4th plenary session: URBAN PUBLIC HEALTH

Design & Health
International Academy for Design and Health

POLITECNICO MILANO 1863
DIPARTIMENTO DI ARCHITETTURA, INGEGNERIA DELLE COSTRUZIONI E AMBIENTE COSTRUITO

Milano, Italy 11-14 April 2024

Design & Health

13TH WORLD CONGRESS & EXHIBITION

REVITALIZING HEALTH BY SALUTOGENIC DESIGN

Healthy environment | Healthy people

Urban health in interdisciplinary resilience assessment
the H2020-HARMONIA project

P.Morandini[1], M.Bicchieri[1], A. Voza[1], M.S. Lux[2], **J.N. Tzortzi**[2]

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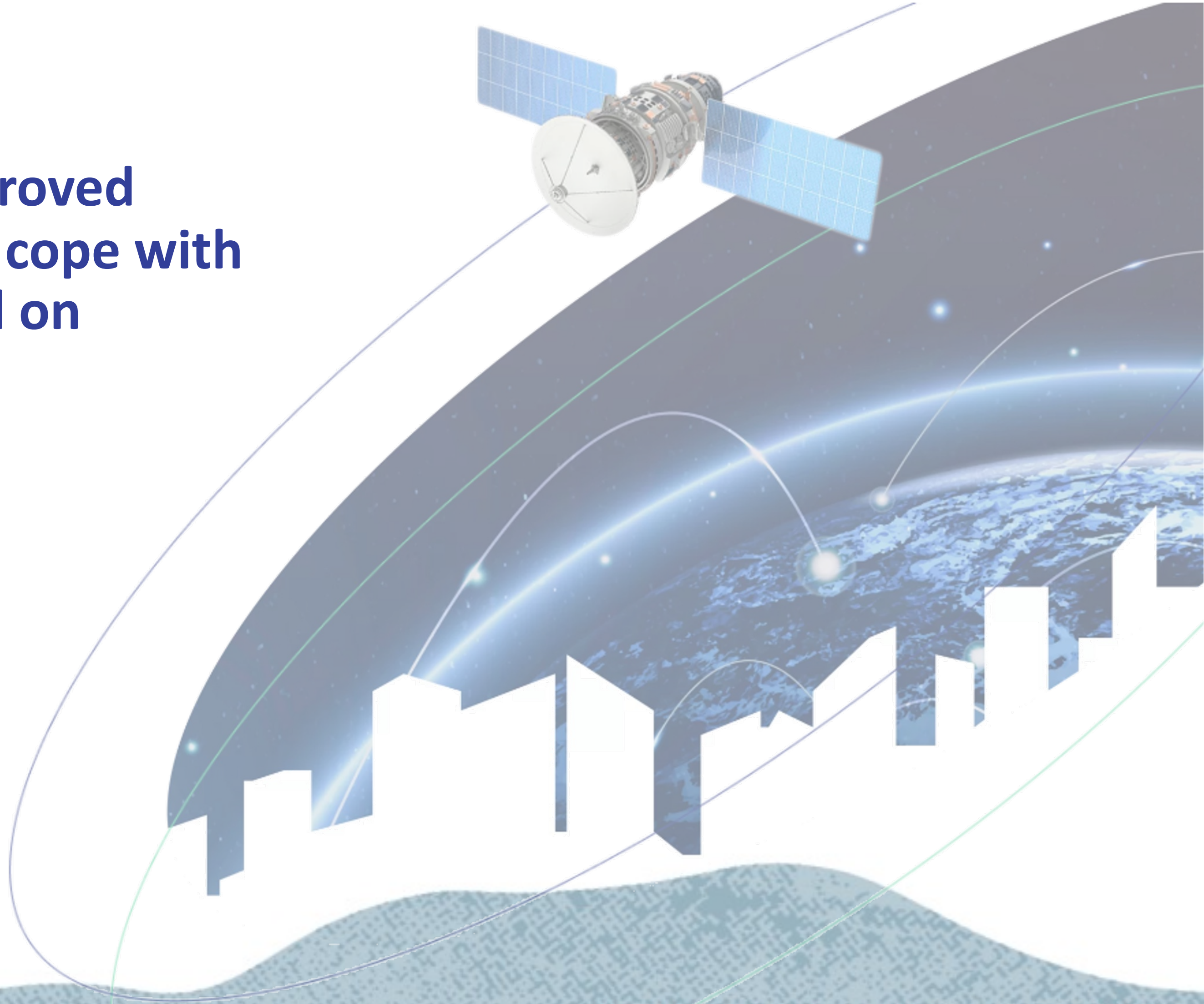
HARMONIA

Development of a Support System for Improved Resilience and Sustainable Urban areas to cope with Climate Change and Extreme Events based on GEOSS and Advanced Modelling Tools

LC-CLA-19-2020: Integrated GEOSS climate applications to support adaptation and mitigation measures of the Paris Agreement

The HARMONIA project has received funding from the EU Horizon 2020 research and innovation programme under agreement No. 101003517.



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P.MORANDINI, M.BICCHIERI, A. VOZA, M.S. LUX, J.N. TZORTZI

THE PURPOSE

HARMONIA's main objective is to reorganise and integrate the huge amount of data already available and to make the best use of existing monitoring technologies and geospatial services for urban hazard assessment and disaster risk management.

