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Air quality around ports

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Contents

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Summary

Air pollutant concentrations in Europe have decreased over recent decades due to reduced emissions in various sectors. However, attention is now shifting to shipping emissions and activities in ports, which are becoming a more significant source of pollution. Future projections of emissions in Europe indicate that while road traffic emissions will decrease, shipping emissions and ports could become the main contributor to adverse health impacts in coastal cities by 2030. Monitoring air quality in ports and nearby cities is crucial to understanding the impact of shipping and port activities. This study focuses on air quality in 23 major European ports, examining how air quality is monitored, comparing pollutant concentrations in ports and nearby areas, identifying trends, and assessing the impact of international shipping on air quality for two case studies.

To address these research questions, the study followed several steps using various datasets. Port areas were identified using the CORINE Land Cover 2018 dataset. Air quality sampling point observations (SPOs) were identified in ports and nearby areas using validated data from the European e-reporting database, focusing on NO_2 and PM_{10} data from 2021. Two main factors were considered for the assessment of the SPOs around ports and nearby cities, the distance of the SPO from the port areas and the wind directions at port location. The measured NO_2 and PM_{10} concentrations were used to identify the potential impact of port activities in the nearby cities and surrounding regions with latest validated data from 2021, and when available the long-term trends (2005-2021) in NO_2 and PM_{10} concentrations. Air quality maps with resolution of 1 km x 1km for 2021 were also used to provide a better geographical representation of air quality around ports, and regional differences. Finally, two case studies examined the impact of shipping emissions during pollution episodes in Antwerpen and Barcelona using the Air Control Toolbox of the Copernicus Atmosphere Monitoring Service. These steps aimed to understand air quality in and around ports, the impact of port activities, and trends in those pollutant concentrations.

Air quality SPOs in and around port areas are limited. Among 23 analysed ports, only 5 had at least one SPO for NO_2 and PM_{10} inside the port areas. Most ports had at least one SPO within 1 km, but only few were downwind of the prevalent wind direction. Measurements at SPOs during downwind conditions from the ports showed increased NO_2 concentrations, with notable increases in cities like Napoli (over 100%), Algeciras (86%), and Hamburg (77%). PM_{10} increases were smaller but still significant in some ports. The air quality maps for 2021 showed higher annual mean NO_2 and PM_{10} concentrations in port areas compared to surrounding regions, with some port areas exceeding the new limit values (LV) set by the revised Ambient Air Quality Directive and to be attained by 2030. From 2005 to 2021, NO_2 concentrations in port areas and nearby cities decreased by about 40%, similar to reductions in nearby cities. PM_{10} concentrations decreased by 40% in port areas and 45% within 20 km of ports. However, limited SPOs make it challenging to draw definitive conclusions for all ports. Only in the port of Antwerpen, the number and location of SPOs allowed to identify a different trend in NO_2 concentrations in the port compared to the rest of the city. Lower concentration reductions (from -25% to –33%) were found in the port, compared to largest NO_2 concentrations reductions in the city (from –39% to –47%), probably showing the impact of larger emission reductions in the city, such as road traffic.

High-resolution air quality modelling is needed for precise impact estimates. Two case studies using the Air Control Toolbox showed that international shipping significantly contributes to NO_2 concentrations during pollution episodes in Antwerpen (38%) and Barcelona (over 55%). PM_{10} contributions from shipping were also significant but varied depending on other emission sources like agriculture and residential heating.

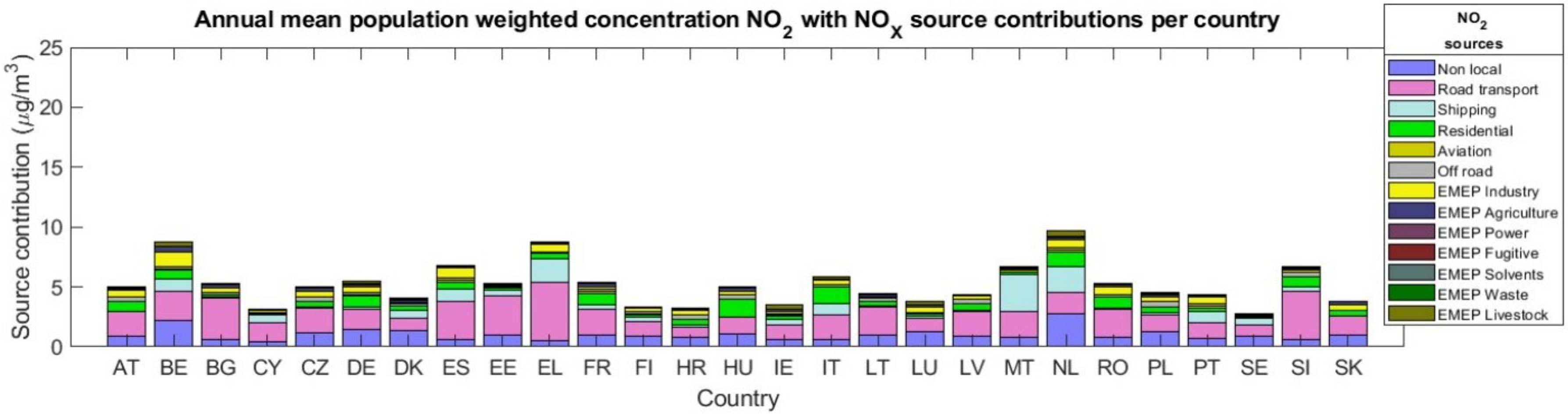
1 Introduction

Air pollutant concentrations in Europe have declined over the last decades due to reduced emissions in many sectors, such as road traffic (Gbangou and Colette, 2023, ETC HE Report 2023/8; EEA Report 08/2024). However, attention has now shifted to other sources like shipping which may become more relevant in the near future to further decrease pollution. Comparing 1990 to 2021 the contribution of the maritime sector to total transport emissions has increased from 20% to 39% for NOx, and from 30% to 42% for $PM_{2.5}$ (data drawn from the Long-Range Transboundary Air Pollution Convention, LRTAP([1]), and EEA Report 08/2024). The relative contribution from international shipping to NO_2 annual mean concentrations in European ports is 22% on average, 5% for $PM_{2.5}$ and 3% for PM_{10} (Concawe, 2023). The Ambient Air Quality Directives (AAQDs, Directives 2004/107/EC and 2008/50/EC set the LVs for annual mean concentrations of $PM_{2.5}$, 20 µg/m^3 to be met as of 1.1.2020, of PM_{10}, 40 µg/m^3 to be met as of 1.1.2005, and of NO_2, 40 µg/m^3 to be met as of 1.1.2010. The revised AAQD (EU 2024/2881) was recently published setting new LVs for annual mean concentrations of these pollutants, 10 µg/m^3 for $PM_{2.5}$, 20 µg/m^3 for PM_{10} and NO_2, and to be attained by 1.1.2030. New LVs for daily mean concentrations were also set for $PM_{2.5}$, PM_{10} and NO_2, respectively at to 25 µg/m^3, 45 µg/m^3 and 50 µg/m^3, and not to be exceeded more than 18 times per calendar year. For NO_2 there is also a LV of 200 µg/m^3 for hourly concentrations, not to be exceeded more than 3 times per calendar year. In this report only annual mean concentrations were assessed, while hourly concentrations were used in the analysis but not assessed towards the newer LVs.

Future emission projections indicate that the contribution of road traffic emissions to the population exposure to high NO_2 concentrations will decrease significantly, while shipping emissions could determine the main contribution to adverse health impacts in coastal European cities in 2030 (EC, DG ENV, 2022). Figure 1.1 shows that, despite road traffic emissions remain the main contributor to annual mean NO_2 concentration at national level, shipping emissions in 2030 will significantly contribute to the overall exposure of population to NO_2 in countries like Malta, the Netherlands, and Greece. The contribution of shipping emissions is smaller in other countries (e.g., Belgium, Spain, Italy and Portugal), but shipping is still one of the main sources of NO_2. At the European level, i.e., for the 27 Member States of the European Union (EU27), shipping is the main sector contributing to the exposure to high NO_2 concentrations. Shipping sector is contributing by 50% to NO_2 annual mean concentrations of 30 µg/m^3. This contribution increases at higher concentrations ranges, more than 80% above 40 µg/m^3 (Figure 1.2). Therefore, monitoring air quality in ports and the nearby cities will become more important in the next decades to understand the role of emissions from international shipping and from all port activities (road traffic, non-road machinery, bulk unloading and industrial installations). Shipping emissions and other port activities are also contributing to particulate matter concentrations, which are detrimental to human health. Thus PM_{10} (particles with diameter below 10 µm) was also added to the analysis in this report. Despite shipping emission mainly contribute to the fine fraction of particulate matter ($PM_{2.5}$, i.e. particles with diameter below 2.5 µm), PM_{10} measurements are available for a larger number of SPOs and for longer time series, which is an important factor to consider when assessing past trends.

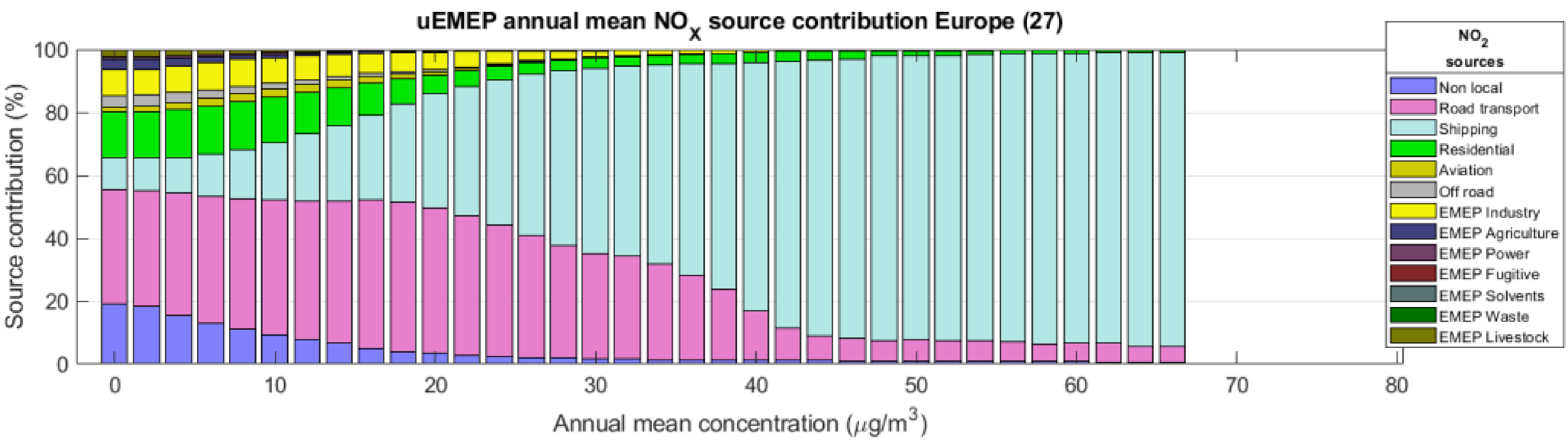
([1]) National emissions reported to the Convention on Long-range Transboundary Air Pollution (LRTAP Convention), v1.2, 2024

Figure 1.1 Population weighted concentrations and source contributions per country in 2030



Source: Extracted from Figure 35 in EC, DG ENV, 2022.

Figure 1.2 Population exposure to NOx in 2030 with source contribution for the EU27



Source: Extracted from Figure 26 in EC, DG ENV, 2022.

As there are many ports in Europe, this study analyses air quality for a selection of European ports. The study focuses on 23 ports selected by the European Maritime Safety Agency (EMSA)([2]) and the European Environment Agency (EEA)([3]). The list includes some of the largest ports in Europe (such as Rotterdam, Antwerpen, Hamburg, Marseille and Barcelona), considering cargo, bulk carrier and passenger ports, and located in 10 different European countries. The full list of ports included in this analysis is provided in Table 1.1 and their geographical location in Figure 1.3.

Table 1.1 List of ports in Europe included in this study

Ports	Country	Country code
Algeciras	Spain	ES
Amsterdam	The Netherlands	NL
Antwerpen	Belgium	BE
Barcelona	Spain	ES
Bremen	Germany	DE
Bremerhaven	Germany	DE
Gdansk	Poland	PL
Genova	Italy	IT
Gioia Tauro	Italy	IT
Hamburg	Germany	DE
Le Havre	France	FR
Marsaxlokk	Malta	MT
Marseille	France	FR
Messina	Italy	IT
Napoli	Italy	IT
Palma de Mallorca	Spain	ES
Piraeus	Greece	GR
Reggio Calabria	Italy	IT
Rotterdam	The Netherlands	NL
Santa Cruz de Tenerife	Spain	ES
Stockholm	Sweden	SE
Trieste	Italy	IT
Valencia	Spain	ES

The aim of this study is to answer the following questions:

1. How is the air quality monitored inside or in the vicinity of ports?
2. How are the ambient air concentrations of NO_2 and PM_{10} in and around ports compared to the nearby cities and regions?
3. What are the trends in pollutant concentrations in ports and nearby cities?
4. What is the potential impact of port activities and international shipping on air quality?

([2]) https://emsa.europa.eu/
([3]) https://www.eea.europa.eu/en

To address these questions, the study followed several steps using various datasets, including air pollutant concentrations, land cover, population and meteorology. The methodology and datasets are described in Section 2. The assessment of air quality monitoring around the 23 selected ports in Europe is presented in Section 3. The comparison of NO_2 and PM_{10} concentrations between port areas and nearby cities and surrounding regions is presented in Section 4, and their trends in Section 5. Finally, two case studies are presented in Section 6 to show the impact of shipping emissions during pollution episodes.

Figure 1.3 Location of the 23 European ports analysed in this study

2 Methodology

In order to answer these questions, different datasets were used according to the following steps:

1. Identification of the port area for each city in Table 1.1: it was used the "port area" polygons classification of land cover (CLC Code 123) available in the **CORINE Land Cover 2018 dataset** from the Copernicus Land Monitoring Services (CLMS)([4]).
2. First air quality SPOs located in the ports and other that could be affected by the port activities in the vicinity of port were identified to be compared with SPOs in the nearby city and surrounding areas. The validated data available from the European e-reporting database([5]) were used. NO_2 and PM_{10} SPOs were considered in the analysis with available data in 2021, which was, at the time of performing the study, the latest air quality validated data.
3. As different industrial activities are typically co-located in port areas, we considered the Directive 2008/50/EC, which specifies the micro- and macroscale siting of industrial SPOs. Industrial SPOs shall be sited at enough distance (> 250 m) from industrial installations and downwind of the industrial sources in the nearest residential area. All types of SPOs were considered in this analysis, industrial, traffic and background. Both the distance of SPOs from the port and the meteorology (frequency of wind direction blowing from the port area) were considered to assess the air quality monitoring in port areas.
4. For each port three types of SPOs were selected for the analysis:
    a. **in port**: located inside the port area polygon
    b. within a **distance of 1 km** from the port area polygon
    c. within a **distance of 1 km to 10 km for** NO_2, and of **1 km to 20 km for** PM_{10} (a larger distance was considered for PM_{10} as this pollutant can be transported at further distances due to its longer lifetime in the atmosphere). The 10 km and 20 km distances were calculated from the centroid of the port area polygons.

    For the first two sets of SPOs (a and b) it was expected to see a stronger impact of the ports due to their proximity to the sources. The SPOs in group c were used to see if the port activities and shipping emissions are affecting the nearby cities and surrounding regions.
5. Meteorology is another important factor to take into account in the analysis. For each port it was considered the frequency (%) of wind blowing in different directions from the ports towards the surrounding areas. The European Centre for Medium-Range Weather Forecasts (ECMWF) re-analysis (i.e. a meteorological model simulation of past years corrected with observations, Berrisford et al., 2011) dataset at a resolution of 0.1 x 0.1 degrees resolution (approximatively 10 km by 10 km). The timeseries of hourly wind directions of the year 2021 were extracted from the modelled gridded data at the location of the centroid of the port area polygon. The timeseries were used to calculate the frequency of wind directions blowing from the port centroid in the surrounding 8 wind sectors 45 degrees wide, centred at 45 degrees (North East, NE), 90 (East, E), 135 (South East, SE), 180 (South, S), 225 (South West, SW), 270 (West, W), 315 (North West, NW), and 360 (North, N).
6. The comparison of the NO_2 and PM_{10} concentration in and around ports compared to the nearby cities and regions, was assessed by analysing the hourly concentrations measured at the selected SPOs for each port. The distribution of NO_2 and PM_{10} concentrations when wind direction was coming from the port, was compared to the distribution of concentrations when wind was not blowing from the port. This comparison may provide a first indication if the air quality SPOs in different regions (wind sectors) around the ports are affected by the port activities. On the other hand, it must be noted that these differences may also be influenced at the same time by other emission sources.
7. Measurements from SPOs may not be available for all ports, and if available their location in relation to the ports may not be always optimal (distance and meteorology). The analysis

([4]) https://land.copernicus.eu/
([5]) https://aqportal.discomap.eea.europa.eu/

based on SPOs was complemented with the analysis of the EEA air quality maps(6) for 2021 at the resolution of 1 km x 1 km (based on the combination of model simulations, observations, and supplementary data (Horálek et al, 2023, ETC HE Report 2023/3). These maps can provide a better geographical representation of air quality in the regions around ports and can be used to estimate the differences between NO_2 and PM_{10} annual mean concentrations in ports compared to the nearby cities and regions.

8. A database of SPOs with long-term trends of air pollutants at European and national level 2005-2021 (Gbangou and Colette, 2023, ETC HE Report 2023/8) was used to assess differences in NO_2 and PM_{10} trends at the SPOs identified in the previous steps of the analysis (1-3). The aim of this comparison was to evaluate if different trends in annual mean concentrations were observed in ports, or in their vicinity, compared to other SPOs in the surrounding region.
9. In order to better quantify the impact of shipping emissions and port activities and evaluate its contribution compared to other emission sectors, it would be necessary to perform air quality modelling studies at a high resolution for each port, which was behind the scope of this study. Nevertheless, case studies were analysed to illustrate the possible impact of shipping emissions and their contribution to the NO_2 and PM_{10} concentrations during different pollution episodes in two cities, Antwerpen and Barcelona. The online Air Control Toolbox was used (Colette et al., 2022), a surrogate model of the Chimere chemistry transport model (Menut et al., 2024) and one of the air quality policy tools developed for the Copernicus Atmosphere Monitoring Services (CAMS)(7).

Section 2 is a summary of how many SPOs are available for each port (question 1), while the results from the analysis of measurements from available SPOs and air quality maps are shown in Section 3 (question 2). Section 4 presents the analysis of observed trends at the identified SPOs (question 3). Section 5 illustrates examples of pollution episodes and the possible contribution from shipping emissions. Section 6 provides general conclusions. Annex 1 provides the complete analysis (graphics and maps) for each port.

3 Air quality monitoring around European ports

Different activities and emission sources are located in the port areas, including national and international shipping, road and non-road traffic, and industrial point sources. This chapter provides a general overview of air quality monitoring around ports. This analysis is not focused only on SPOs downwind of the port and in the nearest populated area, but all SPOs around a port were considered, taking into account the distance from the port, all types of SPOs (background, industrial or traffic), and all wind directions blowing from the port towards the SPOs.

Figure 3.1 shows an overview of the number of air quality SPOs found for each port inside the port area polygons, within 1 km from the port area, and between 1 km to 10 km for NO_2 SPOs and between 1 km to 20 km for PM_{10}. Among the 23 ports analysed in this study, only 5 ports have at least one air quality SPO for NO_2 and PM_{10} located inside the port area: Amsterdam (NL), Antwerpen (BE), Genova (IT), Hamburg (DE), and Piraeus (GR).
Almost all analysed ports have at least one SPO in the vicinity of the port area (within 1 km distance). Only the ports of Marsaxlokk (MT), Marseille (FR), Reggio Calabria (IT) and Stockholm (SE) do not have any SPOs or NO_2 and PM_{10} within 1 km. In addition, the ports of Barcelona (ES), Messina (IT) and Santa Cruz de Tenerife (ES) do not have a SPO for PM_{10} within 1 km.

When considering an area between 1 km to 10 km distance from the port areas, all ports and nearby cities have at least one SPOs for NO_2. The largest number of SPOs for NO_2 are found around the port

(6) https://sdi.eea.europa.eu/catalogue/datahub/eng/catalog.search#/metadata/82700fbd-2953-467b-be0a-78a520c3a7ef
(7) https://policy.atmosphere.copernicus.eu/

of Antwerpen (37 monitoring SPOs) (Figure 3.2). The ports Marsaxlokk (MT), Messina (IT), and Reggio Calabria (IT) do not have any SPO for PM_{10} within 20 km. The largest number of SPOs for PM_{10} are found for the ports of Amsterdam (22) and Antwerpen (19) (Figure 3.2).

Figure 3.1 Number of monitoring SPOs of NO_2 (a) and PM_{10} (b) around 23 European ports and nearby cities with validated measurements for year 2021

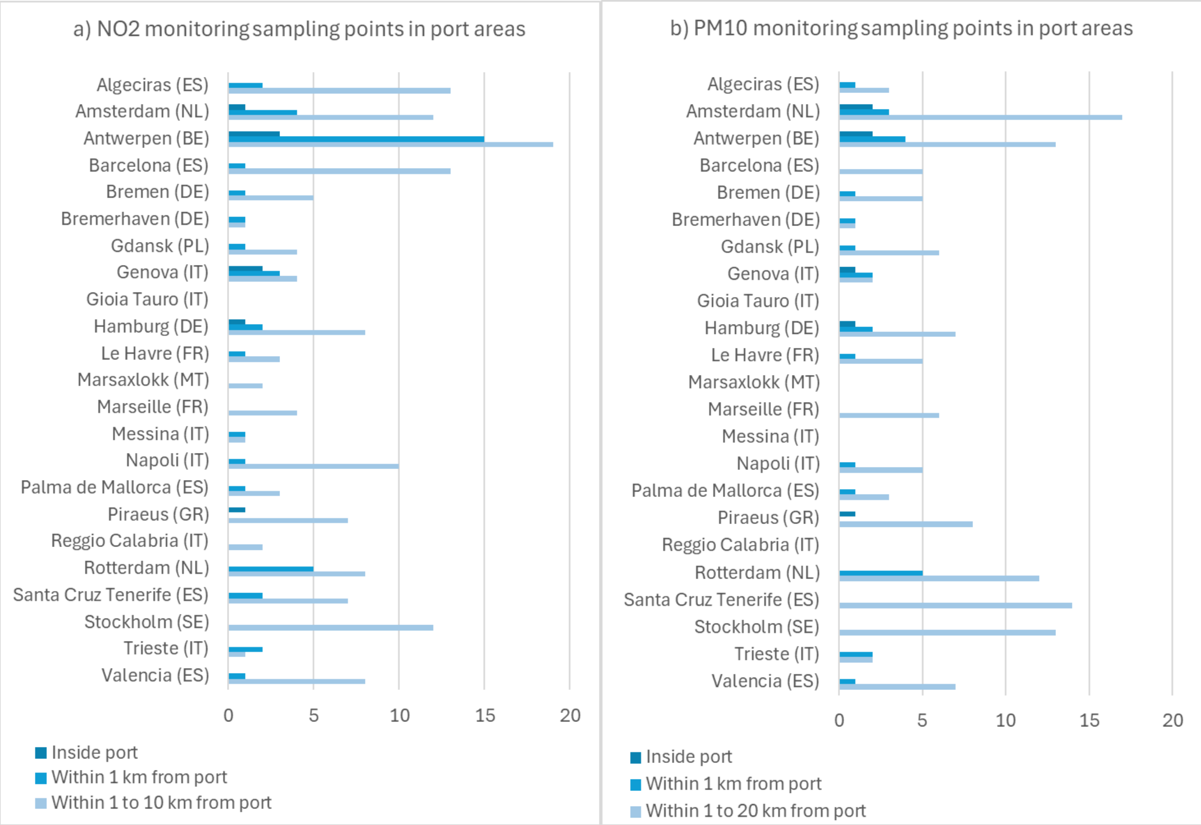


Figure 3.2 Air quality SPOs in the ports of Antwerpen (left) and Amsterdam (right)

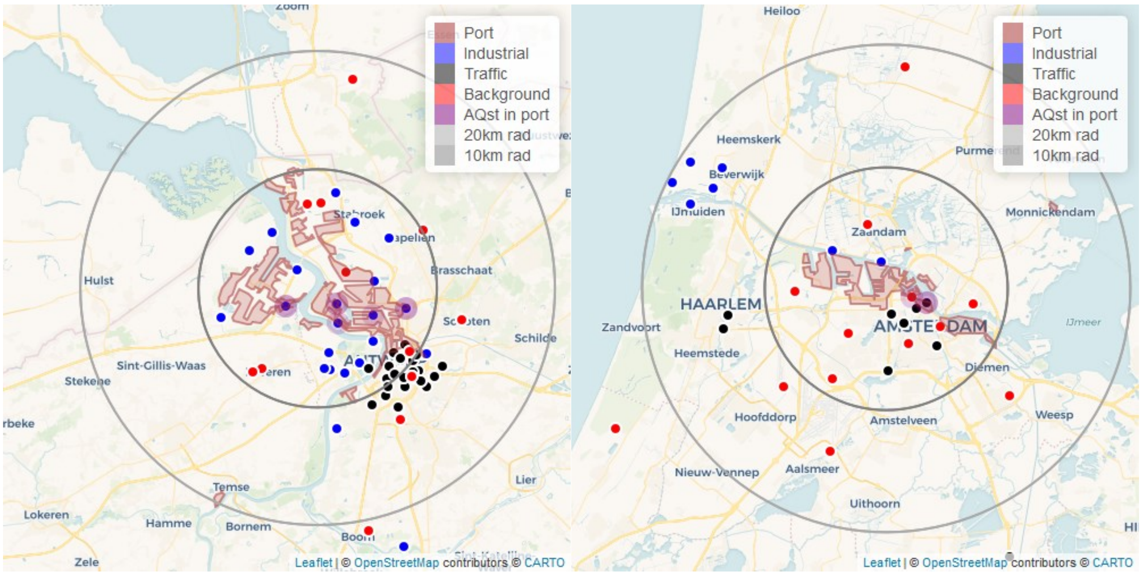


Table 3.1 and Figure 3.2 provide more details about the total number of SPOs identified for NO_2 (within 10 km from the port) and for PM_{10} (within 20 km). For each port it is also indicated:

- how many SPOs are classified as background (B), traffic (T) or industrial (I);
- how many of the total number of SPOs are located inside the port area;
- how many of the total number of SPOs are located within 1 km from the port area;
- the mean distance of all SPOs from the port area in kilometres;
- the number of the wind 8 sectors where at least one s SPO is located;
- the sum of the wind frequencies (%) blowing from the ports towards each sector where at least one monitoring SPO is located.

Most of the NO_2 SPOs found inside port areas are classified as traffic (T) SPOs (1 in Amsterdam, 2 in Genova, and 1 in Piraeus). In the port of Antwerpen 3 industrial (I) SPOs were found, and 1 SPO classified as background (B) is located inside the port of Hamburg.

The mean distances of SPOs from port areas are ranging between 0.6 km (Trieste) and 6.9 km (Piraeus). Only few of the identified SPOs are located downwind of the prevalent wind direction in the port areas. Only 5 ports (Algeciras, Antwerpen, Genova, Marseille, and Napoli) have at least one SPO for NO_2 located in a wind direction sector which is downwind of the port more than 25% of the time (Figure 3.3). The ports of Amsterdam and Antwerpen have SPOs in 7 of the 8 wind sectors around the port. The total frequency of wind directions from the ports toward the seven sectors with SPOs is 79% in Amsterdam, 91% in Antwerpen. The total wind frequency is above 50% in 8 of the 23 ports analysed.

Table 3.1 Number of SPOs within 10 km from a port, in port or within 1km from a port. SPOs in the list are those with available data for NO_2 in 2021

Port	Country code	SPO within 10 km (#)	SPO type	SPO in port (#, type)	SPO within 1 km from port (#, type)	Mean distance from port (km)	wind sectors with at least 1 SPO (#)	Total wind frequency covered by all SPOs
Algeciras	ES	15	1T, 1B, 13I		2I	3.1	5	54 %
Amsterdam	NL	17	6T, 9B, 2I	1T	1T, 2B, 2I	2.6	7	79 %
Antwerpen	BE	37	21T, 6B, 10I	3I	9T, 2B, 4I	1.4	7	91 %
Barcelona	ES	14	11T, 3B		1B	4.1	4	60 %
Bremen	DE	6	1T, 4B, 1I		1B	2.6	3	35 %
Bremerhaven	DE	2	1T, 1B		1B	1.6	2	21 %
Gdansk	PL	5	5B		1B	3	3	32 %
Genova	IT	9	5T, 4B	2T	1T, 2B	2.4	4	69 %
Gioia Tauro	IT	-	-	-	-	-	-	-
Hamburg	DE	11	5T, 4B, 2I	1B	1B, 1I	2.2	5	71 %
Le Havre	FR	4	1T, 2B, 1I		1B	1.8	2	29 %
Marsaxlokk	MT	2	1T, 1B			6.3	2	39 %
Marseille	FR	4	1T, 3B			3.6	3	48 %
Messina	IT	2	1T, 1B		1T	1	2	15 %
Napoli	IT	11	5T, 4B, 2I		1T	5.5	6	78 %
Palma de Mallorca	ES	4	1T,2B, 1I		1B	3.4	4	47 %
Piraeus	GR	8	4T, 2B, 2I	1T		6.9	3	40 %
Reggio Calabria	IT	2	1T, 1B			1.6	2	20 %

Port	Country code	SPO within 10 km (#)	SPO type	SPO in port (#, type)	SPO within 1 km from port (#, type)	Mean distance from port (km)	wind sectors with at least 1 SPO (#)	Total wind frequency covered by all SPOs
Rotterdam	NL	13	5T, 5B, 5I		1T, 3B, 1I	2.8	4	45 %
Santa Cruz Tenerife	ES	9	1T, 2B, 6I		1T, 1I	1.7	1	23 %
Stockholm	SE	12	10T, 2B			4.4	2	21 %
Trieste	IT	3	1T, 2B		2B	0.6	2	13 %
Valencia	ES	9	6T, 3B		1T	4.9	3	50 %

Table 3.2 Number of SPOs within 20 km from a port, in port or within 1km from a port. SPOs in the list are those with available data for PM_{10} in 2021

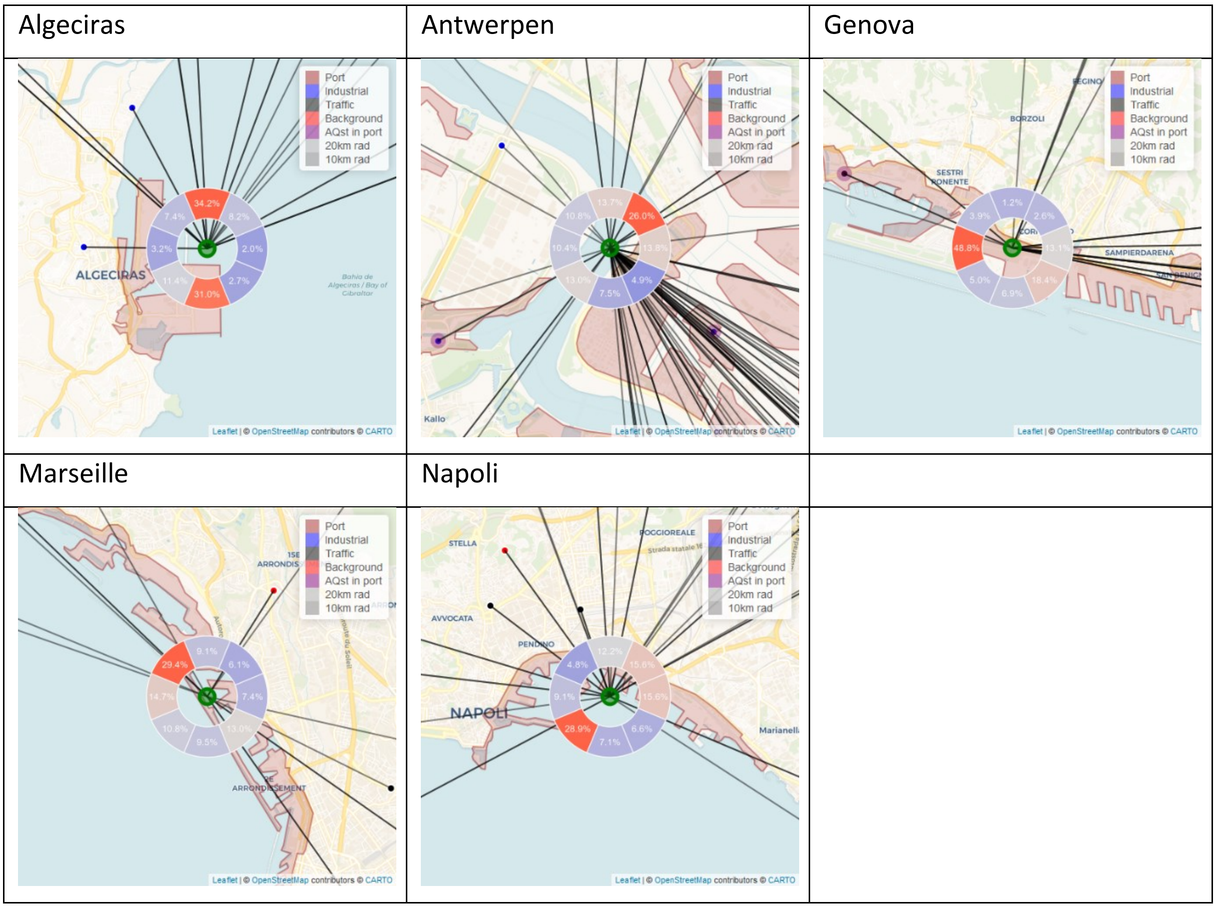
Port	Country code	SPO within 20 km (#)	SPO type	SPO in port (#, type)	SPO within 1 km from port (#, type)	Mean distance from port (km)	wind sectors with at least 1 SPO (#)	Total wind frequency covered by all SPOs
Algeciras	ES	4	4I		1I	2.8	4	46 %
Amsterdam	NL	22	6T, 9B, 7I	1T, 1B	1T, 2I	6.9	7	79 %
Antwerpen	BE	19	2T, 7B,10I	2I	2B, 2I	2.4	8	100 %
Barcelona	ES	5	2T, 3B			10.6	4	58 %
Bremen	DE	6	1T, 4B, 1I		1B	2.6	3	35 %
Bremerhaven	DE	2	1T, 1B		1B	1.6	2	21 %
Gdansk	PL	7	7B		1B	6.9	3	32 %
Genova	IT	5	3T, 2B	1T	1T, 1B	1.3	2	17 %
Gioia Tauro	IT	-	-	-	-	-	-	-
Hamburg	DE	10	3T, 5B, 2I	1B	1B, 1I	3.1	5	71 %

Port	Country code	SPO within 20 km (#)	SPO type	SPO in port (#, type)	SPO within 1 km from port (#, type)	Mean distance from port (km)	wind sectors with at least 1 SPO (#)	Total wind frequency covered by all SPOs
Le Havre	FR	6	1T, 3B, 2I		1B	5.1	5	57 %
Marsaxlokk	MT							
Marseille	FR	6	1T, 3B, 2I			7.5	4	63 %
Messina	IT							
Napoli	IT	6	3T, 3I		1T	4.8	4	42 %
Palma de Mallorca	ES	4	1T,2B, 1I		1B	4.8	4	47 %
Piraeus	GR	9	2T, 6B, 1I	1T		10.6	3	40 %
Reggio Calabria	IT							
Rotterdam	NL	17	6T, 8B, 3I		1T, 3B, 1I	5.9	5	67 %
Santa Cruz Tenerife	ES	14	3B, 11I			6.6	1	23 %
Stockholm	SE	13	12T, 1B			7.7	3	37 %
Trieste	IT	4	1T, 2B, 1I		1B, 1I	1.6	4	31 %
Valencia	ES	8	5T, 2B, 1I		1T	7	3	50 %

Also, for PM$_{10}$, most of the SPOs found inside port areas are classified as traffic (T) (1 in Amsterdam, 2 in Genova, and 1 in Piraeus). In the port of Antwerpen 2 industrial (I) SPOs were found, and 2 SPOs classified as background (B) are located inside the ports of Amsterdam and Hamburg.

The mean distances of SPOs from port areas are ranging between 1.3 km (Genova) and 10.6 km (Piraeus and Barcelona). Only a few of the identified SPOs are located downwind of the prevalent wind direction in the port areas. Only 3 ports (Algeciras, Antwerpen, and Marseille) have at least one SPO for PM$_{10}$ located in a wind direction sector which is downwind of the port more than 25% of the time (Figure 3.3). The port of Antwerpen has SPOs in all the 8 wind sectors around the port (100% of the wind frequency). The port of Amsterdam has SPOs in 7 of the 8 wind sectors around the port (total frequency of 79% of wind directions from the ports toward the seven sectors with SPOs). The total wind frequency is above 50% in 8 of the 23 ports analysed.

Figure 3.3 Air quality SPOs and wind direction frequencies for the ports of Algeciras, Antwerpen, Genova, Marseille and Napoli



Note: A map with location of the air quality SPOs around ports and frequency of wind direction blowing from the ports towards 8 wind sectors is provided for all ports in the Annex 1.

4 Air quality in port areas compared to the nearby cities and regions

An analysis was conducted using wind directions from meteorological data and measured concentrations of the identified SPOs around each port. The change in pollutant concentrations measured at SPOs around the ports was assessed only during downwind conditions and compared to the rest of the observations. For each port the timeseries of hourly NO$_2$ and PM$_{10}$ concentrations for 2021 were analysed. The distribution of the concentrations for all SPOs located in the same wind sector around the port were compared for each port. As shown in the example in Figure 4.1, in the port of

Antwerpen there are three SPOs in the NE wind sector relative to the port, all of them have valid data for NO_2 concentrations, only one for PM_{10}. In these SPOs, the distribution of measured concentrations when air was blowing from the port (green line) was compared to conditions when air is not blowing form the port (blue line), and for all wind directions (red line). The wind blowed 26% of the time during 2021 from the port of Antwerpen toward these the SPOs. When the air was coming from the port, the peak of the distribution of NO_2 concentrations increased from 6.8 µg/m^3 (not from port) to 12 µg/m^3 (from port). The median of NO_2 concentrations increased by 75% when air was coming from the port (21 µg/m^3) compared to not from port conditions (12 µg/m^3). For PM_{10} concentrations in the same sector there is only one SPO, a similar increase was not observed, only a 12% increase in the peak of the distributions, and no change in the median between the two distributions of PM_{10} concentrations. The different distributions of pollutant concentrations can indicate a possible impact of the port in a specific region (in this case NE from the port of Antwerpen), but it must be highlighted that it cannot be considered a precise estimate, as pollution from other sources in the region cannot be separated through this analysis. The same analysis is available in the Annex 1 for all ports and for all wind directions where measurements are available.

Figure 4.1 Distribution of hourly NO_2 (left) and PM_{10} (right) concentrations for SPOs (3 for NO_2, 1 for PM_{10}) located in the NE wind sector relative to the port of Antwerpen. Three distributions are shown, for "all" wind directions (WD), for WD "from port" and for WD "not from port". The number of hourly concentration values (# records) for each distribution is indicated in the legend.

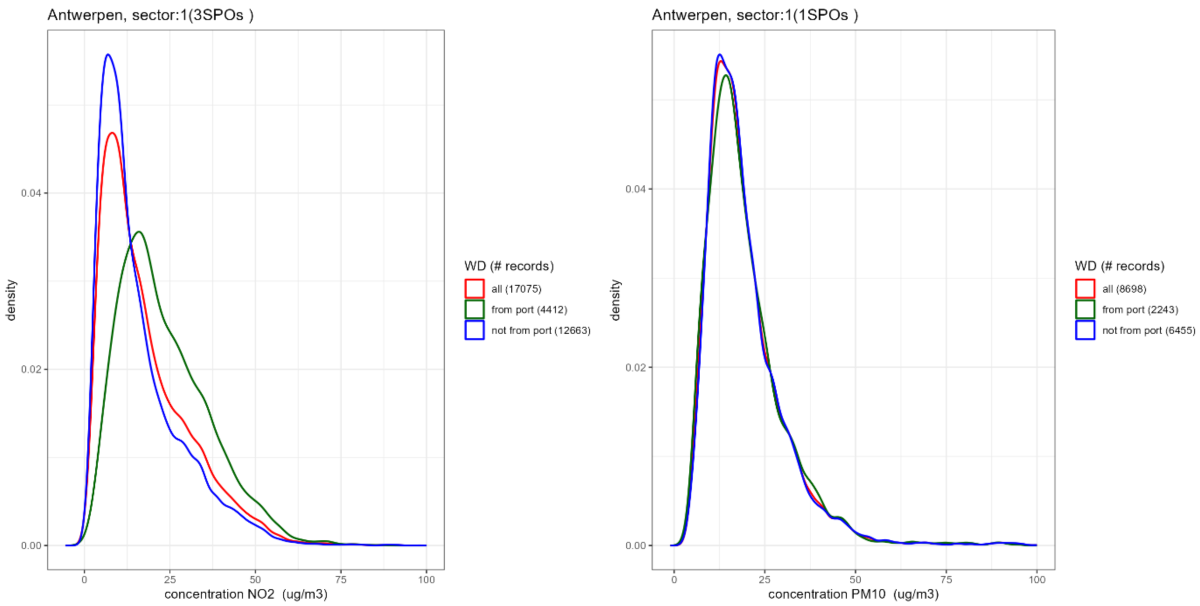


Table 4.1 Summary for all ports with main percentage changes in median NO_2 and PM_{10} concentrations for measurements when air is blowing from the port

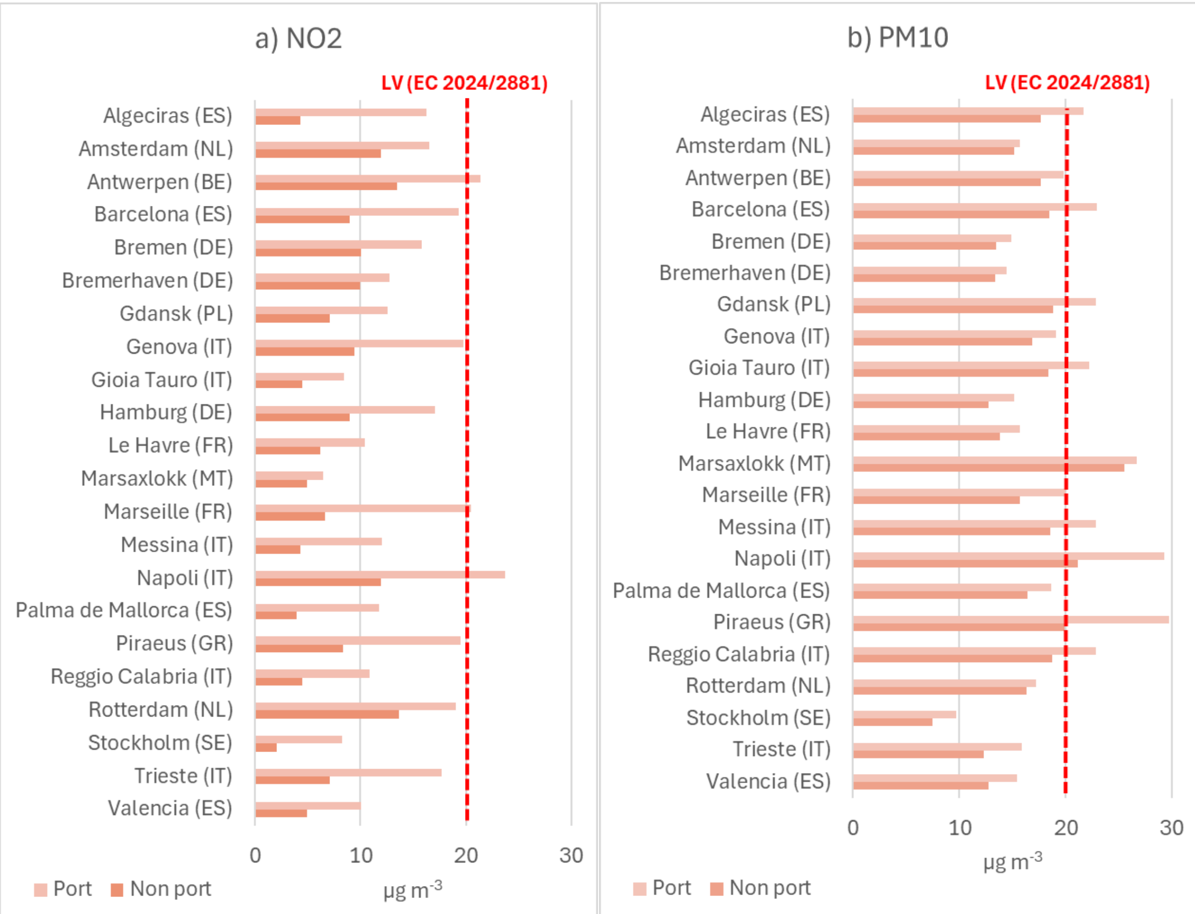
Port	NO_2	PM_{10}	Maps and figures
Algeciras	Data available in 5 wind sectors. Increase in 3 sectors from 40% (W) to 86% (NE).	Data available in 4 wind sectors. Increase in 2 sectors, 12% (E) and 19% (W).	Annex 1.1
Amsterdam	Data available in 7 wind sectors. Increase in 4 sectors from 13% (N) to 51% (W).	Data available in 7 wind sectors. Increase in 3 sectors from 7% (E) to 20% (SE).	Annex 1.2
Antwerpen	Data available in 6 wind sectors. Increase in 5 sectors from 6% (SW) to 75% (NE).	Data available in all 8 wind sectors. Increase in 4 sectors from 6% (E) to 26% (S).	Annex 1.3
Barcelona	Data available in 4 wind sectors. Increase in 2 sectors from 5% (NE) to 29% (SW).	Data available in 4 wind sectors. Increase in 1 sector of 5% (W).	Annex 1.4
Bremen	Data available in 3 wind sectors. Increase in 2 sectors, 21% (E) and 26% (SE).	Data available in 3 wind sectors. Increase in 2 sectors, 14% (E) and 25% (SE).	Annex 1.5
Bremerhaven	Data available in 2 wind sectors. No increase detected in both sectors (E and SE).	Data available in 2 wind sectors. Increase in 2 sectors, 13% (E) and 36% (SE).	Annex 1.6
Gdansk	Data available in 3 wind sectors. No increase detected in all sectors.	Data available in 3 wind sectors. Very small increase detected in one sector, 3% (SW).	Annex 1.7
Genova	Data available in 4 wind sectors. Increase detected in all sectors from 1% (NW) to 32% (W).	Data available in 2 wind sectors. Increase detected in all sectors, 2% (NW) and 11% (E).	Annex 1.8
Gioia Tauro	No data available.	No data available.	Annex 1.9
Hamburg	Data available in 5 wind sectors. Increase detected in 2 sectors, 26% (NE) and 77% (SW).	Data available in 5 wind sectors. Increase detected in 2 sectors, 17% (NE) and 32% (SE).	Annex 1.10
Le Havre	Data available in 2 wind sectors. Increase detected in 1 sector, 73% (NW).	Data available in 5 wind sectors. Increase detected in 1 sector, 15% (SE).	Annex 1.11
Marsaxlokk	Data available in 2 wind sectors. Increase detected in 1 sector, 31% (N).	No data available.	Annex 1.12

Port	NO_2	PM_{10}	Maps and figures
Marseille	Data available in 3 wind sectors. Increase detected in 1 sector, 52% (NE).	Data available in 4 wind sectors. Increase detected in all 4 sectors, from 7% (W) to 25% (NE).	Annex 1.13
Messina	Data available in 2 wind sectors. Increase detected in 1 sector, 46% (SW).	No data available.	Annex 1.14
Napoli	Data available in 6 wind sectors. Increase detected in 4 sectors, from 5% (NW) to 115% (SW).	Data available in 4 wind sectors. No increase detected in all 4 sectors.	Annex 1.15
Palma de Mallorca	Data available in 4 wind sectors. No increase detected in all 4 sectors.	Data available in 4 wind sectors. Small increase detected in 2 sectors, 5% (NE and E).	Annex 1.16
Piraeus	Data available in 3 wind sectors. Increase detected in 1 sector, 45% (NE).	Data available in 3 wind sectors. Increase detected in 2 sectors, 8% (E) and 13% (NE).	Annex 1.17
Reggio Calabria	Data available in 2 wind sectors. No increase detected in both sectors.	No data available.	Annex 1.18
Rotterdam	Data available in 4 wind sectors. Increase detected in 3 sectors, from 35% (N) to 46% (SE).	Data available in 5 wind sectors. Increase detected in 3 sectors, from 9% (NE) to 26% (SE).	Annex 1.19
Santa Cruz Tenerife	Data available in 1 wind sector. Increase detected, 50% (SW).	Data available in 1 wind sector (SW). Increase not detected.	Annex 1.20
Stockholm	Data available in 2 wind sectors. Increase detected in 1 sector, 21% (SW).	Data available in 3 wind sectors. Increase detected in 1 sector, 25% (SW).	Annex 1.21
Trieste	Data available in 2 wind sectors. Increase detected in 1 sector, 41% (N).	Data available in 4 wind sectors. Increase detected in all 4 sectors, from 8% (NW) to 74% (N).	Annex 1.22
Valencia	Data available in 3 wind sectors. Increase detected in all 3 sectors, from 13% (W) to 40% (N).	Data available in 3 wind sectors. Very small increase detected in 1 sector, 4% (W).	Annex 1.23

The majority of the ports analysed do not have air quality SPOs inside port areas. Furthermore, most of the SPOs in the nearby cities are too sparse and often not located downwind of the ports. Thus, it was difficult to derive strong conclusions from the previous analysis based uniquely on measurements. The analysis of the EEA air quality maps([8]) (Horálek et al, 2023, ETC HE Report 2023/3) may represent better the differences between NO_2 and PM_{10} concentrations in ports compared to the nearby cities and regional background levels. The maps are created as a data fusion between a model simulation, thus taking into account the impact of meteorology for a specific year, measurements reported by the Member States to the EEA and other ancillary data, such as land cover. The maps are used to downscale the model results, which have a rather coarse resolution, to a finer resolution of 1 km by 1km, and better geographical distribution of pollutants concentrations.

