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CASA DELLE INNOVAZIONI PER IL ONE HEALTH - CTE TARANTO

FSC Fondo per lo Sviluppo e la Coesione

Ministero delle Imprese e del Made in Italy

One Health Multi-dimensional Impact Assessment of Taranto

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Comune di Taranto – UniBa
Fabio Castellana
ASL Taranto - UniBA

TARAS

UNIVERSITY OF LIVERPOOL

ASL Taranto PugliaSalute

Con oltre 30 Partner aderenti (alcuni ri…uesta slide) coordinati dal …to, CALLIOPE è un vero e … di **competenze** …**mentari e** …**mini di** …**ltati.**

…ento ott… …prese e de… (… Fondo per lo Svil… Coesione (FSC) 2014 - 2020, le attività di ricerca traslazionale sono condotte attraverso un'infrastruttura tecnologica dot… …sitivi IoT, reti 5… …h …nputing) e … …intelligence.

CALLIOPE conse… …ree oggetto di studio, il n… …ioni tra gli age… mi… …capacità degli e… …iali prep… …prevenire potenziali m… sanitar… e di attenuarne gli effetti.

UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

TILEBYTES SRL

ITEMOXYGEN

KEYCONSULTING

ARTES 4.0

DIVA

POLITECNICO DI BARI

CASP

MEDITECH

ERREPI NET

UNIVERSITÀ LUMSA

JONIAN DOLPHIN CONSERVATION

DISTRETTO TECNOLOGICO SPAZIALE

TIM

ARPA PUGLIA

DEEP TRACE

LINKS

ITS

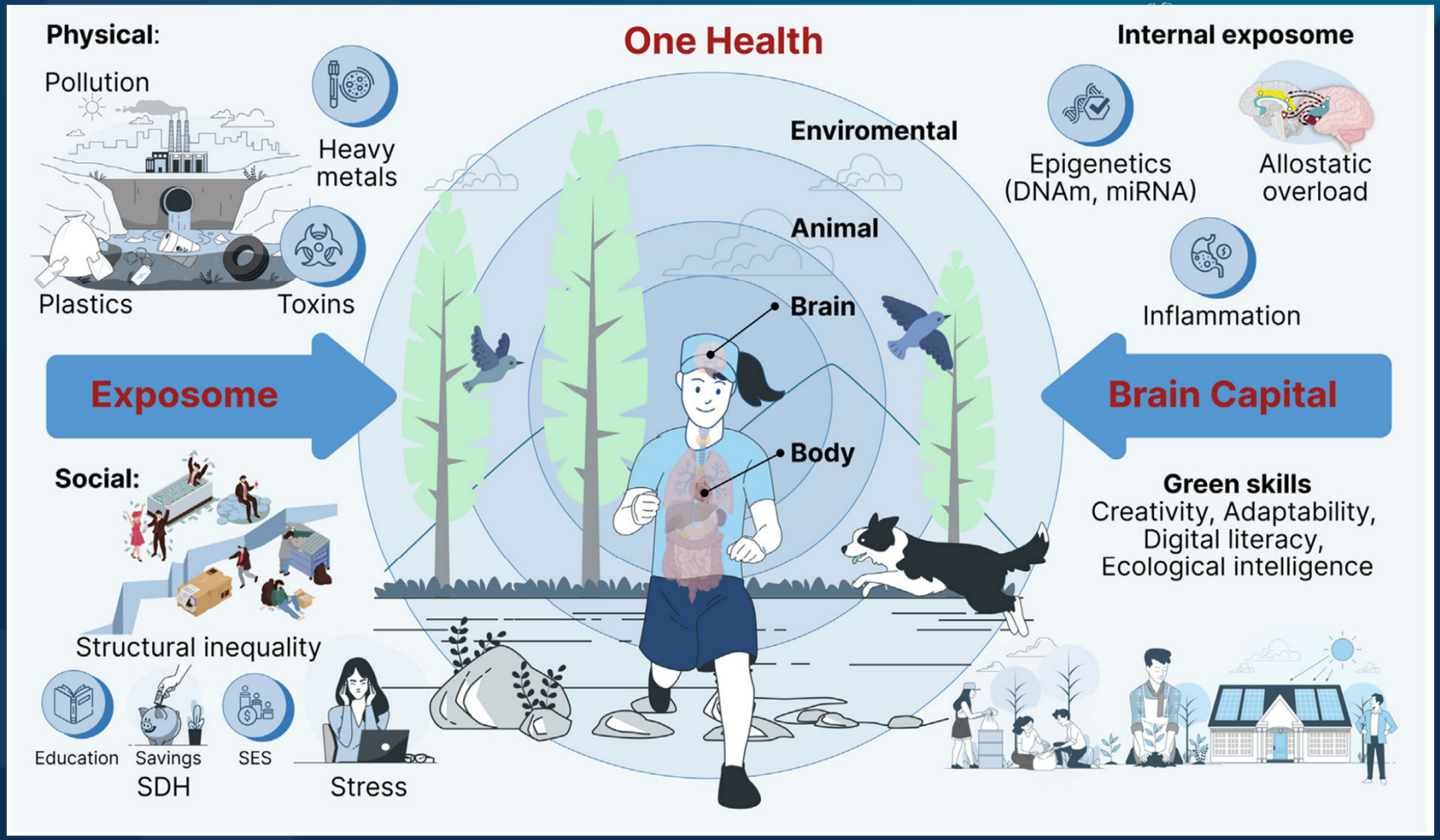
ASL TARANTO

COMUNE DI TARANTO

One health is a holistic concept that integrates all health dimensions in perfect homeostasis

Exposome is the ensemble of exposures that shape the trajectories of the different dimensions of One Health

Human Behaviour social, emotional, and the diversity of cognitive brain resources of individuals that could affect



*Ibanez, A., Melloni, L., Świeboda, P., Hynes, W., Ikiz, B., Ayadi, R., ... & Eyre, H. A. (2024). Neuroecological links of the exposome and One Health. *Neuron*, *112*(12), 1905-1910.

Urban Health

Citizen of a city has different health needs in the framework, related mainly to the PECULIAR SOCIAL FABRIC and **BIODIVERSITY**

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Biodiversity

Population Based Studies

Evidence Based Policy Tools

Innovative IoT Monitoring

Integrating Generative AI

Open Data

Citizen Sciences

Green Skills

Ethics

Urban Exposome

Difference between cities :Indoor Air quality, drinking water, noise pollution, built environment, climates, population density

Health Equity

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URBAN HEALTH CENTER

"Lotto" 2D Ex-BAC : Municipality of Taranto

Comune di TARANTO

Urban Intelligence Lab

Special Senses Lab

BIOREPOSITORY
Environment Matrices
(more than 2000 samples)

Headquarter: Palazzo di Città (Taranto)

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COHRE, “Center for One Health Research and Elaboration”

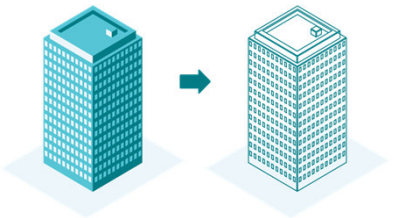
MISTRAL Project (HORIZON-HLTH-2022-ENVHLTH-04-01) : Scope and significance

Create a digital toolkit for URBAN HEALTH impact assessment and interventions using a multimodal large language convolutional model

Population Health

Urban Intelligence

Deep Learning



Digital Twin

Test and simulate urban health policies using real world data

https://mistralplatform.eu/

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HORIZON EUROPE

a toolkit for dynaMic health Impact analysiS to predicT disability-Related costs in the Aging population based on three case studies of steeL-industry exposed areas in europe

ISTITUTO SUPERIORE DI SANITÀ

ASL Taranto

PugliaSalute

AGH

AGH University of Science and Technology

SoGE School of Geography and the Environment

University of Oxford

UHASSELT

KNOWLEDGE IN ACTION

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Clinical Assessment

- Anamnestic evaluation
- Blood Sample (Telomere Lenght)
- QALY (Quality-Adjusted Life Years)
- EQ-5D-5F
- Urine Collection
- Prenatal and Perinatal evaluation

Population Georeferencing

Georeferencing of addresses and identification of environmental exposure

Zephyr Study: Cross Sectional Study

Methods

Machine Learning Approch

Features Selection methods to assess most predictive features of QoL (Quality of Life)

Ensamble Learning Methods

Weighted model creation on QoL as predicted variable based on feature selection method

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Zephyr Study: Cross Selectional Study

