Sensori intelligenti per la valutazione dell'impatto di soluzioni basate sulla natura (NBS) in area urbana

TORINO PM 2024

XI convegno sul particolato atmosferico
PM2024
Torino, 28-31 Maggio 2024

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INFN Istituto Nazionale di Fisica Nucleare

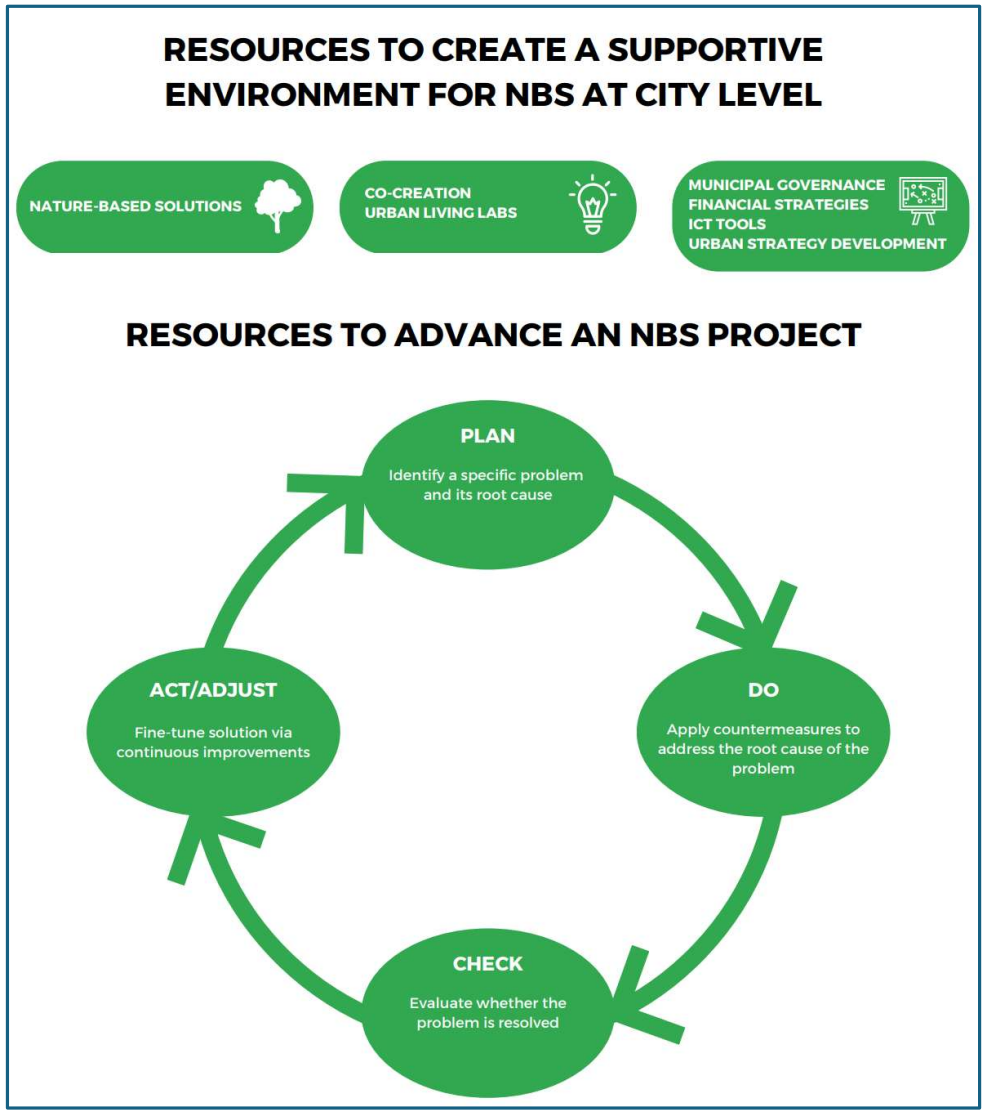
ITINERIS

IL PROGETTO UNALAB

- **UNaLab**: progetto finanziato Horizon 2020
- **QUANDO? : giugno 2017 - novembre 2022** (esteso a Dic 24)
- **COSA?** : - migliorare la **sostenibilità urbana** attraverso soluzioni basate sulla natura **(NBS)**
  - creazione di **Laboratori Naturali Urbani (UNL)** per testare ed implementare soluzioni innovative volte a **ridurre impatto ambientale** e migliorare **biodiversità urbana**
  - creazione **database** di riferimento su benefici, efficacia dei costi, fattibilità economica, replicabilità delle NBS.
- **CHI?** : - **28** partner
  - **3** città **front-runner** (EU): Eindhoven (NL), Tampere (FI) e **Genova** (IT)
  - **7** città **follower**: Stavanger, Praga, Castellón, Cannes e Başakşehir (EU) + Hong Kong, Buenos Aires (extra EU)
  - **2** città **observer:** Guangzhou, rete brasiliana smart cities

UNaLab REPLICATION FRAMEWORK:
Urban Nature Labs (UNL)

- **Replication framework:** raccolta delle risorse, esperienze e buone pratiche del progetto →**Urban Nature Labs (UNL)**
- **Key Project Index (KPI):** indice valutazione efficacia delle diverse **NBS** implementate.
- **KPI DiFi UniGE:** variazione locale di T (Heat Urban Island effect), PM2.5, PM10, NO2, O3 (riduzione livelli inquinamento)
- **Installate 2 centraline: INTERNO – ESTERNO area Urban Nature Lab (UNL)**



UNaLab: LE CITTA' PILOTA

TAMPERE (FI)

CRITICITA': inondazioni, gestione delle acque meteoriche

NBS: strutture per le acque meteoriche come stagni di ritenzione, biofiltri e prati alluvionali per integrare le infrastrutture blu e verdi esistenti in città. Muro verde e biofiltro per trattamento acque contaminate.

HEINDHOVEN (NL)

CRITICITA': inondazioni, stress da calore urbano, inquinamento atmosferico, diminuzione della qualità della vita.

NBS: spazi e strutture verdi in aree del centro cittadino, facciate verdi, tetto verde, corso d'acqua è stato illuminato a giorno.

GENOVA (IT)

CRITICITA': condizioni climatiche estreme, gestione dell'acqua, stress da calore e inquinamento dell'acqua e dell'aria.

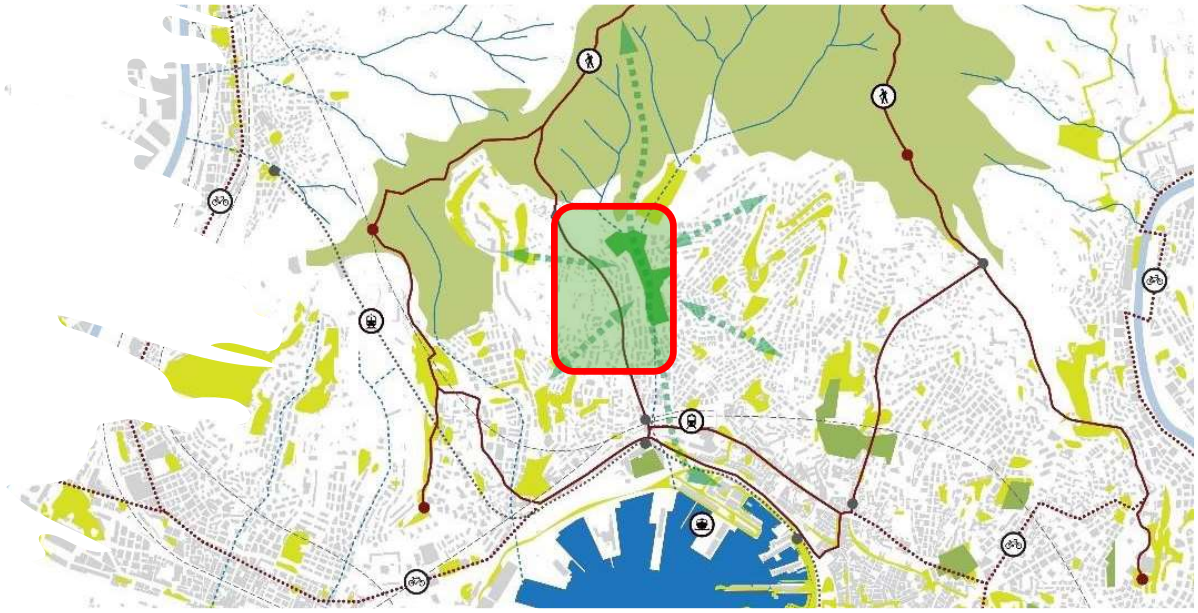
NBS: nuovo **parco urbano**, che accoglie aree verdi dotate di biostuoie (bioswales), bacini di infiltrazione e giardini pluviali per migliorare la gestione e la qualità dell'acqua

