ES Assignment 2:

Prepare a climate change strategy for your town, city, or building

Subject- Environmental Sustainability
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Sr.no

1:- Introduction:-

Climate change is one of the most urgent challenges facing our community today. Rising temperatures, unpredictable weather patterns, and increasing frequency of extreme events such as floods, heatwaves, and droughts threaten our environment, economy, and quality of life. As a responsible community, it is imperative that we develop a comprehensive climate change strategy to reduce our carbon footprint, enhance resilience, and promote sustainable development.

This strategy aims to outline actionable steps that our town/city/building can take to mitigate greenhouse gas emissions, adapt to the changing climate, and safeguard the well-being of current and future generations. By embracing renewable energy, improving energy efficiency, conserving natural resources, and fostering community awareness, we can build a sustainable, resilient, and thriving environment for all.

2:- Objective:-

- Promote sustainable resource management including water conservation, waste reduction, and sustainable transportation.
- Support economic growth that aligns with environmental sustainability and promotes green jobs and innovation.

3:- Methodology:-

3.1. List of parameters:

- Rainfall
- Air quality index
- Water quality index
- Temporal changes
- Land use land cover

4:- Observation(Sample Data) :-

4.1 Water quality index

hs	Parameters								
	pH	Dissolved Oxygen (mg/l)	B.O.D. (mg/l)	C.O.D. (mg/l)	Nitrate (mg/l)	Fecal Coliform (MPN/100 ml)	WQI		
: 2024									
ry	7.6	2.5	32.5	88	1.45	110	40.14		
ary	7.7	3.1	30	84	2.41	425	40.28		
h	7.7	3.4	15	72	1.67	540	44.69		
	7.6	3	16	76	0.53	425	43.65		
	7.6	2.8	19.5	80	0.8	175	44.59		
	7.6	1.8	17.1	60	1.75	275	37.99		
	7.5	1.4	16.6	60	0.7	1600	33.35		
st	7.7	1.2	21.5	52	11.94	220	35.13		
ember	7.9	6.3	1(BDL)	5(BDL)	0.66	210	75.76		
ber	7.6	0.3(BDL)	27	100	0.83	130	33.37		
mber	7.6	2.4	31	100	4.95	240	37.30		
mber	7.4	0.3(BDL)	25.7	60	5.23	430	31.12		
==========									
L	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG
	7.4	7.9	7.63	0.3(BDL)	6.3	2.38	1(BDL)	32.5	21.08
	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG
	60	100	69.75	0.53	11.94	2.74	110	1600	398.33

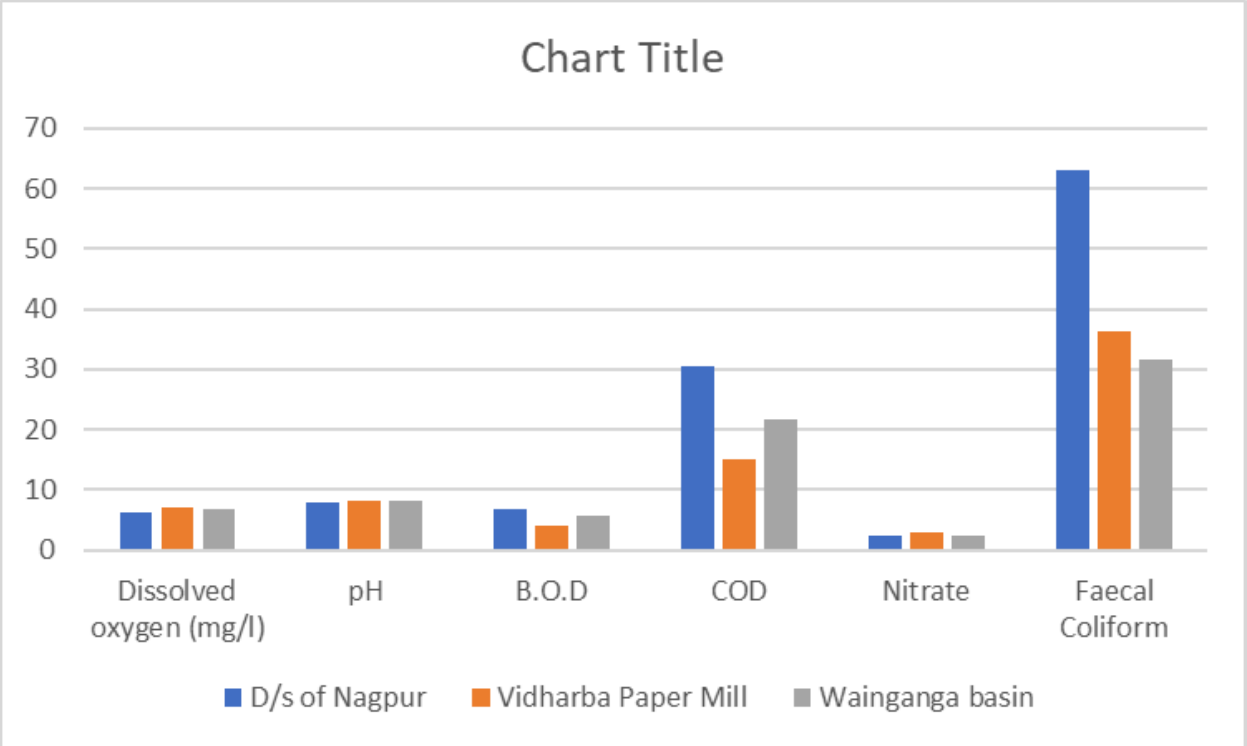
5 :- Graphs:-

A. WQI -

5.1 Analysis of parameters for 3 locations of Kanhan River considering reference year as 2019

Kanhan river

Year : 2019	D/s of Nagpur	Vidharba Paper Mill	Wainganga basin
Dissolved oxygen (mg/l)	6.21	6.99	6.8
pH	8.0	8.26	8.26
B.O.D	6.76	3.99	5.57
COD	30.5	15	21.67
Nitrate	2.51	2.82	2.5
Faecal Coliform	63.13	36.33	31.75



Analysis:-

1) Downstream (D/s) of Nagpur

- **DO 6.21** → good (meets B & C).

