Co-funded by the
Erasmus+ Programme
of the European Union

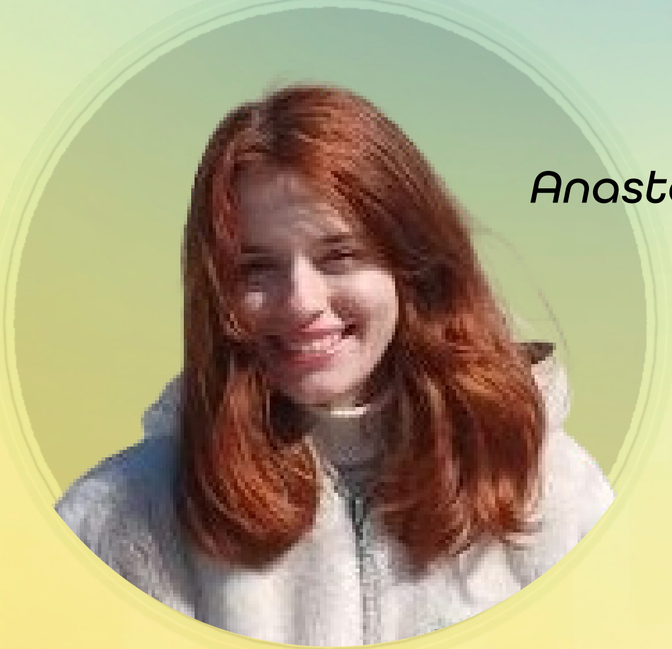
GROMADA

CITIZEN-SCIENCE STUDENT PROJECT UNDER GROMADA ERASMUS+: MONITORING AIR QUALITY IN URBAN AREAS

DEPARTMENT OF METEOROLOGY AND CLIMATOLOGY

ODESA I.I.MECHNIKOV NATIONAL UNIVERSITY 1865

MEET THE TEAM



Anastasiia Mokan

Tetiana Chorna

Dmytro Vakarchuk

Zlata Bratova

Arduino-Based Air Quality Monitoring Stations

Sensors and Measurements

The station includes multiple sensors for comprehensive air quality and environmental monitoring:

- **PMSA003 (Plantower)** – Measures PM1.0, PM2.5, and PM10, providing fine particulate pollution data.
- **SenseAir S8-0053 (NDIR)** – Monitors CO_2 levels (0–5000 ppm), useful for assessing ventilation quality.
-
- **SC01-O3** – Detects ozone (O_3), important for identifying smog and industrial pollution.
- **MQ-135** – Detects volatile organic compounds (VOCs) like ammonia, benzene, and smoke. Requires calibration.
- **BME280** – Records temperature, relative humidity, and atmospheric pressure, offering meteorological context for pollutant levels.

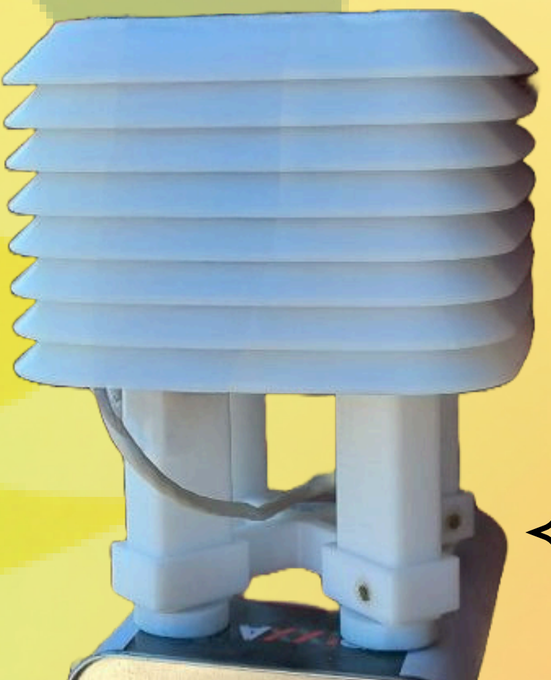
Why Monitoring Air Pollution Matters – What are PM1.0, PM2.5, and PM10?

Tiny particles in the air—called PM1.0, PM2.5, and PM10—can seriously harm our health.

- PM10 particles irritate the nose and throat and can trigger asthma, coughing, and bronchitis.
- PM2.5 particles go deeper into the lungs, reaching areas where oxygen is absorbed into the body–linked to lung disease, heart problems, and even early death.
- PM1.0 are so small they can enter the bloodstream, affecting the heart, brain, and other organs.
- These particles often carry harmful substances like heavy metals, chemicals, and bacteria. That's why air quality monitoring is essential–especially in cities or postwar areas where pollution can increase health risks.

Ground-Level Ozone (O_3): A Harmful Air Pollutant

While ozone high in the atmosphere protects us from harmful UV rays, ground-level ozone is a serious air pollutant that poses major health risks.



- It forms when nitrogen oxides (NOx) and volatile organic compounds (VOCs) react in sunlight—especially in cities and industrial areas.
- When inhaled, ozone:
  - Irritates the respiratory system
  - Triggers coughing, sore throat, and shortness of breath
  - Reduces lung function and worsens asthma, bronchitis, and COPD
  - Can lead to increased hospital visits and even premature death
- Ozone weakens the immune system, increases oxidative stress, and affects not only the lungs but also the cardiovascular system.

Why Monitoring Carbon Dioxide (CO_2)

Why Monitoring Carbon Dioxide (CO_2) Matters

Carbon dioxide (CO_2) is a naturally occurring gas in the atmosphere, but elevated levels can pose serious environmental and health risks.

In enclosed or poorly ventilated spaces, high CO_2 levels can:

- Cause headaches, dizziness, and fatigue
- Reduce concentration and cognitive performance
- Worsen conditions for people with heart or lung problems

On a global scale, CO_2 is a major greenhouse gas driving climate change. Its buildup in the atmosphere contributes to:

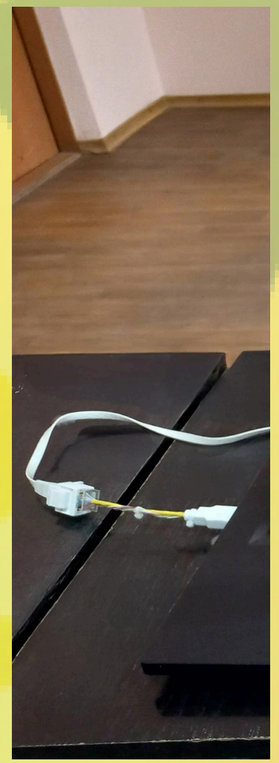
- Rising temperatures
- Extreme weather events
- Long-term changes in ecosystems and sea levels