GENOVA: la città

- **GENOVA** terza città del NORD per numero di abitanti (~600K)
- posizionata in **stretta zona costiera** con **colline e montagne ripide** nel retroterra.
- **frequenti inondazioni** causate da intense precipitazioni su paesaggio altamente urbanizzato
- **sfide ambientali:** meteo estremo, gestione risorse idriche, stress da calore e inquinamento acqua/aria

GENOVA: il quartiere LAGACCIO

- Quartiere **LAGACCIO**: centrale, densamente popolato, collega area Porto Antico, il centro storico e parco naturale del Peralto (~850 ettari)
- Urbanizzazione disorganizzata, **edifici residenziali multipiano** e siti abbandonati (ex caserma militare).
- Il Comune di Genova ha trasformato l'area di **Gavoglio** in un **parco pubblico urbano (16,000 m2)** inclusivo e sostenibile, costruito con **12 diverse NBS**.



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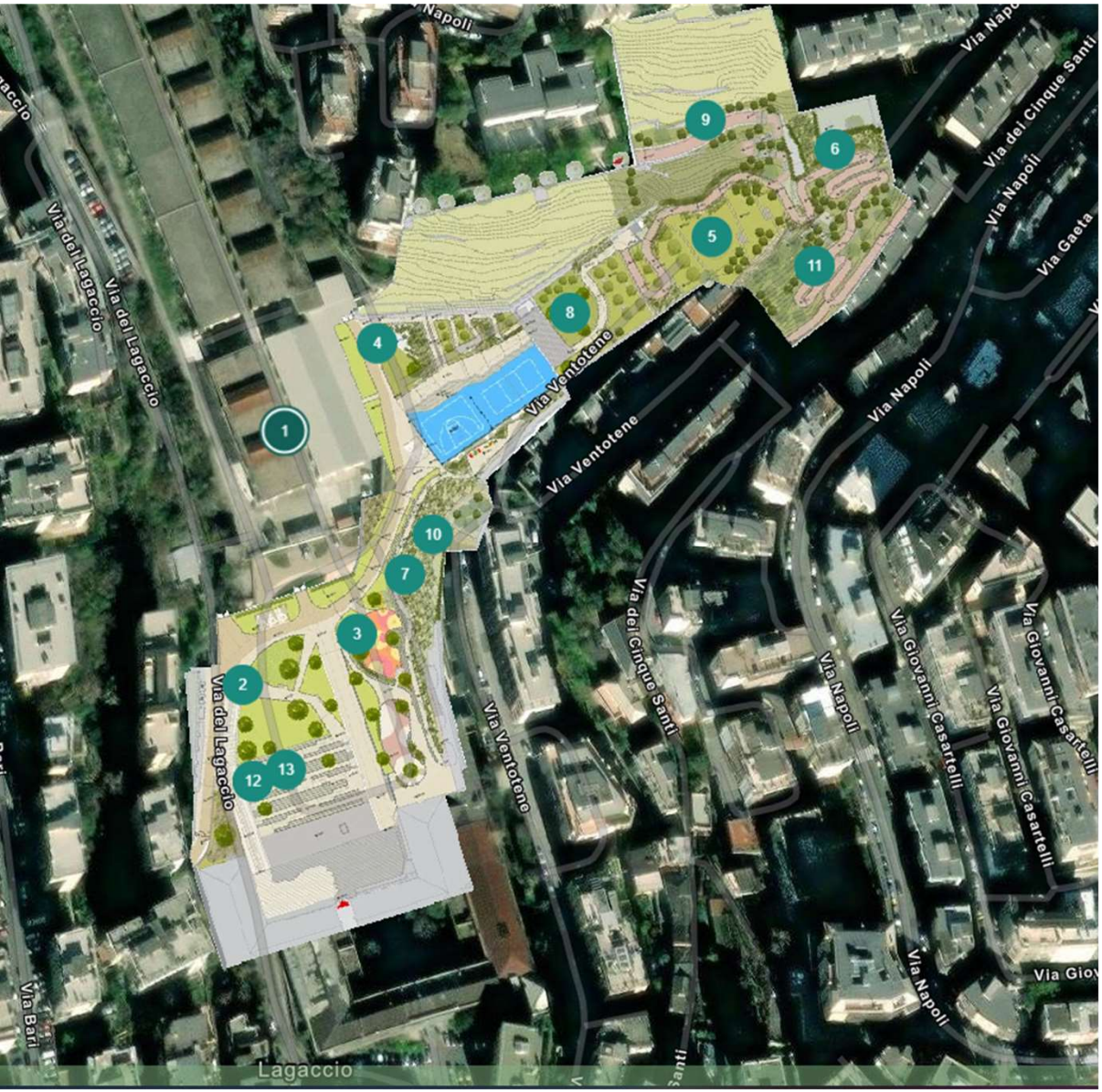


GENOVA: il parco urbano Gavoglio (12 NBS)

2. Draining pavements
3. Sand playground
4. Rain garden
5. Infiltration basin
6. Bioswales
7. Tree groups and green areas
8. Drought-resilient orchard and meadows
9. Slope afforestation
10. Green wall
11. Natural engineering for slope securing
12. Gabions
13. Underground water retention basins


2
Draining pavements


4
Rain Garden


5
Infiltration basin


6
Bioswales


7
Tree groups and green areas


8
Drought-resilient orchard and meadows


9
Slope afforestation


10
Green wall


11
Natural engineering for slope securing


12
Gabions


13
Underground water retention basins

Il sensore intelligente: Sensit Ramp unit

PRODUCT SPECIFICATIONS

Weight	Base unit: 7.5 lbs
Dimensions	Fully assembled without anemometer or antenna D x W x H (5" x 10" x 12")
Mounting	Attached mounting flanges
Voltage Requirements	18V – 24V DC Charging (wired adapter or solar panel)
Current Requirements	2A max current draw when charging
Operating Runtime	3-15 days battery backup
Operating Temp	-20°C to 50°C
Data Outputs	Digital wired output (3.3V TTL - USB) Wireless (Cellular Included) SD card data backup

Notes:
1. The optional anemometer is to be mounted separate to a pole. Could be same pole as sensor.
2. Battery backup time depends on run mode and frequency of transmission.
3. Requires SIM card and suitable data plan on AT&T or T-mobile.
4. Cloud based analytics can be developed with additional contract.
5. When removing SD card to obtain data, it is recommended to power off the sensor box prior to reinserting the SD card to avoid possible errors. If the system stops responding after inserting an SD card, power down the sensor and turn back on.

SENSOR SPECIFICATIONS

CO Detection Range	100 ppb – 25 ppm
CO Accuracy	+/- 100 ppb min or 50%
NO Detection Range	20 ppb – 25 ppm
NO Accuracy	+/- 20 ppb min or 50%
NO_2 Detection Range	20 ppb – 25 ppm
NO_2 Accuracy	+/- 20 ppb min or 50%
O_3 Detection Range	20 ppb – 25 ppm
O_3 Accuracy	+/- 40 ppb min or 50%
SO_2 Detection Range	20 ppb – 25 ppm
SO_2 Accuracy	+/- 20 ppb min or 50%
Response Times	60-90 seconds - CO, NO, NO_2, O_3, SO_2
Detection Method	Electrochemical - CO, NO, NO_2, O_3, SO_2
CO_2 Detection Threshold	100-2000 ppm
CO_2 Accuracy	+/- 200 ppm min or 50%
CO_2 Response Time	15-30 seconds
CO_2 Detection Method	NDIR Optical
PM2.5 Detection Threshold	1 - 1000 µg / m
PM2.5 Accuracy	+/- 10 µg / m3 min or 50%
PM2.5 Response Time	15-30 seconds
PM2.5 Detection Method	Laser Scattering

Periodic Maintenance
Periodic cleaning of sensor openings of dust, zero point calibration, and single point calibration. User replacement of sensors is easily performed as needed.

