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Air quality and population exposure assessment within the SALPIAM project: methodological framework

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The SALPIAM project: Environmental Sustainability and citizens' health in selected Italian port cities

Funded by the Italian Ministry of Health - Complementary plan to Italy's recovery and resilience

Mission: 6 "Health", Component: C.1 "Proximity networks, structures and telemedicine for local healthcare"

Investment: E.1 Health, Environment, Biodiversity, Climate

Investment Line: 1.4 Promotion and financing of applied research with multidisciplinary approaches in specific areas of health-environment-climate intervention. Area: B – programs that involve actions with high synergy with other institutions/sectors. Line of intervention: 3: Support in the development of cities for healthier, more inclusive, safer, more resilient and sustainable environments;

Project leader: **Regional Agency for Health and Social – Apulia Region**

Partners:

- **Department of Epidemiology, Lazio Region Health Service/ASL Roma 1, Rome, Italy.**
- **Department of Earth, Environment and Life Sciences, University of Genoa**
- **Tuscany Regional Environmental protection agency**
- **Marche Regional Environmental protection agency**
- **Medical Statistics Unit, University of Campania "Luigi Vanvitelli," Naples, Italy**
- **Italian Institute for Environmental Protection and Research (ISPRA), Rome, Italy.**

SALUTE PORTI
INQUINAMENTO AMBIENTE
SOSTENIBILITÀ CITTÀ PORTUALI

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Main goal

The general objective of the project is to develop promotional actions, provide indications and support for policies and regulations regarding sustainable urban planning for the purpose of reducing the environmental pressure of impacts on human health in urban contexts characterized by the presence of ports

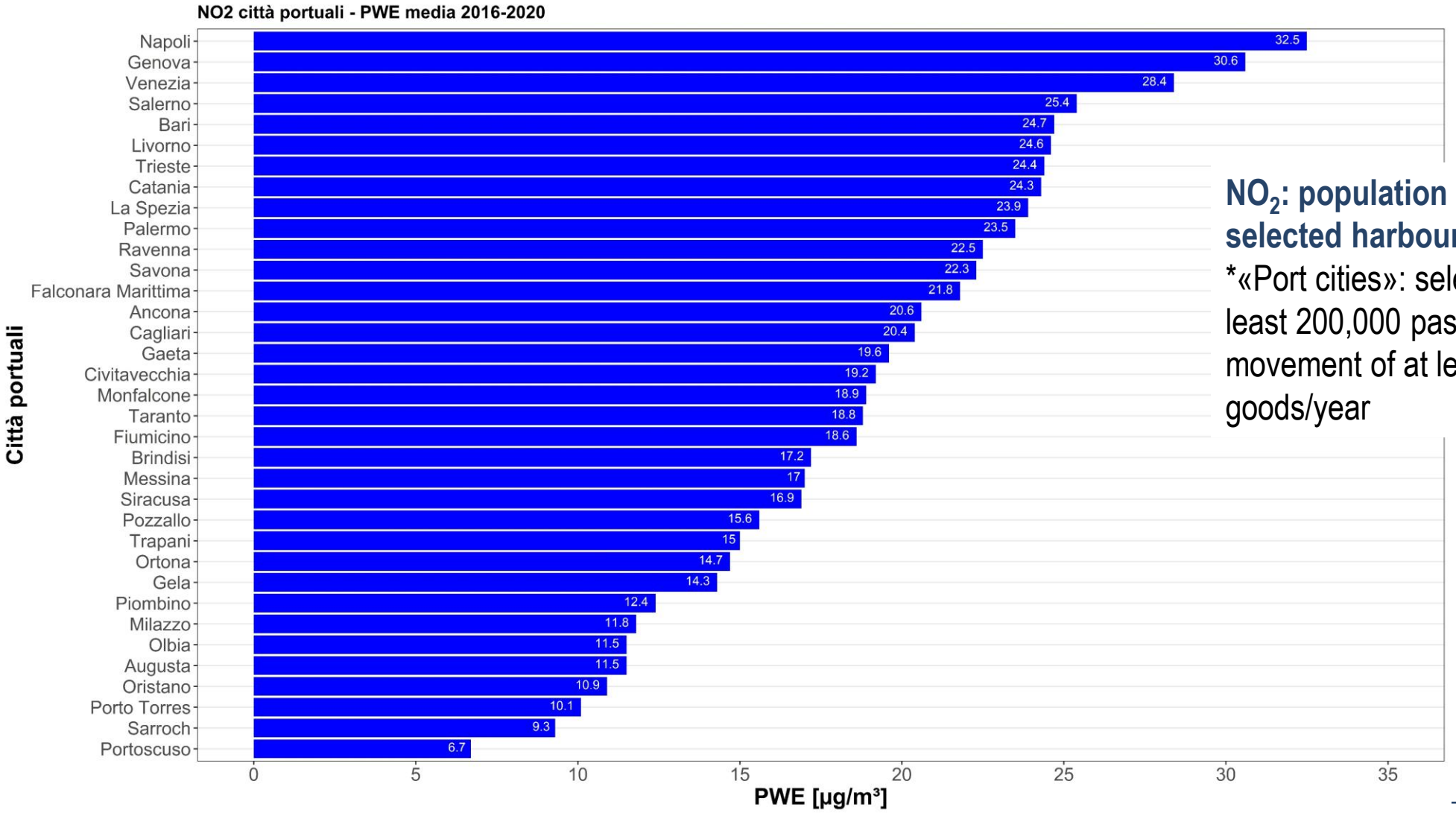
Target cities:

- Genoa
- Piombino (Livorno)
- Civitavecchia (Rome)
- Ancona
- Bari
- Brindisi
- Cagliari

The SALPIAM project tasks

1. **Governance** support
2. **Environmental exposure assessment (air pollution** and noise**)**
3. Air and noise pollution **health impact assessment**: disentagle the port activities and ships contribute.
4. Strengthening of **epidemiological surveillance** activities
5. Air quality and noise **impacts mitigations**: interventions effectiveness assessment.
6. Results **dissemination**
7. **Training** activities

Background



NO_2: population weighted exposure in selected harbour cities

*«Port cities»: selection of cities with at least 200,000 passengers and/or movement of at least 1,000,000 tonnes of goods/year

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Task 2: Environmental exposure assessment: air pollution

The study is focused on five Italian port cities:

Genoa, Ancona, Civitavecchia, Bari and Brindisi.

1. Naval activities emissions' load fine tuned.
2. Population exposure assessment at high spatial resolution.
3. Trend analyses meteorologically adjusted.

A five steps methodological framework.

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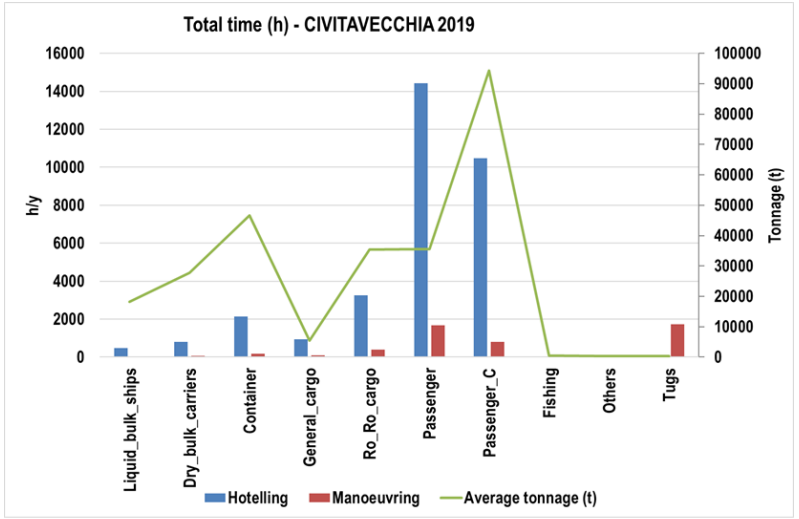
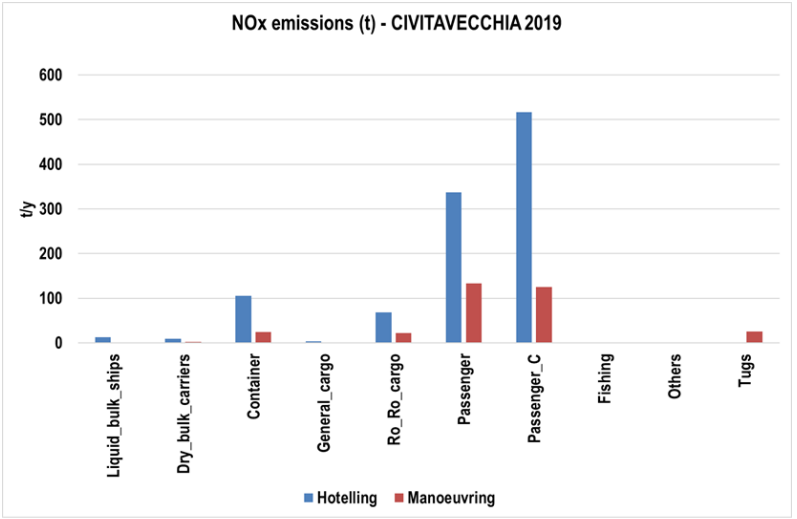
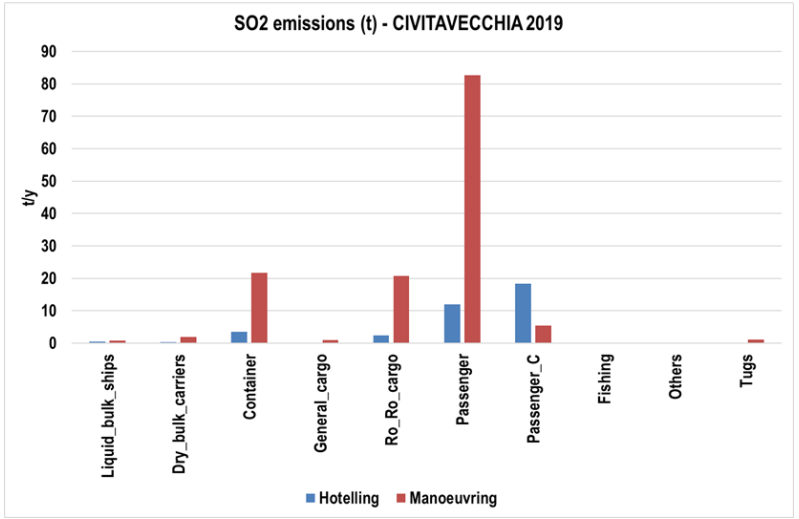
Step 1: Detailed assessment of shipping emissions, using the Bottom Up Harbor software (BUH), which implements the European reference methodology

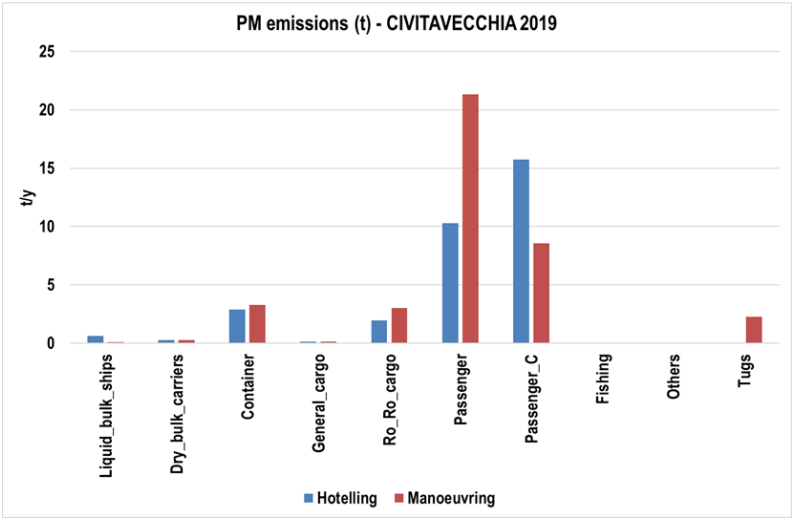
Extremely detailed picture of the shipping related emission by kind of ship and related operational phase.