Whole Children Sample
N:450

Tamburi Area
N: 225

Lama Area
N:225

+

Whole Adults Sample
kinship in the first and second degree
N:1000 /652

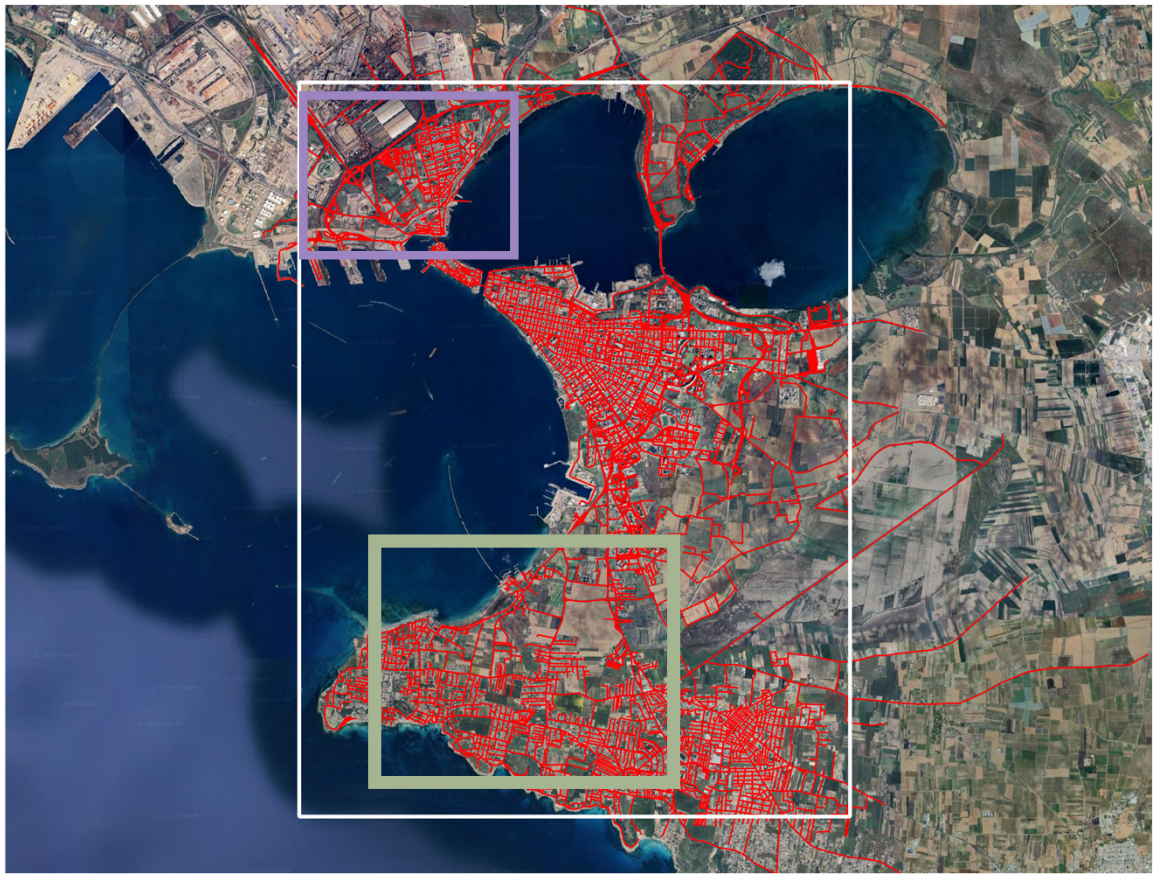
Tamburi Area
N: 500/652

Lama Area
N:500

Matched for:
Age and Sex

M/F: 0.61

Taranto street graph 2023



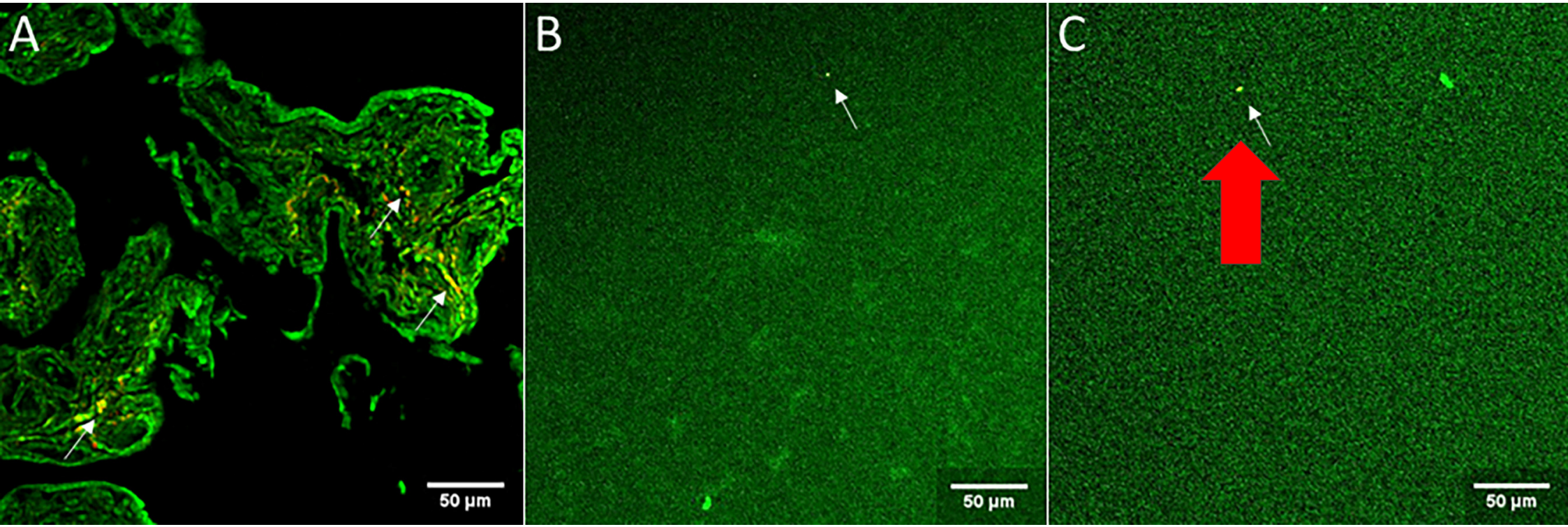


Figure: Evidence of black carbon particles in (A) placental tissue, (B) cord blood, and (C) urine

* Van Pee, T., Hogervorst, J., Dockx, Y., Witters, K., Thijs, S., Wang, C., ... & Nawrot, T. S. (2023). Accumulation of Black Carbon Particles in Placenta, Cord Blood, and Childhood Urine in Association with the Intestinal Microbiome Diversity and Composition in Four-to Six-Year-Old Children in the ENVIR ON AGE Birth Cohort. *Environmental Health Perspectives*, *131*(1), 017010.

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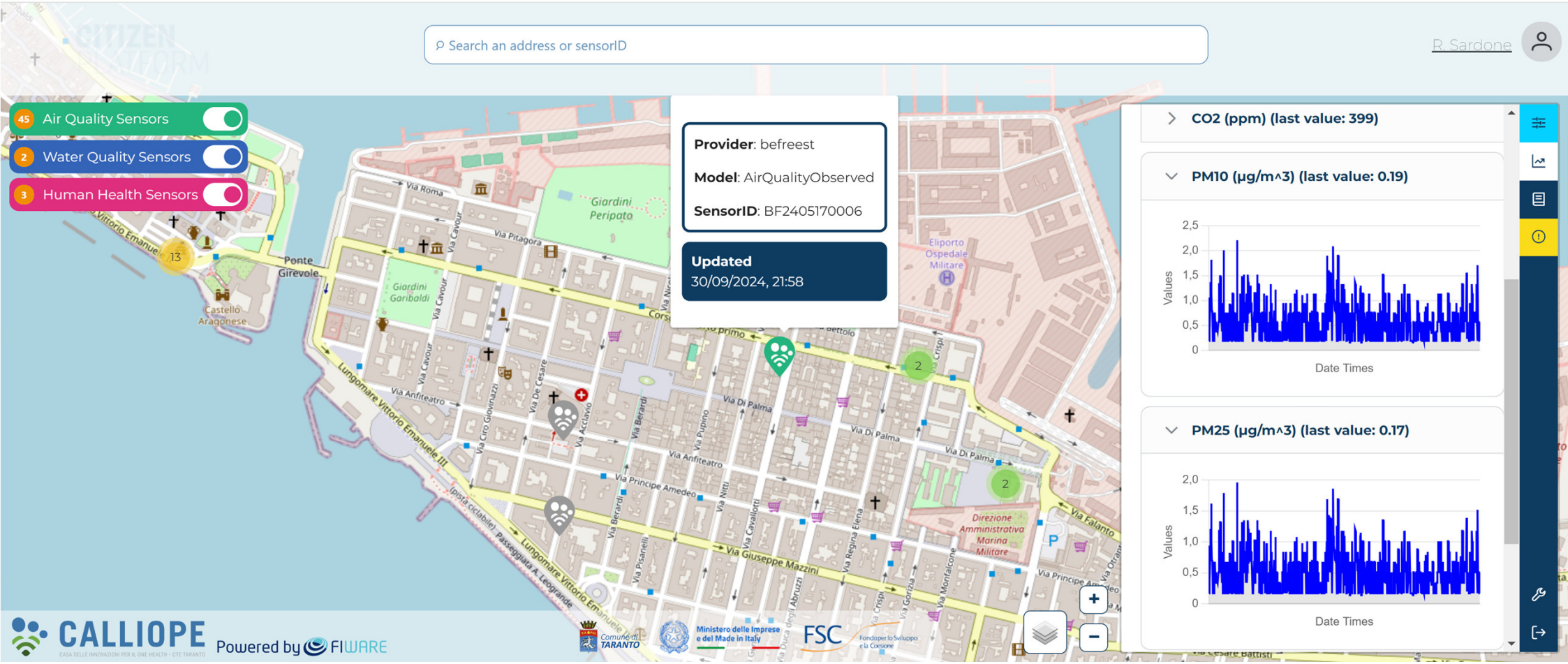
https://urbanhia.eu/



Il sensore indoor è stato sviluppato a partire dalla progettazione della scheda 5G/LTE

MISURA costantemente
RADON
PM2.5
PM10
TVOC
CO2
Temperatura
Umidità
frequenza di 2' (10' per il radon)

Befreest D.25

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Tilebytes. sri

MATHCLICK

Errepi Net

befreest LIFE FORWARD

SYMBIOTICA

CALLIOPE Air-Sentinel 1

Automatic Patrol Drone (in a Box)