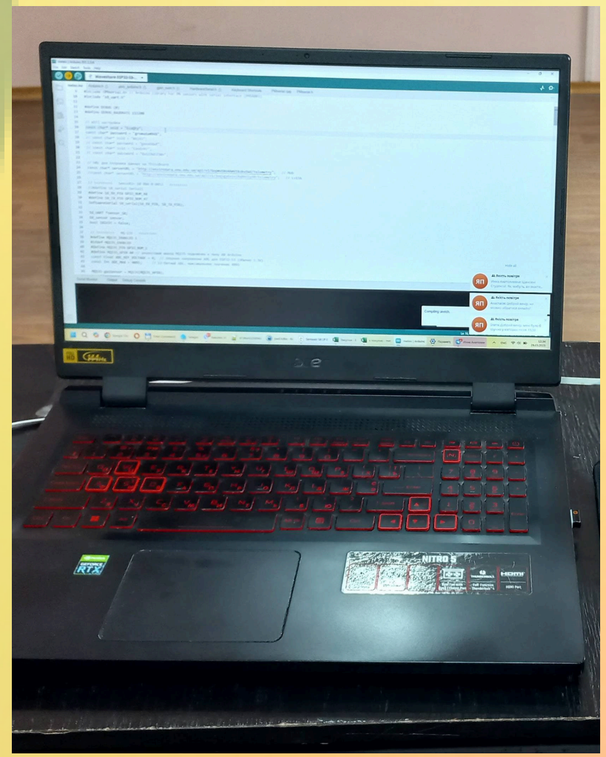
Air Quality Monitoring Stations

OBSERVATIONS

Data Collection and Visualization via ThingsBoard

✧Data Visualization via ThingsBoard

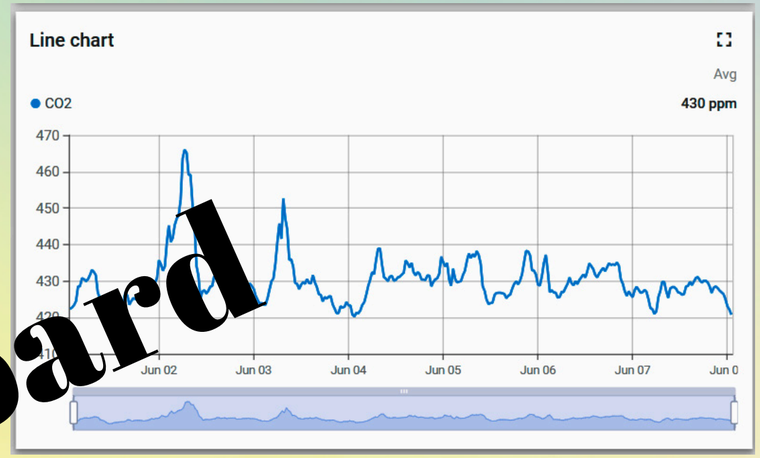


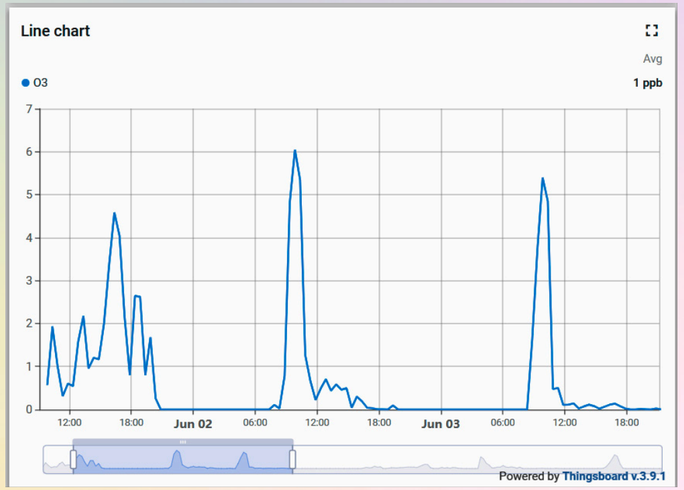


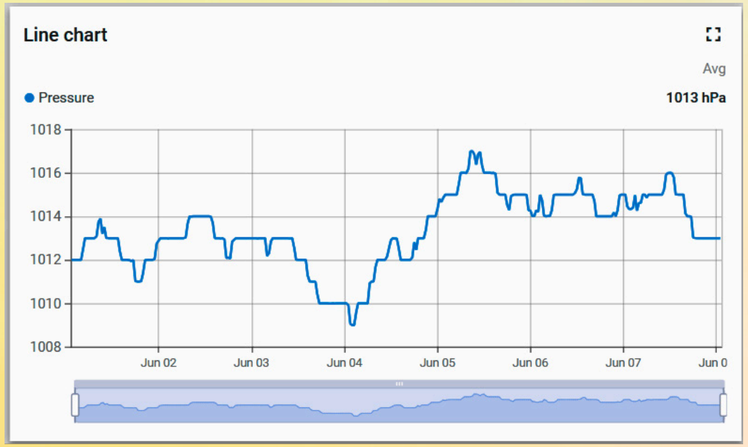
All stations are integrated with ThingsBoard, an open-source IoT platform used for:

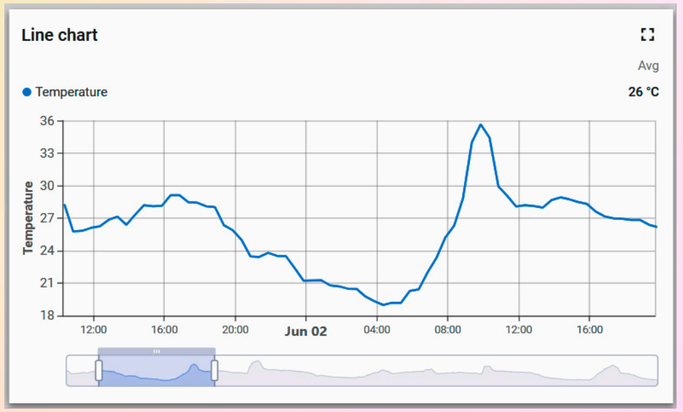
- Real-time data acquisition via Wi-Fi using MQTT or HTTP protocols.
- Custom dashboards showing particulate matter, CO~, temperature, humidity, and pressure trends.
- Alerts when air pollution exceeds defined thresholds.
- Historical data analysis, enabling long-term environmental assessments.