22 PARTNERS

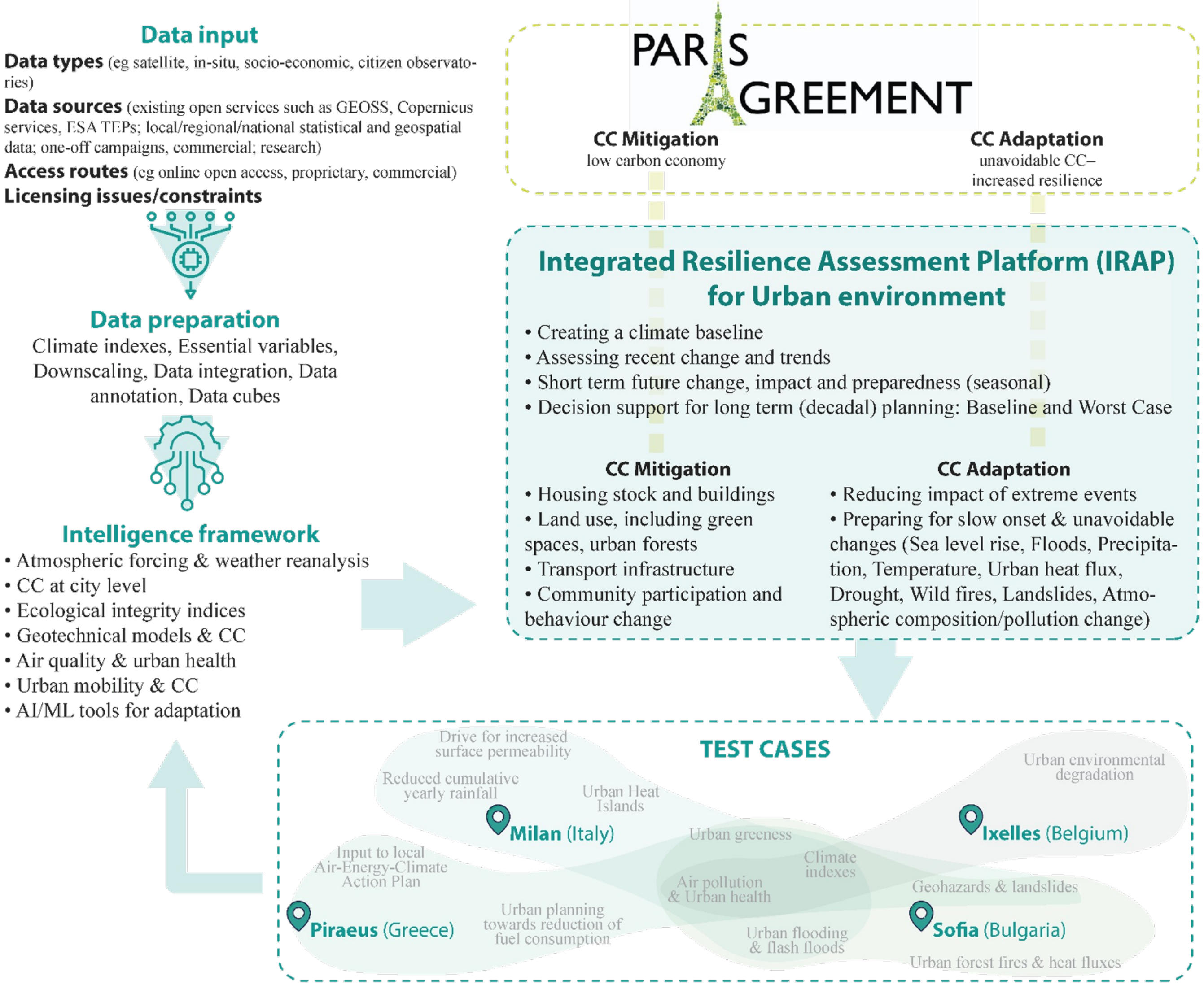
4 Academias
9 Companies
4 Research institutes
1 NGO
4 Municipalities

4 PILOT CITIES

Milan (Italy)
Sofia (Bulgaria)
Piraeus (Greece)
Ixelles (Belgium)

THE APPROACH

HARMONIA capitalises on a wealth of existing Earth Observation (EO) datasets and services with ensemble modelling, socio-economic and in-situ data at the spatial and temporal scales relevant for the urban environment in order to deliver an **Integrated Resilience Assessment Platform** (IRAP)



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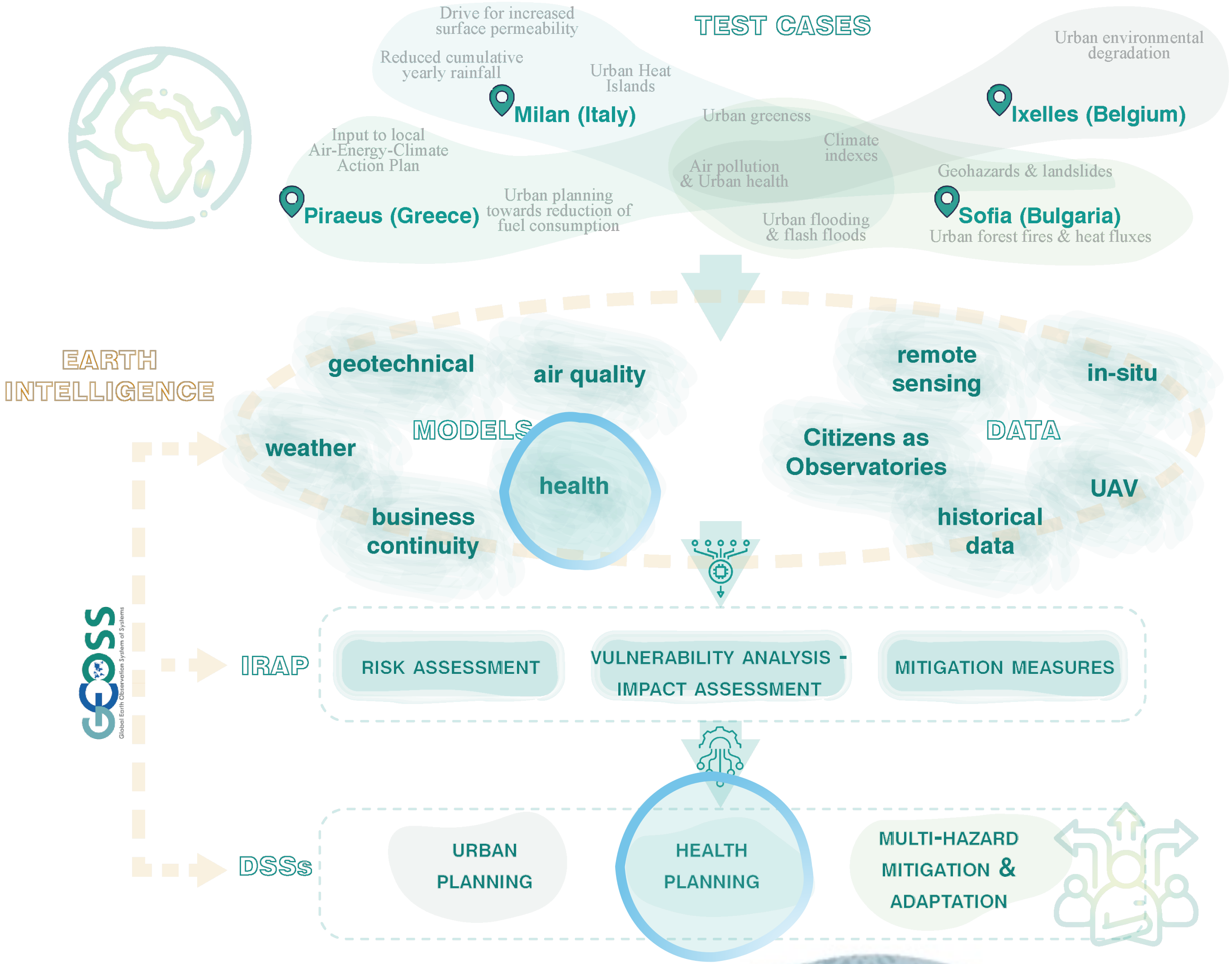
THE GOAL