Figure 4.1 shows the differences between annual mean concentrations of NO_2 (a) and PM_{10} (b) over port areas compared to the surrounding regions. The «Port» concentrations are calculated as the mean concentrations of all the grid cells, in the 1 km x 1 km air quality map, which are intersecting or within 1 km from the port area polygons. The «Non port» concentrations are calculated as the mean concentrations over all other grid cells around the port over a region within 0.5 degrees latitude and longitude (approximatively a region of 100 km by 100 km).

Figure 4.2 Annual mean NO_2 (a) and PM_{10} (b) concentrations in port areas and surrounding regions ("Non port"). The dashed red line represents the LV for NO_2 and PM_{10} annual mean concentrations set by the revised AAQD (EC 2024/2881)



NO_2 concentrations in "Port" areas were larger than the "Non port" regional levels for all the ports analysed (data for Santa Cruz de Tenerife were not available as extra territories are not included in the

([8]) EEA geospatial data catalogue European air quality data (interpolated data)- Series.

EEA air quality maps). The differences in annual mean NO_2 concentrations ranges from 1.5 µg/m^3 (Marsaxlokk, MT) to 13.8 µg/m^3 (Marseille, FR). The differences were above 10 µg/m^3 in 7 ports, Algeciras (ES), Barcelona (ES), Genova (IT), Marseille (FR), Napoli (IT), Piraeus (GR), and Trieste (IT). The annual mean NO_2 concentrations were above 20 µg/m^3 (the LV for the protection of human health set in the revised AAQD, EC 2024/2881, to be attained by 1/1/2030) in three ports, Antwerpen (BE), Marseille (FR), and Napoli (IT). Other ports which are very close to this LV were Barcelona (ES, 19.3 µg/m^3), Genova (IT, 19.8 µg/m^3), Piraeus (GR, 19.5 µg/m^3), Rotterdam (NL, 19 µg/m^3).

Also PM_{10} concentrations in “Port” areas were larger than the “Non port” regional levels for all the port analysed. But, compared to NO_2, the differences were smaller, ranging from 0.5 µg/m^3 (Amsterdam, NL) to 9.8 µg/m^3 (Piraeus, GR). Only two ports stand out from the others with large differences, Piraeus (GR, 9.8 µg/m^3) and Napoli (IT, 8.2 µg/m^3). Differences in PM_{10} concentrations in all other ports were below 4.4 µg/m^3 (Barcelona, ES). The annual mean PM_{10} concentrations were above 20 µg/m^3 (the LV for the protection of human health set in the revised AAQD, EC 2024/2881, to be attained by 1/1/2030) in 10 ports, Algeciras (ES, 21.7 µg/m^3), Barcelona (ES, 22.9 µg/m^3), Gdansk (PL, 22.8 µg/m^3), Gioia Tauro (IT, 22.3 µg/m^3), Marsaxlokk (MT, 26.7 µg/m^3), Marseille (FR, 20 µg/m^3), Messina (IT, 22.8 µg/m^3), Napoli (IT, 293 µg/m^3), Piraeus (GR, 29.7 µg/m^3) and Reggio Calabria (IT, 22.9 µg/m^3). Other ports which are very close to this LV are Antwerpen (BE, 19.8 µg/m^3) and Genova (IT, 19.1 µg/m^3).

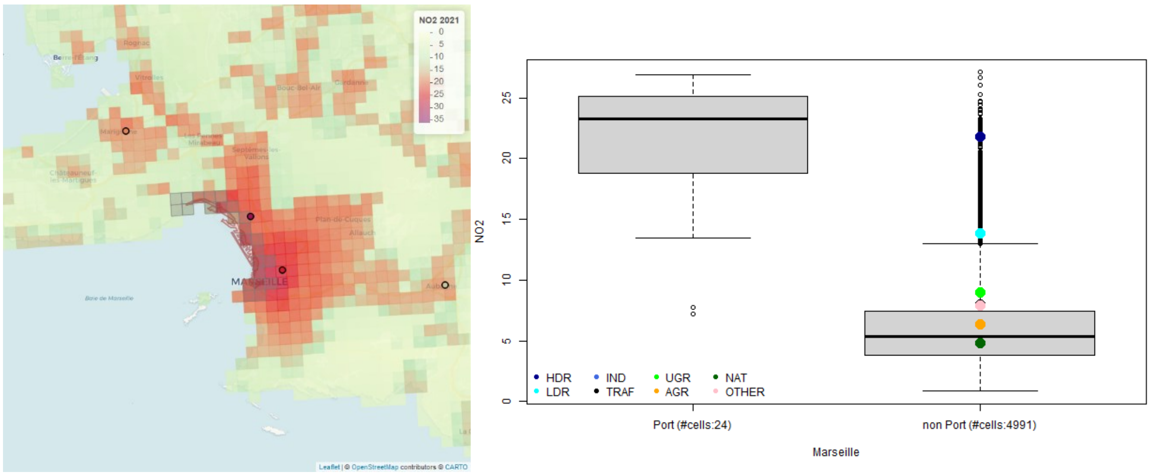
The EEA air quality maps give also the possibility to show a comparison between the mean concentrations in ports and area-weighted mean concentrations for different land covers (i.e. the sum of the concentrations multiplied by the area fraction covered by a specific land cover class, divided by the total area of that land cover). The land cover classes which are used as ancillary data to create the maps are listed in Table 4.2, and are also based on the CORINE CLC 2018 dataset used in this study to identify the port areas (CLC code 123). The port areas in the EEA air quality maps are included in a new class, traffic (TRAF), which includes the codes 122-124, road and rail networks and associated land, ports and airports. Two examples of more detailed comparisons are presented here for two ports where the largest differences in Figure 4.2 were identified, Marseille for NO_2 (Figure 4.3) and Piraeus for PM_{10} (Figure 4.4). Maps of NO_2 and PM_{10} concentrations and their distribution over port and non-port grid cells are available for each port in Annex 1.

Table 4.2 Land cover classes used as ancillary data in the EEA air quality maps

Label	General class description	CLC classes grid codes	CLC classes codes	CLC classes description
HDR	High density residential areas	1	111	Continuous urban fabric
LDR	Low density residential areas	2	112	Discontinuous urban fabric
IND	Industry	3, 7-9	121, 131-133	Industrial or commercial units, Mineral extraction sites, Dump sites, Construction sites
TRAF	Traffic	4-6	122-124	Road and rail networks and associated land, **Ports**, Airports
UGR	Urban green	10-11	141-142	Artificial, non-agricultural vegetated area
AGR	Agricultural areas	12-22	211-244	Agricultural areas
NAT	Natural areas	23-34	311-335	Forest and seminatural areas
OTH	Other areas	35-44	411-523	Wetlands, Water bodies

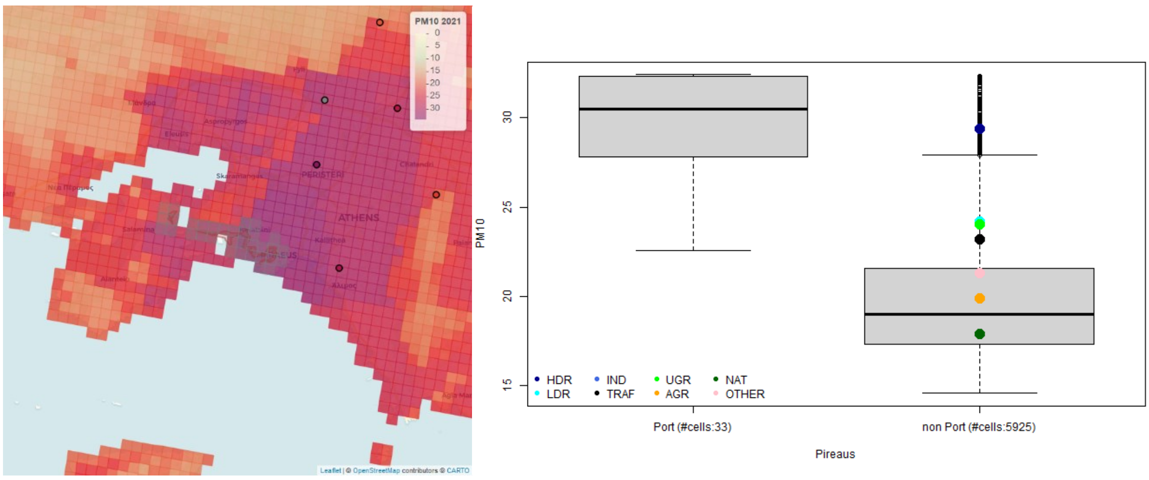
In Marseille, 24 grid cells of the EEA air quality maps are intersecting with the port area polygon (code 123 in CLC 2018) or within a distance of 1 km from it. The NO_2 mean concentration over the 24 port grid cells is 20.5 µg/m^3 (median of 23.3 µg/m^3), which is comparable only with the mean area-weighted concentration for high density residential areas (HDR), 21.8 µg/m^3, while the area-weighted mean for all other land cover classes is ranging between 4.8 µg/m^3 (natural areas, NAT) and 13.8 µg/m^3 (low density residential areas, LDR).

Figure 4.3 EEA air quality map of NO_2 concentrations in Marseille and box-plot distribution of the concentrations over the port (grey shaded grid cells), compared to the surrounding region and area-weighted means for different land cover classes (Table 4.2)



In Piraeus, 33 grid cells of the EEA air quality maps are intersecting with the port area polygon or within a distance of 1 km from it. The PM_{10} mean concentration over the 33 port grid cells is 29.7 µg/m^3 (median of 30.5 µg/m^3). Also in this case the mean PM_{10} concentration in the port is comparable only with the mean area-weighted concentration for high density residential areas (HDR), 29.4 µg/m^3, while the area-weighted mean for all other land cover classes is ranging between 17.9 µg/m^3 (natural areas, NAT) and 24.2 µg/m^3 (low density residential areas, LDR).

Figure 4.4 EEA air quality map of PM_{10} concentrations in Piraeus and box-plot distribution of the concentrations over the port (grey shaded grid cells), compared to the surrounding region and area-weighted means for different land cover classes (Table 4.2)



5 Differences between air pollution trends in port areas and nearby cities

Long-term trends (2005-2021) of air pollutants at European and national level have been studied in Gbangou and Colette (2023, ETC HE Report 2023/8) by analysing the observations through linear statistics. These trends have been investigated to highlight the differences of the evolution of NO_2 and PM_{10} concentrations in port areas and nearby cities.

The summary Table 5.1 and
Table 5.2 present the number of SPOs that are in the vicinity of the main ports, respectively for NO_2 and PM_{10}. SPOs showing trends over the period 2005-2021 are indicated along with the type of pollution influence, i.e. traffic (T), background (B) and industrial (I). The location of the SPOs is also specified, i.e. which SPOs are in the port and within a 1 km radius. The average distance of the SPOs from the port is also indicated.

Table 5.1 Number of NO_2 SPOs within 10 km from a port (#SPOs) and those for which long term measurements and the 2005-2021 trend are available (#w/trends). For the SPOs with trend, it is specified their type (background, B; transport, T; industrial, I), if located inside port (in port) or within 1 km, and the mean distance (in kilometres) from the port of all SPOs with trends.

Port	Country code	SPOs (#)	SPOs w/trends (#)	SPO type	SPO in port (#, type)	SPO within 1 km (#, type)	Mean distance from port in km
Amsterdam	NL	18	13	5T 7B 1I	1T	3T 1B 1I	1.6
Algeciras	ES	15	11	1T 10I	0	1I	3.3
Hamburg	DE	14	11	4T 3B 4I	0	1I	2.7
Barcelona	ES	14	10	3T 7B	0	1B	3.8
Antwerpen	BE	50	9	2B 7I	3I	4I	1.3
Genova	IT	10	5	4T 1B	1T	2T	2.2
Gdansk	PL	6	5	5B	0	1B	2.2
Rotterdam	NL	16	5	1T 3B 1I	0	2B 1I	2.8
Marseille	FR	5	4	2T 2B	0	0	1.9
Bremen	DE	6	4	1T 3B	0	0	3.5
Valencia	ES	11	3	2T 1B	0	1T	2.7
Napoli	IT	11	3	3T	0	1T	1.4
Stockholm	SE	19	3	2T 1B	0	0	3.7
Le Havre	FR	5	2	1B 1I	0	1B 1I	0.5
Palma de Mallorca	ES	4	2	1T 1B	0	1B	0.8
Bremerhaven	DE	2	2	1T 1B	0	1B	1.7
Piraeus	GR	14	2	1T 1I	0	0	7.2
Trieste	IT	8	0	0	0	0	
Santa Cruz de Tenerife	ES	12	0	0	0	0	

Port	Country code	SPOs (#)	SPOs w/trends (#)	SPO type	SPO in port (#, type)	SPO within 1 km (#, type)	Mean distance from port in km
Gioia Tauro	IT	0	0	0	0	0	
Marsaxlokk	MT	2	0	0	0	0	
Messina	IT	2	0	0	0	0	
Reggio Calabria	IT	2	0	0	0	0	

Table 5.2 Number of PM_{10} SPOs within 20 km from a port (#SPOs) and those for which long term measurements and the 2005-2021 trend are available (#w/trends). For the SPOs with trend, it is specified their type (background, B; transport, T; industrial, I), if located inside port (in port) or within 1 km, and the mean distance (in kilometres) from the port of all SPOs with trends

Port	Country code	SPOs (#)	SPOs w/trends (#)	SPO type	SPO in port (#, type)	SPO within 1 km (#, type)	Mean distance from port in km
Hamburg	DE	13	10	3T 4B 3I	0	1I	4.3
Rotterdam	NL	20	6	2T 4B	0	1B	10.2
Antwerpen	BE	29	6	2B 4I	1I	2I	1.9
Gdansk	PL	11	5	5B	0	1B	5.8
Marseille	FR	8	5	2B 3I	0	0	10.3
Stockholm	SE	19	5	4T 1B	0	0	5.4
Le Havre	FR	7	3	1B 2I	0	1B 1I	6.4
Palma de Mallorca	ES	5	3	1T 2B	0	2B	0.7
Bremen	DE	7	3	1T 2B	0	0	3.9
Genova	IT	17	2	2B	0	2B	0.3
Trieste	IT	13	2	2I	2I	2I	0
Bremerhaven	DE	2	2	1T 1B	0	1B	1.7
Amsterdam	NL	25	2	1T 1B	0	0	18.6
Valencia	ES	16	1	1B	0	0	2
Algeciras	ES	12	1	1I	0	0	3.9
Santa Cruz de Tenerife	ES	14	1	1B	0	0	19.7
Barcelona	ES	45	0	0	0	0	
Napoli	IT	17	0	0	0	0	
Piraeus	GR	15	0	0	0	0	

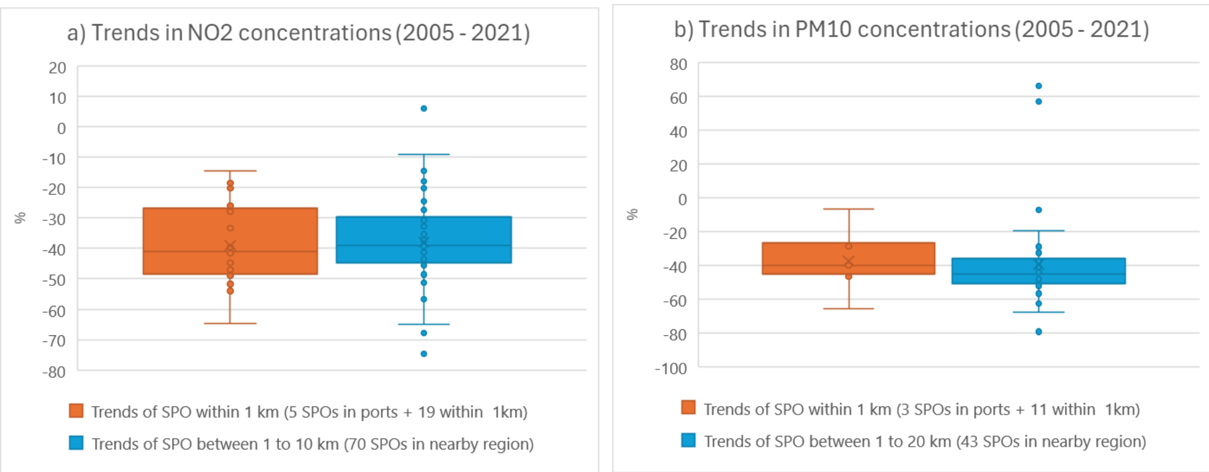
Port	Country code	SPOs (#)	SPOs w/trends (#)	SPO type	SPO in port (#, type)	SPO within 1 km (#, type)	Mean distance from port in km
Gioia Tauro	IT	1	0	0	0	0	
Marsaxlokk	MT	6	0	0	0	0	
Messina	IT	4	0	0	0	0	
Reggio Calabria	IT	4	0	0	0	0	

On average the trends during the period 2005-2021 of NO_2 concentrations measured at SPOs located directly inside port areas or in the near vicinity of the port (within 1 km distance) are not significantly different from the trends observed in other SPOs between 1 km to 10 km from the port area in the nearby cities. Overall, the median trend for available SPOs in ports (5) or within 1 km distance (19) is a reduction of NO_2 concentrations of about 40%. This value is very similar to the median trend for all other SPOs located in nearby cities at distances between 1 to 10 km (70), which shows a decrease of about 39% (Figure 5.1a)

A slightly lower trend (-40%) was found in PM_{10} concentrations for SPOs in ports (3) and within 1 km from the port (11), compared to the trend (-45%) for SPOs within 20 km from the ports (43) (Figure 5.1b).

On the other hand, it must be noted that it is difficult to derive a general conclusion for NO_2 and PM_{10} trends for all ports. Only 3 ports have NO_2 SPOs inside the ports, and only 2 ports for PM_{10}. Even if it was available an overall larger number of ports with SPOs within 1 km from the port area, 13 ports for NO_2 and 11 ports for $PM_{10,}$ it remains challenging to derive a clear conclusion on trends in ports compared to nearby cities and region based only on few SPOs.

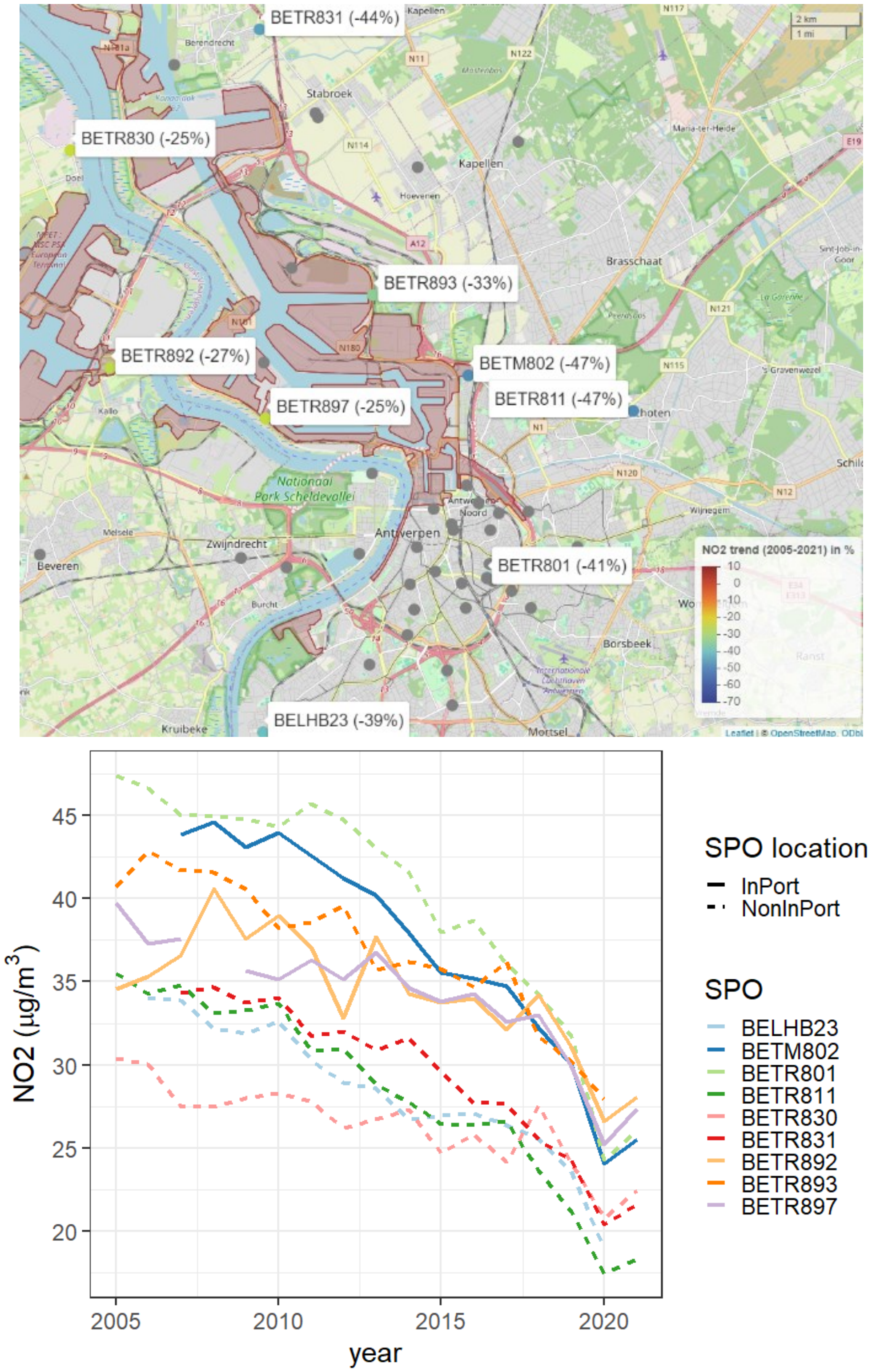
Figure 5.1 Distribution of trends in NO_2 (a) and PM_{10} (b) concentrations at SPOs in ports or within 1 km distance compared to trends found at SPOs in the nearby city



Nevertheless, some differences were seen for the port in Antwerpen, where a larger number of SPOs with measured trends is available, both inside or near ports and in other parts of the city (6). In Antwerpen, three out of four SPOs located in port or near the port show a trend ranging between -25% to -33% in NO_2 concentrations. One SPO inside the port shows a larger reduction trend (-47%), which is comparable with trends observed in other parts of the city. This SPO inside the port area is also the closest to the high-density residential area and main roads. The same is observed for another

SPO in the north, close to the port areas but also to a main road. A gradient in NO_2 concentration trends is visible, with lower concentration reductions in the north-west (from -25% to –33%), where most of the port of Antwerpen is located, and largest NO_2 concentrations reductions in the east and south (from –39% to –47%), showing the impact of larger emission reductions from other source sectors, such as road traffic (Figure 5.2).

Figure 5.2 Trends in NO_2 concentrations at monitoring SPOs in the port and the city of Antwerpen



6 Impact of shipping emissions on the air quality of the nearby cities

Based on available observations, it is challenging to disentangle the impacts on air quality of the activities in the ports and international shipping from other sources in the nearby cities. The analysis presented in this report, shows that there are often insufficient SPOs for NO_2 and PM_{10} and that their locations are not optimal for the purposes of monitoring the impact of port activities on air quality inside the ports and the nearby cities. As meteorology plays an important role on air quality, the SPOs must be located downwind (based on the prevailing wind direction) of the port in order to monitor the impacts in the surrounding region.

High resolution air quality modelling studies are a useful approach to disentangling the impact of port activities and international shipping from other emission sectors and their relative contribution to the air quality in nearby cities. The online ACT model (Colette et al., 2022), a surrogate model of the CHIMERE Chemistry-Transport Model (Menut et al., 2024), was used to analyse the impact of international shipping during pollution episodes in Antwerpen and Barcelona.

Note that the CHIMERE, from which the air quality simulations used for both the design of the numerical experiment and the every-day training of ACT, is not fitted to deal with local hotspot situations that can develop near a port and the associated activities and industrial sites. The model resolution is about 0.25° and is not sufficient to fully catch NO_2 concentrations at traffic and industrial sites, as it is not able to resolve the level detail needed (emissions, meteorology and chemistry) for these local scale occurrences. However, the model gives a good estimate of background concentrations levels. In addition, ACT allows us to estimate the impact of emission reductions related to shipping but not to emissions linked to other activities such as traffic and industrial activities in port.

Several pollution episodes in Antwerpen and Barcelona have been studied using the ACT estimates to better understand the origin of the high NO_2 and PM_{10} concentrations and to assess the role of shipping emissions.

Antwerpen

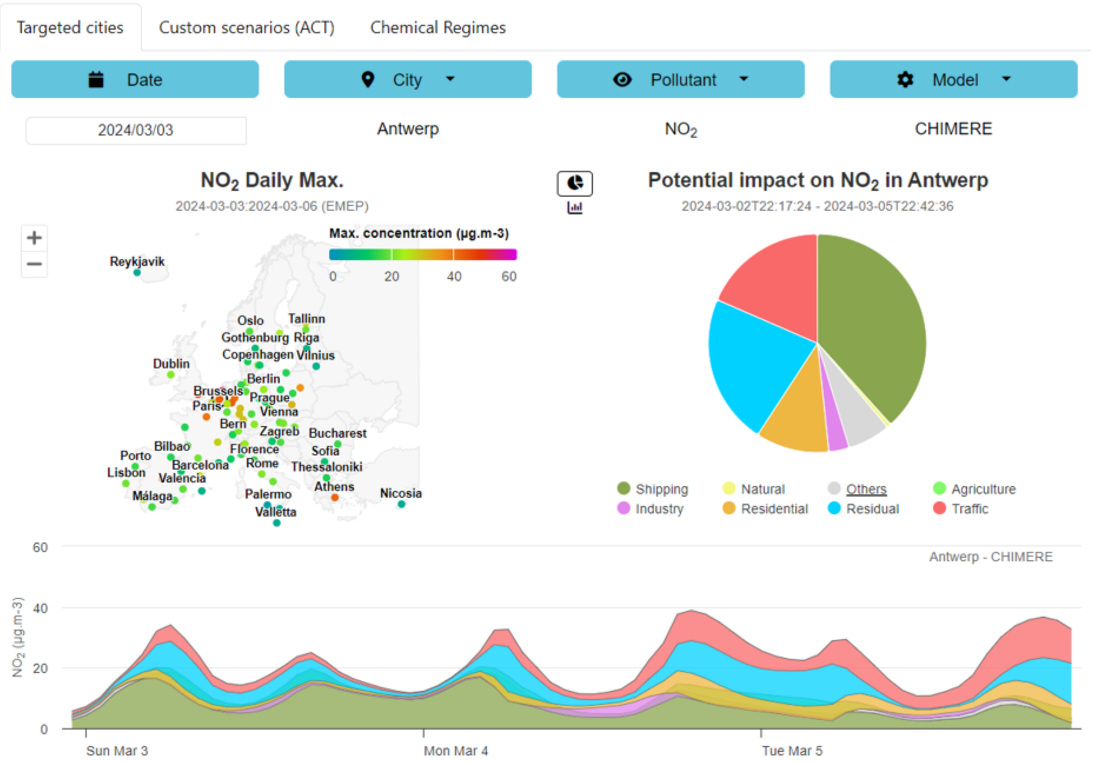
NO_2 episode, 3-7 March 2024

At the beginning of March 2024, a high pollution event in Antwerpen was simulated with NO_2 daily max concentrations of about 39 µg/m^3 (Figure 6.1). High NO_2 concentrations persisted in and around Antwerpen for several days. During this episode, ACT estimated that international shipping was the main source sector contributing to the NO_2 concentrations (38%), more than residential (11%) and road traffic (19%) emissions.

ACT allows to test and directly estimate the impact on air quality of emission reduction scenarios. Therefore, to demonstrate and visualize the spatial impact of shipping-related emissions on this pollution episode, emissions from this sector have been reduced by 100% for instance on March 3, 2024, the day with the highest NO_2 concentration nearby Antwerpen (75 µg/m^3, Figure 6.2).

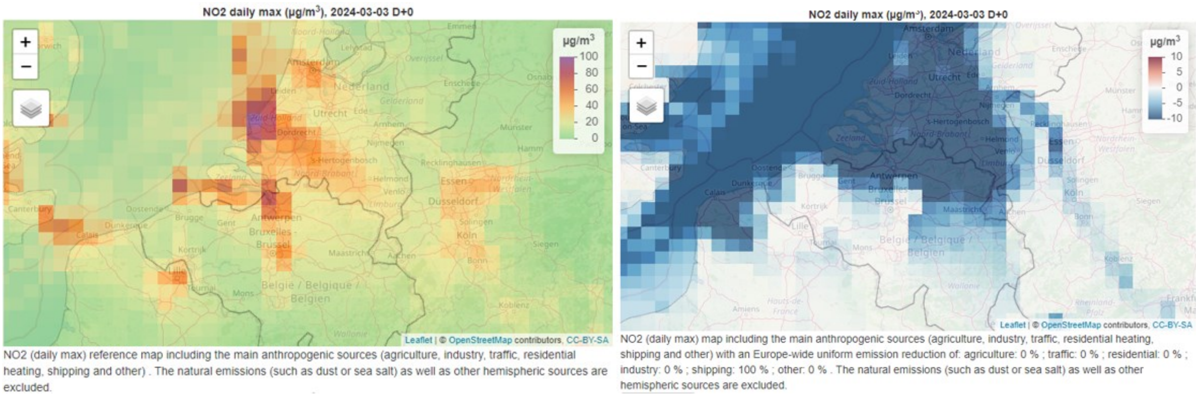
Reducing shipping emissions by 100% implies a significant decrease (up to 11 µg/m^3) in NO_2 concentration in Antwerpen and in surroundings regions. This result is consistent with the sector allocation showing the shipping sector as the main contributor to NO_2 levels during this episode.

Figure 6.1 NO_2 pollution episode in Antwerpen, 3-7 March 2024



Source:https://policy.atmosphere.copernicus.eu/daily_source_attribution/sector_apportionment.php?date=2024-03-03&pollutant=NO_2&city=Antwerp

Figure 6.2 Impact of shipping emissions on NO_2 concentrations during a pollution episode in Antwerpen, 3 March 2024

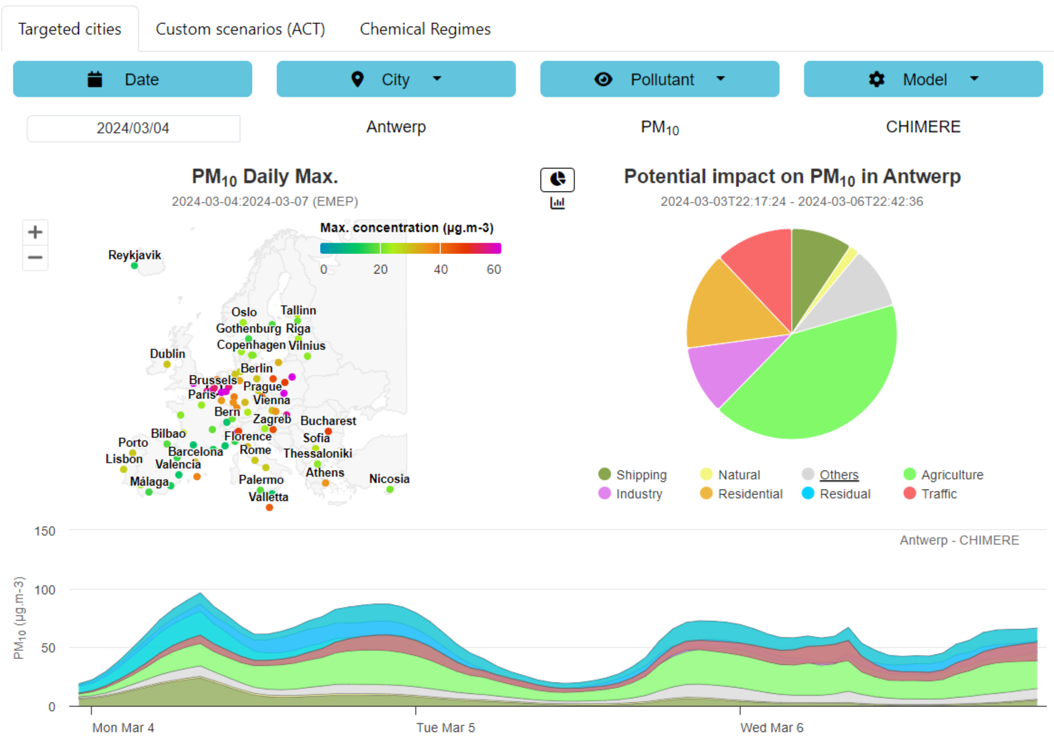


Source:https://policy.atmosphere.copernicus.eu/daily_source_attribution/sector_apportionment.php?date=2024-03-03&tab=nav-act-tab

PM_{10} episode, 4-8 March 2024

In the same days, high daily PM_{10} concentrations levels were simulated in the Antwerpen area (60 µg/m^3). The potential impact on PM_{10} concentrations from international shipping was 6%, which is less than the agricultural sector (43%), the residential (11%) and road traffic (10%) emissions but still significant (Figure 6.3).

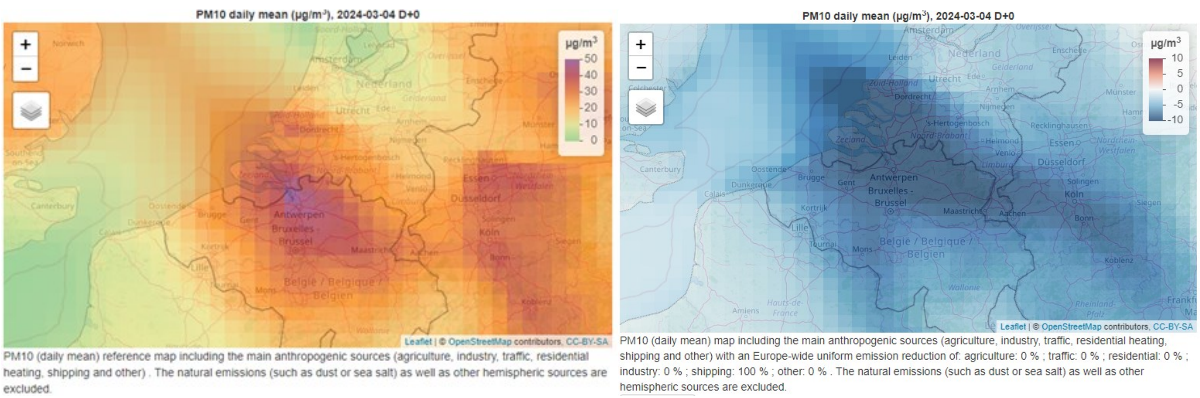
Figure 6.3 PM_{10} pollution episode in Antwerpen, 3-7 March 2024



Source:https://policy.atmosphere.copernicus.eu/daily_source_attribution/sector_apportionment.php?date=2024-03-04&pollutant=PM_{10}[&city=Antwerp]()

Reducing shipping related emissions by 100% on March 4, 2024, the day for which the highest PM_{10} concentration is estimated (48 µg/m^3) implies important decrease of the PM_{10} levels (up to 15 µg/m^3) from the North Sea to far inland, especially around Antwerpen (Figure 6.4).

Figure 6.4 Impact of shipping emissions on PM_{10} concentrations during a pollution episode in Antwerpen, 4 March 2024



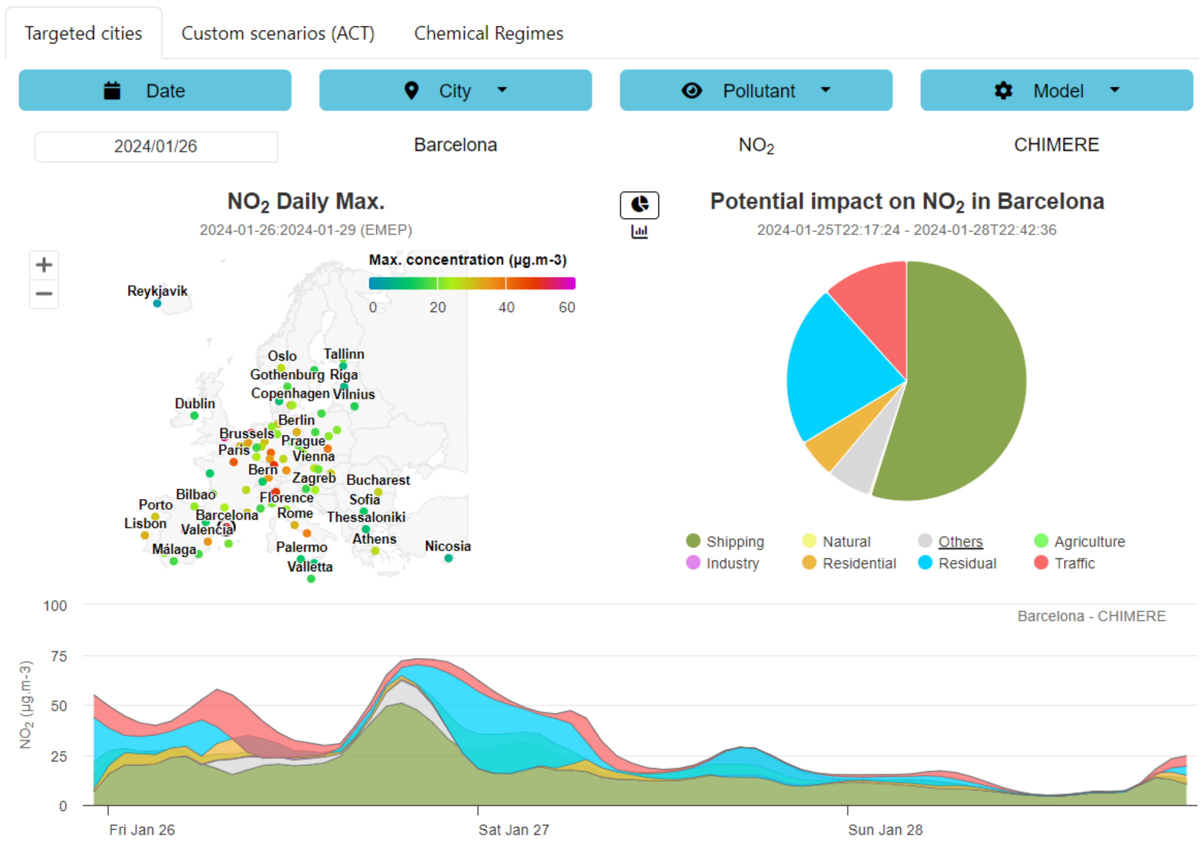
Source:https://policy.atmosphere.copernicus.eu/daily_source_attribution/sector_apportionment.php?date=2024-03-04&tab=nav-act-tab

Barcelona

NO_2 episode, 23-28 January 2024

Even larger contributions were found for another pollution episode at the end of January 2024 in Barcelona, with NO_2 daily concentrations reaching 73 µg/m^3 (Figure 6.5). During this episode international shipping contributed, on average, to more than 55% of the NO_2 concentrations, ahead of road traffic (12%) and residential (5%) emissions.

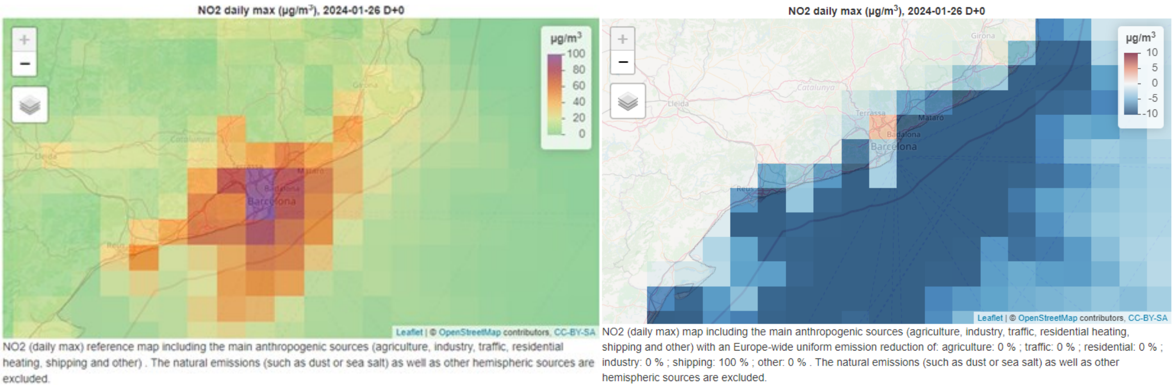
Figure 6.5 NO_2 pollution episode in Barcelona, 23-28 January 2024



Source:https://policy.atmosphere.copernicus.eu/daily_source_attribution/sector_apportionment.php?date=2024-01-26&pollutant=NO_2&city=Barcelona

The highest daily NO_2 concentration estimated by the model nearby Barcelona was 103 µg/m^3 on January 26, 2024. Reducing the shipping related emissions by 100% on this day implies a decrease of NO_2 levels (up to 5 µg/m^3) in most neighbouring areas (Figure 6.6).

Figure 6.6 Impact of shipping emissions on NO_2 concentrations during a pollution episode in Barcelona, 26 January 2024

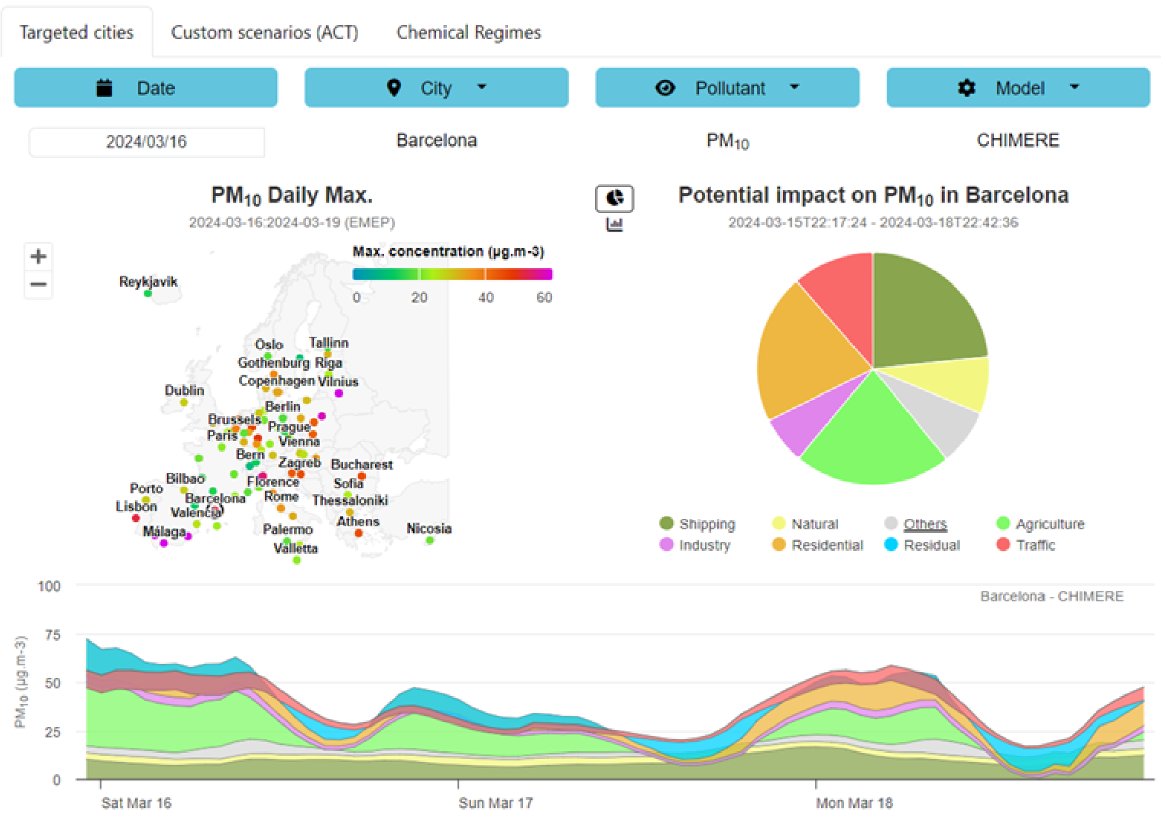


Source:https://policy.atmosphere.copernicus.eu/daily_source_attribution/sector_apportionment.php?date=2024-01-26&tab=nav-act-tab

PM_{10} episode, 15-20 March 2024

During another episode in Barcelona in March 2024, concentration levels up to daily 57 µg/m³ of PM_{10} have been observed. The potential impact on PM_{10} concentrations of international shipping emissions was significant (23%) even though residential (21%) and agriculture (22%) emissions were prevailing (Figure 6.7).