Additional Included Sensor
Additional sensors can be added (external ports)

Front

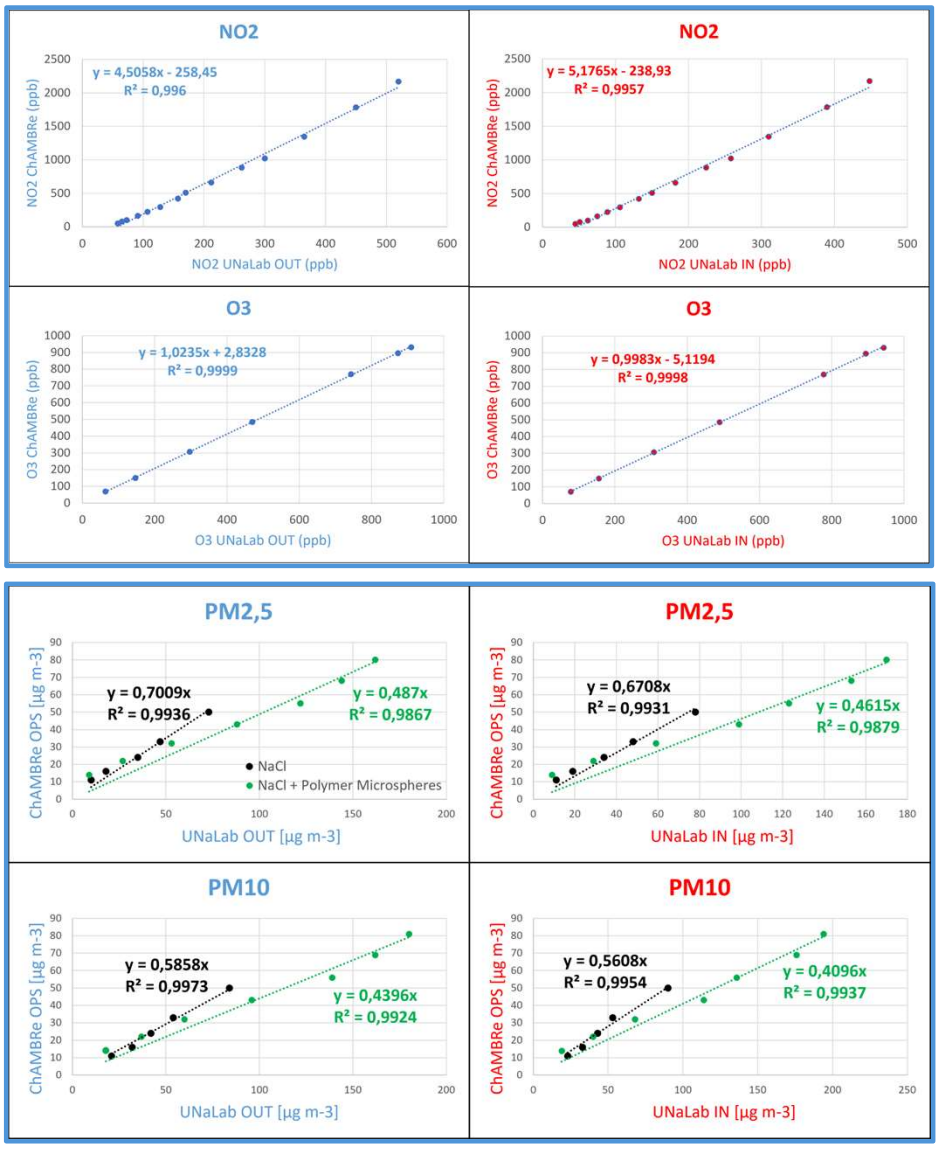

Right Side Left Side


Bottom

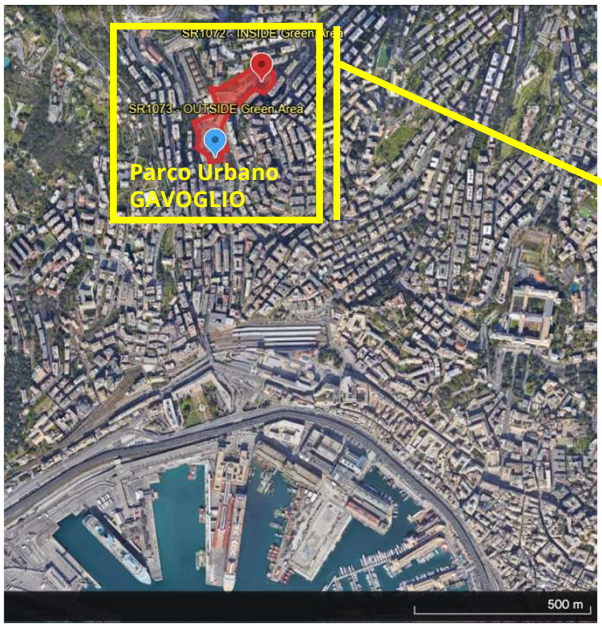

Back

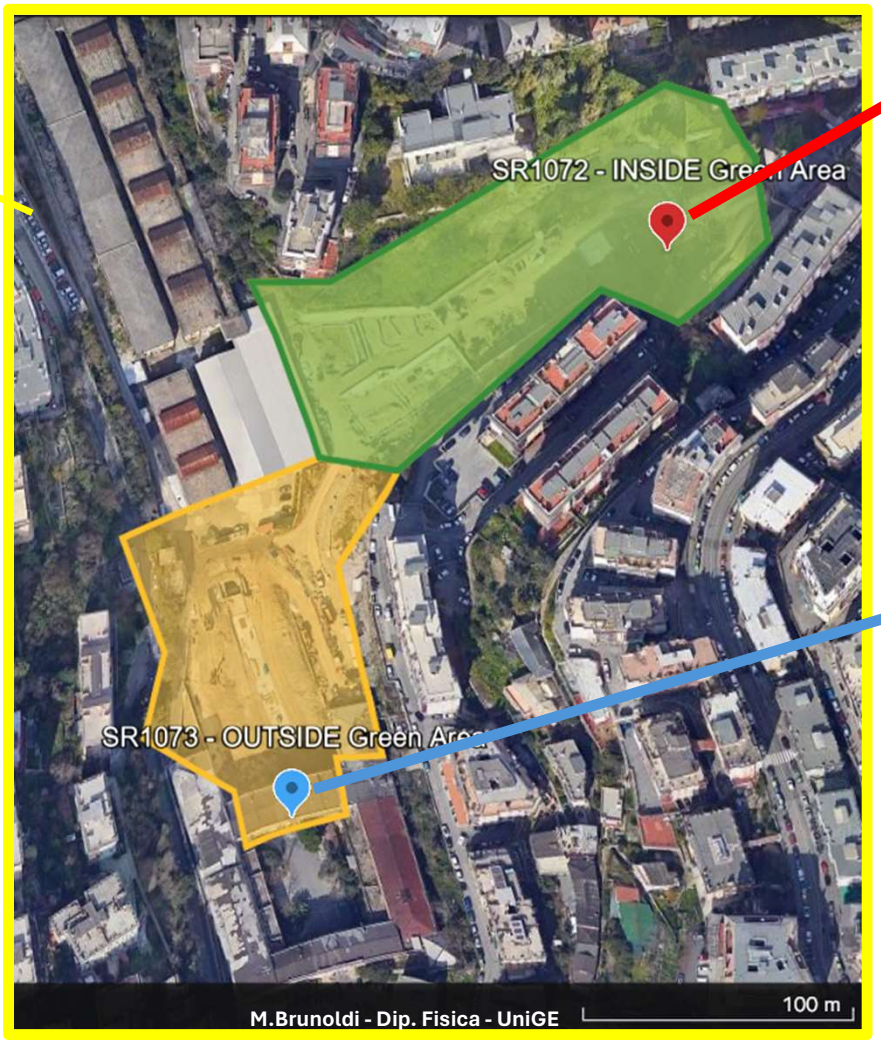
- **Dimensions : 12.7 x 25.4 x 30.5 cm**
- **Weight: 3,5 kg**
- **Voltage requirements : 18V - 24V DC charging (wired or solar panel)**
- **Operating Runtime: 2-15 day battery backup**
- **Data outputs: digital wired (USB), cellular NB-IoT, SD card**
- **Sensors**
  - NO2 ,O3 (electrochemical)
  - PM2.5, PM10 (optical)
  - T, RH, P
  - up to 5 additional sensors
  - provision for external anemometer and GPS

