

NO₂ pollution from shipping in Piraeus, Greece

Dr. Kåre Press-Kristensen, Senior advisor: Air Quality & Climate, Green Global Future, kpk@greenglobalfuture.org

MSc Rikke Bøgebo, project manager, Air Quality & Climate: Green Global Future, rmb@greenglobalfuture.org

Professor Basil Tselentis, Piraeus Observatory in Greece, tselenti@unipi.gr

Background

This poster is based on the work of the Piraeus Observatory and the EU LIFE project LIFE4MECA of which a key purpose is to designate complete Emission Control Areas (ECAs) in the Mediterranean Sea regulating sulphur (SECA) and NO_x (NECA) emissions from shipping thereby reducing health hazardous and climate damaging pollution. The Mediterranean Sea has already been designated as a SECA but not yet as a NECA.

When oil is combusted in ship engines, particles and gasses are generated and emitted. The most harmful particles are fine particles (PM_{2.5}), black carbon (BC) and ultrafine particles whereas the most harmful gasses are sulphur dioxide (SO₂) and nitrogen dioxide (NO₂). Air pollutants are emitted through the chimney of the ship and can be transported thousands of kilometers by the wind.

Particles are health hazardous and increase the risk of cancer, cardiovascular diseases, blood clots, severe respiratory diseases (asthma, bronchitis and COPD) along with several other serious diseases. NO₂ and SO₂ are health hazardous gasses and can be transformed into harmful particles in the atmosphere and, in addition, contribute to eutrophication and acid rain thereby damaging cultural heritage, crops and nature.

This work contains long-term measurements of NO₂ pollution at five key locations in Piraeus performed by research partner Piraeus Observatory.

Purpose

The purpose was to perform long-term measurements of NO₂ pollution in Piraeus to create awareness about pollution from shipping to engage the public (citizen science) and politicians in implementing a Mediterranean NECA to limit NO_x pollution.

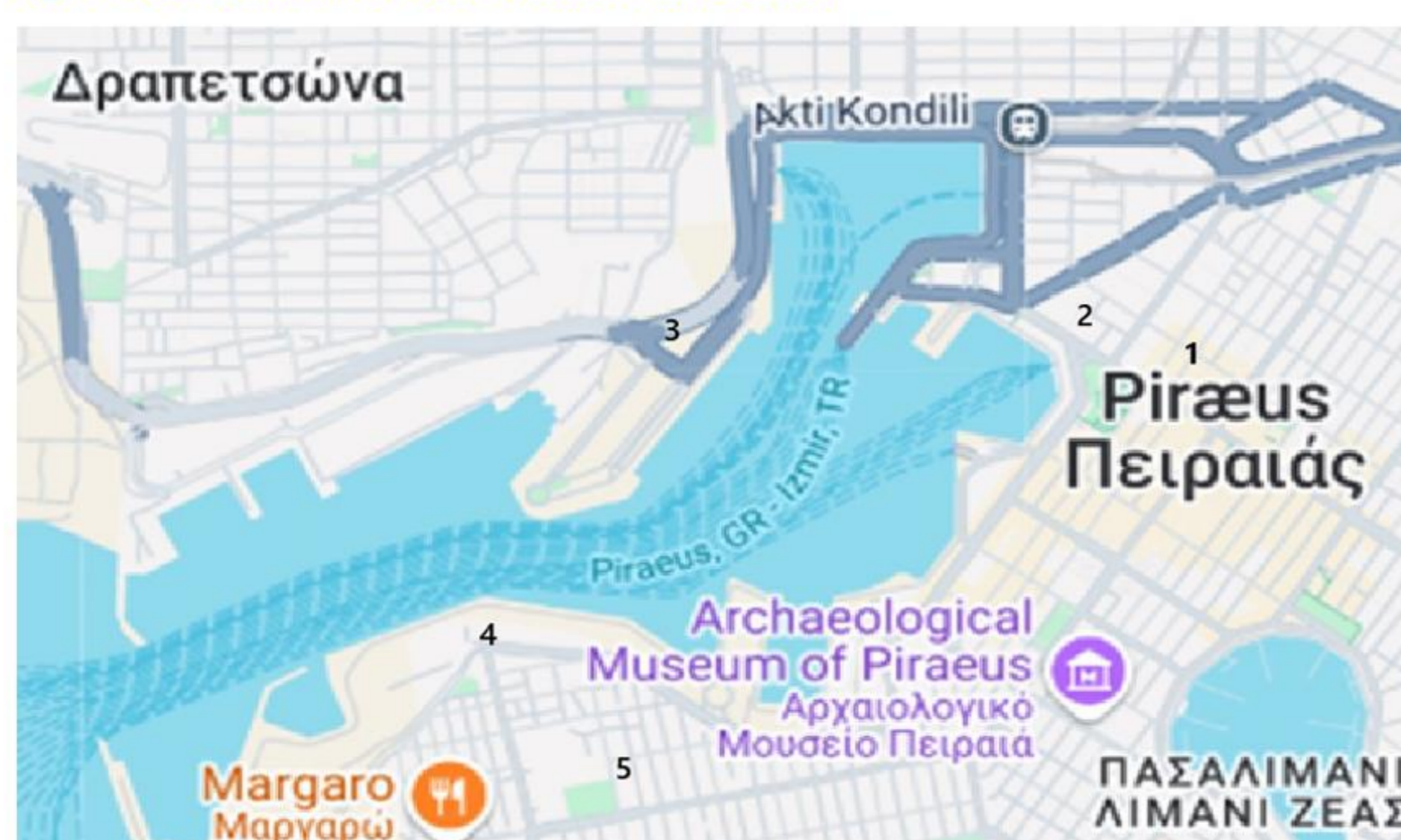
Methods

NO₂ was measured in Piraeus in 2024-25 by passive sampling using NO₂ tubes from Gradko.

