments, exacerbating conditions such as asthma and increasing the risk of lung diseases. Vulnerable populations, such as children and the elderly, are especially at risk. Secondly, addressing air quality issues contributes to environmental conservation. High levels of air pollutants can lead to smog formation, acid rain, and degradation of ecosystems. Monitoring air quality aids in assessing the impact of pollutants on local flora and fauna, soil quality, and water bodies.

In terms of sustainable development, a focus on air quality aligns with global and local environmental goals. Monitoring air quality trends in Haldia Municipality Ward No. 26 contributes to data-driven policy decisions aimed at reducing emissions, promoting renewable energy sources, improving urban planning, and enhancing public transportation. In conclusion, studying air quality in Haldia Municipality Ward No. 26 is essential for safeguarding public health, protecting the environment, supporting economic growth, and promoting sustainable development. It forms the foundation for evidence-based policies and initiatives that collectively lead to a cleaner, healthier, and more resilient community.

1.3 About the study area:

Haldia, situated in the Purba Medinipur district of the Indian state of West Bengal, is an industrial port city. It boasts a significant river port and an industrial belt, strategically positioned approximately 124 km (77 mi) southwest of Kolkata, near the mouth of the Hooghly River – one of the distributaries of the Ganges. The Haldia Township finds itself bounded by the Haldi River, an offshoot of the Ganges River. The study area's latitudinal range spans from 22°02' N to 22°03'30" N, while its longitudinal extension extends from 88°04'30" E to 88°06' E.

According to the 2011 Indian census, in ward number 26 of Haldia city, the total population stands at 7,861 individuals. Among them, 4,073 are males and 3,788 are females. The male population constitutes 52% of the total, while females make up 48%. The literacy rate in the study area (ward number 26) is notably high at 87.9%, surpassing the average literacy rate of 85.12% for Haldia municipality. Within ward number 26, the literacy rates for males and females are 89.54% and 86.14% respectively. Furthermore, 11.16% of the population falls under the age of 6 years.

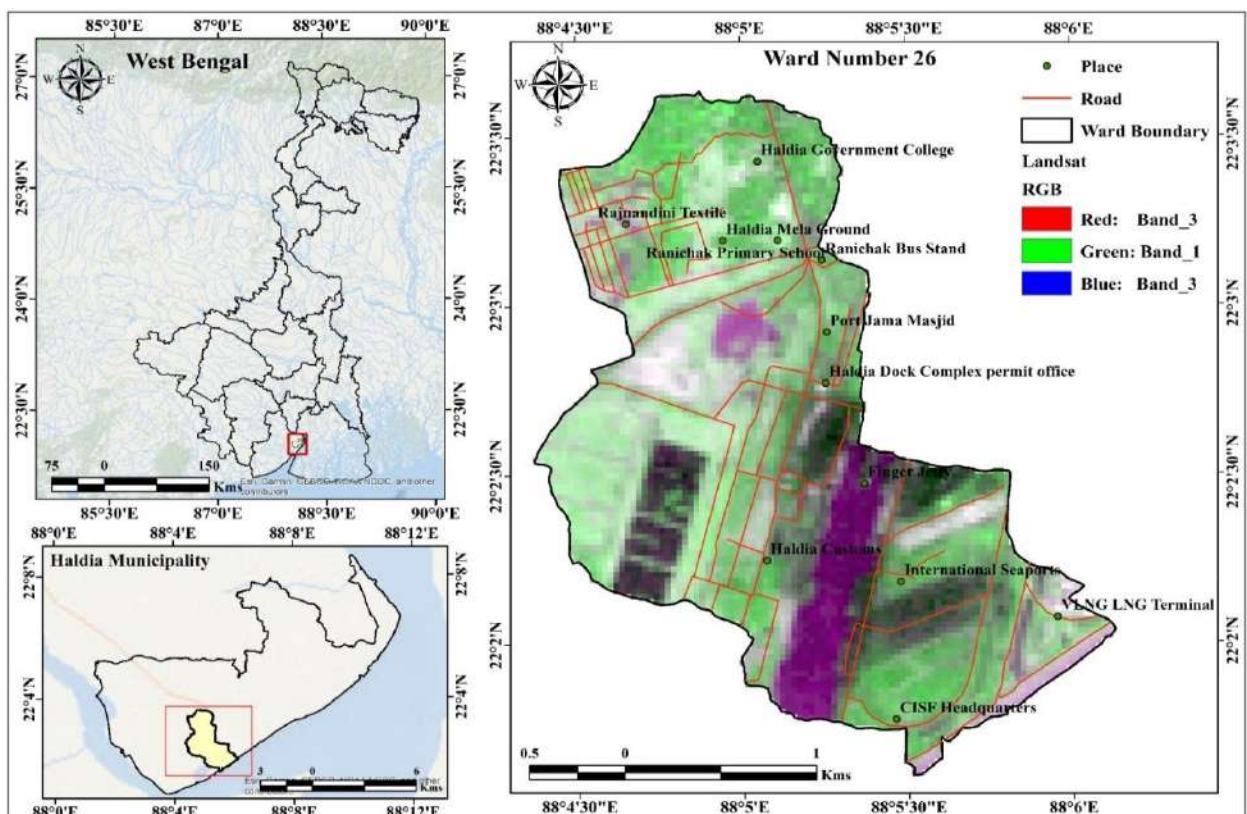


Fig No: 1.0 Location Map

1.3.2 Vegetation cover:

In this survey, the focus is on ward number 26 of Haldia, situated in the southwestern region of the city. The study area's latitudinal span ranges from 22°2' N to 22°3'30" N, while its longitudinal extent reaches from 88°4'30" E to 88°6' E. The purpose of this investigation is to uncover the spatial and temporal alterations in vegetation within ward number 26 of Haldia. The study makes use of two maps, one from the year 2000 and another from 2020.

Upon examining the 2000 map, it is apparent that vegetation covers 77.26% of the total area. However, the 2020 map paints a different picture, indicating a decline in vegetation cover due to the expansion of industries. Specifically, the vegetation cover area in the 2020 map is measured at 56.4%, marking a reduction of 21.22% compared to the previous year. This decrease in vegetation cover is attributed to the increased industrialization in the area.

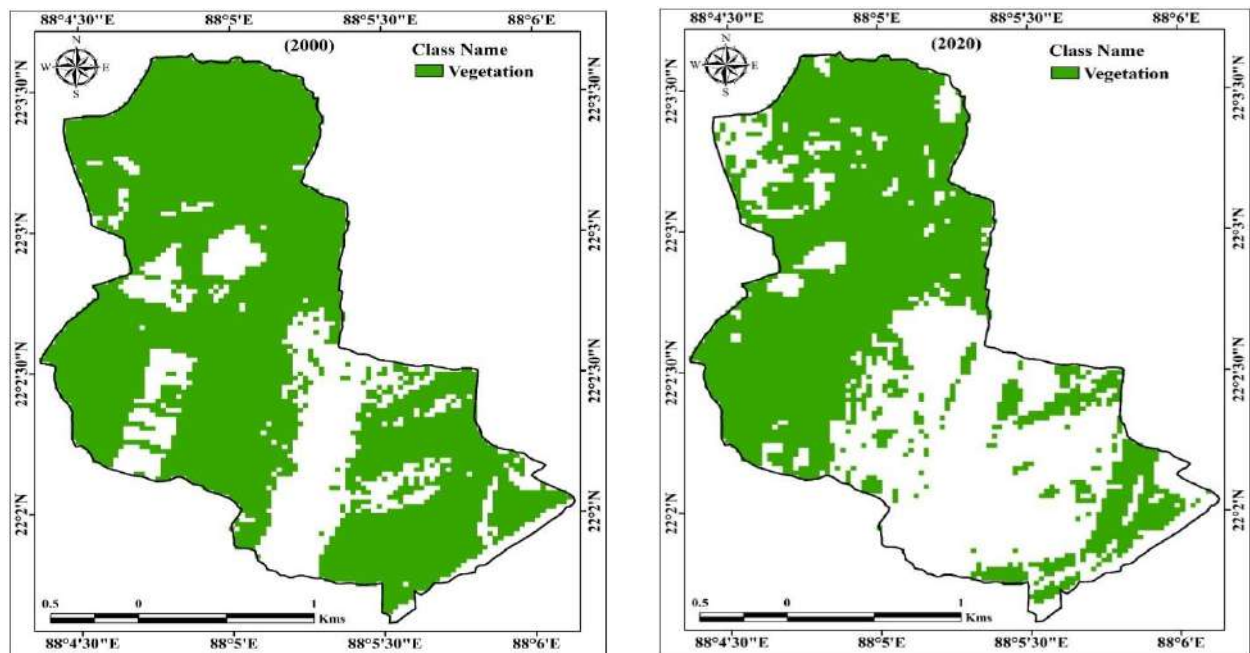


Fig No: 1.1 Vegetation Cover (2000 &2020)

1.3.3 Land-Use and Land Cover Change:

The following table illustrates the changes in land use and land cover within Haldia Municipality's ward number 26 between the years 2000 and 2020. In 2000, the distribution was as follows: natural vegetation accounted for 77.26%, water bodies comprised 14.99%, industrial areas occupied 5.15%, settlement areas encompassed 0.79%, and vacant spaces represented 1.81%. Conversely, by 2020, the industrial area had expanded to 24.36%, while vegetation cover had dwindled to just 56.4% of the total area. The decline in vegetation cover amounted to 21.22%, attributed to industrialization and the increased expansion of settlement areas. Vacant spaces now occupy a mere 0.36% of the total area.

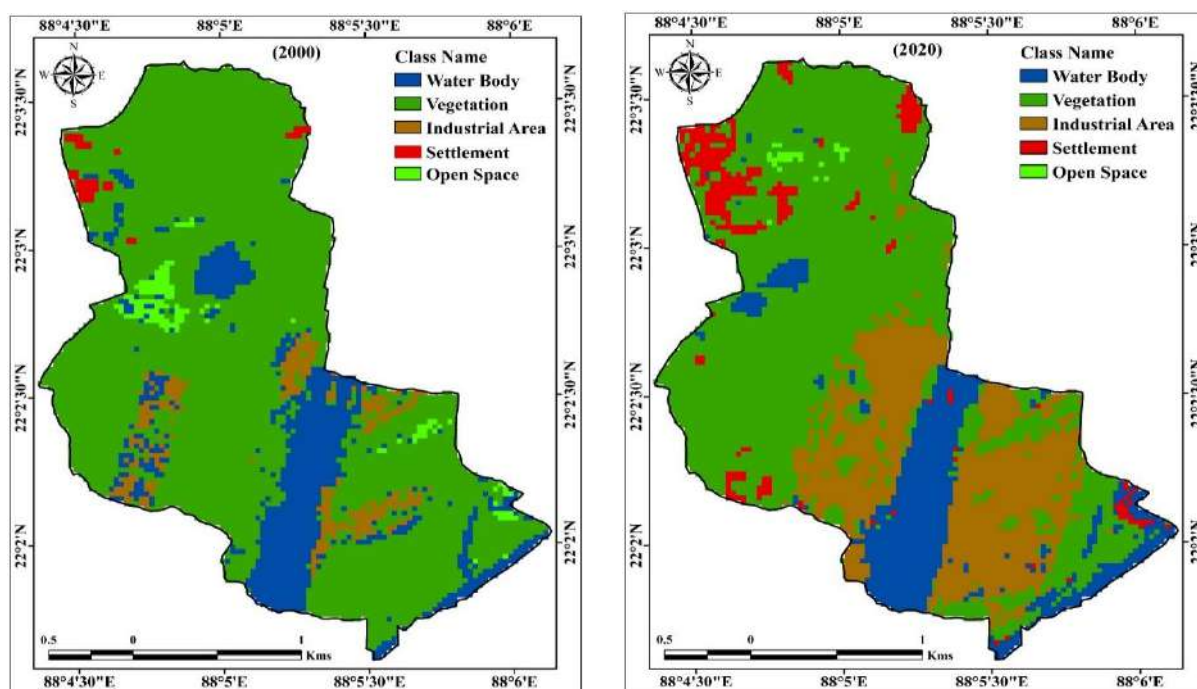


Fig No:1.2 LULC (2000 &2020)

Table No: 2.2 Land-Use and Land Cover			
Land-use types	Area in %		Change in %
	2000	2020	
Natural vegetation	77.26	56.4	-21.22
Water body	14.99	13.86	-1.13
Industrial area	5.15	24.36	+19.21
Settlement	0.79	5.01	+ 4.22
Vacant space	1.81	0.36	- 1.45
Source: Landsat-4&5, TM C2L2			

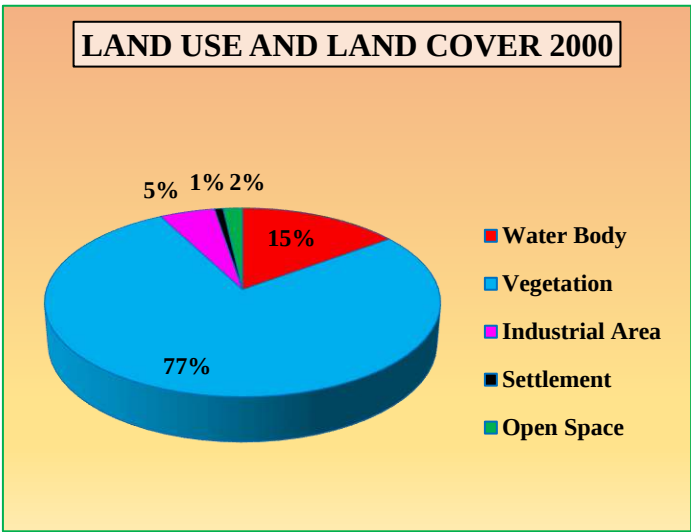
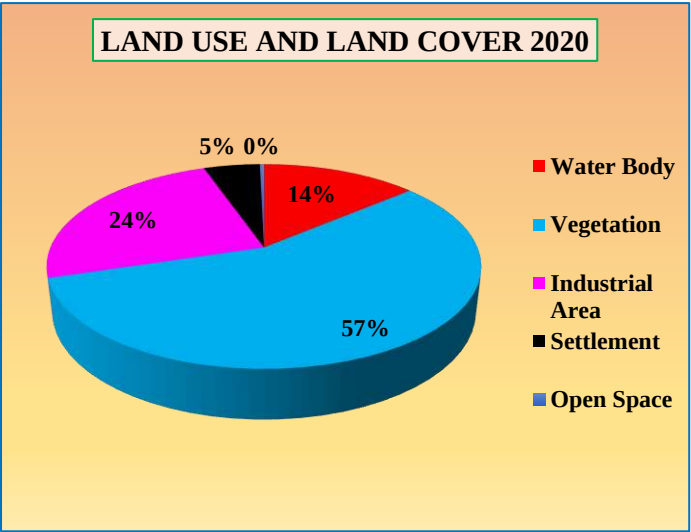
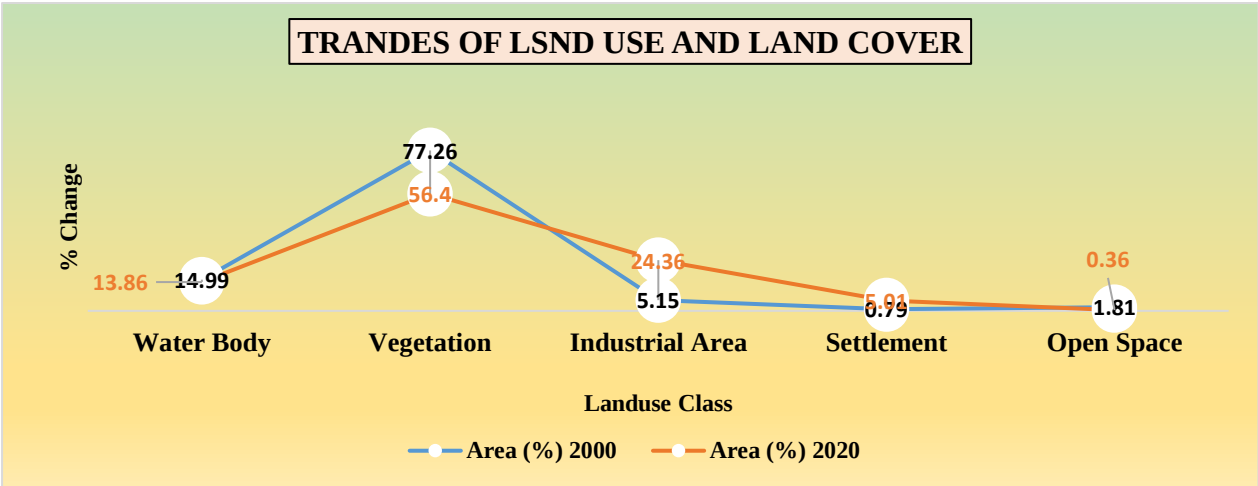


Fig No: 1.3 LULC (2000 & 2020)



1.3.4 Industrial land use:

This survey focuses on ward number 26 of Haldia, situated in the southwestern part of the city. Its latitudinal extension ranges from 22°2' N to 22°3'30" N, while its longitudinal extension spans from 88°4'30" E to 88°6' E. The study aims to uncover spatial and temporal changes in industrial land use within ward number 26 of Haldia. Two maps are examined in this study, one from the year 2000 and another from 2020. According to the 2000 map, industrial land use covers an area of 5.15% of the total area. In contrast, the 2020 map shows a significant increase in industrial land use, covering 24.36% of the total area. This represents a substantial growth in industrial land use cover, amounting to an increase of 19.21% as depicted by the 2020 maps.