- **pH 8.0** → within 6.5–8.5.
- **BOD 6.76** → **fails** B & C (well above 3).
- **COD 30.5** → upper-moderate to high.
- **Nitrate 2.51** → very low (good).

Verdict: Water is well-oxygenated but has **high biodegradable organic load** (likely sewage/effluent inputs from the city). **Class B/C not met** due to BOD.

2) Near Vidarbha Paper Mill

- **DO 6.99** → good.
- **pH 8.26** → within range.
- **BOD 3.99** → **fails** B & C (slightly above 3).
- **COD 15.0** → low (good).
- **Nitrate 2.82** → low.

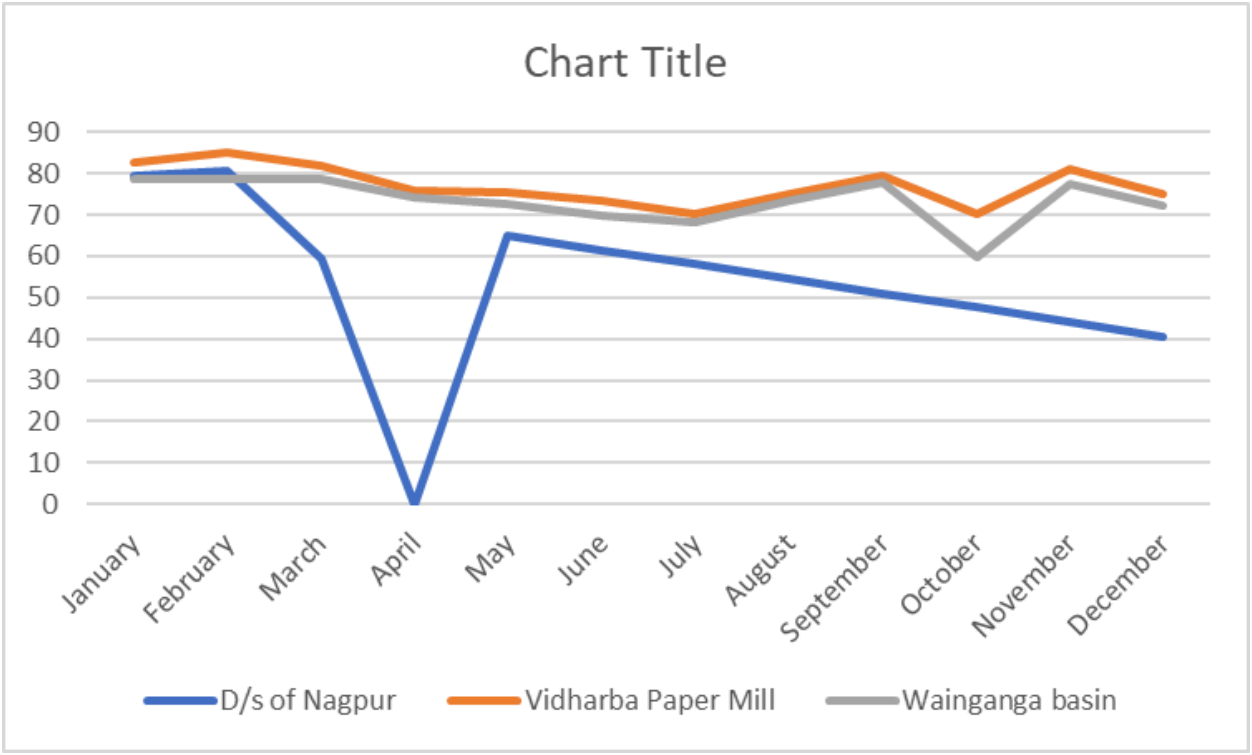
Verdict: Generally better;

3) Wainganga basin (Kanhan reach)

- **DO 6.8** → good.
- **pH 8.26** → within range.
- **BOD 5.57** → **fails** B & C.
- **COD 21.67** → moderate.
- **Nitrate 2.5** → low.
  Verdict: Moderate organic pollution; oxygen levels are fine but BOD is too high for B/C classes.

5.2 Monthly analysis for 2022

Month in 2022	D/s of Nagpur	Vidharba Paper Mill	Wainganga basin
January	79.34	82.63	78.61
February	80.44	85.16	78.5
March	59.46	81.88	78.68
April	74.8]	75.66	74.17
May	64.86	75.41	72.7
June	61.4	73.47	69.76
July	57.94	70.12	68.33
August	54.48	75.14	73.53
September	51.02	79.34	77.68
October	47.56	70.33	59.74
November	44.1	80.94	77.29
December	40.64	75.19	72.35



Analysis:-

- The **Kanhan River quality in 2022** was **best near Paper Mill and Wainganga basin (Good)**.