The IRAP is a system that allows stakeholders to model a range of planning options against a number of CC scenarios towards targeted applications in order to mitigate CC effect in urban areas, helping deliver resilient cities for current and future generations.



HEALTH and RESILIENCE

- Urban conditions can pose issues and risks to human well-being
- Adverse health outcomes include the increased frequency of cardiovascular events (CVEs) and respiratory diseases
- the COVID-19 pandemic made the discussion about urban health even more urgent

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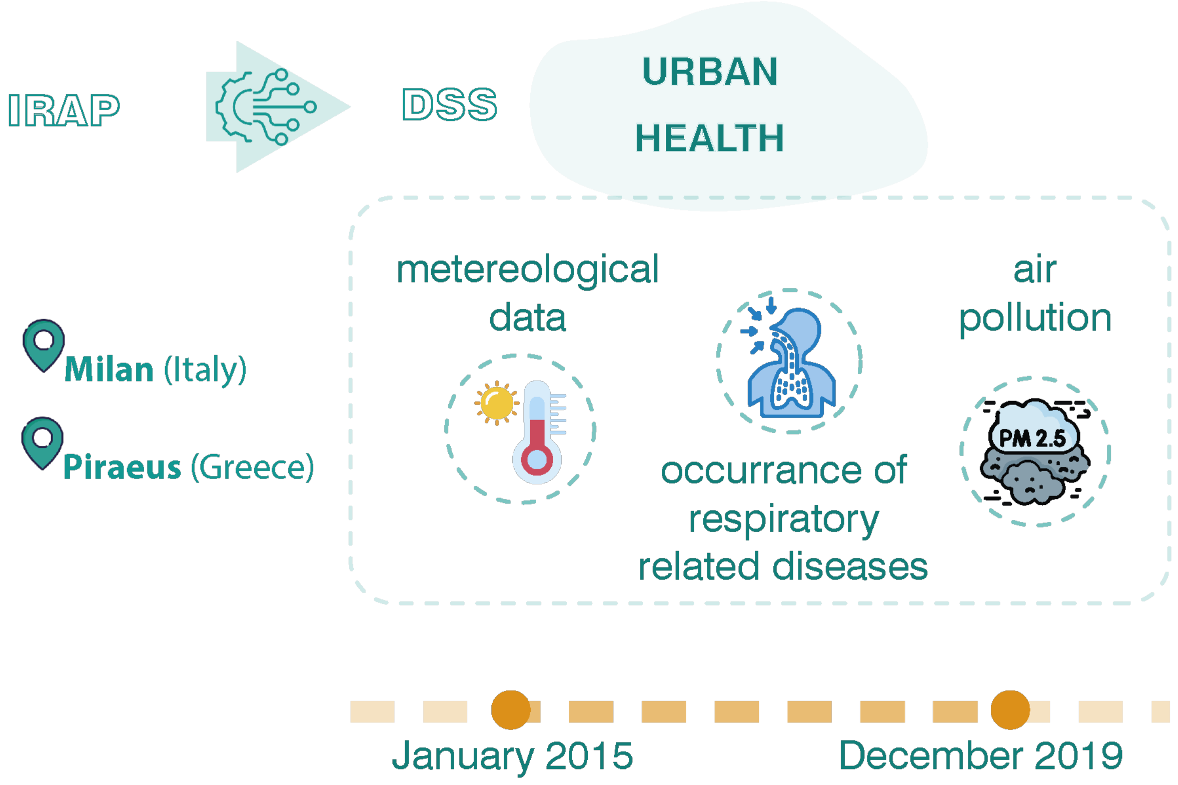
URBAN HEALTH

Decision Support System as a Tool

- correlation between the probability of occurrence of chronic respiratory related diseases and environmental factors
- application in the pilot cases of Milan (Italy) and Piraeus (Greece)
- the final dataset spans from January 2015 to December 2019 (COVID pandemic is excluded)



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INPUT DATA

HEALTH DATA FROM HOSPITALS

MILANO PIRAEUS

- daily number of visits to the hospital's Emergency Department related to respiratory diseases
- reference to the International Classification of Diseases (ICD) version 9 codes assigned to each encounter after the visit performed by a clinician.