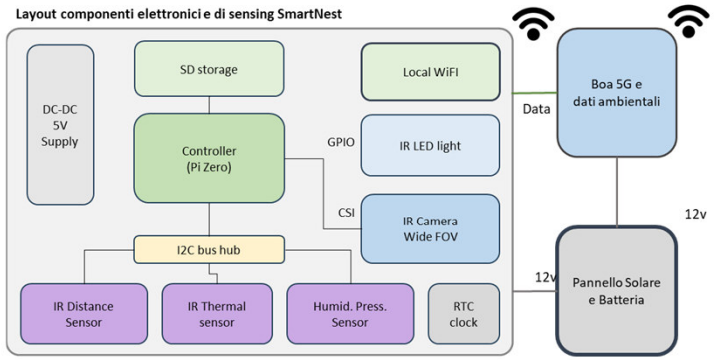
- **Air Quality** : O_3, CO, SO_2 , NO_2 , PM1, PM2.5, PM10, Temperature, Pressure air and Humidity, Black Carbon
- **Light Pollution:** optical radiation and blue light
- **Noise:** filtered Spl in dBA (38 to 143)
- **LIDAR**: laser scan for building green maps
- **cmosCAM**: biodiversity capturing and modeling

SmartNest

Data measurements

Nest equipped with **electronics** and **sensors**

- Event-triggered **Near infrared camera** to monitor **nest population** and **preys** carried to younglings
- Far infrared sensor (**FIR**) to understand behavior with respect to temperatures
- Field operation: **low power, solar panels**
- **Data communication** with CALLIOPE data infrastructure



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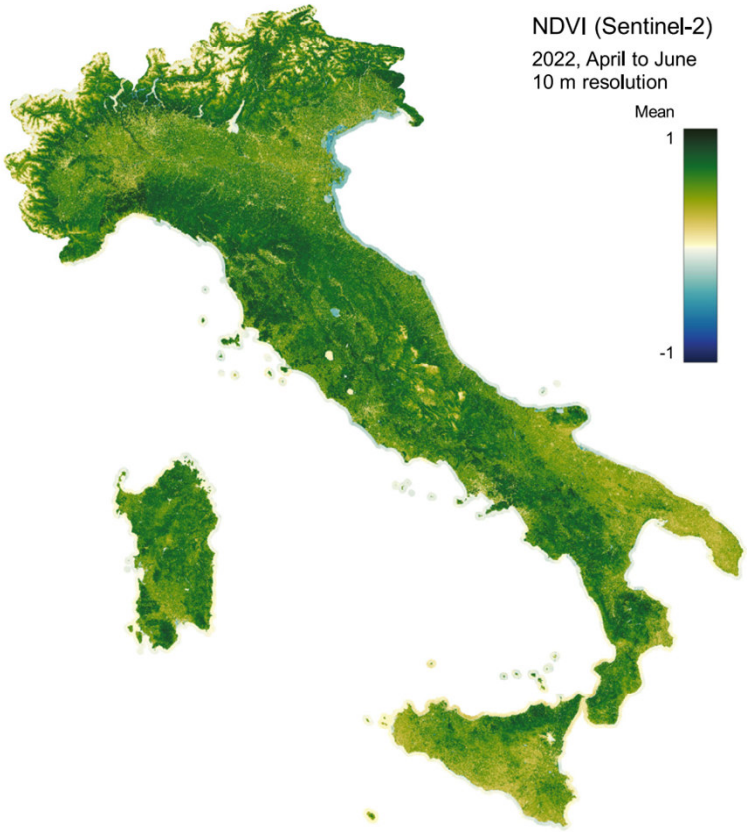
Article | Open access | Published: 01 December 2024

The mortality impacts of greening Italy

Orazio Valerio Giannico, Rodolfo Sardone, Lucia Bisceglia, Francesco Addabbo, Francesco Pirotti, Sante Minerba & Antonia Mincuzzi

Nature Communications **15**, Article number: 10452 (2024) | Cite this article



Preventable Deaths: Achieving the level of residential greenness currently experienced by the top 25% of the population nationwide could potentially prevent approximately 28,433 deaths (95% confidence interval: 21,400–42,350) in Italy for the year 2022.

Years of Life Lost: This increase in green spaces could also result in approximately 279,324 (210,247–415,980) preventable years of life lost

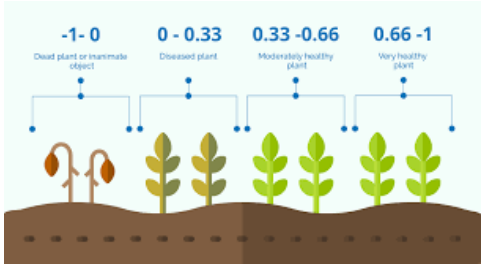
Mortality Burden Reduction: The estimated preventable deaths represent about 5% of the total mortality burden in Italy.

Geospatial Data

Land Surface Temperature (LST) is a crucial geophysical parameter related to the surface energy and water balance of the land-atmosphere system.
Satellite remote sensing offers the best way to measure LST and generate various LST products on regional and global scales.

Normalized Difference Vegetation Index (NDVI) is a simple graphical indicator that can be used to analyze measurements obtained from remote sensing, via satellite, monitoring the level of living vegetation in the analysis area.

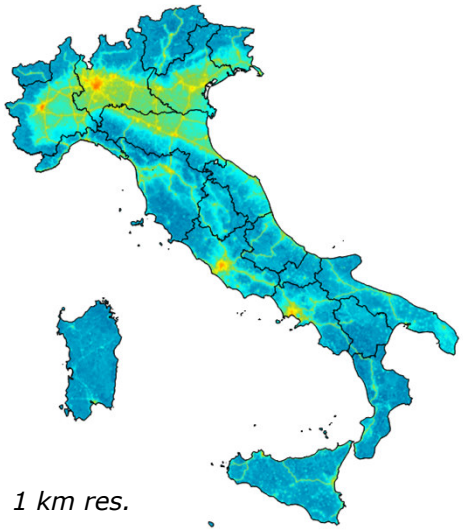
Values of major pollutants such as NO2, PM10, and PM 2.5 were identified according to diffusive models developed by ARIANET on a small scale (100x100m)



Georeferenced Overall Mortality

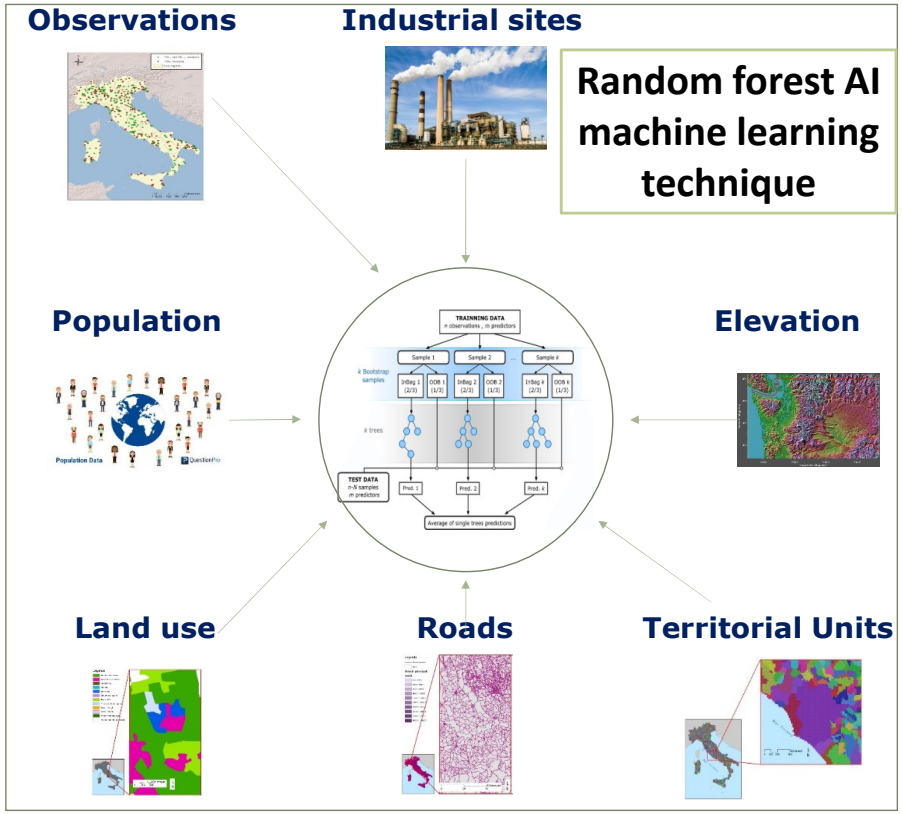
Combination of model and observations – Taranto – Hasselt - Rybnik

CTM (1 km)



1 km res.