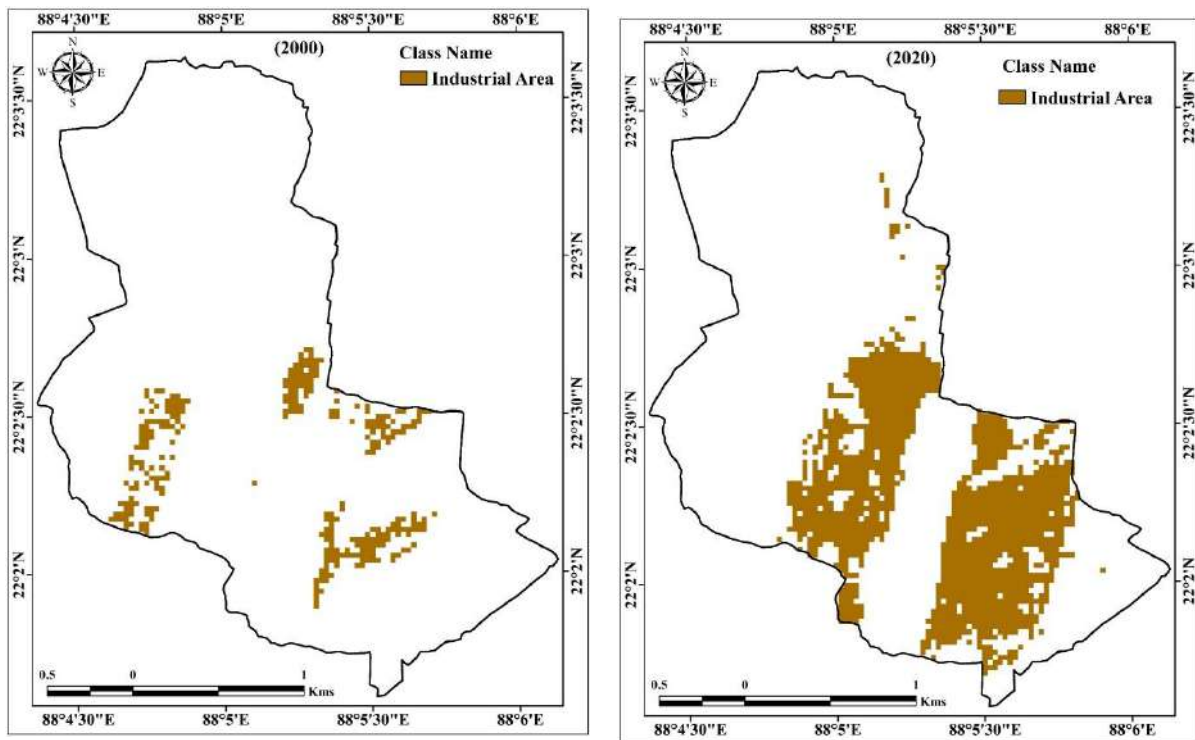


Fig No:1.4 Industrial Landuse (2000 & 2020)

1.3.5 Settlement map:

This survey focuses on ward number 26 of Haldia, situated in the southwestern part of the city. Its latitudinal extension ranges from 22°2' N to 22°3'30" N, while its longitudinal extension spans from 88°4'30" E to 88°6' E. The study aims to reveal spatial and temporal changes in the settlement area within ward number 26 of Haldia. Two maps are analyzed in this study, one from the year 2000 and another from 2020. According to the 2000 map, the settlement area covered 0.79% of the total area. In contrast, the 2020 map demonstrates a significant increase in the settlement area, encompassing 5.01% of the total area. This indicates a notable growth in the settlement area, amounting to an increase of 4.22% as depicted by the 2020 maps.

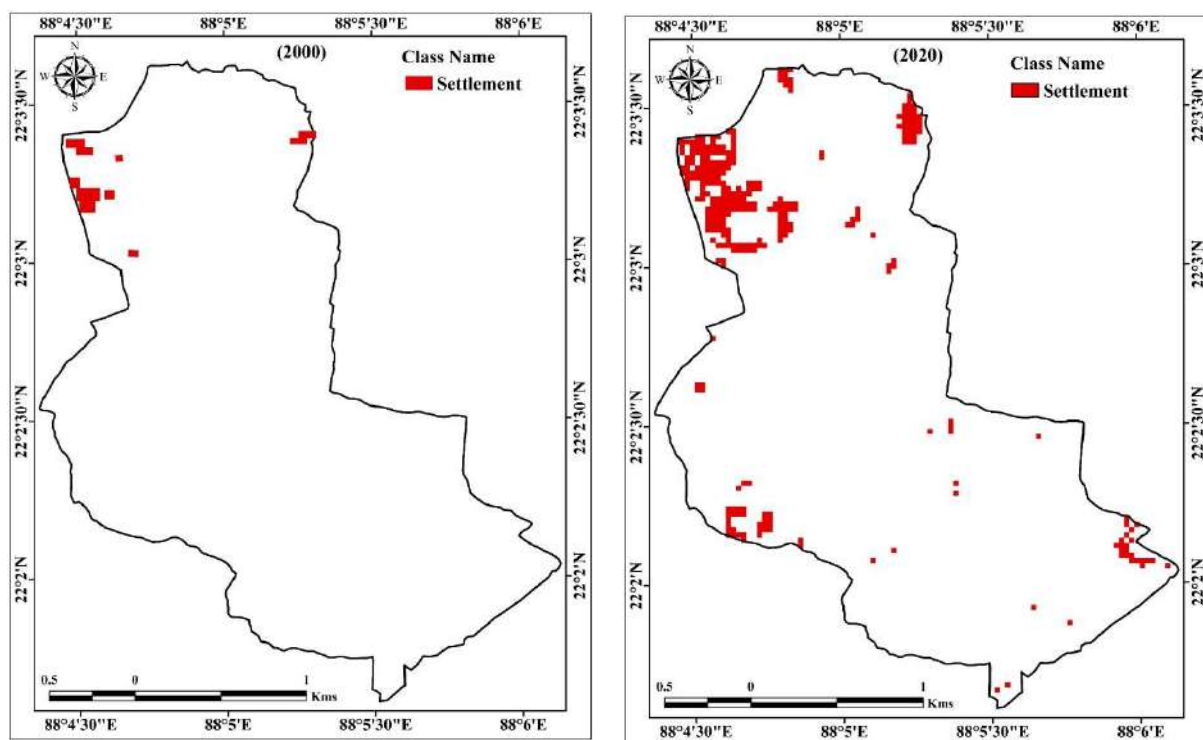


Fig No:1.5 Settlement Map (2000 & 2020)

1.3.6 Water bodies:

This survey focuses on ward number 26 of Haldia, located in the southwestern part of the city. Its latitudinal extension ranges from 22°2' N to 22°3'30" N, while its longitudinal extension spans from 88°4'30" E to 88°6' E. The study aims to uncover spatial and temporal changes in the water bodies within ward number 26 of Haldia. Two maps are analyzed in this study, one from the year 2000 and another from 2020. According to the 2000 map, the water body area covered 14.99% of the total area. In contrast, the 2020 map demonstrates a decrease in the water body area, comprising 13.86% of the total area. This indicates a reduction in the water body area, amounting to a decrease of 1.16% as shown in the 2020 maps.

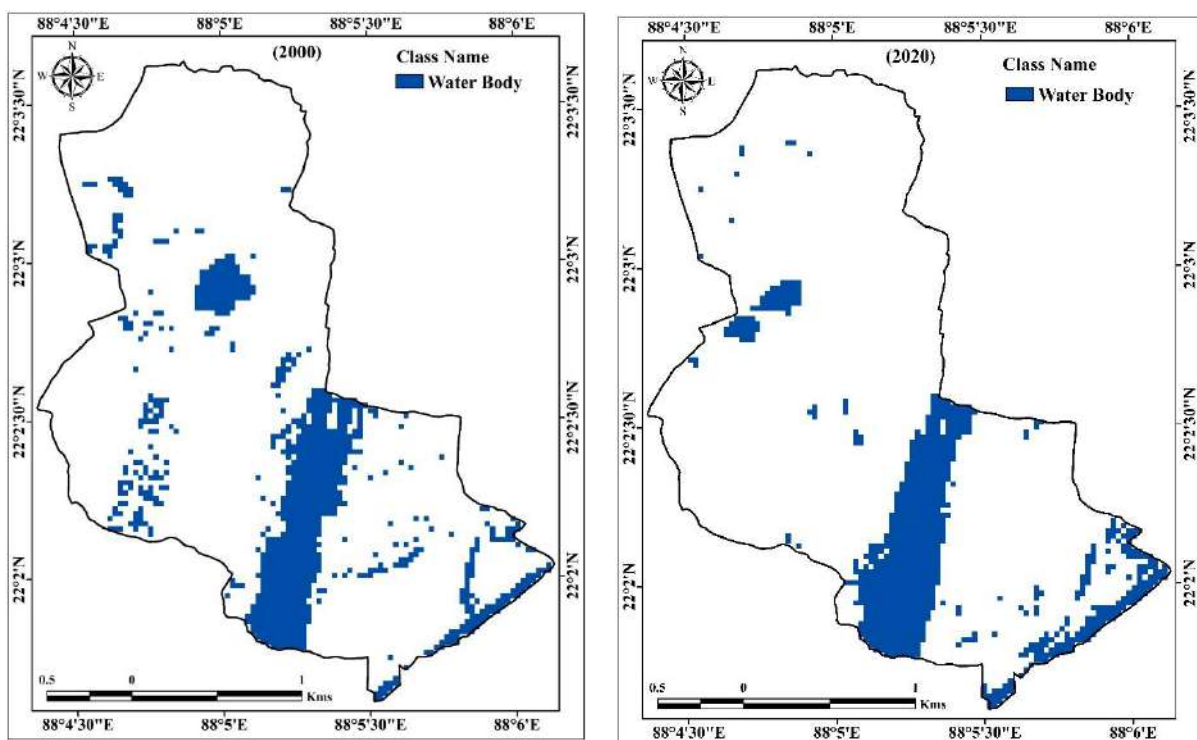


Fig No:1.6 Waterbody Map (2000 & 2020)

CHAPTER-2

Literature Review

- **Perli, B. (April, 2018)**, in his research paper "Ambient Air Quality Assessment in Major Petrochemical Industrial hubs in India" accesses how the petrochemical industry and its emission of gases effect the AQI and human health in Haldia (W.B), Manali (Tamilnadu), Navi Mumbai (Maharashtra), Mangalore (Tamilnadu), Ankleshwar(Gujrat). This research work was published in ISOR Journal of Engineering (ISORJEN) at 7th April, 2018. He used different methods for different air pollutants like, Gravimetric Method for PM10; Modified West and Gaeke Method for SO₂; Modified Jacob & Hocchisser Method for NO₂. He has been shown the annual maximum & minimum variation of three pollutants and their trends in 2014, 2015 & 2016. From his research paper he has find out the PM10 value is decreasing and NO₂ and SO₂ value is increasing in the respective years. But the AQI Value is decreased more than 50 from 2014 to 2016.
- **Dutta, D. & Gupta, S. (2021)** in their research paper "Rising Trend of Air Pollution and Its Decadal Consequences on Meteorology and Thermal Comfort over Gangetic West Bengal, India" has shown the air pollution status is continuously increasing in the lower catchment area at an alarming rate. This research work is published in Spatial Modelling and Assessment of Environmental Contaminants, Environmental Challenges and Solutions, by Springer Nature Switzerland AG 2021. Outcomes of this research work indicate an increase of 0.8 °C to 1.2 °C air temperature with 1.5 to 1.8 W/m² increase of sensible heat flux due to rising air pollution in the lower Gangetic plain of West Bengal. Vertical pressure–temperature profile as well as the boundary layer temperature and surface humidity are to found to be affected by certain high pollution period over this year.
- **Roy, D., Chakraborty, S., Bhowmik, K., Mandal, S., Ghosh, P., Bhattacharya, A., Chowdhury, S., Bhattacharya, R. (2019)** in their research paper "Air Pollution Status: A Case Study in West Bengal" compared the AQI of Haldia with Kolkata. The research work was published in Journal of Multidisciplinary Research (JISUJMR), which is under JIS University in 2019. They are used National Air Quality Index and its indices for their research purposes and analysed the air quality of Kolkata as a case study and compared its status in comparison with an industrial belt of Haldia in West Bengal. The outcomes of their research work are Kolkata is more polluted than Haldia with respect to NO₂ and PM_{2.5} pollutants.

- **Samal, A. C., & Santra, S. C. (2002)** in their research paper “Air quality of Kalyani Township (Nadia, West Bengal) and its impact on surrounding vegetation” has shown that how environmental pollution and its impact on plants have well recognized during past few decades. In their research the plant samples were collected simultaneously from the sampling areas and the air samples were collected by help of high volume sampler (HVS) for 24-hours. In their research it is observed from the present study that the ambient air quality of Kalyani Township is fairly polluted. The increase of stomatal frequency and decrease of stomatal size of leaves have the common phenomenon in polluted environment. The leaf thickness of all the studied plants are higher in polluted areas than the non-polluted areas.

- **Maisonet, M., Correa, A., Misra, D., & Jaakkola, J. J. (2004)** In their research paper “A review of the literature on the effects of ambient air pollution on fetal growth” has shown the effect of air pollution on low birth weight (LBW) and its determinates, preterm delivery (PTD) and intrauterine growth (IUGR), was conducted. Twelve epidemiologic investigation that addressed the impact of air pollution on four pregnancy outcomes were identified. In their research paper as shown the effect of air pollution were apparent on PTD and IUGR, but not on LBW. Most of the associations reported were rather small. Current scientific knowledge on the impact of air pollution on fetal growth is still limited.

- **Rajak, Rahul, and Aparjita Chattopadhyay (2019)** in their research paper “short and long –term exposure to ambient air pollution and impact on health in India: a systematic review” shows how health effects attributable to short-term and long-term ambient air pollution (AAP) exposure in Indian population are less understood. This study evaluates the effect of short-term and long-term exposure to AAP on respiratory morbidity, mortality and premature mortality for the exposed population. Short-term exposures to ambient pollutants have strong associations between COPD, respiratory illnesses and higher rates of hospital admission or visit. The long-term effects of AAP, associated with deficit lung function, asthma, heart attack, cardiovascular mortality and premature mortality have received much attention. Particulate matter (PM2.5 and PM10) IS primarily responsible for respiratory health problems.

- **Sierra-Vargas, M. P., & Teran, L. M. (2012)** in their research paper “Air pollution: Impact and prevention” has shown that Air pollution is becoming a major health problem that affects millions of people worldwide. In support of this observation, the world health organization estimates that every year, 2.4 million people die because of the effects of air pollution on health. This review (i) discuss the impact of air pollution on respiratory disease, (ii) provides evidence that reducing air pollution may have a positive impact on the prevention of disease, and (iii) demonstrates the impact concerted policies may have on population health when governments take actions to reduce air pollution.

- **Gurjar, B. R., Ravindra, k., & Nagpure, A. S. (2016)** in their research paper “Air pollution trends over Indian megacities and their local to global implications” has shown that more than half of the world’s population lives in urban areas. It estimated that by 2030 there will be 41 megacities and India has Delhi, Mumbai, and Kolkata. Increasing population and prosperity results in rapid growth of the large consumption of energy and other resource, which contributes to air pollution among other problems. Megacity pollution outflow plumes contain high levels of criteria pollutants (e.g. particulate matter, SO₂, NO₂), greenhouse gases ozone precursors and aerosols which are the causes of air pollution. India megacity has more air pollution rather than other areas.

CHAPTER –3

Data Sources and Methodology

3.1 Sources of Data

In any study, the database stands as a pivotal tool, holding immense significance. To construct a comprehensive database, the utilization of primary and secondary data sources becomes essential. The study relies on a blend of primary and secondary data, drawn from various sources

3.1.1 Secondary Data Source:

- ❖ To understand the chronological development of the study area literature review have been done from different books, articles, research papers and web pages.
- ❖ Physical background of the study area has been studied from different articles and web pages.

To understand the demographic background of the study area secondary data have been collected from Primary Census Abstract, 2011 and District Census Handbook, 2011.

Table No: 3.1 Data Sources			
SL NO	DATA	YEAR	SOURCES
1	HMB Boundary	2022	Haldia Municipal Board
2	Ward Boundary	2023	Haldia Municipal Board
3	Land Use Land Cover	2000&2020	Landsat-4&5, TM C2L2 Spatial resolution 28.5 m.
4	Industrial Landuse Change	2000&2020	Landsat-4&5, TM C2L2 Spatial resolution 28.5 m.
5	Vegetation Cover	2000&2020	Landsat-4&5, TM C2L2 Spatial resolution 28.5 m.
6	Settlement	2000&2020	Landsat-4&5, TM C2L2 Spatial resolution 28.5 m.

3.1.2 Primary Data Source:

- ❖ Intensive door to door survey has been carried out covering total 50 household at ward no. 26 of Haldia municipality, Purba Medinipur.

3.2 Methodology:

Objective-wise methodology of field report are-

1. Assess the physical back ground of the study area.

The methods of data collection are

- a. Georeferencing
- b. Digitization
- c. Digital Elevation Model
- d. Contour Mapping

2. The study aims to clarify the demographic characteristics of the study area.

The methods of data collection are

- a. Primary data collection through questionnaire.
- b. Secondary data collection from census handbook.
- c. Cartographic and statistical methods.

3. Understand the different phases and chronological development of study area.

The methods of data collection are

- a. Secondary data collection from different Website, Book, Journal And Articles.

4. The study seeks to examine the basic urban amenities available in the study area.

The methods of data collection are

- a. Primary data collection through questionnaire.
- b. Secondary data collection from different website, book, journal and articles.
- c. Cartographic and statistical methods for data analysis.

5. Determine the relationship between economic conditions and socioeconomic status.

The methods of data collection are

- a. Primary data collection through questionnaire.
- b. Secondary data collection from different website, book, journal and articles.
- c. Cartographic and statistical methods for data analysis.
- d. Modified Kupuswamy scale of socio-economic status.