ICD 9 code	Description
460	Acute nasopharyngitis
461	Acute sinusitis
462	Pharyngitis, acute
463	Tonsillitis, acute
464	Acute laryngitis and tracheitis
465	Acute upper respiratory infections of multiple or unspecified sites
466	Acute bronchitis and bronchiolitis
478	Other diseases of upper respiratory tract
480	Viral pneumonia
481	Pneumococcal pneumonia
482	Other bacterial pneumonia
485	Bronchopneumonia, organism unspecified
486	Pneumonia, organism unspecified
487	Influenza
490	Bronchitis, not specified as acute or chronic
491	Chronic bronchitis
493	Asthma
494	Bronchiectasis
496	Chronic airway obstruction, not elsewhere classified
506	Respiratory conditions due to chemical fumes and vapors
507	Pneumonitis due to solids and liquids
508	Respiratory conditions due to other and unspecified external agents
511	Pleurisy
512	Pneumothorax
518.4	Acute edema of lung, unspecified
518.81	Acute respiratory failure
518.82	Other pulmonary insufficiency, not elsewhere classified
518.83	Chronic respiratory failure
518.84	Acute and chronic respiratory failure
519.8	Other diseases of respiratory system, not elsewhere classified

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INPUT DATA

ENVIRONMENTAL DATA

- metereological and air pollution data
- data from the local network of environmental measurements (e.g. ARPA for Milan)

Feature	Unit of Measure
Wind direction	°
Wind speed	m/s
Rain	mm
Temperature	°C
Humidity	%
Atmospheric Pressure	mmHg
Global radiation	W/m2
Hydrometric level	cm

Feature	Unit of Measure
Benzene	µg/m3
Nitrogen Dioxide (NO2)	µg/m3
Nitrogen Oxides (NOx)	µg/m3
Sulfur Dioxide (SO2)	µg/m3
Carbon Dioxide	µg/m3
Ozone (O3)	µg/m3
PM 10	µg/m3
PM 2.5	µg/m3

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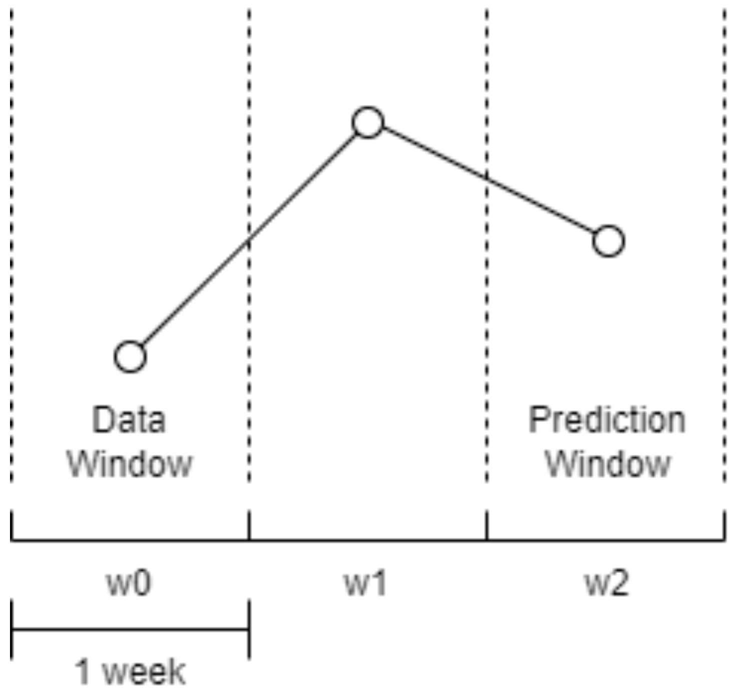
DATA PROCESSING

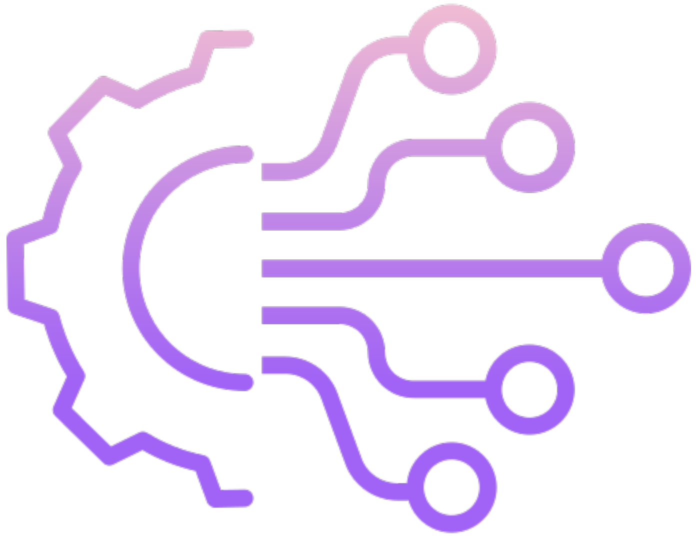
- tests with different aggregation levels (daily, weekly, and bi-weekly) → weekly aggregetion was selected
- 2 steps pre-processing : (1) use of the **Variance Inflation Factor** (VIF) to select only independent features and(2) use of a **feature engineering step** to extract the number of the week within the year
- use of a **regression framework**, in which the environmental data are used as features to predict the number of hospital encounters expected two weeks ahead



BUILDING THE MODEL

ANALYSIS SHOW

- strong non-linearity and periodical behavior of the data → use of the Extreme Gradient Boosting Ensemble Modelling with classification trees
- model in a pipeline after a features scaling stage (standard scaling)
- the target data are composed of integer numbers → the model was trained to optimize a Poisson loss function



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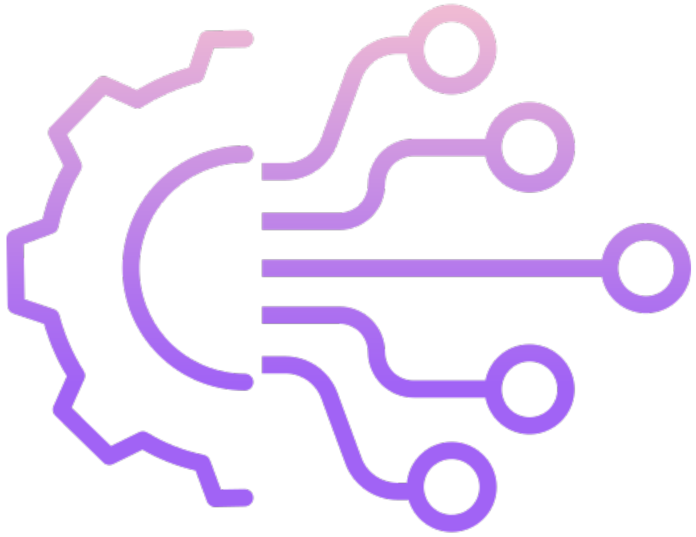
BUILDING THE MODEL