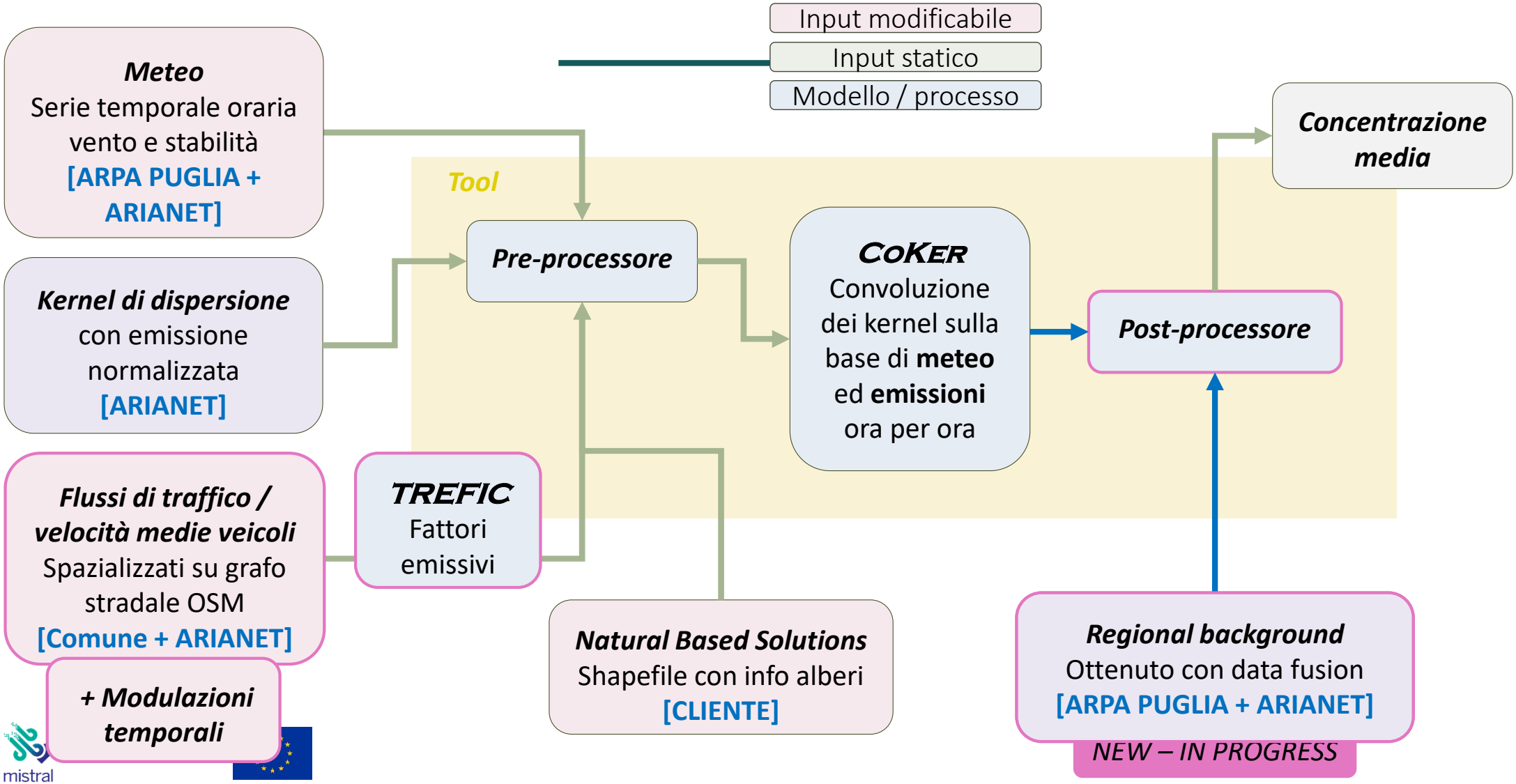
Random Forest (Big Data)



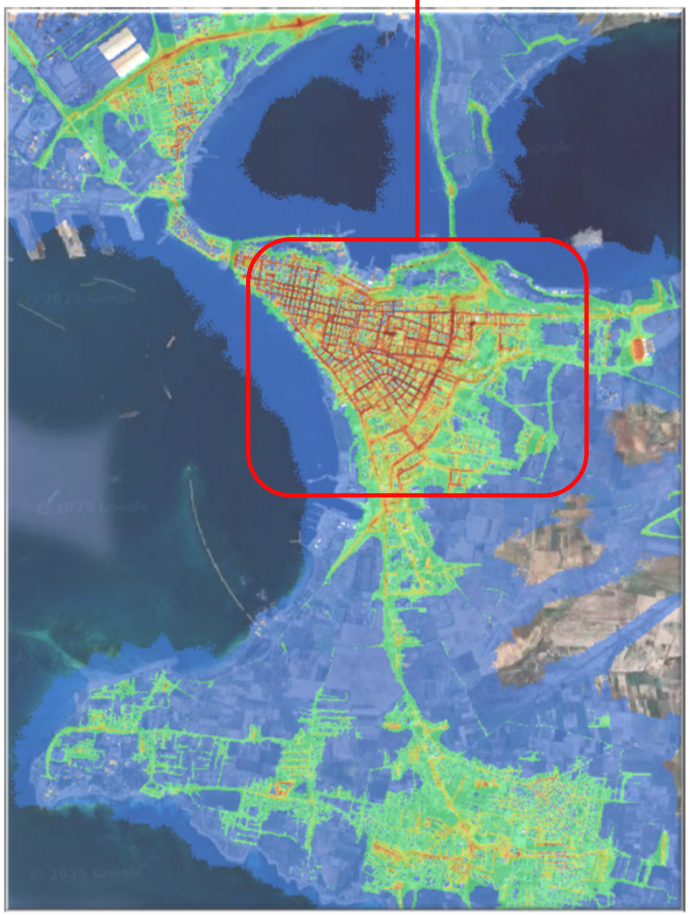
The system will include techniques for the integration of information from monitoring networks (A class stations and IoT Sensors) and from modelling simulations

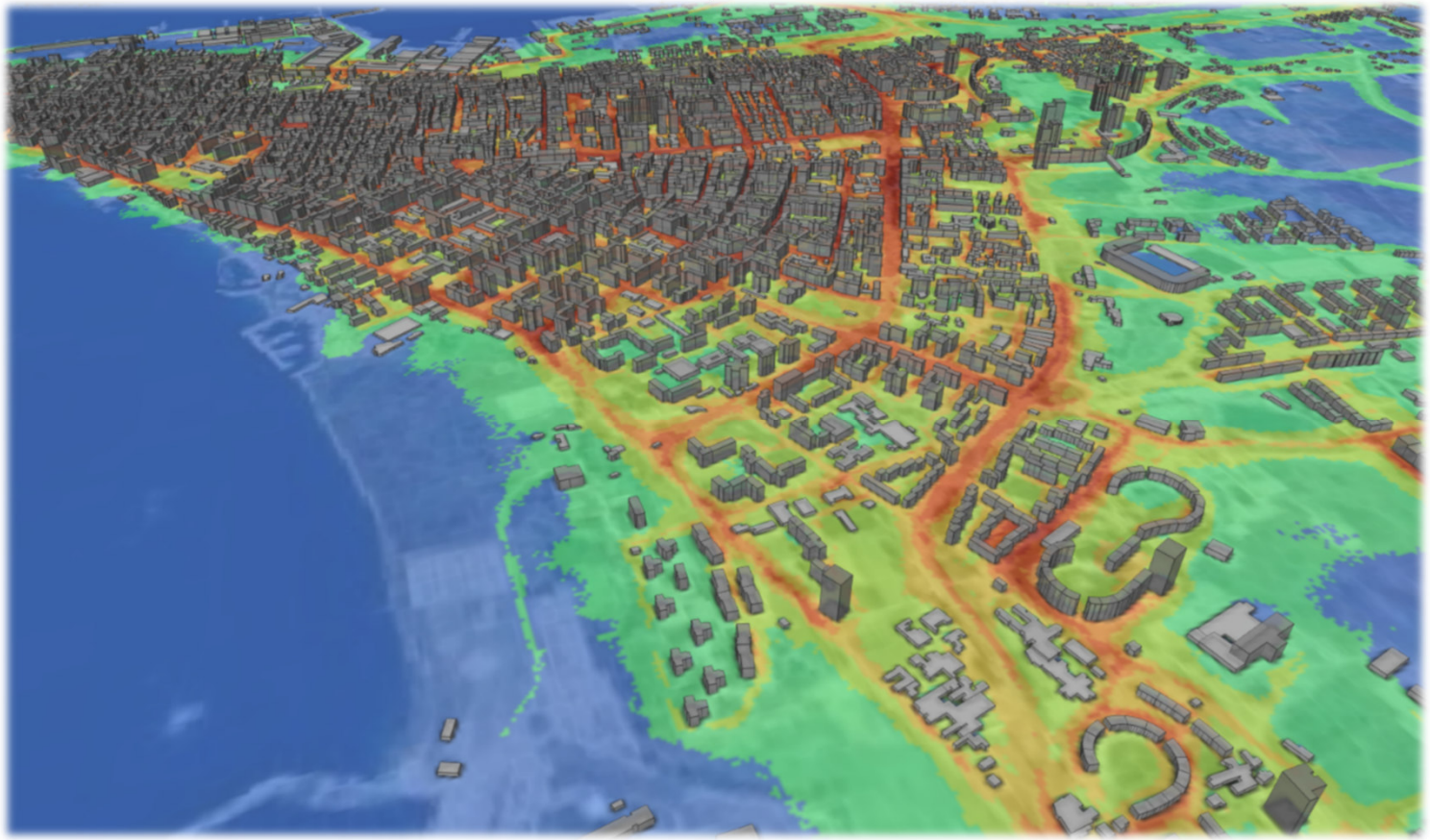
Thanks to the AI, a resolution increase will be made from 1 km to 100 m