❖ House-Hold Survey

We collect primary data through intensive door to door household survey with the help of structured questionnaire.

To fulfill the objectives of the study, data on socio-economic factors (level of education, Occupation, income, expenditure pattern of the family, building types and household assets etc.) were collected from 26 no. ward of Haldia municipality in Purba Medinipur.

❖ Cartographic and Statistical analysis

- ✚ We have compiled all the primary and secondary data and tabulate the data to prepare master table. After that analyzed data for preparation of diagrams and subsequent analysis.
- ✚ Statistical analysis has been done. We have drawn some cartograms by suitable cartographic techniques.
- ✚ Map of Study area has been done by Arc- GIS 10.3 software.
- ✚ Land use Land cover map has been done from Google Earth Image.

❖ Waste generation:

Amount of waste generated from a house mainly depend on the number of people in that house. Considering 0.3 kg/capita/day as a standard, waste generation from each ward have been calculated based on the population data derived from census 2011 and primary survey. The following relationship was created.

$$\text{Amount of waste generated (at Ward)} = 0.3 * \text{population of}$$

(Source: West Bengal State Pollution Control Board)

❖ Sex ratio

The **sex ratio** is the ratio of females to males in a population. Sex ratio has been carried out by using this formula

$$\text{Sex Ratio} = \frac{\text{Female Population}}{\text{Male Population}} \times 1000$$

❖ Literacy rate

Literacy rate is defined by the percentage of the population of a given age group that can read and write. Literacy rate has been calculated by following formula

$$\text{Literacy rate} = \frac{\text{No.of Literate Population}}{\text{Total Population}} \times 100$$

❖ Decadal growth rate

To find out the percentage of total population growth in a decade (2001-2011) of the study area Decadal growth rate has been calculate. Using the following formula

$$DGR = \left(\frac{P_n - P_o}{P_o} \right) * 100$$

DGR = Decadal Growth Rate in %
P_n = Population now
P_o = Population originally
P_n and P_o are ten years apart

❖ Dependency Ratio:

The dependency ratio is a measure of the number of dependents aged zero to 14 and over the age of 65, compared with the total population aged 15 to 64. This demographic indicator gives insight into the number of people of non-working age, compared with the number of those of working age. The dependency ratio has been calculated using the following formula.

$$\text{Dependency Ratio} = \frac{[(\text{Total Number of Children under age 14}) + (\text{Total Number of Senior Citizens above age 65})]}{\text{Total Number of People from the age group of 15 to 65}} * 100$$

❖ Software use

ArcGIS: It is a geographic information system (GIS) for working with maps and geographic information. It is used for creating and using maps, compiling geographic data, analysing mapped information, sharing and discovering geographic information, using maps and geographic information in a range of applications, and managing geographic information in a database.

❖ Ms-Excel:

We have compiled all the primary and secondary data and tabulate the data to prepare master table with Ms-Excel. For the interpretation of data and subsequent analysis we have prepared different diagrams with the help of Ms-Excel software.

❖ **Modified Kupuswamy Scale 2021**

The modified Kupuswamy scale is commonly used to measure SES in urban and rural areas. This scale was formulated by Kupuswamy in 1976 and has a composite score that includes household income per month along with education and occupation of the household head, giving a score of 3–29. The socio-economic status of the study area is calculated on the basis Of Kupuswamy Scale 2021

Table No:3.3 Modified Kupuswamy scale 2021					
Education of head		Occupation of head of Family		Monthly Family Income	
Level of Education	Score	Occupations	Score	Income Ranges (Rs.)	Score
Profession	7	Legislators	10	>123,322	12
Graduate	6	Professionals	9	61633-123321	10
Intermediate or diploma	5	Technicians	8	46129-61622	6
HS Certificate	4	Clerks	7	30831-46128	4
Middle school certificate	3	Skilled workers	6	18497-30830	3
Primary school certificate	2	Agricultural worker	5	6175-18469	2
Illiterate	1	Trade worker	4	<6174	1
		Mechanics	3		
		Elementary occupation	2		
		Unemployed	1		

Source: <https://www.ijfcm.org/>



Plate No:1 Household Survey

CHAPTER-4

Demographic Background

4.0 Demographic Profile

Demography is the statistical study of populations, especially humans. It examines and measures the aspects and dynamics of populations; it can cover entire societies or groups defined by criteria such as education, nationality, religion, and ethnicity. Educational institutions usually treat demography as a field of sociology, though there are a number of independent demography departments. These methods have primarily been developed to study human populations, but are extended to a variety of areas where researchers want to know how populations of social actors can change across time through processes of birth, death, and migration. In the context of human biological populations, demographic analysis uses administrative records to develop an independent estimate of the population.

4.1 Population:

As per census 2011 the total population of 26 no ward of Haldia Municipality was 7861. According to Census 2011 in 26 no ward of Haldia Municipality the male population was 4073 and female population was 3788 and the total child population was 644.

Table No: 4.1 Population	
Population	Number
Total population	7861
Male population	4073
Female population	3788
Child population	644
Source: Census of India, 2011	

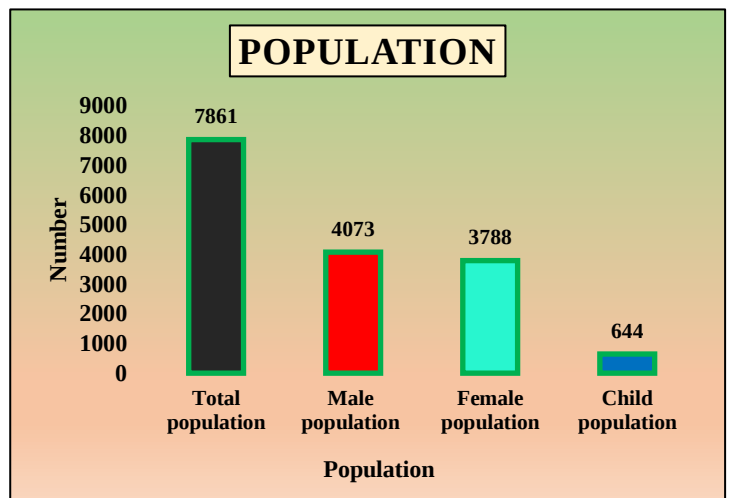


Fig No:4.1 Population Composition

4.2 Gender composition:

Sex Composition of the human population is one of the basic demographic characteristics; as changes in sex composition largely reflect the underlying **socio-economic and cultural** patterns of society in different ways. According to the census year 2011, in the study area (ward no-26) has a total population of 7861 with 3788 females per 4073 male and with a sex ratio 930 per thousand males.

Table No: 4.2 Gender Composition	
Population	Number
Total population	7861
Male population	4073
Male (%)	52
Female population	3788
Female (%)	48
Gender ratio	930
Source: Census data 2011	

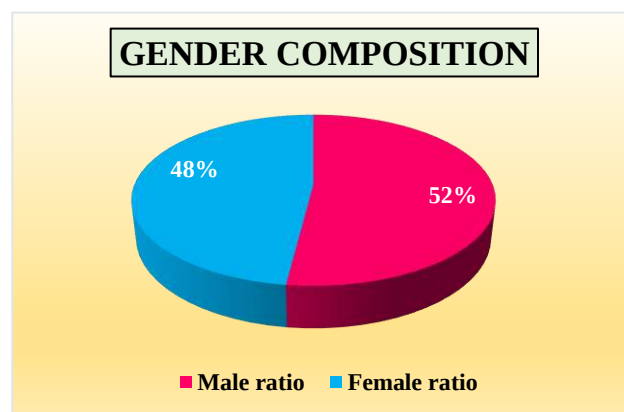


Fig No: 4.2 Gender Composition

4.3 Child sex ratio:

In India, the **child sex ratio** is defined as the number of females per thousand males in the age group 0–6 years in a human population. According to the census year 2011, in the study areas total child population is 644 and including male child population is 343 and female population is 301. So, the child sex ratio is 877.

Table No: 4.3 Child Population				
Child Population	Total child population	Male	Female	Child sex ratio
No Of Child Population	644	343	301	877
Source: Census data 2011				

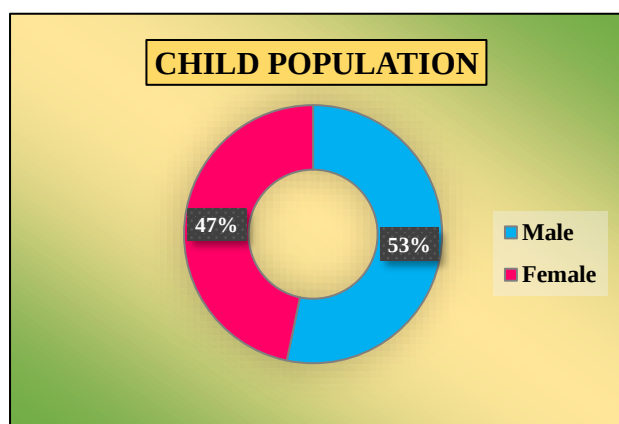


Fig No: 4.3 Child population

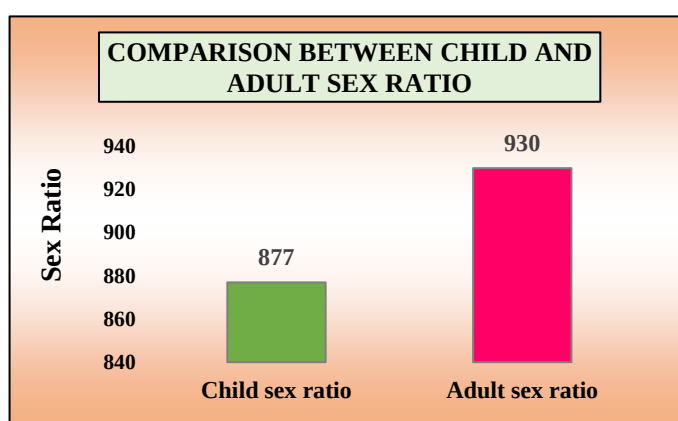


Fig No:4.4 Comparison Between Child and Adult Sex Ratio

4.4 Age Composition:

In population studies, age distribution (also known as age composition) refers to the proportionate numbers of people in various age groups in a population. It is common in demography to split the population into three broad age groups: children and young adolescents (under 15 years old) the working-age population (15-59 years) and the elderly population (60 years and older). The household survey data on age, reveals that 76.05% of the population in the area is in the range of 15-59 years. 15.02% of the population in the area is in the range of 0-14 years. Least amount of population (8.92%) belongs to old groups i.e., above 59 years.

Table No:4.4 Age-sex Composition				
Age Groups(years)	Male		Female	
	Number	%	Number	%
0-14	18	15.38%	14	14.58%
15-59	90	76.92%	72	75%
>60	9	7.69%	10	10.42%

Source: Field survey 2023

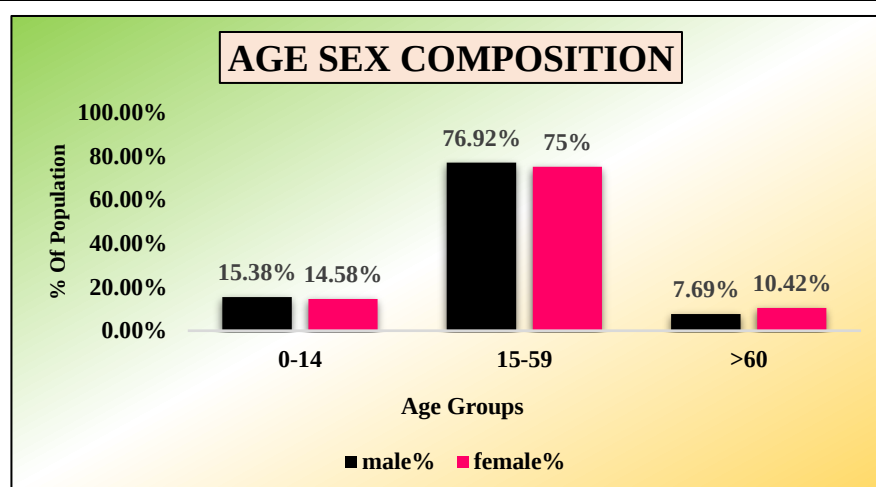


Fig No:4.5 Age Sex Composition

4.5 Dependency Ratio:

The dependency ratio is a measure of the number of dependents aged zero to 14 and over the age of 65, compared with the total population aged 15 to 64. This demographic indicator gives insight into the number of people of non-working age, compared with the number of those of working age. In the study area, the population are not evenly distributed according to their age group. The maximum population concentrated middle age group or working age group, i.e., 15-59 years, which is about 76.06%. The dependent population is about 23.94%, which is further classified into two groups i.e., young age group (15.02%) and older age group (8.92%). So, the dependency ratio of the study area is about 31%. That means 31 non-working population depend on 100 working population.

Table No: 4.3 Dependency Ratio				
Age Groups (Years)	No of Population	Dependent Population	Independent Population	Dependency Ratio (%)
0-14	32	51	162	31.48%
15-59	162			
>59	19			
Source: Field survey 2023				

4.6 Median age:

Median age is the index that divides the entire population numerically into two equal age groups, one younger than age and other older than that age. It is only indicator associated with the age distribution of the population. In this study area a median age of the population are 32 years, which indicates a change in the age distribution of the population, not necessarily a decline in the number of children.

CHAPTER – 5

Socio-economic status

5.0 Socio-economic profile:

Socioeconomic status (SES) is a composite measure that combines economic and sociological factors to gauge an individual's work experience, economic resource access, and social standing in relation to others. When assessing a family's SES, factors such as household income, education level, and occupational pattern are analyzed. For individual SES evaluation, only their personal attributes are considered. SES is divided into three categories—high, middle, and low—to delineate where a family or individual falls. Assigning families or individuals to these categories involves assessing any or all of the three variables (income, education, and occupation).

In higher socioeconomic families, education is typically emphasized as significantly more important, both within the household and the local community. In economically disadvantaged regions, where securing food, shelter, and safety takes precedence, education often takes a back seat.

Furthermore, low income and education have been proven to be robust predictors of various physical and mental health issues, including respiratory infections, arthritis, coronary diseases, and schizophrenia. These health problems might stem from adverse environmental conditions in the workplace. In cases involving disabilities or mental illnesses, these issues can often serve as the primary contributors to the individual's social challenges.

5.1 Literacy Status:

According to the 2011 Census, individuals aged seven and above who possess the ability to read and write are classified as literate. The literacy rate in the study area (ward no. 26) is 87.9%, which surpasses the Haldia municipality's average of 85.12%. The literacy rates for males and females in ward no. 26 are 89.54% and 86.14%, respectively. The total number of literate individuals in the study area was 6909, with 3647 being males and the remaining 3262 being females. The study area exhibits a literacy gender gap of 3.4 percentage points.

Table No: 5.1 Literacy Status			
Gender	Literate persons	Literacy rate (%)	Literacy gap(gender gap)
Male	3647	89.54%	3.4%
Female	3262	86.14%	
Source: Census of India 2011			

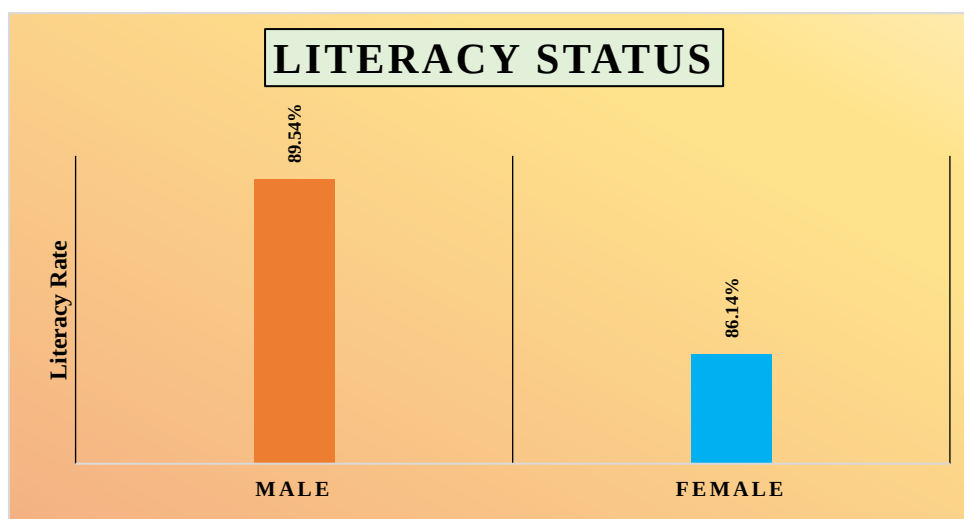


Fig No:5.1 Literacy Status

5.2 Caste Composition:

Caste is a social stratification characterized by endogamy and the hereditary transmission of a particular lifestyle. According to the field survey, the overall population has been categorized into scheduled castes, scheduled tribes, OBC-A, OBC-B, etc. The data indicates that the largest portion of the population falls under the UR category, comprising approximately 86%. OBC-A constitutes 8% of the population, while OBC-B accounts for 6%.

Table No:5.2 Caste Composition		
Categories	No of Households	(%)
Unreserved	43	86%
OBC-A	4	8%
OBC-B	3	6%
Source: Field survey2023		

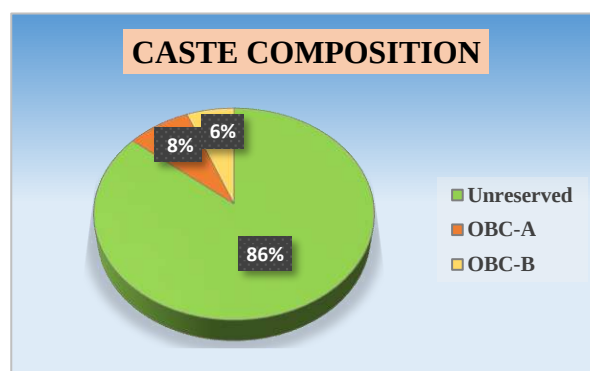


Fig No:5.2 Caste Composition

5.3 Poverty Status:

Poverty is a condition in which an individual or household lacks the financial resources to afford a basic minimum standard of living. According to field survey, out of the 50 household in the study area are 88% APL household and 25% BPL category belong in this area. According to the field survey 12% family belong in low level of poverty status.