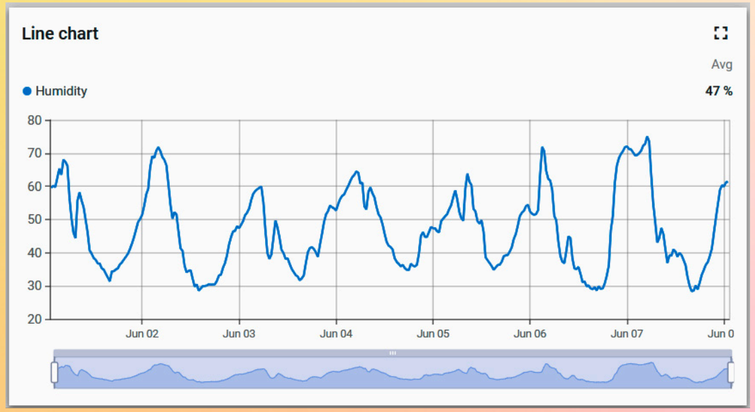
ThingsBoard

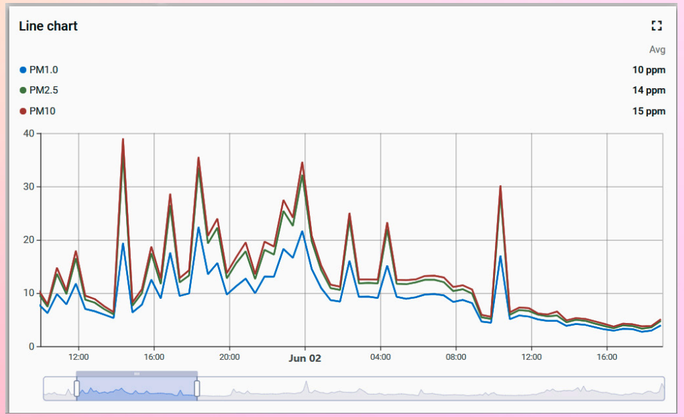




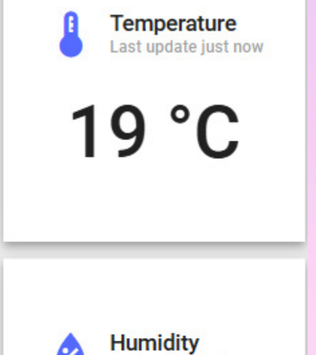


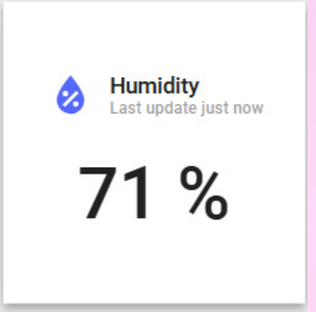






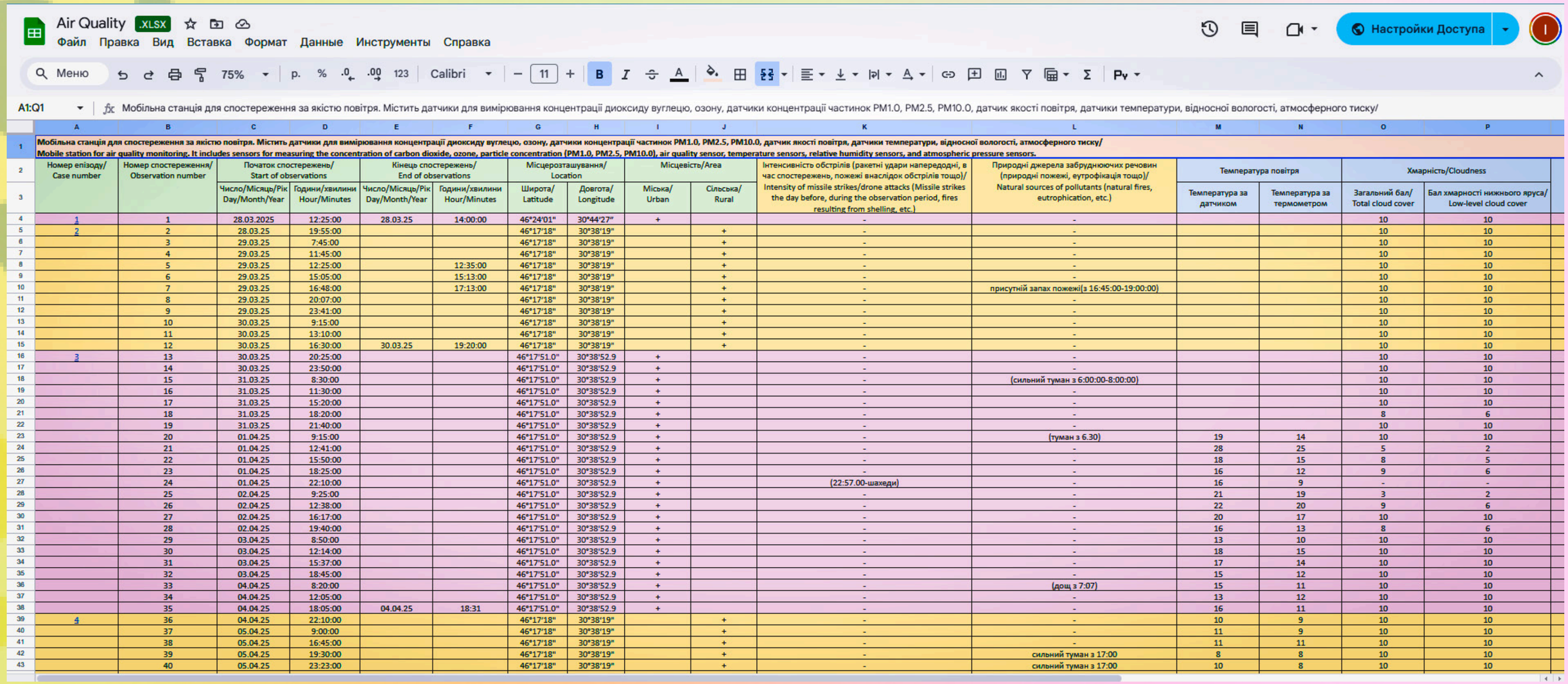
SCAN ME





Complementary Data Tables (Google Sheets)

SCAN ME



Air Quality .XLSX

Файл Правка Вид Вставка Формат Данные Инструменты Справка

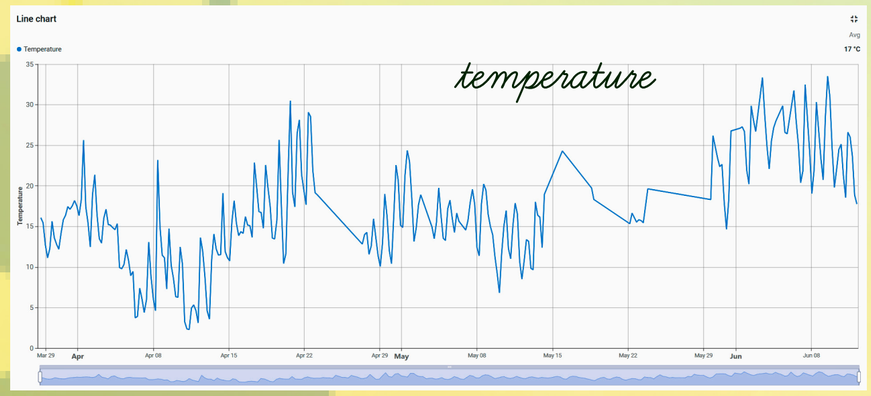
Настройки Доступа

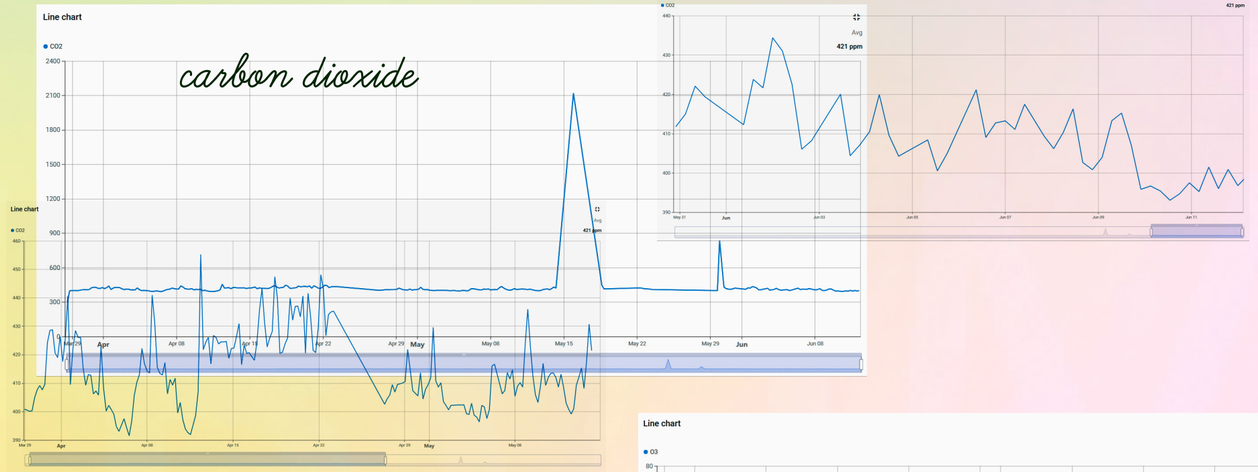
A1:Q1 | Мобільна станція для спостереження за якістю повітря. Містить датчики для вимірювання концентрації діоксиду вуглецю, озону, датчики концентрації частинок PM1.0, PM2.5, PM10.0, датчик якості повітря, датчики температури, відносної вологості, атмосферного тиску/