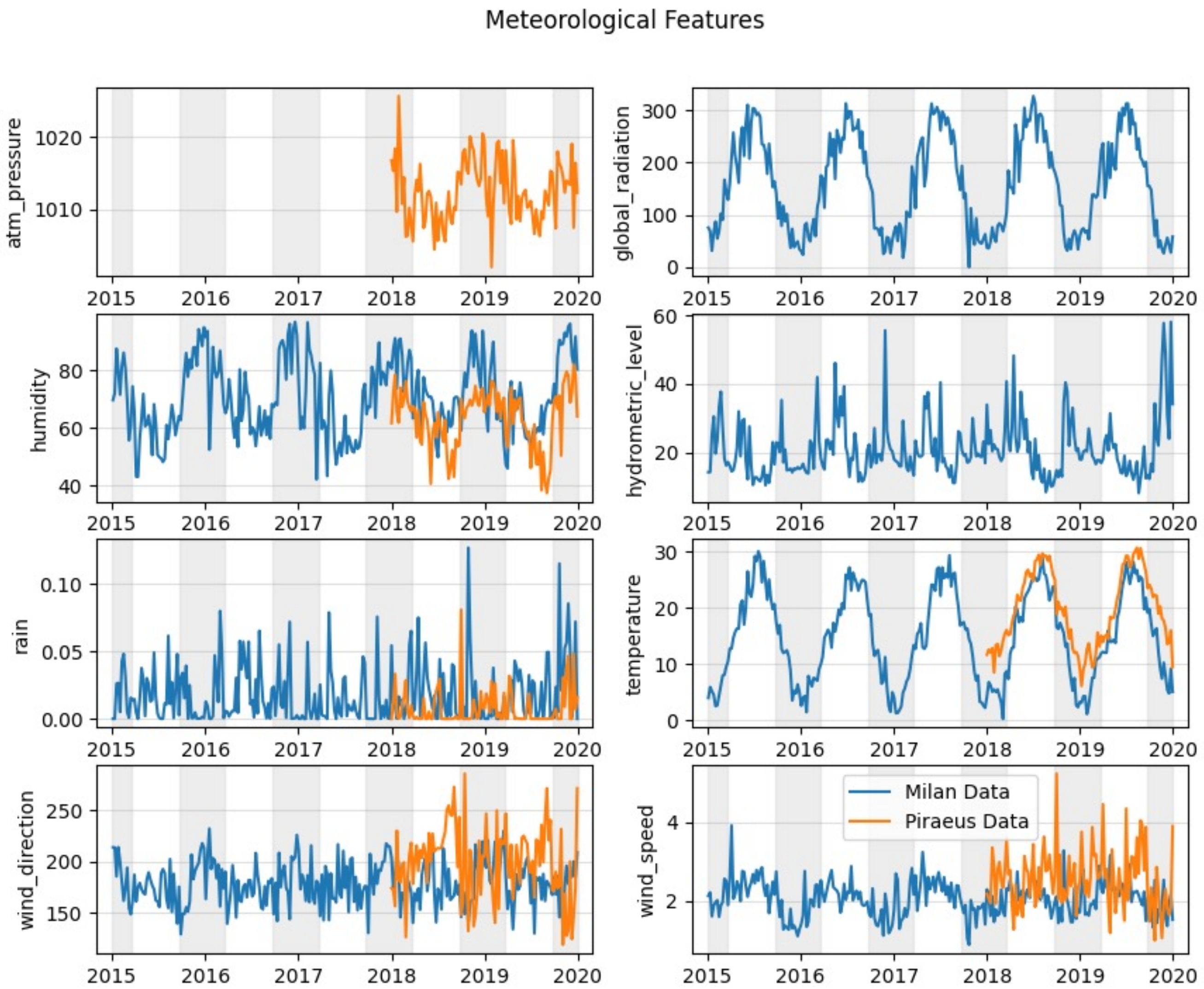
- hyper-parameter tuning with a Random Sample approach to optimize mainly the regularization parameters
- non-independent and non-identically distributed nature of the dataset → stratified splitting approach: training set (2015-17), validation set (2018), and test set (2019)
- use of various performance indices (R2, explained variance, and mean Poisson deviance)



RESULTS

ENVIRONMENTAL DATA

- good quality and completeness of the data time series in Milan
- missing data and gaps in the time series for Piraeus → reduction of the period considered for the model training