Calibrazione @ ChAMBRe

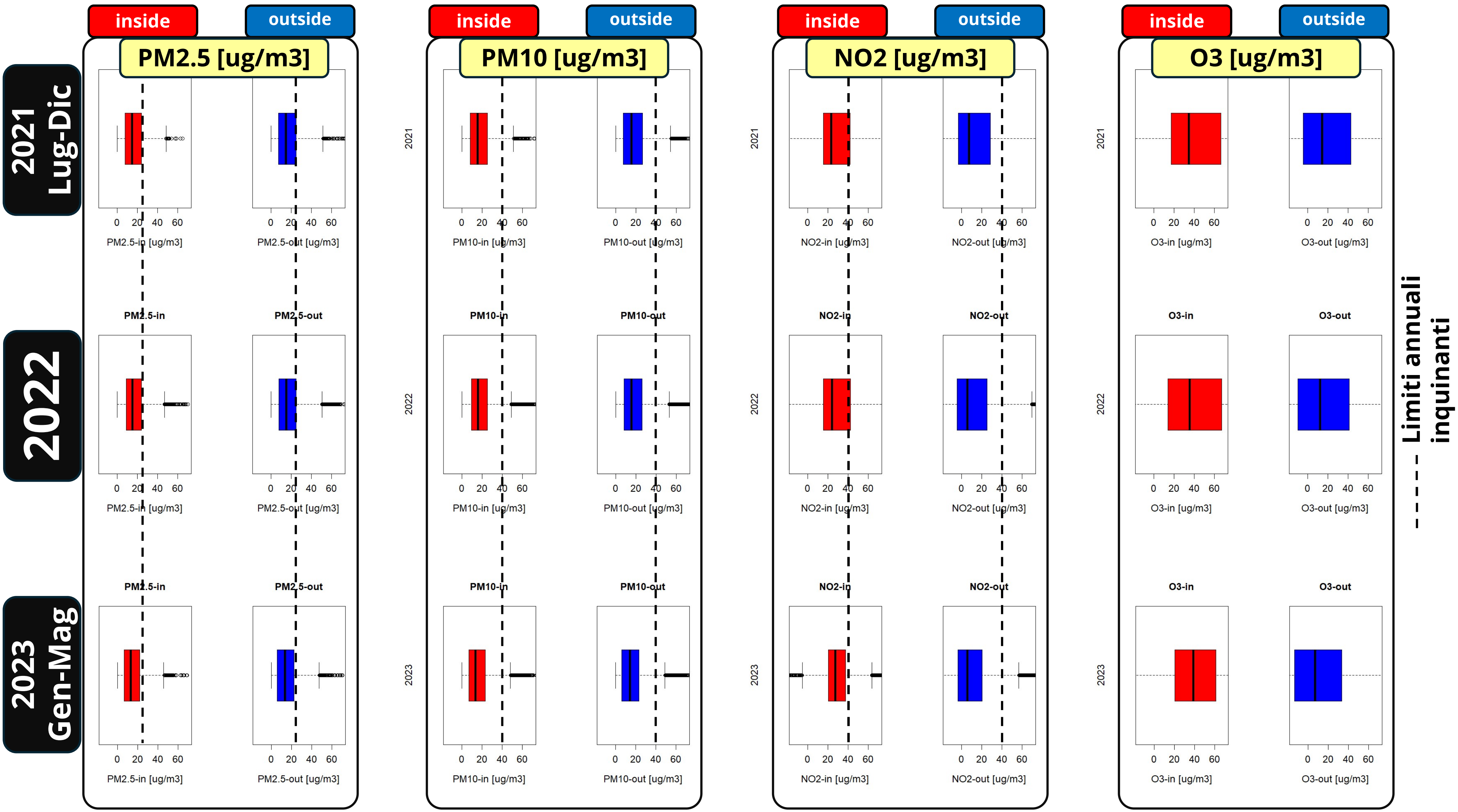


Installazione @ UNL Gavoglio



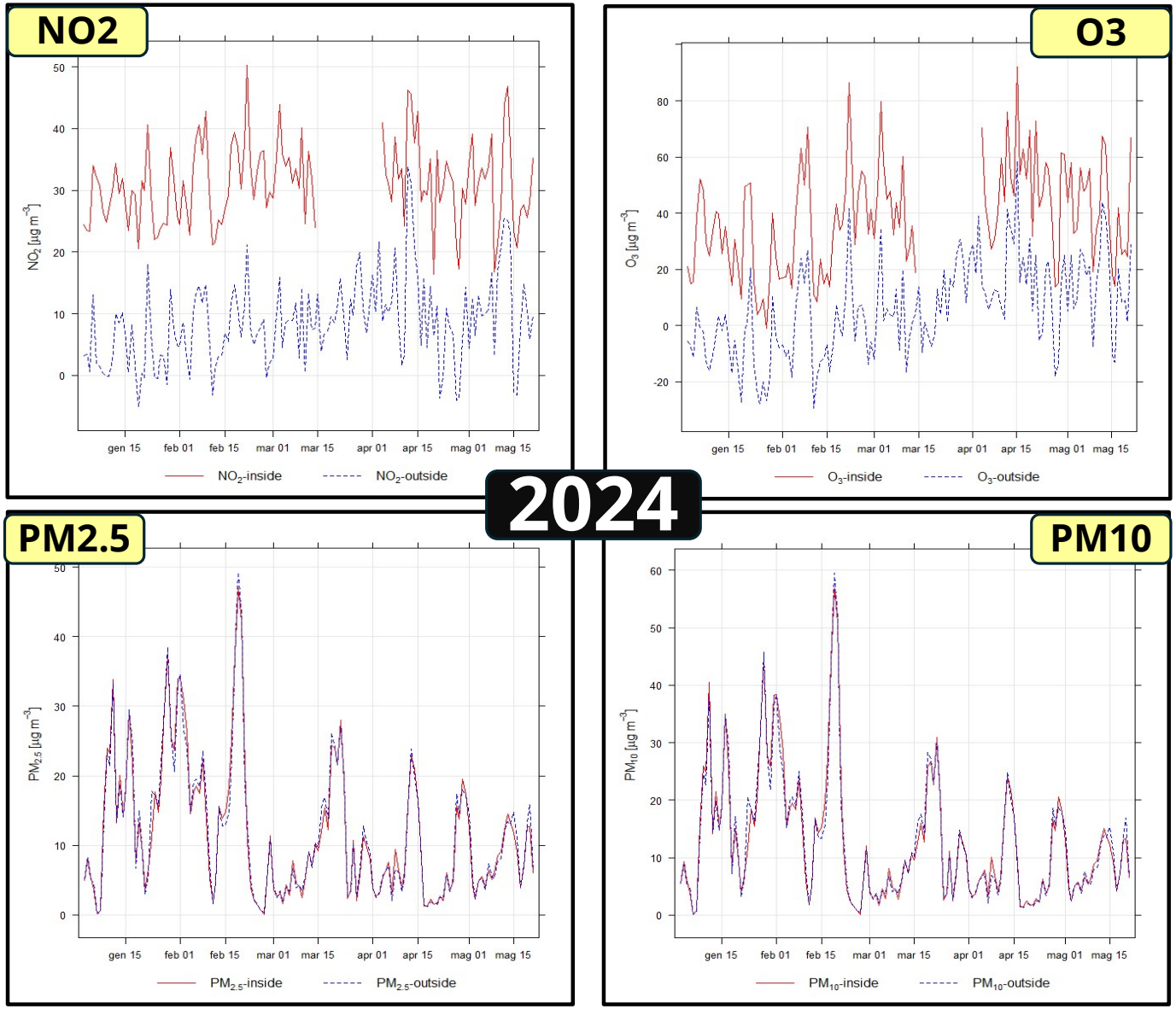


- **START: Giugno 2021**
- **PAUSA: Maggio 2023**
- **MISURE: PM2.5, PM10, NO2, O3, T, RH, P**
- **INAUGURAZIONE PARCO URBANO GAVOGLIO: Dicembre 2022**