Reference years: 2019 and 2021









ISPRA Rapporti 382/2023
https://www.isprambiente.gov.it/files2023/pubblicazioni/rapporti/rapporti_382-2023.pdf

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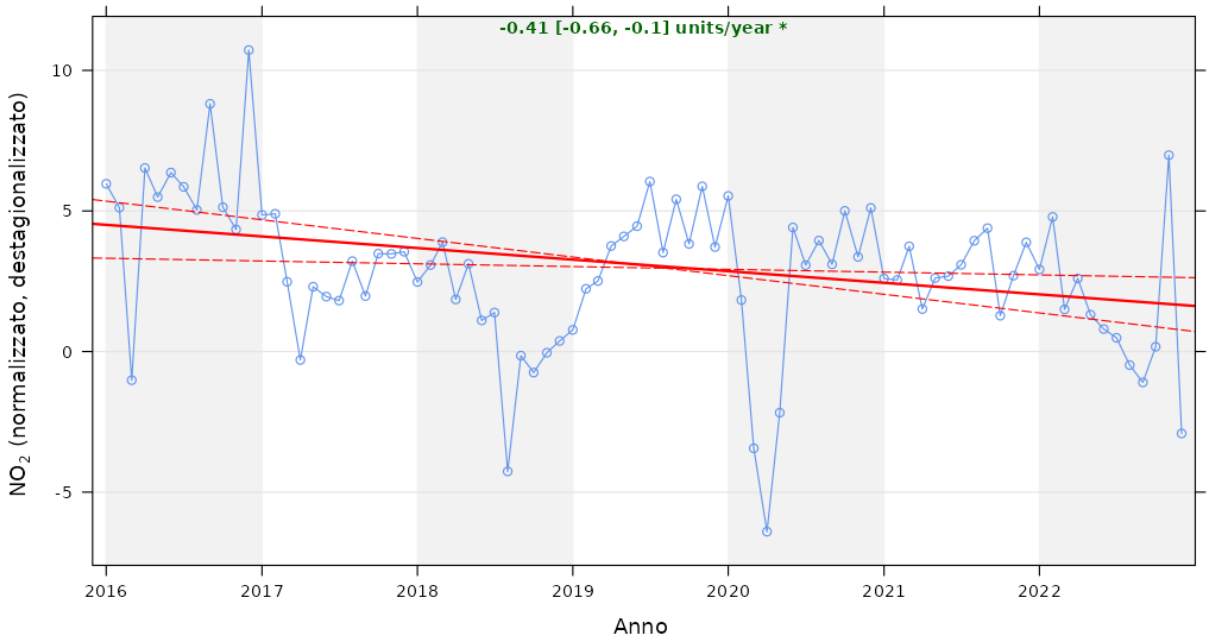
Step 2: Long-term air quality trend analysis seasonally and meteorologically adjusted

- ✓ 35 monitoring stations included
- ✓ PM_{10}, $PM_{2.5}$, NO_2
- ✓ non-parametric Seasonal Kendall Test approach (Hirsch et al., 1984), using the Theil-Sen estimate of the slope (Theil 1950; Sen 1968).
- ✓ meteorologically adjusted trend assessment using Generalized Additive Models (GAMs)