Tool per modellazione degli scenari di dispersione da traffico

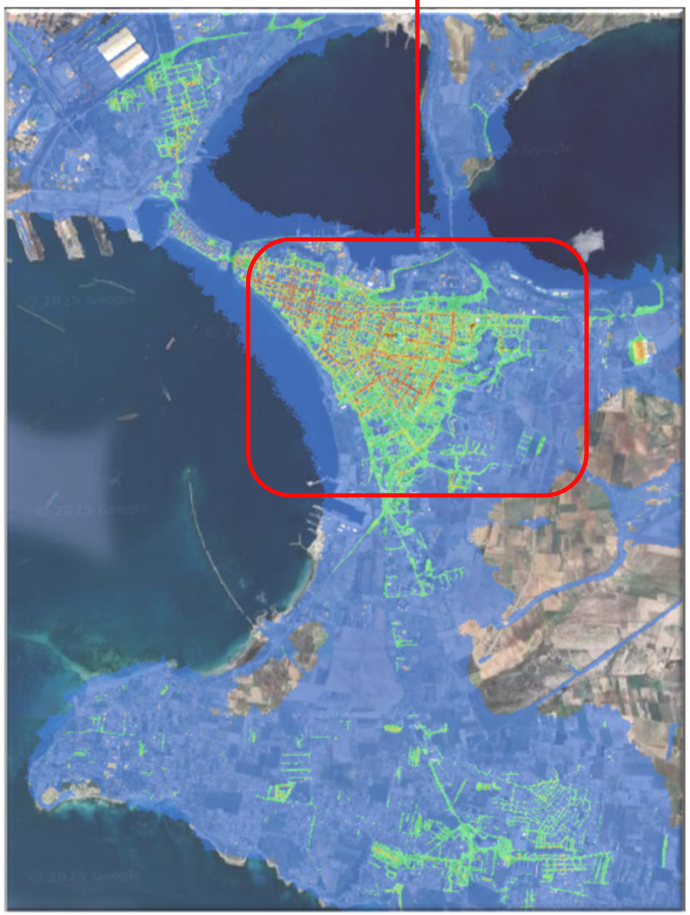


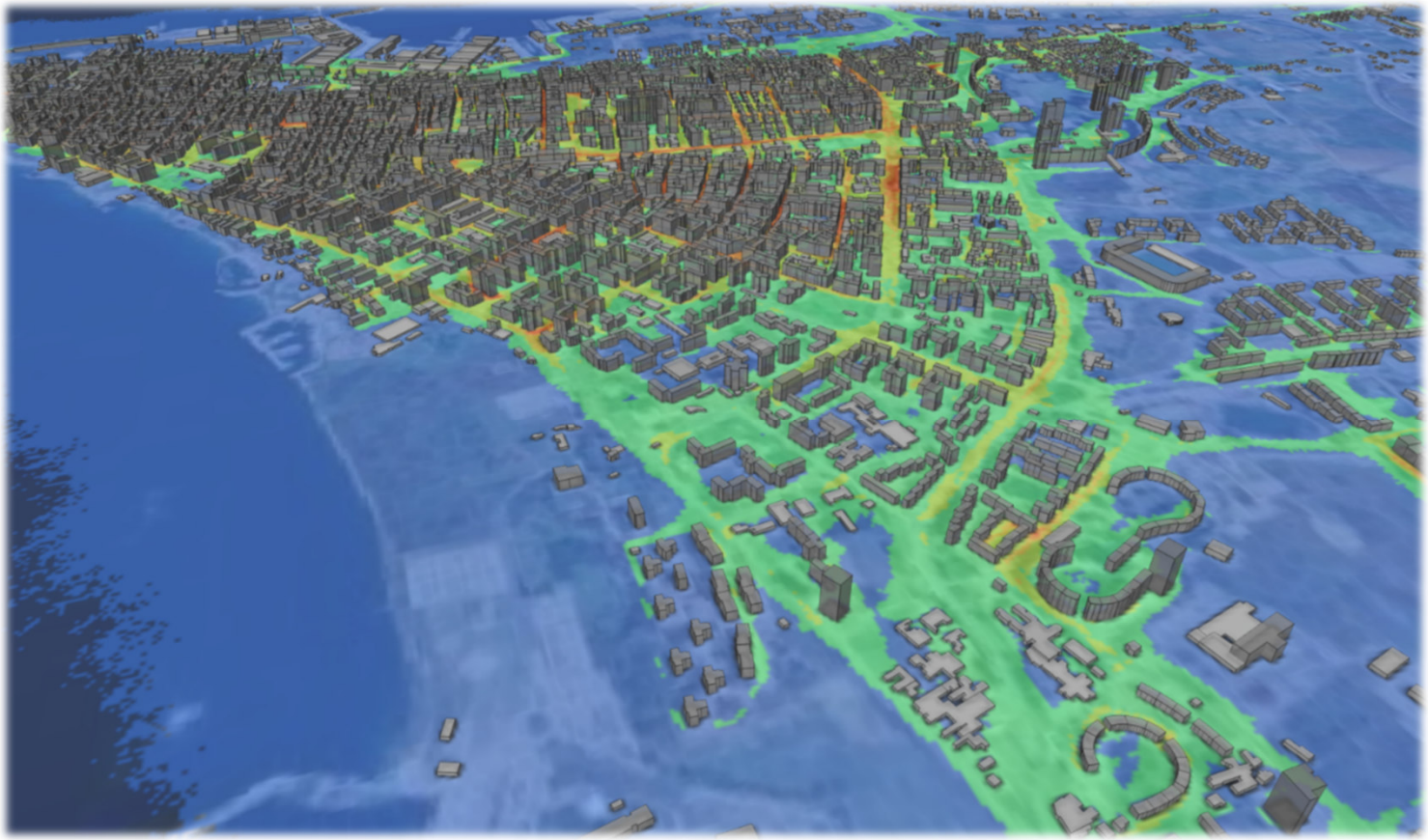
Concentrazione media di NO2 sull'anno meteorologico 2023