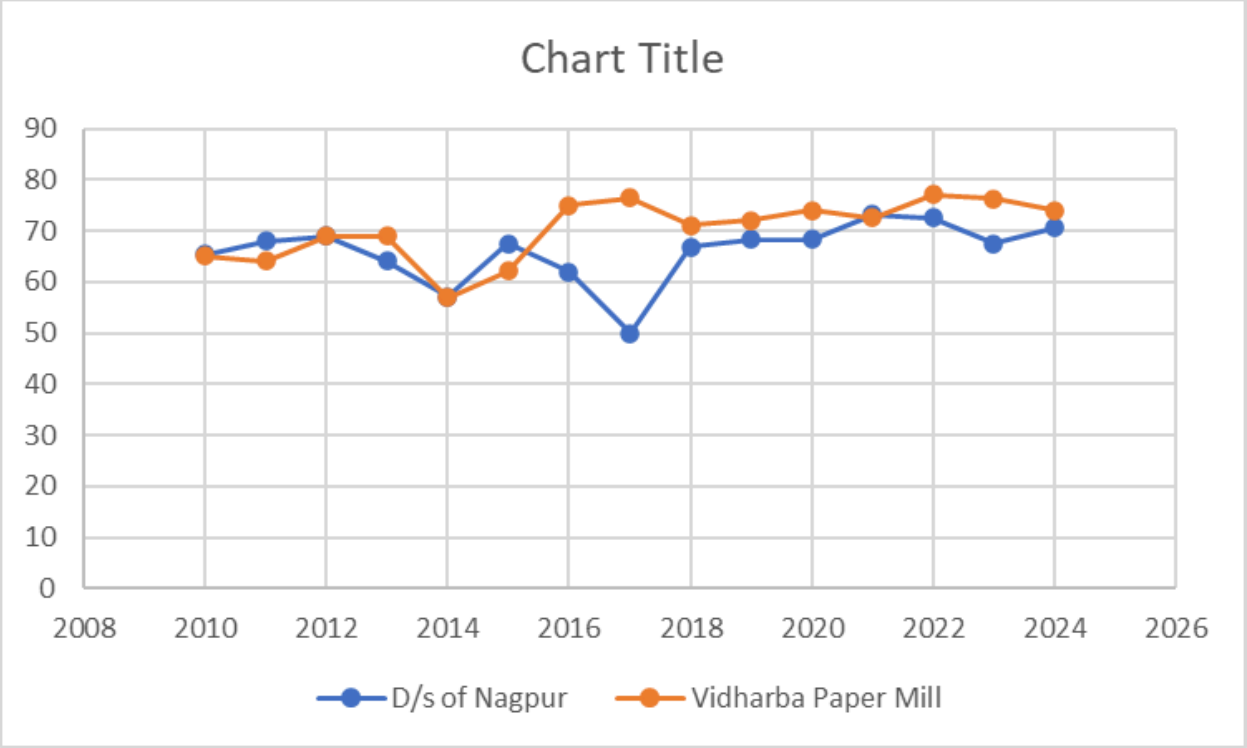
- **Downstream of Nagpur showed serious deterioration (Medium–Poor by year end)** → direct impact of **urban wastewater**.

- Seasonal pattern shows **monsoon dilution is not enough to offset pollution**, and **winter-summer drop is sharpest in urban stretch**.

5.3 Yearly analysis

Month in 2022	**D/s of Nagpur**	**Vidharba Paper Mill**
2010	65.42	65
2011	68	64
2012	69	69
2013	64.02	68.9
2014	57.06	57
2015	67.57	62.1
2016	62	75
2017	50	76.5
2018	66.79	71.01
2019	68.28	72
2020	68.32	74
2021	73.16	72.6
2022	72.58	77.13
2023	67.54	76.3

2024	70.52	74.01



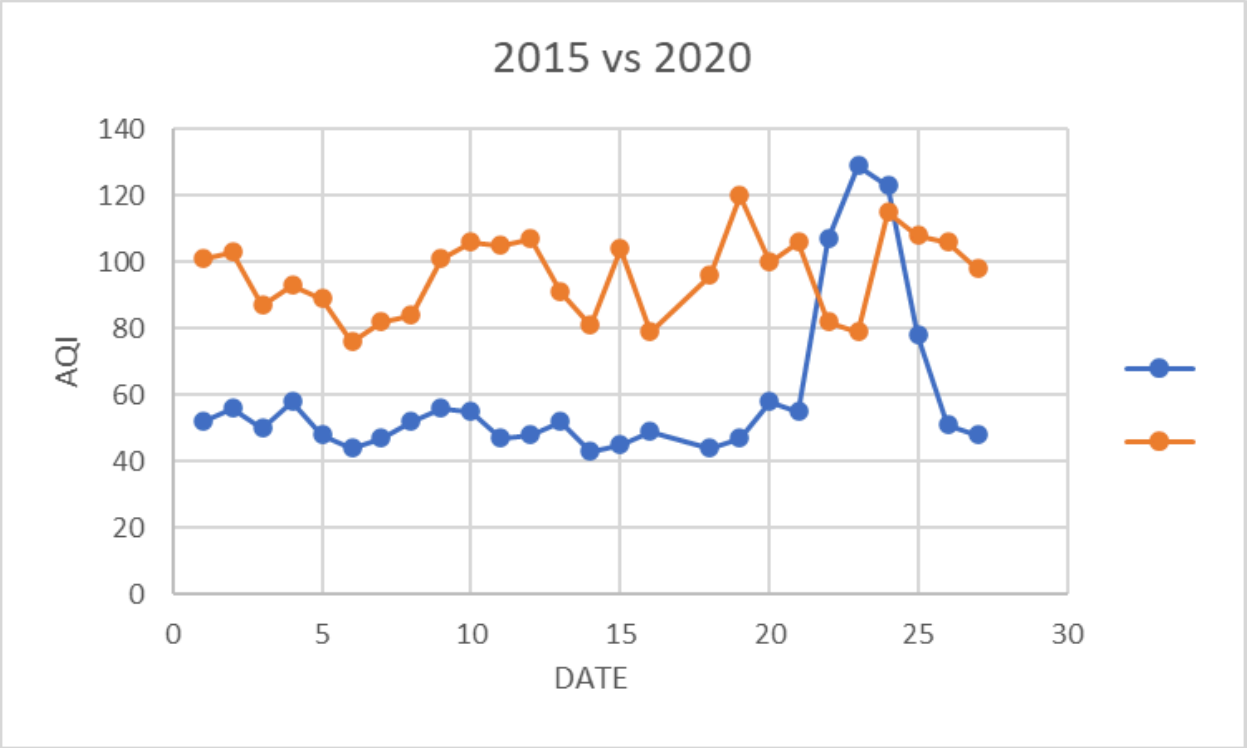
Analysis:-

- **D/s Nagpur:** Highly variable; shows vulnerability to city sewage inputs; improving slightly after 2017 but still unstable.
- **Vidarbha Paper Mill:** Much steadier; marked improvement post-2015; now consistently “Good”.
- **Overall:** Urban stretch (Nagpur downstream) is the weak link, while industrial stretch (Paper Mill) is relatively well-managed.