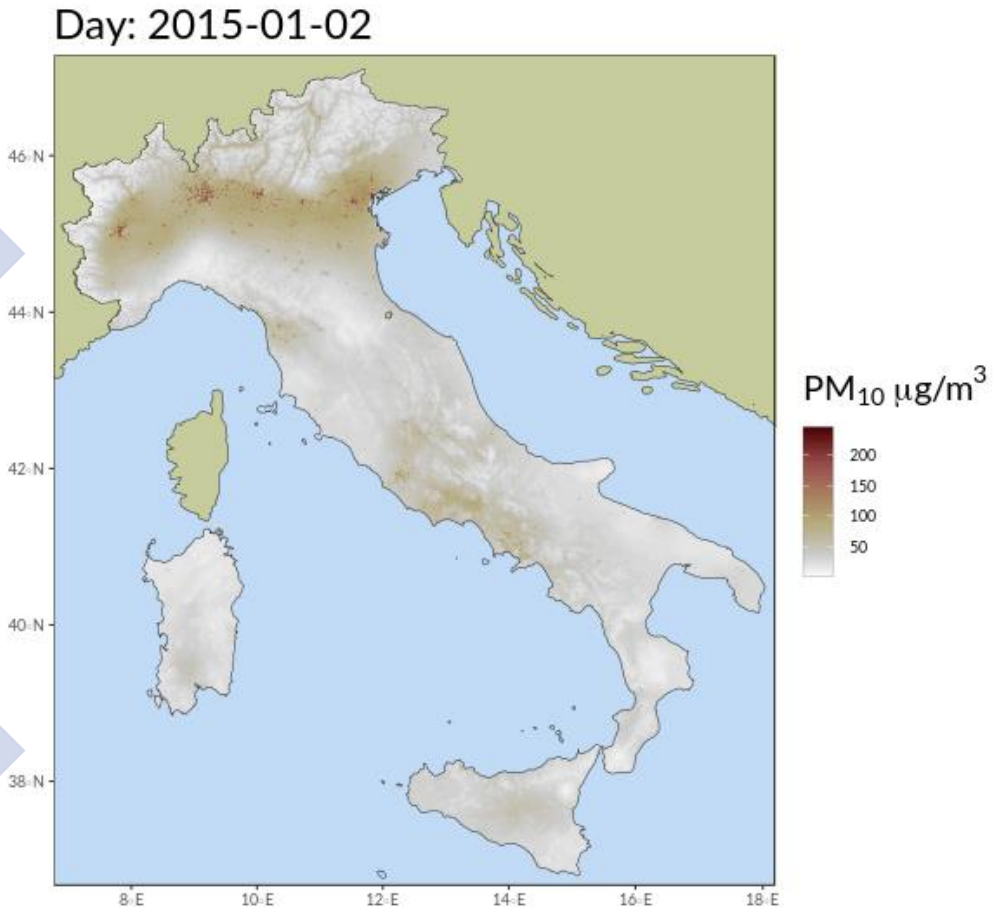
Step 3: Spatio-temporal modelling of daily concentrations in Italy using the SPDE approach

Explanatory variables

- Meteorological (ERA5)
- Dust events (BSC-NMMB)
- Aerosol Optical Depth (CAMS)
- Street network (OPEN STREET)
- Imperviousness
- Altitude