inside
outside
PM2.5 [ug/m3]
PM10 [ug/m3]
NO2 [ug/m3]
O3 [ug/m3]
2021 Lug-Dic
2022
2023 Gen-Mag
PM2.5-in
PM2.5-out
PM2.5-in [ug/m3]
PM2.5-out [ug/m3]
PM10-in
PM10-out
PM10-in [ug/m3]
PM10-out [ug/m3]
NO2-in
NO2-out
NO2-in [ug/m3]
NO2-out [ug/m3]
O3-in
O3-out
O3-in [ug/m3]
O3-out [ug/m3]
0 20 40 60
Limiti annuali inquinanti

UNaLab
Time-plot
inside vs outside



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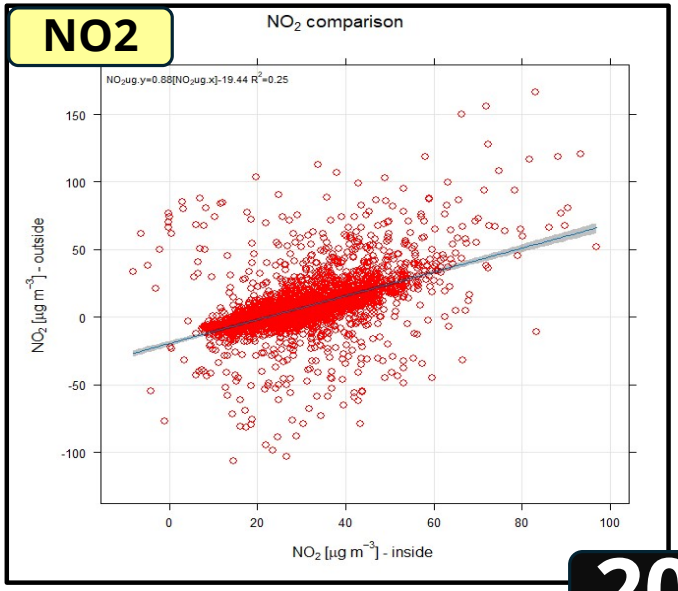
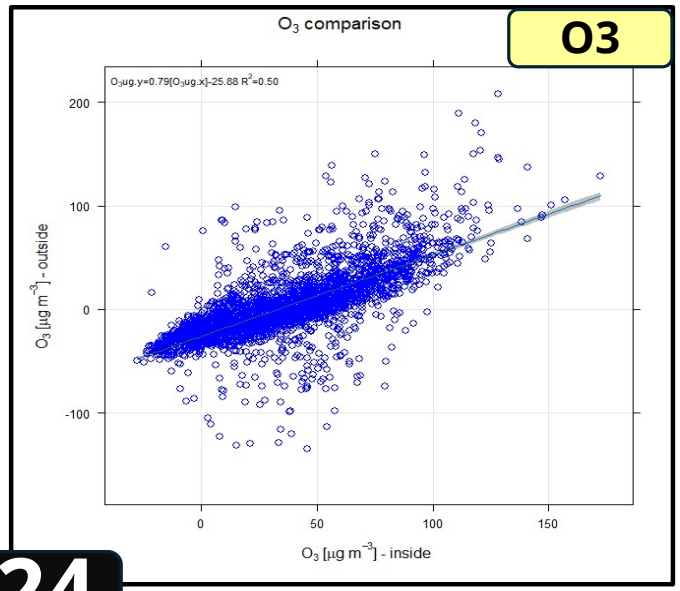
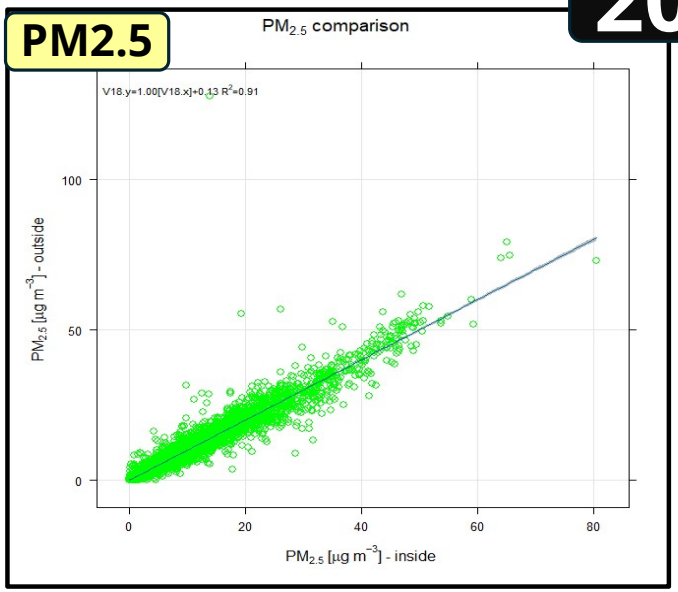
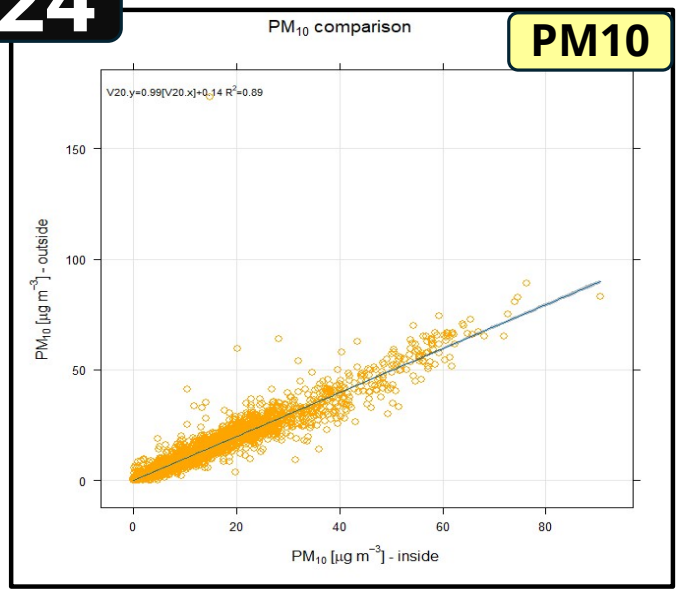
UNaLab
Scatter-plot
inside vs outside