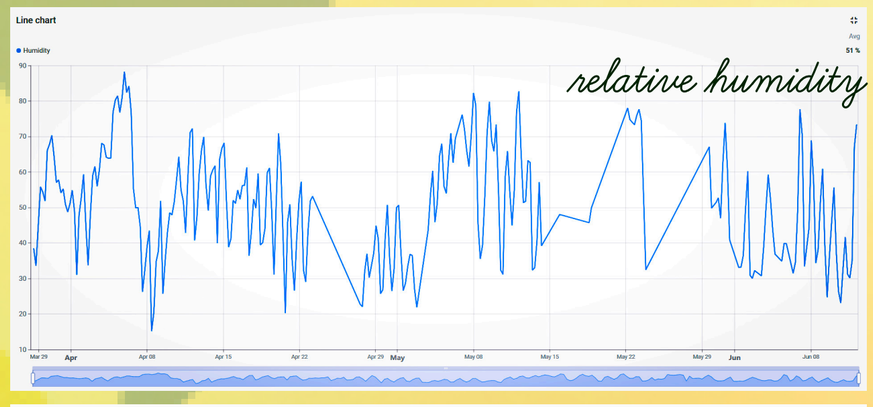
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Мобільна станція для спостереження за якістю повітря. Містить датчики для вимірювання концентрації діоксиду вуглецю, озону, датчики концентрації частинок PM1.0, PM2.5, PM10.0, датчик якості повітря, датчики температури, відносної вологості, атмосферного тиску/ Mobile station for air quality monitoring. It includes sensors for measuring the concentration of carbon dioxide, ozone, particle concentration (PM1.0, PM2.5, PM10.0), air quality sensor, temperature sensors, relative humidity sensors, and atmospheric pressure sensors.															
2	Номер епізоду/ Case number	Номер спостереження/ Observation number	Початок спостережень/ Start of observations		Кінець спостережень/ End of observations		Місцерозташування/ Location		Місцевість/Area		Інтенсивність обстрілів (ракетні удари напередодні, в час спостережень, пожежі внаслідок обстрілів тощо)/ Intensity of missile strikes/drone attacks (Missile strikes the day before, during the observation period, fires resulting from shelling, etc.)	Природні джерела забруднюючих речовин (природні пожежі, еутрофікація тощо)/ Natural sources of pollutants (natural fires, eutrophication, etc.)	Температура повітря		Хмарність/Cloudness	
3			Число/Місяць/Рік Day/Month/Year	Години/хвилини Hour/Minutes	Число/Місяць/Рік Day/Month/Year	Години/хвилини Hour/Minutes	Широта/ Latitude	Довгота/ Longitude	Міська/ Urban	Сільська/ Rural			Температура за датчиком	Температура за термометром	Загальний бал/ Total cloud cover	Бал хмарності нижнього яруса/ Low-level cloud cover
4	1	1	28.03.2025	12:25:00	28.03.25	14:00:00	46°24'01"	30°44'27"	+		-	-			10	10
5	2	2	28.03.25	19:55:00			46°17'18"	30°38'19"		+	-	-			10	10
6		3	29.03.25	7:45:00			46°17'18"	30°38'19"		+	-	-			10	10
7		4	29.03.25	11:45:00			46°17'18"	30°38'19"		+	-	-			10	10
8		5	29.03.25	12:25:00		12:35:00	46°17'18"	30°38'19"		+	-	-			10	10
9		6	29.03.25	15:05:00		15:13:00	46°17'18"	30°38'19"		+	-	-			10	10
10		7	29.03.25	16:48:00		17:13:00	46°17'18"	30°38'19"		+	-	присутній запах пожежі(з 16:45:00-19:00:00)			10	10
11		8	29.03.25	20:07:00			46°17'18"	30°38'19"		+	-	-			10	10
12		9	29.03.25	23:41:00			46°17'18"	30°38'19"		+	-	-			10	10
13		10	30.03.25	9:15:00			46°17'18"	30°38'19"		+	-	-			10	10
14		11	30.03.25	13:10:00			46°17'18"	30°38'19"		+	-	-			10	10
15		12	30.03.25	16:30:00	30.03.25	19:20:00	46°17'18"	30°38'19"		+	-	-			10	10
16	3	13	30.03.25	20:25:00			46°17'51.0"	30°38'52.9	+		-	-			10	10
17		14	30.03.25	23:50:00			46°17'51.0"	30°38'52.9	+		-	-			10	10
18		15	31.03.25	8:30:00			46°17'51.0"	30°38'52.9	+		-	(сильний туман з 6:00:00-8:00:00)			10	10
19		16	31.03.25	11:30:00			46°17'51.0"	30°38'52.9	+		-	-			10	10
20		17	31.03.25	15:20:00			46°17'51.0"	30°38'52.9	+		-	-			10	10
21		18	31.03.25	18:20:00			46°17'51.0"	30°38'52.9	+		-	-			8	6
22		19	31.03.25	21:40:00			46°17'51.0"	30°38'52.9	+		-	-			10	10
23		20	01.04.25	9:15:00			46°17'51.0"	30°38'52.9	+		-	(туман з 6.30)	19	14	10	10
24		21	01.04.25	12:41:00			46°17'51.0"	30°38'52.9	+		-	-	28	25	5	2
25		22	01.04.25	15:50:00			46°17'51.0"	30°38'52.9	+		-	-	18	15	8	5
26		23	01.04.25	18:25:00			46°17'51.0"	30°38'52.9	+		-	-	16	12	9	6
27		24	01.04.25	22:10:00			46°17'51.0"	30°38'52.9	+		(22:57.00-шахеди)	-	16	9	-	-
28		25	02.04.25	9:25:00			46°17'51.0"	30°38'52.9	+		-	-	21	19	3	2
29		26	02.04.25	12:38:00			46°17'51.0"	30°38'52.9	+		-	-	22	20	9	6
30		27	02.04.25	16:17:00			46°17'51.0"	30°38'52.9	+		-	-	20	17	10	10
31		28	02.04.25	19:40:00			46°17'51.0"	30°38'52.9	+		-	-	16	13	8	6
32		29	03.04.25	8:50:00			46°17'51.0"	30°38'52.9	+		-	-	13	10	10	10
33		30	03.04.25	12:14:00			46°17'51.0"	30°38'52.9	+		-	-	18	15	10	10
34		31	03.04.25	15:37:00			46°17'51.0"	30°38'52.9	+		-	-	17	14	10	10
35		32	03.04.25	18:45:00			46°17'51.0"	30°38'52.9	+		-	-	15	12	10	10
36		33	04.04.25	8:20:00			46°17'51.0"	30°38'52.9	+		-	(дощ з 7:07)	15	11	10	10
37		34	04.04.25	12:05:00			46°17'51.0"	30°38'52.9	+		-	-	13	12	10	10
38		35	04.04.25	18:05:00	04.04.25	18:31	46°17'51.0"	30°38'52.9	+		-	-	16	11	10	10
39	4	36	04.04.25	22:10:00			46°17'18"	30°38'19"		+	-	-	10	9	10	10
40		37	05.04.25	9:00:00			46°17'18"	30°38'19"		+	-	-	11	9	10	10
41		38	05.04.25	16:45:00			46°17'18"	30°38'19"		+	-	-	11	11	10	10
42		39	05.04.25	19:30:00			46°17'18"	30°38'19"		+	-	сильний туман з 17:00	8	8	10	10
43		40	05.04.25	23:23:00			46°17'18"	30°38'19"		+	-	сильний туман з 17:00	10	8	10	10

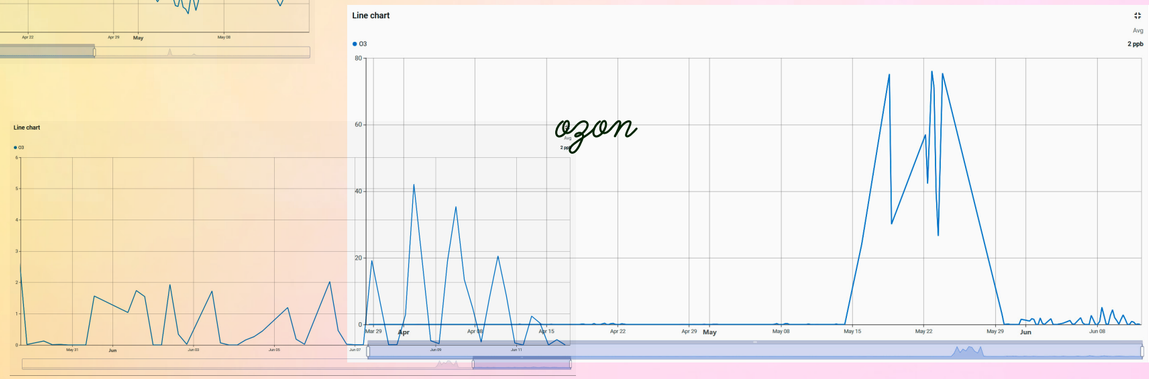
Data Analysis

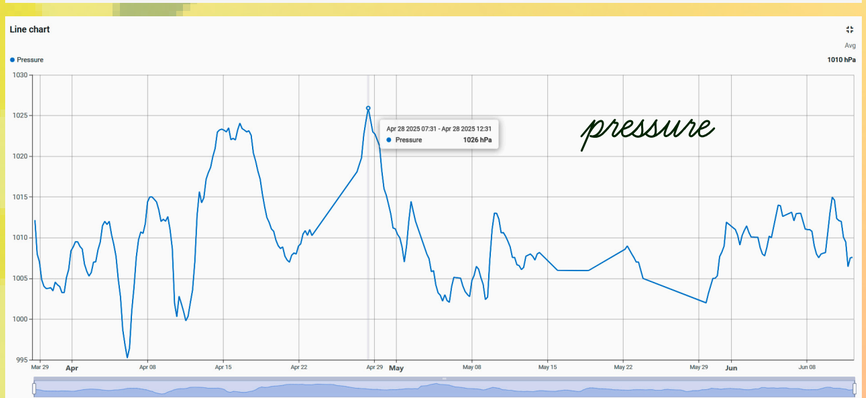
Data covering the entire observation period from March 28 to June 11

