Air quality report

AtmoTrack - Air quality report - Wassenaar 2024

With data measured by the AtmoTrack network from 01/01/2024 to 31/12/2024

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Summary

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1. Presentation of the measured pollutants

The AtmoTrack sensor integrates different components that allow it to measure pollutants present in the air. All versions have an optical particle counter, to measure concentrations of particulate matter: PM1, PM2.5 and PM10.

Version 2 of the sensor also includes a semiconductor (MEMS), in order to estimate the concentrations of NO_2, NH_3 and CO. For an indicative measurement, this version can also integrate an electrochemical capsule, which gives the possibility to measure additional gases (notably NO_2 and O_3).

For the 2024 air quality measurement campaign in Wassenaar, the sensors measured PM2.5, PM10, NO_2, and O_3, which we present in the following pages.

In The Hague area, main sources for air pollution are traffic, mobile equipment used for construction works, wood burning (mainly PM), and agriculture. Wassenaar doesn't have much construction works and agriculture compared to other towns in The Hague area: the main sources of air pollution are traffic and wood burning.

The following presentations of the pollutants are based on data from the Netherlands as a whole and not on the city of Wassenaar.

On average in the Netherlands, only 5% to 15% of the air pollution is caused from the town itself, the rest has sources from outside the area.

Sources:

- https://www.rivm.nl/ggd-richtlijn-medische-milieukunde-luchtkwaliteit-en-gezondheid/toelichting-en-tools-luchtkwaliteit/toelichting-en-tools-luchtkwaliteit/Bronnen-per-component
- https://www.government.nl/topics/nature-and-biodiversity
- https://www.clo.nl

1.1. Particulate Matter - PM1, PM2.5 & PM10

Particles, commonly referred to as dust or "fijnstof" in Dutch. They are, most often, characterized by their size. 4 categories exist:

- PM10 (or coarse particles): particles with a diameter less than 10 µm
- PM2.5 (or particulate matter) : particles with a diameter less than 2.5 µm
- PM1: particles with a diameter less than 1 µm

In the Netherlands, the main sources of particulate matter emissions differ somewhat from the general European profile. While residential wood burning is a factor, it's less dominant than in some other countries. The key sources in the Netherlands are:

- **Industry:** A significant contributor, particularly in areas with heavy industry (e.g., Rotterdam port, industrial zones). This includes emissions from manufacturing processes, power generation, and refineries.
- **Agriculture**: A major and a specific issue in Netherlands. Livestock farming (intensive animal husbandry) is a very significant source of PM, primarily through ammonia (NH3) emissions. Ammonia reacts in the atmosphere to form secondary particulate matter (ammonium nitrate and ammonium sulfate).
- **Road Transport:** While emissions controls have improved, road traffic (especially diesel vehicles) remains a contributor, particularly in urban areas and near major highways. This includes exhaust emissions and tire/brake wear.
- **Shipping:** Given the Netherlands' extensive port infrastructure and inland waterways, shipping contributes to PM levels, especially in port cities and along major waterways.
- **Constructions**: Demolition and construction activities.
- **Other transport** (Non-road mobile machinary): Off-road vehicles like in constructions.

The smaller the particles, the more they can penetrate into the deep ramifications of the respiratory tracts (at the level of the pulmonary alveoli) and reach the blood circulation, and thus the more dangerous to health they are.

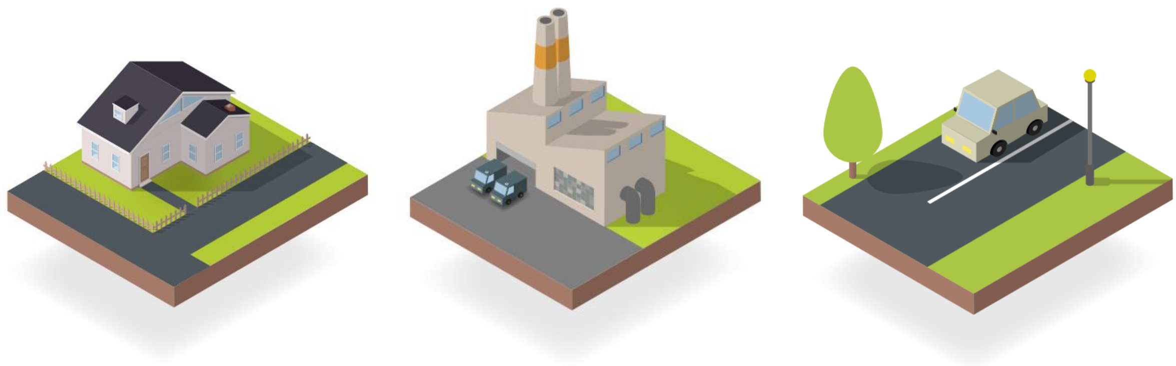

Figure 1: Main sources of particulate matter emissions

1.2. Nitrogen oxides - NOx (NO & NO_2)

Nitrogen oxides, “stikstofdioxide” in Dutch, mainly include two molecules, which are emitted during combustion phenomena:

- nitrogen monoxide NO
- and nitrogen dioxide NO_2.