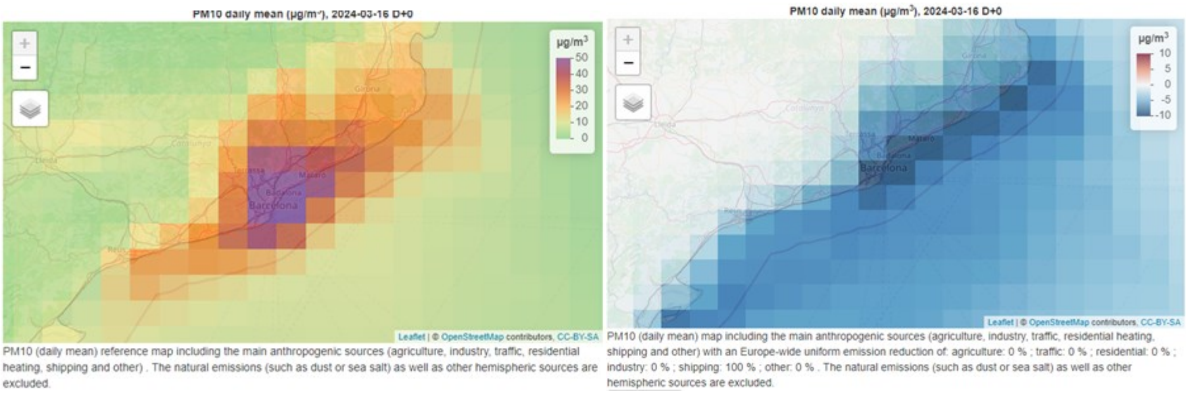
Figure 6.7 PM_{10} pollution episode in Barcelona, 15-20 March 2024



Source:https://policy.atmosphere.copernicus.eu/daily_source_attribution/sector_apportionment.php?date=2024-03-16&pollutant=PM_{10}&city=Barcelona

Reducing the shipping emissions by 100% on March 16, 2024, when the highest PM_{10} daily concentration levels were calculated (up to 64 µg/m³) allows to decrease by up to 15 µg/m³ the PM_{10} concentrations in the vicinity of Barcelona (Figure 6.8).

Figure 6.8 Impact of shipping emissions on PM_{10} concentrations during a pollution episode in Antwerpen, March 16, 2024



Source:https://policy.atmosphere.copernicus.eu/daily_source_attribution/sector_apportionment.php?date=2024-03-16&tab=nav-act-tab

7 Conclusions

Concentrations of NO_2 and PM_{10} in Europe have declined over the last decades due to reduced emissions in many sectors, such as road traffic. The relative contribution of shipping to air pollution in Europe is increasing. Monitoring air quality in ports and the nearby cities will become more important in the next decades to understand the role of emissions from international shipping, but also from all port activities (road traffic, non-road machinery, bulk unloading and industrial installations). In this report 4 questions were addressed, and the following conclusions were derived:

1. **How is the air quality monitored inside or in the vicinity of ports?**
   The availability of SPOs in and around port areas is limited. Given the increasing share of shipping and other port-related emissions, there is a need for increased knowledge of air quality in these areas. Among the 23 ports analysed, only 5 ports had at least one air quality SPO for NO_2 and PM_{10} located inside the port area. Almost all analysed ports had at least one SPO in the vicinity (within 1 km distance) of the port area. On the other hand, only a few of the identified SPOs are located downwind of the prevalent wind direction of the port areas.

2. **How are the ambient air concentrations of NO_2 and PM_{10} in and around ports compared to the nearby cities and regions?**
   As meteorology plays an important role in air quality, the SPOs must be located downwind (based on the prevailing wind direction) of the port to monitor the impacts on air quality in the surrounding region. An analysis was completed using meteorological data to assess the change in pollutant concentrations during downwind conditions (i.e. wind coming from the port) and compared to all other observations. A significant increase in NO_2 median concentrations was found at several SPOs around ports in different cities, for example in Napoli (above 100% increase), Algeciras (86%), Hamburg (77%), Antwerpen (75%), Le Havre (73%), Marseille (52%), Amsterdam (51%), Santa Cruz de Tenerife (50%), Rotterdam (46%), Messina (46%), Piraeus (45%). The same analysis showed smaller increases in median PM_{10} concentrations at some of the SPOs around ports (74% in Trieste, 36% in Bremerhaven, 32% in Hamburg, 31% in Trieste, 26% in Rotterdam, and 26% in Antwerpen). On the other hand, these differences were not consistent for all wind sectors around the port and may be influenced also by other pollution sources in the cities.

Due to the low numbers of SPOs in ports and surrounding areas, it is difficult to assess the differences between air pollutant concentrations in ports and the nearby cities and regions, based only on monitoring data. Therefore, EEA air quality maps for 2021 were used to estimate the distribution and differences of air pollutants in ports and the surrounding regions. Annual mean NO_2 concentrations in port areas in 2021 were higher than the mean concentrations in the surrounding regions, ranging between 1.5 µg/m^3 (Marsaxlokk) to more than 10 µg/m^3 (Algeciras, Barcelona, Genova, Marseille, Napoli, Piraeus, and Trieste). In Antwerpen, Marseille and Napoli the annual mean NO_2 concentrations in ports were above the LV of 20 µg/m^3 for the protection of human health to be attained by 1 January 2030 of the revised Ambient Air Quality Directive. Also, annual mean PM_{10} concentrations in 2021 were higher in port areas compared to the surrounding regions. The difference was below 5 µg/m^3 for almost all the ports analysed, except for Napoli and Piraeus. In nine ports (Algeciras, Barcelona, Gdansk, Gioia Tauro, Marsaxlokk, Messina, Napoli, Piraeus and Reggio Calabria) the annual mean PM_{10} concentrations were above the new LV of 20 µg/m^3 for the protection of human health to be attained by 1 January 2030.

3. **What are the trends in pollutant concentrations in ports and nearby cities?**
   Long-term trends (2005-2021) of NO_2 and PM_{10} air pollutants were analysed at the identified SPOs in European port areas and nearby cities. The findings show that on average NO_2 concentrations in port areas and within 1 km decreased by about 40%, similar to the 39% reduction in nearby cities. PM_{10} concentrations decreased by 40% in port areas and 45% within 20 km of ports. However, due to the limited number of SPOs identified in this report, it is challenging to draw definitive conclusions about trends in all ports.
   In the port of Antwerpen, a gradient in NO_2 concentration trends is visible, with lower concentration reductions in the north-west (from -25% to –33%), where the port of Antwerpen is located, and largest NO_2 concentrations reductions in the city (from –39% to –47%), probably showing the impact of larger emission reductions from other source sectors, such as road traffic.

4. **What is the potential impact of port activities and international shipping on air quality?**
   Only high-resolution air quality modelling studies specific for each port could provide an estimate of the impact of port activities and international shipping on air quality in the nearby city. In this study the online Air Control Toolbox (ACT) was used, which is one of the air quality policy tools developed for the Copernicus Atmosphere Monitoring Services (CAMS). The ACT was used to analyse the impact of international shipping during pollution episodes in Antwerpen and Barcelona. In Antwerpen, international shipping was the main source sector contributing to the NO_2 concentrations (38%) during a pollution episode in March 2024. In the same days, the contribution to PM_{10} concentrations from international shipping was 6%, which is less than the agricultural sector (43%) the residential (11%) and road traffic (9%) emissions but still significant. Even larger contributions were found in another pollution episode at the end of January 2024 in Barcelona. During this episode international shipping contributed, on average, more than 55% to the NO_2 concentrations. On the other hand, PM_{10} concentrations were high on March 15-20, 2024, the potential impact on PM_{10} concentrations of international shipping emissions was significant (23%) even though residential (21%) and agriculture (22%) emissions were prevailing in this episode.
   These case studies show that international shipping emissions may be the main contributors to NO_2 in port cities. This is more nuanced for PM_{10} whose formation is associated with complex chemical processes, and which can be heavily impacted by emissions from the agricultural and residential sectors depending on the city location and other factors (e.g. residential heating).

List of abbreviations

Abbreviation	Name	Reference
AAQD	Ambient Air Quality Directives	https://environment.ec.europa.eu/topics/air/air-quality_en
ACT	Air Control Toolbox	https://policy.atmosphere.copernicus.eu/act.php
AGR	Agricultural areas	
CAMS	Copernicus Atmosphere Monitoring Service	https://atmosphere.copernicus.eu/
CLC	CORINE Land Cover	https://land.copernicus.eu/pan-european/corineland-cover
CLMS	Copernicus Land Monitoring Service	https://land.copernicus.eu/en
CORINE	Co-ORdinated INformation on the Environment	https://land.copernicus.eu/pan-european/corineland-cover
DG ENV	The Directorate-General for Environment	https://commission.europa.eu/about/departments-and-executive-agencies/environment_en
EC	European Commission	https://commission.europa.eu/index_en
ECMWF	European Centre for Medium-Range Weather Forecasts	https://www.ecmwf.int/
EEA	European Environment Agency	www.eea.europa.eu
EMSA	European Maritime Safety Agency	https://emsa.europa.eu/
ETC HE	European Topic Centre on Human health and environment	https://www.eionet.europa.eu/etcs/etc-he
EU27	European Union 27 member states	
HDR	High density residential areas	
IND	Industry	
LDR	High density residential areas	
LRTAP	Convention on Long-Range Transboundary Air Pollution	https://unece.org/environmental-policy-1/air
LV	Limit value	
NAT	Natural areas	
NO_2	Nitrogen dioxide	
NOx	Nitrogen oxides	
OTH	Other areas	
$PM_{2.5}$	Particulate Matter with a diameter of 2.5 micrometres or less	
PM_{10}	Particulate Matter with a diameter of 10 micrometres or less	
SPO	Sampling point observation	
TRAF	Traffic	
UGR	Urban green	

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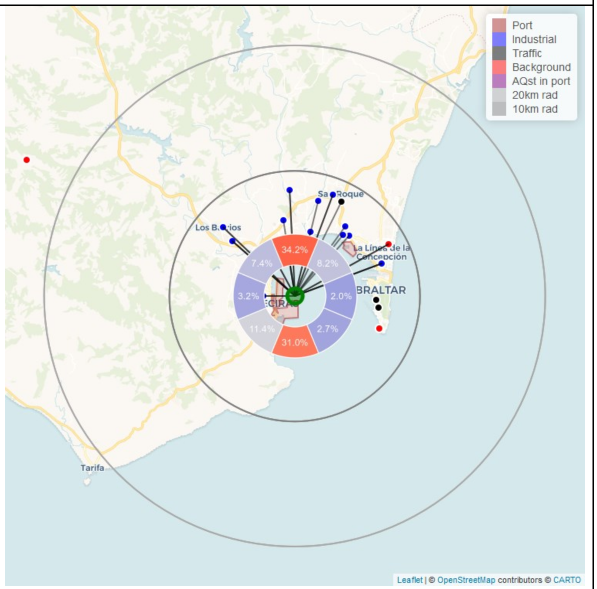
Annex 1 Maps and tables for each port

This Annex contains the full analysis with all plots for each port with the following structure:

- Map of the port area (CL20218, code 123 polygon) and map with location of identified air quality SPOs within 10 km for NO_2 and 20 km for PM_{10} from the port polygon centroid. The frequency of wind directions blowing form the port centroid towards 8 different sectors (45 degrees wide sectors centred at directions NE, E, SE, S, SW, W, NW, N) is also displayed.
- Table with identified air quality SPOs and their description, including distance from the port polygon, in which wind sector they are located relative to port centroid and wind frequency in that sector, observed long-term trend (2005-2021) if available.
- Distribution of hourly NO_2 concentrations for monitoring SPOs located in the 8 wind sectors relative to the port. Three distributions are displayed for each direction if data are available: hourly concentration corresponding to wind from all directions (red); hourly concentration corresponding to wind blowing from the port (green); hourly concentration corresponding to wind not blowing from the port (blue). In the centre of the figure the wind frequency in each sector is reported.
- Distribution of hourly PM_{10} concentrations for monitoring SPOs located in the 8 wind sectors relative to the port. In the centre of the figure the wind frequency in each sector is reported. Three distributions are displayed for each direction if data are available: hourly concentration corresponding to wind from all directions (red); hourly concentration corresponding to wind blowing from the port (green); hourly concentration corresponding to wind not blowing from the port (blue). In the centre of the figure the wind frequency in each sector is reported.
- EEA air quality maps of NO_2 and PM_{10} concentrations at the resolution of 1 km by 1km for 2021.
- Box-plot distribution of NO_2 and PM_{10} concentrations over the port (grey shaded grid cells), compared to the surrounding region, including area-weighted means for different land cover classes.

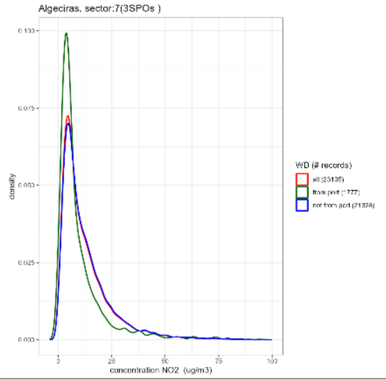
Annex 1.1 Algeciras

Port area	Air quality SPO within 10 km and 20 km
	

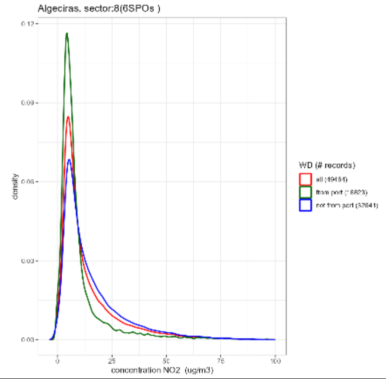
Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Algeciras	ES	ES0556A	industrial	suburban	NO2	36.18	-5.38	FALSE	0.50	8.2	1	
Algeciras	ES	ES1664A	industrial	urban	NO2	36.14	-5.45	FALSE	0.67	3.2	6	-38.8
Algeciras	ES	ES0557A	industrial	rural	NO2	36.19	-5.38	FALSE	1.24	8.2	1	-65.1
Algeciras	ES	ES1637A	industrial	urban	NO2	36.16	-5.44	FALSE	1.45	7.4	7	-35.4
Algeciras	ES	ES1072A	industrial	urban	NO2	36.16	-5.35	FALSE	2.19	2.0	2	-26.7
Algeciras	ES	ES1634A	background	urban	NO2	36.17	-5.34	FALSE	2.57	8.2	1	
Algeciras	ES	ES0893A	industrial	urban	NO2	36.18	-5.41	FALSE	2.69	34.2	8	
Algeciras	ES	ES0633A	industrial	urban	NO2	36.17	-5.43	FALSE	2.94	34.2	8	-22.8
Algeciras	ES	ES1074A	traffic	suburban	NO2	36.20	-5.38	FALSE	3.22	8.2	1	-74.6
Algeciras	ES	ES0894A	industrial	rural	NO2	36.20	-5.40	FALSE	3.86	34.2	8	-55.0
Algeciras	ES	ES1169A	industrial	suburban	NO2	36.21	-5.39	FALSE	3.87	34.2	8	-39.3
Algeciras	ES	ES1076A	industrial	suburban	NO2	36.19	-5.44	FALSE	4.65	34.2	8	-48.6
Algeciras	ES	ES0712A	industrial	suburban	NO2	36.18	-5.48	FALSE	4.66	7.4	7	
Algeciras	ES	ES0634A	industrial	suburban	NO2	36.21	-5.43	FALSE	5.95	34.2	8	-36.3
Algeciras	ES	ES0629A	industrial	urban	NO2	36.19	-5.49	FALSE	5.96	7.4	7	-40.1
Algeciras	ES	ES1664A	industrial	urban	PM10	36.14	-5.45	FALSE	0.67	3.2	6	
Algeciras	ES	ES1072A	industrial	urban	PM10	36.16	-5.35	FALSE	2.19	2.0	2	
Algeciras	ES	ES1169A	industrial	suburban	PM10	36.21	-5.39	FALSE	3.87	34.2	8	-31.9
Algeciras	ES	ES0712A	industrial	suburban	PM10	36.18	-5.48	FALSE	4.66	7.4	7	

NO_2 concentrations when wind is blowing from the port

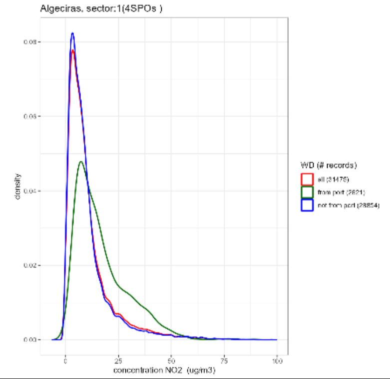
Wind sector 7: NW



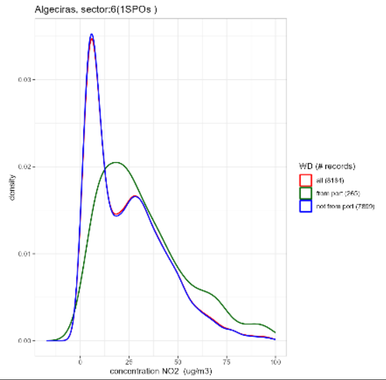
Wind sector 8: N



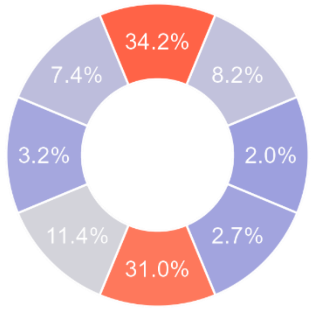
Wind sector 1: NE



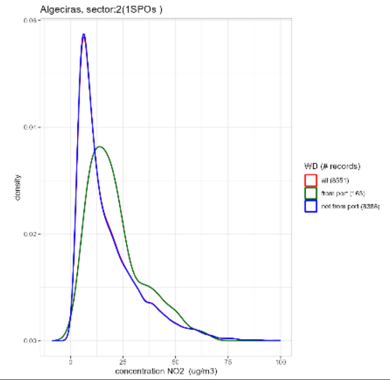
Wind sector 6: W



Wind frequency by sector



Wind sector 2: E



Wind sector 5: SW

NO DATA

Wind sector 4: S

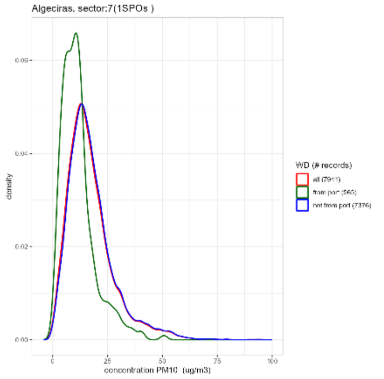
NO DATA

Wind sector 3: SE

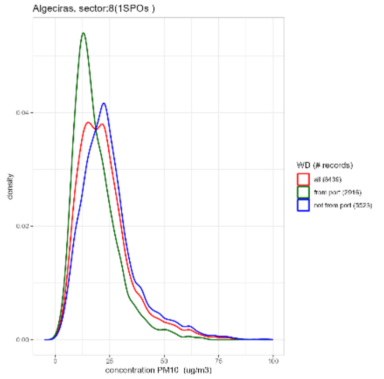
NO DATA

PM$_{10}$ concentrations when wind is blowing from the port

Wind sector 7: NW



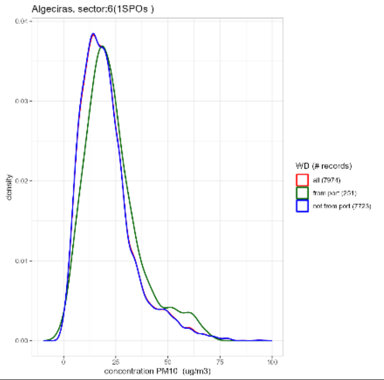
Wind sector 8: N



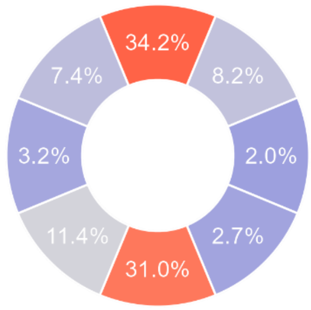
Wind sector 1: NE

NO DATA

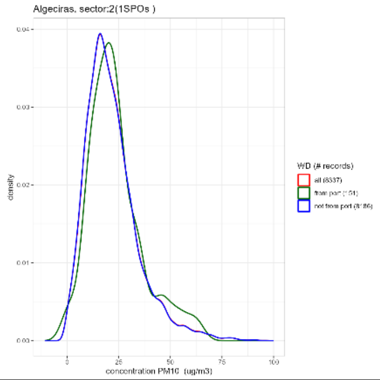
Wind sector 6: W



Wind frequency by sector



Wind sector 2: E



Wind sector 5: SW

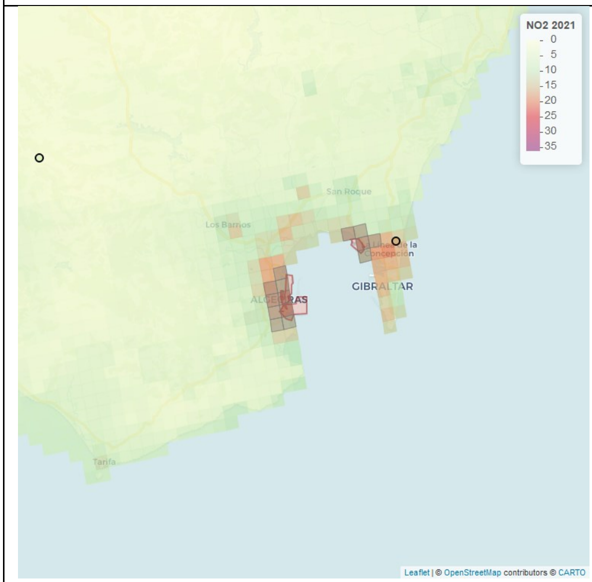
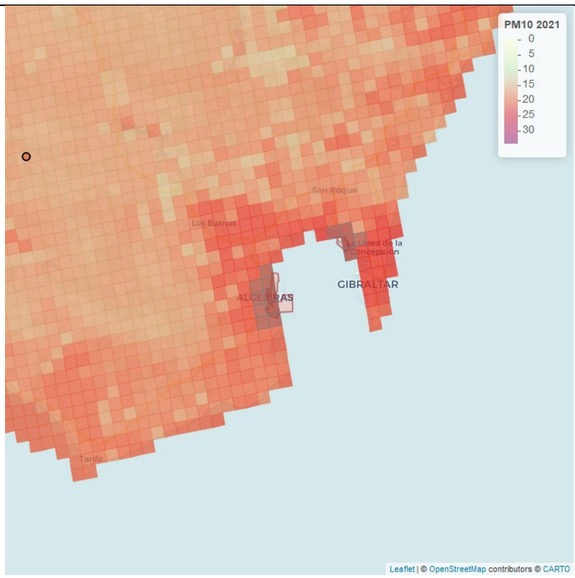
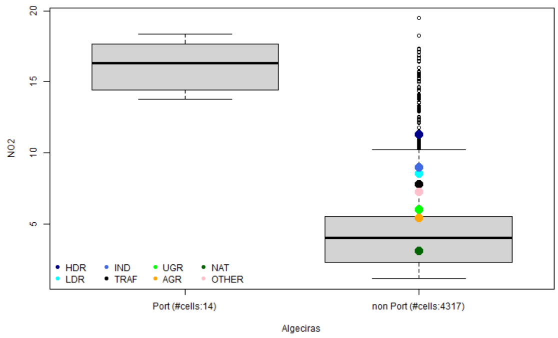
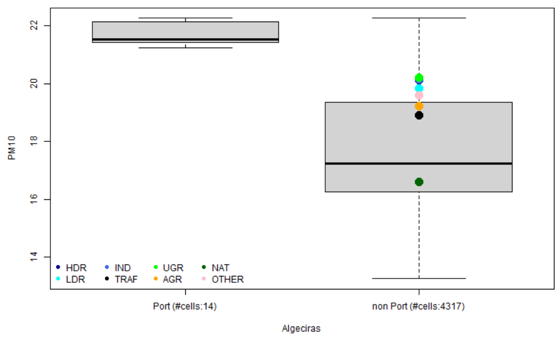
NO DATA

Wind sector 4: S

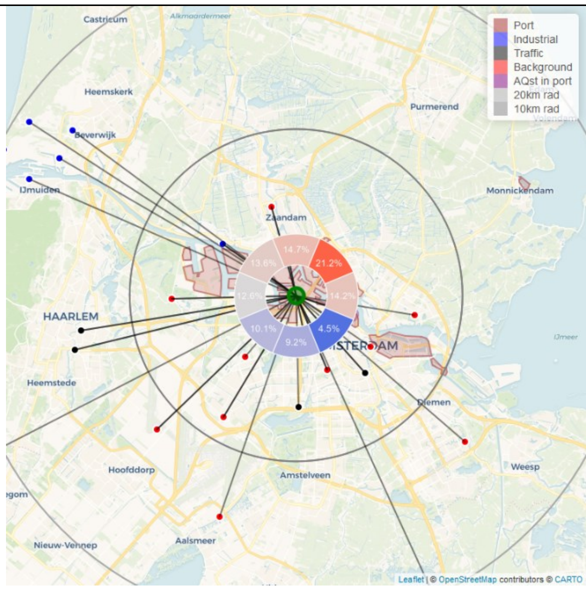
NO DATA

Wind sector 3: SE

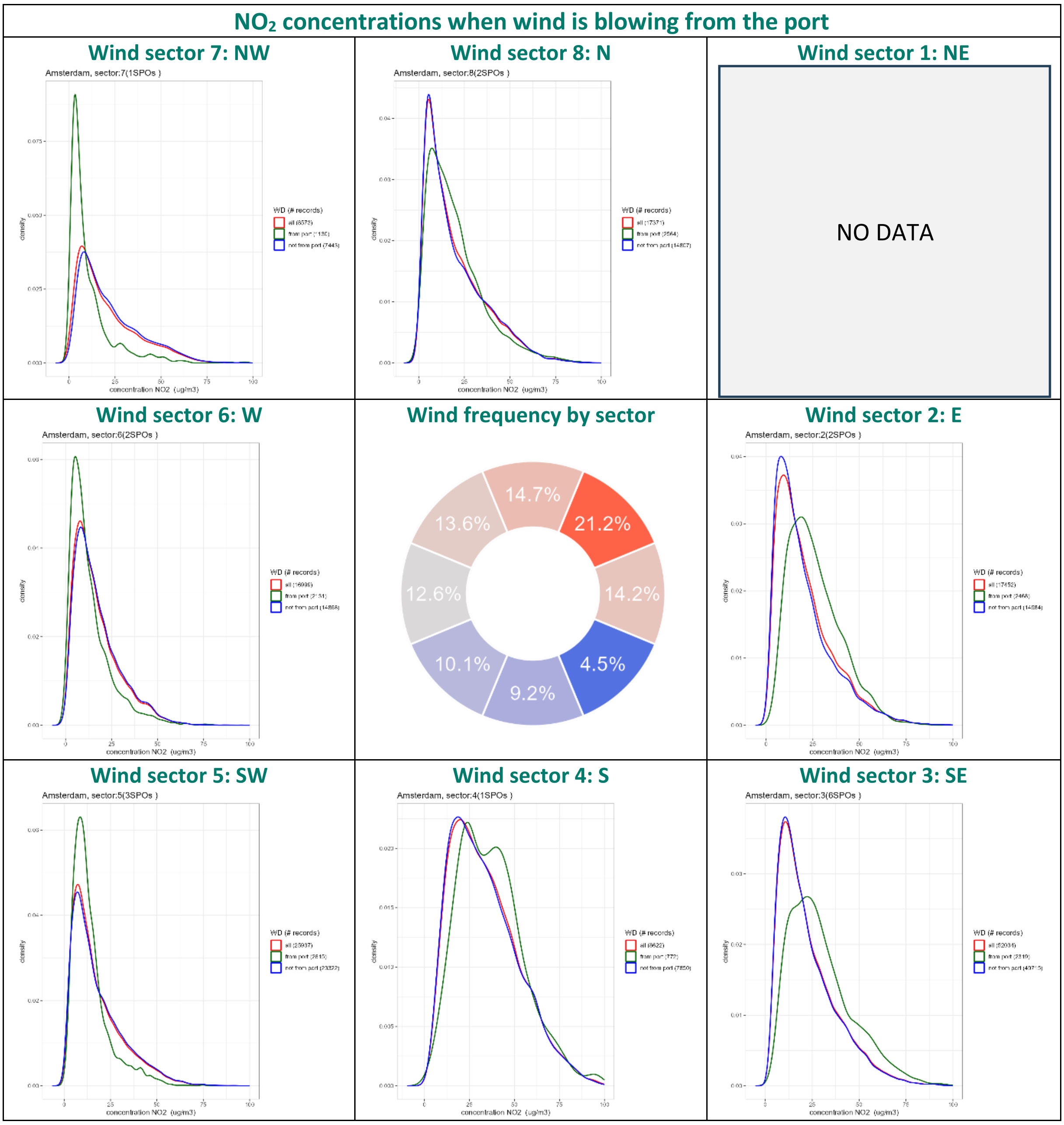
NO DATA

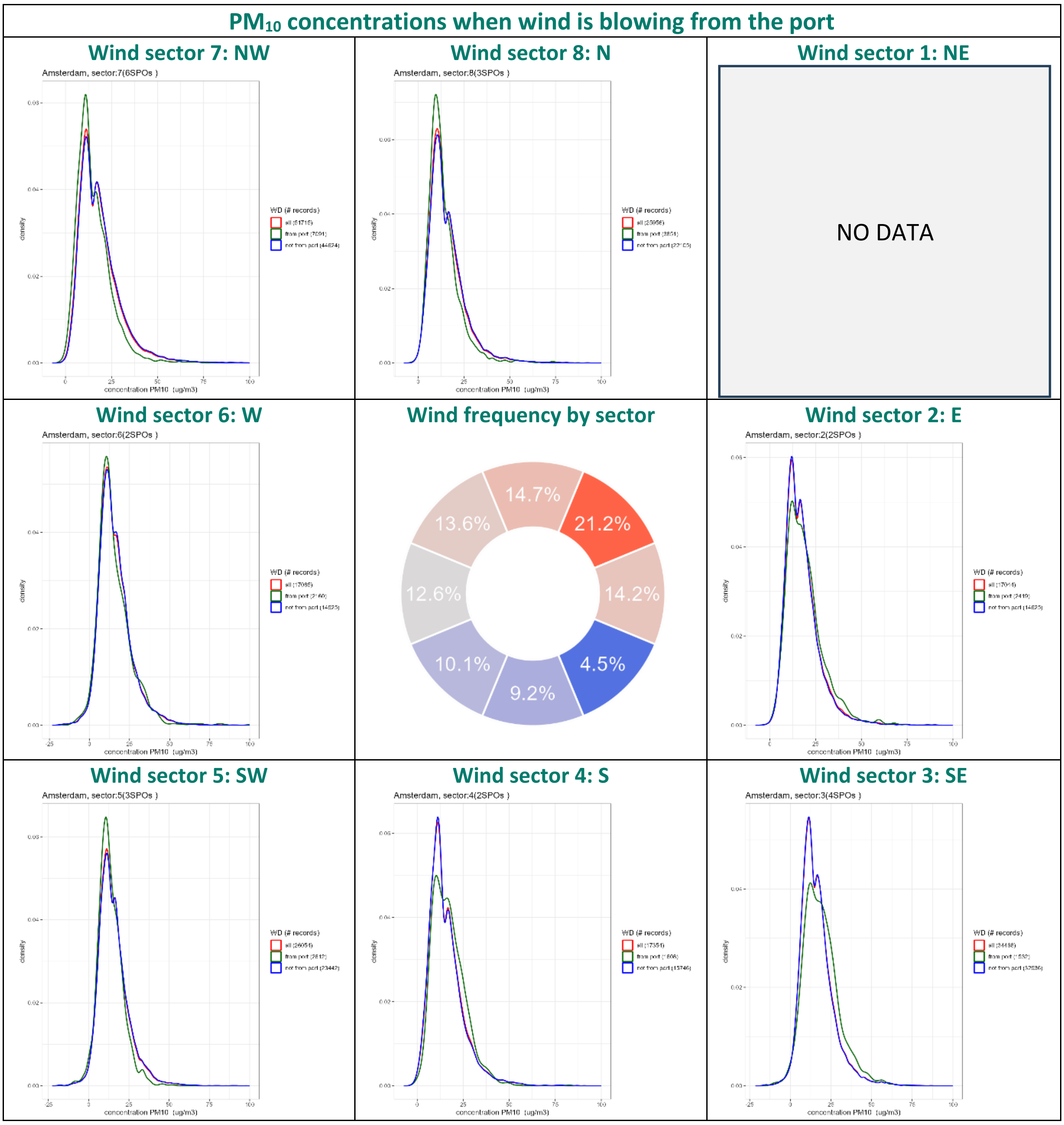
NO_2	PM_{10}
 NO2 2021 0 5 10 15 20 25 30 35 San Roque Los Barrios GIBRALTAR Tarifa Leaflet | © OpenStreetMap contributors © CARTO	 PM10 2021 0 5 10 15 20 25 30 San Roque Los Barrios GIBRALTAR Tarifa Leaflet | © OpenStreetMap contributors © CARTO
 NO2 5 10 15 20 HDR IND UGR NAT LDR TRAF AGR OTHER Port (#cells:14) non Port (#cells:4317) Algeciras	 PM10 14 16 18 20 22 HDR IND UGR NAT LDR TRAF AGR OTHER Port (#cells:14) non Port (#cells:4317) Algeciras

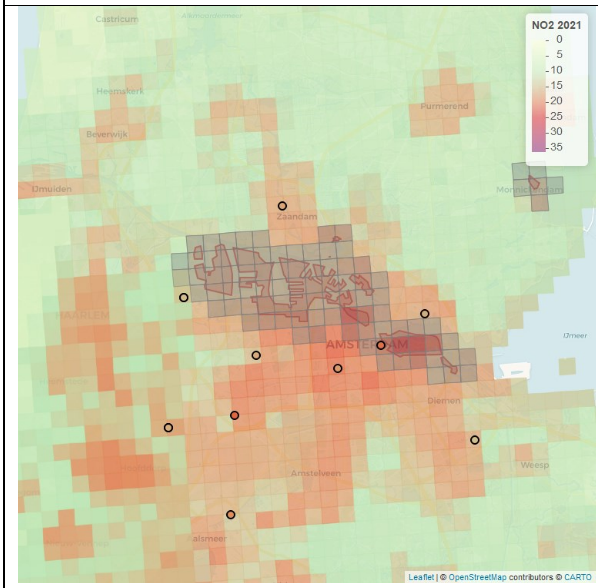
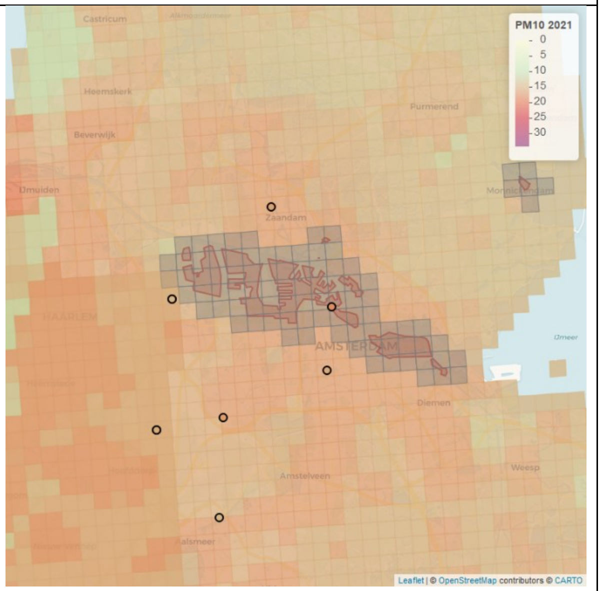
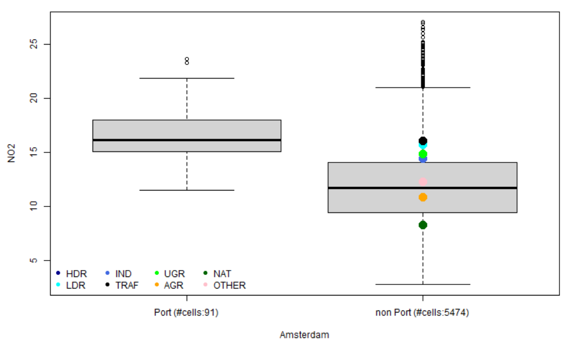
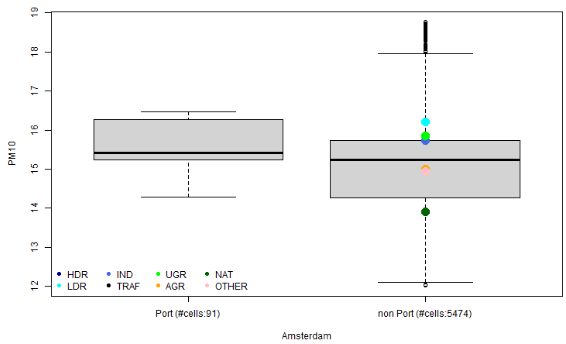
Annex 1.2 Amsterdam

Port area	Air quality SPO within 10 km and 20 km
	

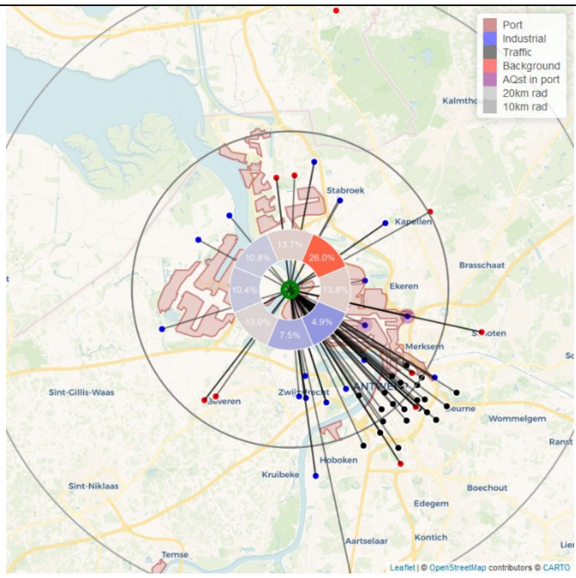
Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Amsterdam	NL	NL00012	traffic	urban	NO2	52.39	4.89	TRUE	0.00	14.2	2	-52.5
Amsterdam	NL	NL00546	industrial	urban	NO2	52.42	4.83	FALSE	0.26	14.7	8	
Amsterdam	NL	NL00704	industrial	urban	NO2	52.43	4.77	FALSE	0.28	13.6	7	-18.4
Amsterdam	NL	NL00019	background	urban	NO2	52.37	4.90	FALSE	0.28	4.5	3	-39.7
Amsterdam	NL	NL00002	traffic	urban	NO2	52.39	4.88	FALSE	0.32	4.5	3	-48.4
Amsterdam	NL	NL00007	traffic	urban	NO2	52.38	4.85	FALSE	0.61	9.2	4	-45.8
Amsterdam	NL	NL00003	background	urban	NO2	52.39	4.94	FALSE	1.28	14.2	2	-42.4
Amsterdam	NL	NL00703	background	rural	NO2	52.40	4.73	FALSE	1.39	12.6	6	-43.9
Amsterdam	NL	NL00017	traffic	urban	NO2	52.36	4.90	FALSE	1.50	4.5	3	-44.7
Amsterdam	NL	NL00020	traffic	urban	NO2	52.37	4.86	FALSE	1.85	4.5	3	-44.0
Amsterdam	NL	NL00022	background	urban	NO2	52.37	4.79	FALSE	2.49	10.1	5	-31.3
Amsterdam	NL	NL00014	background	urban	NO2	52.36	4.87	FALSE	3.06	4.5	3	-44.8
Amsterdam	NL	NL00701	background	urban	NO2	52.45	4.82	FALSE	3.10	14.7	8	-39.4
Amsterdam	NL	NL00021	background	urban	NO2	52.32	4.99	FALSE	4.17	4.5	3	-44.4
Amsterdam	NL	NL00561	background	rural	NO2	52.33	4.77	FALSE	6.30	10.1	5	
Amsterdam	NL	NL00550	traffic	urban	NO2	52.37	4.64	FALSE	7.94	12.6	6	
Amsterdam	NL	NL00564	background	rural	NO2	52.33	4.72	FALSE	8.65	10.1	5	
Amsterdam	NL	NL00012	traffic	urban	PM10	52.39	4.89	TRUE	0.00	14.2	2	
Amsterdam	NL	NL00016	background	urban	PM10	52.39	4.87	TRUE	0.00	14.2	2	
Amsterdam	NL	NL00546	industrial	urban	PM10	52.42	4.83	FALSE	0.26	14.7	8	
Amsterdam	NL	NL00704	industrial	urban	PM10	52.43	4.77	FALSE	0.28	13.6	7	
Amsterdam	NL	NL00007	traffic	urban	PM10	52.38	4.85	FALSE	0.61	9.2	4	
Amsterdam	NL	NL00703	background	rural	PM10	52.40	4.73	FALSE	1.39	12.6	6	
Amsterdam	NL	NL00017	traffic	urban	PM10	52.36	4.90	FALSE	1.50	4.5	3	
Amsterdam	NL	NL00020	traffic	urban	PM10	52.37	4.86	FALSE	1.85	4.5	3	
Amsterdam	NL	NL00014	background	urban	PM10	52.36	4.87	FALSE	3.06	4.5	3	
Amsterdam	NL	NL00701	background	urban	PM10	52.45	4.82	FALSE	3.10	14.7	8	
Amsterdam	NL	NL00561	background	rural	PM10	52.33	4.77	FALSE	6.30	10.1	5	
Amsterdam	NL	NL00550	traffic	urban	PM10	52.37	4.64	FALSE	7.94	12.6	6	
Amsterdam	NL	NL00564	background	rural	PM10	52.33	4.72	FALSE	8.65	10.1	5	
Amsterdam	NL	NL00572	industrial	urban	PM10	52.47	4.63	FALSE	9.24	13.6	7	
Amsterdam	NL	NL00570	industrial	urban	PM10	52.49	4.64	FALSE	9.73	13.6	7	
Amsterdam	NL	NL00551	industrial	urban	PM10	52.46	4.60	FALSE	10.19	13.6	7	
Amsterdam	NL	NL00553	industrial	urban	PM10	52.49	4.60	FALSE	12.01	13.6	7	
Amsterdam	NL	NL00565	background	rural	PM10	52.28	4.77	FALSE	12.25	9.2	4	
Amsterdam	NL	NL00573	industrial	urban	PM10	52.48	4.58	FALSE	12.34	13.6	7	
Amsterdam	NL	NL00556	background	rural	PM10	52.56	4.86	FALSE	14.69	14.7	8	
Amsterdam	NL	NL00641	traffic	rural	PM10	52.20	4.99	FALSE	17.29	4.5	3	-62.5
Amsterdam	NL	NL00444	background	rural	PM10	52.30	4.51	FALSE	19.97	10.1	5	-48.9


NO2 concentrations when wind is blowing from the port
Wind sector 7: NW
Amsterdam, sector:7(1SPOs)
Wind sector 8: N
Amsterdam, sector:8(2SPOs)
Wind sector 1: NE
NO DATA
Wind sector 6: W
Amsterdam, sector:6(2SPOs)
Wind frequency by sector
14.7%
21.2%
14.2%
4.5%
9.2%
10.1%
12.6%
13.6%
Wind sector 2: E
Amsterdam, sector:2(2SPOs)
Wind sector 5: SW
Amsterdam, sector:5(3SPOs)
Wind sector 4: S
Amsterdam, sector:4(1SPOs)
Wind sector 3: SE
Amsterdam, sector:3(6SPOs)
concentration NO2 (ug/m3)
density
WD (# records)


PM10 concentrations when wind is blowing from the port
Wind sector 7: NW
Amsterdam, sector:7(6SPOs)
Wind sector 8: N
Amsterdam, sector:8(3SPOs)
Wind sector 1: NE
NO DATA
Wind sector 6: W
Amsterdam, sector:6(2SPOs)
Wind frequency by sector
14.7%
21.2%
14.2%
4.5%
9.2%
10.1%
12.6%
13.6%
Wind sector 2: E
Amsterdam, sector:2(2SPOs)
Wind sector 5: SW
Amsterdam, sector:5(3SPOs)
Wind sector 4: S
Amsterdam, sector:4(2SPOs)
Wind sector 3: SE
Amsterdam, sector:3(4SPOs)
concentration PM10 (ug/m3)
WD (# records)