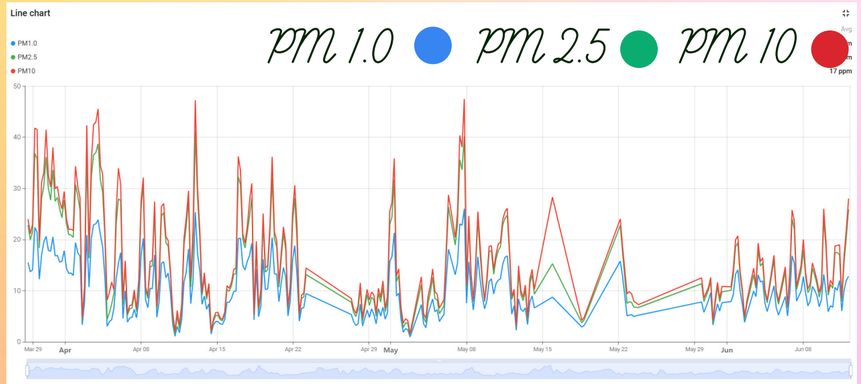






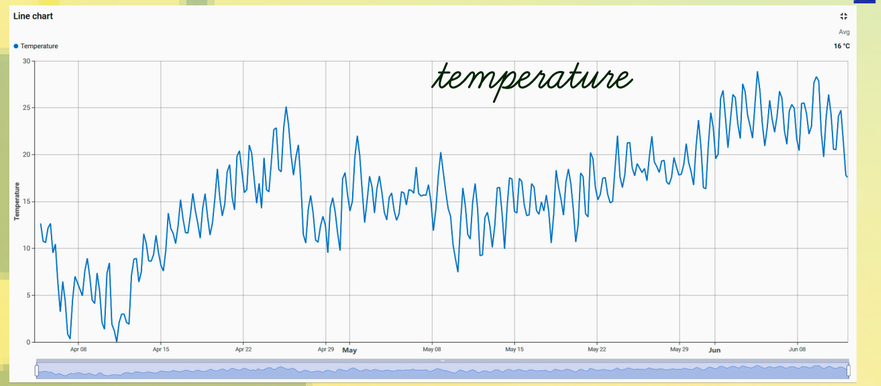


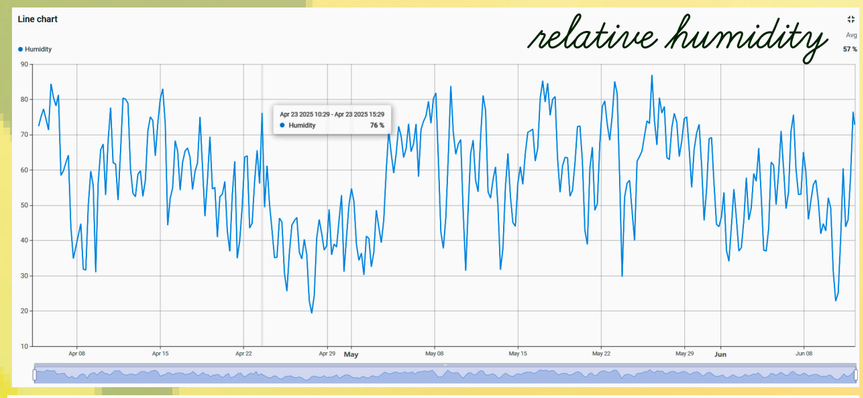


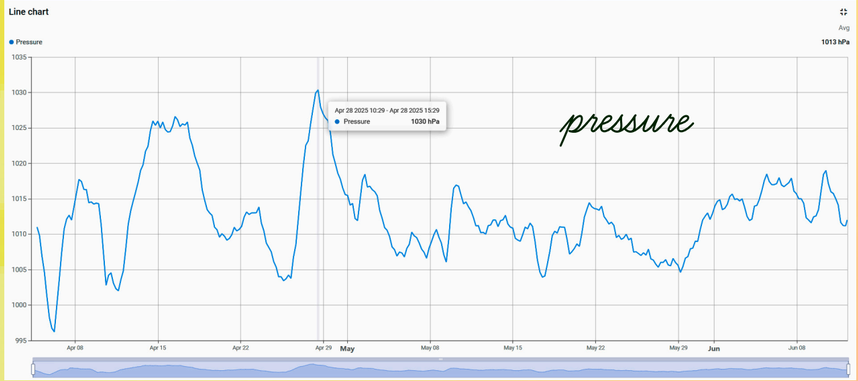


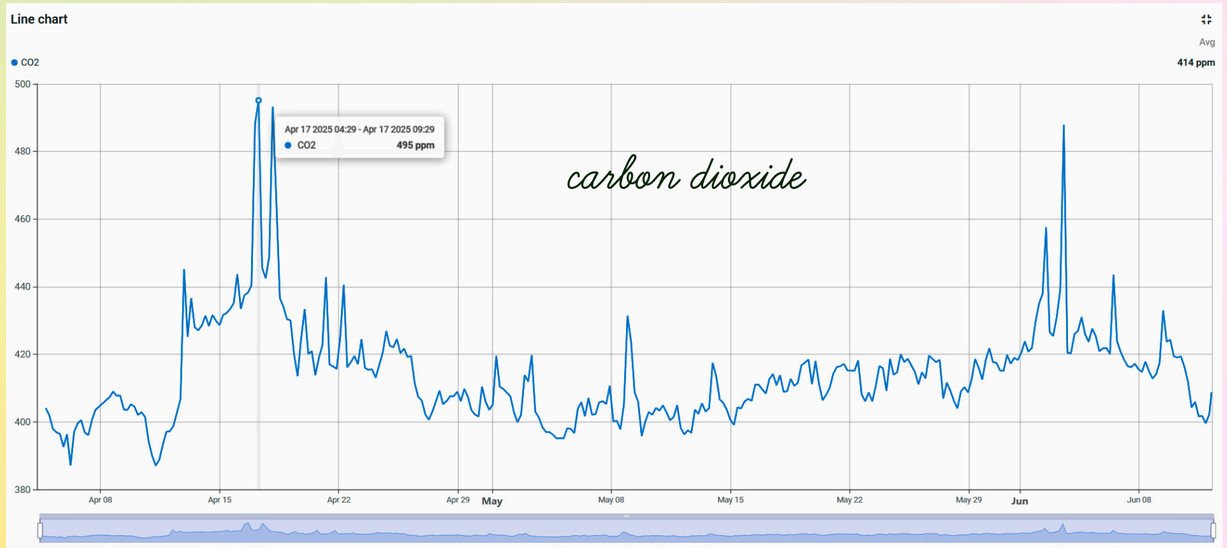
Mobile Station

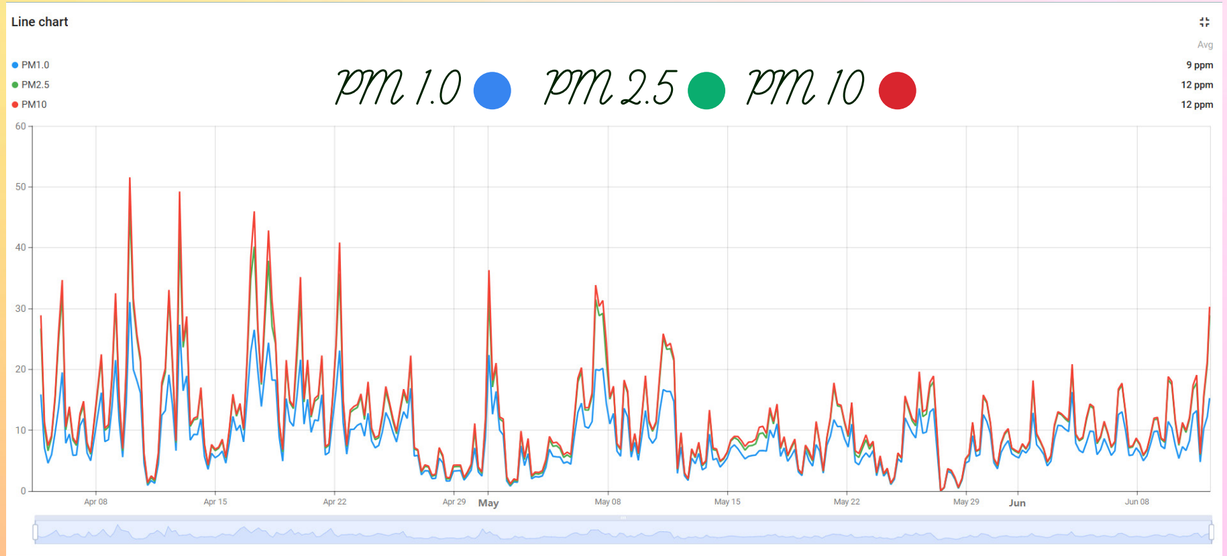
Data covering the entire observation period from April 4 to June 11