2024





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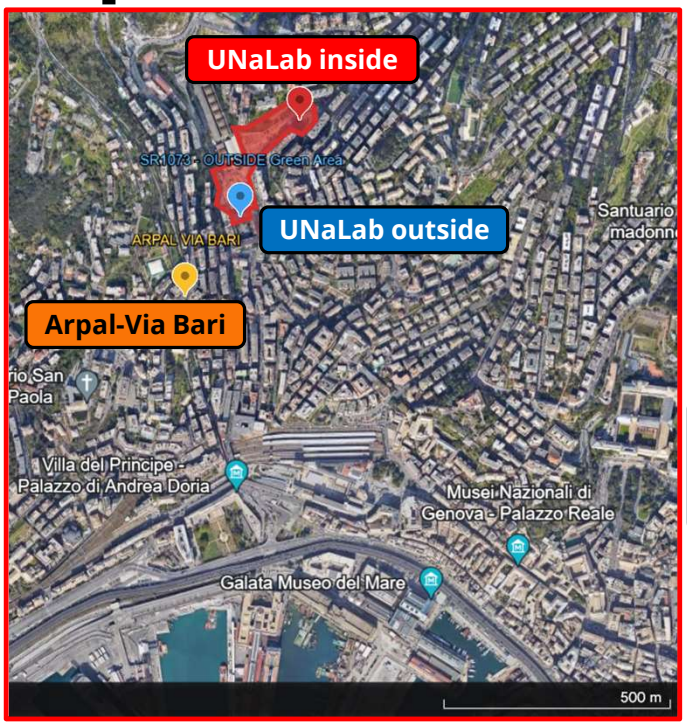
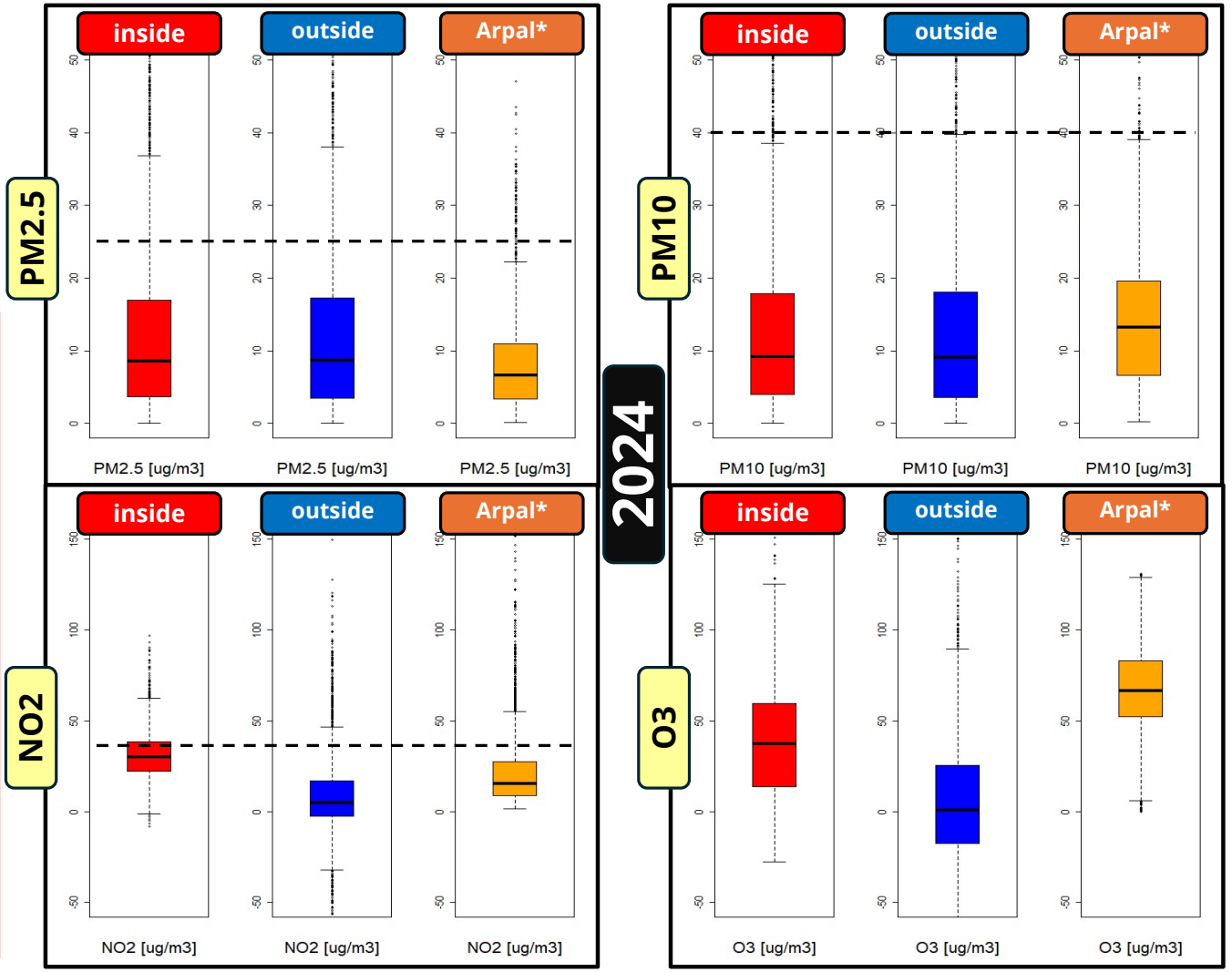
Box-plot