B. AQI :-

DECEMBER AQI	2015	2020
1	52	101
2	56	103
3	50	87
4	58	93
5	48	89
6	44	76
7	47	82
8	52	84
9	56	101
10	55	106
11	47	105
12	48	107
13	52	91
14	43	81
15	45	104
16	49	79
18	44	96
19	47	120
20	58	100
21	55	106
22	107	82
23	129	79
24	123	115

25	78	108
26	51	106
27	48	98



Analysis and Causes:-

Trends Observed:

- **Overall Increase:** Most days show significantly higher AQI in 2020 compared to 2015 (e.g., Dec 1: 52 → 101; Dec 10: 55 → 106).
- **High Spikes:** The highest AQI in 2015 was 129 (Dec 23), whereas in 2020, several days cross 100, showing persistent “Unhealthy for Sensitive Groups” levels.
- **Some Decrease:** A few days (Dec 22–24) show lower AQI in 2020 than in 2015, indicating day-to-day variability.

Possible Causes of Increased AQI (2015 → 2020):

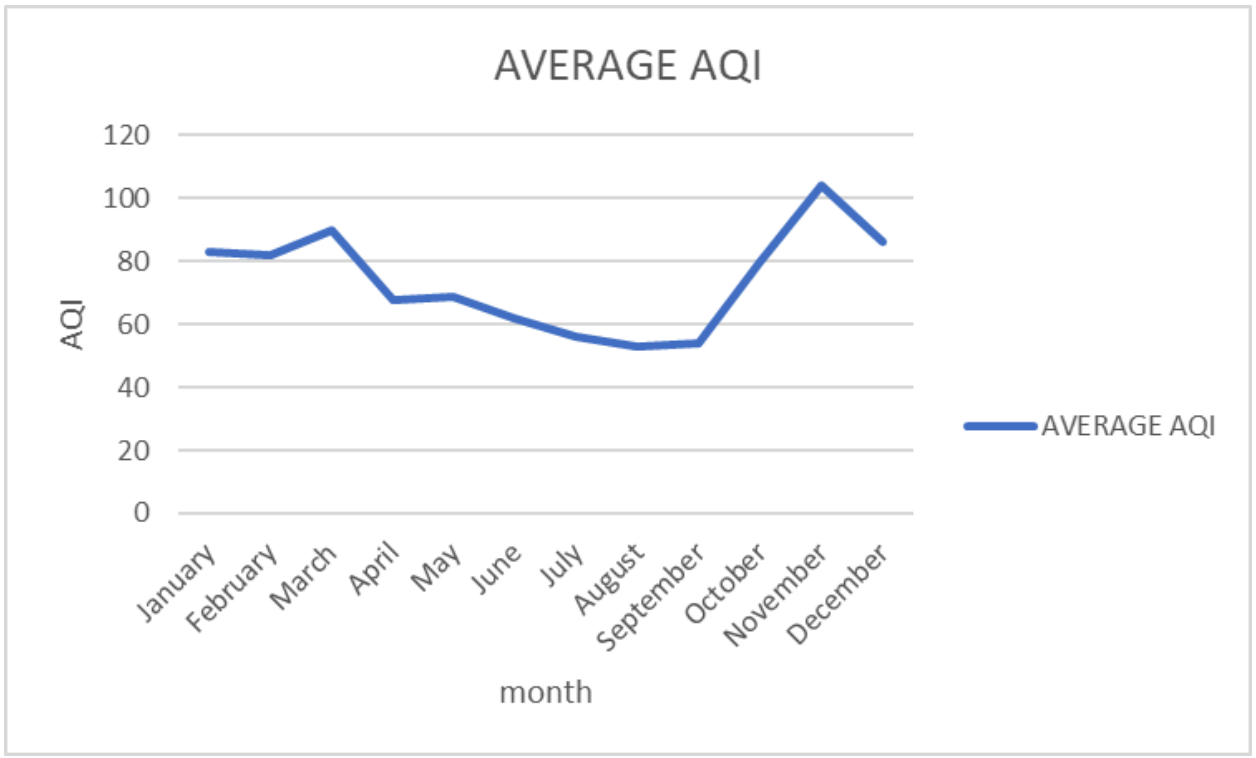
1. **Vehicular emissions:** Rapid increase in vehicles in cities leads to higher PM2.5 and PM10.
2. **Industrial growth:** More factories and power plants contribute to air pollution.

3. **Meteorological factors:** December is winter; lower wind speeds and temperature inversions trap pollutants near the ground.

4. **Construction and road dust:** Dry conditions in winter contribute to particulate matter.

5.2 Seasonal AQI

MONTH (2019)	AVERAGE AQI
January	83
February	82
March	90
April	68
May	69
June	62
July	56
August	53
September	54
October	80
November	104
December	86



Analysis and Causes:-

Monthly Trend:

- **Lowest AQI:** July–September (53–56) – monsoon season, rains help reduce dust and particulate matter.
- **Moderate AQI:** April–June (62–69) – pre-monsoon season, dust contributes moderately.
- **High AQI:** November–January (83–104) – winter months, pollution peaks due to temperature inversion and human activities.
- **Spike in November:** AQI 104 – likely due to Diwali fireworks and stubble burning (if in northern regions).