15 Lvivska str.

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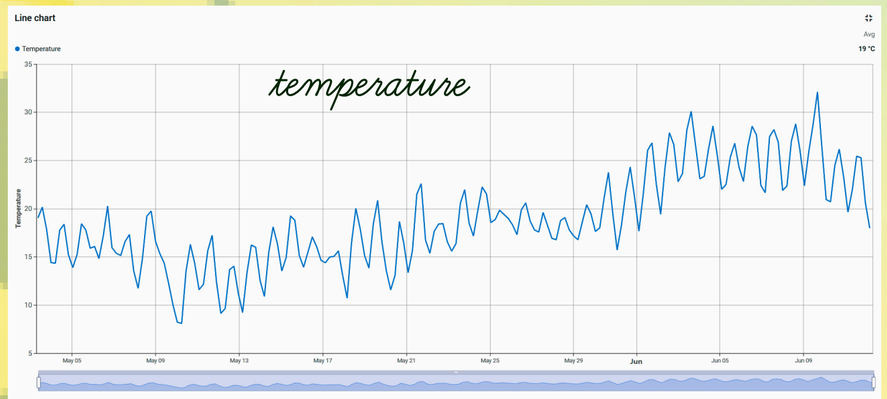
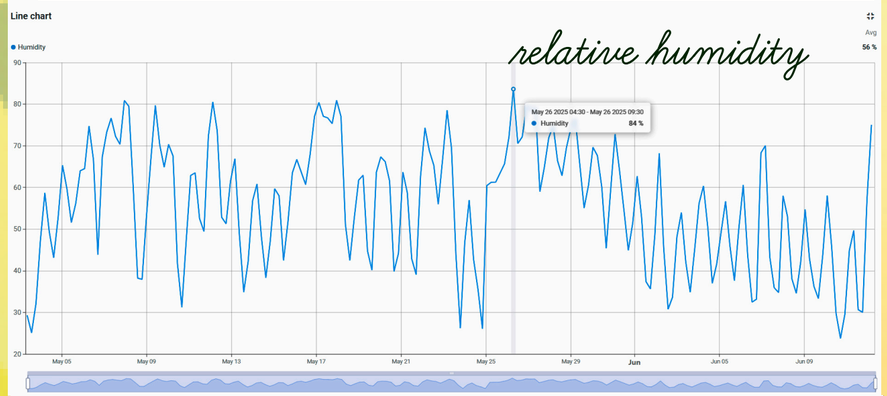
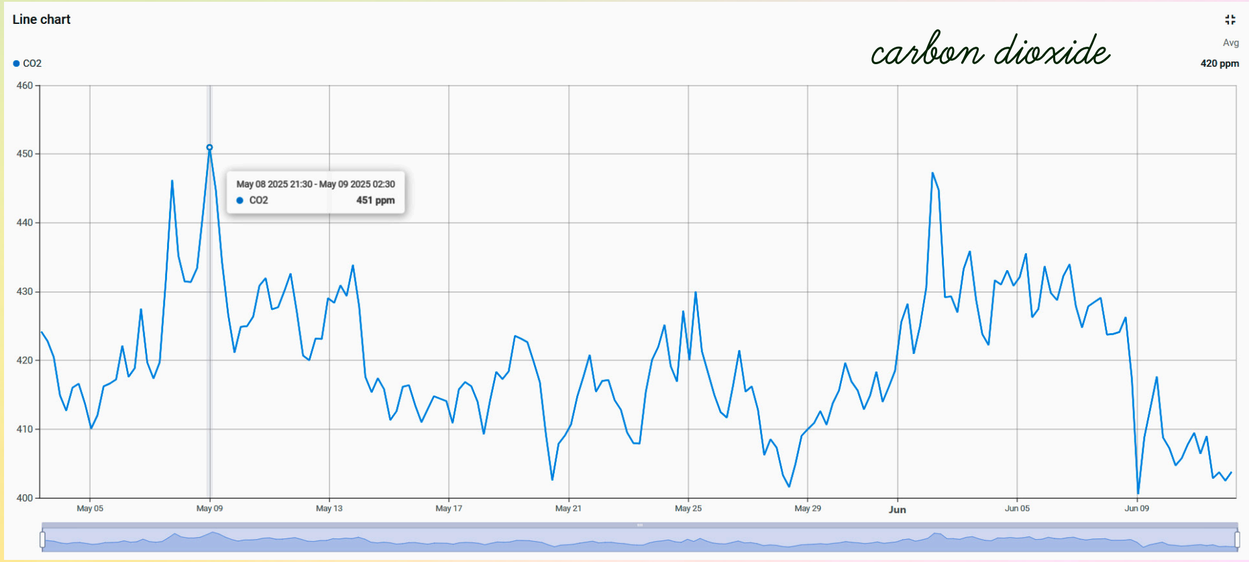
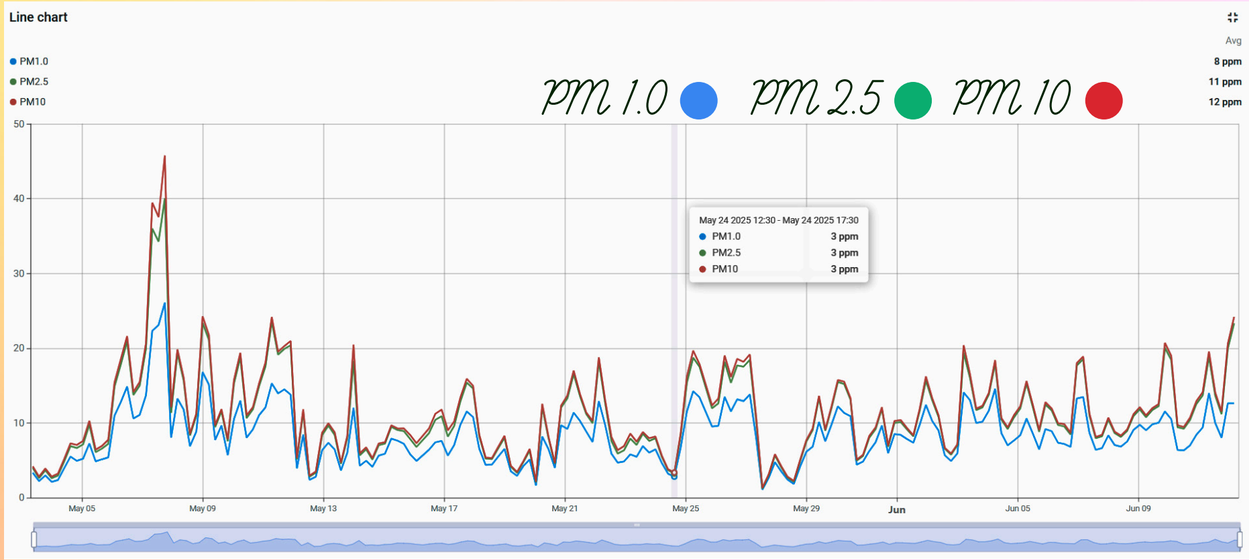
Data covering the entire observation period from May 2 to June 11









7 Futurystiv Lane

→ ODESA I.I. MECHNIKOV NATIONAL UNIVERSITY 2025

odesa drone-attack

16 April 2025

On **15–16 April 2025**, air raid alerts were issued in the region in response to UAV (unmanned aerial vehicle) threats. The first alert lasted from **21:28 to 22:37**. A second alert was declared at 00:42 and lifted at **02:15**. During this period, explosions were reported in Odesa at approximately **01:45** and **01:58**.

As a result of the attack, civilian infrastructure in the city was damaged. Fires broke out at several locations – residential buildings were burning, and warehouse facilities, premises of civilian businesses, a pharmacy, a church, and vehicles were damaged.

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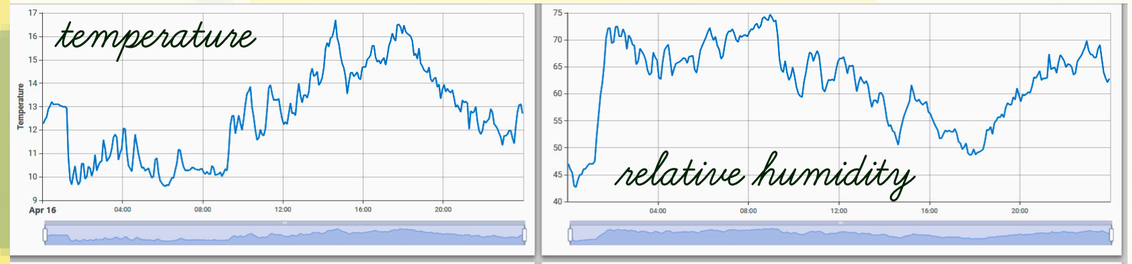
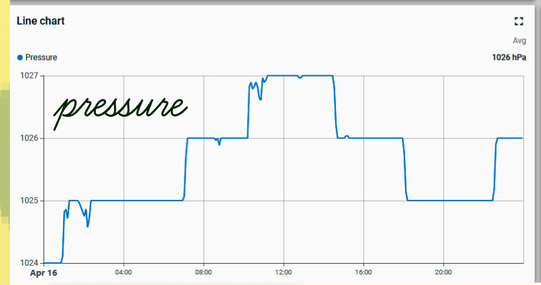
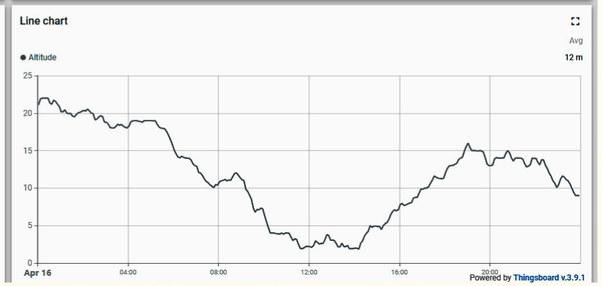
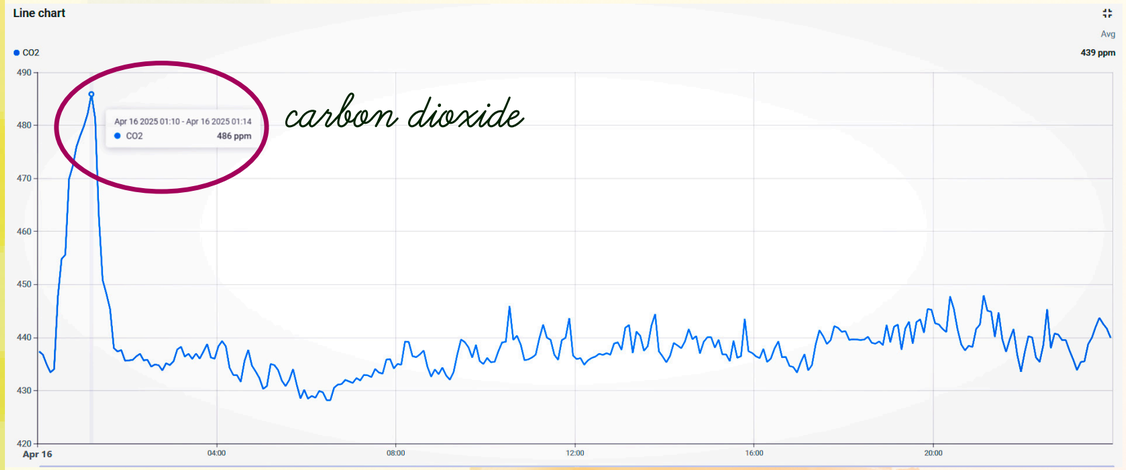
16 April 2025