Confronto con dati certificati ArpaL – Via Bari



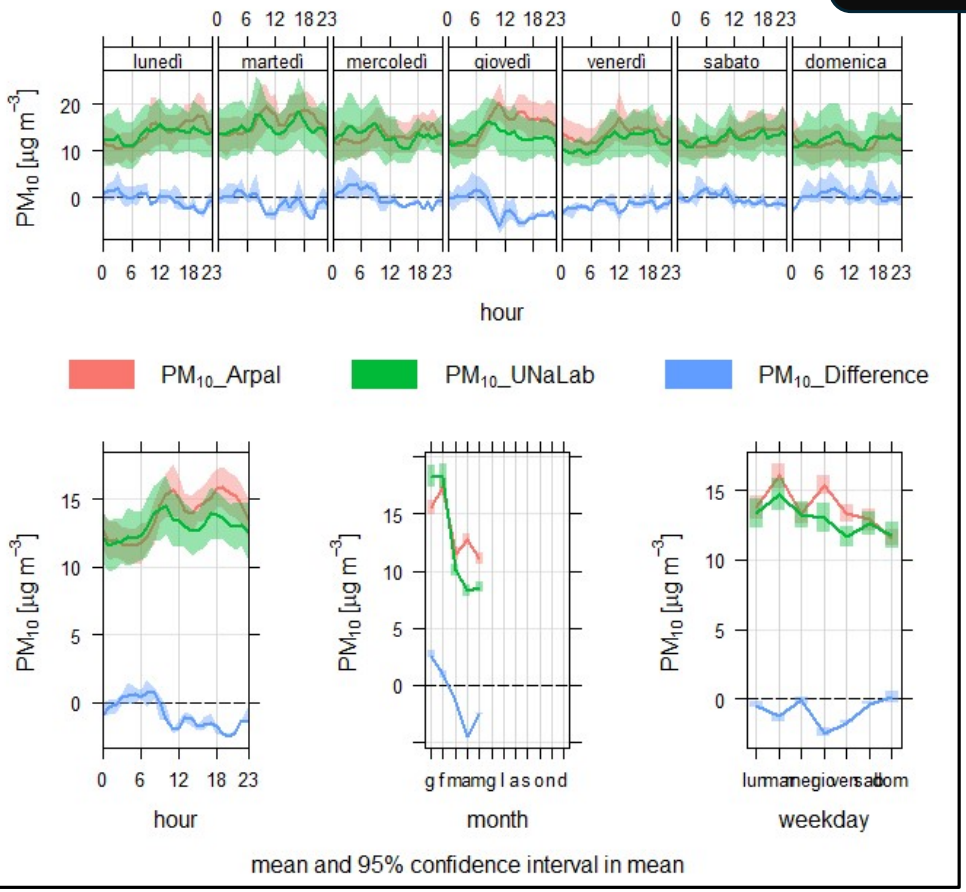
*Fonte Arpa Liguria - OPAS



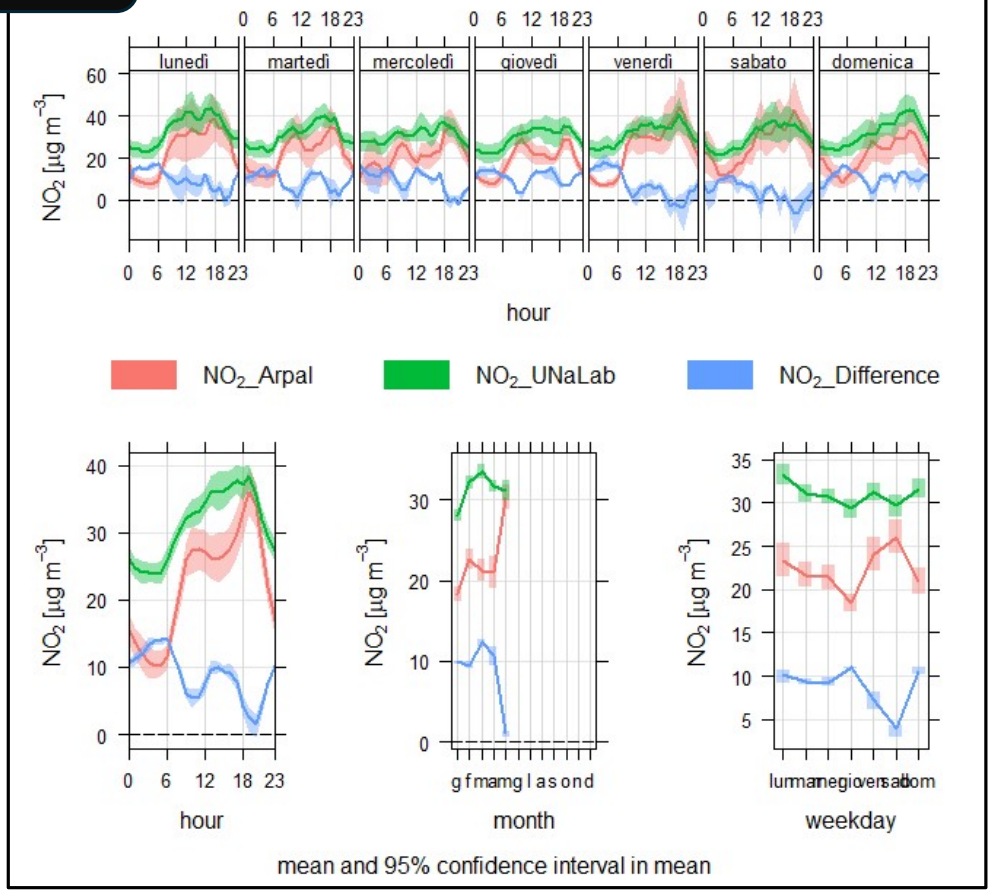
— — — Limiti annuali: PM2.5 = 25 ug/m3
PM10 = 40 ug/m3
NO2 = 40 ug/m3

UNaLab INSIDE vs Arpal
Difference Plot
2024

PM10 [ug/m3]

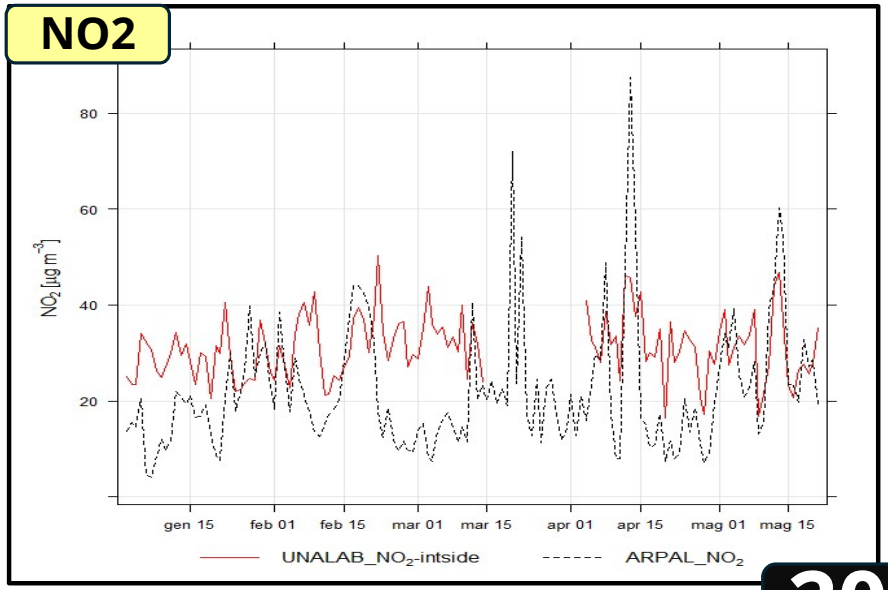


NO2 [ug/m3]