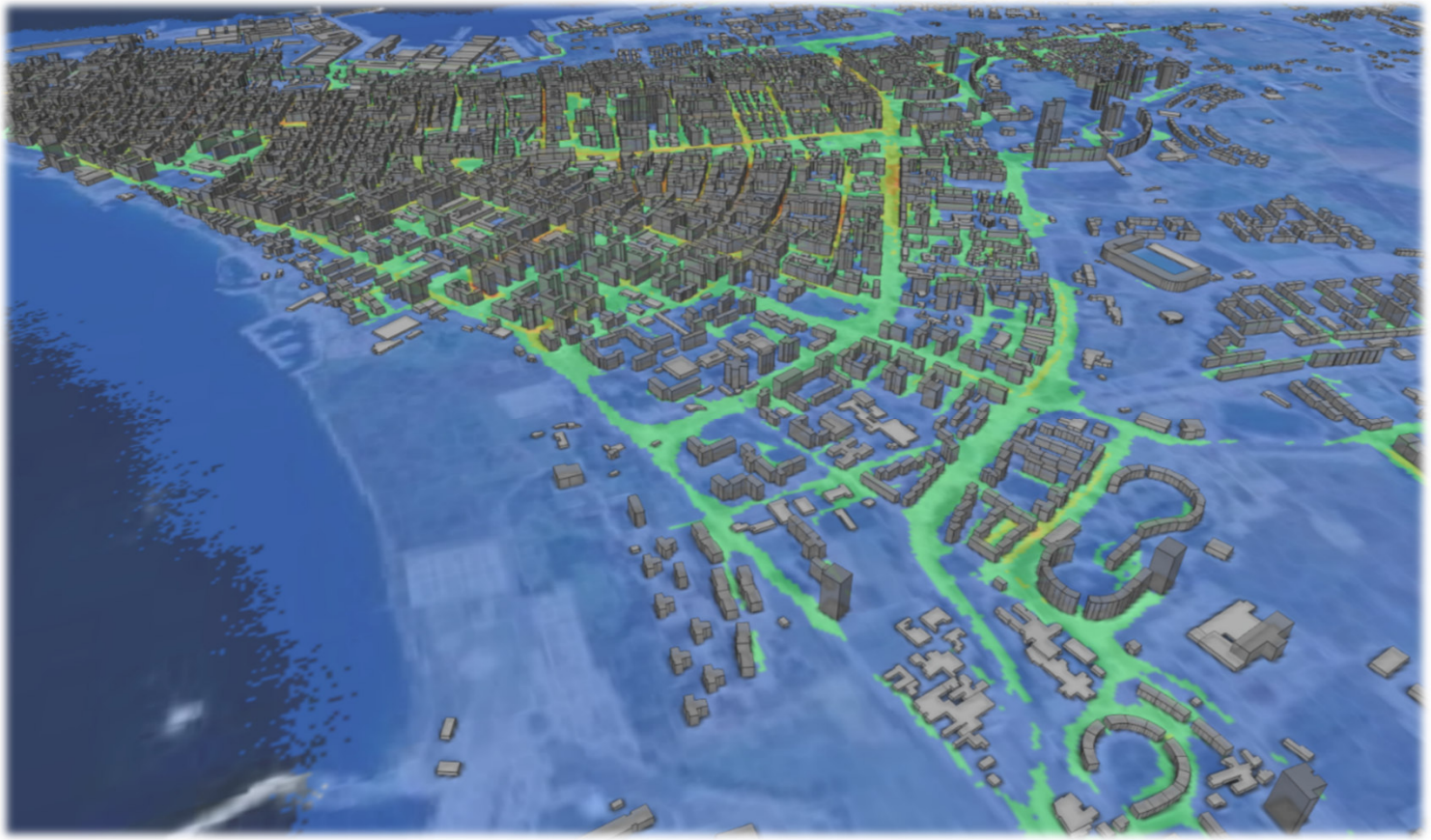


Concentrazione media di PM10 sull'anno meteorologico 2023

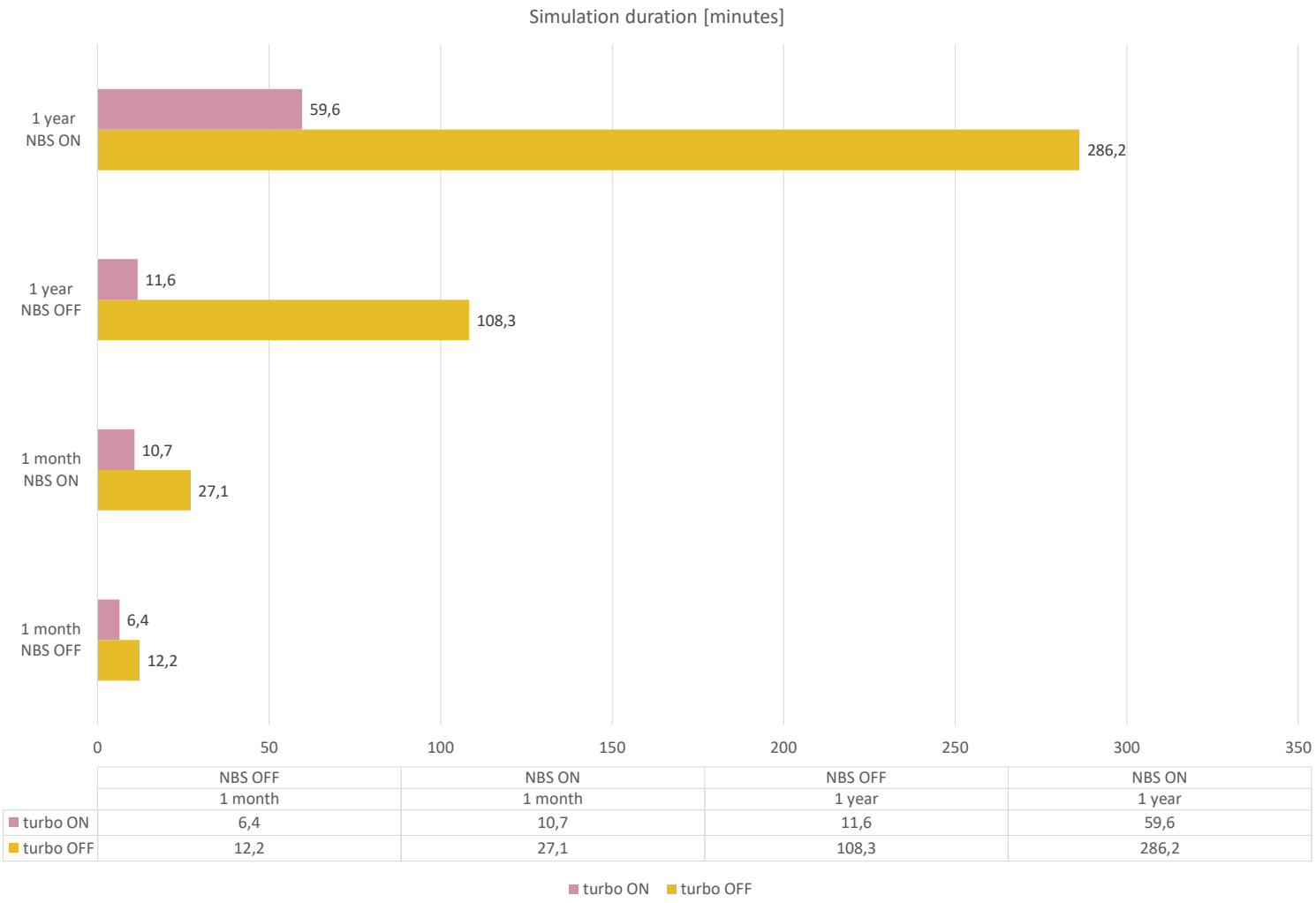




Concentrazione media di PM25 sull'anno meteorologico 2023



Ottimizzazione del tool e test di performance su macchina HPC Calliope



	NBS OFF 1 month	NBS ON 1 month	NBS OFF 1 year	NBS ON 1 year
turbo ON	6,4	10,7	11,6	59,6
turbo OFF	12,2	27,1	108,3	286,2

- Test del tool su macchina HPC Calliope superati
- Tempi stazionari inclusi:
  - TREFIC : ***3 minuti***
  - Post-processing: ***30 secondi***
- ***Turbo***: Implementata ottimizzazione del codice che consente di caricare in memoria tutti i kernel prima del loop temporale
  - **Funziona se a regime saranno effettivamente disponibili 200 GB di RAM (al momento sono 1,47 TB in totale)**

Data Fusion

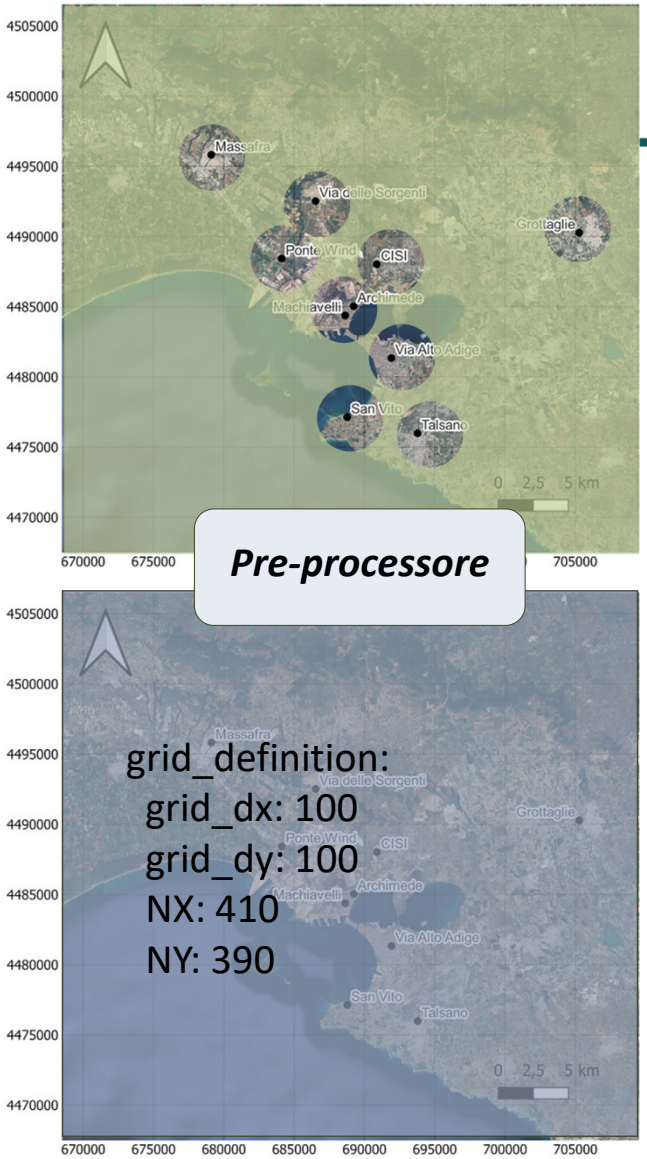
Osservazioni
Serie temporali orarie/giornaliere degli inquinanti PM10, NO2, PM2.5

Predittori - Proxies

Spatio-temporal
FARM (1 km)
Leaf Area Index (LAI)

Temporal (homogeneous)
Periodic functions of Julian day, day of week

Spatial (stationary)
Length roads in buf.
Population density
Land use
……



Pre-processore

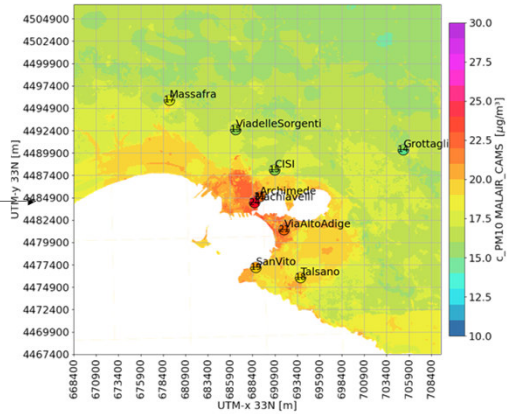
Training

ML model for PM10

Inference

Random Forest

Regional background
Ottenuto con data fusion
[ARPA PUGLIA + ARIANET]



Risoluzione: 100 m
Yearly conc maps

training
inference

Dati di Input
Modello / processo

Natural based solutions – scenario input

The user selects the areas where the nature-based solutions will be applied as disjointed georeferenced polygons (e.g., on QGIS).
Each polygon must intersect at least one road segment and contain the following attributes:

- **Type of leaves** (broad/needle – evergreen/deciduous)
- **Planting density** (average area occupied by trees as a percentage of the total free surface area of the polygon excluding buildings)
- **Tree height**

ID	H_TREE	TREE_TYPE	TREE_DENS
1	5	evergreen_needleleaf	0,5
2	52	deciduous_needleleaf	0,8
3	20	evergreen_broadleaf	0,6

Nature-based solutions must be provided to the tool in shapefile format: attributes and geometry are used as input to model their impact on concentration.