RESULTS

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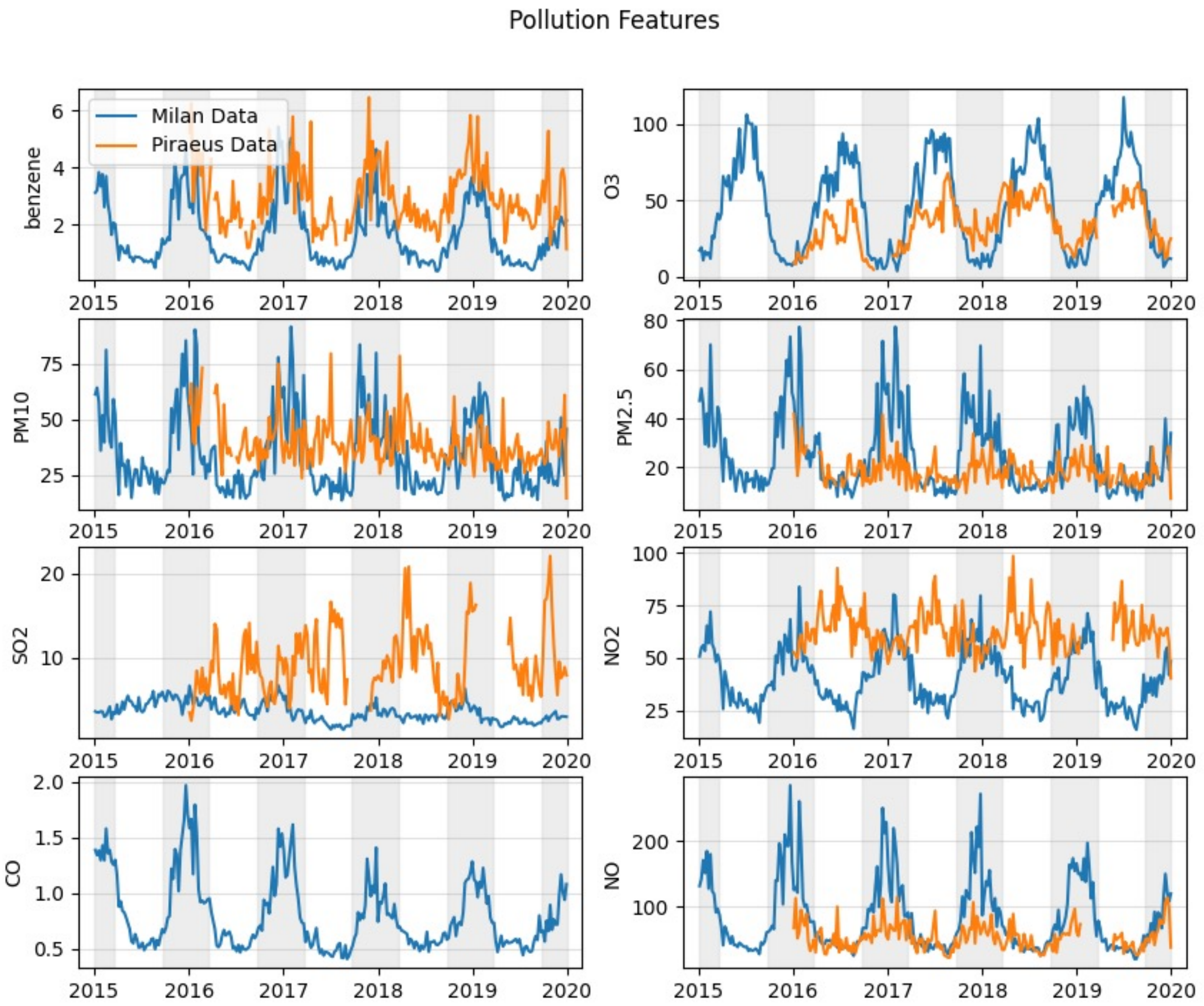
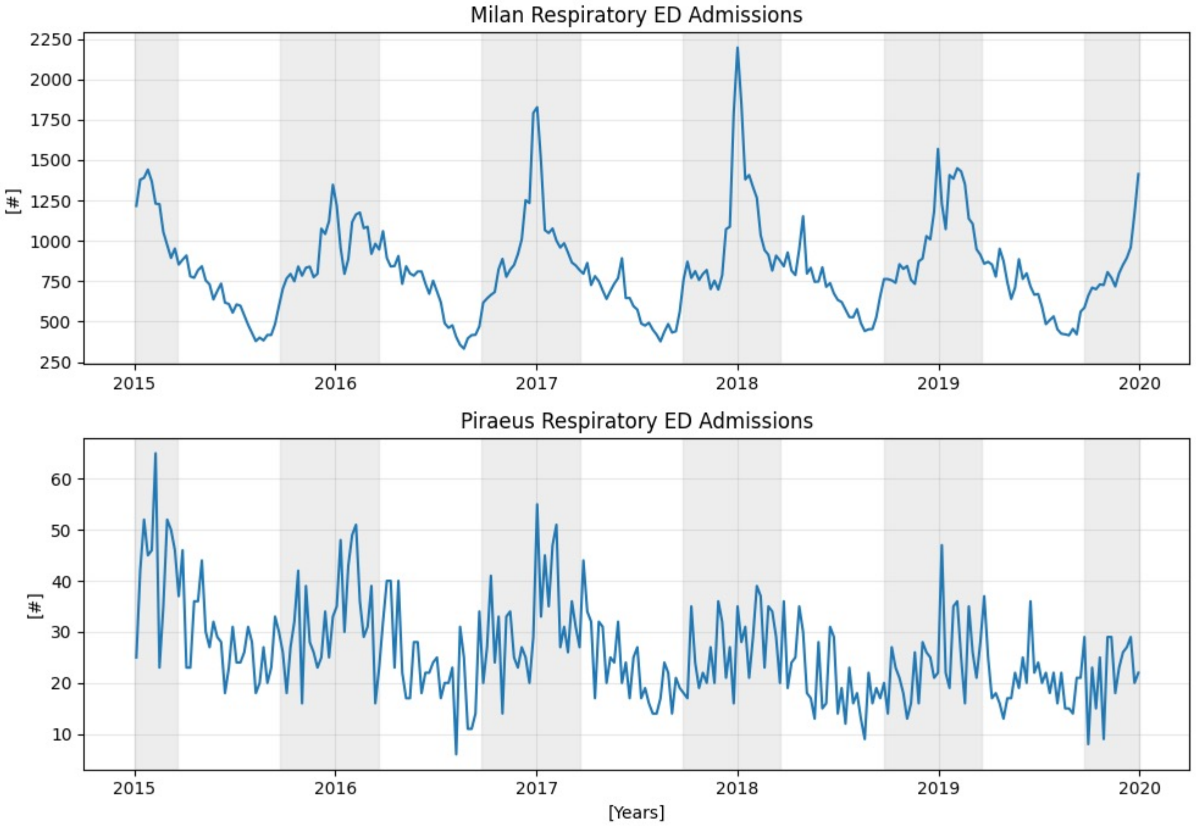