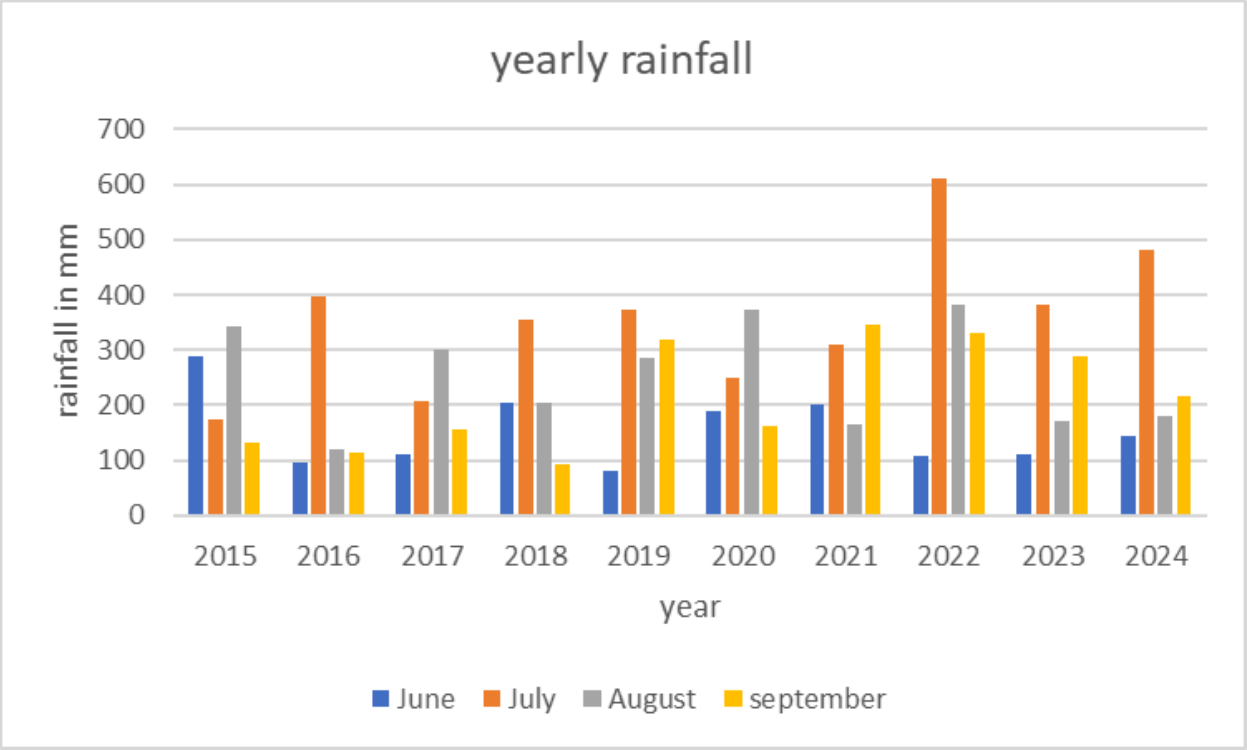
Observations:

- Winter months consistently have poor air quality.
- Monsoon months have cleaner air due to rain washing out pollutants.
- The AQI pattern is strongly **seasonal**, influenced by weather and human activity.

C. Rainfall

5.1 Yearly rainfall:-

Year and season rainfall	June	July	August	september
2015	289.4	173.3	343.8	131.7
2016	97.1	397.2	119.7	115.3
2017	110	205.9	302.1	154.9
2018	204.7	356.2	205.8	92.2
2019	80.9	373.2	284.5	318.1
2020	188.3	249.5	372.2	162
2021	200	309.6	165.7	345
2022	108	611	381	331
2023	111	382	170	289
2024	145.3	482.5	181.6	215.8



Overall Observations

1. **High variability:** Rainfall in monsoon months fluctuates significantly from year to year.
2. **July and September increasing:** Recent years show extreme rainfall in July (2022, 2024) and September (2019–2023).
3. **June less predictable:** Some years see early monsoon deficiency (2016, 2019).
4. **August stable:** Rainfall is relatively moderate-to-high but variable without a clear trend.

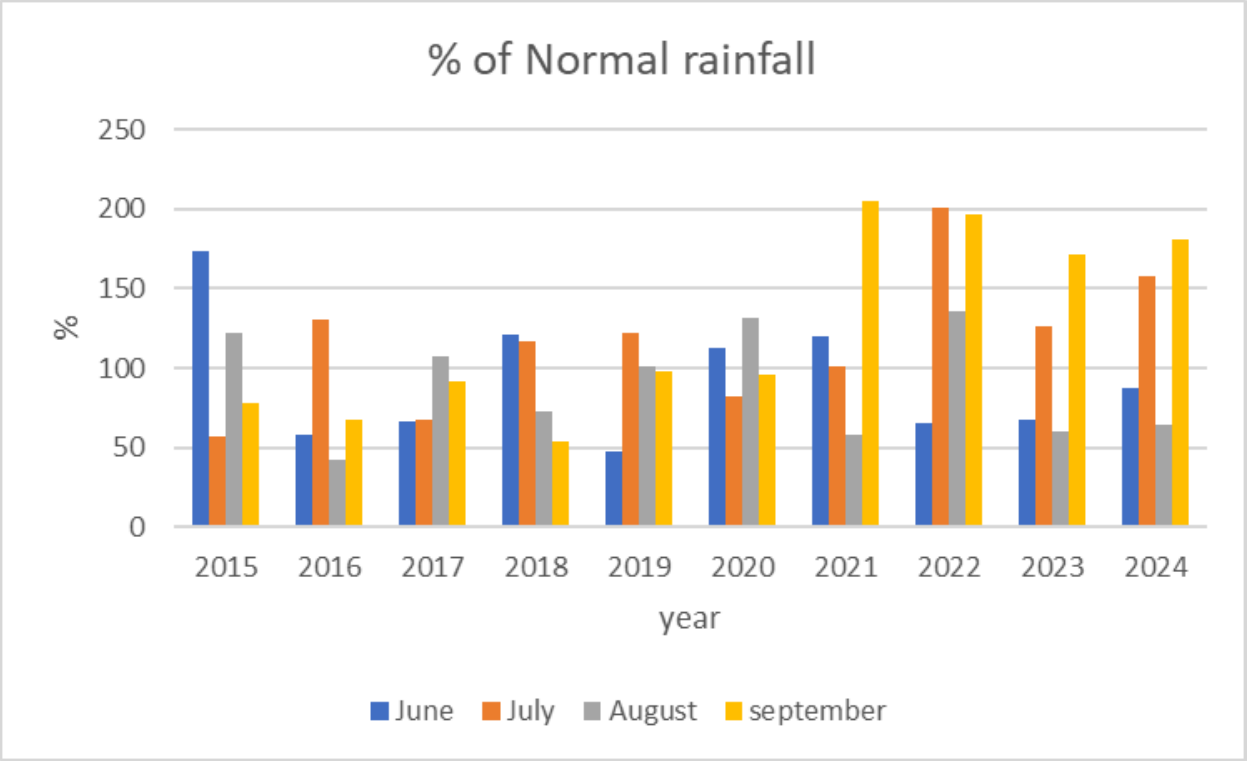
Possible Causes

1. **Climate change:**
    - Rising temperatures cause more intense and erratic monsoon rainfall.
    - Can explain extreme July and September rainfall in recent years.
2. **Monsoon pattern shift:**
    - Early or delayed onset (June deficits) and prolonged withdrawal (heavy September) indicate shifting monsoon patterns.
3. **Urbanization:**
    - Local changes (concrete surfaces, reduced greenery) can increase runoff and perceived rainfall intensity.