In the Netherlands, the main sources of NOx emissions are:

- **Road Transport**: This is the most significant source.
- **Industry:** Similar to particulate matter, industrial processes, power generation, and refineries contribute substantially to NOx emissions.
- **Agriculture:** Again, intensive livestock farming is a major contributor due to ammonia emissions, which indirectly contribute to NOx formation.
- **Shipping**: Is also important in Netherlands.
- **Built Environment**: Including heating in residential and commercial buildings.

In contact with air, nitrogen monoxide (NO) is rapidly oxidized to nitrogen dioxide (NO_2).

NO_2 is an irritant gas, which can penetrate the finest branches of the respiratory tract and is more toxic than NO. Under the effect of solar radiation and combined with volatile organic compounds (VOC), NOx promotes the formation of tropospheric ozone (O_3).

While NOx concentrations in the Netherlands have generally decreased over the past few decades due to stricter emission standards for vehicles and industry, they remain a concern, particularly in urban areas and near major roadways. The Netherlands has faced challenges in meeting EU air quality standards for NO_2, leading to legal action and government measures to reduce emissions, such as speed limit reductions on highways and efforts to promote electric vehicles and sustainable agriculture.

As part of this project, only the NO_2 is measured.

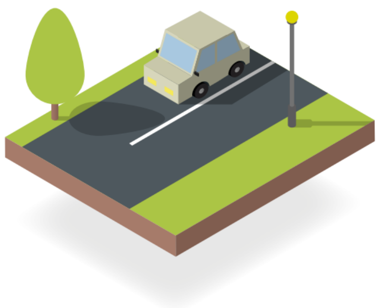

Figure 2: Main source of nitrogen oxides emissions

1.3. Ozone - O_3

Ozone,

- at very high altitude: protects living organisms by absorbing part of UV rays (layer of ozone).
- at low altitude: is a pollutant which irritates the eyes and the respiratory system and which has harmful effects on vegetation.

It is a so-called "secondary" pollutant, that is to say that it is not released directly into the atmosphere, but comes from chemical transformations of pollutants already present in the air (NOx and VOC). These chemical reactions are carried out under the action of sun rays. Ozone is therefore more present in summer.

At high concentrations, ozone causes respiratory problems (asthma attacks, reduction in lung function and the appearance respiratory diseases). Ozone also has effects on the environment by disrupting the growth of certain plant species and causing reduced yields in crops. It also contributes to the greenhouse effect.

2. General statistics

2.1. Air quality

In 2024, 10 sensors were functional: 3.66M data has been collected. The annual average values are displayed in red if they exceed the EU thresholds, which are:

- 25 µg/m³ for PM2.5
- 40 µg/m³ for PM10
- 40 µg/m³ for NO_2

In 2022, 2023 and 2024, none of these three pollutants exceeded their respective threshold.

2.1.1. PM2.5

	2022	2023	2024
Average (µg/m³)	9	7 ▼	9 ▲
Daily maximum (µg/m³)	43	61 ▲	40 ▼
Number of days the WHO daily threshold was exceeded (> 15 µg/m³)	74	12 ▼	15 ▲

Table 1: Statistics of PM2.5 in 2022, 2023 and 2024

2.1.2. PM10

	2022	2023	2024
Average (µg/m³)	14	11 ▼	13 ▲
Daily maximum (µg/m³)	65	84 ▲	58 ▼
Number of days the WHO daily threshold was exceeded (> 45 µg/m³)	24	3 ▼	10 ▲

Table 2: Statistics of PM10 in 2022, 2023 and 2024

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2.1.3. NO_2

	2022	2023	2024
Average (µg/m³)	26	16 ▼	11 ▼
Daily maximum (µg/m³)	61	58 ▼	26 ▼
Number of days the WHO daily threshold was exceeded (> 25 µg/m³)	169	52 ▼	7 ▼

Table 3: Statistics of NO_2 in 2022, 2023 and 2024

2.1.3. O_3

There is no daily threshold available for ozone.

	2022	2023	2024
Average (µg/m³)	29	27 ▼	54 ▲
Daily maximum (µg/m³)	86	131 ▲	110 ▼

Table 4: Statistics of O_3 in 2022, 2023 and 2024

2.2. Weather data

	2022	2023	2024
Average temperature (°C)	12.3	12.2	12.4
Average humidity (%)	76.9	80	83
Cumulative rainfall (mm)	N/A	435	892
Average cloudiness (%)	64.1	70	73

Table 5: Statistics in 2022, 2023 and 2024 (source: OpenWeatherMap, Wassenaar station)