Table No: 5.3 Poverty Status		
Poverty status	Number	Percentage (%)
APL	44	88%
BPL	6	12%
Source: Field survey 2023		

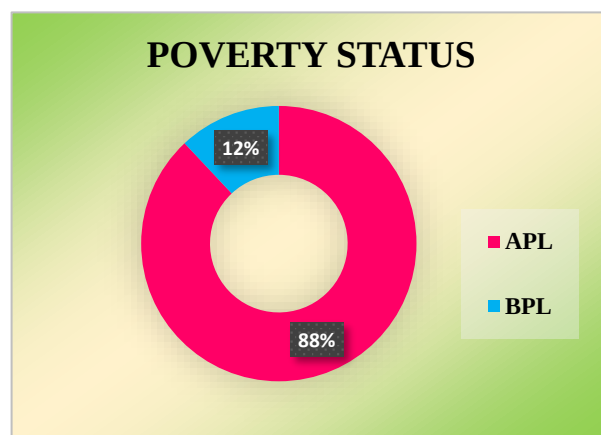


Fig No:5.3 Poverty Status

5.4 Level of Education:

According to the field survey, a higher population in study area held a secondary education degree as their highest level of educational attainment compared with all other level of educational attainment. Specially 29.58% of adult in study area had a higher secondary degree, compare with 15.02% of adult who have bachelor's degree and 5.64% of adult had a post graduate degree or higher degree.

Table No. 5.4 Level of Education		
Level of education	Number	Percentage (%)
Illiterate	13	6.10%
Primary	27	12.68%
Secondary	66	30.99%
Higher secondary	63	29.58%
Graduate	32	15.02%
Post-graduate	6	2.82%
Higher Education	6	2.82%
Source: Field survey 2023		

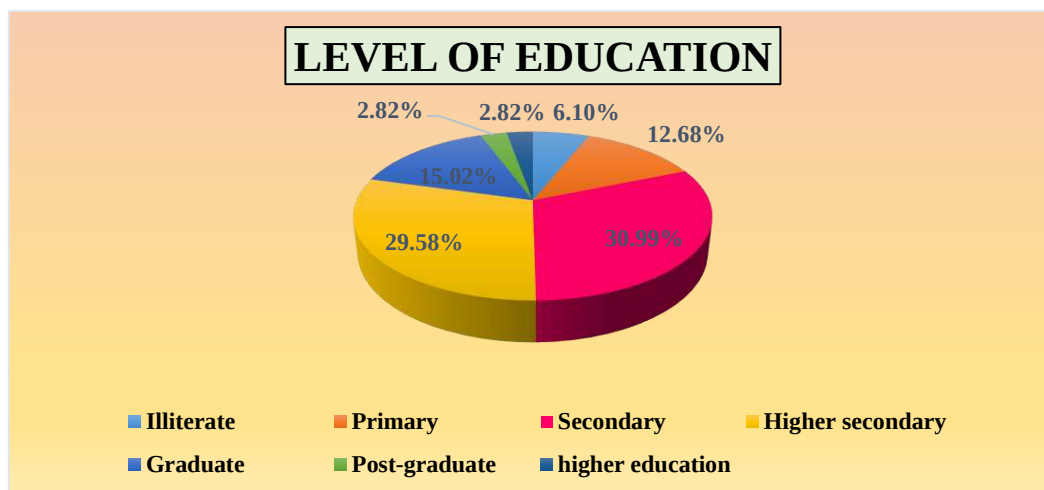


Fig No: 5.4 Level of Education

5.5 Marital Status:

Marital status is the legally defined marital state. There are several types of marital status: single, married, widowed, divorced, separated and, in certain cases, registered partnership. According field survey most of the people is married (61.97%) followed by the unmarried people is 34.74%, widow people are 3.295%.

Table No:5.5 Marital Status		
Marital Status	Number	Percentage (%)
Married	132	61.97%
Unmarried	74	34.74%
widow	7	3.29%
Source: field survey 2023		

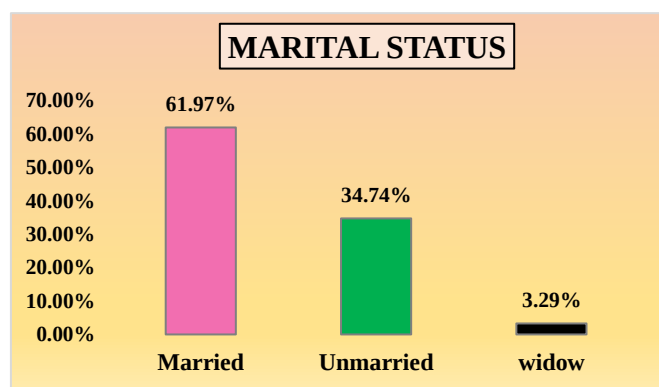


Fig No:5.5 Marital Status

5.6 Age of Marriage

Based on the field survey, the deterministic age limit for marriage is categorized into three segments: less than 20 years, 21-30 years, and more than 30 years. Within this framework of deterministic marriage age, there is a further distinction between male and female groups. The female population totals 65 individuals. Among them, 80% of the female population falls within the marriage age bracket of less than 20 years, while 20% are in the age range of 21-30 years. This data indicates that 20% of the female population is mindful of their marriage age and prefers to postpone marriage. On the flip side, the male population comprises 67 individuals. Within this group, 91.04% have a marriage age between 21-30 years, and 8.96% have a marriage age above 30 years. Overall, the data illustrates that the male population is more conscious about their marriage age compared to the female population.

Table No: 5.6 Age of Marriage				
Age of Marriage (Years)	Male		Female	
	Number	%	Number	%
<20			52	80%
21-30	61	91.04%	13	20%
>30	5	8.96%		
Source: Field Survey 2023				

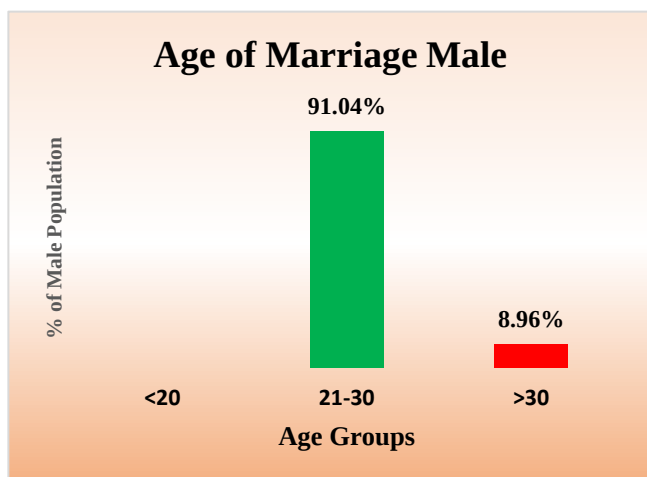


Fig No:5.6 Male Age of Marriage

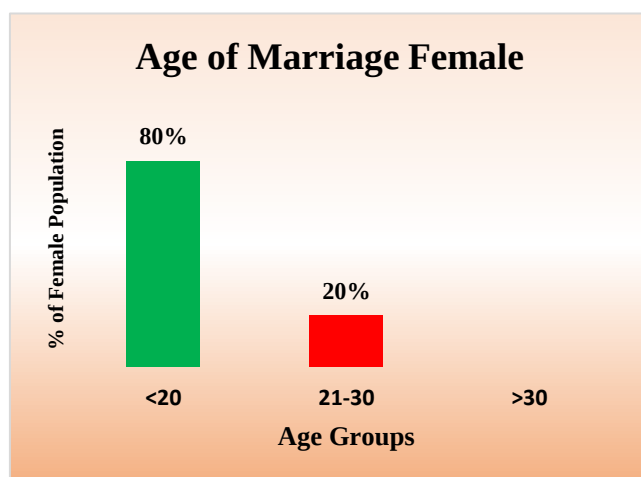


Fig No:5.7 Female Age of Marriage

5.7 Occupation Pattern

The occupational structure of a nation pertains to the distribution of its workforce across different economic activities. The field survey conducted in Ward No. 26 of Haldia provides us with insightful occupation-related data. The results indicate that the majority of individuals are employed as unskilled wage workers (42.86%), 28.57% are engaged in the private sector, 4.76% work in the government sector, 14.29% are skilled wage workers, and 9.52% are involved in business and trade.

Table No: 5.7 Occupation Pattern		
Occupation Pattern	Number	Percentage (%)
Skilled wage worker	9	14.29%
Unskilled wage worker	27	42.86%
Salaried employment in government	3	4.76%
salaried employment in privet sector	18	28.57%
Other trade and business	6	9.52%
Source: Field survey 2023		

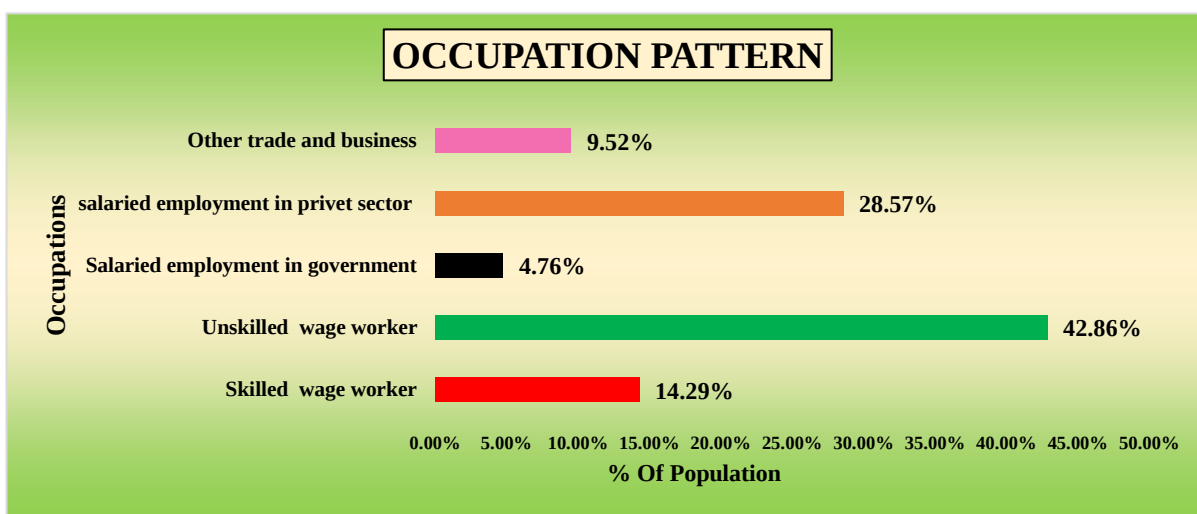


Fig No:5.8 Occupation Pattern

5.8 Ownership of House:

The pattern of house ownership in India varies significantly in urban areas. According to field survey, 90% of the total households in study area own house, most of the people there have their own house and the minor population belongs in rental house that 10%.

Table No: 5.8 Ownership of House		
Owner of house	Number	Percentage (%)
Own	45	90%
Rental	5	10%
Source: Field survey 2023		

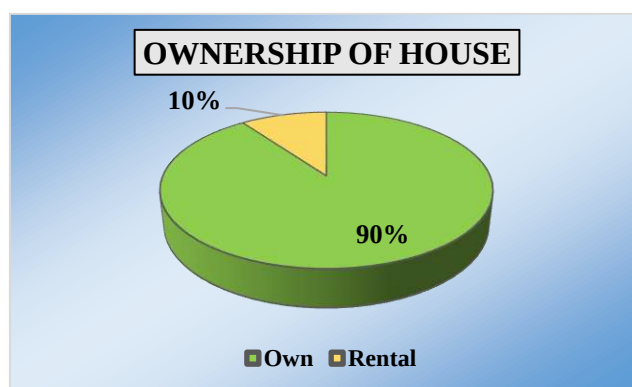


Fig No:5.9 Ownership of House



Plate No:2 Nature of Housing



Plate No: 3 Educational Institutions

5.9 Nature of House:

According to the field survey, it was observed that 84% of households have pucca houses, 10% have semi pucca houses, and 6% have kutcha houses. Pucca houses are constructed using durable and sturdy materials such as stones, bricks, and concrete. These houses, including apartments and buildings, are designed to withstand the test of time and endure for extended periods.

Table No: 5.9 Nature of House			
Nature Of House	Number	Percentage (%)	
Pucca	3	84%	
Semi pucca	5	10%	
Kutcha	42	6%	
Homeless			
Source: Field survey 2023			

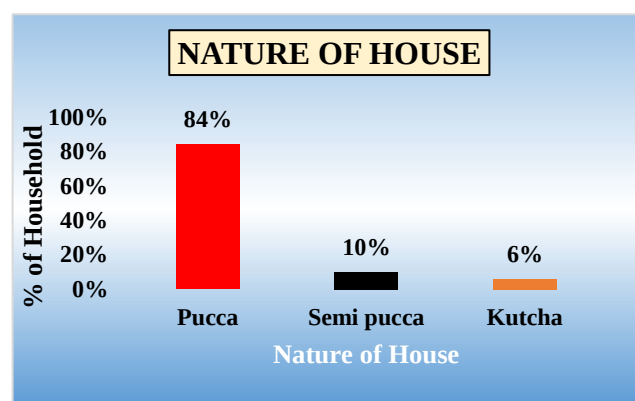


Fig No:5.10 Nature of House

5.10 Monthly Family Income:

Based on the field survey, it was determined that more than 70 percent of households maintain a luxurious standard of living, with the majority falling into the higher income categories (High-Middle and Rich). A mere 7.5 percent of families have an income below Rs 20,000 per month, classifying them as part of the aspiring or lowest-income group. Furthermore, the survey revealed that 93 percent of households engage in financial savings through bank deposits, insurance, and other means.

Table No:5.10 Monthly Family Income		
Monthly family income (in Rupees)	Number	Percentage (%)
<5000		0%
5000-10,000		0%
10,000-20,000	19	38%
20,000-30,000	19	38%
>30,000	12	24%
Source: Field survey 2023		

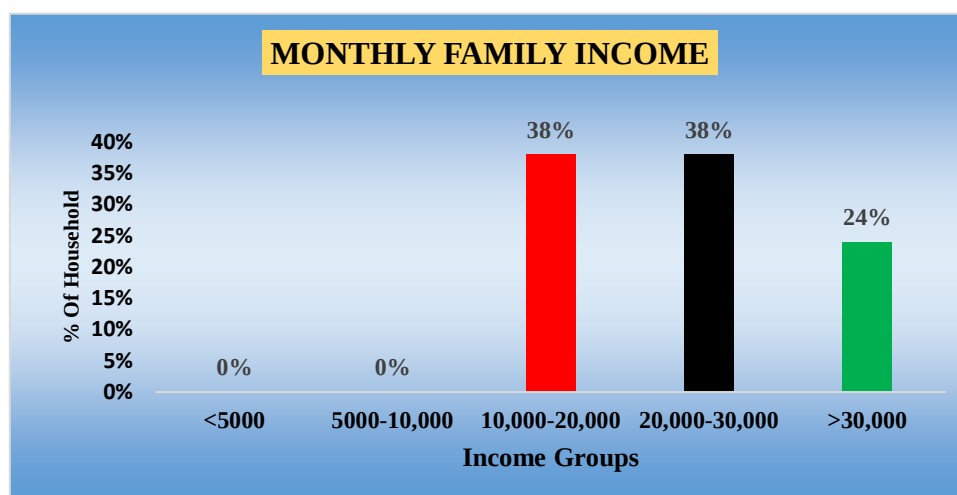


Fig No:5.11 Monthly Family Income

5.11 Bank Account:

Ward No. 26 of Haldia municipality represents an urban area where a significant portion of the population is educated and engaged in various sectors such as the private sector, government jobs, business, and other trades (57.14%). As a result of their technological awareness, a high percentage of individuals in Haldia have bank accounts (92%), showcasing their proficiency in utilizing modern financial services. However, a small percentage of the population (8%) identified in the survey data does not possess bank accounts.

Table No: 5.11 Bank Account		
Bank Account	Number	Percentage
Yes	196	92%
No	17	8%
Source: Field survey 2023		

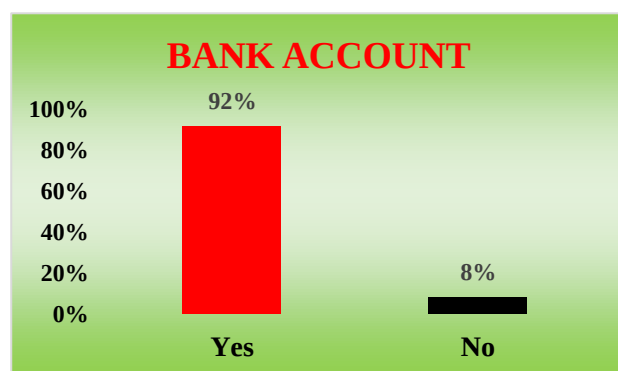


Fig No:5.12 Bank Account

5.12 Cooking Fuel:

The study area, Ward No. 26, is situated in the southwestern region of the Haldia municipality. Nearly all households, specifically a total of 50 households, rely exclusively on LPG fuel for cooking. As a result, indoor air pollution in the study area is lower than outdoor air pollution, primarily due to the prevalent use of LPG as a cooking fuel.