5.2 % To the Normal rainfall:-

% to normal	June	July	August	september
2015	174	57.2	122	78.4
2016	58	130	42	68
2017	66	67	107	92
2018	121	117	73	54
2019	48	122	101	98
2020	113	82	132	96
2021	120	101	58	205

2022	65	201	136	197
2023	67	126	60	171.7
2024	87	158	64	181



Analysis and Causes:-

June rainfall is unpredictable: large deviations from normal in both deficit and excess years.

July shows increasing tendency, especially after 2020 → more frequent heavy rain events.

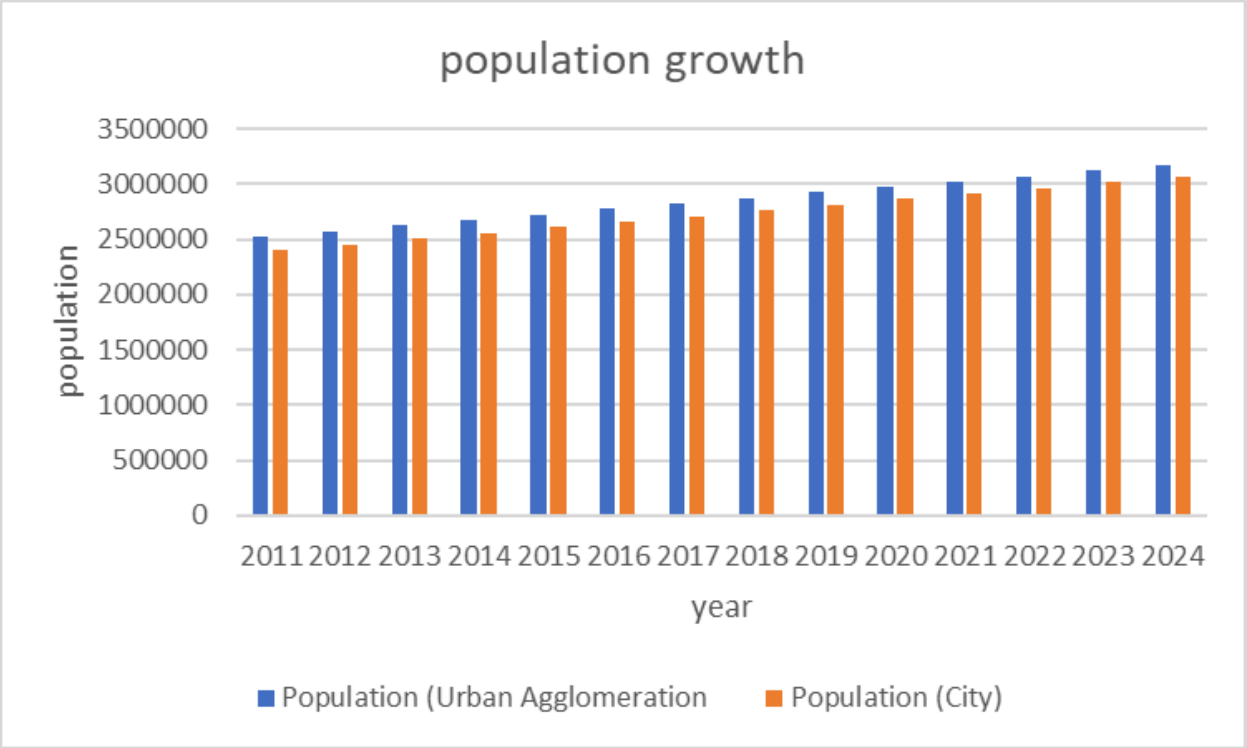
August remains variable, alternating between below and above normal.

September shows a strong upward trend, with multiple years having **well above normal rainfall**, indicating delayed monsoon withdrawal or late heavy rains.

Recent years (2021–2024): high % of normal in July & September → late monsoon extremes are becoming more common

D. Temporal changes(Population) :-

year	**Population (Urban Agglomeration**	**Population (City)**
2011	2523911	2405665
2012	2573000	2456000
2013	2624000	2507000
2014	2674000	2558000
2015	2724000	2609000
2016	2774000	2660000
2017	2824000	2711000
2018	2874000	2762000
2019	2924000	2813000
2020	2974000	2864000
2021	3024000	2915000
2022	3074000	2966000
2023	3124000	3017000
2024	3174000	3068000



Analysis:-

Urban Agglomeration (UA):

- 2011: 2.52 million → 2024: 3.17 million
- Increase of **~650,000** over 13 years.
- **Average annual growth:** ~50,000 per year.

City Population:

- 2011: 2.40 million → 2024: 3.07 million
- Increase of **~660,000** over 13 years.
- **Average annual growth:** ~50,700 per year.