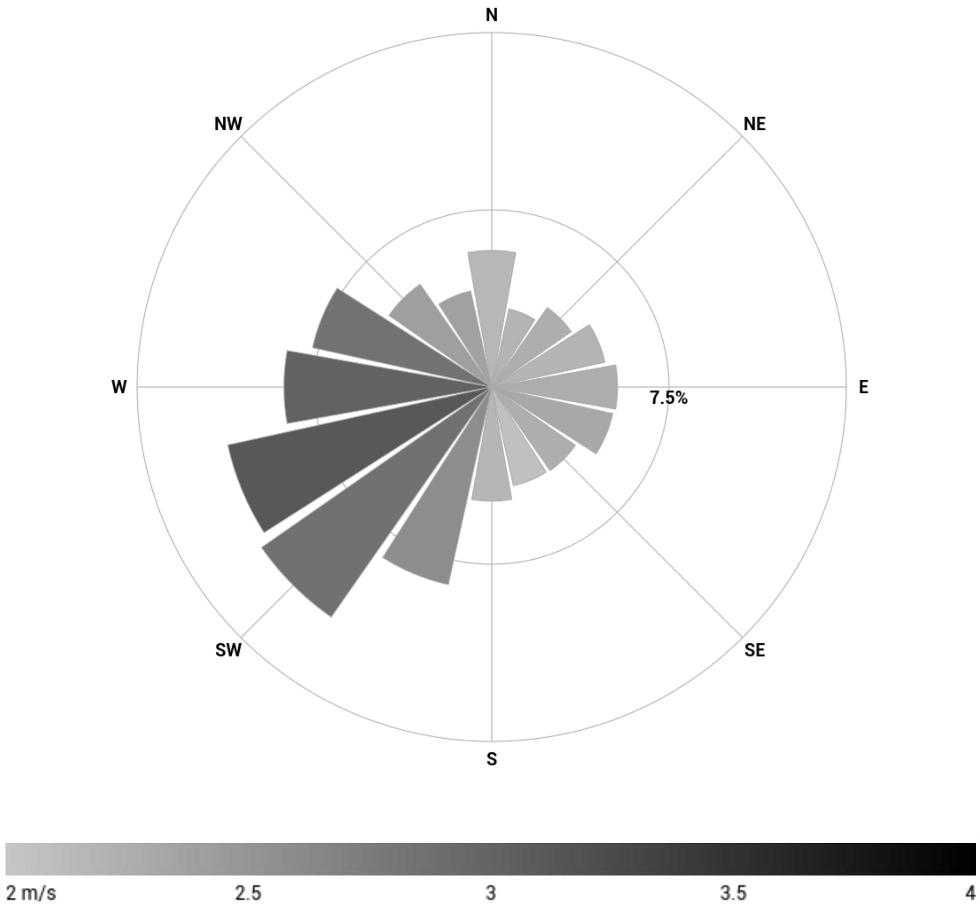

Figure 3: Frequency (in %) and intensity (in m/s) of winds according to their origin in 2024 (source: OpenWeatherMap, Wassenaar station)

3. Charts

The figures presented serve two main objectives. First, they show the daily concentration of each pollutant in comparison to the WHO recommended threshold. Second, they provide a comparison between the sensor measurements and the reference station data, highlighting both similarities and differences.

Regarding reference stations, the ones located in The Hague are geographically closer to Wassenaar than the station in De Zilk. However, their typologies differ. The Hague has two "Street stations" and one "City background station," whereas the De Zilk station is a "Background station" with less urban influence. This typology aligns more closely with Wassenaar's environment.

For The Hague, only the data from the "City background station" has been included in the analysis to ensure a more relevant comparison.