Table No: 5.12 Cooking fuel		
Cooking fuel	Number	Percentage (%)
LPG	50	100%
Source: Field survey 2023		

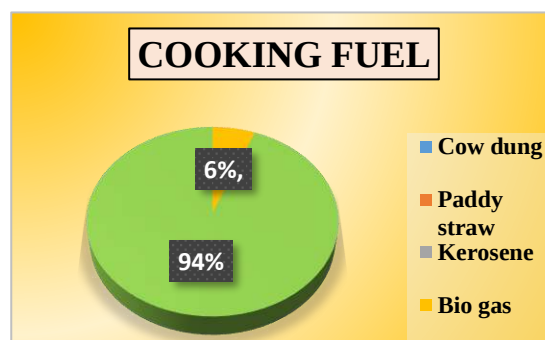


Fig No:5.13 Cooking Fuel

5.13 Use of medical instruments:

The 26th ward of the Haldia municipality is situated in the southwestern part of Haldia. The concept of "health wealth" encompasses a combination of medical instruments. The survey results demonstrate that thermometers (86%) constitute the primary and most commonly used medical instrument in this region. Additionally, sugar test kits (38%) and sphygmomanometers (20%) are also notable medical instruments that are widely utilized.

Table No: 5.13 Use of Medical Instruments		
Use Of Medical Instruments	NOs	Percentage (%)
Thermometer	7	14%
Sphygmomanometer	40	80%
Pulse Oximeter	49	98%
Weight machine	50	100%
Sugar test kit	31	62%
Source: Field survey 2022		

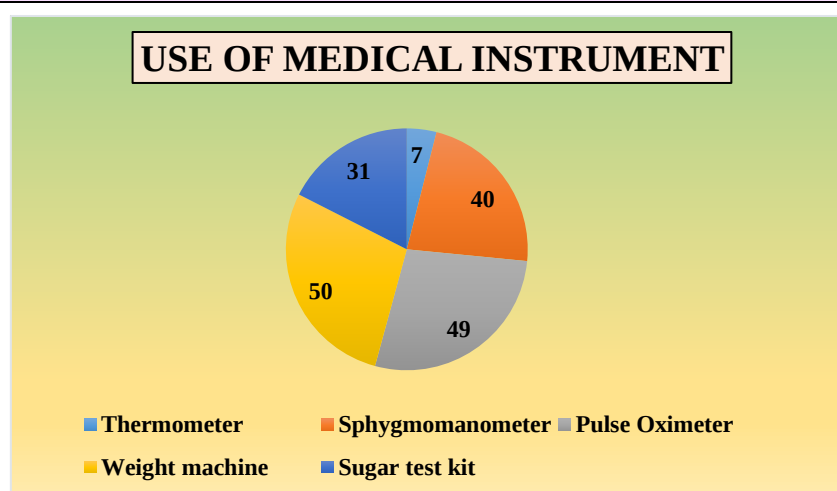


Fig No:5.14 Use of Medical Instruments

5.14 Socio Economic Status:

In the present study, 50 households were visited. It was observed from Table 5.13 that the majority of households, 25 (50%), belong to the upper-middle class. Additionally, 9 (18%) households were classified as upper-lower class, 12 (24%) households were categorized as lower-middle class, and 4 (8%) households were identified as upper class when the modified Kuppuswamy scale was applied.

Table No:5.14 Socio Economic Status (after Kupuswamy 2021)		
Socio Economic Status	No of Households	% of Households
Upper	4	8%
Upper Middle	25	50%
Lower Middle	12	24%
Upper Lower	9	18%
Lower		

Source: Field Survey 2023

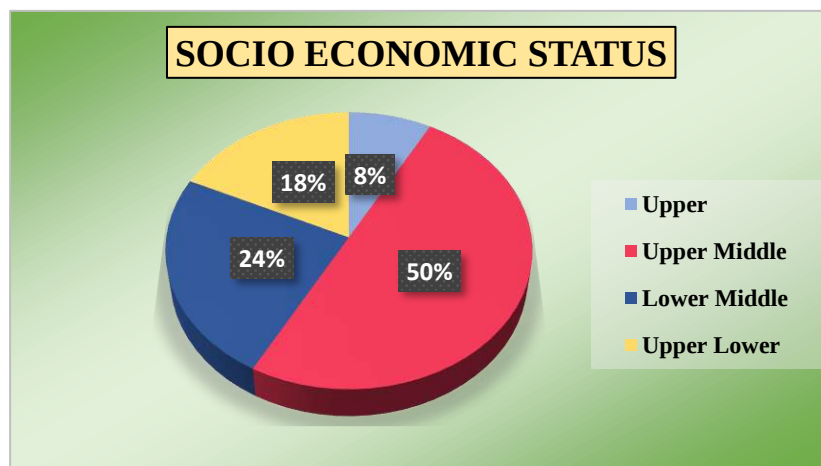


Fig No:5.15 Socioeconomic Status

CHAPTER-6

Air Quality Analysis

6.0 Air Quality

The air quality in Haldia Ward No. 26 exhibits varying levels of pollution throughout the year, as indicated by the collected data. The concentrations of key pollutants—NO₂ (nitrogen dioxide), Pm₁₀ (particulate matter with a diameter of 10 micrometers or less), Pm_{2.5} (particulate matter with a diameter of 2.5 micrometers or less), and SO₂ (sulfur dioxide)—have been consistently measured and analyzed

From January to June, the air quality has shown distinct patterns. The levels of NO₂, Pm₁₀, Pm_{2.5}, and SO₂ vary across these months, with each pollutant experiencing fluctuations in concentration. These concentrations are subject to various factors, including weather conditions, local sources of pollution (such as industrial activity and vehicular emissions), and atmospheric dynamics

The analysis indicates that the air quality generally falls within the Moderately Polluted category, suggesting that the region experiences a moderate level of air pollution. The higher concentrations of NO₂, Pm₁₀, and Pm_{2.5} during specific months, particularly in March, April, and May, can be attributed to factors such as dry air flow, reduced mixing height, and increased vehicular activity.

The fluctuations in the Air Quality Index (AQI) also reflect the changing pollution levels. While certain periods exhibit Satisfactory to Moderately Polluted air quality, there are instances of higher AQI values, indicating more polluted conditions. These higher values, especially in months with increased vehicular activity and lower atmospheric dispersion, are indicative of elevated pollution concentrations.

Overall, the air quality data for Haldia Ward No. 26 emphasizes the importance of continuous monitoring and targeted interventions to mitigate air pollution. Such efforts could include controlling industrial emissions, promoting clean energy sources, improving vehicular emissions standards, and implementing measures to enhance air quality during months with higher pollution levels. This analysis underscores the need for informed decision-making and community engagement to ensure a healthier and cleaner environment for the residents of Haldia Ward No. 26.

6.1 Air quality index:

The National Air Quality Index (NAQI) is a system used in India to report and communicate air quality levels to the public. It provides a standardized way to measure and assess air quality across various cities and regions in India. The NAQI categorizes air quality into different levels of pollution and associated health effects, similar to the Air Quality Index (AQI) used in many other countries. The NAQI takes into account various pollutants including particulate matter (PM_{2.5} and PM₁₀), sulfur dioxide (SO₂), nitrogen dioxide (NO₂), carbon monoxide (CO), and ozone (O₃).

To get the most current and accurate information about the National Air Quality Index in different cities or regions of India, I recommend checking with the Central Pollution Control Board (CPCB) or other reliable environmental agencies that provide real-time air quality data. Keep in mind that air quality can change rapidly due to various factors, so it's important to stay updated with real-time information if you're concerned about air quality in a specific area.

Table No:6.1 Air Quality Index			
AQI	Remark	Color Code	Air Quality Index possible health impacts (AQI)
0-50	Good		Minimal impact
51-100	Satisfactory		Minor breathing discomfort to the people with lung, heart disease, children and older adults
101-200	Moderate		Breathing discomfort to people on prolonged exposure
201-300	Poor		Respiratory discomfort to people on prolonged exposure
301-400	Very poor		Respiratory illness to the people on prolonged exposure
>400	Severe		Respiratory effects even on healthy people
Source: CPCB.			

6.2 Air Quality In January:

In January, according to air quality data from the 26th ward of Haldia Municipality, the concentration of various pollutants exhibited distinct trends. The highest concentration of NO₂, at 32 µg/m³, was recorded on 16.01.23, while the lowest NO₂ concentration of 27 µg/m³ was observed on 28.01.23. Pm₁₀ concentration reached its peak at 123 µg/m³ on 10.01.23 and dipped to the lowest point of 107 µg/m³ on 16.10.23. Similarly, Pm_{2.5} showed a range from the highest concentration of 78 µg/m³ on 12.01.23 to the lowest concentration of 63 µg/m³ on 04.01.23. The concentration of SO₂ ranged between 15 µg/m³ at its peak and 13 µg/m³ at its lowest point.

On average, NO₂ concentration measured 28.88 µg/m³, Pm₁₀ averaged at 114.75 µg/m³, Pm_{2.5} had an average concentration of 69.88 µg/m³, and SO₂ concentration averaged 13.50 µg/m³. Notably, the higher averages of Pm₁₀ and Pm_{2.5} concentrations indicated elevated air pollution levels in January. This could be attributed to increased dry air flow and limited water vapor content, creating conditions favourable for particulate matter retention in the atmosphere.

The air quality status in January falls within the moderately polluted category. The highest Air Quality Index (AQI) reached 160 on 12.01.23, whereas the lowest AQI of 110 was registered on 04.01.23. The average AQI for January stood at 132.75, indicative of a moderate air quality level. This moderate status suggests higher air pollution due to factors such as lower mixing height and the formation of inversion atmospheric layers. Furthermore, heightened use of heating sources in households and industries likely contributed to increased emissions of particulate matter and other pollutants. Additionally, calm wind conditions may have limited the dispersion of pollutants, leading to stagnant air and elevated concentrations of pollutants.

Table No: 6.2 Air Quality in January						
Date	NO ₂ (µg/m ³)	Pm ₁₀ (µg/m ³)	Pm _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	AQI	Category
04.01.2023	28	108	63	13	110	Moderately Polluted
06.01.2023	30	121	68	14	127	Moderately Polluted
10.01.2023	28	123	73	13	143	Moderately Polluted
12.01.2023	30	115	78	14	160	Moderately Polluted
16.01.2023	32	107	76	13	153	Moderately Polluted
20.01.2023	28	114	70	13	133	Moderately Polluted
25.01.2023	28	114	67	15	123	Moderately Polluted
28.01.2023	27	116	64	13	113	Moderately Polluted
Average	28.88	114.75	69.88	13.50	132.75	Moderately Polluted
Source: Source: https://www.wbpcb.gov.in						

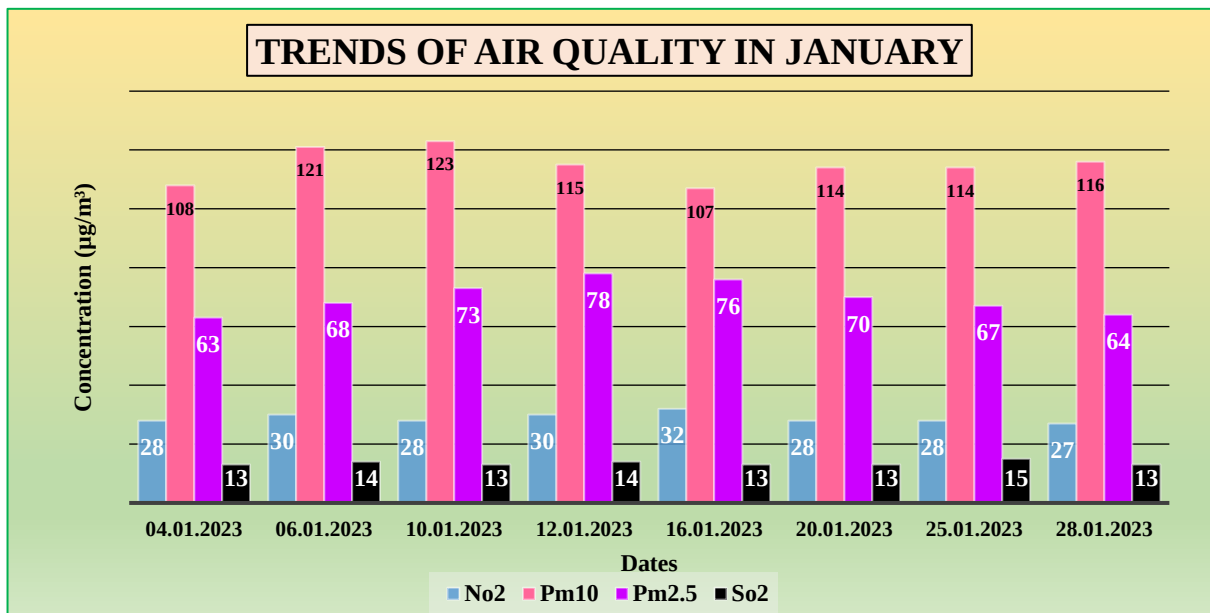


Fig No:6.1 Air Pollutant Concentration in January

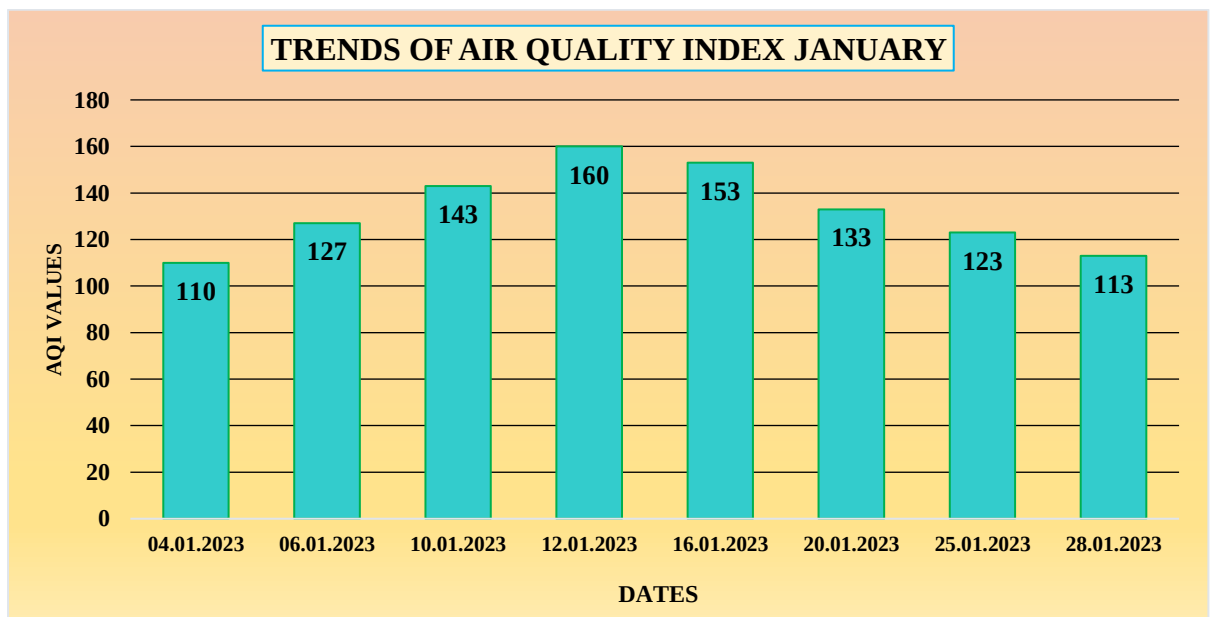


Fig No: 6.2 AQI in January

6.3 Air Quality in February:

In February, based on air quality data from the 26th ward of Haldia Municipality, a distinct pattern of pollutant concentrations emerged. The highest NO₂ concentration, reaching 34 µg/m³, was documented on 07.02.23, while the lowest NO₂ concentration of 25 µg/m³ was observed on 28.02.23. For Pm₁₀, the highest concentration recorded was 107 µg/m³ on 07.02.23, contrasting with the lowest concentration of 85 µg/m³ on 28.02.23. Similarly, Pm_{2.5} displayed its peak concentration of 72 µg/m³ on 07.02.23 and its lowest concentration of 53 µg/m³ on 26.02.23. The concentration of SO₂ ranged between the highest value of 16 µg/m³ and the lowest reading of 8 µg/m³.

On average, the concentration of NO₂ stood at 30.13 µg/m³, while Pm₁₀ had an average concentration of 94.43 µg/m³, Pm_{2.5} averaged 62.75 µg/m³, and SO₂ averaged 10.75 µg/m³. Notably, the higher average concentrations of Pm₁₀ and Pm_{2.5} indicated elevated air pollution levels in February. This could be attributed to increased dry air flow and a scarcity of water vapor in the atmosphere during the month.

The air quality status during February falls within the moderately polluted category. The highest Air Quality Index (AQI), recorded at 140 on 07.02.2023, contrasts with the lowest AQI of 91 registered on 26.02.23. The average AQI for February settled at 111.88, denoting a moderate air quality level. This suggests a higher degree of air pollution due to factors such as a lower mixing height and the presence of inversion atmospheric layers. The use of heating sources in households and industries might have contributed to increased emissions of particulate matter and other pollutants. Additionally, calm wind conditions could have hindered the dispersion of pollutants, resulting in stagnant air and heightened concentrations of pollutants.