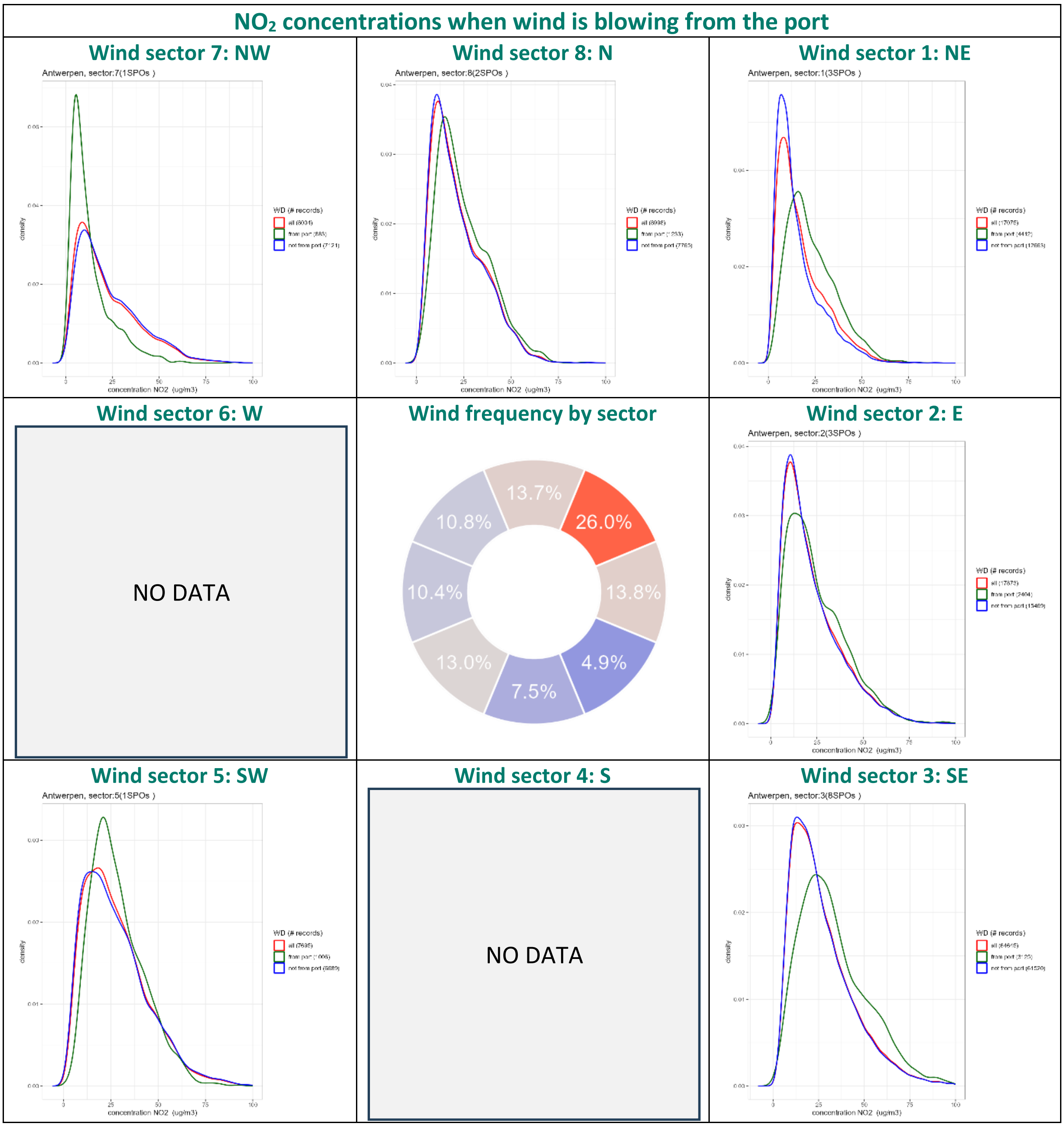
NO_2	PM_{10}
 NO2 2021 0 5 10 15 20 25 30 35 Castricum Heemskerk Beverwijk Purmerend IJmuiden Zaandam AMSTERDAM Diemen Weesp Amstelveen Aalsmeer Leaflet | © OpenStreetMap contributors © CARTO	 PM10 2021 0 5 10 15 20 25 30 Castricum Heemskerk Beverwijk Purmerend IJmuiden Zaandam HAARLEM AMSTERDAM Diemen Weesp Amstelveen Aalsmeer Leaflet | © OpenStreetMap contributors © CARTO
 NO2 5 10 15 20 25 HDR LDR IND TRAF UGR AGR NAT OTHER Port (#cells:91) non Port (#cells:5474) Amsterdam	 PM10 12 13 14 15 16 17 18 19 HDR LDR IND TRAF UGR AGR NAT OTHER Port (#cells:91) non Port (#cells:5474) Amsterdam

Annex 1.3 Antwerpen

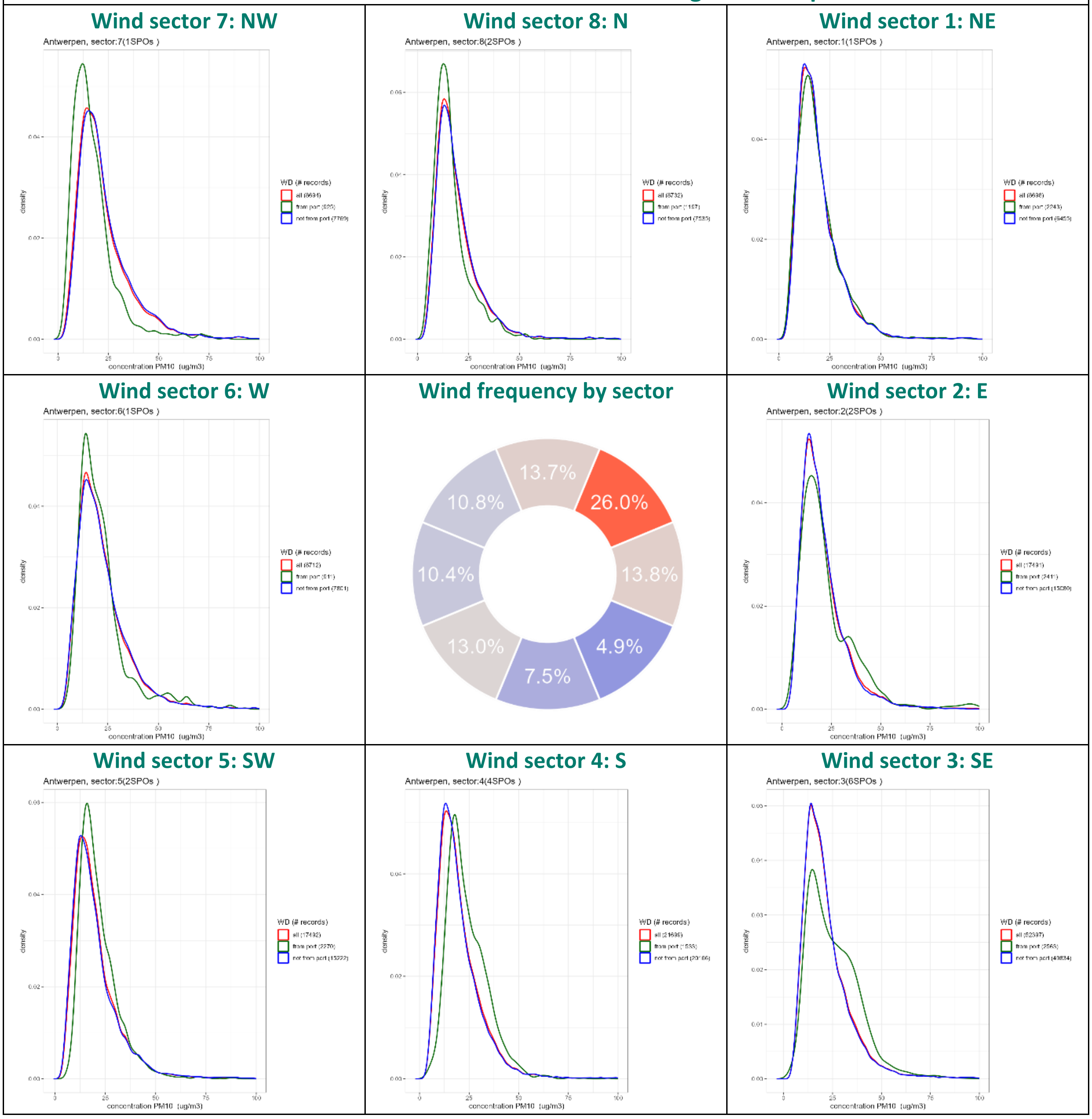
Port area	Air quality SPO within 10 km and 20 km
	

Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Antwerpen	BE	BETM802	industrial	suburban	NO2	51.26	4.42	TRUE	0.00	13.8	2	-47.0
Antwerpen	BE	BETR897	industrial	suburban	NO2	51.25	4.34	TRUE	0.00	4.9	3	-25.3
Antwerpen	BE	BETR892	industrial	rural	NO2	51.26	4.28	TRUE	0.00	13.0	5	-26.6
Antwerpen	BE	BETR893	industrial	suburban	NO2	51.28	4.39	FALSE	0.03	13.8	2	-33.2
Antwerpen	BE	BENAT38	traffic	urban	NO2	51.23	4.41	FALSE	0.11	4.9	3	
Antwerpen	BE	BENAT43	traffic	urban	NO2	51.23	4.42	FALSE	0.17	4.9	3	
Antwerpen	BE	BENAT46	traffic	urban	NO2	51.23	4.44	FALSE	0.30	4.9	3	
Antwerpen	BE	BETR803	background	urban	NO2	51.23	4.43	FALSE	0.30	4.9	3	
Antwerpen	BE	BELAL01	industrial	suburban	NO2	51.24	4.39	FALSE	0.50	4.9	3	
Antwerpen	BE	BELAT83	background	urban	NO2	51.34	4.30	FALSE	0.56	13.7	8	
Antwerpen	BE	BETR806	traffic	urban	NO2	51.22	4.42	FALSE	0.57	4.9	3	
Antwerpen	BE	BENAT37	traffic	urban	NO2	51.22	4.40	FALSE	0.59	4.9	3	
Antwerpen	BE	BENAL08	traffic	urban	NO2	51.22	4.38	FALSE	0.70	4.9	3	
Antwerpen	BE	BENAT47	traffic	urban	NO2	51.22	4.42	FALSE	0.75	4.9	3	
Antwerpen	BE	BENAT45	traffic	urban	NO2	51.22	4.43	FALSE	0.77	4.9	3	
Antwerpen	BE	BENAT20	traffic	urban	NO2	51.21	4.40	FALSE	0.89	4.9	3	
Antwerpen	BE	BELR833	industrial	rural	NO2	51.33	4.36	FALSE	0.96	26.0	1	
Antwerpen	BE	BELSA08	industrial	suburban	NO2	51.33	4.36	FALSE	0.99	26.0	1	
Antwerpen	BE	BETR830	industrial	rural	NO2	51.32	4.26	FALSE	1.19	10.8	7	-24.5
Antwerpen	BE	BENAT39	traffic	urban	NO2	51.21	4.44	FALSE	1.24	4.9	3	
Antwerpen	BE	BENAT40	traffic	urban	NO2	51.21	4.41	FALSE	1.35	4.9	3	
Antwerpen	BE	BENAT49	traffic	urban	NO2	51.19	4.38	FALSE	1.39	4.9	3	
Antwerpen	BE	BENAT48	traffic	urban	NO2	51.20	4.40	FALSE	1.41	4.9	3	
Antwerpen	BE	BENBT03	traffic	urban	NO2	51.21	4.43	FALSE	1.54	4.9	3	
Antwerpen	BE	BETR831	industrial	rural	NO2	51.35	4.34	FALSE	1.58	13.7	8	-43.7
Antwerpen	BE	BENDU05	traffic	urban	NO2	51.22	4.47	FALSE	1.65	4.9	3	
Antwerpen	BE	BENAT29	traffic	urban	NO2	51.20	4.40	FALSE	1.81	4.9	3	
Antwerpen	BE	BENDU06	traffic	urban	NO2	51.21	4.46	FALSE	1.82	4.9	3	
Antwerpen	BE	BETR801	background	urban	NO2	51.21	4.43	FALSE	1.91	4.9	3	-41.2
Antwerpen	BE	BETR802	traffic	urban	NO2	51.21	4.43	FALSE	1.92	4.9	3	
Antwerpen	BE	BETR805	traffic	urban	NO2	51.21	4.42	FALSE	2.14	4.9	3	
Antwerpen	BE	BENBT04	traffic	urban	NO2	51.20	4.45	FALSE	2.47	4.9	3	
Antwerpen	BE	BELHB23	industrial	suburban	NO2	51.17	4.34	FALSE	2.57	7.5	4	-39.0
Antwerpen	BE	BENAT41	traffic	urban	NO2	51.20	4.42	FALSE	2.58	4.9	3	
Antwerpen	BE	BETR817	background	suburban	NO2	51.18	4.42	FALSE	4.00	4.9	3	
Antwerpen	BE	BETR811	background	suburban	NO2	51.25	4.49	FALSE	4.14	13.8	2	-47.4
Antwerpen	BE	BETR820	background	suburban	NO2	51.32	4.44	FALSE	5.64	26.0	1	

Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Antwerpen	BE	BETM802	industrial	suburban	PM10	51.26	4.42	TRUE	0.00	13.8	2	-46.7
Antwerpen	BE	BELAL05	industrial	rural	PM10	51.26	4.28	TRUE	0.00	13.0	5	
Antwerpen	BE	BETR803	background	urban	PM10	51.23	4.43	FALSE	0.30	4.9	3	
Antwerpen	BE	BELAL01	industrial	suburban	PM10	51.24	4.39	FALSE	0.50	4.9	3	-26.6
Antwerpen	BE	BELAT83	background	urban	PM10	51.34	4.30	FALSE	0.56	13.7	8	
Antwerpen	BE	BELAL03	industrial	rural	PM10	51.25	4.20	FALSE	0.89	10.4	6	
Antwerpen	BE	BELAL02	industrial	rural	PM10	51.30	4.23	FALSE	1.37	10.8	7	
Antwerpen	BE	BETR831	industrial	rural	PM10	51.35	4.34	FALSE	1.58	13.7	8	
Antwerpen	BE	BETR801	background	urban	PM10	51.21	4.43	FALSE	1.91	4.9	3	-32.5
Antwerpen	BE	BETR802	traffic	urban	PM10	51.21	4.43	FALSE	1.92	4.9	3	
Antwerpen	BE	BETR805	traffic	urban	PM10	51.21	4.42	FALSE	2.14	4.9	3	
Antwerpen	BE	BETZD08	industrial	suburban	PM10	51.23	4.33	FALSE	2.38	7.5	4	
Antwerpen	BE	BETZD01	industrial	suburban	PM10	51.22	4.33	FALSE	2.46	7.5	4	
Antwerpen	BE	BELHB23	industrial	suburban	PM10	51.17	4.34	FALSE	2.57	7.5	4	-45.2
Antwerpen	BE	BELSA04	industrial	rural	PM10	51.31	4.40	FALSE	3.22	26.0	1	
Antwerpen	BE	BETR817	background	suburban	PM10	51.18	4.42	FALSE	4.00	4.9	3	
Antwerpen	BE	BETR823	background	suburban	PM10	51.21	4.24	FALSE	4.01	13.0	5	
Antwerpen	BE	BETR811	background	suburban	PM10	51.25	4.49	FALSE	4.14	13.8	2	-36.4
Antwerpen	BE	BETR834	background	suburban	PM10	51.09	4.38	FALSE	10.96	7.5	4	


NO2 concentrations when wind is blowing from the port
Wind sector 7: NW
Antwerpen, sector:7(1SPOs)
Wind sector 8: N
Antwerpen, sector:8(2SPOs)
Wind sector 1: NE
Antwerpen, sector:1(3SPOs)
Wind sector 6: W
NO DATA
Wind frequency by sector
13.7%
26.0%
13.8%
4.9%
7.5%
13.0%
10.4%
10.8%
Wind sector 2: E
Antwerpen, sector:2(3SPOs)
Wind sector 5: SW
Antwerpen, sector:5(1SPOs)
Wind sector 4: S
NO DATA
Wind sector 3: SE
Antwerpen, sector:3(8SPOs)
concentration NO2 (ug/m3)
WD (# records)

PM_{10} concentrations when wind is blowing from the port



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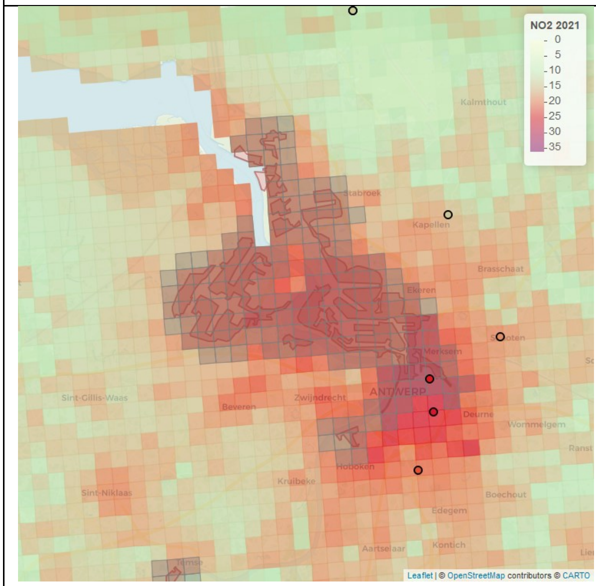

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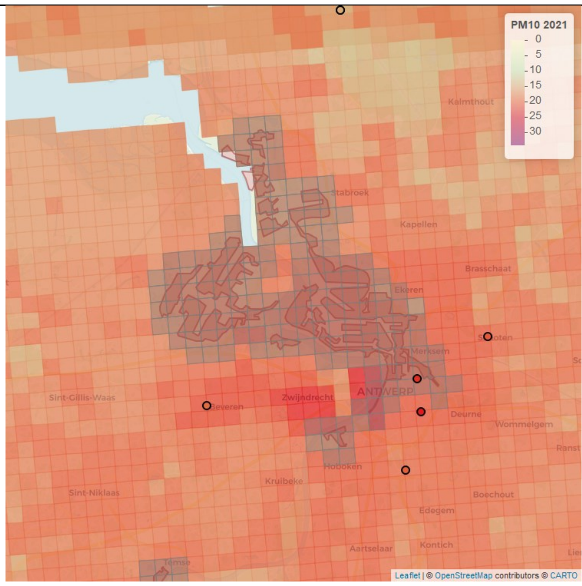

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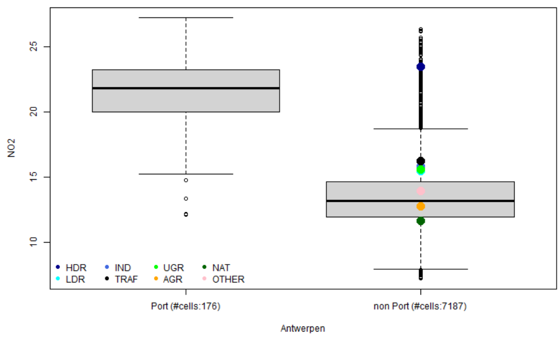

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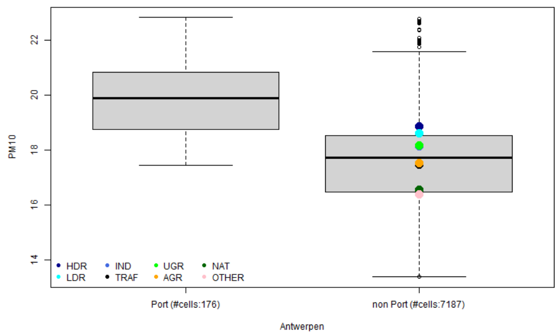

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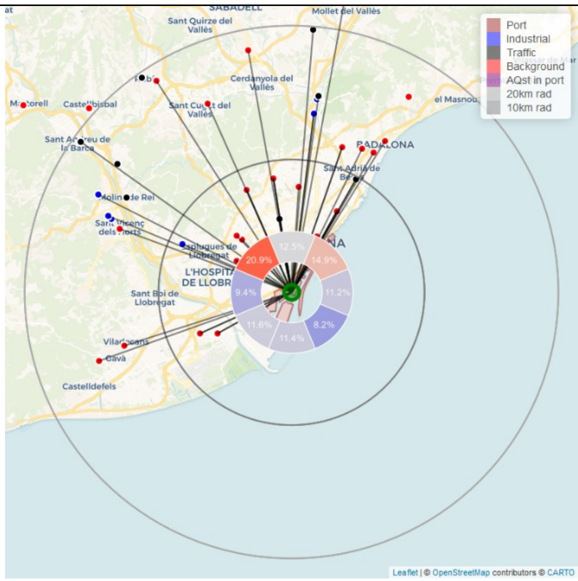
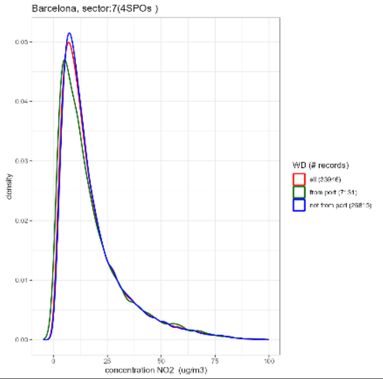
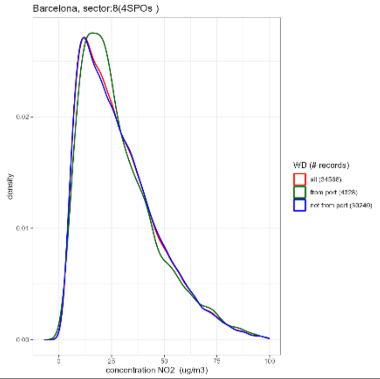
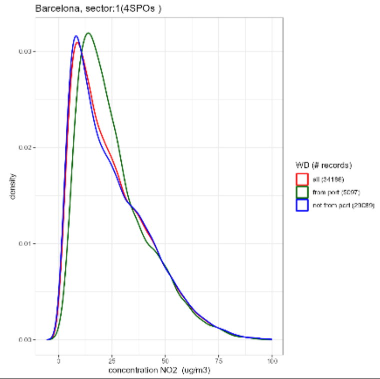
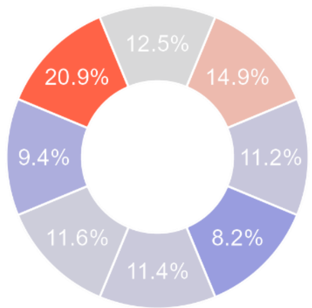
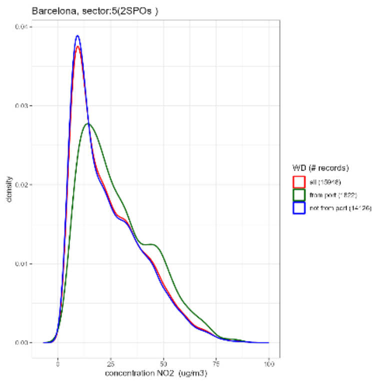
Annex 1.4 Barcelona

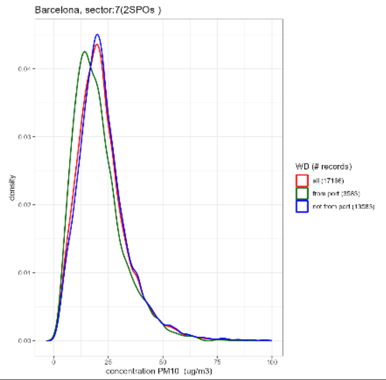
Port area	Air quality SPO within 10 km and 20 km
	

Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Barcelona	ES	ES1679A	background	urban	NO2	41.39	2.19	FALSE	0.48	14.9	1	-41.7
Barcelona	ES	ES0691A	background	urban	NO2	41.40	2.20	FALSE	1.65	14.9	1	-38.4
Barcelona	ES	ES1438A	traffic	urban	NO2	41.39	2.15	FALSE	2.26	12.5	8	-37.4
Barcelona	ES	ES1480A	traffic	urban	NO2	41.40	2.15	FALSE	3.09	12.5	8	-55.5
Barcelona	ES	ES1396A	background	urban	NO2	41.38	2.13	FALSE	3.41	20.9	7	-51.0
Barcelona	ES	ES0692A	background	urban	NO2	41.37	2.11	FALSE	3.65	20.9	7	-29.4
Barcelona	ES	ES1929A	background	suburban	NO2	41.32	2.10	FALSE	3.70	11.6	5	
Barcelona	ES	ES1148A	traffic	urban	NO2	41.43	2.22	FALSE	4.42	14.9	1	-37.0
Barcelona	ES	ES1983A	background	suburban	NO2	41.32	2.08	FALSE	4.93	11.6	5	
Barcelona	ES	ES1992A	background	urban	NO2	41.39	2.12	FALSE	5.04	20.9	7	
Barcelona	ES	ES1856A	background	urban	NO2	41.43	2.15	FALSE	5.71	12.5	8	-47.5
Barcelona	ES	ES2090A	background	suburban	NO2	41.42	2.12	FALSE	6.38	20.9	7	
Barcelona	ES	ES1453A	background	urban	NO2	41.45	2.21	FALSE	6.50	12.5	8	-47.3
Barcelona	ES	ES1892A	background	urban	NO2	41.44	2.24	FALSE	6.83	14.9	1	-43.6
Barcelona	ES	ES0692A	background	urban	PM10	41.37	2.11	FALSE	3.65	20.9	7	
Barcelona	ES	ES1148A	traffic	urban	PM10	41.43	2.22	FALSE	4.42	14.9	1	
Barcelona	ES	ES0694A	background	suburban	PM10	41.39	2.01	FALSE	12.52	9.4	6	
Barcelona	ES	ES1817A	traffic	suburban	PM10	41.53	2.18	FALSE	15.34	12.5	8	
Barcelona	ES	ES1684A	background	urban	PM10	41.49	2.04	FALSE	16.95	20.9	7	

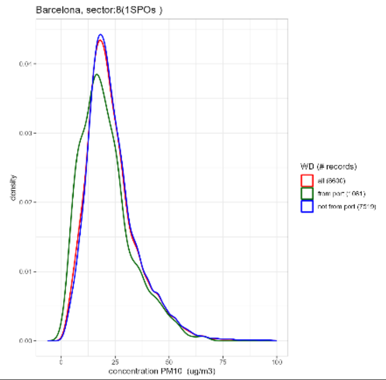
NO_2 concentrations when wind is blowing from the port		
Wind sector 7: NW 	Wind sector 8: N 	Wind sector 1: NE 
Wind sector 6: W NO DATA	Wind frequency by sector 	Wind sector 2: E NO DATA
Wind sector 5: SW 	Wind sector 4: S NO DATA	Wind sector 3: SE NO DATA

PM_{10} concentrations when wind is blowing from the port

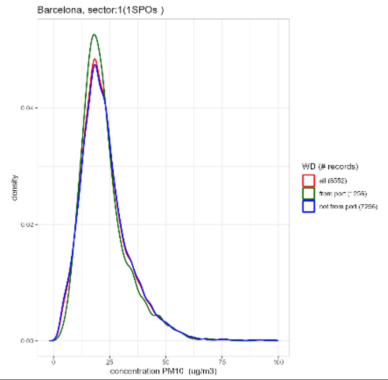
Wind sector 7: NW



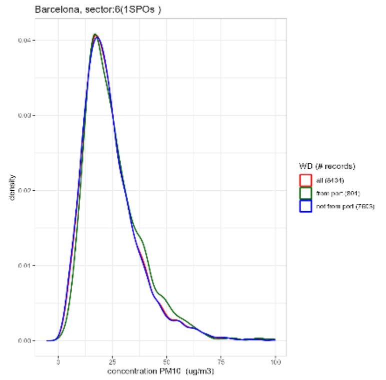
Wind sector 8: N



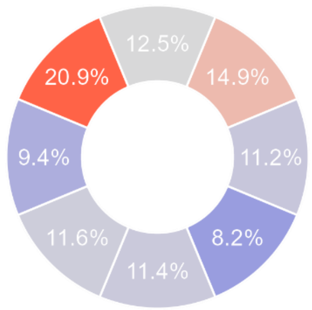
Wind sector 1: NE



Wind sector 6: W



Wind frequency by sector



Wind sector 2: E

NO DATA

Wind sector 5: SW

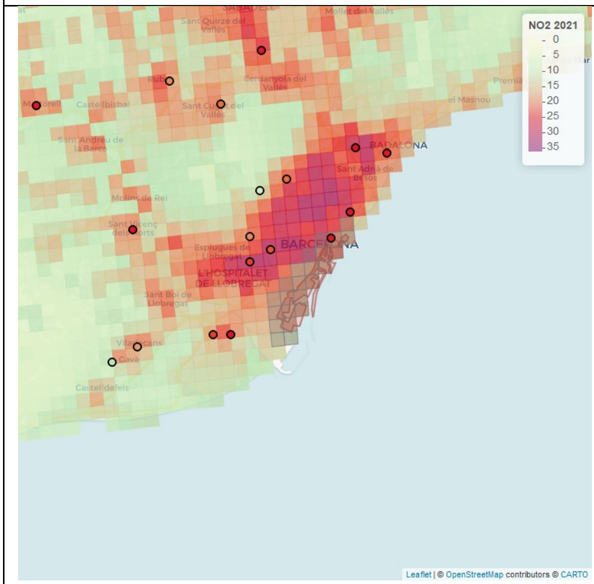
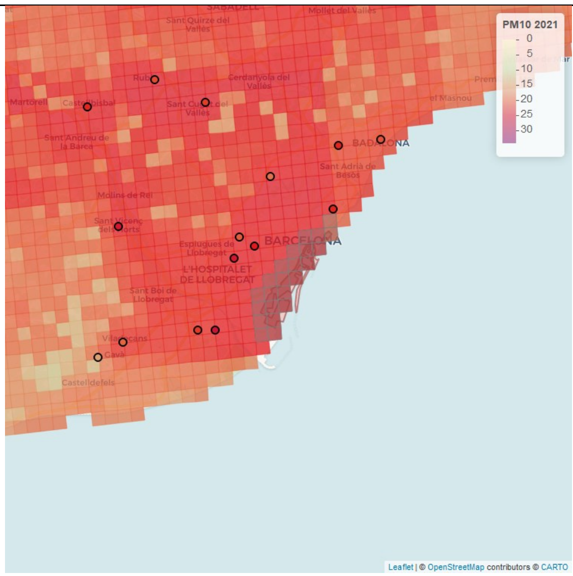
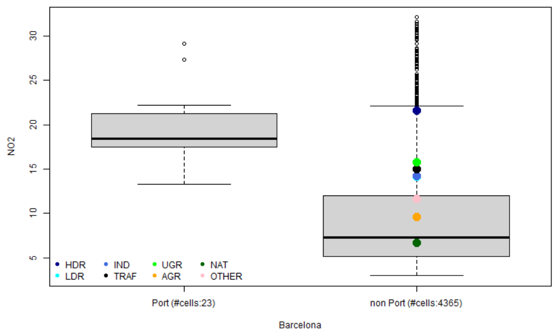
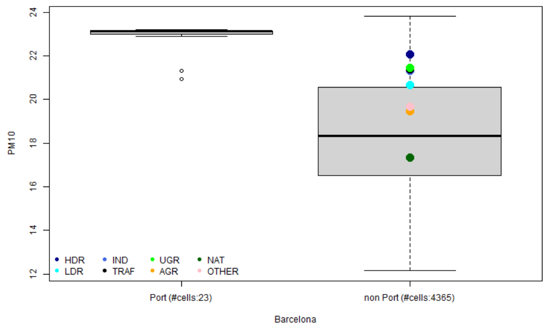
NO DATA

Wind sector 4: S

NO DATA

Wind sector 3: SE

NO DATA

NO_2	PM_{10}
	
	

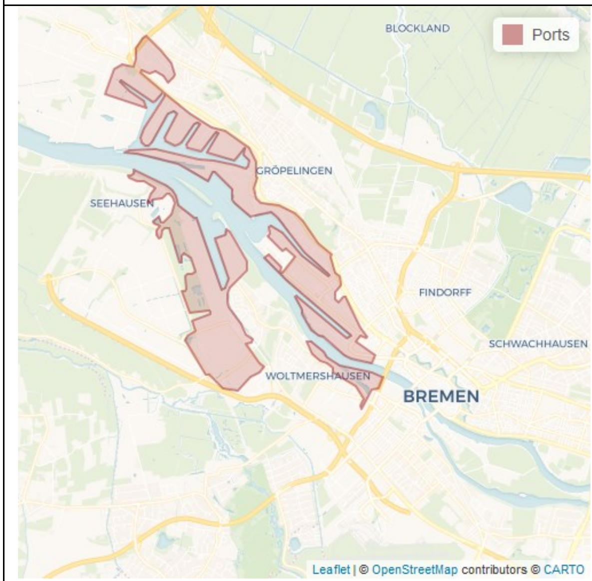
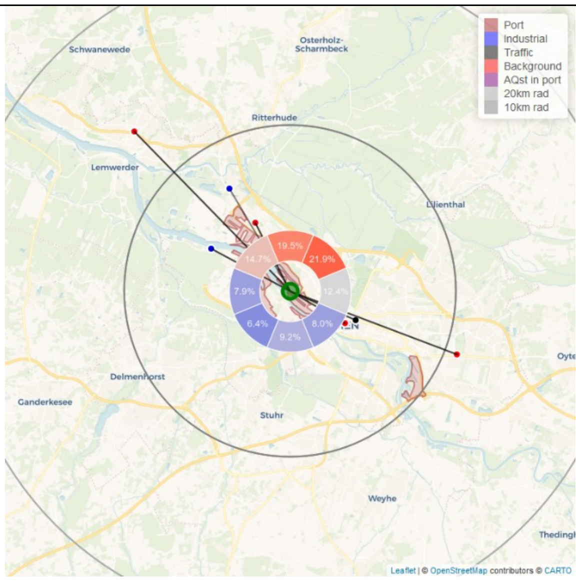
NO2 2021
0
5
10
15
20
25
30
35
BADALONA
BARCELONA
L'HOSPITALET DE LLOBREGAT
Leaflet | © OpenStreetMap contributors © CARTO

PM10 2021
0
5
10
15
20
25
30
BADALONA
BARCELONA
L'HOSPITALET DE LLOBREGAT
Leaflet | © OpenStreetMap contributors © CARTO

NO2
5
10
15
20
25
30
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:23)
non Port (#cells:4365)
Barcelona

PM10
12
14
16
18
20
22
24
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:23)
non Port (#cells:4365)
Barcelona

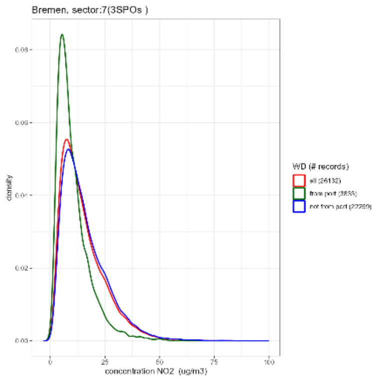
Annex 1.5 Bremen

Port area	Air quality SPO within 10 km and 20 km
	

Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Bremen	DE	DEHB012	background	urban	NO2	53.13	8.74	FALSE	0.55	14.7	7	
Bremen	DE	DEHB013	industrial	rural-regional	NO2	53.12	8.70	FALSE	1.17	14.7	7	
Bremen	DE	DEHB001	background	urban	NO2	53.08	8.82	FALSE	1.75	8.0	3	-20.2
Bremen	DE	DEHB002	background	urban	NO2	53.06	8.92	FALSE	2.33	12.4	2	-17.9
Bremen	DE	DEHB006	traffic	urban	NO2	53.08	8.83	FALSE	2.36	8.0	3	-40.3
Bremen	DE	DEHB004	background	urban	NO2	53.18	8.63	FALSE	7.58	14.7	7	-25.9
Bremen	DE	DEHB012	background	urban	PM10	53.13	8.74	FALSE	0.55	14.7	7	
Bremen	DE	DEHB013	industrial	rural-regional	PM10	53.12	8.70	FALSE	1.17	14.7	7	
Bremen	DE	DEHB001	background	urban	PM10	53.08	8.82	FALSE	1.75	8.0	3	-35.1
Bremen	DE	DEHB002	background	urban	PM10	53.06	8.92	FALSE	2.33	12.4	2	
Bremen	DE	DEHB006	traffic	urban	PM10	53.08	8.83	FALSE	2.36	8.0	3	-44.2
Bremen	DE	DEHB004	background	urban	PM10	53.18	8.63	FALSE	7.58	14.7	7	-28.9

NO_2 concentrations when wind is blowing from the port

Wind sector 7: NW



Wind sector 8: N

NO DATA

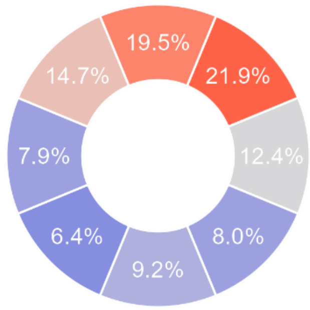
Wind sector 1: NE

NO DATA

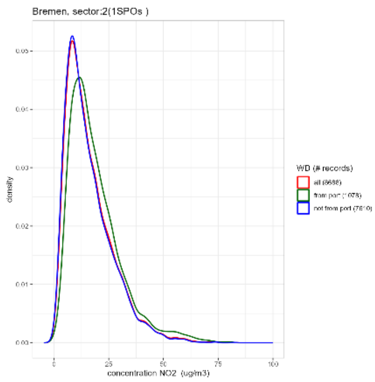
Wind sector 6: W

NO DATA

Wind frequency by sector



Wind sector 2: E



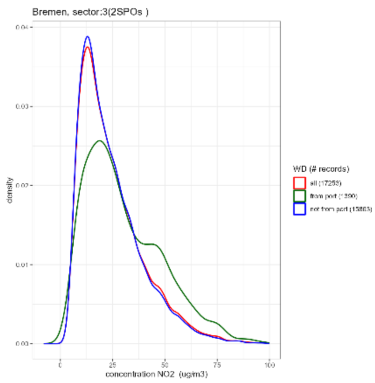
Wind sector 5: SW

NO DATA

Wind sector 4: S

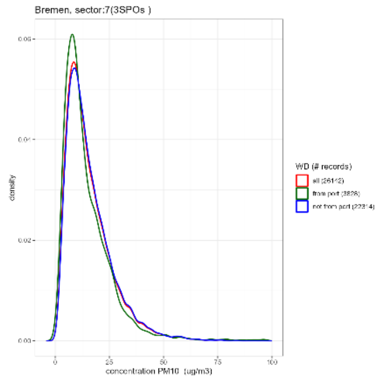
NO DATA

Wind sector 3: SE



PM_{10} concentrations when wind is blowing from the port

Wind sector 7: NW



Wind sector 8: N

NO DATA

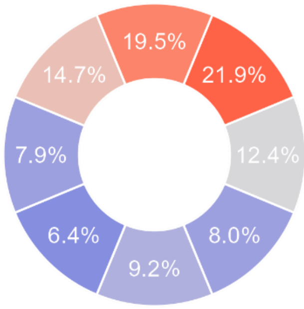
Wind sector 1: NE

NO DATA

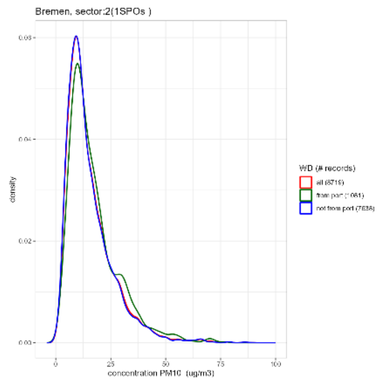
Wind sector 6: W

NO DATA

Wind frequency by sector



Wind sector 2: E



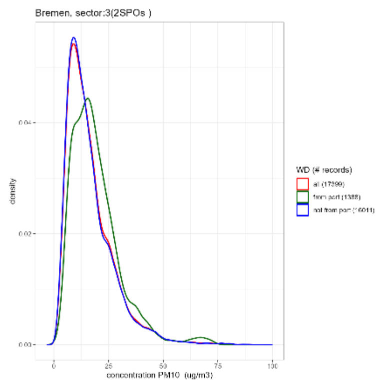
Wind sector 5: SW

NO DATA

Wind sector 4: S

NO DATA

Wind sector 3: SE



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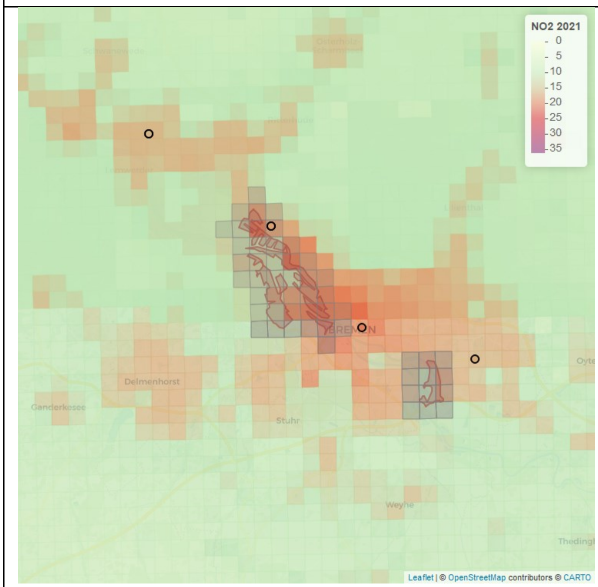
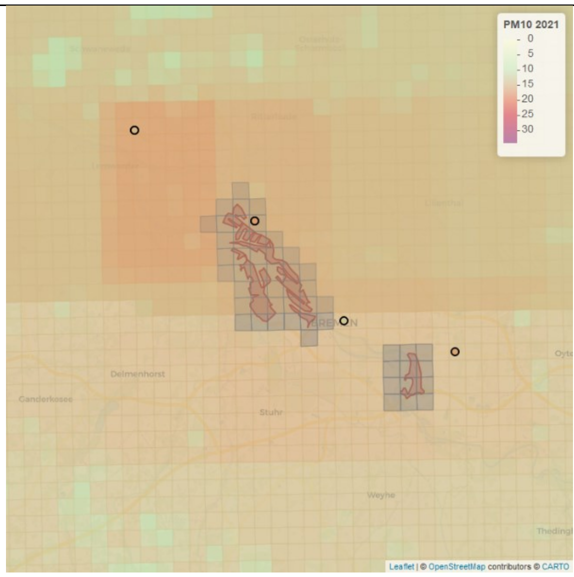
<tr><td>
</td><td>
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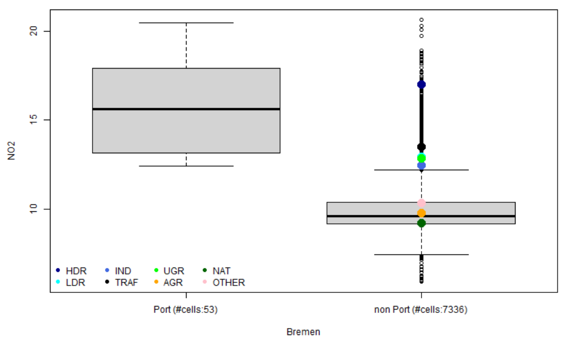
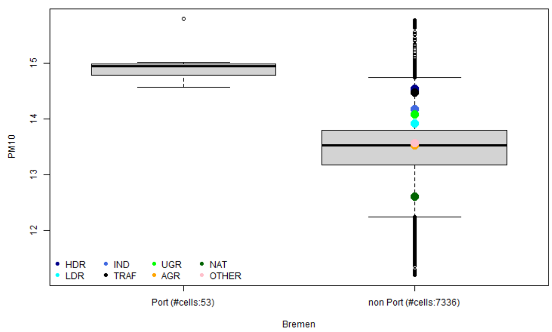
<tr><td>
</td><td>
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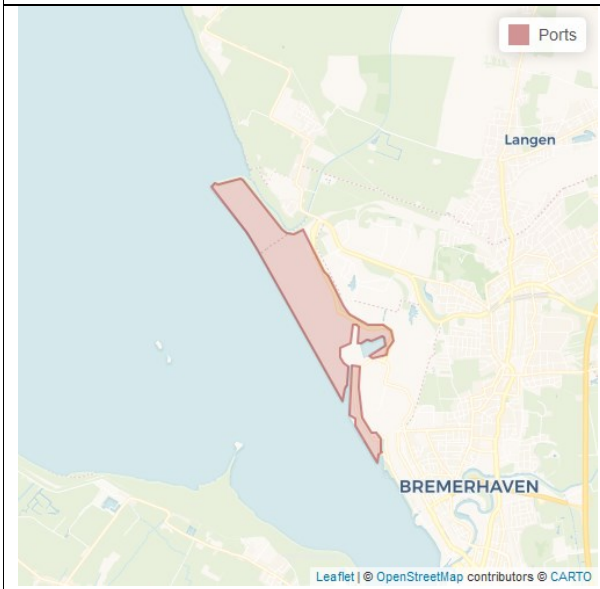
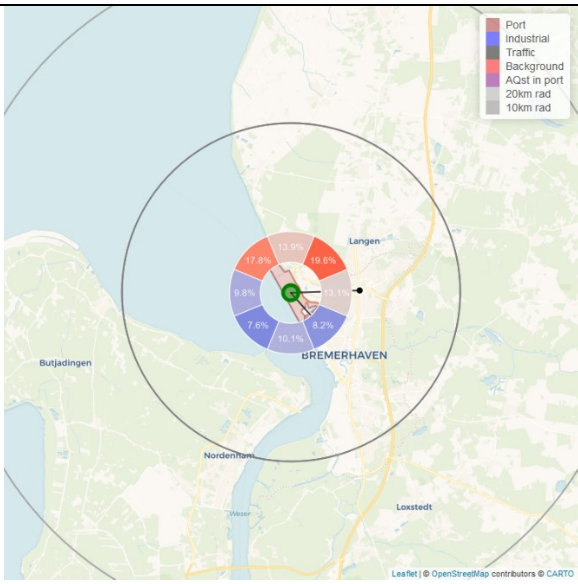
Annex 1.6 Bremerhaven

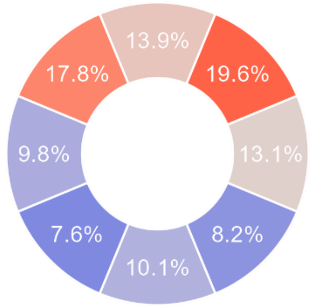
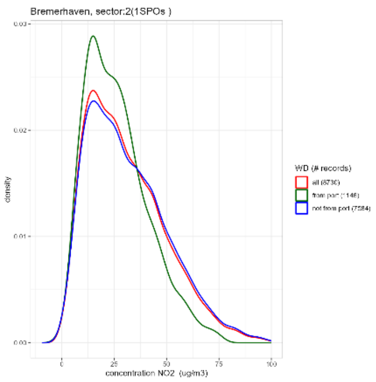
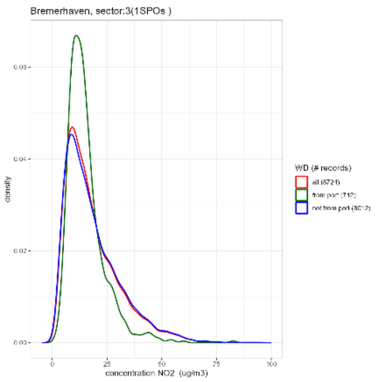
Port area