Odesa was heavily attacked by drones









CO_2 (Carbon Dioxide):

Peak concentration: 486 ppm during the attack

Daily average: 437 ppm

Cause:

- The sharp spike in carbon dioxide levels was caused by intense combustion immediately following the drone strike.
- Explosions and fires from targeted areas likely ignited materials such as plastics, building components, and household goods.

PM (Particulate Matter – PM_1, $PM_{2.5}$, PM_{10}):

Peak concentration: 40 μg/m³ in the evening

Cause: Unlike CO_2, PM levels peaked later in the day due to:

- Ongoing smoldering of debris and materials after the initial fires
- Dust and soot from damaged structures being gradually released or stirred by wind and emergency response

Analysis

16 April 2025

odesa drone-attack

1 May 2025

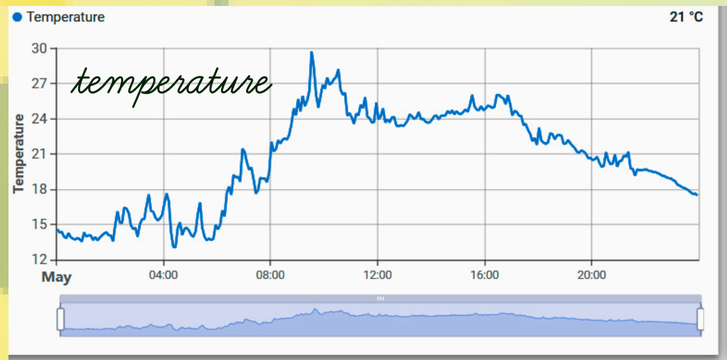
On the night of **April 30 to May 1, 2025,** Russian forces launched a massive drone strike on Odesa. As of **00:28 on 1 May**, at least **15 explosions** were reported in Odesa. The air raid alert was lifted at **00:38**. As a result of the attack, two people were killed, five others were injured, and the search continues for an elderly couple. Residential buildings, social infrastructure, and vehicles were damaged.

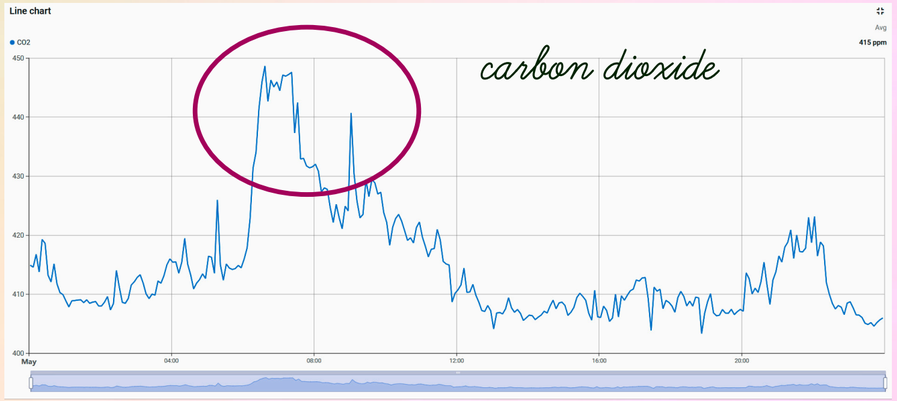
The building destroyed during the attack

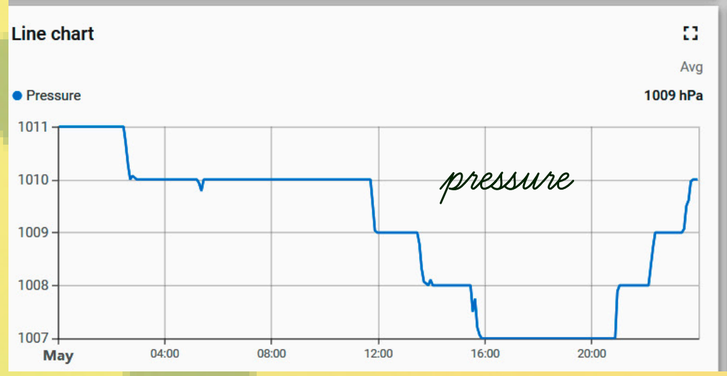
Mobile station

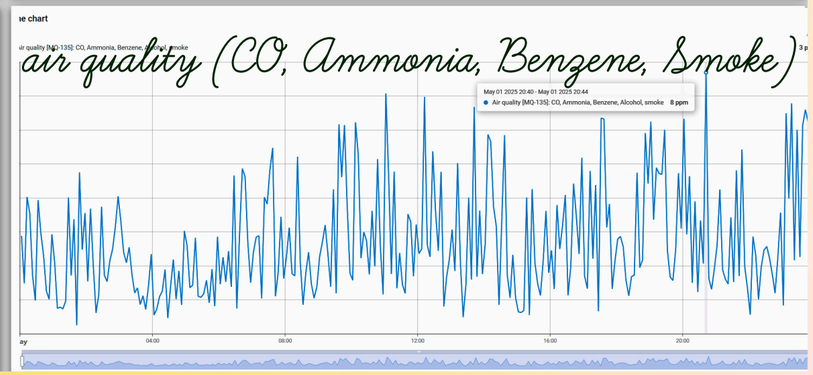
1 May 2025

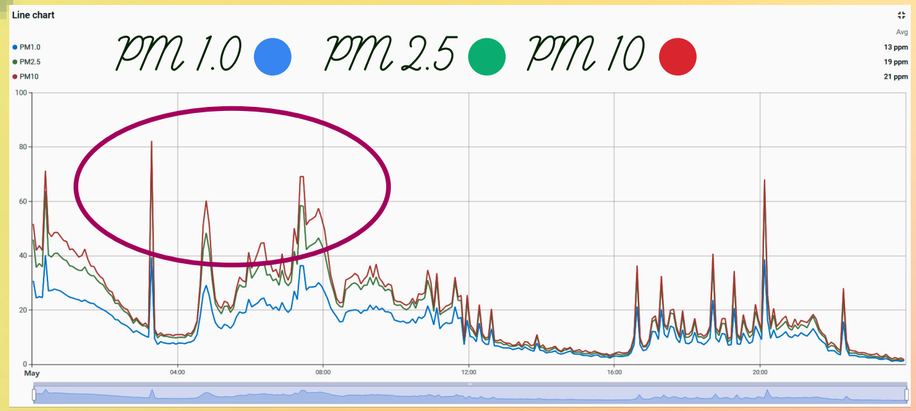
Odesa was heavily attacked by drones

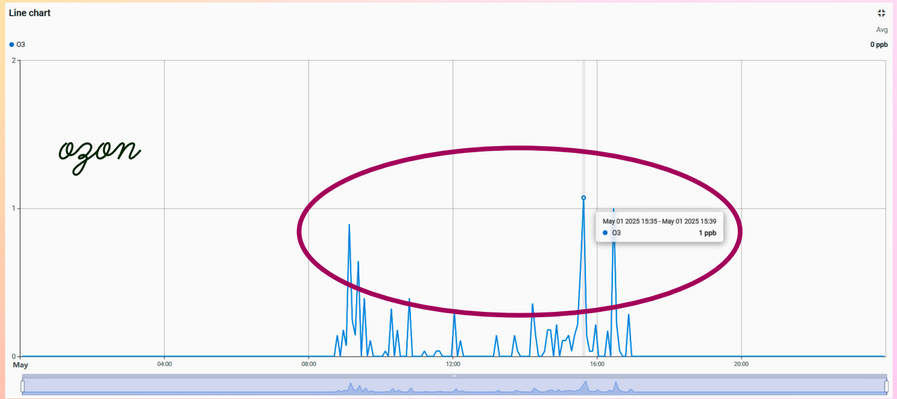












CO_2 (Carbon Dioxide):

- Peak concentration: 449 ppm at 06:40

Cause: The sharp early-morning spike in CO_2 is likely linked to intense combustion during and after the explosions.