Table No: 6.3 Air Quality in February						
Date	NO ₂ (µg/m ³)	Pm ₁₀ (µg/m ³)	Pm _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	AQI	Category
02.02.2023	29	96	68	9	127	Moderately Polluted
04.02.2023	30	89	64	10	113	Moderately Polluted
07.02.2023	34	107	72	11	140	Moderately Polluted
13.02.2023	33	97	67	16	123	Moderately Polluted
15.02.2023	31	87	63	11	110	Moderately Polluted
23.02.2023	31	94	59	11	98	Satisfactory
26.02.2023	28	91	53	10	91	Satisfactory
28.02.2023	25	85	56	8	93	Satisfactory
Average	30.13	94.43	62.75	10.75	111.88	Moderately Polluted
Source: https://www.wbpcb.gov.in						

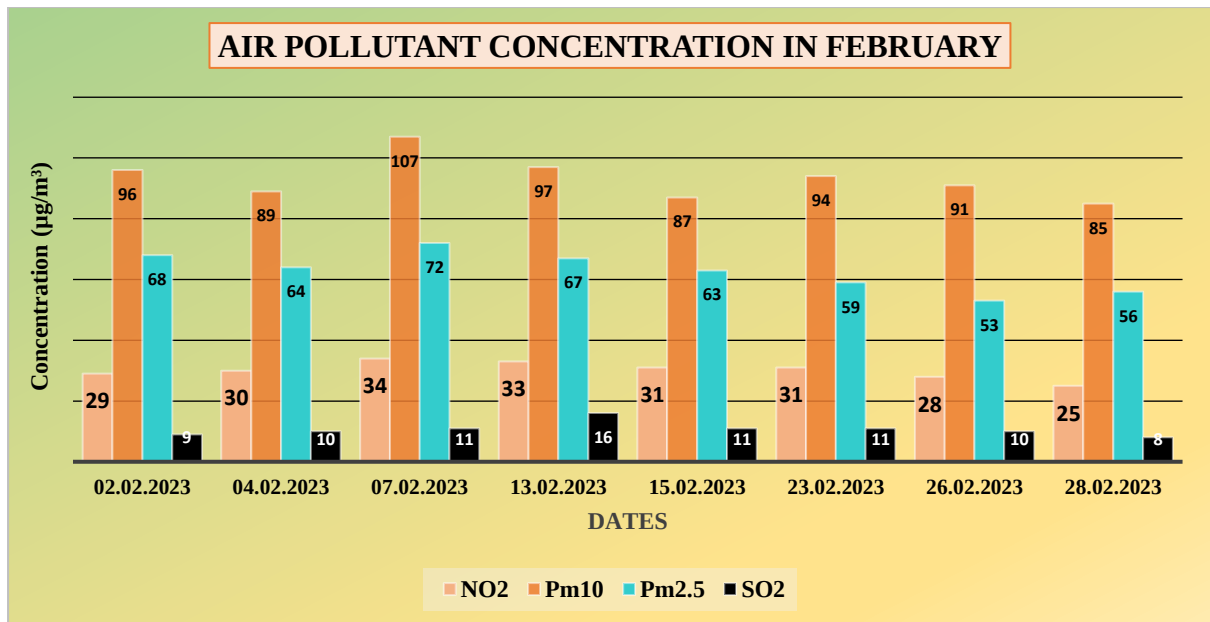


Fig No:6.3 Air Pollutant Concentration in February

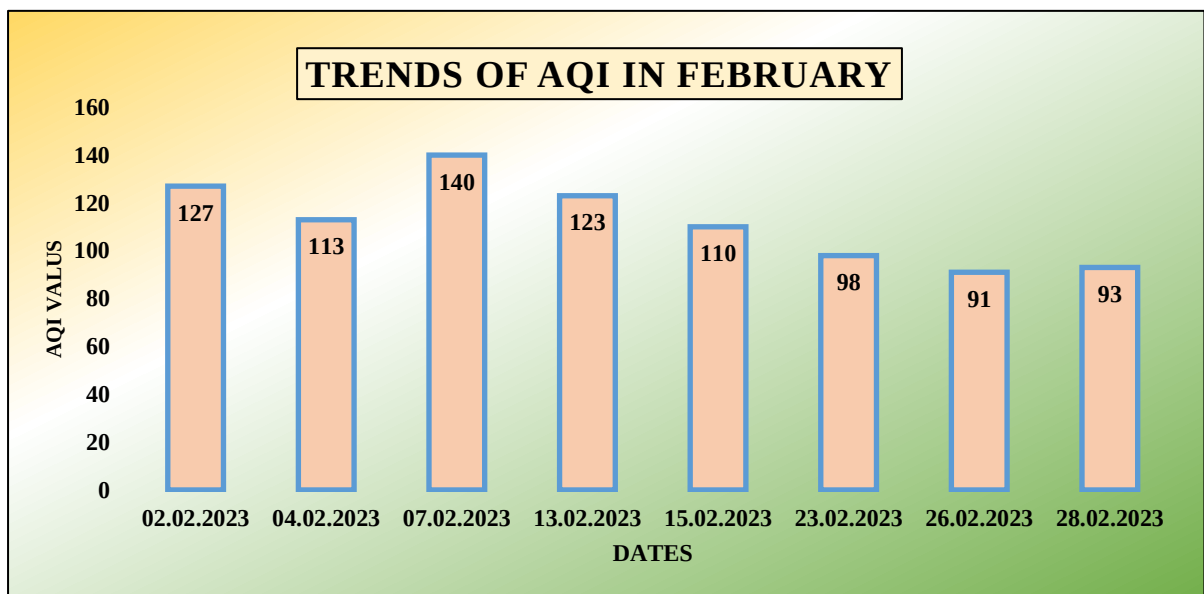


Fig No:6.4 AQI in February

6.4 Air Quality in March:

In March, analysing the air quality data from the 26th ward of Haldia Municipality reveals distinct trends in pollutant concentrations. The highest NO₂ concentration, peaking at 31 µg/m³, occurred on 19.03.23, while the lowest NO₂ concentration registered was 19 µg/m³. For Pm₁₀, the highest concentration reached 100 µg/m³ on 04.03.23, and the lowest concentration was 74 µg/m³ on 29.03.23. Similarly, Pm_{2.5} displayed its highest concentration of 63 µg/m³ and its lowest concentration of 32 µg/m³ on 21.03.23. The concentration of SO₂ ranged between the highest value of 12 µg/m³ and the lowest reading of 2 µg/m³.

On average, the concentration of NO₂ stood at 25.56 µg/m³, while Pm₁₀ exhibited an average concentration of 82.11 µg/m³, Pm_{2.5} averaged 53.67 µg/m³, and SO₂ averaged 6.67 µg/m³. Interestingly, the average concentrations of Pm₁₀ and Pm_{2.5} indicated relatively lower air pollution levels in March. This may be attributed to the normal air flow patterns with sufficient water vapor content in the atmosphere during the month.

The air quality status for March falls within the Satisfactory polluted category. The highest recorded Air Quality Index (AQI), at 110 on 04.03.2023, contrasts with the lowest AQI of 64 registered on 21.03.23. The average AQI for March settled at 90.56, which is lower than the figures observed in January and February. This suggests a relatively low level of air pollution due to factors such as higher mixing height, enhanced dispersion, and turbulence of wind.

The findings underscore that March generally experiences satisfactory air quality, reflecting favorable conditions for dispersion and a lower impact of pollutants. This could be attributed to the conducive atmospheric dynamics during the month, contributing to relatively healthier air quality in the area.

Table No: 6.4 Air Quality in March						
Date	NO ₂ (µg/m ³)	Pm ₁₀ (µg/m ³)	Pm _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	AQI	Category
04.03.2023	29	100	63	9	110	Moderately Polluted
06.03.2023	28	91	61	9	103	Moderately Polluted
09.03.2023	27	87	56	8	93	Satisfactory
15.03.2023	30	96	63	12	96	Satisfactory
19.03.2023	31	84	58	10	97	Satisfactory
21.03.2023	19	64	32	2	64	Satisfactory
24.03.2023	23	79	46	3	79	Satisfactory
27.03.2023	24	64	53	4	88	Satisfactory
29.03.2023	19	74	51	3	85	Satisfactory
Average	25.56	82.11	53.67	6.67	90.56	Satisfactory
Source: https://www.wbpcb.gov.in						

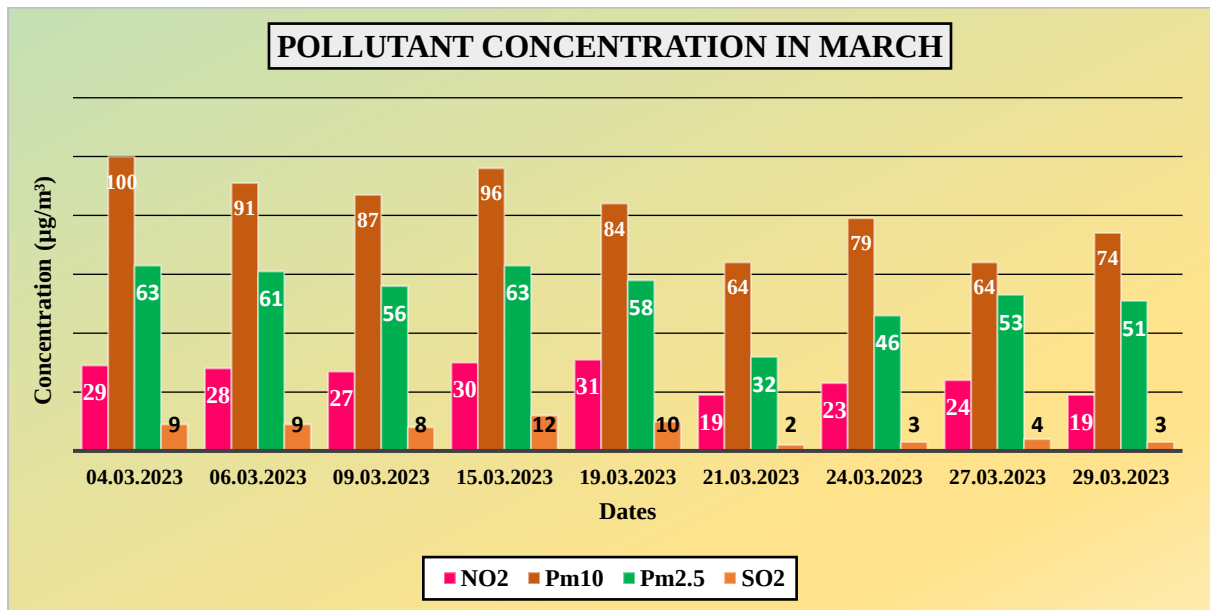


Fig No:6.5 Air Pollutant Concentration in March

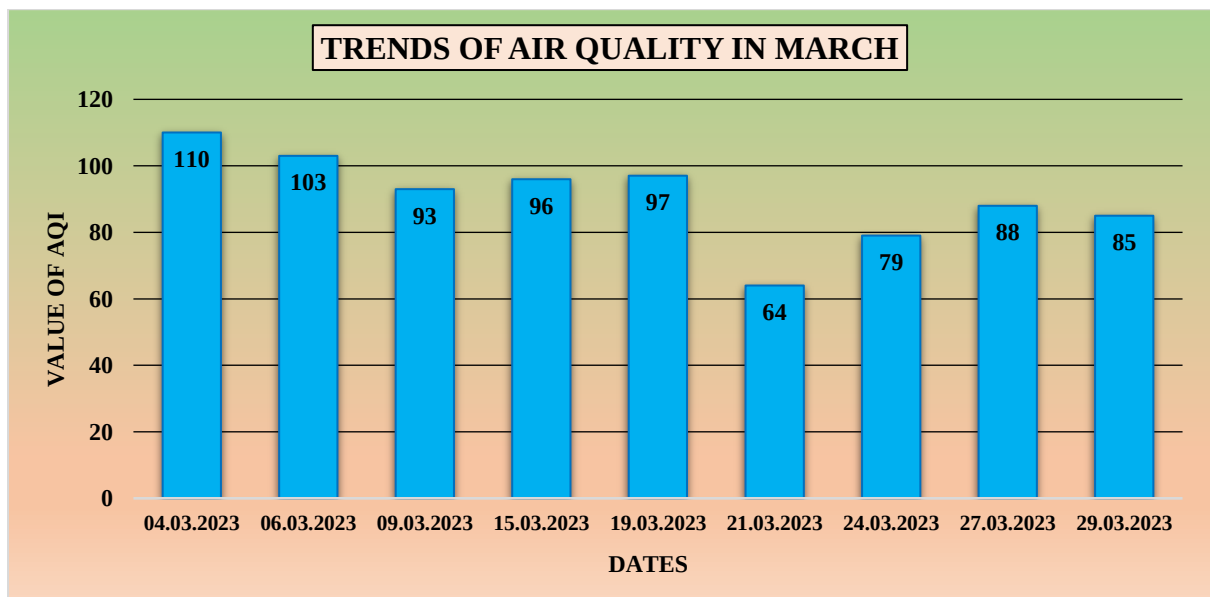


Fig No:6.6 AQI in March

6.5 Air Quality in April:

In April, the analysis of air quality data from the 26th ward of Haldia Municipality uncovers distinct patterns in pollutant concentrations. The highest NO₂ concentration, reaching 37 µg/m³, was documented on 03.04.23, while the lowest NO₂ concentration was 29 µg/m³ on 26.04.23. For Pm₁₀, the highest concentration recorded was 105 µg/m³ on 26.04.23, while the lowest concentration was 90 µg/m³ on 22.04.23. Similarly, Pm_{2.5} displayed its peak concentration of 73 µg/m³ on 18.04.23, contrasting with the lowest concentration of 58 µg/m³ on 13.04.23. The concentration of SO₂ ranged between the highest value of 14 µg/m³ and the lowest reading of 5 µg/m³.

On average, the concentration of NO₂ stood at 33.63 µg/m³, while Pm₁₀ exhibited an average concentration of 97.50 µg/m³, Pm_{2.5} averaged 64.13 µg/m³, and SO₂ averaged 11.63 µg/m³. Interestingly, the higher average concentrations of Pm₁₀ and Pm_{2.5} indicated elevated air pollution levels in April. This could be attributed to increased dry air flow resulting from the lack of water vapor due to reduced rainfall during the month.

The air quality status for April falls within the Moderately polluted category. The highest recorded Air Quality Index (AQI), at 143 on 18.04.2023, contrasts with the lowest AQI of 97 registered on 13.04.23. The average AQI for April settled at 114.13, higher than that of March. This points to relatively higher air pollution, potentially due to increased vehicular activity and reduced mixing of air in the lower atmosphere.

The analysis underscores that April experiences a moderate level of air pollution, driven by factors such as increased vehicular emissions and atmospheric conditions that hinder proper dispersion. The lack of substantial rainfall in the month could have contributed to the buildup of pollutants in the air, emphasizing the need for targeted interventions to mitigate pollution levels during this period.

Table No: 6.5 Air Quality in April						
Date	NO ₂ (µg/m ³)	Pm ₁₀ (µg/m ³)	Pm _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	AQI	Category
03.04.2023	37	96	64	12	113	Moderately Polluted
08.04.2023	36	97	62	13	107	Moderately Polluted
13.04.2023	33	93	58	14	97	Satisfactory
16.04.2023	32	95	64	12	113	Moderately Polluted
18.04.2023	36	100	73	14	143	Moderately Polluted
22.04.2023	32	90	63	5	110	Moderately Polluted
26.04.2023	29	105	68	11	127	Moderately Polluted
28.04.2023	34	104	61	12	103	Moderately Polluted
Average	33.63	97.50	64.13	11.63	114.13	Moderately Polluted
Source: https://www.wbpcb.gov.in						

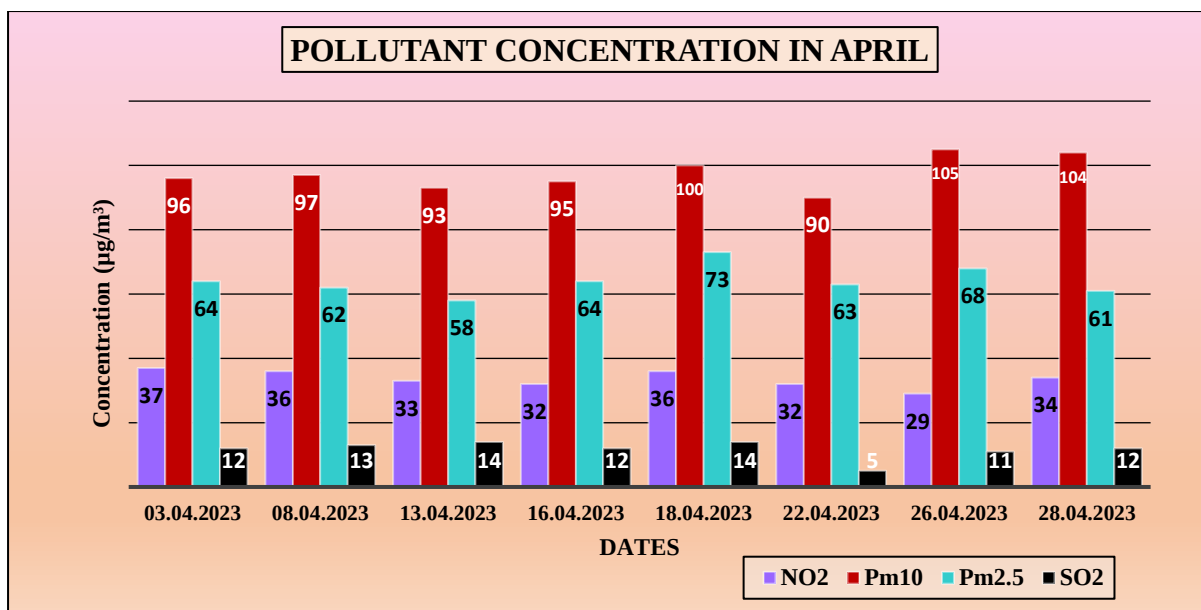


Fig No:6.7 Air Pollutant Concentration in April

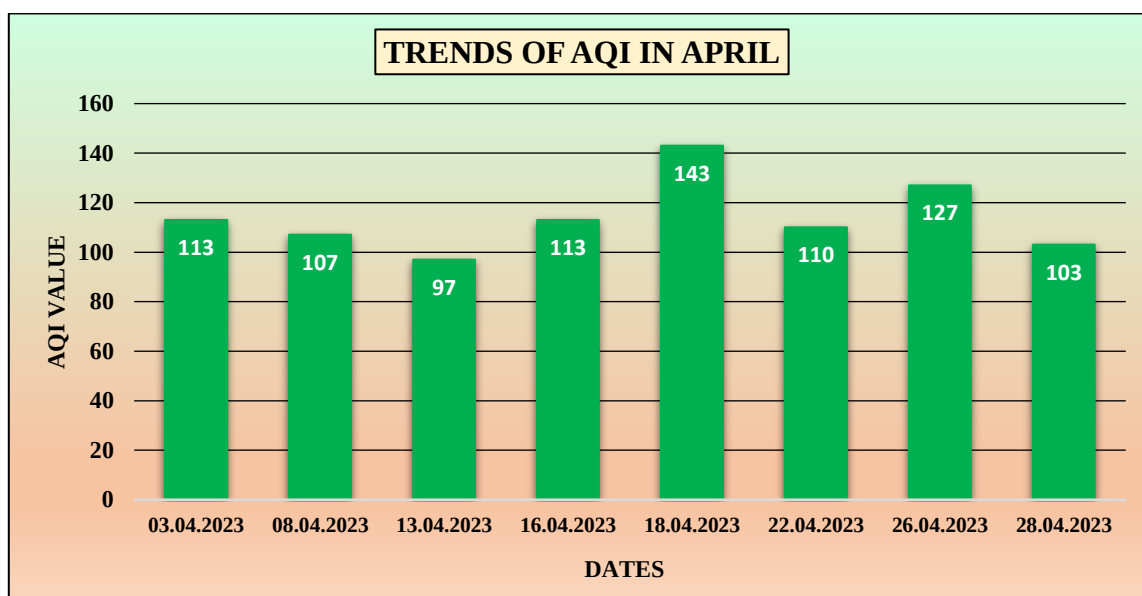


Fig No:6.8 AQI in April

6.6 Air Quality in May:

In May, analyzing the air quality data from the 26th ward of Haldia Municipality reveals distinct trends in pollutant concentrations. The highest NO₂ concentration, peaking at 34 µg/m³, occurred on 10.05.23, while the lowest NO₂ concentration was 24 µg/m³ on 29.05.23. For Pm₁₀, the highest concentration reached 103 µg/m³ on 31.05.23, and the lowest concentration was 89 µg/m³. Similarly, Pm_{2.5} displayed its highest concentration of 72 µg/m³ on 14.05.23 and its lowest concentration of 56 µg/m³ on 29.05.23. The concentration of SO₂ ranged between the highest value of 12 µg/m³ and the lowest reading of 5 µg/m³.