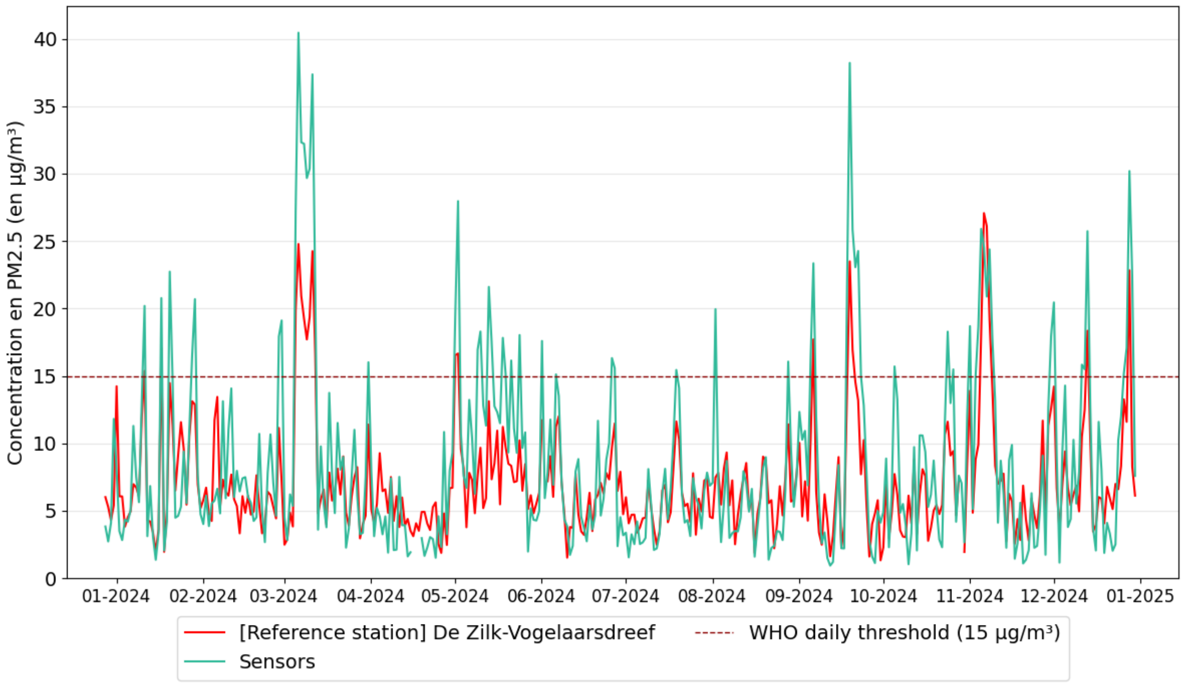

Figure 4: Daily PM2.5 concentrations (µg/m³) for the average of AtmoTrack sensors and for the references stations in 2024 (the station at The Hague doesn't measure PM2.5)

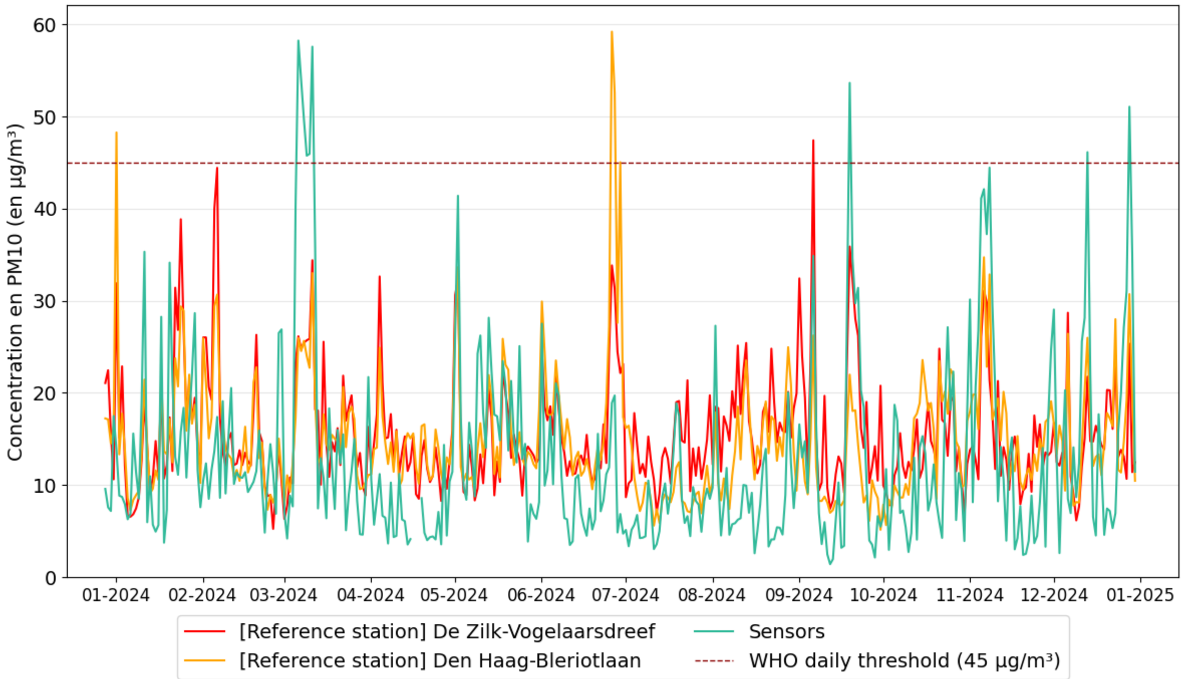

Figure 5: Daily PM10 concentrations (µg/m³) for the average of AtmoTrack sensors and for the reference stations in 2024