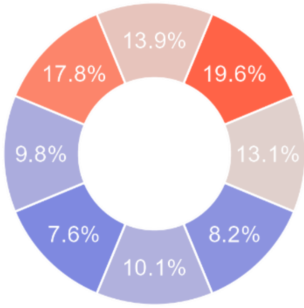
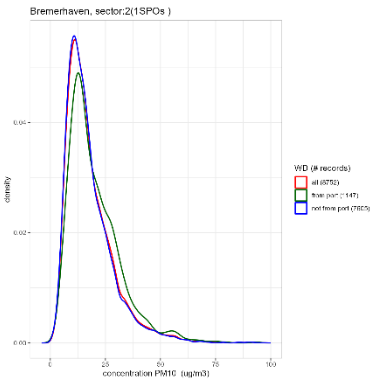
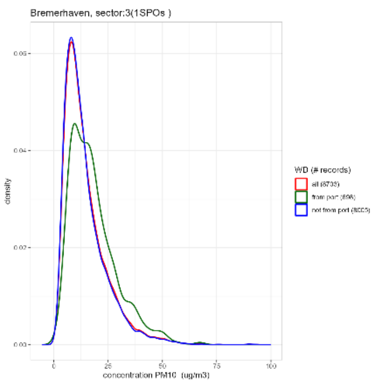
Air quality SPO within 10 km and 20 km



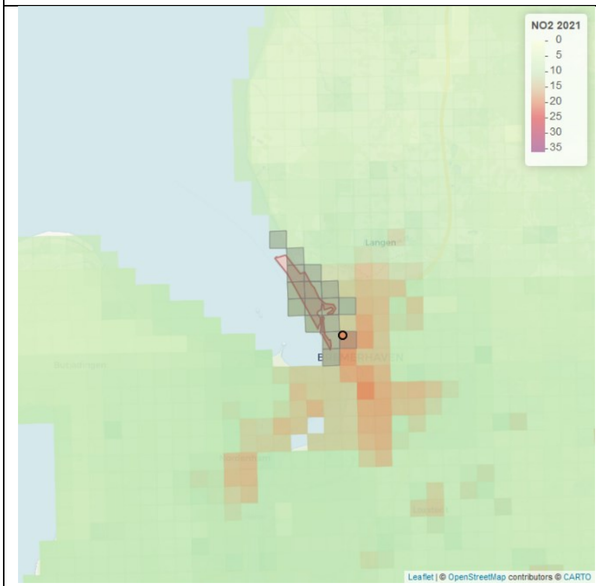
Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Bremerhaven	DE	DEHB005	background	urban	NO2	53.56	8.57	FALSE	0.79	8.2	3	-25.9
Bremerhaven	DE	DEHB011	traffic	urban	NO2	53.59	8.60	FALSE	2.54	13.1	2	-49.9
Bremerhaven	DE	DEHB005	background	urban	PM10	53.56	8.57	FALSE	0.79	8.2	3	-28.9
Bremerhaven	DE	DEHB011	traffic	urban	PM10	53.59	8.60	FALSE	2.54	13.1	2	-45.0

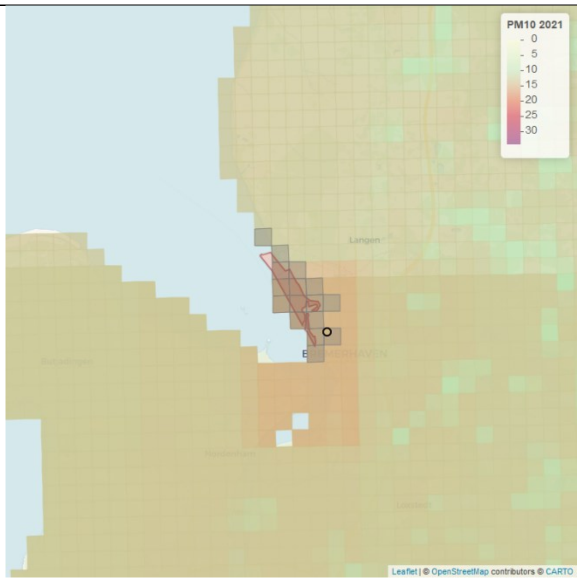
NO_2 concentrations when wind is blowing from the port		
Wind sector 7: NW NO DATA	**Wind sector 8: N** NO DATA	**Wind sector 1: NE** NO DATA
Wind sector 6: W NO DATA	**Wind frequency by sector** 	**Wind sector 2: E** 
Wind sector 5: SW NO DATA	**Wind sector 4: S** NO DATA	**Wind sector 3: SE** 

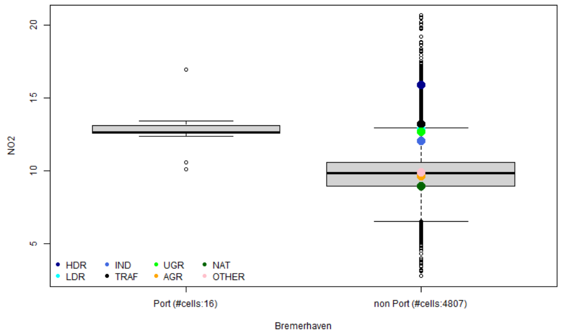
PM10 concentrations when wind is blowing from the port

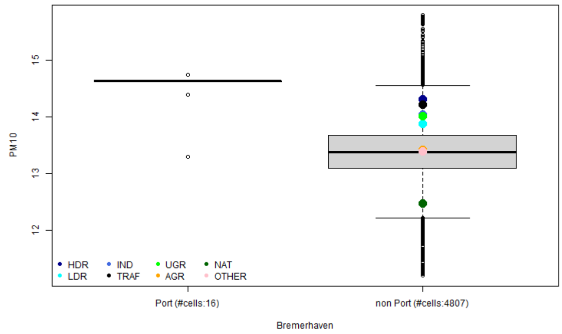
Wind sector 7: NW	Wind sector 8: N	Wind sector 1: NE
NO DATA	NO DATA	NO DATA
Wind sector 6: W	**Wind frequency by sector**	**Wind sector 2: E**
NO DATA		
Wind sector 5: SW	**Wind sector 4: S**	**Wind sector 3: SE**
NO DATA	NO DATA	

NO_2	PM_{10}


NO2 2021
0
5
10
15
20
25
30
35
Langen
Leaflet | © OpenStreetMap contributors © CARTO

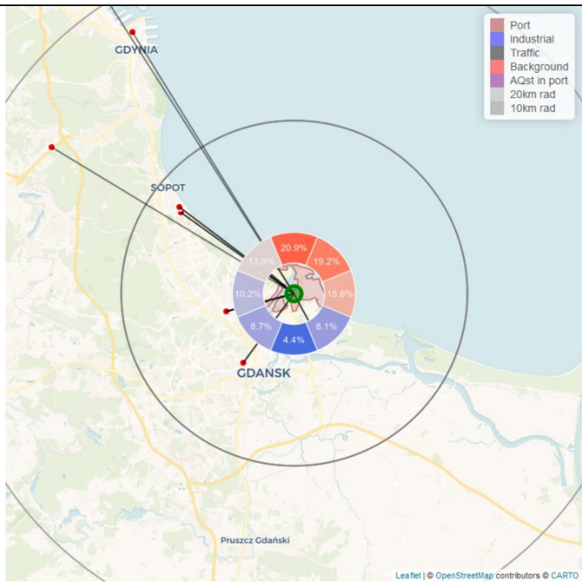

PM10 2021
0
5
10
15
20
25
30
Langen
Leaflet | © OpenStreetMap contributors © CARTO


NO2
5
10
15
20
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:16)
non Port (#cells:4807)
Bremerhaven


PM10
12
13
14
15
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:16)
non Port (#cells:4807)
Bremerhaven

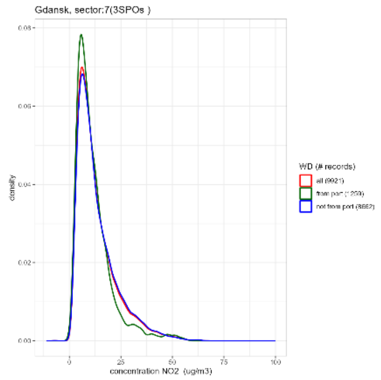
Annex 1.7 Gdansk

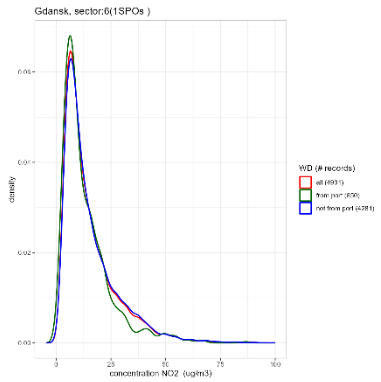
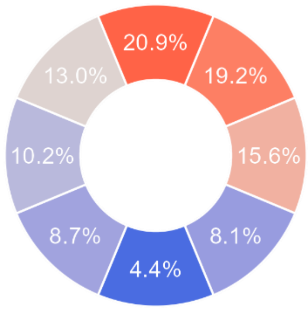
Port area	Air quality SPO within 10 km and 20 km

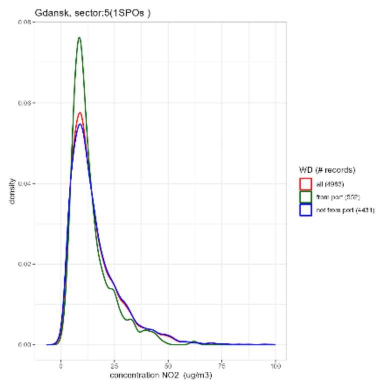


Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Gdansk	PL	PL0047A	background	urban	NO2	54.40	18.66	FALSE	0.42	13.0	7	-20.3
Gdansk	PL	PL0052A	background	urban	NO2	54.38	18.62	FALSE	1.67	10.2	6	-23.8
Gdansk	PL	PL0045A	background	urban	NO2	54.35	18.64	FALSE	2.11	8.7	5	-45.5
Gdansk	PL	PL0050A	background	urban	NO2	54.43	18.58	FALSE	5.18	13.0	7	-14.6
Gdansk	PL	PL0790A	background	urban	NO2	54.43	18.58	FALSE	5.40	13.0	7	
Gdansk	PL	PL0047A	background	urban	PM10	54.40	18.66	FALSE	0.42	13.0	7	-6.8
Gdansk	PL	PL0052A	background	urban	PM10	54.38	18.62	FALSE	1.67	10.2	6	
Gdansk	PL	PL0045A	background	urban	PM10	54.35	18.64	FALSE	2.11	8.7	5	65.9
Gdansk	PL	PL0050A	background	urban	PM10	54.43	18.58	FALSE	5.18	13.0	7	-30.8
Gdansk	PL	PL0790A	background	urban	PM10	54.43	18.58	FALSE	5.40	13.0	7	
Gdansk	PL	PL0520A	background	urban	PM10	54.47	18.46	FALSE	13.49	13.0	7	
Gdansk	PL	PL0048A	background	urban	PM10	54.56	18.49	FALSE	19.80	13.0	7	-41.3

NO$_2$ concentrations when wind is blowing from the port

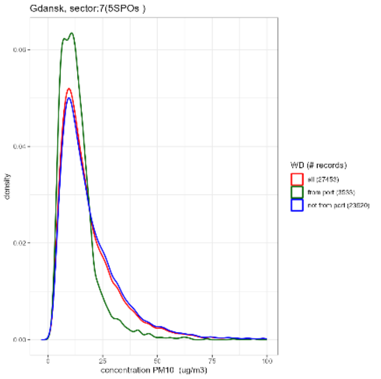
Wind sector 7: NW	Wind sector 8: N	Wind sector 1: NE
	NO DATA	NO DATA

Wind sector 6: W	Wind frequency by sector	Wind sector 2: E
		NO DATA

Wind sector 5: SW	Wind sector 4: S	Wind sector 3: SE
	NO DATA	NO DATA

PM_{10} concentrations when wind is blowing from the port

Wind sector 7: NW



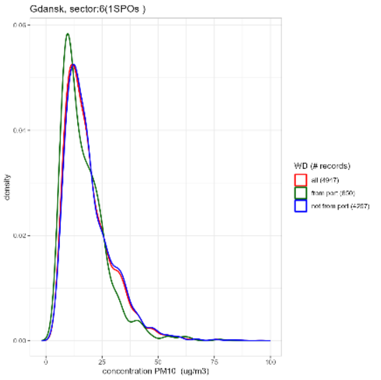
Wind sector 8: N

NO DATA

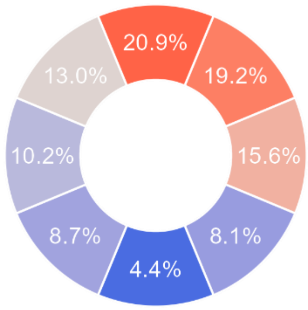
Wind sector 1: NE

NO DATA

Wind sector 6: W



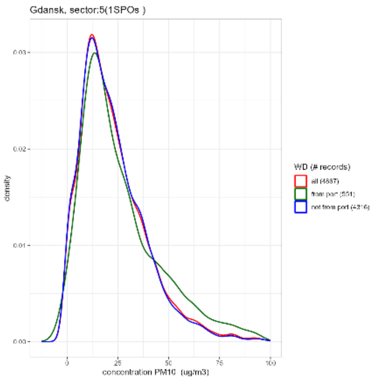
Wind frequency by sector



Wind sector 2: E

NO DATA

Wind sector 5: SW

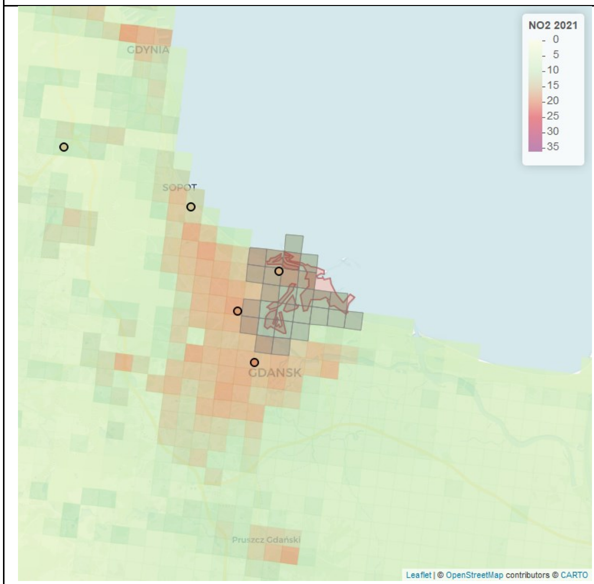
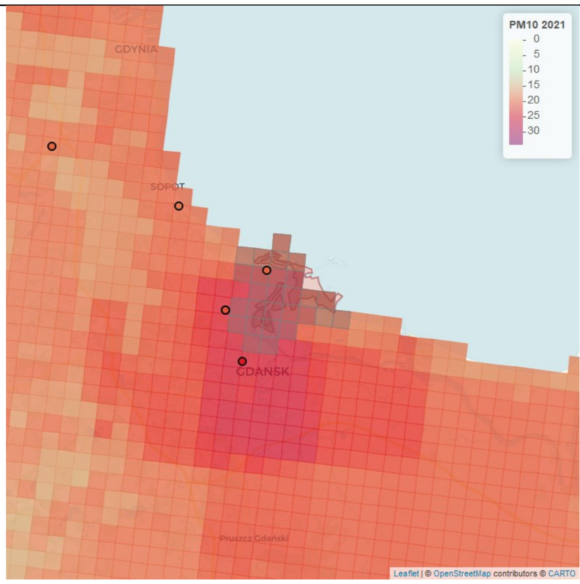
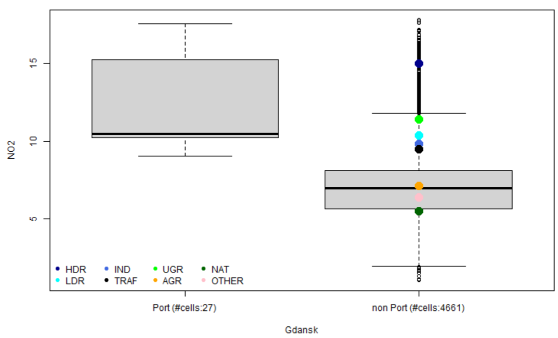
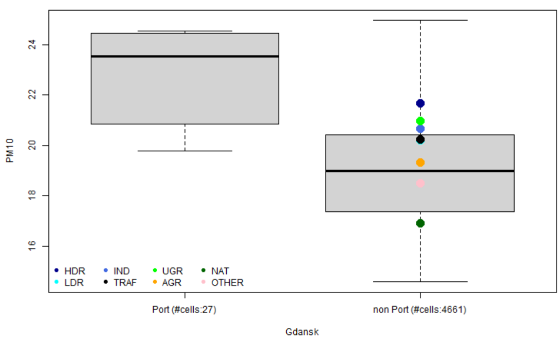


Wind sector 4: S

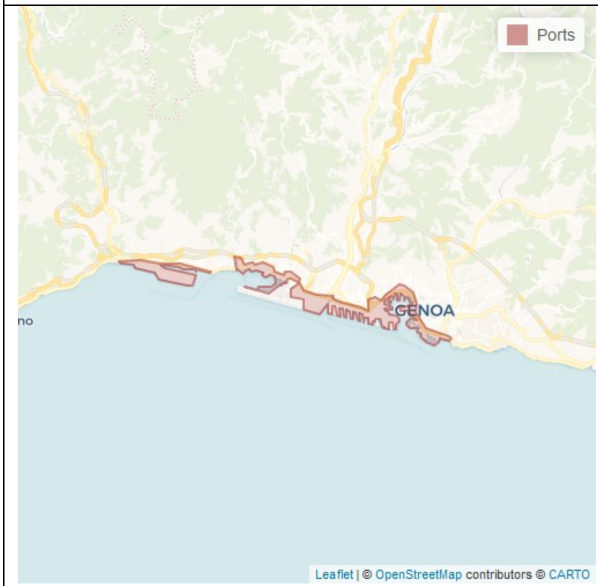
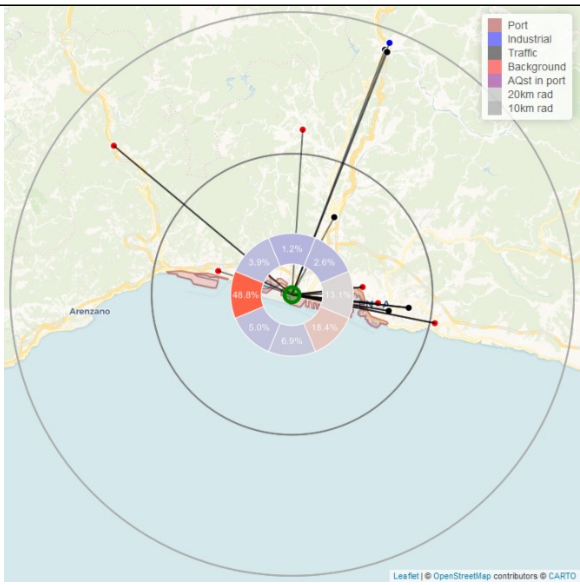
NO DATA

Wind sector 3: SE

NO DATA

NO_2	PM_{10}
NO2 2021 0 5 10 15 20 25 30 35 GDYNIA SOPOT GDANSK Pruszcz Gdański Leaflet | © OpenStreetMap contributors © CARTO	PM10 2021 0 5 10 15 20 25 30 GDYNIA SOPOT GDANSK Pruszcz Gdański Leaflet | © OpenStreetMap contributors © CARTO
NO2 5 10 15 HDR IND UGR NAT LDR TRAF AGR OTHER Port (#cells:27) non Port (#cells:4661) Gdansk	PM10 16 18 20 22 24 HDR IND UGR NAT LDR TRAF AGR OTHER Port (#cells:27) non Port (#cells:4661) Gdansk

Annex 1.8 Genova

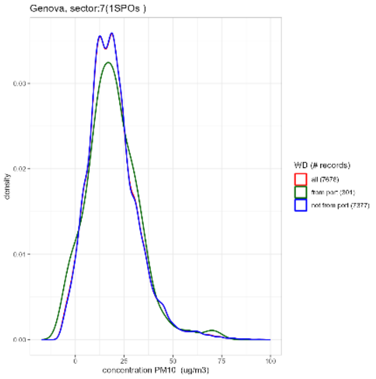
Port area	Air quality SPO within 10 km and 20 km
	

Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Genova	IT	IT0852A	traffic	urban	NO2	44.43	8.83	TRUE	0.00	3.9	7	-54.0
Genova	IT	IT1887A	traffic	urban	NO2	44.41	8.91	TRUE	0.00	13.1	2	
Genova	IT	IT0854A	background	urban	NO2	44.42	8.93	FALSE	0.31	13.1	2	
Genova	IT	IT2259A	background	suburban	NO2	44.43	8.80	FALSE	0.34	48.8	6	
Genova	IT	IT1884A	traffic	urban	NO2	44.40	8.95	FALSE	0.81	13.1	2	-64.6
Genova	IT	IT1698A	traffic	urban	NO2	44.40	8.97	FALSE	1.82	13.1	2	-27.3
Genova	IT	IT0858A	background	urban	NO2	44.39	8.99	FALSE	3.32	13.1	2	-47.3
Genova	IT	IT1850A	traffic	urban	NO2	44.46	8.90	FALSE	5.16	2.6	1	-41.3
Genova	IT	IT2298A	background	suburban	NO2	44.51	8.70	FALSE	9.68	3.9	7	
Genova	IT	IT0852A	traffic	urban	PM10	44.43	8.83	TRUE	0.00	3.9	7	
Genova	IT	IT0854A	background	urban	PM10	44.42	8.93	FALSE	0.31	13.1	2	-39.8
Genova	IT	IT1884A	traffic	urban	PM10	44.40	8.95	FALSE	0.81	13.1	2	
Genova	IT	IT1698A	traffic	urban	PM10	44.40	8.97	FALSE	1.82	13.1	2	
Genova	IT	IT0858A	background	urban	PM10	44.39	8.99	FALSE	3.32	13.1	2	

NO₂ concentrations when wind is blowing from the port
Wind sector 7: NW
Genova, sector:7(2SPOs)
density
concentration NO2 (ug/m3)
WD (# records)
Wind sector 8: N
NO DATA
Wind sector 1: NE
Genova, sector:1(1SPOs)
density
concentration NO2 (ug/m3)
WD (# records)
Wind sector 6: W
Genova, sector:6(1SPOs)
density
concentration NO2 (ug/m3)
WD (# records)
Wind frequency by sector
1.2%
2.6%
13.1%
18.4%
6.9%
5.0%
48.8%
3.9%
Wind sector 2: E
Genova, sector:2(5SPOs)
density
concentration NO2 (ug/m3)
WD (# records)
Wind sector 5: SW
NO DATA
Wind sector 4: S
NO DATA
Wind sector 3: SE
NO DATA

PM$_{10}$ concentrations when wind is blowing from the port

Wind sector 7: NW



Wind sector 8: N

NO DATA

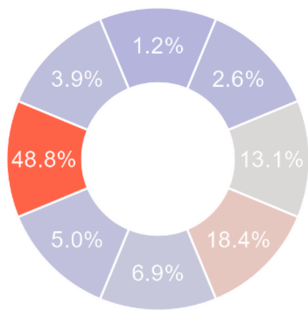
Wind sector 1: NE

NO DATA

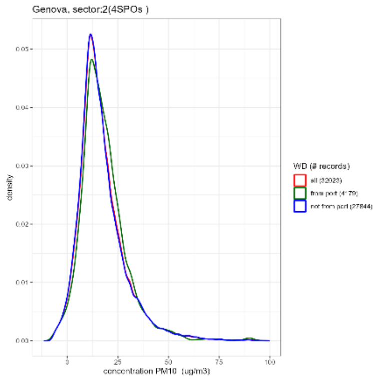
Wind sector 6: W

NO DATA

Wind frequency by sector



Wind sector 2: E



Wind sector 5: SW

NO DATA

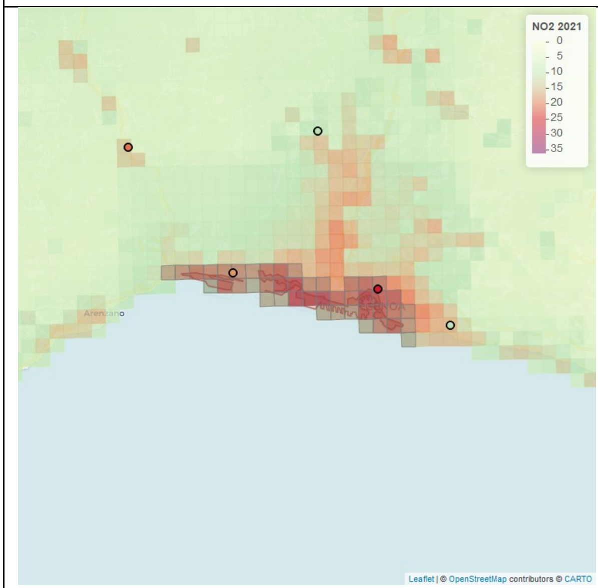
Wind sector 4: S

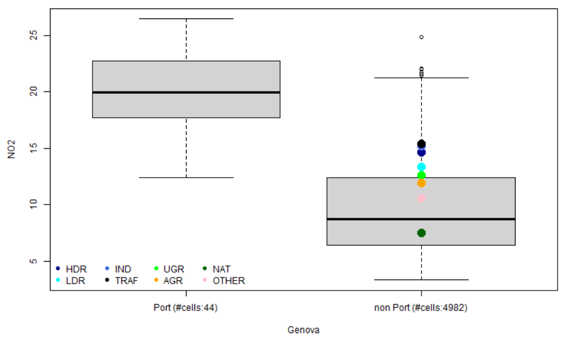
NO DATA

Wind sector 3: SE

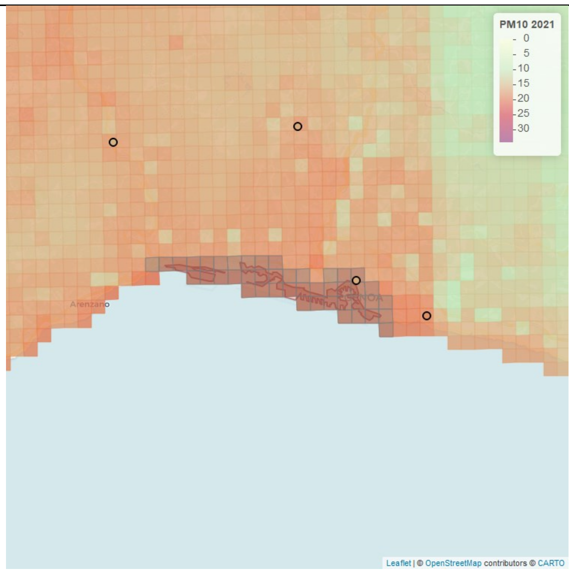
NO DATA

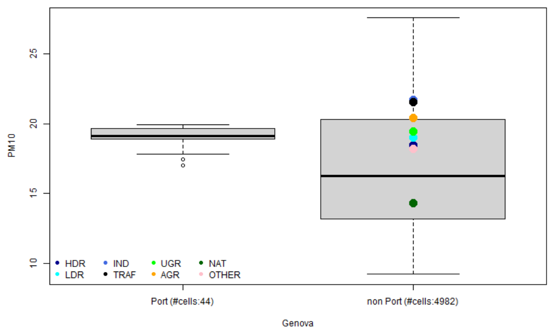
NO_2


NO2 2021
0
5
10
15
20
25
30
35
Arenzano
Leaflet | © OpenStreetMap contributors © CARTO

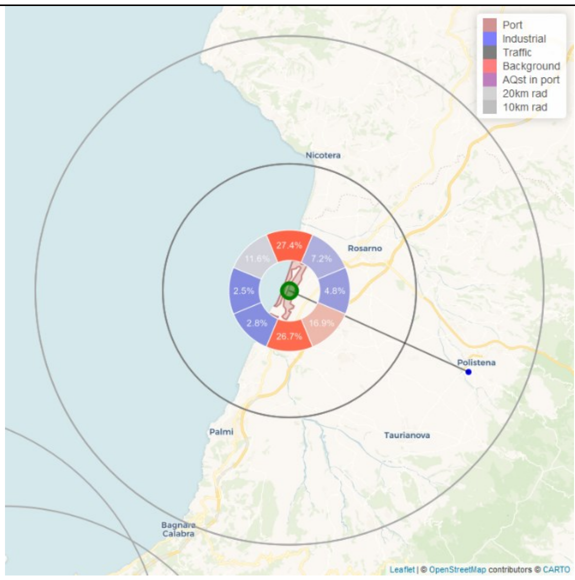

NO2
5
10
15
20
25
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:44)
non Port (#cells:4982)
Genova

PM_{10}


PM10 2021
0
5
10
15
20
25
30
Arenzano
Leaflet | © OpenStreetMap contributors © CARTO


PM10
10
15
20
25
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:44)
non Port (#cells:4982)
Genova

Annex 1.9 Gioia Tauro

<table>
<tr><th>Port area</th><th>Air quality SPO within 10 km and 20 km</th></tr>
<tr><td>
</td><td>
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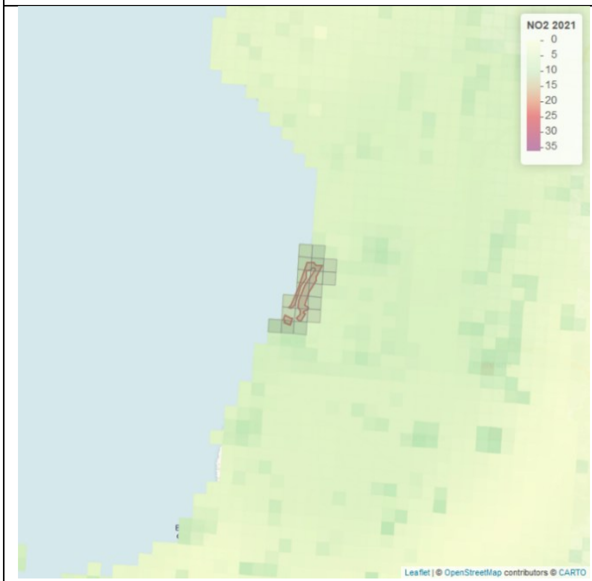
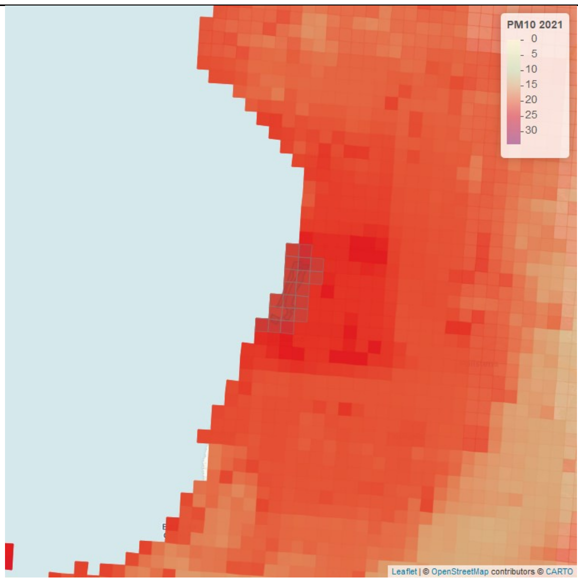
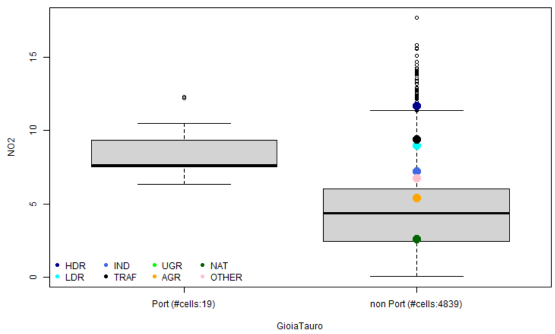
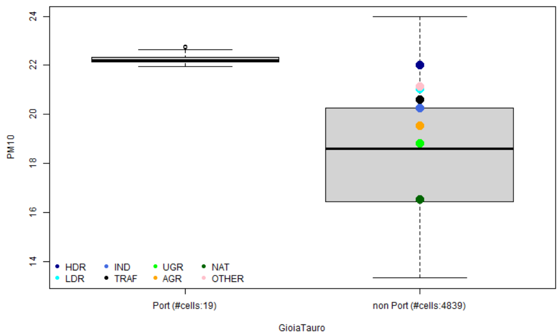
</table>

NO_2	PM_{10}
	
	

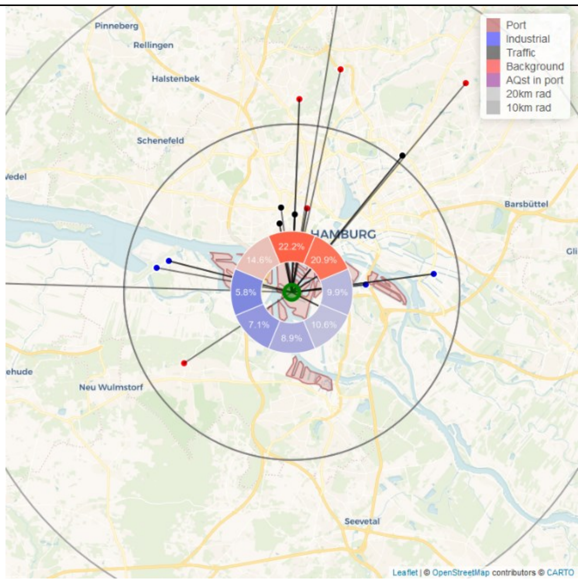
NO2 2021
0
5
10
15
20
25
30
35
Leaflet | © OpenStreetMap contributors © CARTO

PM10 2021
0
5
10
15
20
25
30
Leaflet | © OpenStreetMap contributors © CARTO

NO2
0
5
10
15
HDR
IND
UGR
NAT
LDR
TRAF
AGR
OTHER
Port (#cells:19)
non Port (#cells:4839)
GioiaTauro

PM10
14
16
18
20
22
24
HDR
IND
UGR
NAT
LDR
TRAF
AGR
OTHER
Port (#cells:19)
non Port (#cells:4839)
GioiaTauro

Annex 1.10 Hamburg

Port area	Air quality SPO within 10 km and 20 km
	

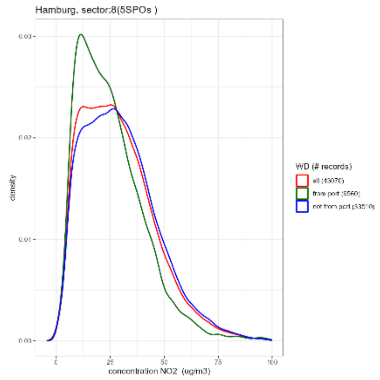
Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Hamburg	DE	DEHH081	background	urban	NO2	53.53	9.98	TRUE	0.00	20.9	1	
Hamburg	DE	DEHH015	industrial	urban	NO2	53.52	10.02	FALSE	0.17	9.9	2	-32.1
Hamburg	DE	DEHH079	background	urban	NO2	53.55	9.94	FALSE	0.65	22.2	8	
Hamburg	DE	DEHH059	background	urban	NO2	53.51	9.99	FALSE	1.34	10.6	3	-29.8
Hamburg	DE	DEHH070	traffic	urban	NO2	53.56	9.94	FALSE	1.65	22.2	8	-47.8
Hamburg	DE	DEHH026	traffic	urban	NO2	53.56	9.96	FALSE	1.94	22.2	8	-51.2
Hamburg	DE	DEHH016	industrial	urban	NO2	53.53	10.08	FALSE	2.18	9.9	2	-37.9
Hamburg	DE	DEHH008	background	urban	NO2	53.56	9.97	FALSE	2.34	22.2	8	-34.4
Hamburg	DE	DEHH064	traffic	urban	NO2	53.56	9.94	FALSE	2.52	22.2	8	-39.6
Hamburg	DE	DEHH050	background	suburban	NO2	53.48	9.86	FALSE	4.46	7.1	5	-34.3
Hamburg	DE	DEHH068	traffic	urban	NO2	53.59	10.05	FALSE	7.15	20.9	1	-25.6
Hamburg	DE	DEHH081	background	urban	PM10	53.53	9.98	TRUE	0.00	20.9	1	
Hamburg	DE	DEHH015	industrial	urban	PM10	53.52	10.02	FALSE	0.17	9.9	2	-37.8
Hamburg	DE	DEHH079	background	urban	PM10	53.55	9.94	FALSE	0.65	22.2	8	
Hamburg	DE	DEHH059	background	urban	PM10	53.51	9.99	FALSE	1.34	10.6	3	-36.1
Hamburg	DE	DEHH070	traffic	urban	PM10	53.56	9.94	FALSE	1.65	22.2	8	-45.9
Hamburg	DE	DEHH026	traffic	urban	PM10	53.56	9.96	FALSE	1.94	22.2	8	-39.0
Hamburg	DE	DEHH016	industrial	urban	PM10	53.53	10.08	FALSE	2.18	9.9	2	-45.4
Hamburg	DE	DEHH008	background	urban	PM10	53.56	9.97	FALSE	2.34	22.2	8	-46.6
Hamburg	DE	DEHH068	traffic	urban	PM10	53.59	10.05	FALSE	7.15	20.9	1	-42.3
Hamburg	DE	DENI063	background	rural	PM10	53.52	9.69	FALSE	13.05	5.8	6	-41.0

NO_2 concentrations when wind is blowing from the port

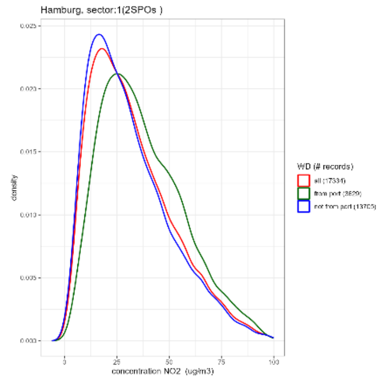
Wind sector 7: NW

NO DATA

Wind sector 8: N



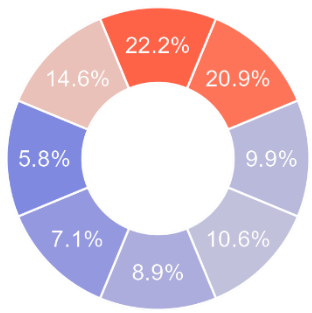
Wind sector 1: NE



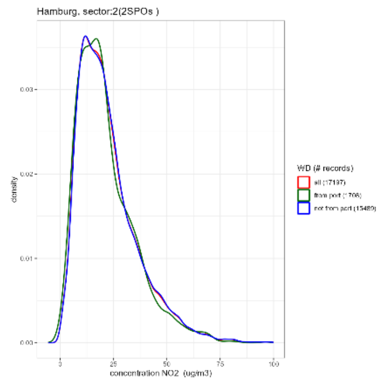
Wind sector 6: W

NO DATA

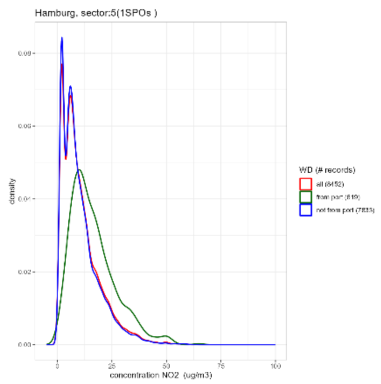
Wind frequency by sector



Wind sector 2: E



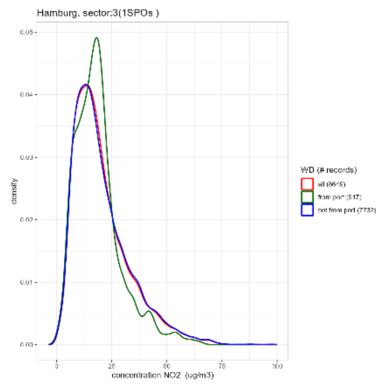
Wind sector 5: SW



Wind sector 4: S

NO DATA

Wind sector 3: SE

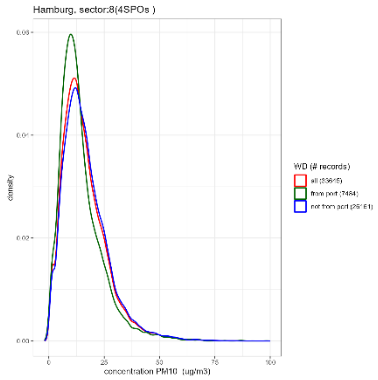


PM_{10} concentrations when wind is blowing from the port

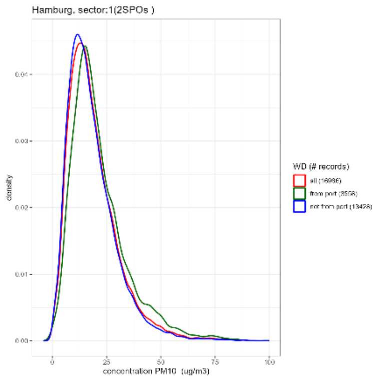
Wind sector 7: NW

NO DATA

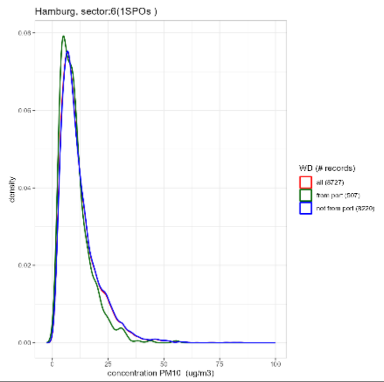
Wind sector 8: N



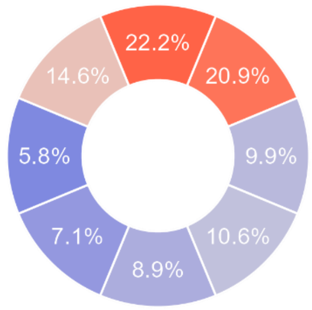
Wind sector 1: NE



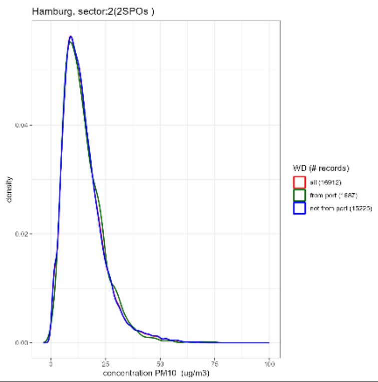
Wind sector 6: W



Wind frequency by sector



Wind sector 2: E



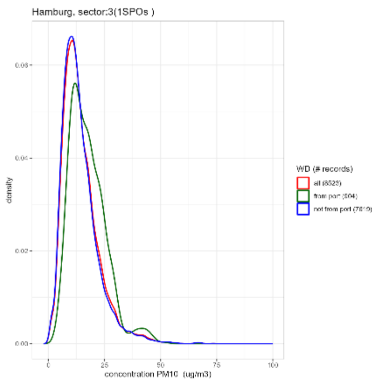
Wind sector 5: SW

NO DATA

Wind sector 4: S

NO DATA

Wind sector 3: SE



<table>
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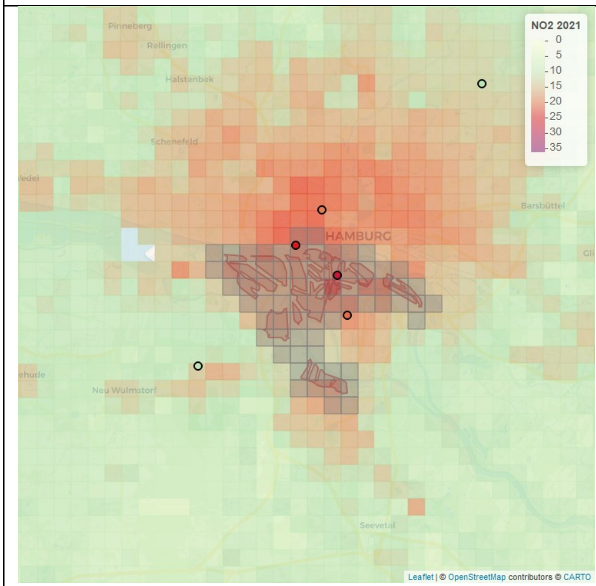

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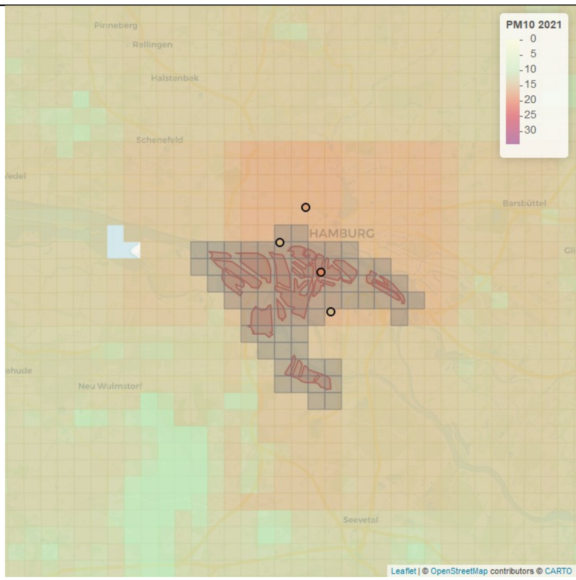

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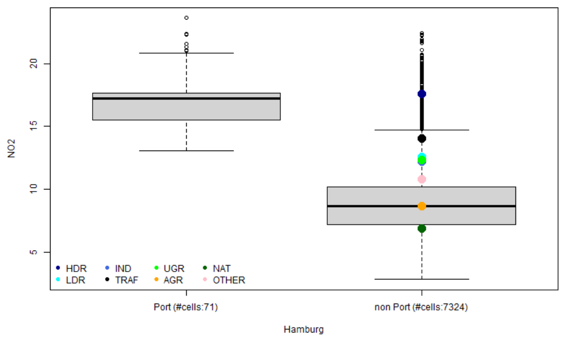

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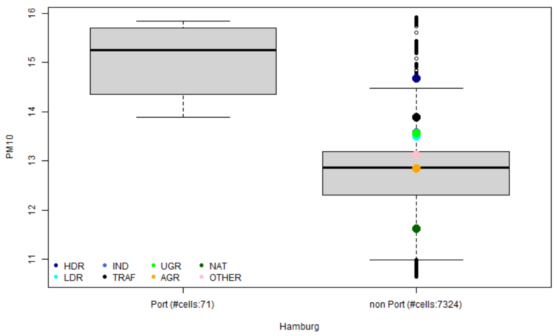