On average, the concentration of NO₂ stood at 29.63 µg/m³, while Pm₁₀ exhibited an average concentration of 95.38 µg/m³, Pm_{2.5} averaged 64.25 µg/m³, and SO₂ averaged 8.75 µg/m³. Interestingly, the higher average concentrations of Pm₁₀ and Pm_{2.5} indicated elevated air pollution levels in May. This could be attributed to increased dry air flow due to the lack of sufficient water vapor content in the atmosphere during the month.

The air quality status for May falls within the Moderately polluted category. The highest recorded Air Quality Index (AQI), at 140 on 14.05.2023, contrasts with the lowest AQI of 93 registered on 29.05.23. The average AQI for May settled at 115.13, higher than that of April. This suggests relatively higher air pollution, potentially due to increased vehicular activity and reduced mixing of air in the lower atmosphere.

The analysis underscores that May experiences a moderate level of air pollution, driven by factors such as increased vehicular emissions and atmospheric conditions that hinder proper dispersion. The lack of substantial rainfall in the month could have contributed to the buildup of pollutants in the air, emphasizing the need for targeted interventions to mitigate pollution levels during this period.

Table No: 6.6 Air Quality in May						
Date	NO ₂ (µg/m ³)	Pm ₁₀ (µg/m ³)	Pm _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	AQI	Category
02.05.2023	32	97	59	11	98	Moderately Polluted
06.05.2023	32	96	63	12	110	Moderately Polluted
10.05.2023	34	97	61	11	103	Moderately Polluted
14.05.2023	30	96	72	8	140	Moderately Polluted
16.05.2023	30	96	68	10	127	Moderately Polluted
19.05.2023	25	89	71	5	137	Moderately Polluted
29.05.2023	24	89	56	6	93	Satisfactory
31.05.2023	30	103	64	7	113	Moderately Polluted
Average	29.63	95.38	64.25	8.75	115.13	Moderately Polluted
Source: https://www.wbpcb.gov.in						

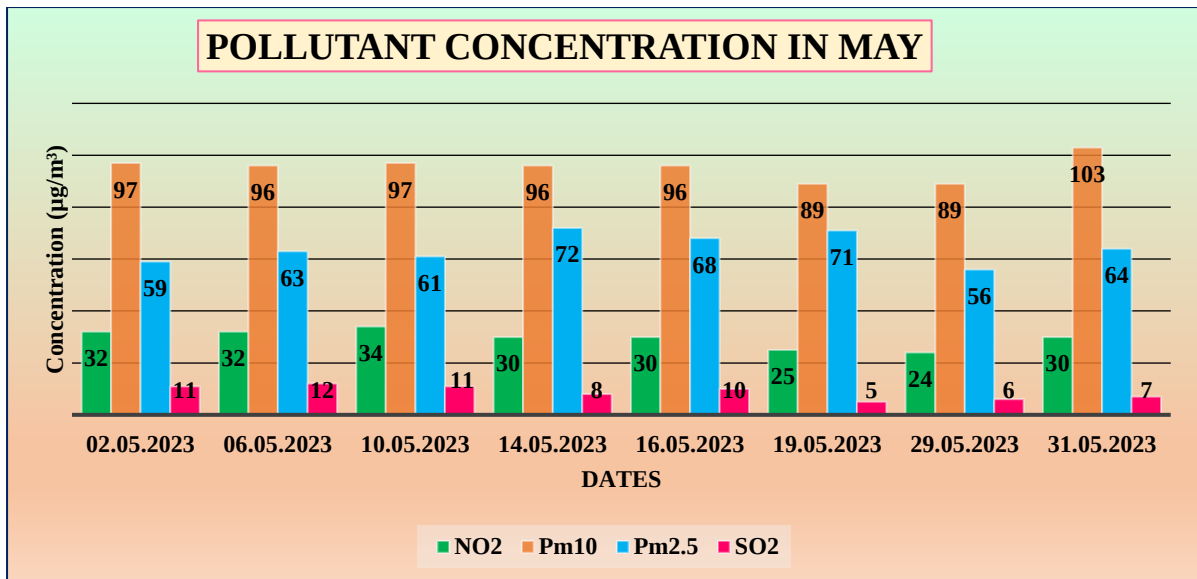


Fig No:6.9 Air Pollutant Concentration in May

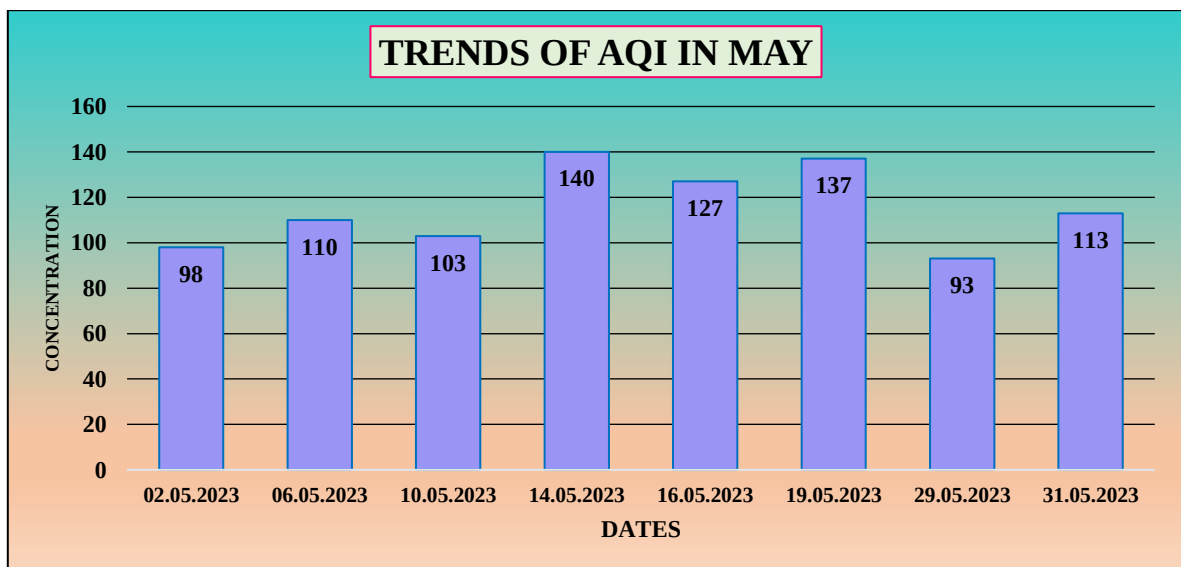


Fig No:6.10 AQI in May

6.7 Air Quality in June:

In June, a thorough examination of air quality data from the 26th ward of Haldia Municipality unveils distinct trends in pollutant concentrations. The highest NO₂ concentration, reaching 40 µg/m³, was documented on 02.06.23, while the lowest NO₂ concentration was 16 µg/m³ on 28.06.23. For Pm₁₀, the highest concentration reached a notable 106 µg/m³, and the lowest concentration was 46 µg/m³, both observed on 28.06.23. Similarly, Pm_{2.5} exhibited its peak concentration of 72 µg/m³ on 18.06.23, contrasting with the lowest concentration of 43 µg/m³ on 28.06.23. The concentration of SO₂ ranged between the highest value of 13 µg/m³ and the lowest reading of 2 µg/m³.

On average, the concentration of NO₂ stood at 31.67 µg/m³, while Pm₁₀ exhibited an average concentration of 89.89 µg/m³, Pm_{2.5} averaged 59.78 µg/m³, and SO₂ averaged 9.22 µg/m³. Notably, the higher average concentrations of Pm₁₀ and Pm_{2.5} indicated elevated air pollution levels in June. This may be attributed to increased air flow during the month, potentially leading to the retention of pollutants in the atmosphere.

The air quality status for June falls within the Moderately polluted category. The highest recorded Air Quality Index (AQI), at 140 on 18.06.2023, contrasts with the lowest AQI of 72 registered on 28.06.23. The average AQI for June settled at 106.22, lower than that of May but still indicating relatively high air pollution levels. This could be due to increased vehicular activity and decreased mixing of air in the lower atmosphere, which contribute to higher pollution concentrations.

The analysis underscores that June experiences a moderate level of air pollution, influenced by factors such as increased vehicular emissions and atmospheric conditions that influence air movement. While air quality improved compared to May, the findings emphasize the persistent need for measures to mitigate pollution levels, particularly during periods of higher vehicular activity.

Table No: 6.7 Air Quality in June

Date	NO ₂ (µg/m ³)	Pm ₁₀ (µg/m ³)	Pm _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	AQI	Category
02.06.2023	40	104	62	13	107	Moderately Polluted
05.06.2023	33	91	56	10	97	Satisfactory
07.06.2023	30	100	68	10	127	Moderately Polluted
13.06.2023	37	106	67	13	123	Moderately Polluted
18.06.2023	37	106	72	11	140	Moderately Polluted
22.06.2023	35	98	64	10	113	Moderately Polluted
24.06.2023	32	88	57	11	95	Satisfactory
26.06.2023	25	70	49	3	82	Satisfactory
28.06.2023	16	46	43	2	72	Satisfactory
Average	31.67	89.89	59.78	9.22	106.22	Moderately Polluted

Source: <https://www.wbpcb.gov.in>

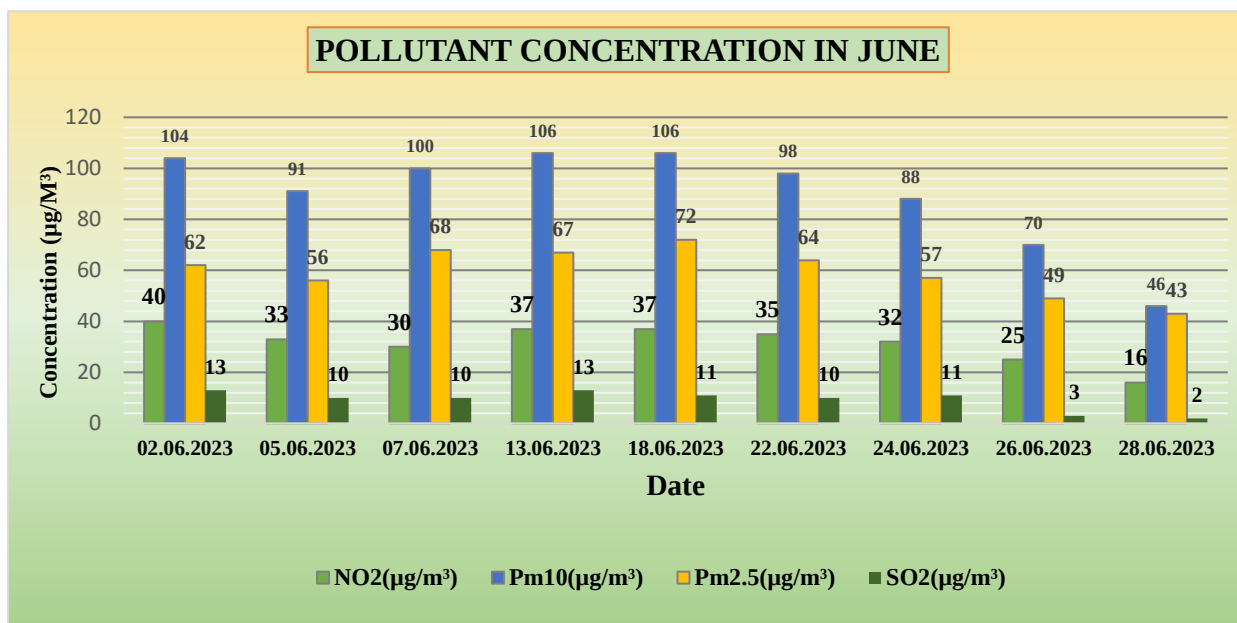


Fig No:6.11 Air Pollutant Concentration in June

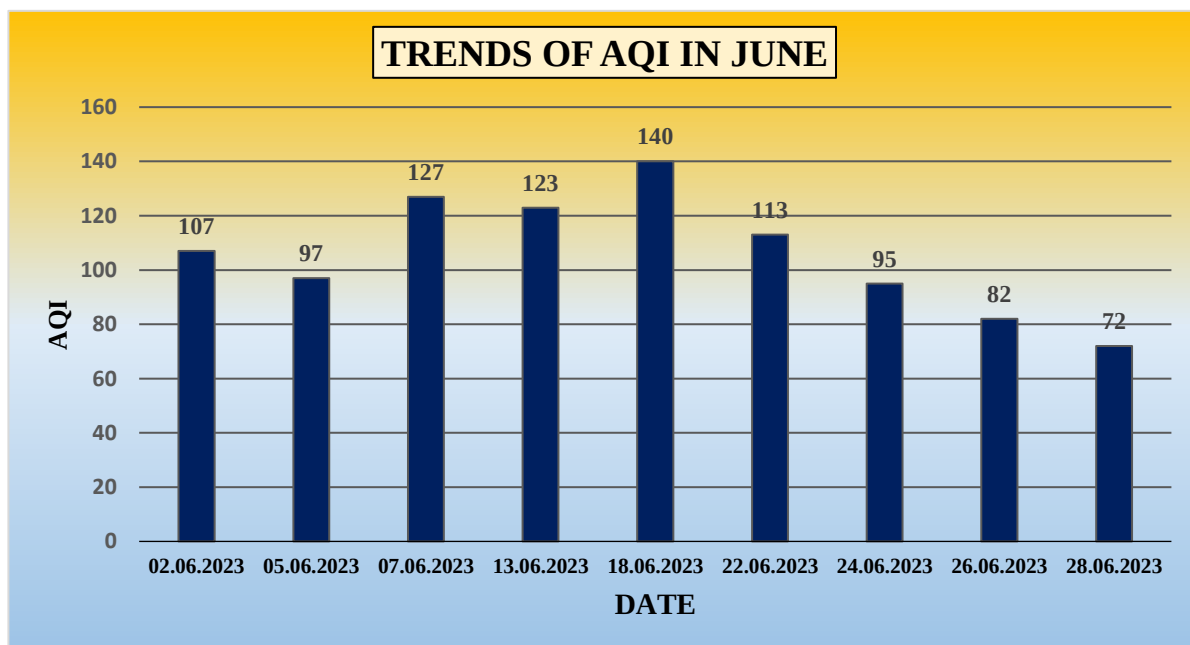


Fig No:6.12 AQI in June

6.8 Seasonal variation of air quality:

- ❖ **Winter (Dec-Feb):** Haldia, a major industrial and port city located in West Bengal, India, experiences seasonal variations in air quality, much like many other urban areas. Several factors contribute to these fluctuations, including weather patterns, industrial activities, vehicular emissions, and agricultural practices.
- ❖ **Pre-monsoon (March to May):** During the winter months, temperature inversions can occur, trapping pollutants close to the ground. This can lead to poor air quality, with higher levels of pollutants like particulate matter (PM_{2.5} and PM₁₀), nitrogen dioxide (NO₂), and sulphur dioxide (SO₂). Increased use of fossil fuels for heating and atmospheric conditions that prevent the dispersion of pollutants can exacerbate the situation.
- ❖ **Monsoon (June-sept):** As temperatures rise in the pre-monsoon period, there can be an increase in industrial and vehicular activities. Dust and other particulate matter from construction sites and roads, as well as emissions from vehicles, contribute to deteriorating air quality.