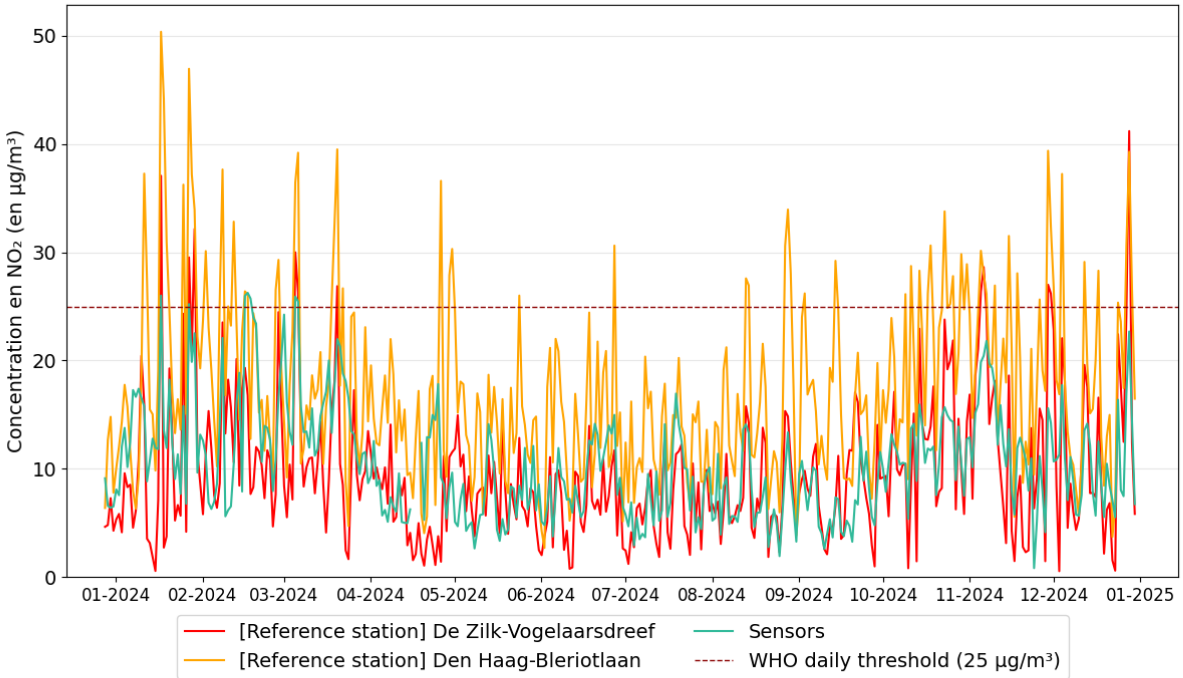

Figure 6: Daily NO_2 concentrations (µg/m³) for the average of AtmoTrack sensors and for the reference stations in 2024

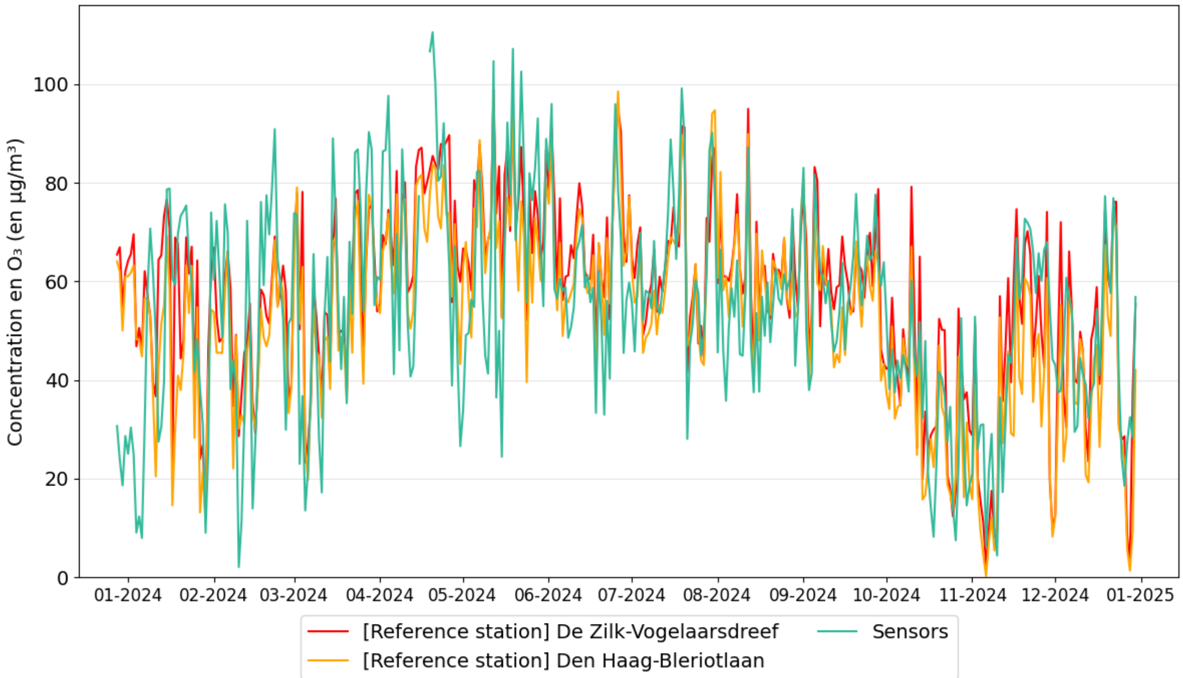

Figure 7: Daily O_3 concentrations (µg/m³) for the average of AtmoTrack sensors and for the reference stations in 2024