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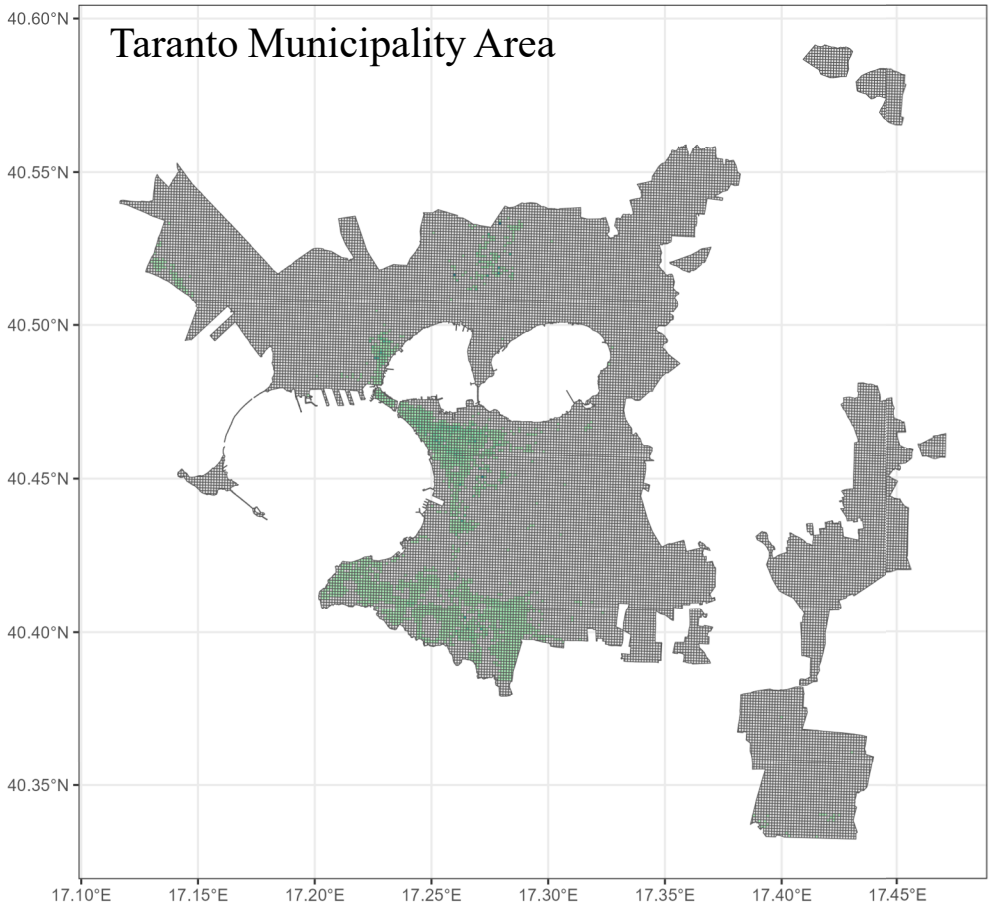
Overall Mortality and exposure to pollutants from an aggregate approach based on machine learning methods



Prediction of Deaths

Aim

Prediction of Deaths for each grid unit in Taranto Municipality map (100x100) using Air Pollutants exposure

Population

Residents in Taranto Municipality in 2023 (use of georeferencing)

Methods

Machine Learning approach using an Xgboost for regression model.

Mistral data platform structure

Individual primitive data (KEY-people Join)

Primary Data

1. Epidemiological Studies
   a. MISTRAL
   b. CALLIOPE
   c. ROAD
   d. POLEIS
   e. ….

Secondary Data

1. Health Electronics Records
a) Mortality data
b) SDO (hospital discharge records)
c) SDA (outpatient discharge forms)
d) Exemptions
e) Pharmaceutical prescriptions
f) Pathologic anatomies
g) Vaccinations
h) Infectious diseases
i) ....

2. Administrative flows (Common platforms)
a) Tax data
b) Real estate data
c) Subsidy data
d) ...

3. Benefit flows
a) INPS
b) INAIL
c) Disability conditions
d) ...

Primitive environmental data (point JOIN with KEY-geo).

1. Geospatial data (Sentinel, Landsat, TIM) [Punctual JOIN]
   a) Green and blue areas
   b) Air pollution
   c) Meteorological data
   d) Traffic data
2. Modeling data (Arianet, ARPA, TIM) [Punctual JOIN].
   a) Green and blue areas
   b) Air pollution
   c) Meteorological data
   d) Traffic data
3. Eletronic Contorl Units data [Join with nearest monitoring station(s)]

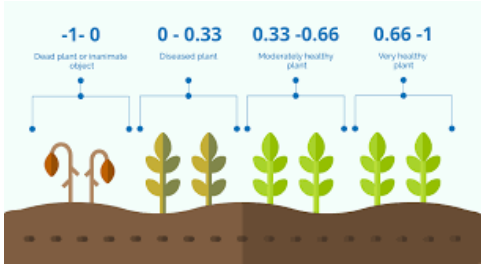
Mistral data platform structure

Geospatial Data and Preliminary Results

Land Surface Temperature (LST) is a crucial geophysical parameter related to the surface energy and water balance of the land-atmosphere system.
Satellite remote sensing offers the best way to measure LST and generate various LST products on regional and global scales.

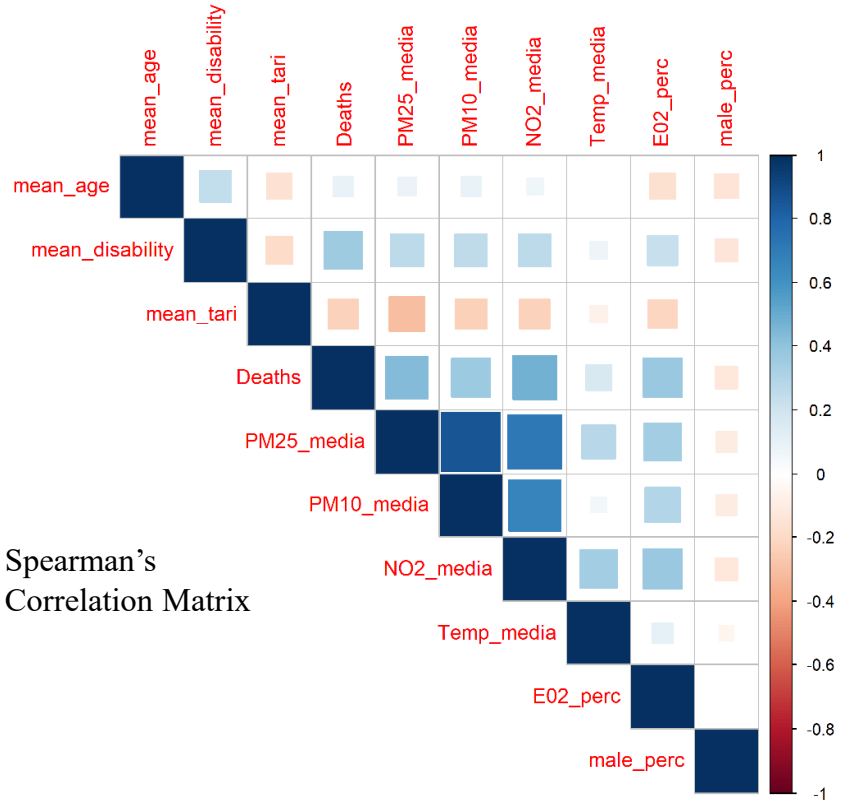
Normalized Difference Vegetation Index (NDVI) is a simple graphical indicator that can be used to analyze measurements obtained from remote sensing, via satellite, monitoring the level of living vegetation in the analysis area.

Values of major pollutants such as NO2, PM10, and PM 2.5 were identified according to diffusive models developed by ARIANET on a small scale (100x100m)



Georeferenced Overall Mortality

Aim: Association between air pollutants, SES and overall mortality in the 24567 grids