The monsoon season brings relief from the heat and often helps in clearing pollutants from the air. However, heavy rainfall can also lead to waterlogging and stagnant water, which can create breeding grounds for mosquitoes and other pests, affecting both air and public health.

6.9 IMPACT OF AIR POLLUTION:

6.9.1 Impact of Air pollution on Environment:

The hazardous effects of air pollution on the environment include:

➤ **Diseases:**

Air pollution has resulted in several respiratory disorders and heart diseases among humans. The cases of lung cancer have increased in the last few decades. Children living near polluted areas are more prone to pneumonia and asthma. Many people die every year due to the direct or indirect effects of air pollution.

➤ **Climate Change:**

Climate change is a great concern in today's scenario. This problem has surfaced in the last few decades. Greenhouse gases are the major cause of climate change. Environmental changes have several destructive impacts such as the melting of glaciers, change in seasons, epidemics, etc.

➤ **Ozone Layer Depletion:**

The ozone layer is a layer of concentrated ozone gas. It protects us from the sun's harmful ultraviolet rays. This very important layer is being destroyed by CFCs (chlorofluorocarbons), which are used in industries and everyday life (e.g., aerosol cans). The chlorine in these compounds destroys the ozone layer. The depleting ozone layer does not prevent the harmful ultraviolet rays coming from the sun and causes skin diseases and eye problems among individuals. The hole in the ozone layer leaves

humans and wildlife exposed to the harmful UV rays resulting in several skin diseases including cancer.

➤ **Global Warming:**

Due to the emission of greenhouse gases, there is an imbalance in the gaseous composition of the air. This has led to an increase in the temperature of the earth. This increase in earth's temperature is known as global warming. This has resulted in the melting of glaciers and an increase in sea levels. Many areas are submerged underwater.

➤ **Acid Rain:**

The burning of fossil fuels releases harmful gases such as nitrogen oxides and sulphur oxides in the air. The water droplets combine with these pollutants, become acidic and fall as acid rain which damages human, animal and plant life.

➤ **Effect on Animals:**

The air pollutants suspend on the water bodies and affect the aquatic life. Pollution also compels the animals to leave their habitat and shift to a new place. This renders them stray and has also led to the extinction of a large number of animal species.

6.9.2 Impact of Air Pollution on Human Health:

The main substances affecting human health are: nitrogen oxides (NO₂), sulphur oxides (SO₂), ozone and particulate matter with the latter – especially particulate matter below 2.5 microns (PM 2.5) – being of greatest concern, as these tiny particles penetrate deep into the lungs, affecting both the respiratory and vascular systems. Both extent and duration of the exposure influence health outcomes.

The impact of air pollution on human health is of growing concern as research unravels more links between a number of serious diseases among various age groups and air pollution e.g., diabetes, neurodevelopment, pre-term birth, low weight birth, etc.

When air pollution occurs in the environment, it affects our physical and psychological well-being in different ways. Our organs like the liver, the lung can damage because of Air Pollution on Human Health.

- **Effects of Air Pollution on Human Health** is increasing day by day. And it becomes a great matter of tension. As a result, people have to face harmful diseases like asthma, chronic bronchitis, emphysema, heart attacks and strokes, and even cancer.
- Child health problem is one of the big effects of Air Pollution on Human Health. In case the air pollutants harm the lungs in the earlier stage of life, children may face big issues like asthma, underdeveloped brains, respiratory infections, and many more.
- During the pregnancy of women, you need to be aware of the effects of Air Pollution on Human Health. You must take the necessary steps as it may cause autism, premature birth, miscarriages, etc.
- Global warming has a major effect on Air Pollution on Human Health. As the temperature of the earth is getting increased daily, therefore it causes air pollution.

- The harmful air pollutants like Sulphur dioxide, carbon monoxide, etc. causes acid rain which spoils crops and causes diseases to human and animal. It is one of the bad effects of Air Pollution on Human Health.
- Eutrophication is a big effect of Air Pollution on Human Health. As a few air pollutants contain a high amount of Nitrogen, therefore these turn themselves into Algae which results in bad further for animals and humans.
- When the number of harmful air pollutants such as chlorofluorocarbons, Hydrofluorocarbons increase, then the ozone layer is starting to deplete. As the ozone layer saves us from UV rays, therefore it is vital for our environment.
- The **effects of Air Pollution on Human Health** are also seen in the reproductive organs, liver, spleen, and blood. The damaged nervous system is also one of the effects of Air Pollution on Human Health.

Table No: 6.8 Human Disease by Air pollution		
Disease	Number	Percentage (%)
Breathing problem	16	7.51%
Heart problem	10	4.69%
Lung disease	4	1.88%
Eye problem	17	7.98%
Dust allergy	16	7.51%
Hair loss	19	8.92%

Source: Field survey 2023

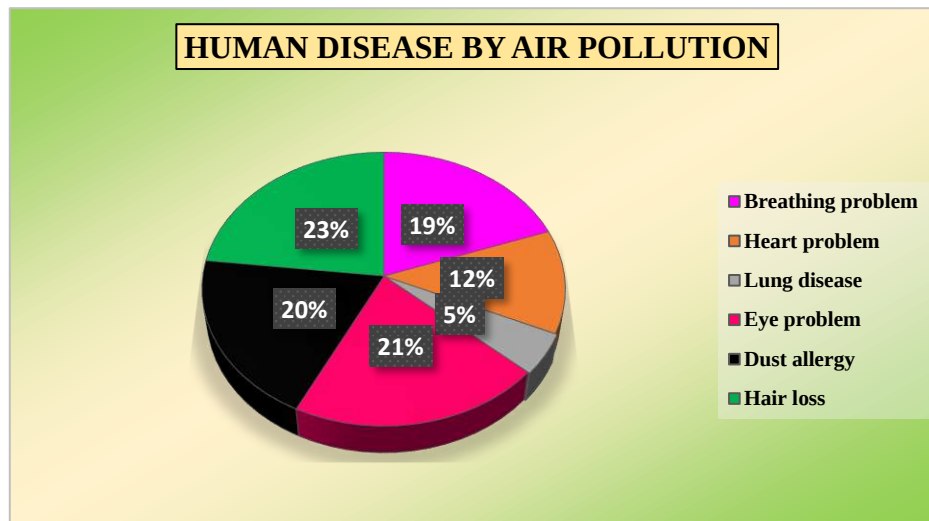


Fig No:6.13 Human Disease by Air Pollution

CHAPTER-7

Basic urban amenities

7.0 Urban Amenities

Basic urban amenities include essential services and facilities necessary for a comfortable and functional urban lifestyle. These amenities comprise clean and safe drinking water, sanitation and waste management systems to maintain hygiene, and reliable electricity for powering homes and businesses. Efficient transportation systems, including roads and public transit, enable easy movement within the city. Access to healthcare facilities and educational institutions ensures residents' well-being and personal development. Adequate housing options offer shelter, while communication networks provide connectivity. Recreational spaces, parks, and cultural centres offer opportunities for relaxation and social interaction. Public safety services, commercial facilities, green spaces, and accessibility features for all residents contribute to a balanced urban environment. These basic amenities collectively create a foundation for a liveable and thriving urban area, enhancing the overall quality of life for its inhabitants.

7.1 Source of Drinking Water:

Water a necessity of humans. The Haldia municipality made tremendous progress in providing safe drinking water to its people. Almost 50 household or 100% household of the study area has access to safe drinking water. So, the study area successfully archived universal (100%) drinking water supply water supply to the households. The main source of drinking Water, a basic necessity of humans. The Haldia municipality made tremendous water is pipe water which is about 50 household (100%)

Table No: 7.1 Source of Drinking Water	
Sources	Household (%)
Piped Water at home	100%
community water tap	0
Hand pump	0
Open Well	0
Any other source	0
Source: Field Survey 2023	

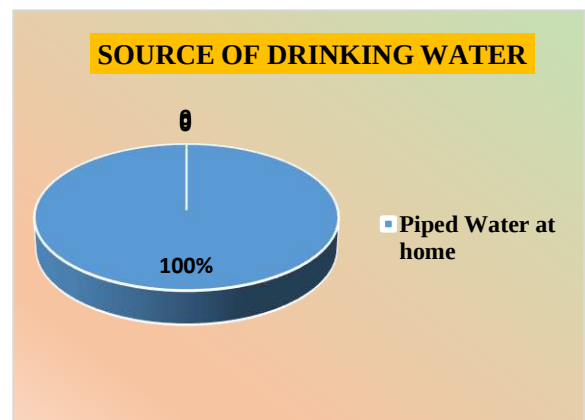


Fig No: 7.1 Source of drinking water

7.2 Electrification Status:

Haldia municipality to provide energy access to all by last mile connectivity and electricity connection to all remaining un-electrified households in study area (ward no-26) to archived universal household electrification. In the study area all households (50) have electricity connection. So, the study area successfully achieved universal household electrification.

Table No.7.2 Electrification Status	
Use of electricity	Household (%)
Yes	100%
No	0%
Source: Field Survey 2023	

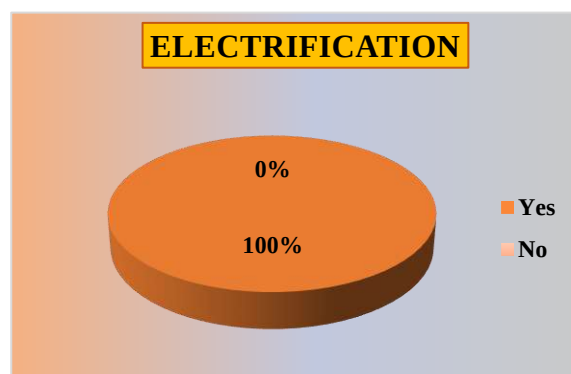


Fig No:7.2 Electrification Status

7.3 Education Facilities:

Haldia (26 no ward) is fast emerging or an educational hub for entire Haldia municipality. Important educational institutions located in 26 no ward of Haldia are i.e. Haldia Government College, Haldia Govt. Spon. Vivekananda Vidyabhaban (H.S), Ranichak Primary School, Debhog Purba primary school, Satyajit Ray NCLP AND some ICDS etc. The study area (word no-26) rich with different educational institutions. The total household 100% households receives different educational facilities. Male and Female both education is more progressive in study area. Almost all household receives educational facilities which is about 100%

Table No:7.3 Education Facilities	
Received education facilities	Household (%)
YES	100%
NO	0%
Source: Field Survey 2023	

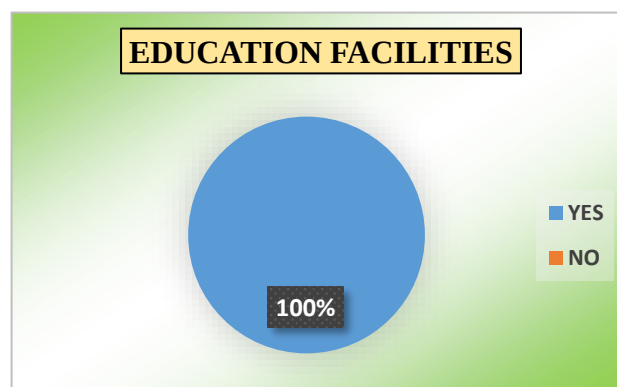


Fig No:7.3 Education Facilities

7.4 Waste Collection System:

In the 26 no ward of Haldia municipality area, the overall households are distributed as follows: approximately 84% of houses have a doorstep collection system, 10% have a common point system, and 6% have no collection system in place.

Table No:7.4 Waste Collection System	
Sources	Household (%)
Door step	84%
Common point	10%
No collection system	6%
Source: Field Survey 2023	

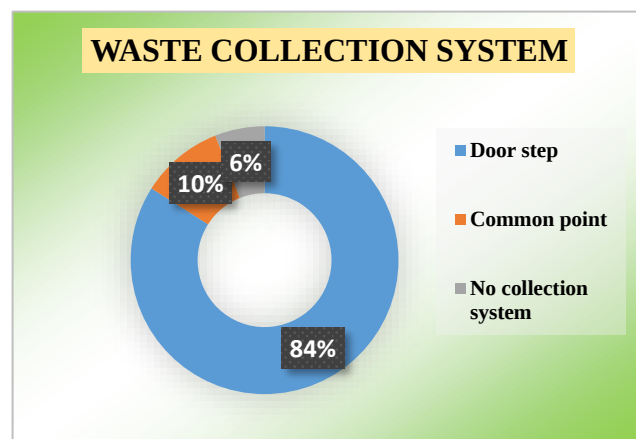


Fig No:7.4 Waste Collection System

7.5 Access to Toilet:

The field data indicates that households in the 26th ward of Haldia municipality use flush toilets connected to septic tanks, ensuring proper sanitation. This results in 100% toilet access within the study area, with all houses effectively connected to septic systems.

Table no:7.5 Toilet Facilities	
Received Toilet Facilities	(%)
YES	100
NO	0
Source: Field Survey 2023	



Fig No:7.5 Toilet Facilities



Plate No: 4 Open Drainage System



7.6 E-Shram card:

The "e-Shram" card is a digital platform introduced by the Government of India to provide social security benefits and welfare measures to unorganized workers. This electronic card serves to register and provide various benefits to workers in the informal sector. It includes details about the worker's occupation, skillset, personal information, and other relevant data. The e-Shram card aims to ensure better identification, record-keeping, and accessibility of social security benefits for workers who are not part of the formal employment sector. It's an initiative to extend support and improve the livelihoods of these workers by granting them access to various government schemes and benefits.

During the field survey conducted in the 26th ward of Haldia municipality, it was found that out of the total households, 55 individuals possess an E-Shram card, while 158 individuals do not have an E-Shram card.

Table No:7.6 E-Shram card		
E-Shram card	Number	Percentage (%)
YES	55	25.82%
NO	158	74.18%
Source: Field Survey 2023		

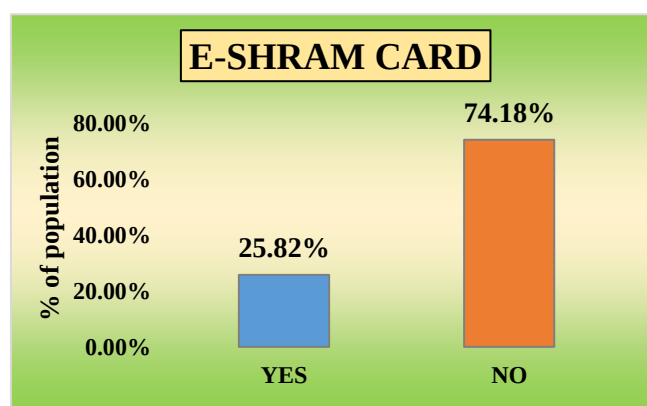


Fig No:7.6 E-Shram Card

CHAPTER-8

Major findings and conclusion

8.1 Major findings:

- Looking at the land use and land cover map, it's evident that the percentage of industrial land use has increased from 5.15% in 2000 to 24.36% in 2020. Simultaneously, the percentage of natural vegetation has decreased from 77.26% in 2000 to 56.4% in 2020 due to industrialization and the expansion of settlements.
- According to the 2011 census data for the study area, the sex ratio stands at 930 females per 1000 males, and the child sex ratio is 877.
- Analysis of age composition reveals that the majority of the population (76.06%) falls into the adult age group, while the smallest portion belongs to the elderly age group (8.92%).
- Survey data also indicate that a significant portion of the population has received education up to the secondary level (30.99%). Regarding marital status, 61.97% are married, and 34.74% are unmarried.
- Poverty levels are notably low in this area, with 88% of households holding APL cards and the remaining 12% classified as BPL holders.
- The majority of residents in the study area are employed in the industrial sector and private companies, with their monthly family income averaging around 30 thousand rupees or more.
- Among the air quality index pollutants in Haldia, PM10 stands out as the most prominent.
- In the study area, the highest AQI recorded was 160 in January, while the lowest was 64 in March.
- Similarly, the highest PM10 reading was 123 in January, while the lowest was 64 in March within the study area.
- According to field surveys conducted in the study area, Haldia municipality supplies drinking water through pipes to approximately 50 households (100%).

8.2 Suggestion:

- ❖ To control air pollution, planting more trees around the ash ponds is essential. It's also feasible to cultivate flowers like sunflowers and China roses in soil mixed with ash.
- ❖ All industries should adhere to proper guidelines set by the pollution control board. Such adherence will significantly contribute to improving air quality.
- ❖ Examining the feasibility of technological advancements in ash disposal and management from different developed countries is crucial for India.
- ❖ Strict rules and registration for ash transportation should be enforced to prevent its spread. Private agencies should face penalties for non-compliance.
- ❖ The plant authority must undertake long-term planning for sediment clearance. Depositing these sediments away from the river would enhance navigability year-round and ensure consistent maintenance.

8.3 Conclusion:

Air is an essential element for all life on the planet; without it, no creature can survive. In the era of globalization, air has become a highly significant matter in the contemporary world. Air quality is a significant concern, particularly in developed cities and megacities, where it often falls short of desired standards. The primary cause of this issue is secondary activities. Haldia, an emerging port city in India, is no exception to this trend. While Haldia is experiencing rapid growth and development, it is chiefly identified as an industrial hub. With over 25 operational industries and several proposed ones, the city's economy is deeply intertwined with industrial activities. Unfortunately, the air quality in Haldia is far from satisfactory due to human activities, particularly industrialization and traffic congestion. Addressing this concern requires comprehensive efforts from the Haldia development authority. Improving the quality of technology and mechanisms within the industrial belt, expanding highways, rigorously adhering to pollution control board regulations, and establishing a robust management system are imperative steps. In conclusion, the significance of air quality cannot be overstated, and Haldia's trajectory as an industrial city necessitates a proactive approach to enhance air quality through strategic measures.

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