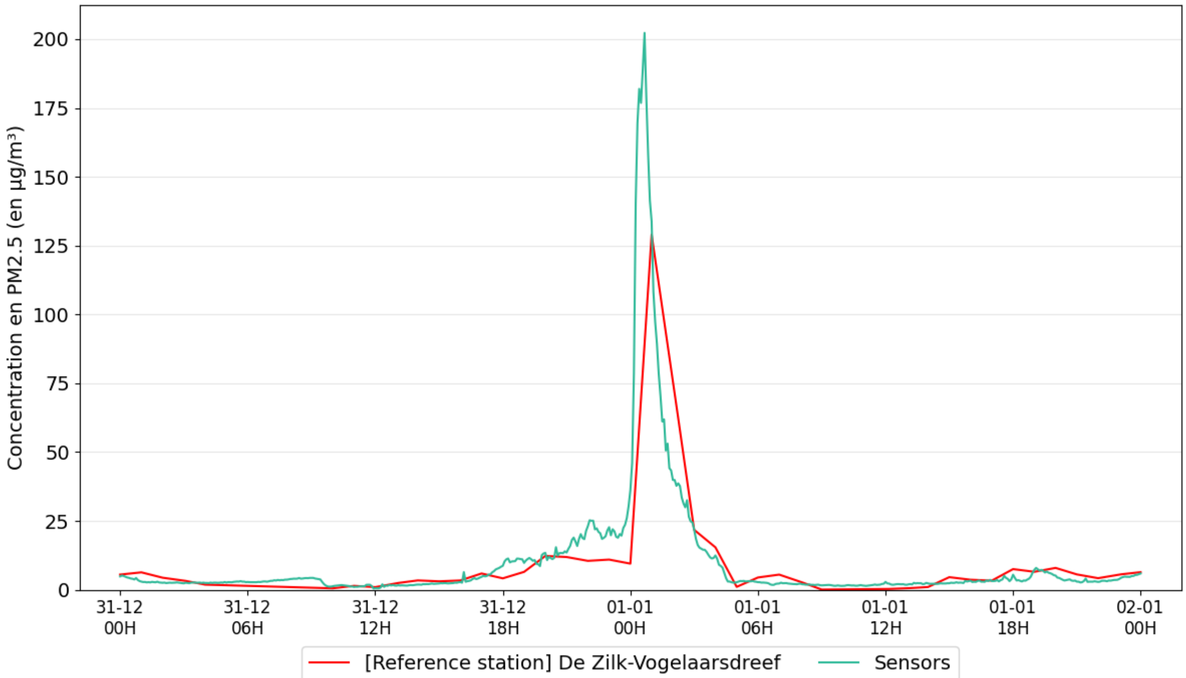

Figure 8: PM2.5 concentrations (µg/m³) for the average of AtmoTrack sensors and for the reference station during the New Year's celebration in 2024

4. Maps

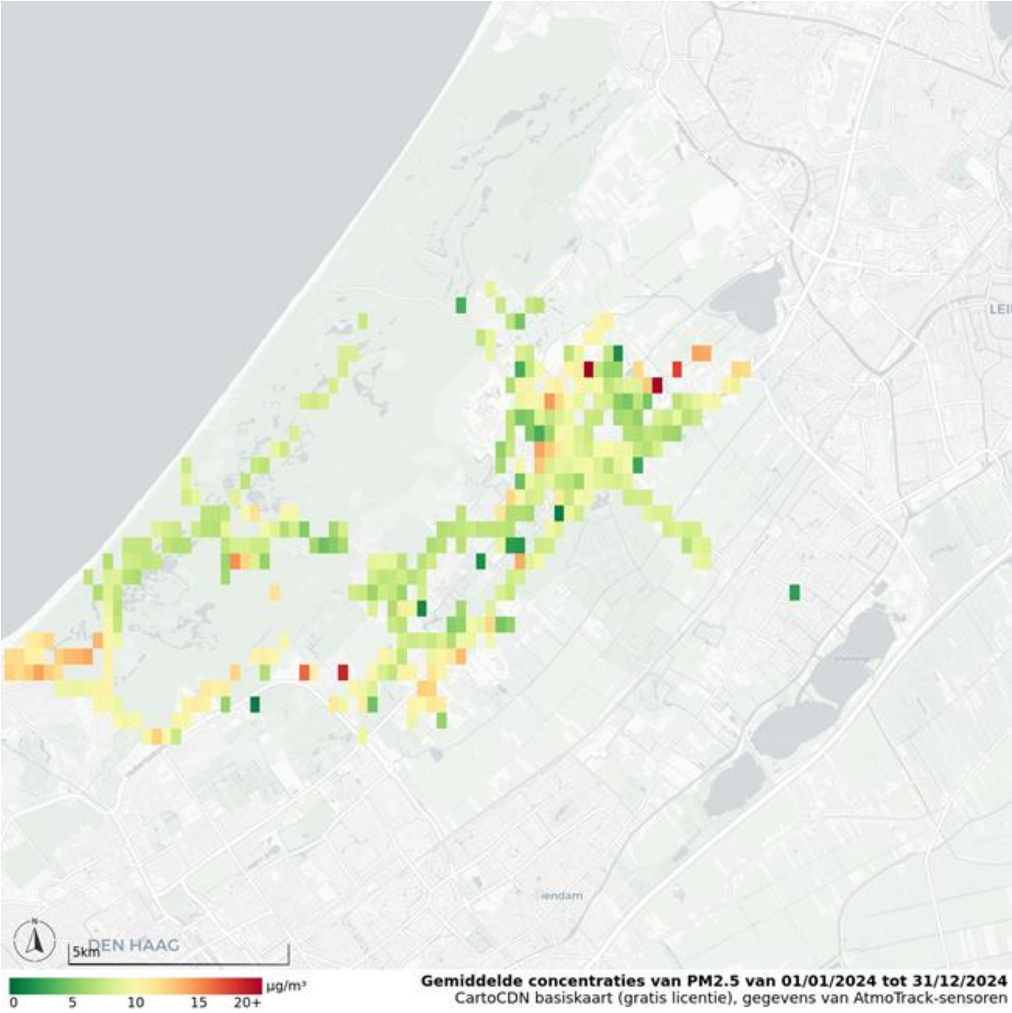

Figure 9: Average PM2.5 concentrations in 2024. Squares representing less than 20 data are not displayed.