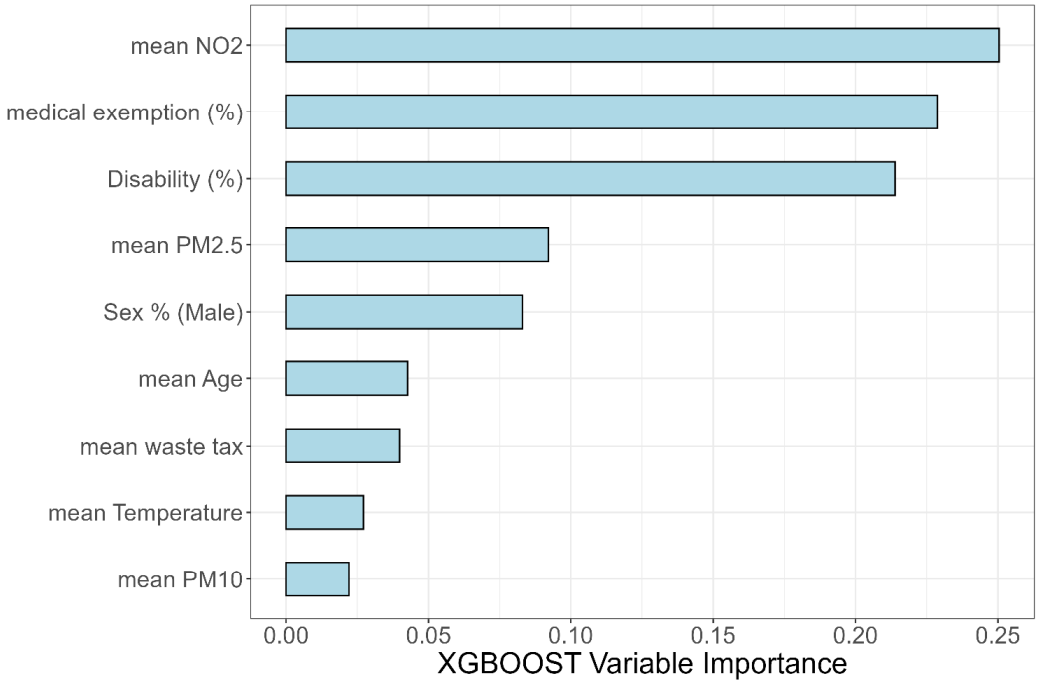
Spearman's Correlation Matrix

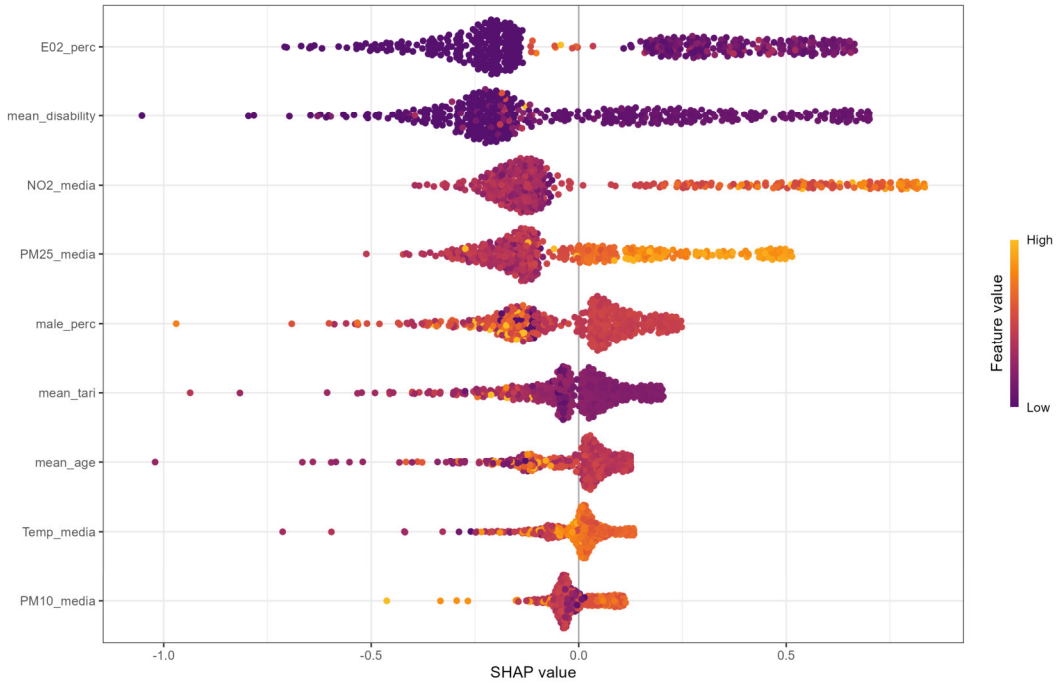
Linear Regression Model on Deaths as dependent variables and Sociodemographic and Enviromental features as regressors.

	Beta	Stand. Error	CI 95%
Age (years)	0.004	0.006	-0.007 to 0.015
Disability (%)	0.016	0.008	-0.01 to 0.032
Waste tax (€)	-0.001	0.001	-0.0001 to -0.001
PM 2.5 (25 µg/m³)	1.323	0.172	0.986 to 1.661
PM 10 (µg/m³)	-0.538	0.085	-0.704 to -0.371
NO2 (µg/m³)	0.26	0.023	0.215 to 0.304
Temperature (°C) (LST)	-0.097	0.052	-0.198 to 0.004
Medical Exemption (%)	0.014	0.006	0.003 to 0.025
Sex (Male. (%))	-0.007	0.004	-0.014 to 0.001

Statistical Learning Model (LM)

Extreme Gradient Boosting for regression (XGBoost) on overall mortality\grid





RMSE 0.91\0.88

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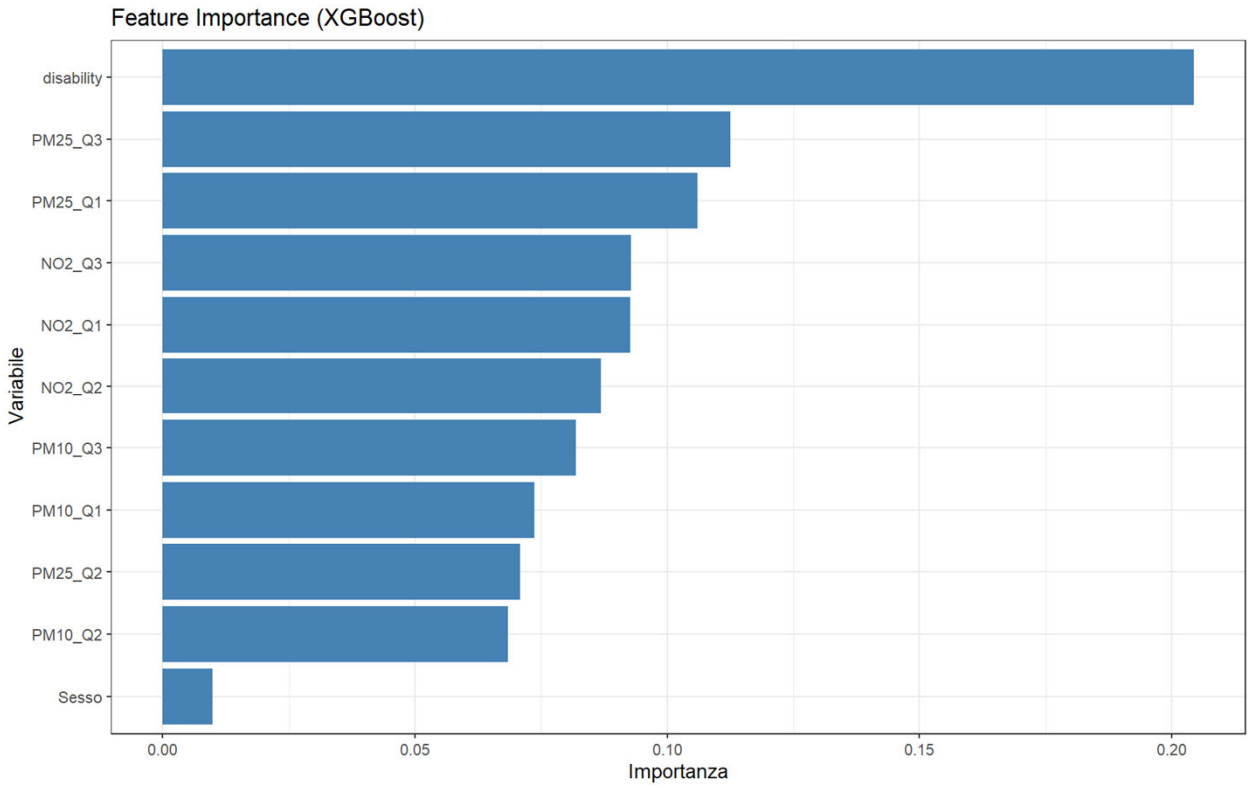
Aim: Association between air pollutants, SES and overall mortality in the 191.027 individuals from 2020 to 2023

	Alive		Dead		
	mean ± sd	median (iqr)	mean ± sd	median (iqr)	P
Proportions (n (%))	188604 (98.7)		2423 (1.30)		
Age (years)	47.394 ± 23.568	49.74 (37.65)	81.051 ± 12.76	83.73 (14.615)	<0.01
Sex					
Male	90436 (48.00)		1124 (46.40)		<0.01
Female	98168 (52.00)		1299 (53.60)		
Medical Expemption (yes)	14706 (0.08)		--		0.12
Disability (yes)	10882 (5.80)		390 (16.10)		<0.01
PM25_Q1	9.388 ± 0.686	9.671 (1.135)	9.515 ± 0.639	9.763 (0.879)	<0.01
PM25_Q2	10.42 ± 0.488	10.57 (0.656)	10.491 ± 0.457	10.634 (0.43)	<0.01
PM25_Q3	11.611 ± 0.687	11.871 (1.23)	11.734 ± 0.644	11.976 (0.898)	<0.01
PM10_Q1	18.642 ± 1.286	19.028 (1.945)	18.873 ± 1.184	19.177 (1.213)	<0.01
PM10_Q2	19.806 ± 1.171	20.067 (1.559)	19.985 ± 1.087	20.18 (1.162)	<0.01
PM10_Q3	21.159 ± 1.259	21.39 (1.651)	21.356 ± 1.178	21.547 (1.29)	<0.01
NO2_Q1	15.985 ± 3.466	15.923 (5.775)	16.629 ± 3.389	16.941 (4.84)	<0.01
NO2_Q2	17.054 ± 3.544	17.185 (5.818)	17.73 ± 3.474	18.167 (5.072)	<0.01
NO2_Q3	18.686 ± 3.818	18.819 (6.192)	19.437 ± 3.727	20.169 (5.614)	<0.01

COX Regression

	Thresholds	HR	CI 95%	Stand. Err.	p
Sex (F)		0.81	0.75 to 0.88	0.04	<0.01
disability1		1.03	0.92 to 1.15	0.04	0.58
PM25_Q1	9,39 ± 0,686	1.05	0.85 to 1.31	0.11	0.63
PM25_Q2	10,421 ± 0,488	0.80	0.63 to 1.02	0.12	0.07
PM25_Q3	11,613 ± 0,687	1.25	0.94 to 1.65	0.14	0.11
PM10_Q1	18,645 ± 1,285	1.14	0.96 to 1.35	0.08	0.13
PM10_Q2	19,809 ± 1,17	0.87	0.69 to 1.10	0.04	0.24
PM10_Q3	21,162 ± 1,258	0.97	0.81 to 1.15	0.06	0.70
NO2_Q1	15,993 ± 3,466	0.86	0.77 to 0.95	0.03	<0.01
NO2_Q2	17,062 ± 3,544	1.18	1.04 to 1.35	0.05	0.01
NO2_Q3	18,695 ± 3,817	0.99	0.91 to 1.07	0.06	0.77
age_group (10-19y)		0.26	0.05 to 1.35	0.03	0.11
age_group (20-39y)		0.71	0.25 to 2.02	0.83	0.52
age_group (40-59y)		5.83	2.39 to 14.24	0.44	<0.01
age_group (60-79y)		31.99	13.27 to 77.10	0.43	<0.01
age_group (>80y)		215.77	89.65 to 519.32	0.44	<0.01

ML Approach (XG BOOST survival) 2020 al 2023



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