Target variable

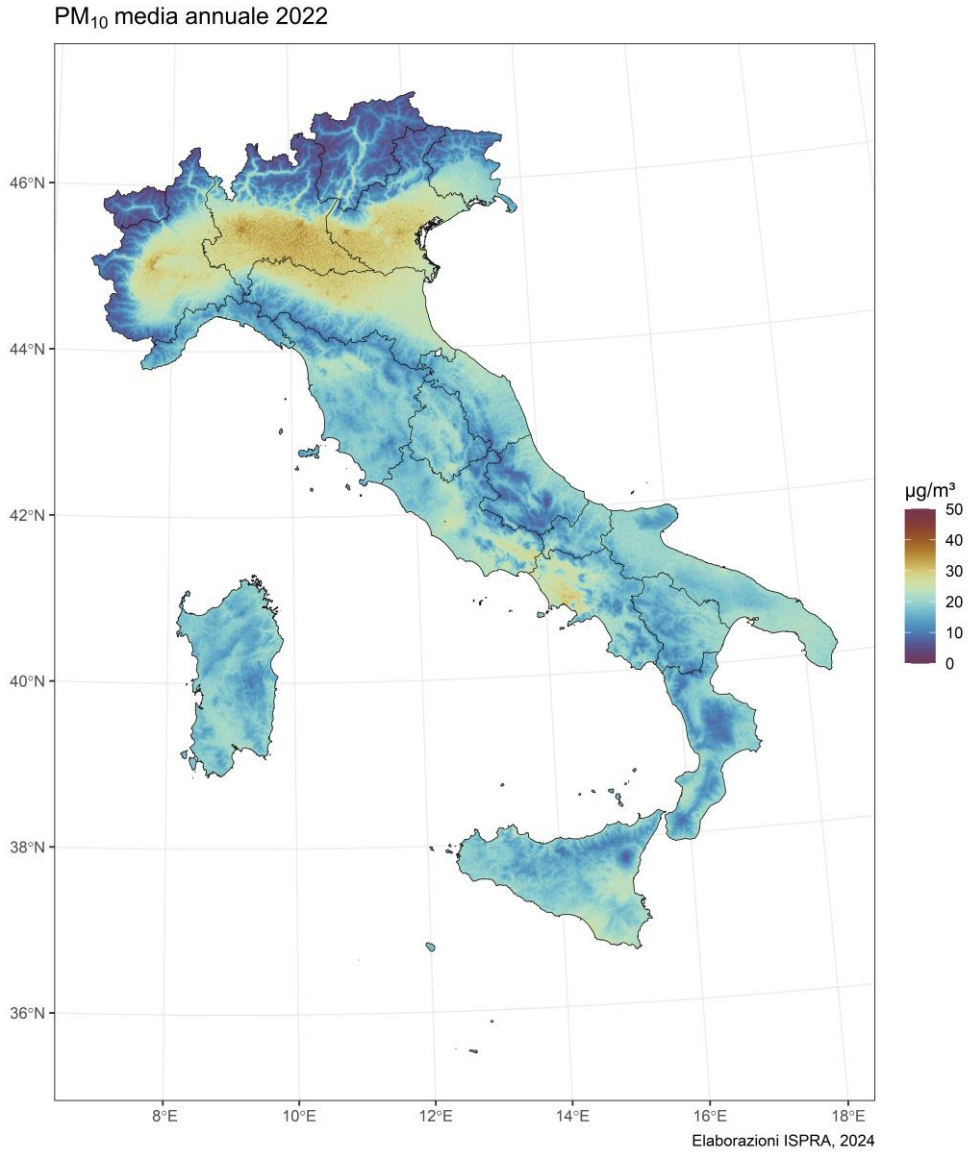
- Daily log[PM10] mass concentration



Guido Fioravanti, Sara Martino, Michela Cameletti, Giorgio Cattani. Spatio-temporal modelling of PM10 daily concentrations in Italy using the SPDE approach. Atmospheric Environment 248 (2021) 118192

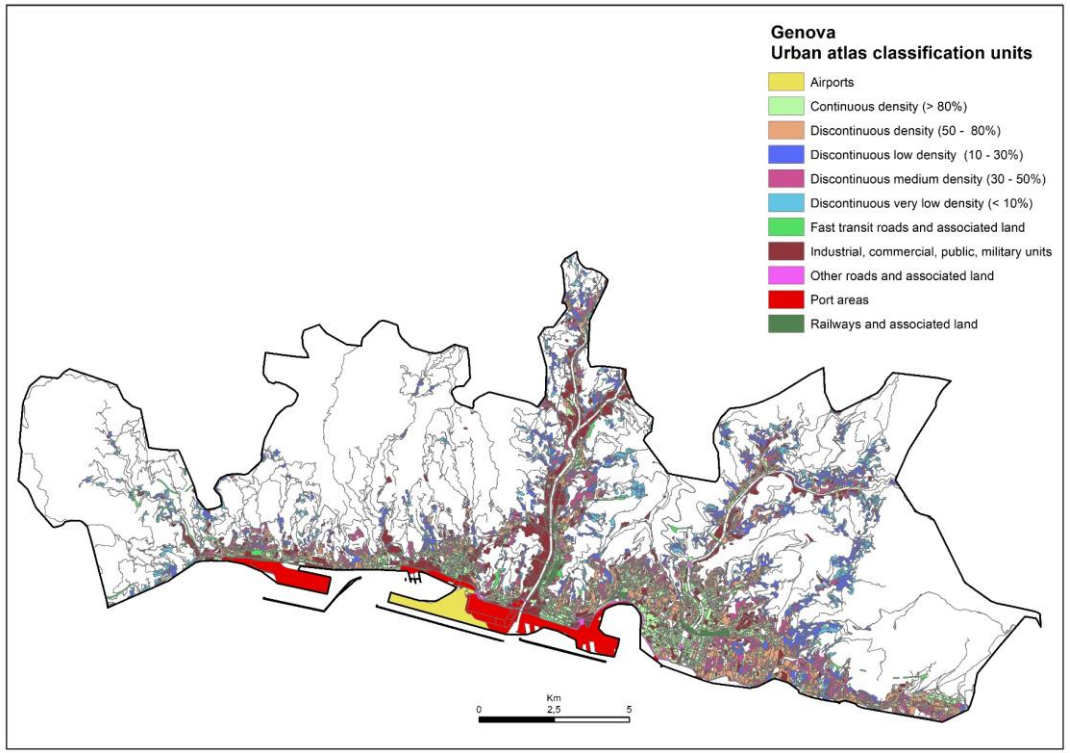
Step 3: National scale spatially resolved exposure assessment at 1 km^2