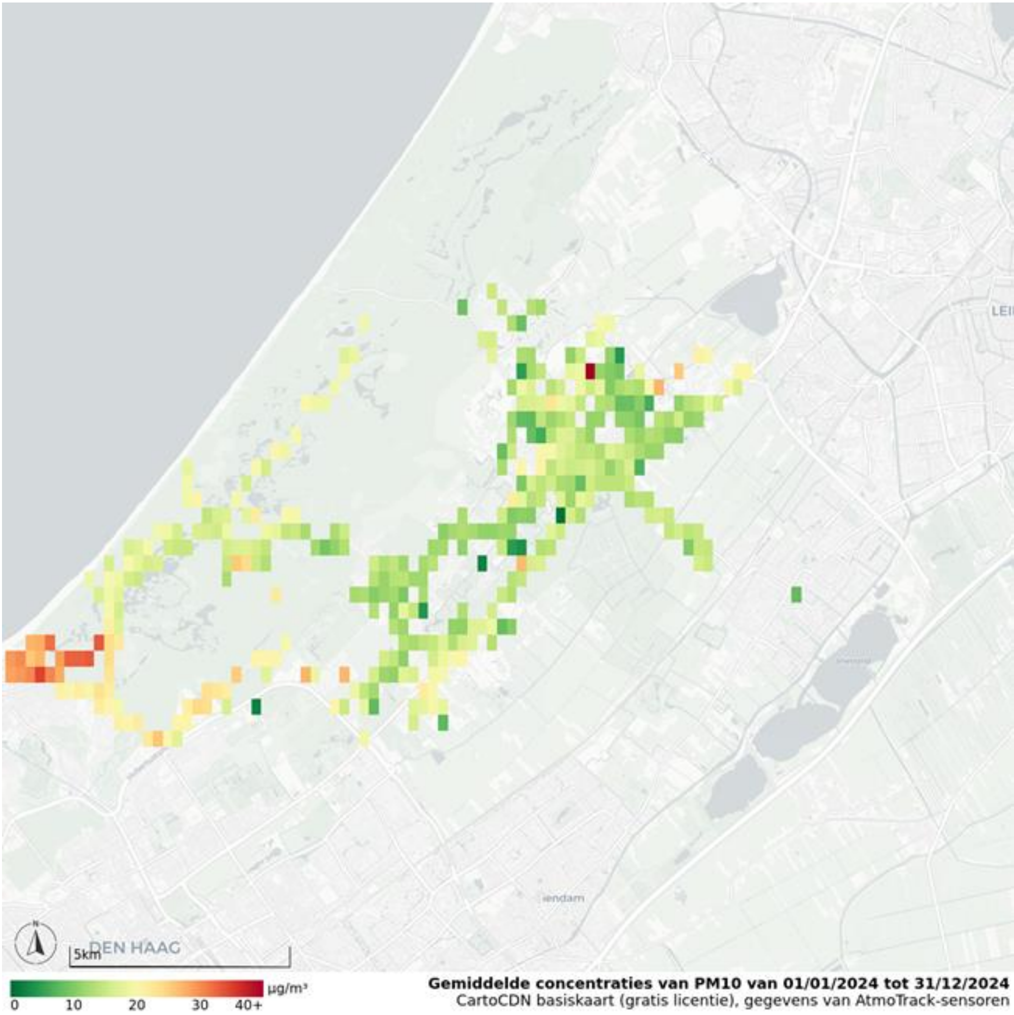

Figure 10: Average PM10 concentrations in 2024. Squares representing less than 20 data are not displayed.