RESULTS

HEALTH DATA

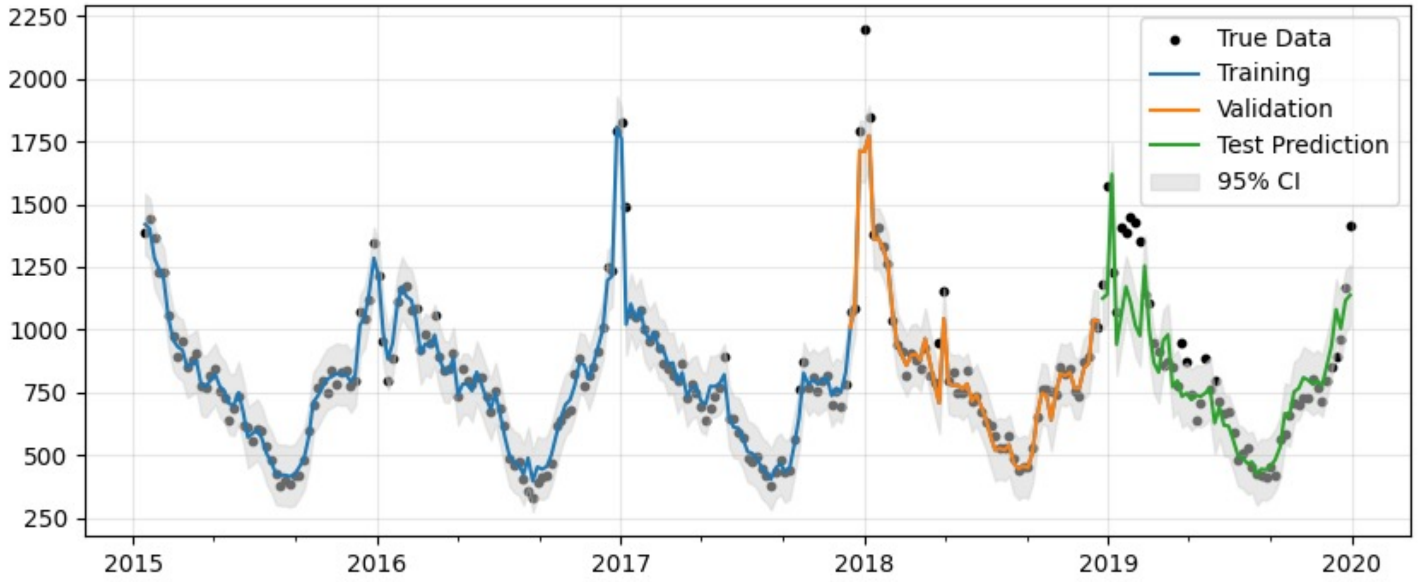
- data provided by Osservatorio Epidemiologico of Milan and by the Municipality of Piraeus
- good quality and completeness of the time series in both cases
- high seasonality can be observed



MODELLING

MILAN (ITALY)

- 95% confidence interval for the predictions (gray area)
- the model is able to identify the relationship between features and outcomes
- the quality of the predictions remains almost stable between validation and test sets



Index	Validation	Test
explained_variance	0,952	0,828
r2	0,943	0,821
mean_poisson_deviance	5,869	15,044
mean_absolute_percentage_error	0,053	0,095

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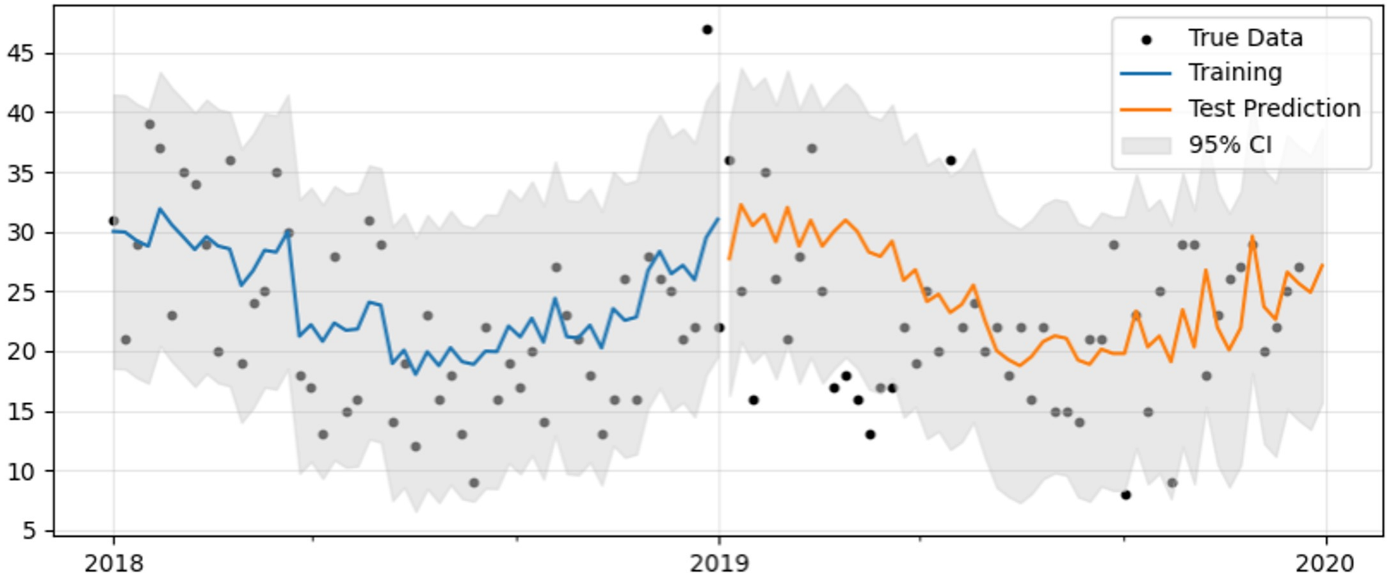
MODELLING

PIRAEUS (GREECE)

- do to data misalignment, 2018 data were used as training set, and 2019 data for validation
- there is a significant variance around the seasonal mean which complicates the modelling



Index	Validation	Test
explained_variance	0,485	0,146
r2	0,449	0,016
mean_poisson_deviance	1,435	1,858
mean_absolute_percentage_error	0,248	0,291

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RESULTS

Milan

- The model fitted on Milan data shows a good fit and could be used in a deployment stage.
- A final validation using fresh data might be necessary to validate the model for a more comprehensive and final evaluation.