- ✓ Retrospective assessment (2013-2022)
- ✓ Target pollutants:
  - ✓ PM_{10}, $PM_{2.5}$, NO_2
- ✓ Annual mean used for health impact assessment

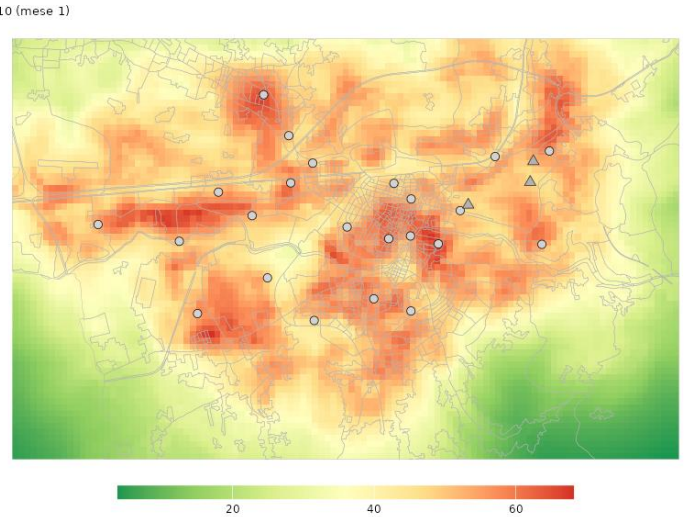


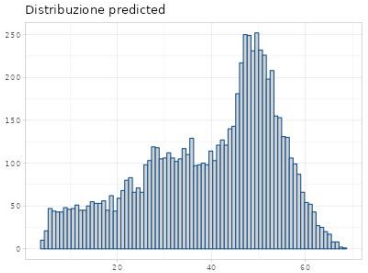
Step 4: Assessing the pollutant small scale spatial variability within grid cell, while capturing local sources contribution in a LUR-GAM framework

- Selection of possible explanatory variables:
  - Imperviousness Density (Buffer 25,50,100 m)
  - Urban Atlas Building Height (Buffer 25,50,100 m)
  - Corine Land Cover (Buffer 25,50,100):
  - Urban Atlas Land Cover/Land Use (Buffer 25,50,100 m)
  - Normalised Difference Vegetation Index (NDVI)/Leaf area index (LAI) (Buffer 25,50,100 m)
  - Population density (ISTAT) (Buffer 25,50,100 m)
  - Road network (Open Street Map) (Buffer 25,50,100 m)
  - Contribution of ship emissions by prevailing wind direction



Step 5: monitoring campaigns as case studies with PM chemical characterization at selected cities





- Very-low volume devices for high spatial resolution PM_{10} sampling
- Quantitative source apportionment by Positive Matrix Factorization (PMF) (e.g. Massimi et al, 2022).
- PM main and traces components Spatio-temporal variability using GAMs (RespiraMi Conference, Morelli et al., 2024).

Example result from a previous study in Terni (Italy) RespiraMi Conference, Morelli et al., 2024.

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Thank you for your attention!