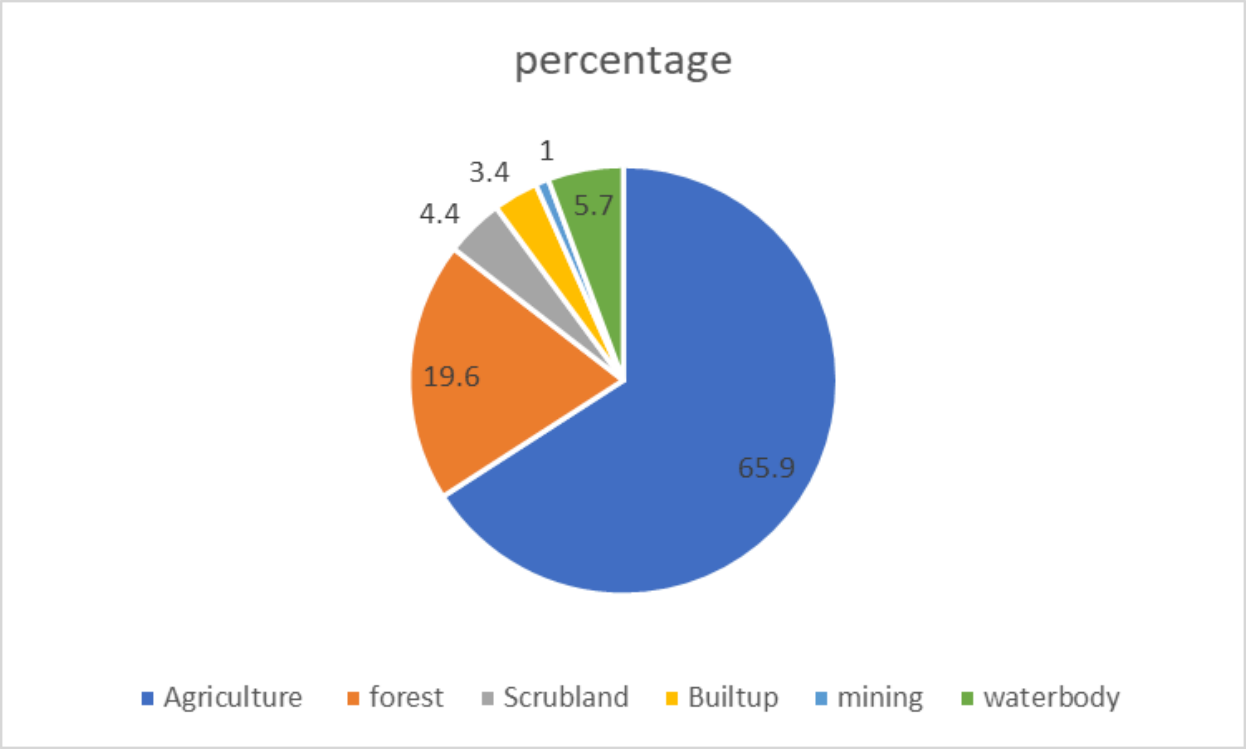
Implications

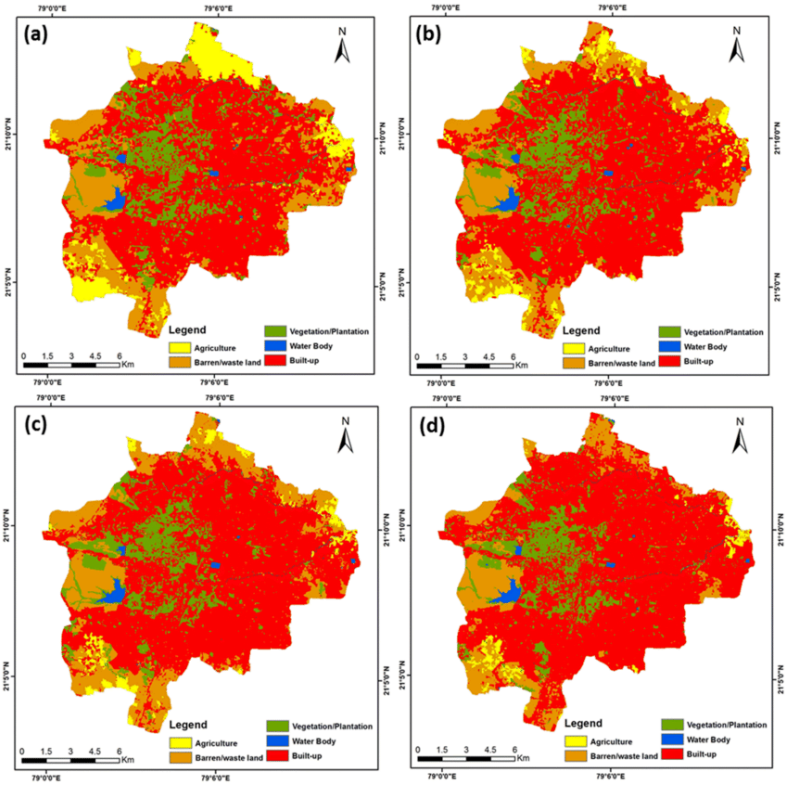
- **Urbanization Trend:** Steady growth indicates Nagpur is expanding, both in city limits and suburbs.

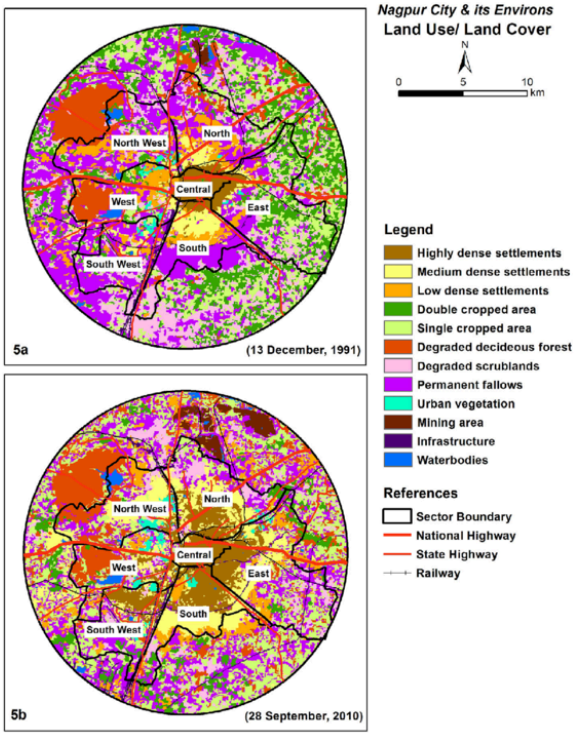
- **Infrastructure Demand:** More population → higher need for housing, water, transportation, and waste management.
- **Environmental Impact:** Population growth may **increase pollution, traffic emissions, and pressure on resources**, which can contribute to **higher AQI** if mitigation measures are not implemented.

E. Land use and land cover:-

LAND USE COVER	percentage
Agriculture	65.9
forest	19.6
Scrubland	4.4
Builtup	3.4
mining	1.0
waterbody	5.7







Increase in Built-up Area:

- Driven by population growth .