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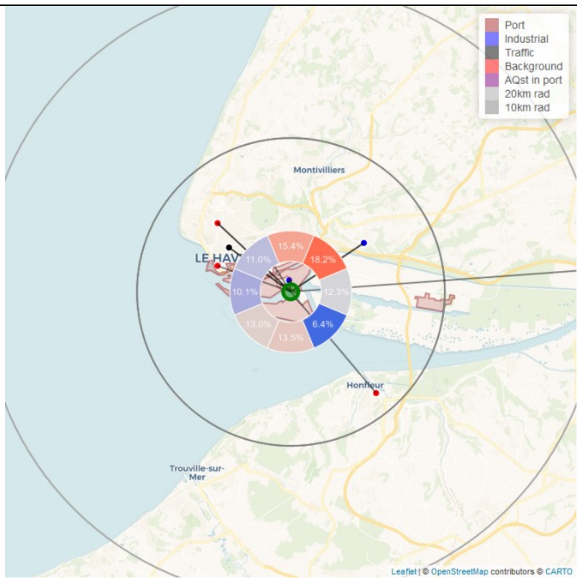
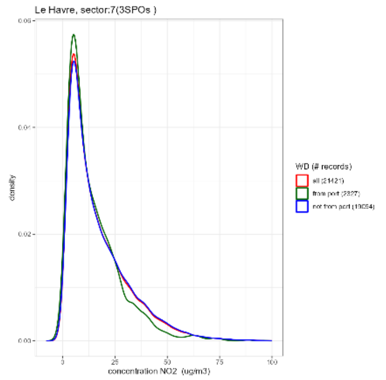
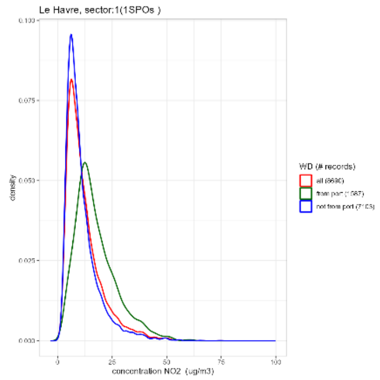
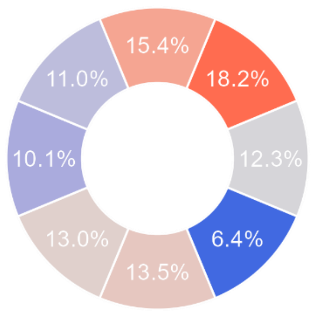
Annex 1.11 Le Havre

Port area	Air quality SPO within 10 km and 20 km
	

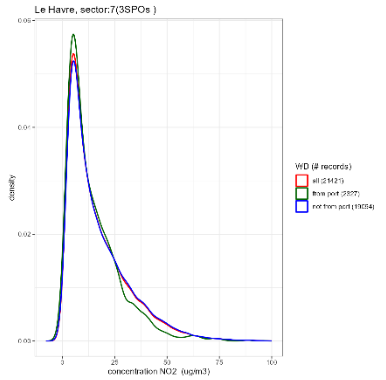
Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Le Havre	FR	FR05078	background	urban	NO2	49.50	0.14	FALSE	0.86	11.0	7	-44.4
Le Havre	FR	FR05089	traffic	urban	NO2	49.50	0.11	FALSE	1.03	11.0	7	
Le Havre	FR	FR05090	background	urban	NO2	49.51	0.10	FALSE	2.49	11.0	7	
Le Havre	FR	FR05083	industrial	urban	NO2	49.50	0.23	FALSE	2.78	18.2	1	
Le Havre	FR	FR05074	background	urban	PM10	49.49	0.10	FALSE	0.21	10.1	6	-45.0
Le Havre	FR	FR05089	traffic	urban	PM10	49.50	0.11	FALSE	1.03	11.0	7	
Le Havre	FR	FR05090	background	urban	PM10	49.51	0.10	FALSE	2.49	11.0	7	
Le Havre	FR	FR05083	industrial	urban	PM10	49.50	0.23	FALSE	2.78	18.2	1	
Le Havre	FR	FR05040	background	urban	PM10	49.42	0.24	FALSE	5.59	6.4	3	
Le Havre	FR	FR05084	industrial	urban	PM10	49.49	0.57	FALSE	18.74	12.3	2	-41.8

NO_2 concentrations when wind is blowing from the port

Wind sector 7: NW	Wind sector 8: N	Wind sector 1: NE
	NO DATA	
Wind sector 6: W	**Wind frequency by sector**	**Wind sector 2: E**
NO DATA		NO DATA
Wind sector 5: SW	**Wind sector 4: S**	**Wind sector 3: SE**
NO DATA	NO DATA	NO DATA

PM$_{10}$ concentrations when wind is blowing from the port

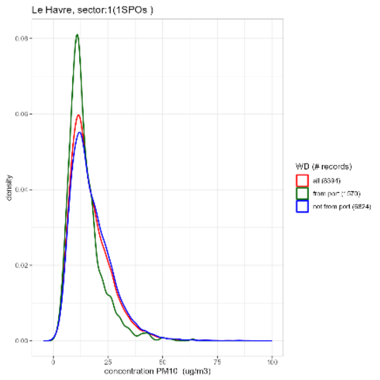
Wind sector 7: NW



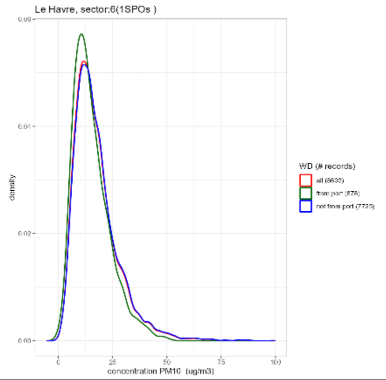
Wind sector 8: N

NO DATA

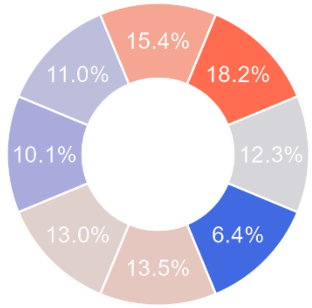
Wind sector 1: NE



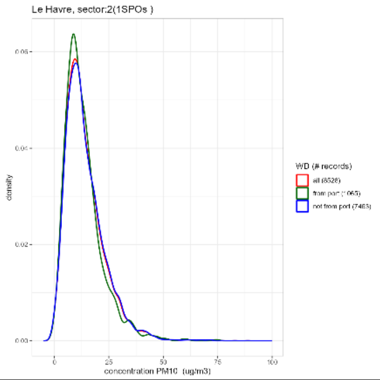
Wind sector 6: W



Wind frequency by sector



Wind sector 2: E



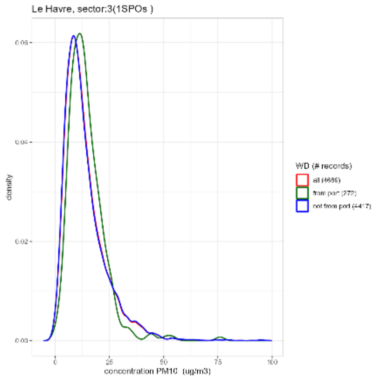
Wind sector 5: SW

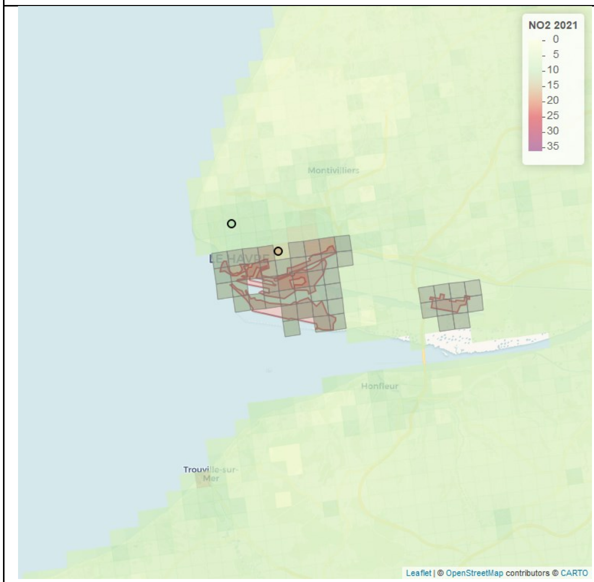
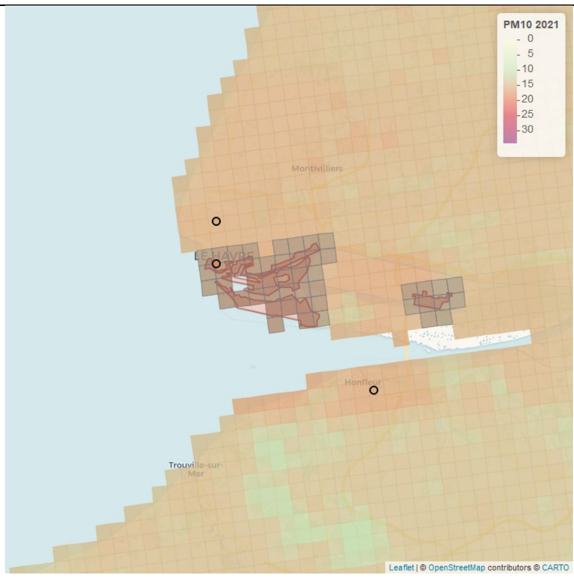
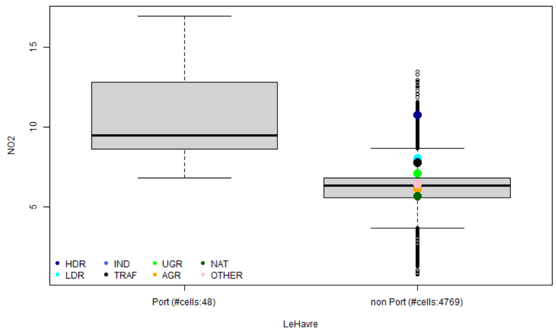
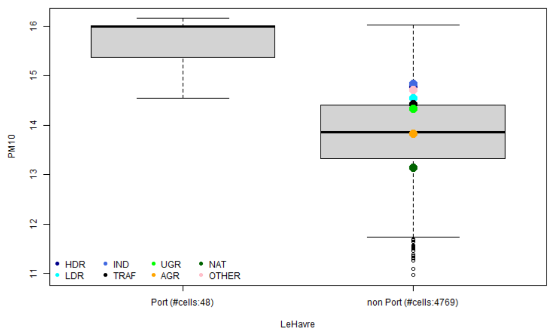
NO DATA

Wind sector 4: S

NO DATA

Wind sector 3: SE

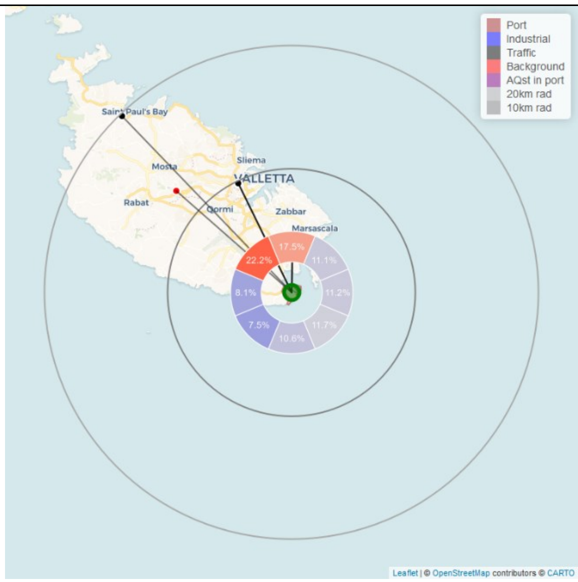


NO_2	PM_{10}
NO2 2021 0 5 10 15 20 25 30 35 Montivilliers LE HAVRE Honfleur Trouville-sur-Mer Leaflet | © OpenStreetMap contributors © CARTO	PM10 2021 0 5 10 15 20 25 30 Montivilliers LE HAVRE Honfleur Trouville-sur-Mer Leaflet | © OpenStreetMap contributors © CARTO
NO2 5 10 15 HDR LDR IND TRAF UGR AGR NAT OTHER Port (#cells:48) non Port (#cells:4769) LeHavre	PM10 11 12 13 14 15 16 HDR LDR IND TRAF UGR AGR NAT OTHER Port (#cells:48) non Port (#cells:4769) LeHavre

Annex 1.12 Marsaxlokk

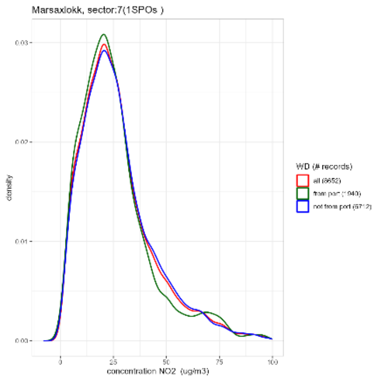
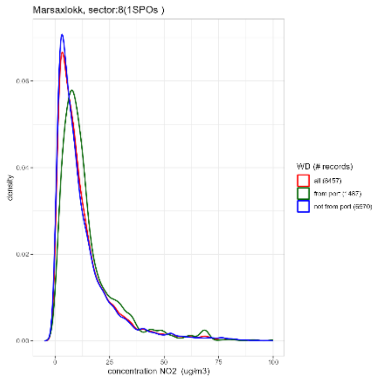
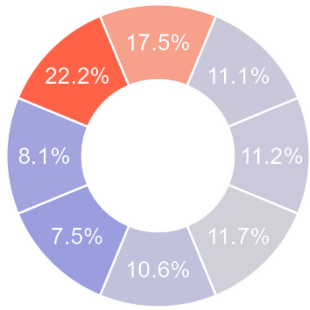
Port area

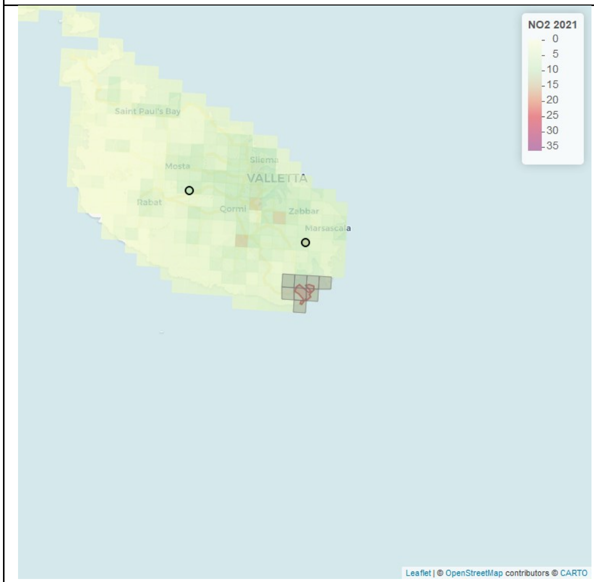
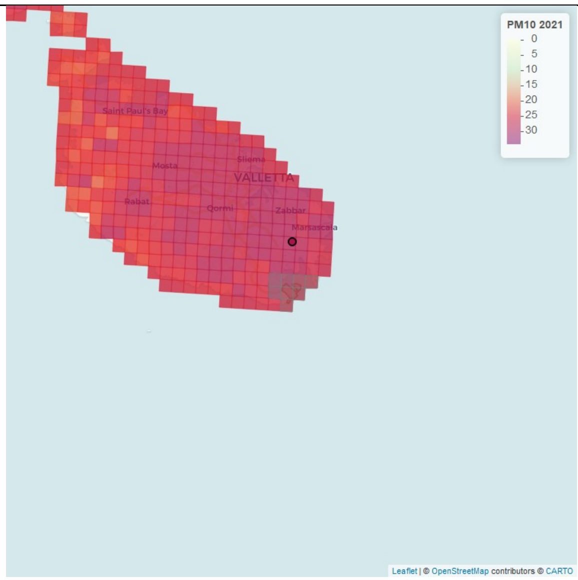
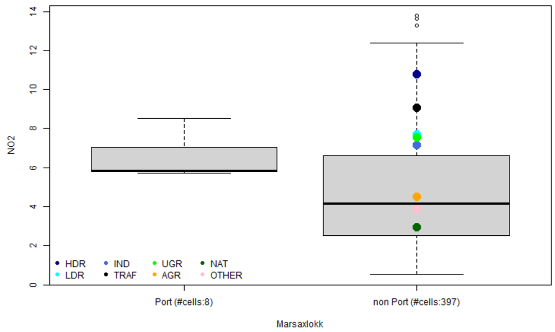
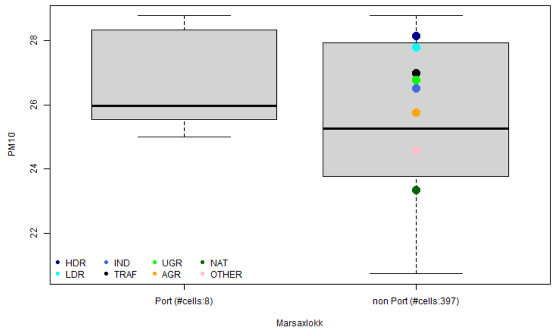
Air quality SPO within 10 km and 20 km



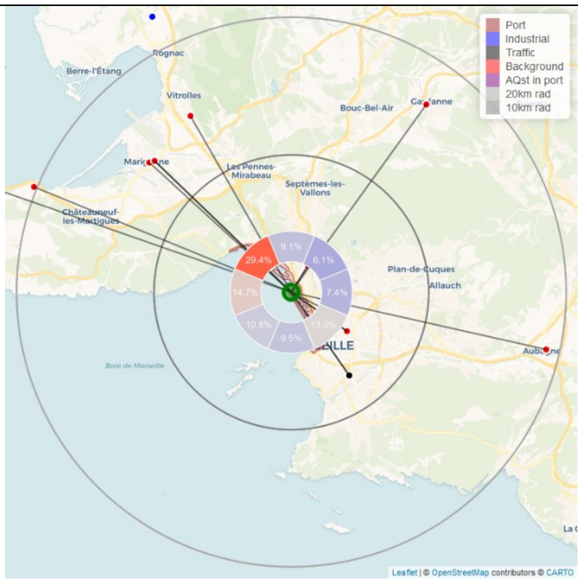
Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Marsaxlokk	MT	MT00004	background	urban	NO2	35.85	14.54	FALSE	3.38	17.5	8	
Marsaxlokk	MT	MT00005	traffic	urban	NO2	35.90	14.49	FALSE	9.12	22.2	7	

NO_2 concentrations when wind is blowing from the port

Wind sector 7: NW	Wind sector 8: N	Wind sector 1: NE
		NO DATA
Wind sector 6: W	**Wind frequency by sector**	**Wind sector 2: E**
NO DATA		NO DATA
Wind sector 5: SW	**Wind sector 4: S**	**Wind sector 3: SE**
NO DATA	NO DATA	NO DATA

NO_2	PM_{10}
NO2 2021 0 5 10 15 20 25 30 35 Saint Paul's Bay Mosta Sliema VALLETTA Rabat Qormi Zabbar Marsascala Leaflet | © OpenStreetMap contributors © CARTO	PM10 2021 0 5 10 15 20 25 30 Saint Paul's Bay Mosta Sliema VALLETTA Rabat Qormi Zabbar Marsascala Leaflet | © OpenStreetMap contributors © CARTO
NO2 0 2 4 6 8 10 12 14 HDR IND UGR NAT LDR TRAF AGR OTHER Port (#cells:8) non Port (#cells:397) Marsaxlokk	PM10 22 24 26 28 HDR IND UGR NAT LDR TRAF AGR OTHER Port (#cells:8) non Port (#cells:397) Marsaxlokk

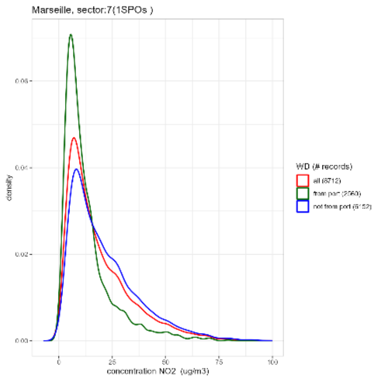
Annex 1.13 Marseille

Port area	Air quality SPO within 10 km and 20 km
	

Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Marseille	FR	FR03014	background	urban	NO2	43.35	5.36	FALSE	1.33	6.1	1	-14.3
Marseille	FR	FR03043	background	urban	NO2	43.31	5.39	FALSE	1.95	13.0	3	-33.8
Marseille	FR	FR03006	traffic	urban	NO2	43.28	5.40	FALSE	2.70	13.0	3	-31.6
Marseille	FR	FR02043	background	urban	NO2	43.42	5.22	FALSE	8.44	29.4	7	
Marseille	FR	FR03014	background	urban	PM10	43.35	5.36	FALSE	1.33	6.1	1	-53.6
Marseille	FR	FR03043	background	urban	PM10	43.31	5.39	FALSE	1.95	13.0	3	-50.9
Marseille	FR	FR03006	traffic	urban	PM10	43.28	5.40	FALSE	2.70	13.0	3	
Marseille	FR	FR02043	background	urban	PM10	43.42	5.22	FALSE	8.44	29.4	7	
Marseille	FR	FR02029	industrial	suburban	PM10	43.40	5.11	FALSE	14.94	14.7	6	-61.0
Marseille	FR	FR03030	industrial	suburban	PM10	43.45	5.47	FALSE	15.48	6.1	1	-50.8

NO$_2$ concentrations when wind is blowing from the port

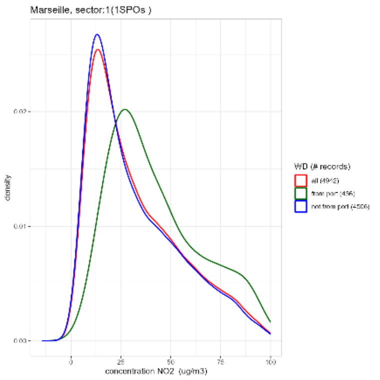
Wind sector 7: NW



Wind sector 8: N

NO DATA

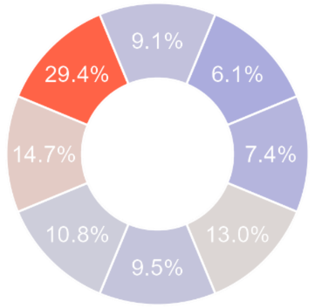
Wind sector 1: NE



Wind sector 6: W

NO DATA

Wind frequency by sector



Wind sector 2: E

NO DATA

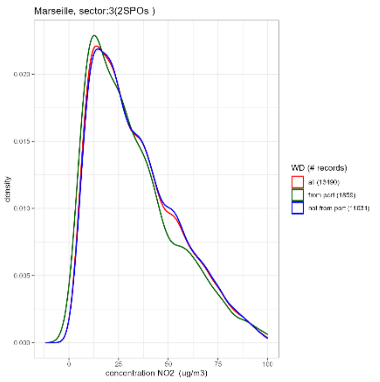
Wind sector 5: SW

NO DATA

Wind sector 4: S

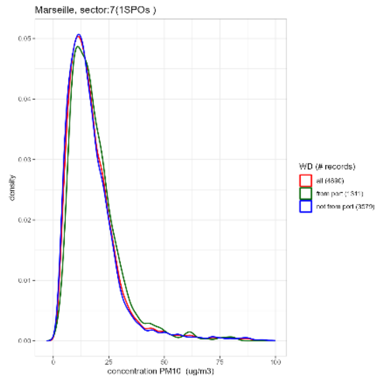
NO DATA

Wind sector 3: SE



PM_{10} concentrations when wind is blowing from the port

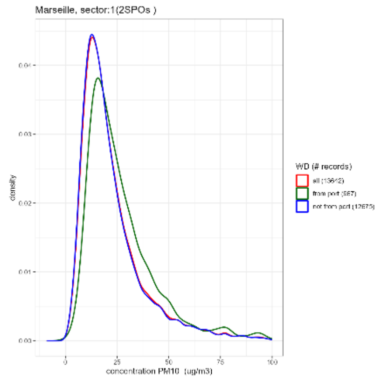
Wind sector 7: NW



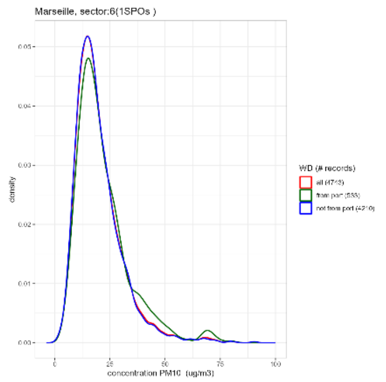
Wind sector 8: N

NO DATA

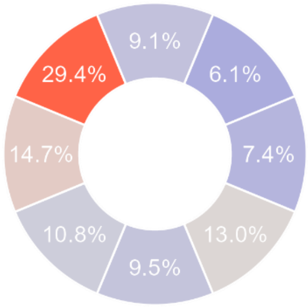
Wind sector 1: NE



Wind sector 6: W



Wind frequency by sector



Wind sector 2: E

NO DATA

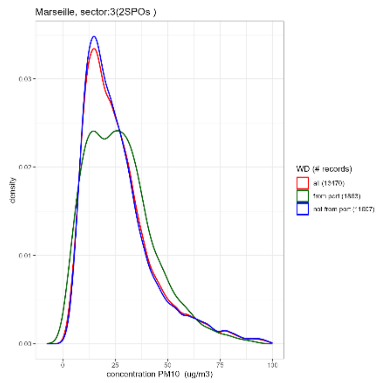
Wind sector 5: SW

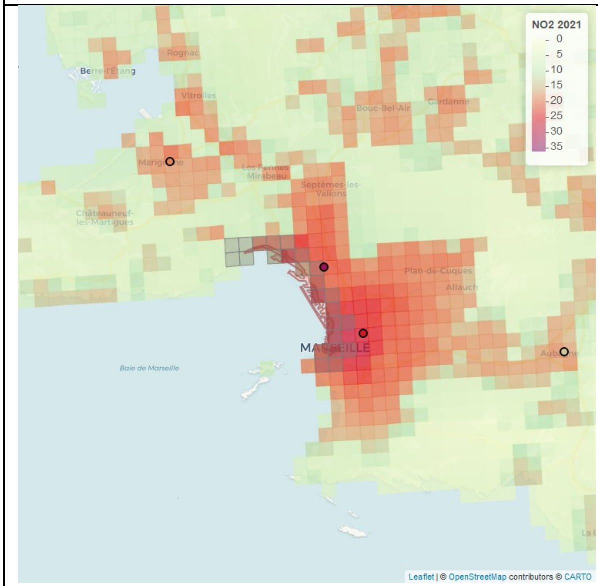
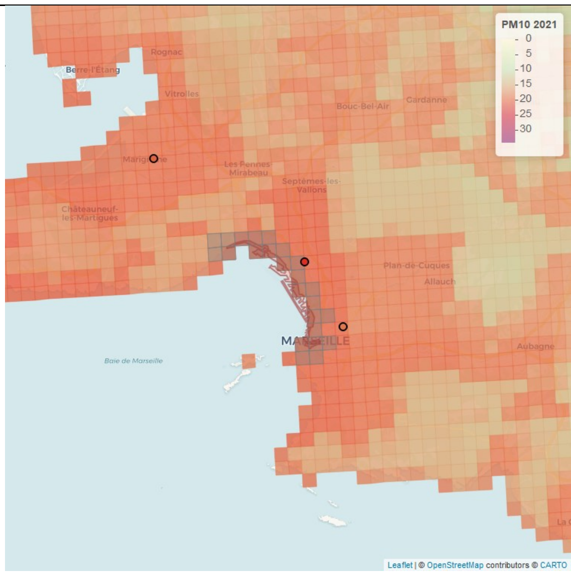
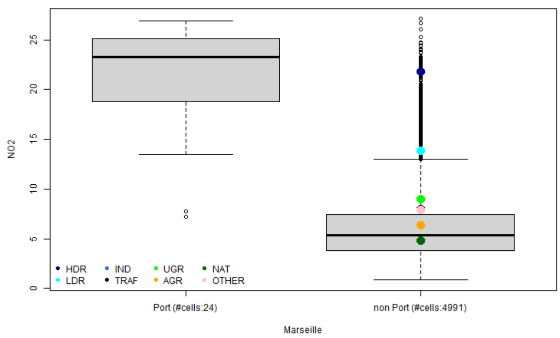
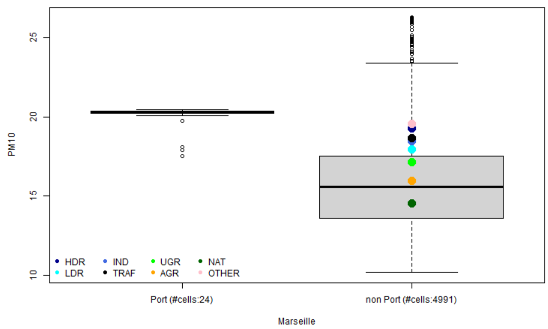
NO DATA

Wind sector 4: S

NO DATA

Wind sector 3: SE



NO_2	PM_{10}
	
	

NO2 2021
0
5
10
15
20
25
30
35
Rognac
Vitrolles
Bouc-Bel-Air
Les Pennes-Mirabeau
Septèmes-les-Vallons
Plan-de-Cuques
Allauch
MARSEILLE
Baie de Marseille
Leaflet | © OpenStreetMap contributors © CARTO

PM10 2021
0
5
10
15
20
25
30
Rognac
Vitrolles
Bouc-Bel-Air
Cardanne
Les Pennes-Mirabeau
Septèmes-les-Vallons
Châteauneuf-les-Martigues
Plan-de-Cuques
Allauch
Aubagne
MARSEILLE
Baie de Marseille
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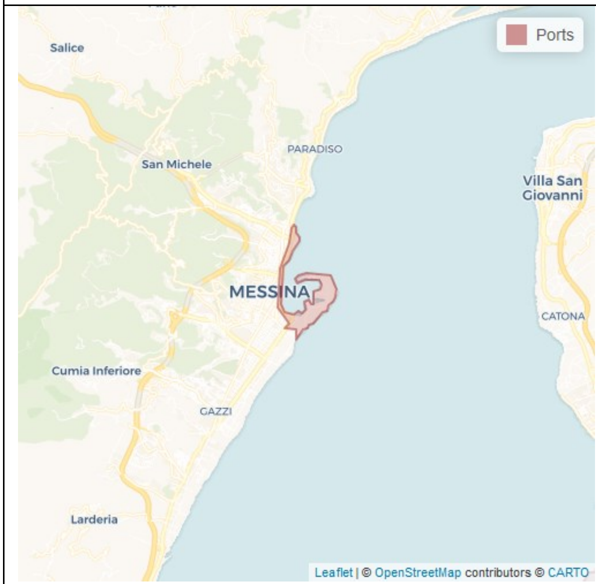
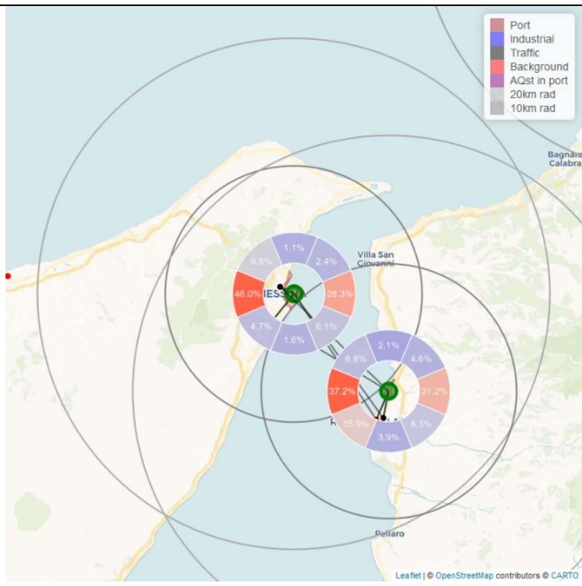
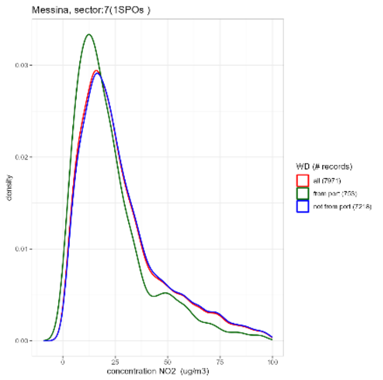
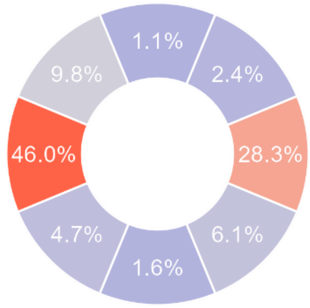
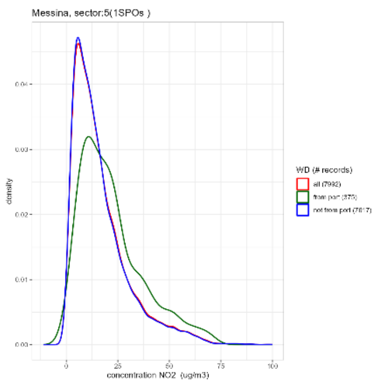
NO2
0
5
10
15
20
25
HDR
IND
UGR
NAT
LDR
TRAF
AGR
OTHER
Port (#cells:24)
non Port (#cells:4991)
Marseille

PM10
10
15
20
25
HDR
IND
UGR
NAT
LDR
TRAF
AGR
OTHER
Port (#cells:24)
non Port (#cells:4991)
Marseille

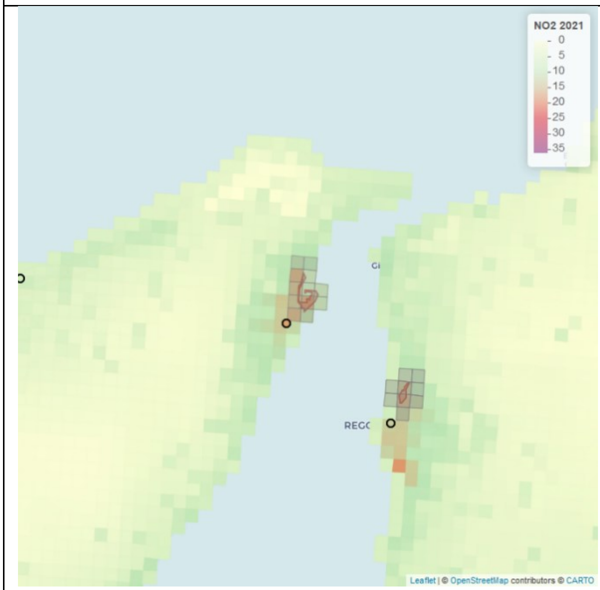
Annex 1.14 Messina

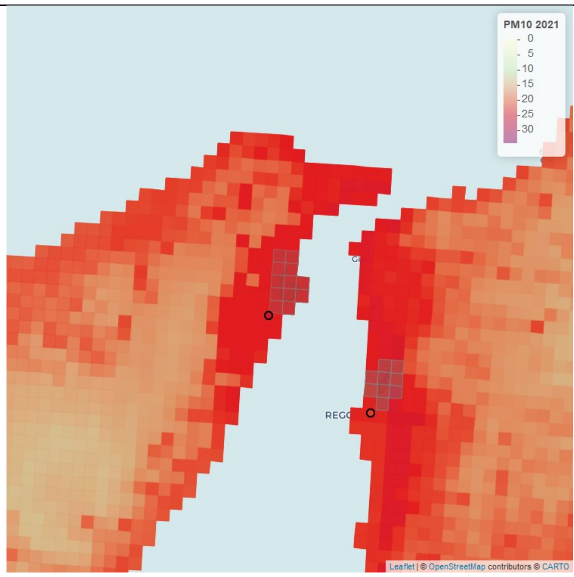
Port area	Air quality SPO within 10 km and 20 km
	

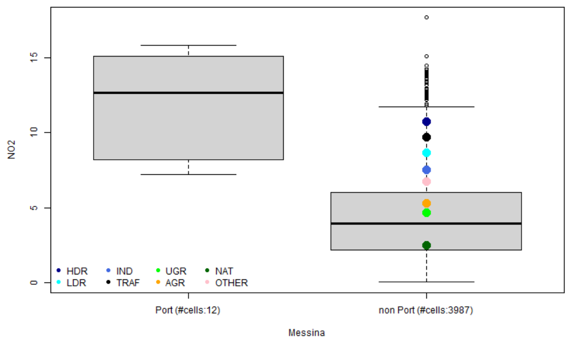
Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downwind frequency (%)	Wind sector	Trend 2005-2021 (%)
Messina	IT	IT1829A	traffic	urban	NO2	38.20	15.55	FALSE	0.38	9.8	7	
Messina	IT	IT2275A	background	urban	NO2	38.17	15.55	FALSE	1.61	4.7	5	

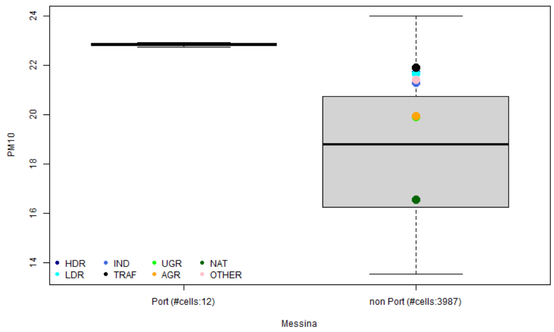
NO$_2$ concentrations when wind is blowing from the port		
Wind sector 7: NW 	**Wind sector 8: N** NO DATA	**Wind sector 1: NE** NO DATA
Wind sector 6: W NO DATA	**Wind frequency by sector** 	**Wind sector 2: E** NO DATA
Wind sector 5: SW 	**Wind sector 4: S** NO DATA	**Wind sector 3: SE** NO DATA

NO_2	PM_{10}

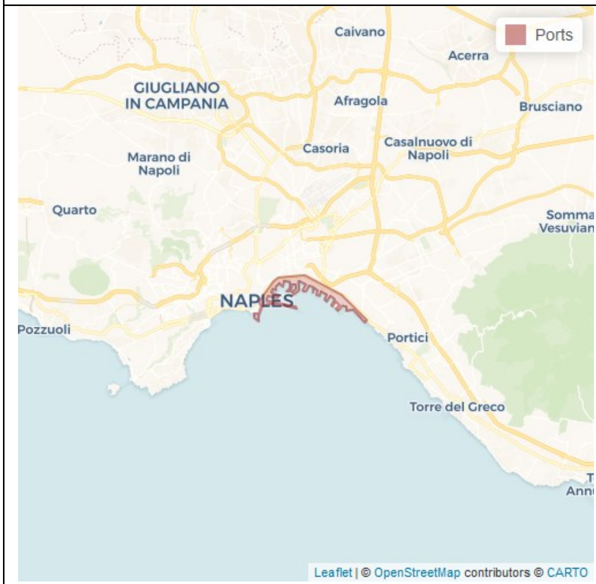
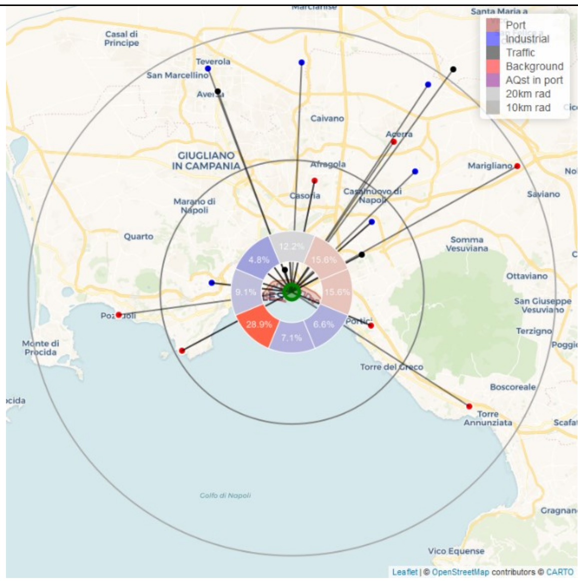

NO2 2021
0
5
10
15
20
25
30
35
REGC
Leaflet | © OpenStreetMap contributors © CARTO


PM10 2021
0
5
10
15
20
25
30
REGC
Leaflet | © OpenStreetMap contributors © CARTO

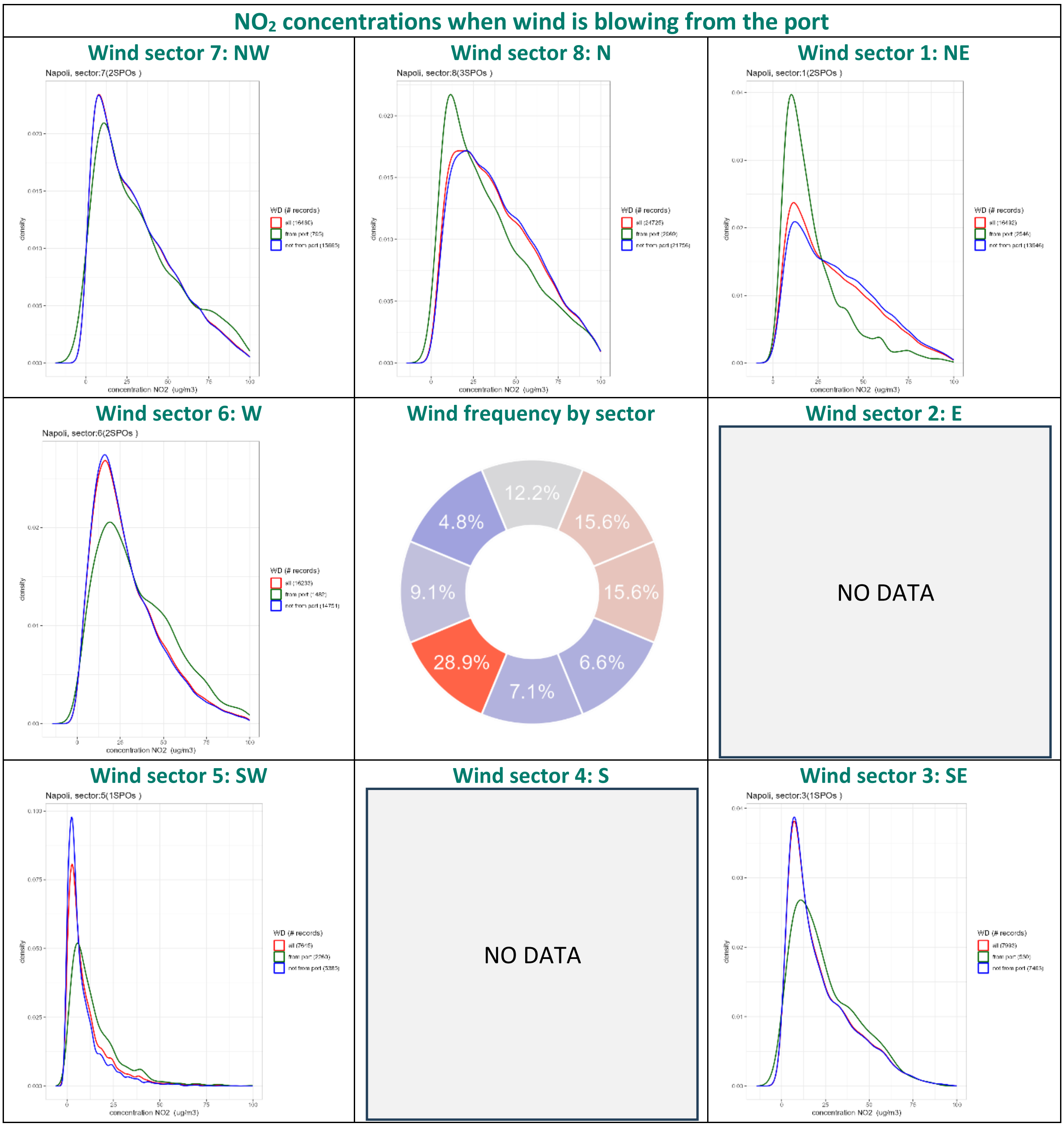

NO2
0
5
10
15
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:12)
non Port (#cells:3987)
Messina


PM10
14
16
18
20
22
24
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:12)
non Port (#cells:3987)
Messina

Annex 1.15 Napoli

Port area	Air quality SPO within 10 km and 20 km
	

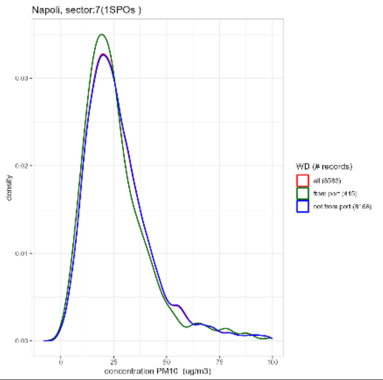
Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downwind frequency (%)	Wind sector	Trend 2005-2021 (%)
Napoli	IT	IT1491A	traffic	urban	NO2	40.85	14.27	FALSE	0.77	12.2	8	-14.6
Napoli	IT	IT0898A	traffic	urban	NO2	40.85	14.25	FALSE	1.25	4.8	7	-25.9
Napoli	IT	IT1497A	background	urban	NO2	40.86	14.25	FALSE	2.08	4.8	7	
Napoli	IT	IT1496A	traffic	urban	NO2	40.85	14.23	FALSE	2.20	9.1	6	-32.8
Napoli	IT	IT1495A	traffic	urban	NO2	40.87	14.28	FALSE	2.82	12.2	8	
Napoli	IT	IT2270A	background	urban	NO2	40.82	14.35	FALSE	3.19	6.6	3	
Napoli	IT	IT2221A	industrial	urban	NO2	40.84	14.21	FALSE	3.85	9.1	6	
Napoli	IT	IT1493A	traffic	suburban	NO2	40.86	14.34	FALSE	4.48	15.6	1	
Napoli	IT	IT2277A	background	suburban	NO2	40.80	14.18	FALSE	6.57	28.9	5	
Napoli	IT	IT2223A	industrial	suburban	NO2	40.89	14.35	FALSE	6.84	15.6	1	
Napoli	IT	IT2216A	background	suburban	NO2	40.91	14.30	FALSE	7.75	12.2	8	
Napoli	IT	IT1491A	traffic	urban	PM10	40.85	14.27	FALSE	0.77	12.2	8	
Napoli	IT	IT0898A	traffic	urban	PM10	40.85	14.25	FALSE	1.25	4.8	7	
Napoli	IT	IT2221A	industrial	urban	PM10	40.84	14.21	FALSE	3.85	9.1	6	
Napoli	IT	IT1493A	traffic	suburban	PM10	40.86	14.34	FALSE	4.48	15.6	1	
Napoli	IT	IT2223A	industrial	suburban	PM10	40.89	14.35	FALSE	6.84	15.6	1	
Napoli	IT	IT2226A	industrial	suburban	PM10	40.92	14.39	FALSE	11.90	15.6	1	



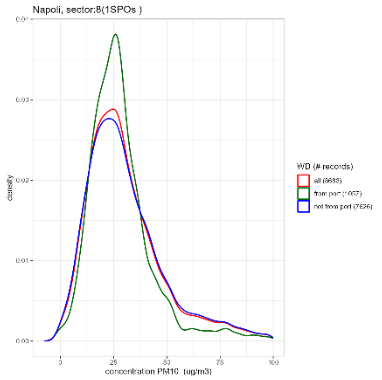
NO₂ concentrations when wind is blowing from the port
Wind sector 7: NW
Napoli, sector:7(2SPOs)
Wind sector 8: N
Napoli, sector:8(3SPOs)
Wind sector 1: NE
Napoli, sector:1(2SPOs)
Wind sector 6: W
Napoli, sector:6(2SPOs)
Wind frequency by sector
12.2%
15.6%
15.6%
6.6%
7.1%
28.9%
9.1%
4.8%
Wind sector 2: E
NO DATA
Wind sector 5: SW
Napoli, sector:5(1SPOs)
Wind sector 4: S
NO DATA
Wind sector 3: SE
Napoli, sector:3(1SPOs)
concentration NO2 (ug/m3)
WD (# records)