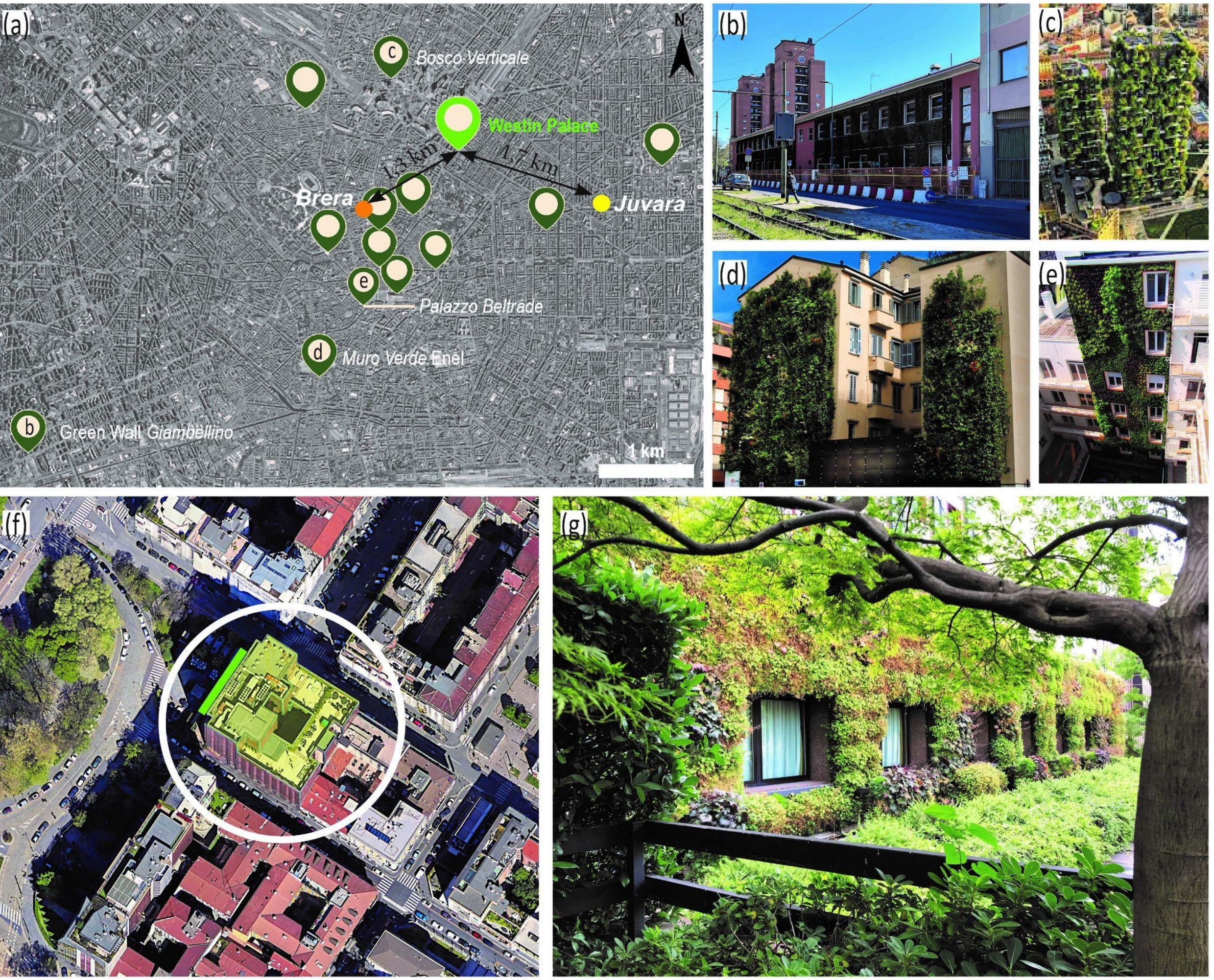
Piraeus

- The model quality is lower due to missing data that are not possible to interpolate.
- The proximity of Piraeus to Athens raises the possibility of patients from Piraeus seeking medical attention in Athens hospitals.
- A more in-depth validation process is imperative to investigate these complexities and ensure the model's reliability.

HARMONIA

Evaluating climate change mitigation capability of a living wall located in Milan through a 1-year microclimate monitoring

Ozge Ogut[a,b], Nerantzia Tzortzi[a], Stefano Cavazzani[b,c] Chiara Bertolin[b]

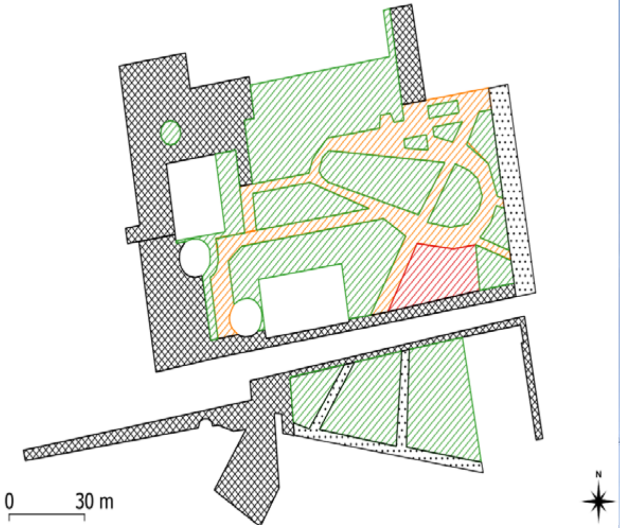


land

Article

Remote Sensing and Field Measurements for the Analysis of the Thermal Environment in the "Bosco Verticale" Area in Milan City

Georgios Kalogeropoulos [1,*], Julia Tzortzi [2,*] and Argiro Dimoudi [1]



Thanks for your attention!

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