- Urban sprawl expands into previously agricultural or green areas.
- Often correlated with **higher AQI** due to construction dust, traffic, and reduced vegetation.

Decrease in Vegetation/Crop Land:

- As cities expand, green cover shrinks.
- Leads to **urban heat island effect** and poorer air quality.

Changes in Water Bodies:

- Encroachment, pollution, or drying up due to climate change or urbanization.
- Can affect local hydrology and groundwater recharge.

Fluctuation in Barren Land:

- Can decrease if land is converted to urban use.
- Sometimes increases if abandoned areas accumulate, e.g., post-industrial zones.

Agricultural Land:

- Often decreases with urban expansion.
- Some peri-urban areas may remain agricultural, especially near city outskirts.

6. Sources of Pollution:-

1. Air Pollution (AQI)

- AQI rises sharply in **winter months** (Nov–Jan).
- December AQI increased from **2015 to 2020**, often above 100 (“Unhealthy for Sensitive Groups”).

- **Monsoon months (July–Sept)** have lower AQI due to rain washing out particulate matter.

Major Sources & Causes:

1. **Vehicular Emissions:**
    - Population growth (~2.4M in 2011 → 3.1M in 2024) → more vehicles → higher NOx, CO, PM2.5/PM10.
2. **Industrial Activities:**
    - Factories, power plants, and construction dust contribute to particulate matter.
3. **Biomass & Crop Burning:**
    - Seasonal crop residue burning in surrounding agricultural areas can spike winter AQI.
4. **Urbanization:**
    - Increased built-up areas reduce vegetation → less pollutant absorption.

Rainfall Influence:

- Monsoon rainfall reduces air pollution by removing dust and particulates.
- Years with below-normal rainfall (June–Sept) show higher AQI trends due to reduced pollutant washout.

2. Water Pollution (WQI)

General trend observations

- Dissolved Oxygen (DO) often low in highly urbanized and industrial areas.
- BOD, COD, and nutrient levels rise due to **domestic sewage and industrial effluents**.

Major Sources & Causes:

1. **Domestic Sewage:**
    - Growing population → more wastewater discharge.
2. **Industrial Effluents:**
    - Chemical industries, tanneries, and textiles → higher BOD/COD.
3. **Urban Runoff:**
    - Rainwater washes pollutants from roads, markets, and construction sites into rivers.
4. **Solid Waste Disposal:**
    - Encroachment of waste into water bodies → deterioration of water quality.

Rainfall Influence:

- Heavy monsoon rainfall can **dilute pollutants**, temporarily improving WQI.
- Conversely, sudden high rainfall can **increase runoff and sediment load**, affecting water quality.

3. Population Growth Impact

- **Population (2011–2024):** 2.4M → 3.1M in city, 2.5M → 3.17M in UA.
- **Impact on Pollution:**
    1. **More vehicles → higher air pollution**.
    2. **Higher water demand → more sewage discharge**.
    3. **Urban sprawl → loss of green cover**, increasing AQI and decreasing natural pollutant absorption.
    4. **Waste generation** rises with population, affecting both air and water quality.

4. Land Use & Urbanization Contribution

- **Trend:** Increasing built-up areas, decreasing vegetation/green cover.
- **Impact:**
    - Less tree cover → less dust and particulate absorption.
    - More impervious surfaces → more runoff and potential water pollution.
    - Encroachment on natural water bodies → lower water quality.

5. Rainfall Influence on Pollution

- **Monsoon (June–Sept):**
    - Washes away air pollutants → temporarily improves AQI.
    - High rainfall can **dilute water pollutants**, improving WQI.
- **Deficient rainfall years:**
    - Reduced washout → higher AQI.
    - Less dilution → higher pollutant concentration in rivers.

7. Recommendations (Nagpur)

Air Quality Improvement

1. **Control Vehicular Emissions in Nagpur:**
    - Promote public transport, electric vehicles, and stricter emission standards in the city.
    - Implement carpooling and traffic management in congested areas like Sitabuldi and Dharampeth.
2. **Industrial Emission Regulation:**
    - Enforce pollution control equipment in Nagpur's industrial zones (MIDC areas).
3. **Increase Green Cover:**

- Urban afforestation programs, parks, and green belts along major roads to absorb pollutants.

4. **Seasonal Pollution Management:**

    - Monitor air quality during winter (Nov–Jan) and implement temporary emission restrictions.

Water Quality Improvement

1. **Wastewater Treatment:**

    - Upgrade municipal sewage treatment plants discharging into rivers such as the Nag River and its tributaries.

2. **Industrial Effluent Control:**

    - Strict monitoring of industrial wastewater from MIDC and other industrial areas.

3. **Solid Waste Management:**

    - Prevent dumping of waste into Nag River and local ponds.

    - Promote recycling and composting programs.

Land Use and Urban Planning

1. **Sustainable Urban Development:**

    - Limit conversion of green and agricultural areas in Nagpur's periphery into urban settlements.

2. **Stormwater Management:**

    - Use permeable pavements, rain gardens, and retention ponds to reduce runoff during monsoon.

Public Awareness

- Community engagement programs for pollution mitigation in neighborhoods and schools.

- Educate Nagpur residents on reducing indoor and outdoor pollution sources.

8. Conclusion (Nagpur)

- Nagpur has seen **steady population growth (Urban Agglomeration: 2.52M in 2011 → 3.17M in 2024)** and expansion of built-up areas.

- **Air Quality (AQI) trends** indicate worse air quality in winter months, primarily due to vehicular emissions, industrial activities, and construction dust.

- **Water Quality (WQI) trends** show domestic sewage and industrial effluents are the major contributors to water pollution in rivers like Nag River.

- **Rainfall patterns** influence pollution: heavy monsoon improves air quality but can increase water runoff and sediment loads.

- **Integrated analysis** shows that population growth, urbanization, industrial activity, and seasonal climatic factors collectively drive pollution trends in Nagpur.

- **Recommendations** focus on sustainable urban planning, pollution control measures, green infrastructure, and public awareness to improve both air and water quality in Nagpur.

9. References:

https://mpcb.gov.in/node
https://maharain.maharashtra.gov.in/test/maharain/
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