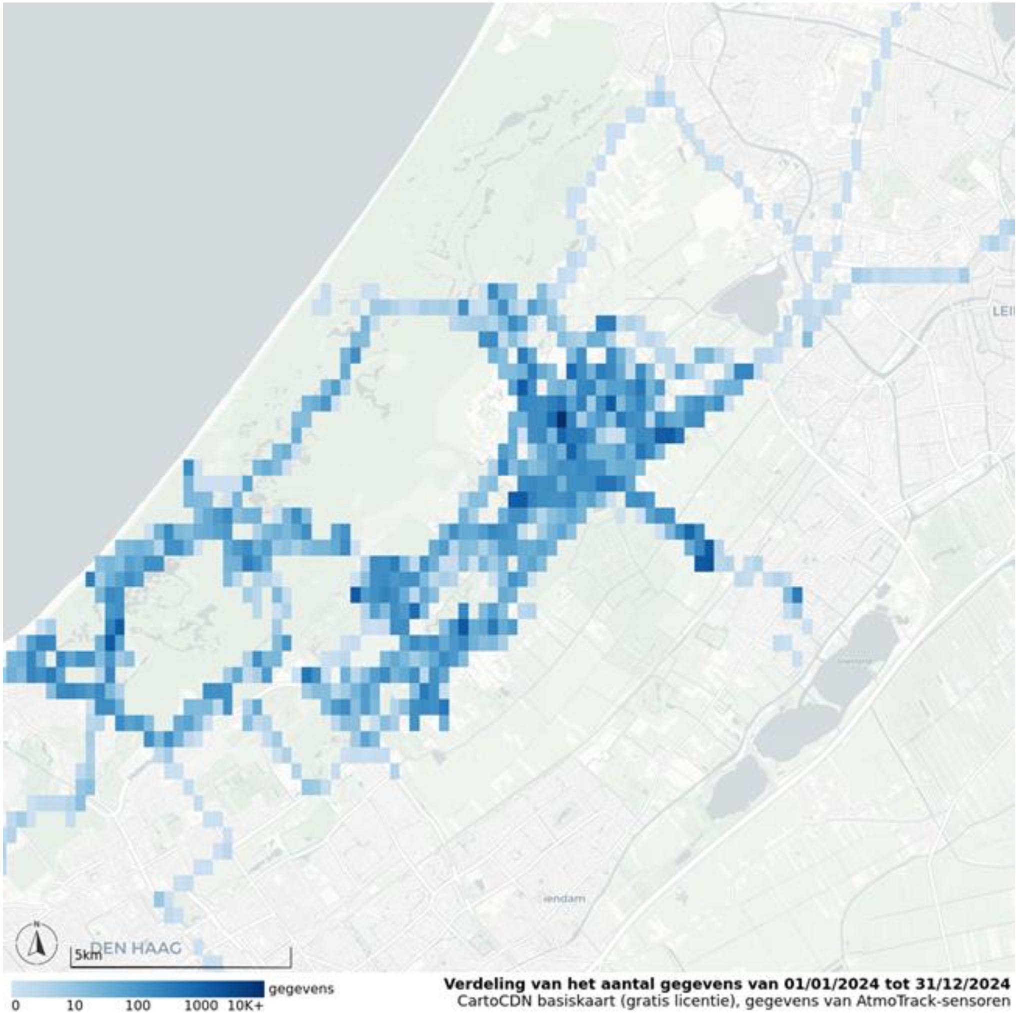

Figure 11 : Distribution of the number of data in 2024

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5. Caeli Statistics

	Unique users	Connections	Average connections per user
January	1	1	1
Ferbuary	1	1	1
March	1	1	1
April	3	3	1
May	3	5	2
June	1	1	1
July	5	7	1
August	7	16	2
September	6	11	2
October	6	8	1
November	4	10	2
December	3	10	3

Table 6: Number of users and connections per month in 2024

	Unique users	Connections	Average connections per user
2023	19	76	4
2024	21	74	4

Table 7: Number of users and connections in 2023 and 2024

6. Conclusion

The annual average concentration of PM2.5 has increased from 7 µg/m³ in 2023 to 9 µg/m³ in 2024. However, the daily maximum has significantly decreased from 61 to 40 µg/m³. The number of days exceeding the WHO recommendation threshold (15 µg/m³) has slightly increased from 12 to 15, suggesting more frequent but less intense pollution episodes.

For PM10, a similar trend is observed. The annual average has risen from 11 to 13 µg/m³, while the daily maximum has dropped from 84 to 58 µg/m³. Notably, the number of days exceeding the WHO recommendation threshold (45 µg/m³) has increased from 3 to 10, indicating more frequent pollution peaks despite lower intensity compared to 2023.

Overall, there are no significant changes in fine particle concentrations between 2023 and 2024 in Wassenaar. The increase of days exceeding WHO thresholds for fine particles between 2023 and 2024 may be explained by different meteorological conditions from one year to the next.

As every year, New Year's Eve fireworks are a major source of fine particle emissions for a few hours, but the air quality on December 31st and January 1st remained below the WHO recommendation threshold.

In contrast, NO_2 concentrations have decreased significantly. The annual average has dropped from 16 to 11 µg/m³, and the daily maximum has been nearly halved, going from 58 to 26 µg/m³. The number of days exceeding the WHO threshold (25 µg/m³) has fallen drastically from 52 to just 7, highlighting a substantial improvement in nitrogen dioxide levels.

Conversely, O_3 concentrations have risen sharply. The annual average has doubled, increasing from 27 to 54 µg/m³, although the daily maximum has slightly decreased from 131 to 110 µg/m³.

As ozone is a secondary pollutant formed through photochemical reactions involving NO_2 and volatile organic compounds (VOCs), the rise in ozone concentrations may have contributed to the decrease in NO_2 levels.

For all four pollutants presented, the average sensor measurements indicate a similar trend between Wassenaar and official monitoring station located in Vogelaarsdreef.

These trends align with known seasonal variations: fine particle and NO_2 concentrations tend to be higher in winter due to heating emissions, while ozone levels peak in summer under strong sunlight. The observed shifts in air quality may be influenced by meteorological conditions and changes in local emissions sources.