PM_{10} concentrations when wind is blowing from the port

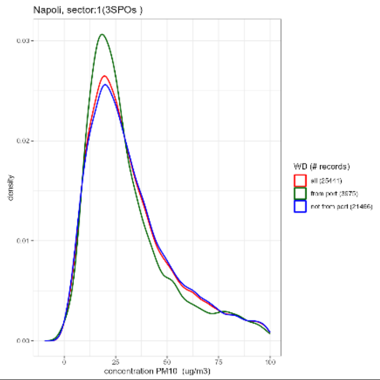
Wind sector 7: NW



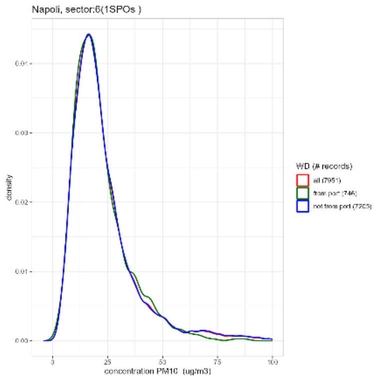
Wind sector 8: N



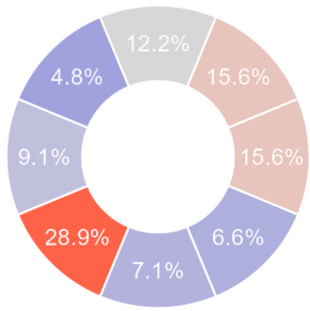
Wind sector 1: NE



Wind sector 6: W



Wind frequency by sector



Wind sector 2: E

NO DATA

Wind sector 5: SW

NO DATA

Wind sector 4: S

NO DATA

Wind sector 3: SE

NO DATA

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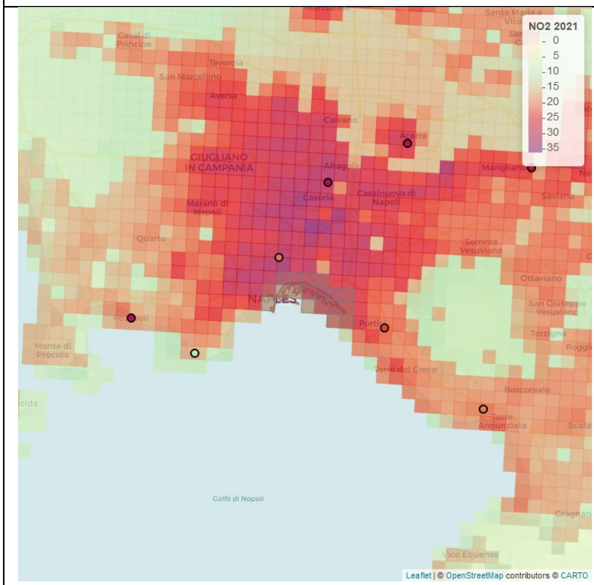

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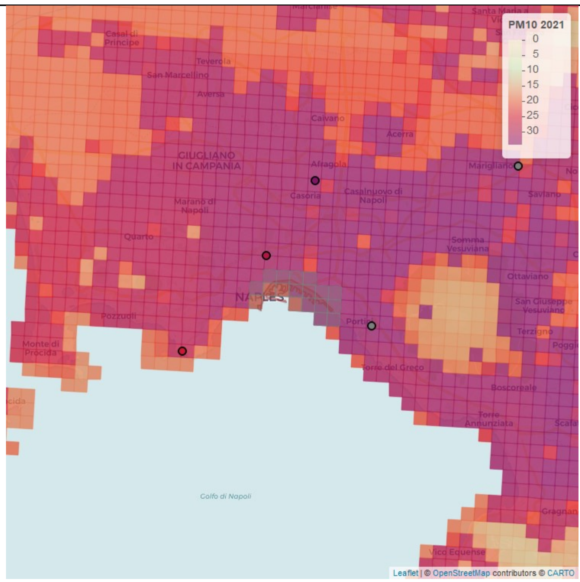

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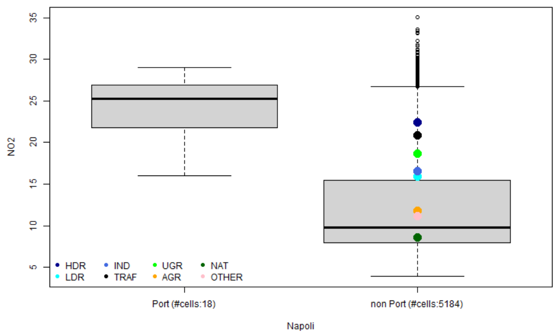

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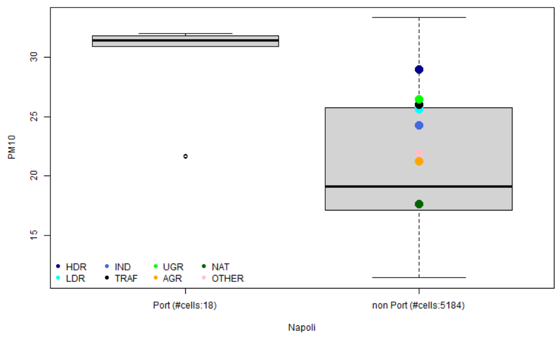

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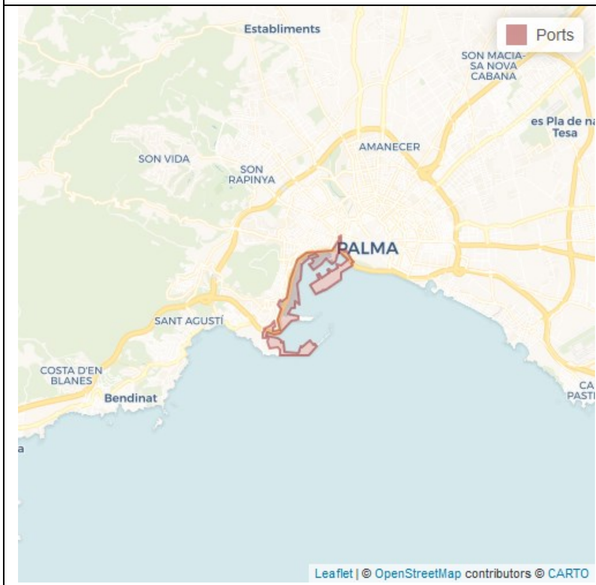
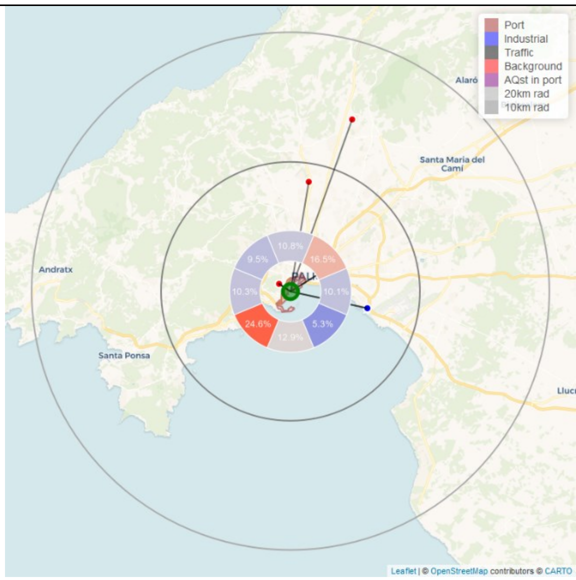
Annex 1.16 Palma de Mallorca

Port area	Air quality SPO within 10 km and 20 km

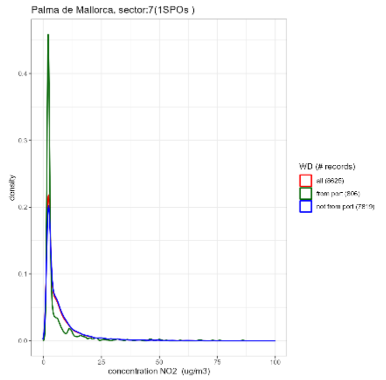




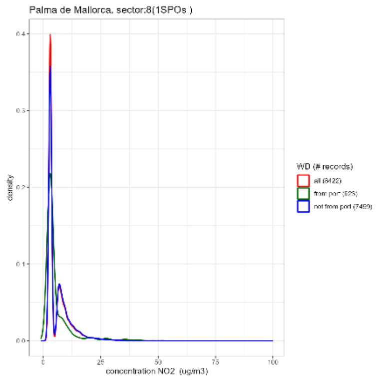
Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Palma de Mallorca	ES	ES1604A	background	suburban	NO2	39.56	2.62	FALSE	0.51	9.5	7	-27.9
Palma de Mallorca	ES	ES1610A	traffic	urban	NO2	39.57	2.66	FALSE	1.08	16.5	1	-44.6
Palma de Mallorca	ES	ES1995A	industrial	urban	NO2	39.55	2.70	FALSE	5.16	10.1	2	
Palma de Mallorca	ES	ES1829A	background	rural	NO2	39.64	2.65	FALSE	7.02	10.8	8	
Palma de Mallorca	ES	ES1604A	background	suburban	PM10	39.56	2.62	FALSE	0.51	9.5	7	-43.6
Palma de Mallorca	ES	ES1610A	traffic	urban	PM10	39.57	2.66	FALSE	1.08	16.5	1	-29.6
Palma de Mallorca	ES	ES1995A	industrial	urban	PM10	39.55	2.70	FALSE	5.16	10.1	2	
Palma de Mallorca	ES	ES1827A	background	rural	PM10	39.68	2.69	FALSE	12.44	10.8	8	

NO_2 concentrations when wind is blowing from the port

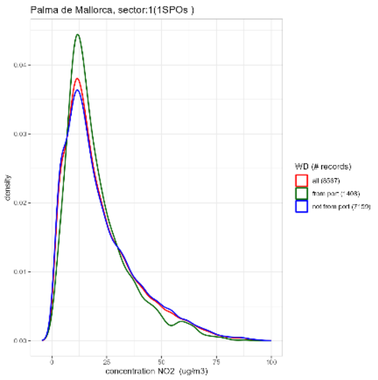
Wind sector 7: NW



Wind sector 8: N



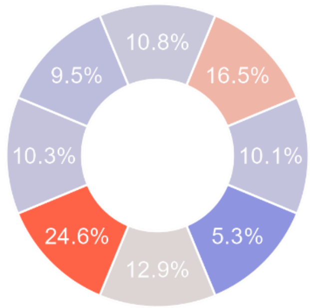
Wind sector 1



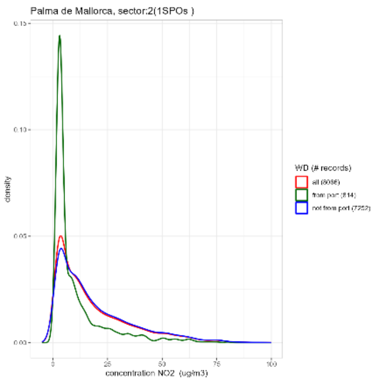
Wind sector 6: W

NO DATA

Wind frequency by sector



Wind sector 2: E



Wind sector 5: SW

NO DATA

Wind sector 4: S

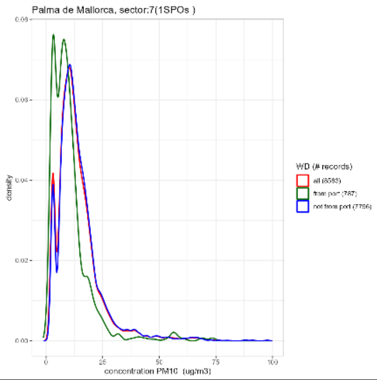
NO DATA

Wind sector 3: SE

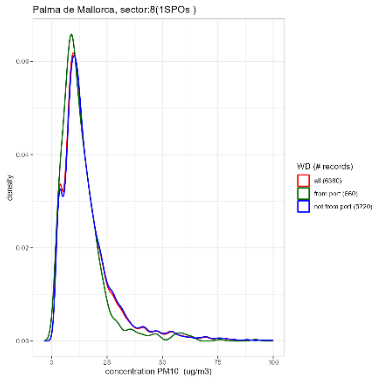
NO DATA

PM$_{10}$ concentrations when wind is blowing from the port

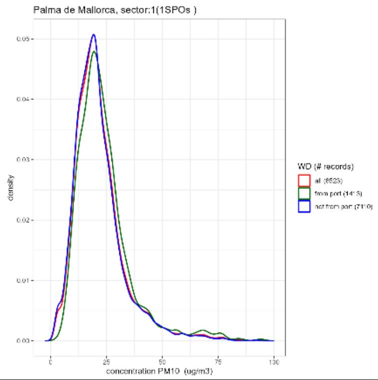
Wind sector 7: NW



Wind sector 8: N



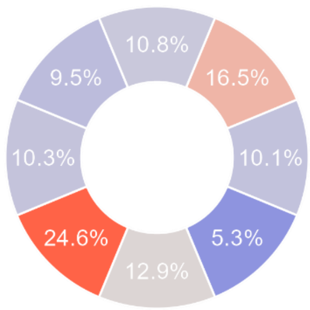
Wind sector 1: NE



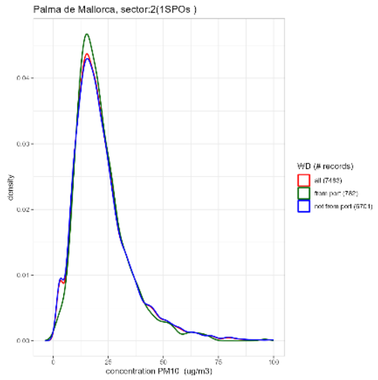
Wind sector 6: W

NO DATA

Wind frequency by sector



Wind sector 2: E



Wind sector 5: SW

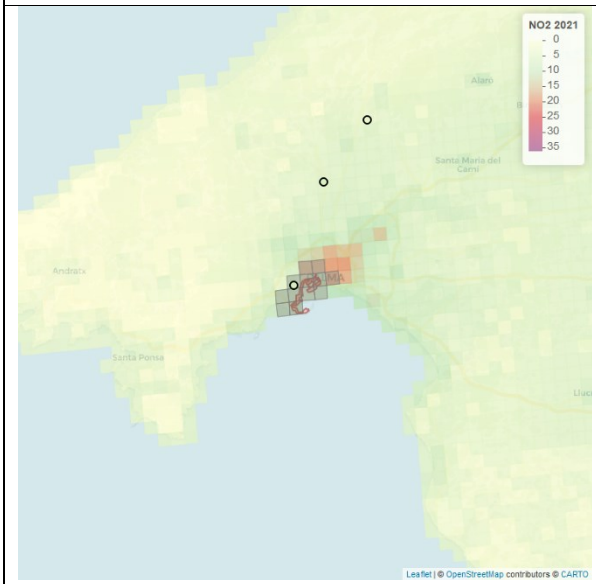
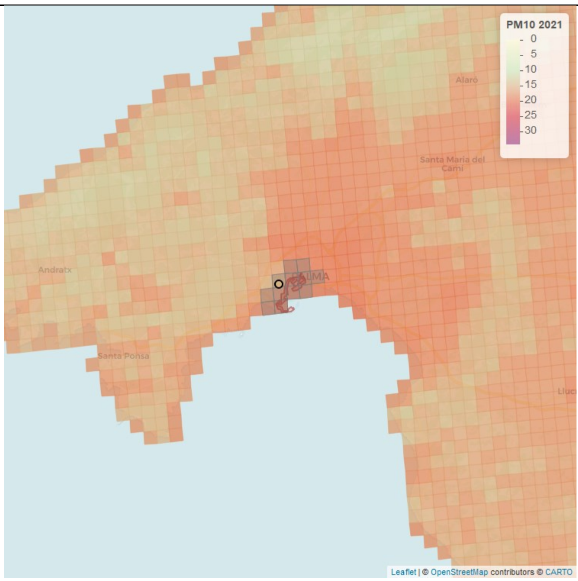
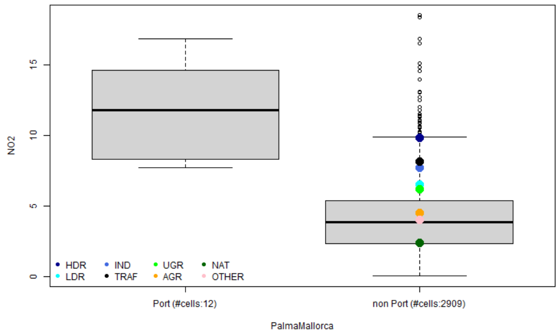
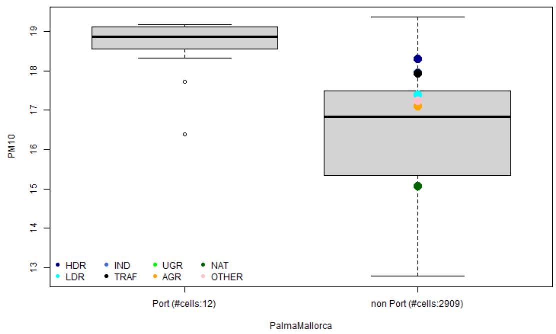
NO DATA

Wind sector 4: S

NO DATA

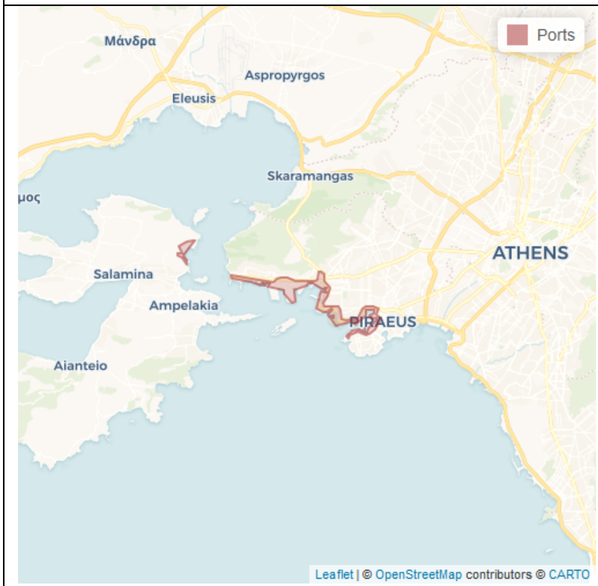
Wind sector 3: SE

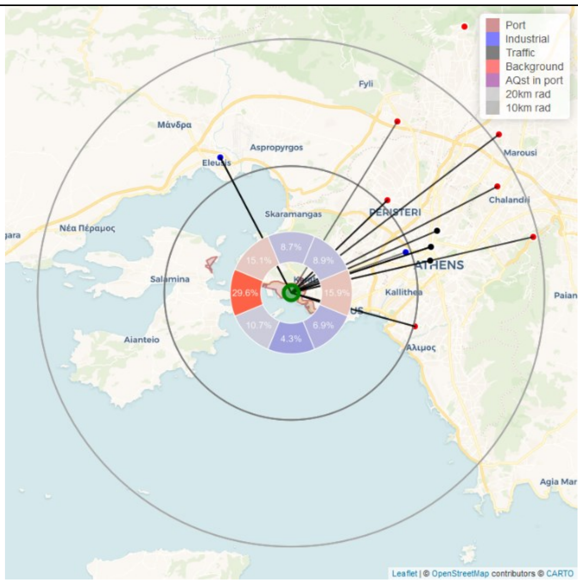
NO DATA

NO_2	PM_{10}
NO2 2021 0 5 10 15 20 25 30 35 Leaflet	© OpenStreetMap contributors © CARTO	PM10 2021 0 5 10 15 20 25 30 Leaflet	© OpenStreetMap contributors © CARTO
NO2 HDR IND UGR NAT LDR TRAF AGR OTHER Port (#cells:12) non Port (#cells:2909) PalmaMallorca	PM10 HDR IND UGR NAT LDR TRAF AGR OTHER Port (#cells:12) non Port (#cells:2909) PalmaMallorca

Annex 1.17 Piraeus

Port area	Air quality SPO within 10 km and 20 km



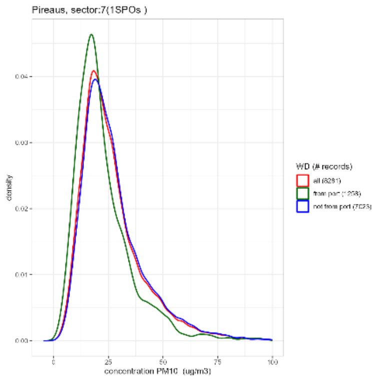


Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Pireaus	GR	GR0030A	traffic	urban	NO2	37.94	23.65	TRUE	0.00	15.9	2	
Pireaus	GR	GR0031A	background	urban	NO2	37.93	23.71	FALSE	6.06	15.9	2	
Pireaus	GR	GR0029A	industrial	suburban	NO2	37.98	23.71	FALSE	6.58	15.9	2	-45.0
Pireaus	GR	GR0038A	industrial	suburban	NO2	38.05	23.54	FALSE	7.83	15.1	7	
Pireaus	GR	GR0002A	traffic	urban	NO2	37.98	23.73	FALSE	7.90	15.9	2	-67.8
Pireaus	GR	GR0003A	traffic	urban	NO2	37.99	23.73	FALSE	8.47	15.9	2	
Pireaus	GR	GR0028A	background	urban	NO2	38.02	23.69	FALSE	8.83	8.9	1	
Pireaus	GR	GR0032A	traffic	urban	NO2	38.00	23.73	FALSE	9.57	8.9	1	
Pireaus	GR	GR0030A	traffic	urban	PM10	37.94	23.65	TRUE	0.00	15.9	2	
Pireaus	GR	GR0031A	background	urban	PM10	37.93	23.71	FALSE	6.06	15.9	2	
Pireaus	GR	GR0038A	industrial	suburban	PM10	38.05	23.54	FALSE	7.83	15.1	7	
Pireaus	GR	GR0003A	traffic	urban	PM10	37.99	23.73	FALSE	8.47	15.9	2	
Pireaus	GR	GR0028A	background	urban	PM10	38.02	23.69	FALSE	8.83	8.9	1	
Pireaus	GR	GR0027A	background	suburban	PM10	38.08	23.70	FALSE	14.46	8.9	1	
Pireaus	GR	GR0022A	background	urban	PM10	38.03	23.79	FALSE	15.46	8.9	1	
Pireaus	GR	GR0039A	background	suburban	PM10	38.00	23.82	FALSE	16.16	15.9	2	
Pireaus	GR	GR0035A	background	suburban	PM10	38.07	23.79	FALSE	18.27	8.9	1	


NO₂ concentrations when wind is blowing from the port
Wind sector 7: NW
Pireaus, sector:7(1SPOs)
density
concentration NO2 (ug/m3)
WD (# records)
Wind sector 8: N
NO DATA
Wind sector 1: NE
Pireaus, sector:1(2SPOs)
density
concentration NO2 (ug/m3)
WD (# records)
Wind sector 6: W
NO DATA
Wind frequency by sector
8.7%
8.9%
15.9%
6.9%
4.3%
10.7%
29.6%
15.1%
Wind sector 2: E
Pireaus, sector:2(5SPOs)
density
concentration NO2 (ug/m3)
WD (# records)
Wind sector 5: SW
NO DATA
Wind sector 4: S
NO DATA
Wind sector 3: SE
NO DATA

PM$_{10}$ concentrations when wind is blowing from the port

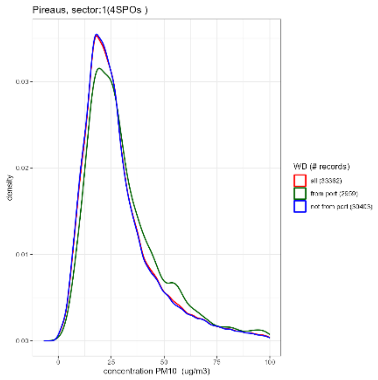
Wind sector 7: NW



Wind sector 8: N

NO DATA

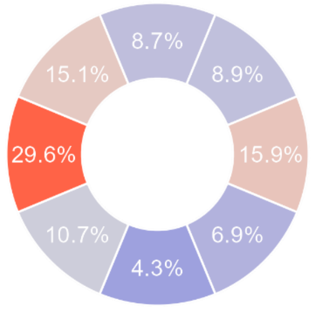
Wind sector 1: NE



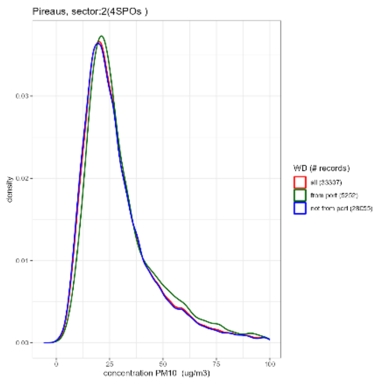
Wind sector 6: W

NO DATA

Wind frequency by sector



Wind sector 2: E



Wind sector 5: SW

NO DATA

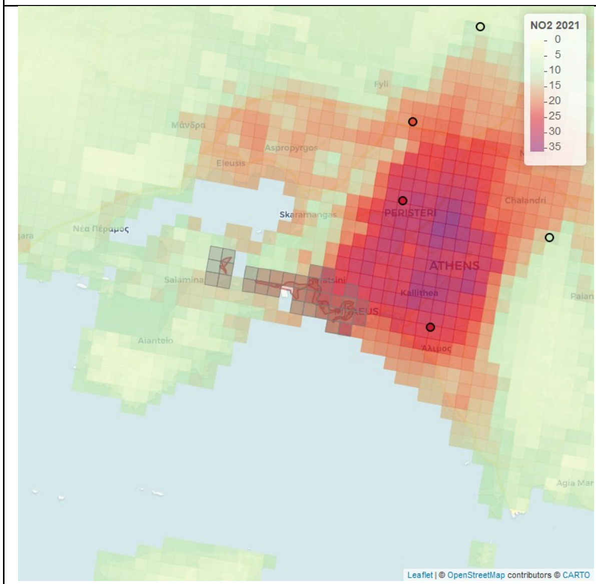
Wind sector 4: S

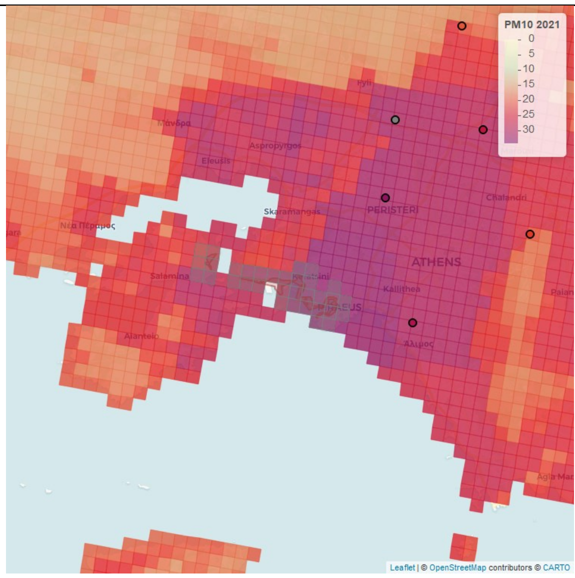
NO DATA

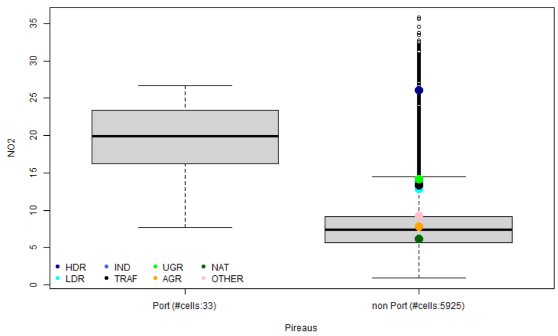
Wind sector 3: SE

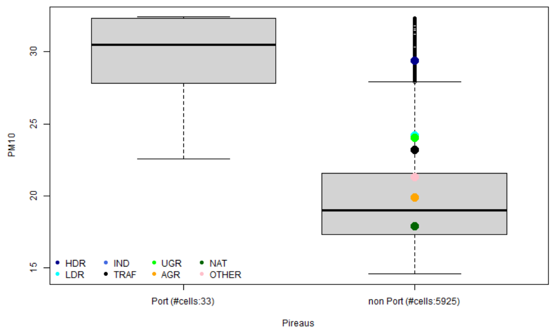
NO DATA

NO_2	PM_{10}


NO2 2021
0
5
10
15
20
25
30
35
PERISTERI
ATHENS
Chalandri
Aspropyrgos
Eleusis
Salamina
Leaflet | © OpenStreetMap contributors © CARTO

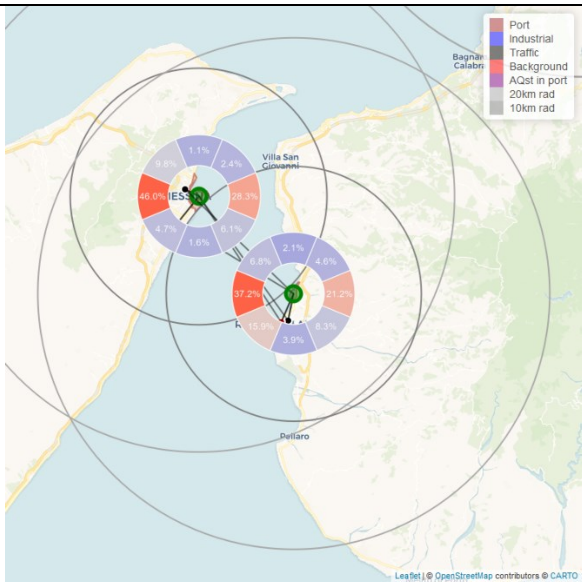

PM10 2021
0
5
10
15
20
25
30
PERISTERI
ATHENS
Chalandri
Aspropyrgos
Eleusis
Salamina
Leaflet | © OpenStreetMap contributors © CARTO


NO2
0
5
10
15
20
25
30
35
HDR
IND
UGR
NAT
LDR
TRAF
AGR
OTHER
Port (#cells:33)
non Port (#cells:5925)
Pireaus


PM10
15
20
25
30
HDR
IND
UGR
NAT
LDR
TRAF
AGR
OTHER
Port (#cells:33)
non Port (#cells:5925)
Pireaus

Annex 1.18 Reggio Calabria

Port area	Air quality SPO within 10 km and 20 km



Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Reggio Calabria	IT	IT1989A	traffic	urban	NO2	38.11	15.65	FALSE	1.45	3.9	4	
Reggio Calabria	IT	IT2028A	background	urban	NO2	38.10	15.64	FALSE	1.71	15.9	5	

NO_2 concentrations when wind is blowing from the port

Wind sector 7: NW

NO DATA

Wind sector 8: N

NO DATA

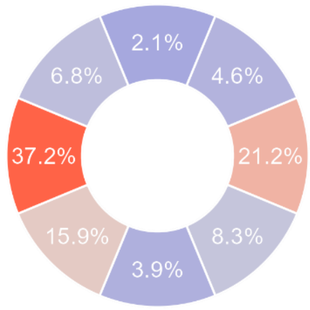
Wind sector 1: NE

NO DATA

Wind sector 6: W

NO DATA

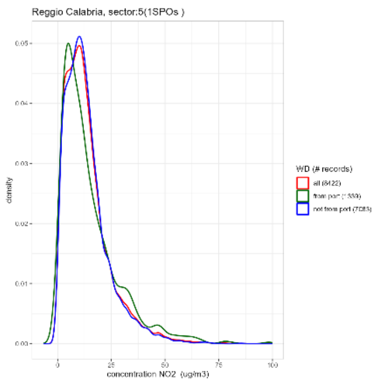
Wind frequency by sector



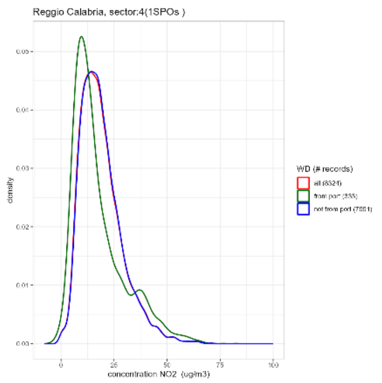
Wind sector 2: E

NO DATA

Wind sector 5: SW

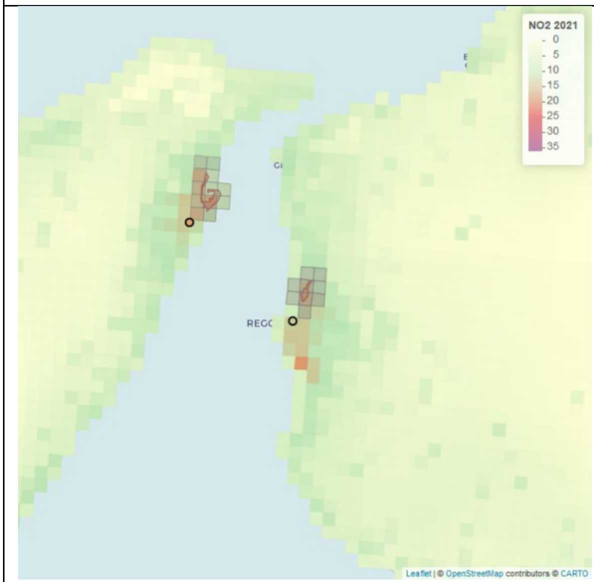
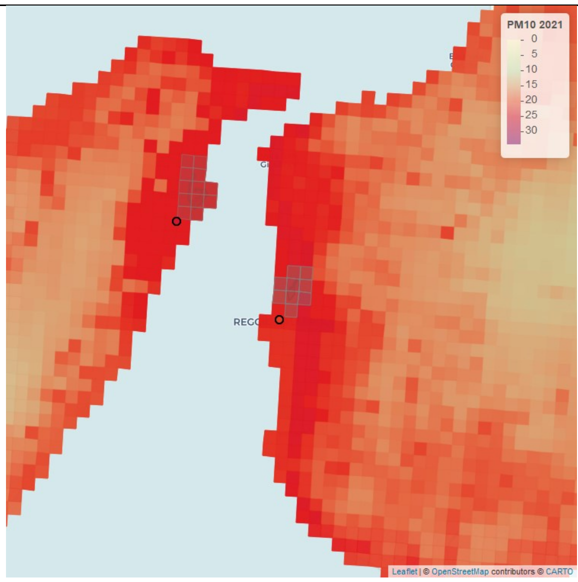
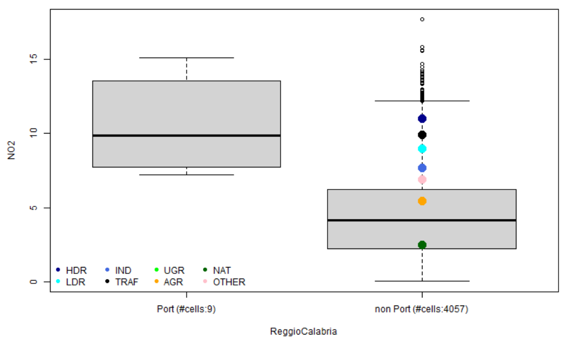
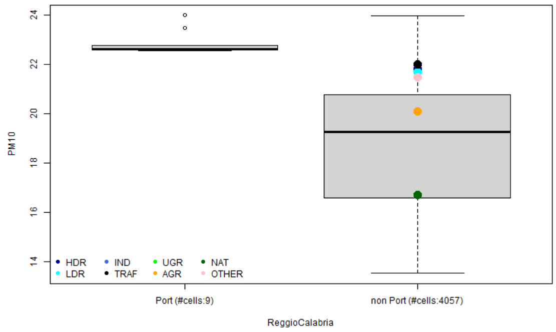


Wind sector 4: S



Wind sector 3: SE

NO DATA

<table>
<tr><th>NO_2</th><th>PM_{10}</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>
</td><td>
</td></tr>
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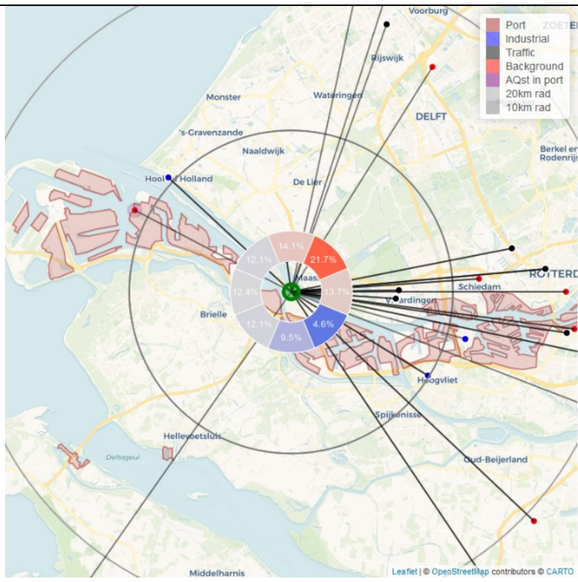
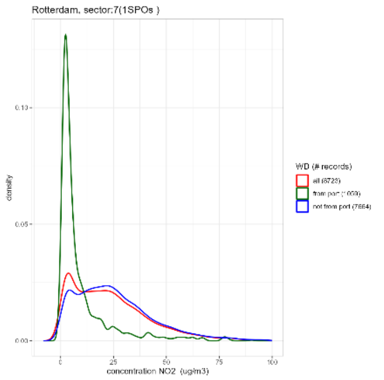
Annex 1.19 Rotterdam

Port area	Air quality SPO within 10 km and 20 km
	

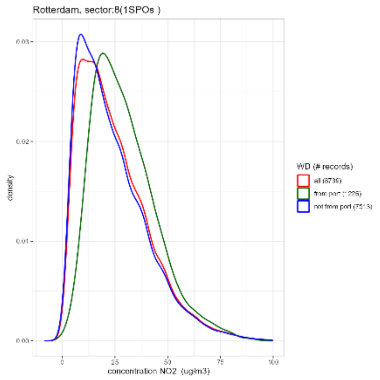
Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Rotterdam	NL	NL00488	background	urban	NO2	51.89	4.49	FALSE	0.18	13.7	2	
Rotterdam	NL	NL00487	traffic	urban	NO2	51.89	4.48	FALSE	0.31	13.7	2	
Rotterdam	NL	NL00494	background	urban	NO2	51.92	4.40	FALSE	0.77	13.7	2	-44.8
Rotterdam	NL	NL00485	industrial	urban	NO2	51.87	4.36	FALSE	0.93	4.6	3	-48.6
Rotterdam	NL	NL00418	background	urban	NO2	51.91	4.48	FALSE	0.99	13.7	2	-40.1
Rotterdam	NL	NL00496	industrial	rural	NO2	51.98	4.12	FALSE	1.53	12.1	7	
Rotterdam	NL	NL00449	traffic	urban	NO2	51.91	4.33	FALSE	1.80	13.7	2	
Rotterdam	NL	NL00495	industrial	urban	NO2	51.93	4.23	FALSE	1.97	14.1	8	
Rotterdam	NL	NL00493	traffic	urban	NO2	51.93	4.46	FALSE	2.28	13.7	2	
Rotterdam	NL	NL00491	traffic	urban	NO2	51.94	4.43	FALSE	2.77	13.7	2	
Rotterdam	NL	NL00489	traffic	urban	NO2	51.87	4.58	FALSE	4.04	13.7	2	
Rotterdam	NL	NL00246	background	rural	NO2	51.65	4.52	FALSE	9.29	4.6	3	
Rotterdam	NL	NL00437	background	rural	NO2	51.79	4.45	FALSE	9.42	4.6	3	-39.2
Rotterdam	NL	NL00488	background	urban	PM10	51.89	4.49	FALSE	0.18	13.7	2	
Rotterdam	NL	NL00487	traffic	urban	PM10	51.89	4.48	FALSE	0.31	13.7	2	
Rotterdam	NL	NL00494	background	urban	PM10	51.92	4.40	FALSE	0.77	13.7	2	
Rotterdam	NL	NL00485	industrial	urban	PM10	51.87	4.36	FALSE	0.93	4.6	3	
Rotterdam	NL	NL00418	background	urban	PM10	51.91	4.48	FALSE	0.99	13.7	2	-46.2
Rotterdam	NL	NL00496	industrial	rural	PM10	51.98	4.12	FALSE	1.53	12.1	7	
Rotterdam	NL	NL00449	traffic	urban	PM10	51.91	4.33	FALSE	1.80	13.7	2	
Rotterdam	NL	NL00495	industrial	urban	PM10	51.93	4.23	FALSE	1.97	14.1	8	
Rotterdam	NL	NL00493	traffic	urban	PM10	51.93	4.46	FALSE	2.28	13.7	2	
Rotterdam	NL	NL00491	traffic	urban	PM10	51.94	4.43	FALSE	2.77	13.7	2	
Rotterdam	NL	NL00489	traffic	urban	PM10	51.87	4.58	FALSE	4.04	13.7	2	
Rotterdam	NL	NL00246	background	rural	PM10	51.65	4.52	FALSE	9.29	4.6	3	
Rotterdam	NL	NL00437	background	rural	PM10	51.79	4.45	FALSE	9.42	4.6	3	-42.5
Rotterdam	NL	NL00446	background	suburban	PM10	52.04	4.36	FALSE	14.17	21.7	1	-46.8
Rotterdam	NL	NL00442	background	urban	PM10	51.80	4.71	FALSE	15.68	13.7	2	
Rotterdam	NL	NL00404	background	urban	PM10	52.08	4.29	FALSE	16.97	14.1	8	-48.1
Rotterdam	NL	NL00445	traffic	urban	PM10	52.08	4.32	FALSE	17.88	14.1	8	-51.2

NO_2 concentrations when wind is blowing from the port

Wind sector 7: NW



Wind sector 8: N



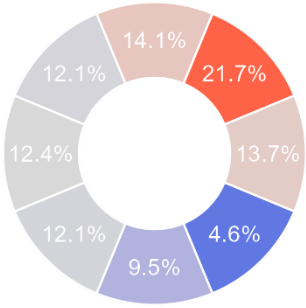
Wind sector 1: NE

NO DATA

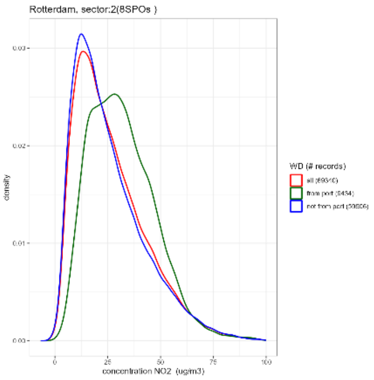
Wind sector 6: W

NO DATA

Wind frequency by sector



Wind sector 2: E



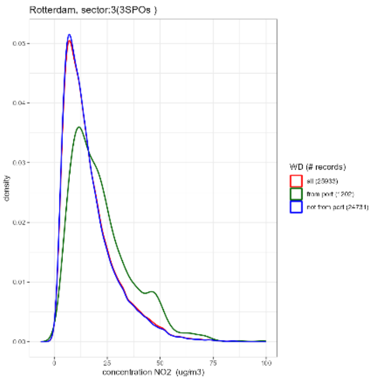
Wind sector 5: SW

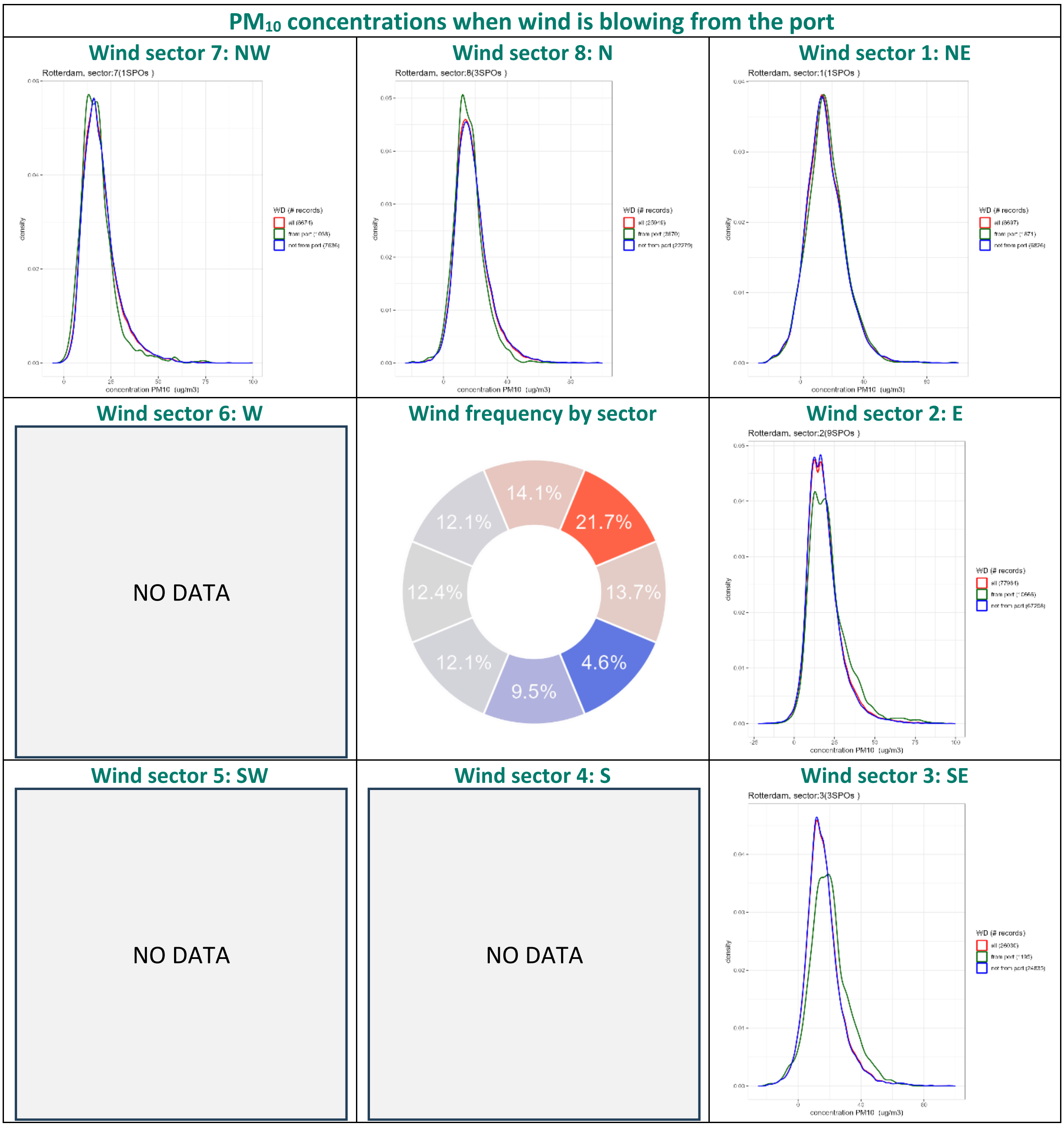
NO DATA

Wind sector 4: S

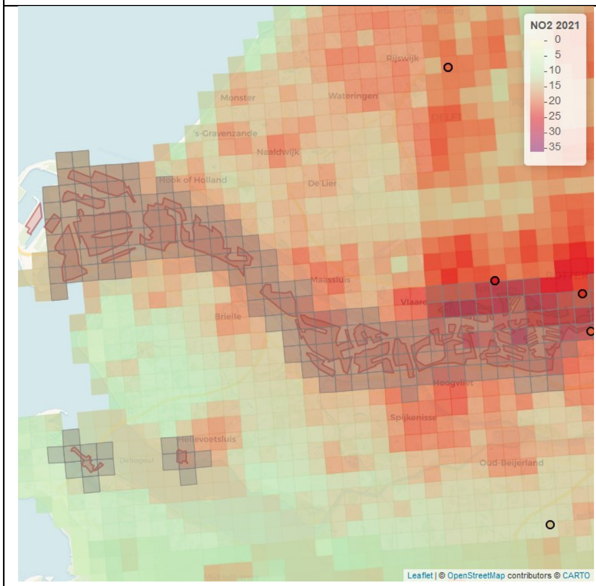
NO DATA

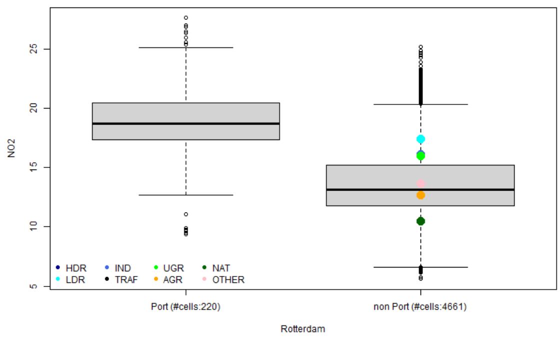
Wind sector 3: SE




PM10 concentrations when wind is blowing from the port
Wind sector 7: NW
Rotterdam, sector:7(1SPOs)
concentration PM10 (ug/m3)
Wind sector 8: N
Rotterdam, sector:8(3SPOs)
concentration PM10 (ug/m3)
Wind sector 1: NE
Rotterdam, sector:1(1SPOs)
concentration PM10 (ug/m3)
Wind sector 6: W
NO DATA
Wind frequency by sector
14.1%
21.7%
13.7%
4.6%
9.5%
12.1%
12.4%
12.1%
Wind sector 2: E
Rotterdam, sector:2(9SPOs)
concentration PM10 (ug/m3)
Wind sector 5: SW
NO DATA
Wind sector 4: S
NO DATA
Wind sector 3: SE
Rotterdam, sector:3(3SPOs)
concentration PM10 (ug/m3)