Temperature during measurements was taken from local weather forecasts. Passive samplers measure mean NO₂ concentrations over longer periods. As it is difficult to localize pollution plumes inside port cities where many other pollution sources (e.g. traffic) also contributes to NO₂ pollution, the best measuring locations are in port areas. The measuring locations should be safe from vandalism. In figure 1 is seen the five measuring locations in Piraeus

The selection of measurement points are based on rigorous scientific criteria developed by the Piraeus Observatory, under the scientific guidance of Professor Tselentis. This represents an innovative approach within the framework of citizen science, where the local community actively participates in the collection, analysis, and evaluation of data, ensuring scientific accuracy and social transparency in the monitoring and study of environmental and traffic phenomena in the area.

Figure 1: Locations for measurements in Piraeus.



No. on map	1	2	3	4	5
Location	Ag. Triada	HSAP	Ag. Dionysios	Liontari	Dimitra

Table 1 summarizes results from the NO₂ air quality measurements in Piraeus. For comparison are shown the EU air quality limit values in 2025 and for 2030 as well as the WHO air quality guidelines.

From Table 1 is seen that the annual mean NO₂ pollution at all five measuring locations in Piraeus violates the existing EU annual NO₂ air quality limit value that should have been fulfilled more than 10 years ago (in 2015).

Table 1: Results of NO₂ air quality measurements in Piraeus

Locations	NO ₂ pollution (µg/m ³)													
	2024										2025		All period	
	M	A	M	J	J	A	S	O	N	D	J	F	Max	Mean
Ag. Triada	61.0	42.5	65.6	73.3	64.1	53.0	67.2	55.2	44.8	44.5	40.0	35.6	73.3	53.9
HSAP (bridge)	61.2	46.1	72.0	80.0	54.7	48.3	70.6	49.4	30.8	49.1	44.2	39.3	80.0	53.8
Ag. Dionysios	65.8	49.6	81.7	89.3	68.4	60.1	83.0	50.6	43.4	55.0	49.5	44.0	89.3	61.7
Liontari	48.2	39.8	35.4	28.5	59.3	42.4	56.9	37.7	30.3	40.0	36.0	32.0	59.3	40.5
Dimitra	27.9	37.0	47.7	54.8	52.8	44.4	55.1	41.3	34.7	36.9	33.2	29.5	55.1	41.3
EU air quality limit values	2015										Annual mean		40	
	2030										24-hour mean		---	
	2030										Annual mean		20	
	2030										24-hour mean		50*	
WHO air quality guideline	2021										Annual mean		10	
	2021										24-hour mean		25**	

*Not to be exceeded more than 18 times (days) per calendar year. **99th percentile (i.e. 3-4 exceedance days per year).

Pollution levels are more than twice as high as the coming EU annual NO₂ air quality limit value that must be fulfilled in 2030 – and more than 4 times higher than the existing WHO air quality guideline to protect human health.

Furthermore, several monthly mean concentrations at the five locations violate the EU 2030 NO₂ limit value for 24-hour mean indicating that this limit value was probably violated many days during these months and thereby not fulfilled (the limit value is not to be exceeded more than 18 days per year). All locations seem to violate WHO air quality guideline for 24-hour mean every month.

Finally, the mean concentration at all locations in the port exceeds the WHO NO₂ air quality criteria (both the annual mean and the 24-hour mean) i.e., the WHO air quality criteria are clearly violated.

Many Mediterranean port cities almost complete a circle around the port and are built uphill. Hence, the main pollution plume from ship chimneys are in window height of apartments and will reach residential areas regardless of wind direction (see pictures). Windows and balcony doors are open most of the year due to the warm climate.

More detailed investigations focusing on air pollution in ports and residential areas around ports should be carried out to identify pollution levels and raise awareness on the poor air quality and the connected risks of morbidity and mortality.

Conclusions

NO₂ levels measured in Piraeus show very high concentrations that increase the risk of morbidity and mortality and need to be reduced significantly to fulfil the EU 2030 NO₂ limit values. The measured pollution levels show clear exceedances of the WHO air quality guidelines as well. Hence, there is an urgent need to reduce the NO₂ pollution from shipping (and other pollution sources) to improve public health in Piraeus. Shore power eliminating pollution from ships at berth and a NECA reducing pollution from ships at sea are important steps towards cleaner air to the benefit of public health.

Recommendations

- Build shore power systems for ferries and cruise/cargo ships.
- Start investing in fully electric ferries and tour boats.
- Establish a Mediterranean NO_x Emission Control Area.
- Enforce the Mediterranean sulphur Emission Control Area.
- Ban the discharge of scrubber water in territorial seas.
- Establish air monitoring stations to monitor port pollution.



Author

Kåre Press-Kristensen has a master and Ph.D. in environmental engineering from the Technical University of Denmark. He has been teaching air pollution for 24 years at the Technical University of Denmark (recent years as external). He works as senior air quality advisor in Green Global Future. He works with pollution from shipping, wood burning, road traffic, non-road machinery, and aircrafts focused on both emissions, ambient air quality, and the connected risks and costs to public and occupational health. He mainly works on an international level. Contact: kpk@greenglobalfuture.org / (+45) 22 81 10 27.

Acknowledgement

This poster is part of the EU LIFE project: LIFE4MECA with the purpose to designate Emission Control Areas in Atlantic Sea and the Mediterranean Sea. The project is co-funded by the European Union. Views and opinions expressed are, however, those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them. More info: www.life4medeca.com/life4medeca. This work could not have been carried out without the assistance and scientific contribution of research partner Piraeus Observatory.