PM (Particulate Matter – PM_1, $PM_{2.5}$, PM_{10}):

- First peak: ~82 ppm at 03:20
- Second rise in evening: up to 68 ppm

Initial peak cause: The immediate collapse of the residential building likely generated a significant cloud of dust and fine debris, including concrete, glass, insulation, and other structural particles.
Evening increase cause: ongoing rescue and cleanup operations may have stirred up settled dust or/and wind shifts or changing humidity could have resuspended particles.

Analysis

1 May 2025

Odesa drone-attack 25 May 2025

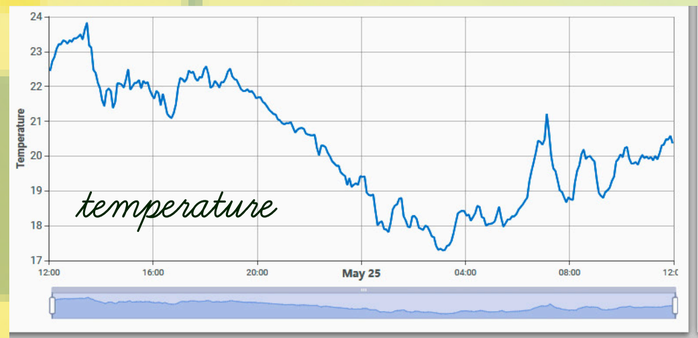
On the night of May 25, the Odesa region was attacked by drones. Air raid alerts were issued twice in the region: at 11:08 p.m. on May 24 and at 1:19 a.m. on May 25. Both times, drones attacked the region from the Black Sea. Explosions were heard in Odesa during the attack.

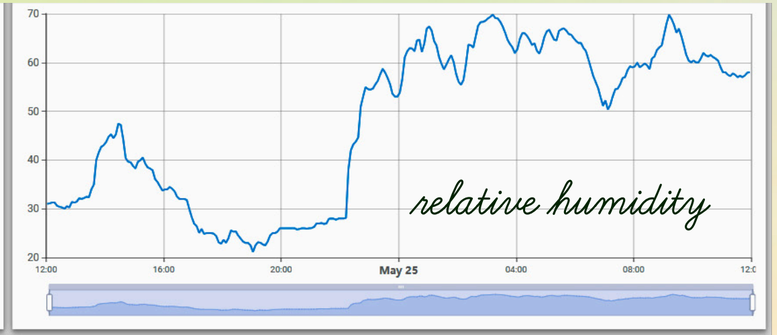
A fire broke out at a parking lot in a residential area, destroying at least 20 vehicles belonging to local residents.

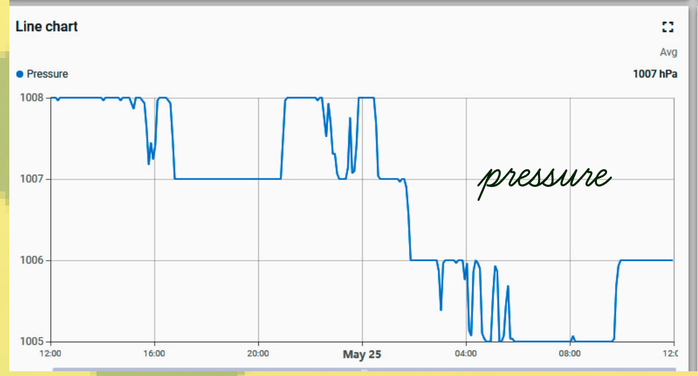
25 May 2025

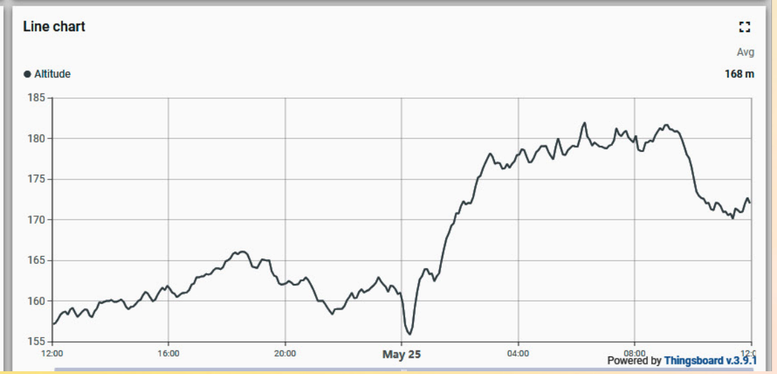
Odesa was heavily attacked by drones

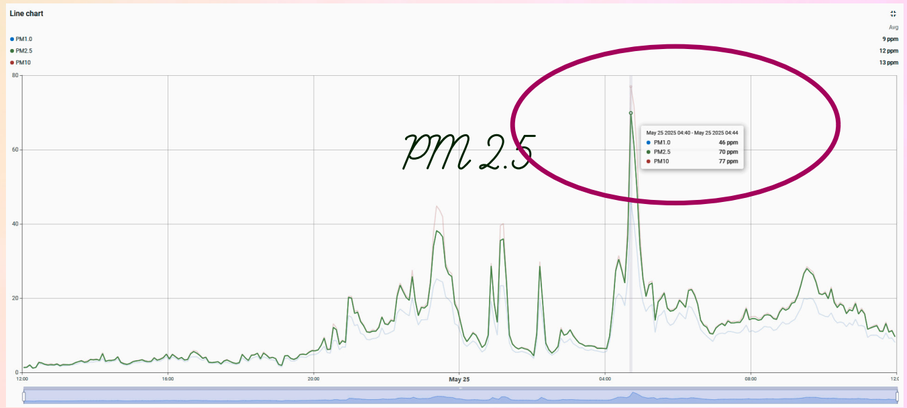
7 Futurystiv Lane

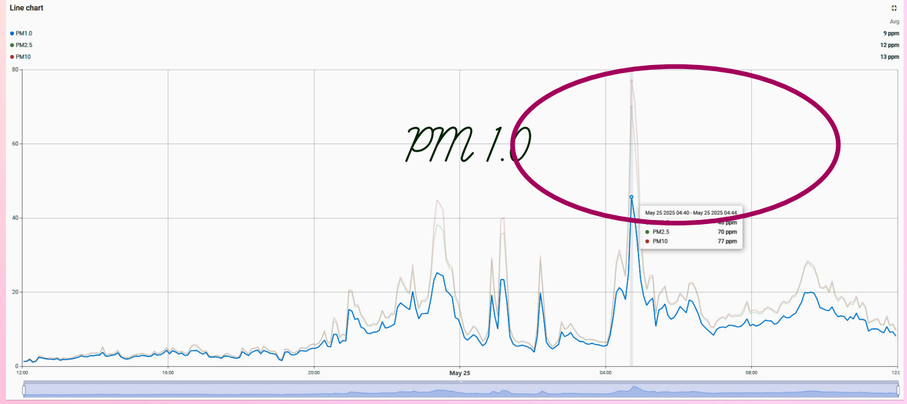












25 May 2025

CO_2 (Carbon Dioxide):
First peak: 443 ppm at 22:30 on 24 May
Second peak: 443 ppm at 07:50 on 25 May

Cause:

- The late-night rise may reflect immediate burning of fuel, infrastructure, and residential materials.
- The morning peak could result from continued smoldering or delayed detection of gas concentrations, as fires reignited or cleanup activities stirred residual emissions.

PM (Particulate Matter – $PM_{1.0}$, $PM_{2.5}$, PM_{10}):
Initial spike: 44 ppm immediately after the explosion
Highest level: 74 ppm at 04:40 on 25 May

Cause:

- The early PM spike was caused by the blast impact, dispersing debris and fine dust.
- The higher concentration in the early morning suggests continued emission from smoldering materials, resuspension of dust, and stagnant atmospheric conditions that prevented dispersion.

Analysis

CONCLUSIONS

1. Air Quality Deterioration Is Immediate and Detectable

- Each drone attack led to sharp increases in CO_2 and particulate matter (PM_1, $PM_{2.5}$, PM_{10}).
- CO_2 peaks occurred shortly after explosions due to intense combustion.

2. Particulate Matter Shows Multi-Phase Peaks

- PM levels often spiked twice: right after the blast and again hours later.
- Causes include building collapse, fires, dust resuspension, and weather conditions.

3. Weather Conditions Affect Pollutant Buildup

- Evening and early morning peaks often resulted from low dispersion in calm or stagnant conditions.

4. Monitoring Is Crucial

- Continuous air quality data offers vital insights for impact assessment, health alerts, and environmental forensics.