NO_2


NO2 2021
0
5
10
15
20
25
30
35
Rijswijk
Monster
Wateringen
's Gravenzande
Naaldwijk
Hook of Holland
De Lier
Maassluis
Brielle
Hoogvliet
Spijkenisse
Hellevoetsluis
Oud-Beijerland
Leaflet | © OpenStreetMap contributors © CARTO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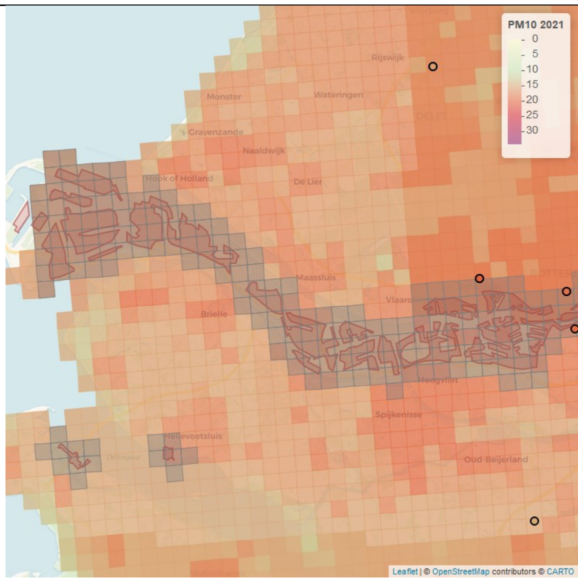
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:220)
non Port (#cells:4661)
Rotterdam

PM_{10}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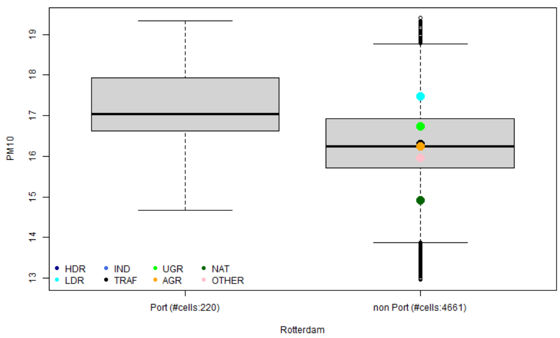
20
25
30
Rijswijk
Monster
Wateringen
's Gravenzande
Naaldwijk
Hook of Holland
De Lier
Maassluis
Brielle
Hoogvliet
Spijkenisse
Hellevoetsluis
Oud-Beijerland
Leaflet | © OpenStreetMap contributors © CARTO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16
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18
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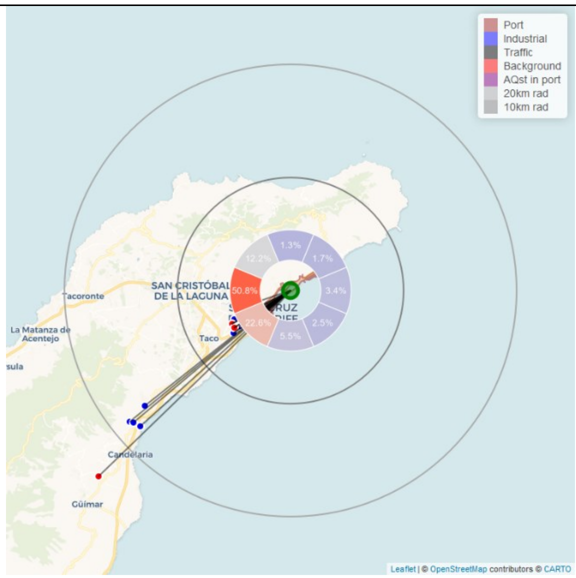
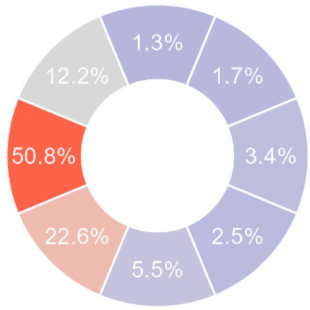
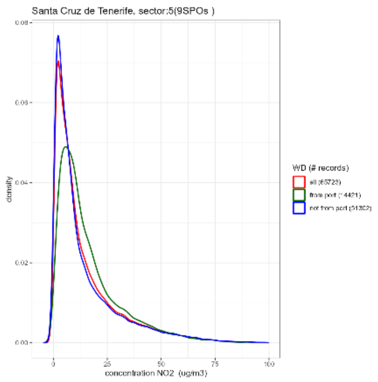
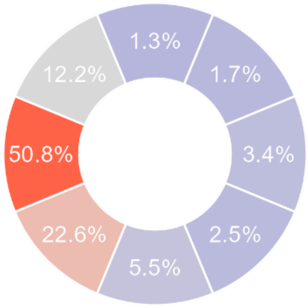
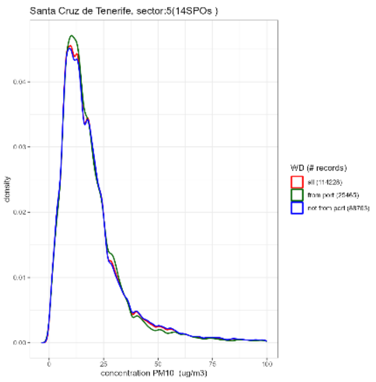
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:220)
non Port (#cells:4661)
Rotterdam

Annex 1.20 Santa Cruz de Tenerife

Port area	Air quality SPO within 10 km and 20 km
	

Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Santa Cruz de Tenerife	ES	ES2115A	traffic	urban	NO2	28.46	-16.25	FALSE	0.02	22.6	5	
Santa Cruz de Tenerife	ES	ES2114A	industrial	urban	NO2	28.46	-16.26	FALSE	0.91	22.6	5	
Santa Cruz de Tenerife	ES	ES2000A	industrial	urban	NO2	28.46	-16.26	FALSE	1.14	22.6	5	
Santa Cruz de Tenerife	ES	ES2021A	industrial	urban	NO2	28.46	-16.26	FALSE	1.42	22.6	5	
Santa Cruz de Tenerife	ES	ES2020A	industrial	urban	NO2	28.46	-16.27	FALSE	1.97	22.6	5	
Santa Cruz de Tenerife	ES	ES2003A	background	urban	NO2	28.46	-16.28	FALSE	2.46	22.6	5	
Santa Cruz de Tenerife	ES	ES1976A	industrial	urban	NO2	28.46	-16.28	FALSE	2.50	22.6	5	
Santa Cruz de Tenerife	ES	ES1759A	industrial	urban	NO2	28.45	-16.28	FALSE	2.63	22.6	5	
Santa Cruz de Tenerife	ES	ES1975A	background	urban	NO2	28.46	-16.28	FALSE	2.65	22.6	5	
Santa Cruz de Tenerife	ES	ES1131A	industrial	urban	PM10	28.46	-16.26	FALSE	1.12	22.6	5	
Santa Cruz de Tenerife	ES	ES2000A	industrial	urban	PM10	28.46	-16.26	FALSE	1.14	22.6	5	
Santa Cruz de Tenerife	ES	ES2021A	industrial	urban	PM10	28.46	-16.26	FALSE	1.42	22.6	5	
Santa Cruz de Tenerife	ES	ES2038A	industrial	urban	PM10	28.46	-16.27	FALSE	1.83	22.6	5	
Santa Cruz de Tenerife	ES	ES2020A	industrial	urban	PM10	28.46	-16.27	FALSE	1.97	22.6	5	
Santa Cruz de Tenerife	ES	ES2003A	background	urban	PM10	28.46	-16.28	FALSE	2.46	22.6	5	
Santa Cruz de Tenerife	ES	ES1976A	industrial	urban	PM10	28.46	-16.28	FALSE	2.50	22.6	5	
Santa Cruz de Tenerife	ES	ES1759A	industrial	urban	PM10	28.45	-16.28	FALSE	2.63	22.6	5	
Santa Cruz de Tenerife	ES	ES1975A	background	urban	PM10	28.46	-16.28	FALSE	2.65	22.6	5	
Santa Cruz de Tenerife	ES	ES1772A	industrial	suburban	PM10	28.39	-16.36	FALSE	12.57	22.6	5	
Santa Cruz de Tenerife	ES	ES1756A	industrial	urban	PM10	28.38	-16.36	FALSE	13.99	22.6	5	
Santa Cruz de Tenerife	ES	ES2022A	industrial	suburban	PM10	28.38	-16.37	FALSE	14.24	22.6	5	
Santa Cruz de Tenerife	ES	ES1764A	industrial	suburban	PM10	28.38	-16.37	FALSE	14.51	22.6	5	
Santa Cruz de Tenerife	ES	ES1920A	background	suburban	PM10	28.34	-16.40	FALSE	19.66	22.6	5	56.7

NO$_2$ concentrations when wind is blowing from the port		
Wind sector 7: NW NO DATA	**Wind sector 8: N** NO DATA	**Wind sector 1: NE** NO DATA
Wind sector 6: W NO DATA	**Wind frequency by sector** 	**Wind sector 2: E** NO DATA
Wind sector 5: SW 	**Wind sector 4: S** NO DATA	**Wind sector 3: SE** NO DATA

<table>
<tr><th colspan="3">PM_{10} concentrations when wind is blowing from the port</th></tr>
<tr><th>Wind sector 7: NW</th><th>Wind sector 8: N</th><th>Wind sector 1: NE</th></tr>
<tr><td>NO DATA</td><td>NO DATA</td><td>NO DATA</td></tr>
<tr><th>Wind sector 6: W</th><th>Wind frequency by sector</th><th>Wind sector 2: E</th></tr>
<tr><td>NO DATA</td><td>
</td><td>NO DATA</td></tr>
<tr><th>Wind sector 5: SW</th><th>Wind sector 4: S</th><th>Wind sector 3: SE</th></tr>
<tr><td>
</td><td>NO DATA</td><td>NO DATA</td></tr>
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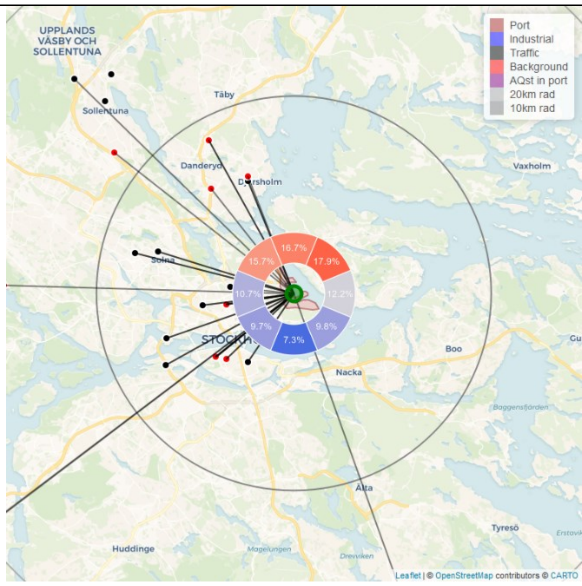
Annex 1.21 Stockholm

Port area

Air quality SPO within 10 km and 20 km



Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Stockholm	SE	E274650	traffic	urban	NO2	59.35	18.06	FALSE	2.39	10.7	6	
Stockholm	SE	SE18641	traffic	urban	NO2	59.34	18.06	FALSE	2.85	10.7	6	
Stockholm	SE	SE0027A	traffic	urban	NO2	59.34	18.06	FALSE	2.87	10.7	6	-35.4
Stockholm	SE	SE18640	background	urban	NO2	59.34	18.06	FALSE	2.87	10.7	6	
Stockholm	SE	E159403	traffic	urban	NO2	59.31	18.08	FALSE	3.36	9.7	5	
Stockholm	SE	SE0022A	background	urban	NO2	59.32	18.06	FALSE	3.99	9.7	5	-37.8
Stockholm	SE	E157992	traffic	urban	NO2	59.34	18.04	FALSE	4.04	10.7	6	
Stockholm	SE	SE0003A	traffic	urban	NO2	59.32	18.05	FALSE	4.30	9.7	5	-40.7
Stockholm	SE	E164905	traffic	urban	NO2	59.37	18.00	FALSE	5.86	10.7	6	
Stockholm	SE	SE0087A	traffic	urban	NO2	59.33	18.00	FALSE	6.19	10.7	6	
Stockholm	SE	E157993	traffic	urban	NO2	59.31	18.00	FALSE	6.71	9.7	5	
Stockholm	SE	E301757	traffic	urban	NO2	59.36	17.98	FALSE	7.01	10.7	6	
Stockholm	SE	SE0027A	traffic	urban	PM10	59.34	18.06	FALSE	2.87	10.7	6	-56.5
Stockholm	SE	E159403	traffic	urban	PM10	59.31	18.08	FALSE	3.36	9.7	5	
Stockholm	SE	SE0022A	background	urban	PM10	59.32	18.06	FALSE	3.99	9.7	5	-49.4
Stockholm	SE	E157992	traffic	urban	PM10	59.34	18.04	FALSE	4.04	10.7	6	
Stockholm	SE	SE0003A	traffic	urban	PM10	59.32	18.05	FALSE	4.32	9.7	5	-67.8
Stockholm	SE	E164905	traffic	urban	PM10	59.37	18.00	FALSE	5.86	10.7	6	
Stockholm	SE	SE0087A	traffic	urban	PM10	59.33	18.00	FALSE	6.19	10.7	6	
Stockholm	SE	E157993	traffic	urban	PM10	59.31	18.00	FALSE	6.71	9.7	5	
Stockholm	SE	E301757	traffic	urban	PM10	59.36	17.98	FALSE	7.01	10.7	6	
Stockholm	SE	E274652	traffic	urban	PM10	59.43	17.95	FALSE	11.83	15.7	7	
Stockholm	SE	E159402	traffic	urban	PM10	59.45	17.95	FALSE	12.62	15.7	7	
Stockholm	SE	SE0071A	traffic	urban	PM10	59.44	17.92	FALSE	13.71	15.7	7	-49.3
Stockholm	SE	SE37479	traffic	urban	PM10	59.49	17.92	FALSE	17.62	15.7	7	

NO_2 concentrations when wind is blowing from the port

Wind sector 7: NW

NO DATA

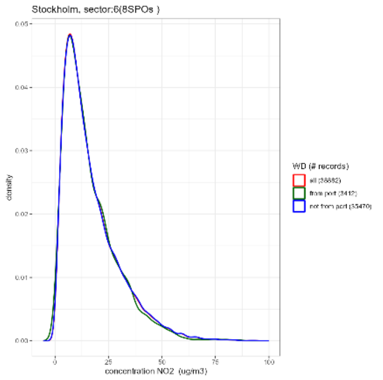
Wind sector 8: N

NO DATA

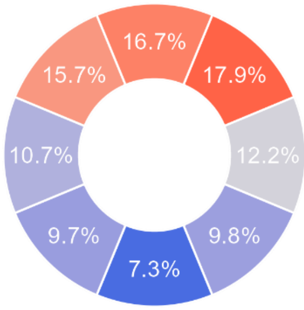
Wind sector 1: NE

NO DATA

Wind sector 6: W



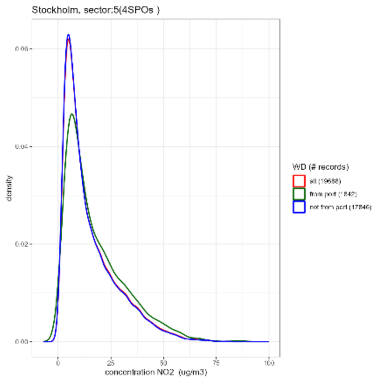
Wind frequency by sector



Wind sector 2: E

NO DATA

Wind sector 5: SW

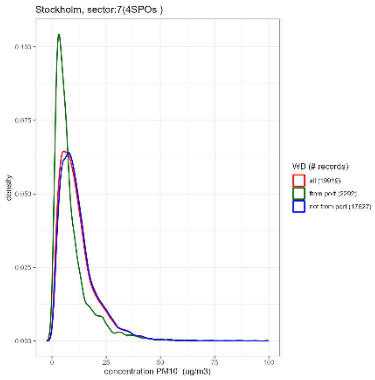
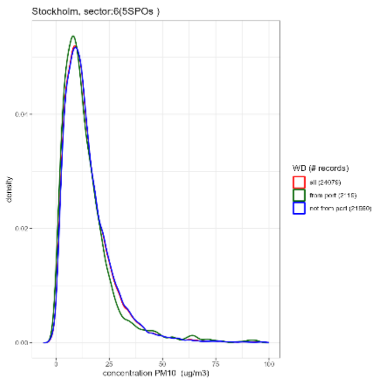
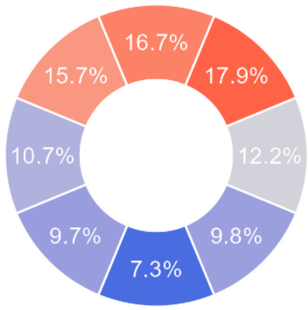
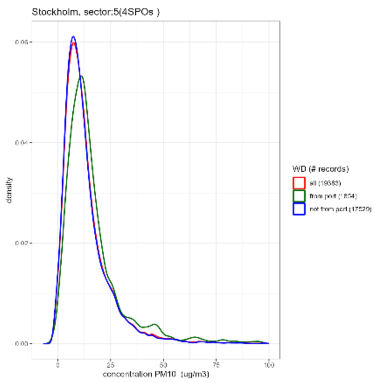


Wind sector 4: S

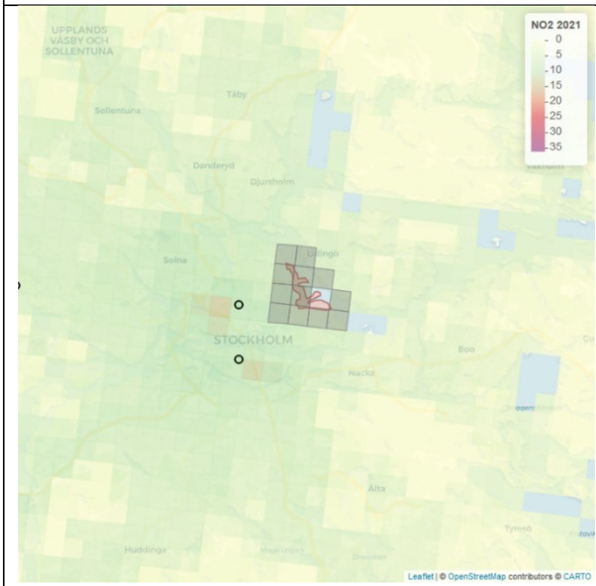
NO DATA

Wind sector 3: SE

NO DATA

PM10 concentrations when wind is blowing from the port		
Wind sector 7: NW 	**Wind sector 8: N** NO DATA	**Wind sector 1: NE** NO DATA
Wind sector 6: W 	**Wind frequency by sector** 	**Wind sector 2: E** NO DATA
Wind sector 5: SW 	**Wind sector 4: S** NO DATA	**Wind sector 3: SE** NO DATA

NO_2



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10
15
20
25
30
35
STOCKHOLM
Täby
Sollentuna
Danderyd
Djursholm
Solna
Nacka
Boo
Älta
Tyresö
Huddinge
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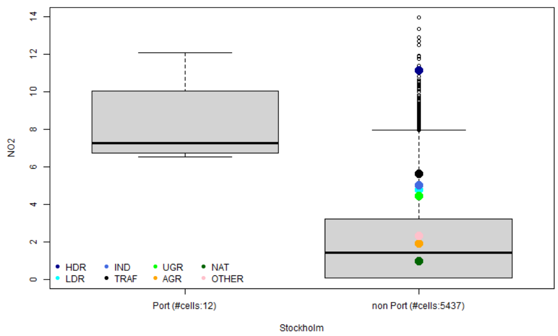

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6
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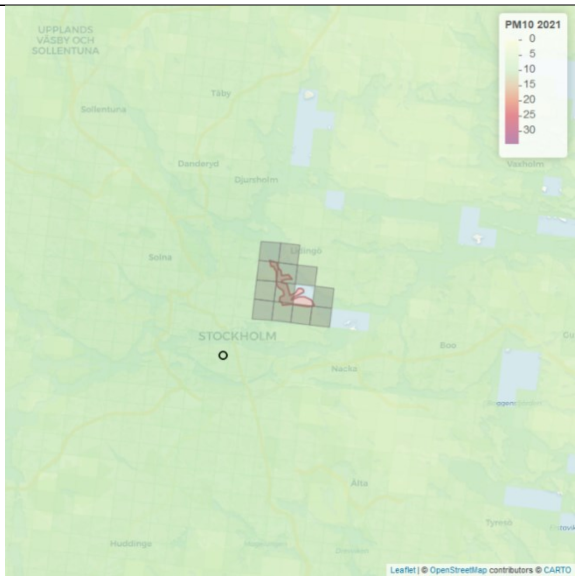
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:12)
non Port (#cells:5437)
Stockholm

PM_{10}



PM10 2021
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15
20
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30
STOCKHOLM
Täby
Sollentuna
Danderyd
Djursholm
Solna
Nacka
Boo
Älta
Tyresö
Huddinge
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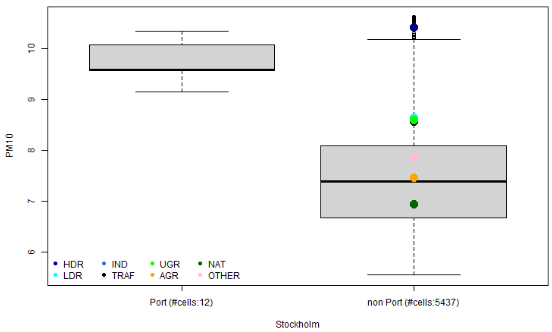

PM10
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9
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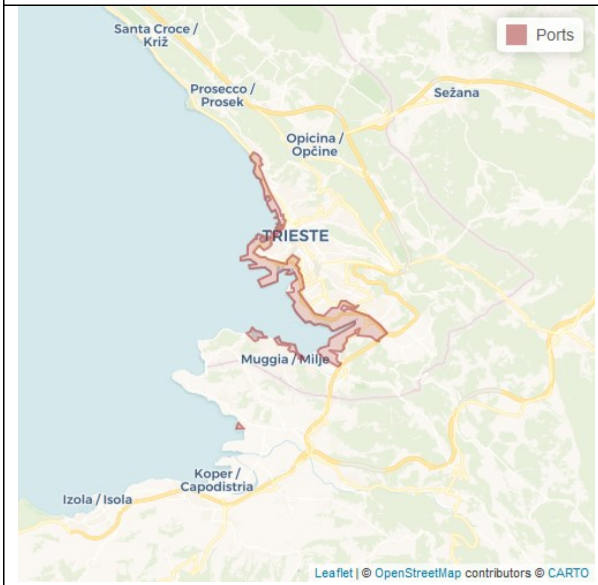
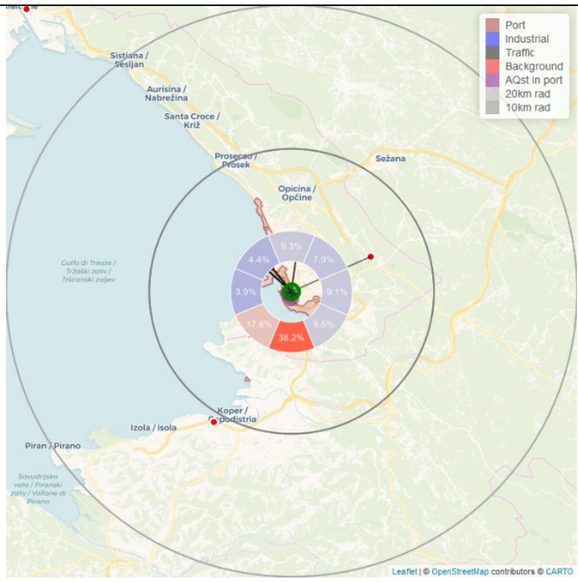
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:12)
non Port (#cells:5437)
Stockholm

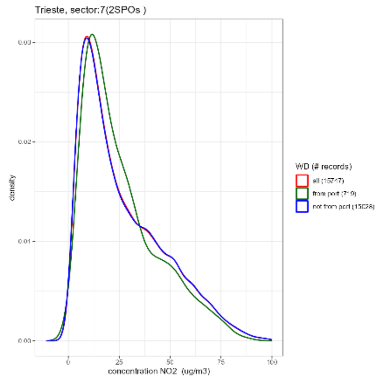
Annex 1.22 Trieste

Port area	Air quality SPO within 10 km and 20 km
	

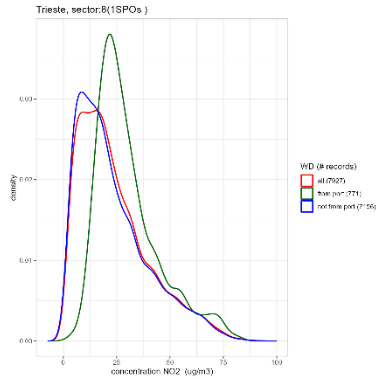
Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Trieste	IT	IT2262A	background	urban	NO2	45.64	13.76	FALSE	0.19	4.4	7	
Trieste	IT	IT2280A	background	urban	NO2	45.64	13.77	FALSE	0.20	4.4	7	
Trieste	IT	IT2261A	traffic	urban	NO2	45.65	13.79	FALSE	1.38	9.3	8	
Trieste	IT	IT2262A	background	urban	PM10	45.64	13.76	FALSE	0.19	4.4	7	
Trieste	IT	IT1090A	industrial	suburban	PM10	45.62	13.79	FALSE	0.37	9.6	3	
Trieste	IT	IT2261A	traffic	urban	PM10	45.65	13.79	FALSE	1.38	9.3	8	
Trieste	IT	IT2260A	background	rural-nearcity	PM10	45.65	13.85	FALSE	4.36	7.9	1	

NO_2 concentrations when wind is blowing from the port

Wind sector 7: NW



Wind sector 8: N



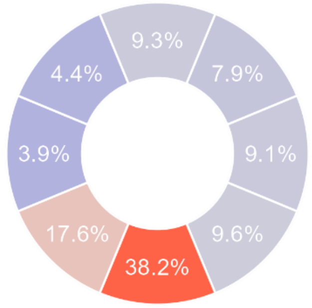
Wind sector 1: NE

NO DATA

Wind sector 6: W

NO DATA

Wind frequency by sector



Wind sector 2: E

NO DATA

Wind sector 5: SW

NO DATA

Wind sector 4: S

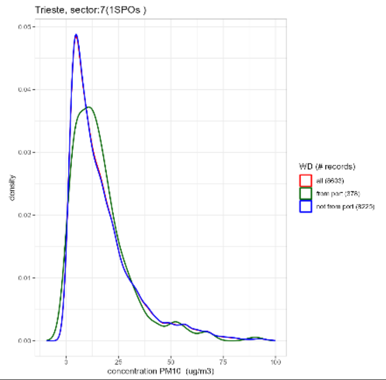
NO DATA

Wind sector 3: SE

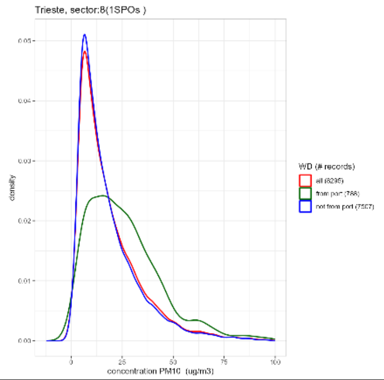
NO DATA

PM_{10} concentrations when wind is blowing from the port

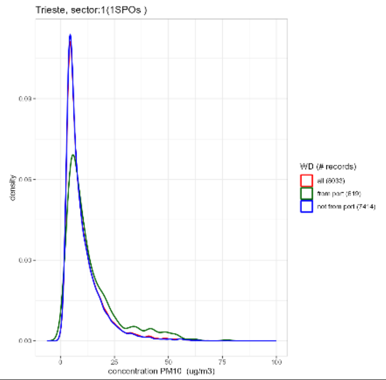
Wind sector 7: NW



Wind sector 8: N



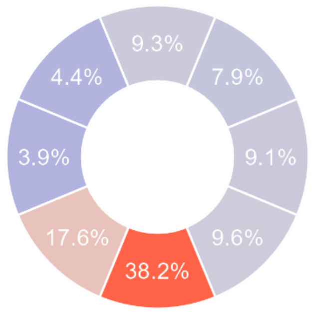
Wind sector 1: NE



Wind sector 6: W

NO DATA

Wind frequency by sector



Wind sector 2: E

NO DATA

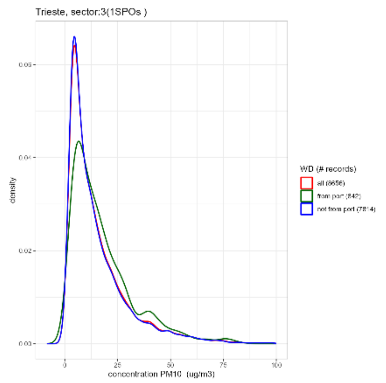
Wind sector 5: SW

NO DATA

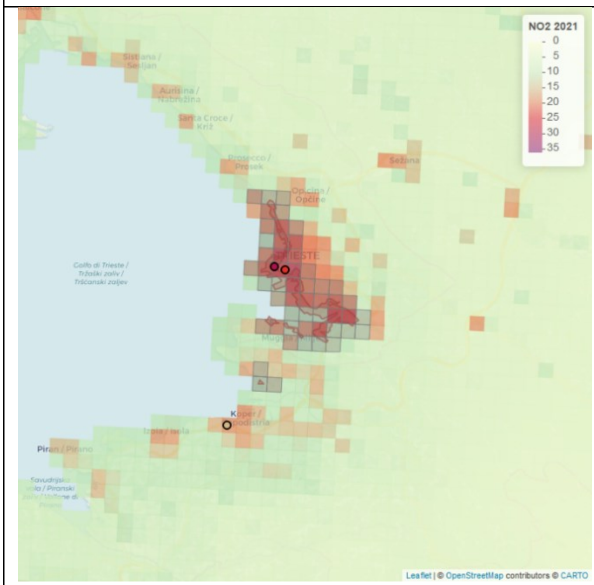
Wind sector 4: S

NO DATA

Wind sector 3: SE



NO_2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5
10
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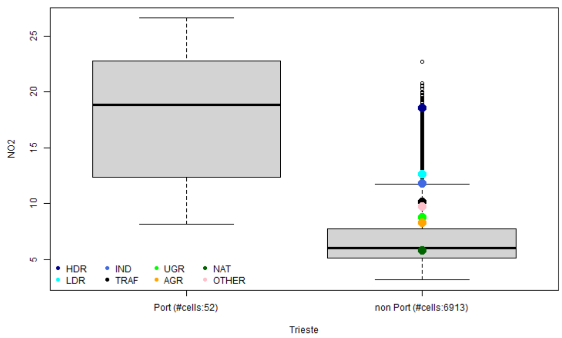
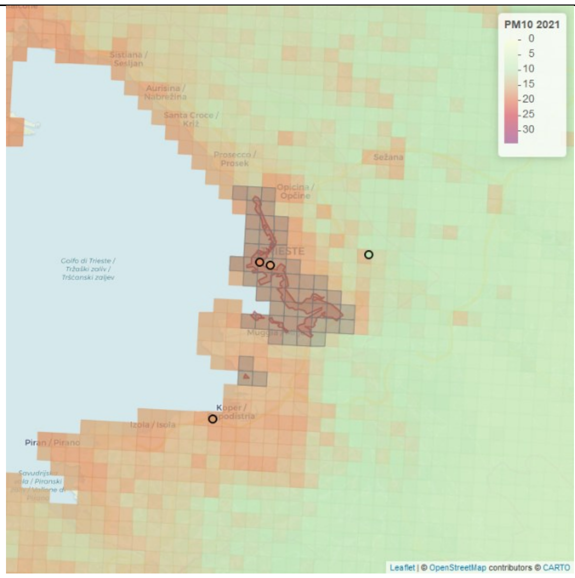
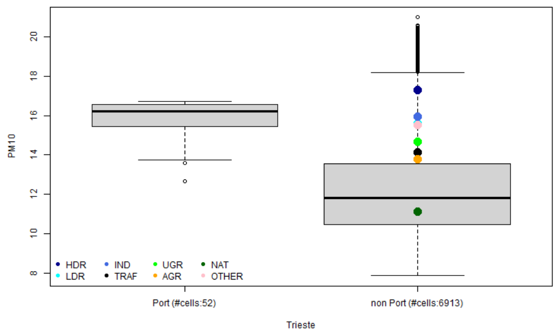
20
25
30
35
Leaflet | © OpenStreetMap contributors © CARTO


NO2
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:52)
non Port (#cells:6913)
Trieste

PM_{10}


PM10 2021
0
5
10
15
20
25
30
Leaflet | © OpenStreetMap contributors © CARTO


PM10
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LDR
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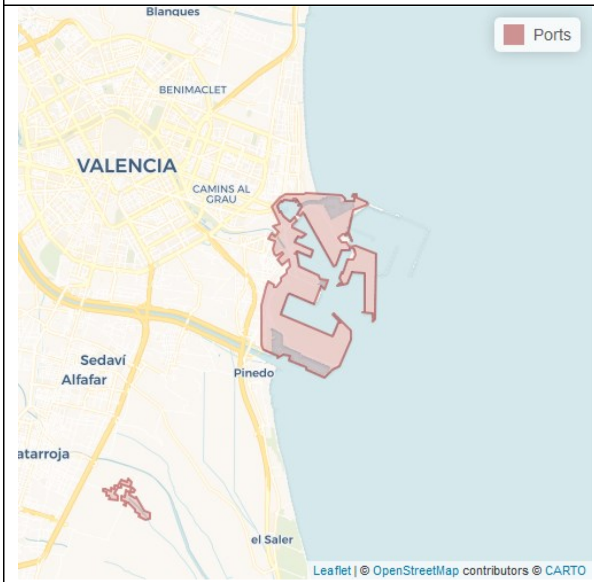
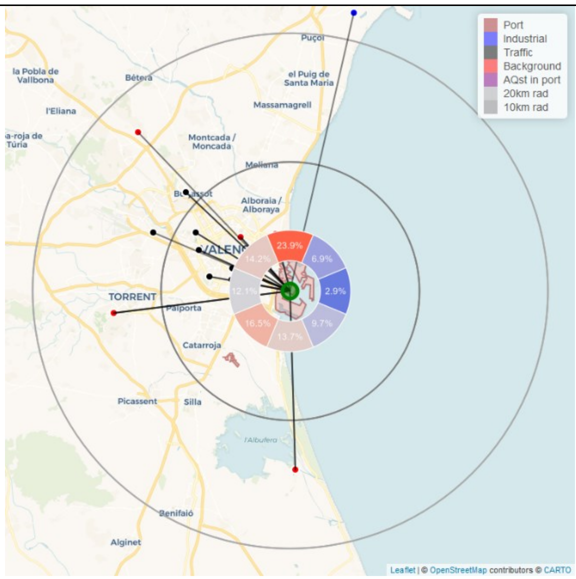
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:52)
non Port (#cells:6913)
Trieste

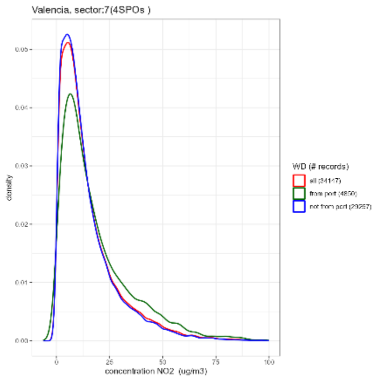
Annex 1.23 Valencia

Port area	Air quality SPO within 10 km and 20 km
	

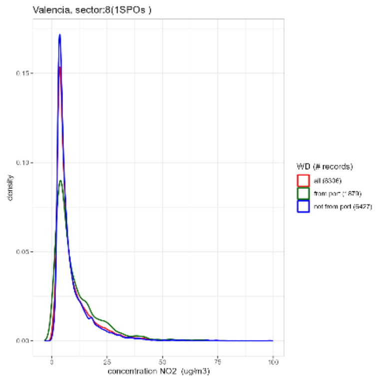
Port	Country	Station code	Station type	Area type	Pollutant	Latitude	Longitude	in Port area	Distance from port polygon (km)	Port downind frequency (%)	Wind sector	Trend 2005-2021 (%)
Valencia	ES	ES1912A	traffic	urban	NO2	39.46	-0.34	FALSE	0.88	14.2	7	-49.1
Valencia	ES	ES1885A	background	suburban	NO2	39.48	-0.34	FALSE	2.02	23.9	8	
Valencia	ES	ES1239A	traffic	urban	NO2	39.46	-0.38	FALSE	3.59	12.1	6	-56.7
Valencia	ES	ES1619A	background	urban	NO2	39.48	-0.37	FALSE	3.63	14.2	7	-37.3
Valencia	ES	ES2095A	traffic	urban	NO2	39.45	-0.38	FALSE	3.66	12.1	6	
Valencia	ES	ES1970A	traffic	urban	NO2	39.45	-0.40	FALSE	5.35	12.1	6	
Valencia	ES	ES1926A	traffic	suburban	NO2	39.48	-0.41	FALSE	6.87	14.2	7	
Valencia	ES	ES1625A	traffic	urban	NO2	39.51	-0.42	FALSE	9.11	14.2	7	
Valencia	ES	ES2055A	background	suburban	NO2	39.43	-0.48	FALSE	9.16	12.1	6	
Valencia	ES	ES1912A	traffic	urban	PM10	39.46	-0.34	FALSE	0.88	14.2	7	
Valencia	ES	ES1885A	background	suburban	PM10	39.48	-0.34	FALSE	2.02	23.9	8	-45.6
Valencia	ES	ES1239A	traffic	urban	PM10	39.46	-0.38	FALSE	3.59	12.1	6	
Valencia	ES	ES2095A	traffic	urban	PM10	39.45	-0.38	FALSE	3.66	12.1	6	
Valencia	ES	ES1926A	traffic	suburban	PM10	39.48	-0.41	FALSE	6.87	14.2	7	
Valencia	ES	ES2055A	background	suburban	PM10	39.43	-0.48	FALSE	9.16	12.1	6	
Valencia	ES	ES1181A	traffic	urban	PM10	39.48	-0.45	FALSE	10.08	14.2	7	
Valencia	ES	ES1884A	industrial	suburban	PM10	39.63	-0.27	FALSE	19.38	23.9	8	

NO_2 concentrations when wind is blowing from the port

Wind sector 7: NW



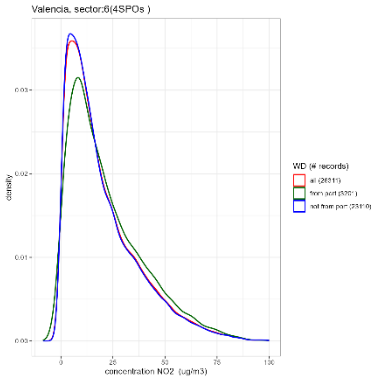
Wind sector 8: N



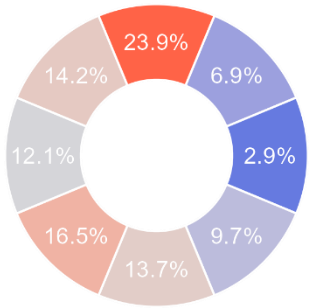
Wind sector 1: NE

NO DATA

Wind sector 6: W



Wind frequency by sector



Wind sector 2: E

NO DATA

Wind sector 5: SW

NO DATA

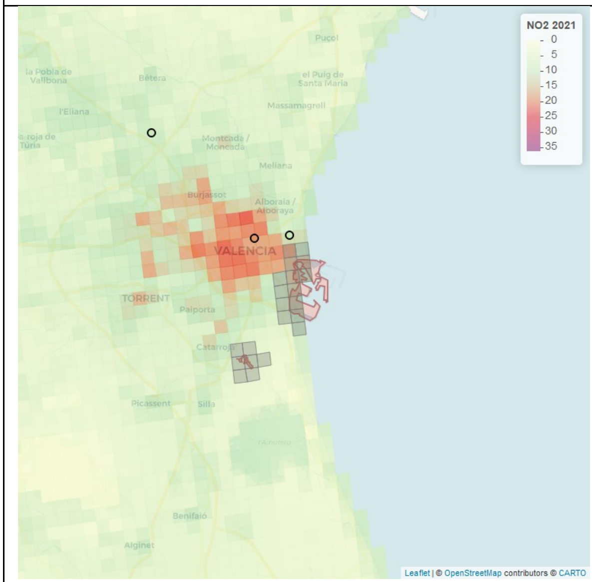
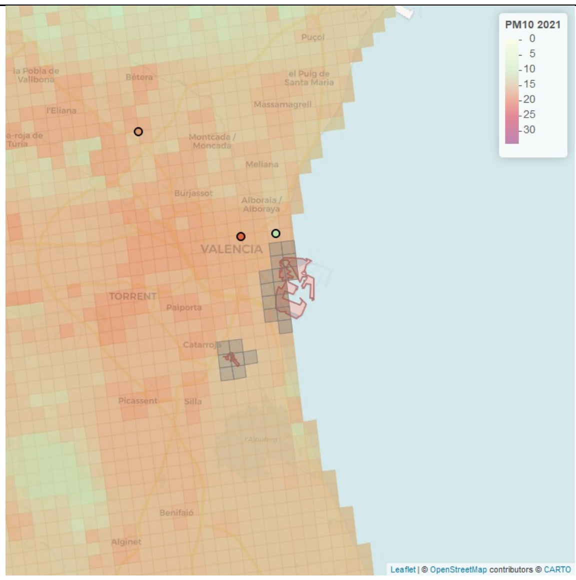
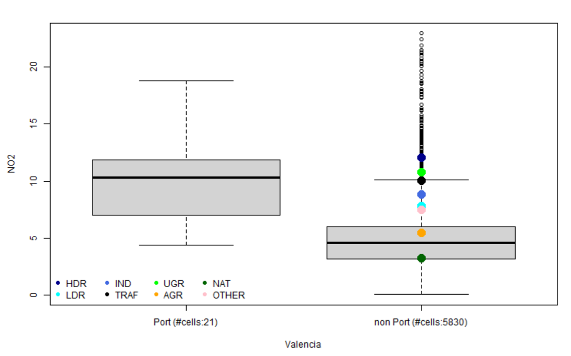
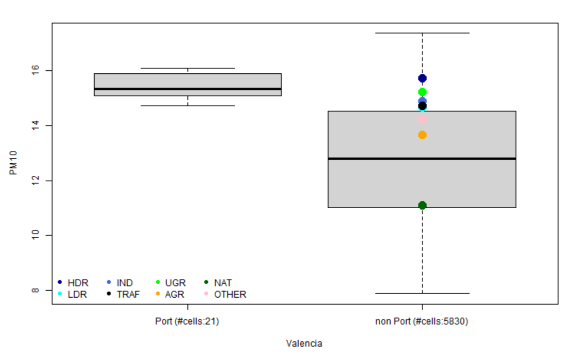
Wind sector 4: S

NO DATA

Wind sector 3: SE

NO DATA

PM10 concentrations when wind is blowing from the port
Wind sector 7: NW
Valencia, sector:7(3SPOs)
density
concentration PM10 (ug/m3)
WD (# records)
Wind sector 8: N
Valencia, sector:8(2SPOs)
density
concentration PM10 (ug/m3)
WD (# records)
Wind sector 1: NE
NO DATA
Wind sector 6: W
Valencia, sector:6(3SPOs)
density
concentration PM10 (ug/m3)
WD (# records)
Wind frequency by sector
23.9%
6.9%
2.9%
9.7%
13.7%
16.5%
12.1%
14.2%
Wind sector 2: E
NO DATA
Wind sector 5: SW
NO DATA
Wind sector 4: S
NO DATA
Wind sector 3: SE
NO DATA

NO_2	PM_{10}
	
	

NO2 2021
0
5
10
15
20
25
30
35
VALENCIA
TORRENT
Leaflet | © OpenStreetMap contributors © CARTO

PM10 2021
0
5
10
15
20
25
30
VALENCIA
TORRENT
Leaflet | © OpenStreetMap contributors © CARTO

NO2
0
5
10
15
20
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:21)
non Port (#cells:5830)
Valencia

PM10
8
10
12
14
16
HDR
LDR
IND
TRAF
UGR
AGR
NAT
OTHER
Port (#cells:21)
non Port (#cells:5830)
Valencia

European Topic Centre on
Human Health and the Environment
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European Environment Agency
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Human health and the environment