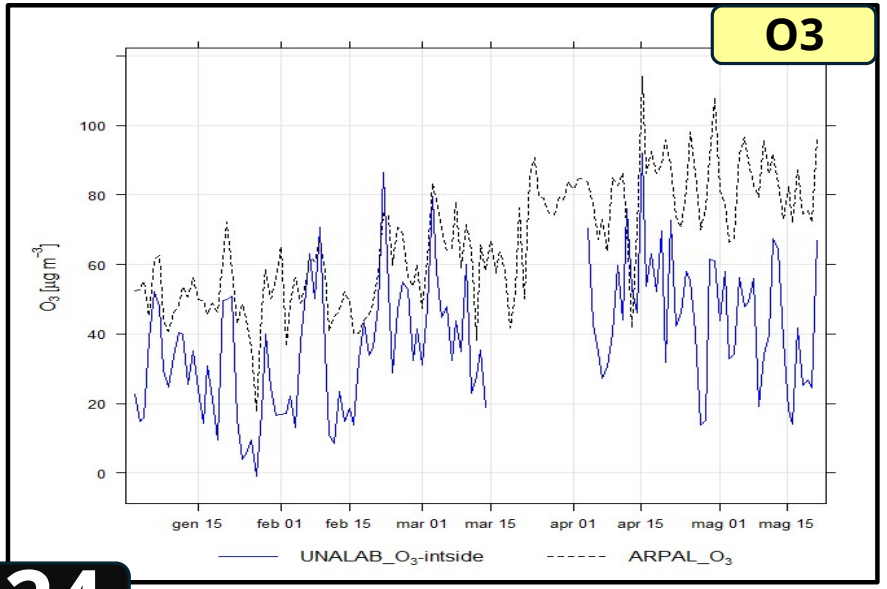


UnaLab vs Arpal
Time-plot

NO2

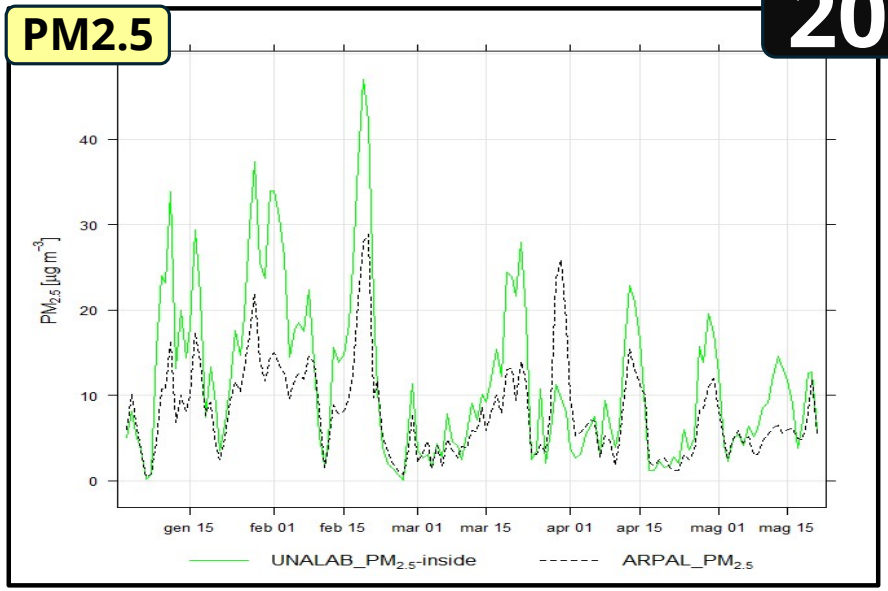


O3

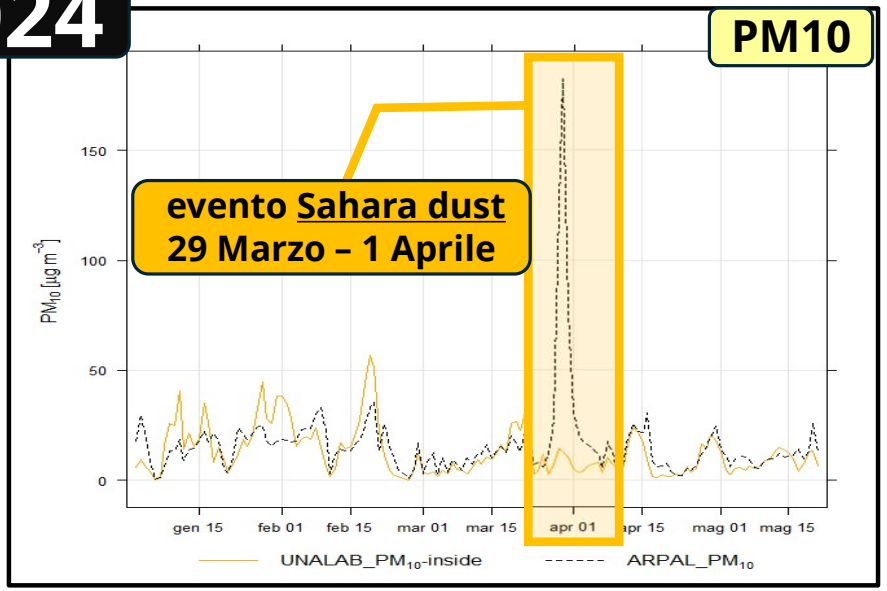


2024

PM2.5



PM10



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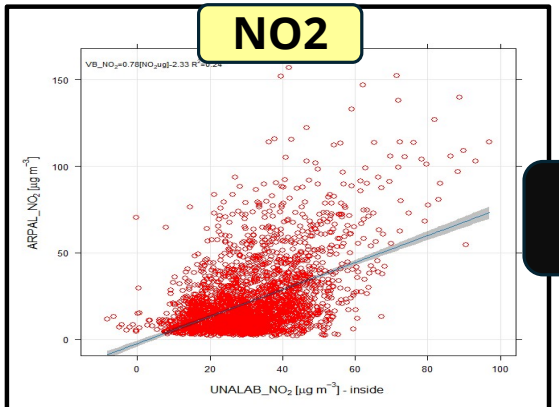
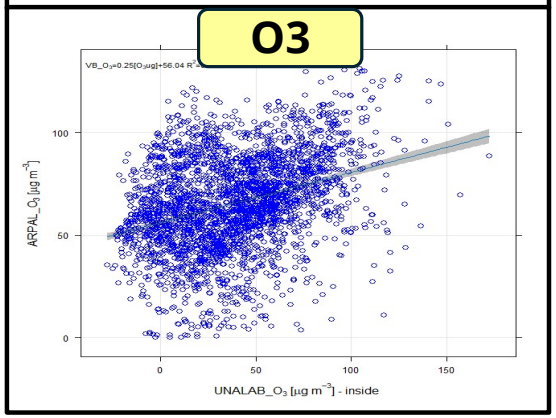
UNaLab vs ARPAL
Scatter-plot

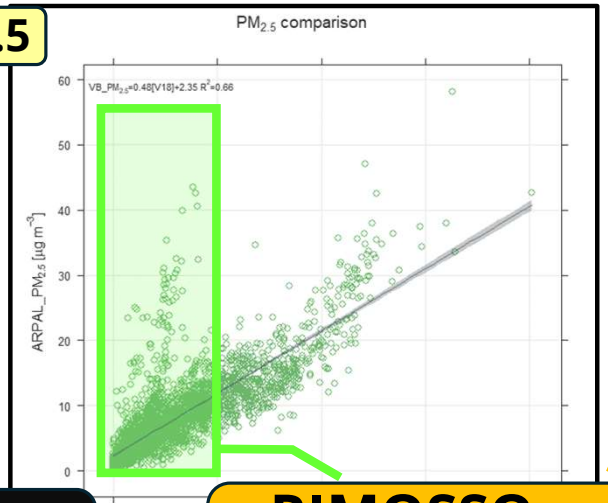
NO2



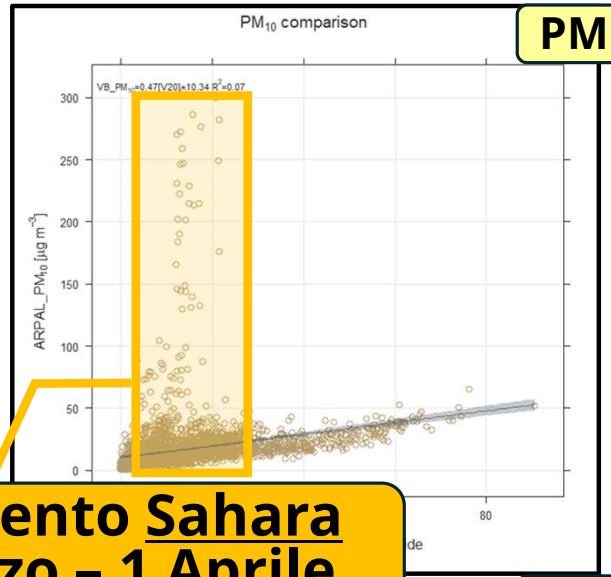
O3



PM2.5



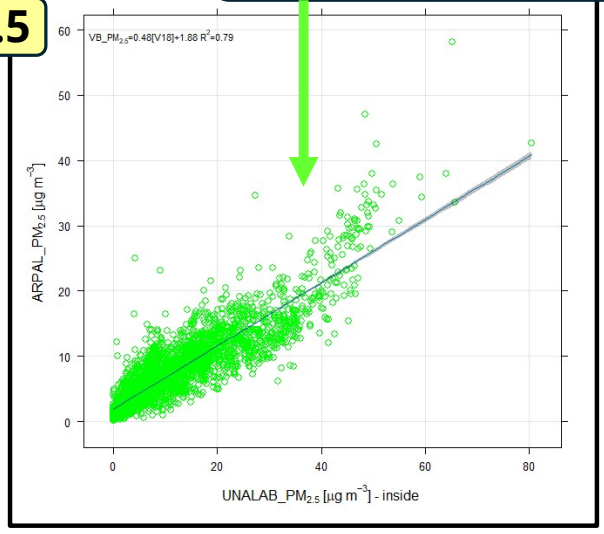
PM10



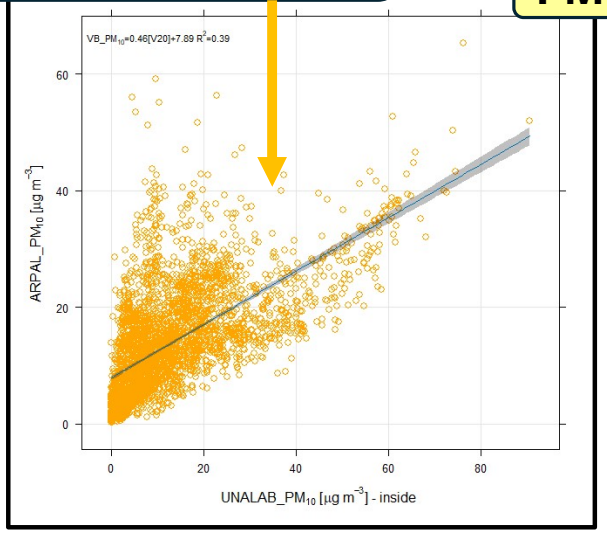
2024

RIMOSSO evento Sahara dust 29 Marzo – 1 Aprile

PM2.5



PM10



CONCLUSIONI

- **Inaugurazione parco urbano GAVOGLIO : Dicembre 2022**
- **FASE 1: misura durante il cantiere (giugno 2021 – dicembre 2022) : NON SIGNIFICATIVA per verificare efficacia NBS**
- **PAUSA misure @maggio 2023 per motivi tecnici**
- **FASE 2: misura gennaio-maggio 2024. Primi dati significativi dopo fine lavori. Crescita vegetazione e sviluppo NBS**
- **FASE3: misura fino a dicembre 2024 → SIGNIFICATIVA per misurare efficacia NBS (KPI)**

GRAZIE PER L' ATTENZIONE!!!