Climate Change application for supporting port infrastructure and transport environmental policies by predicting atmospheric pollution with augmented GEOSS datasets of the Balearic Islands

Amelia del Rey[1], Victor Centella[1], J.A. Clemente[1], Maria Dekavalla[2], Dimitris Bliziotis[2], Cristina Alburquerque[3], Benjamin Molina[4], C.E. Palau[4],

1. Prodevelop, Valencia, Spain
2. Institute of Communication and Computer Systems (ICCS), Athens, Greece
3. Balearic Port Authority, Palma de Mallorca, Spain
4. Universitat Politecnica de Valencia, Valencia, Spain

{adelrey, vcentella, jclemente}@prodevelop.es, {maria.dekavalla, dimitris.bliziotis}@iccs.gr, cristinaalburquerque@portsdebalears.com, benmomo@upvnet.upv.es, capalu@dcom.upv.es

Overview

Eiffel GEOSS APPLICATIONS FOR CLIMATE CHANGE

The **Copernicus** program provides a wide range of **earth observation data** at **temporal** and **spatial** scales relevant to various **Climate Change (CC) mitigation** and **adaptation applications**. Their uptake in the context of CC applications is limited due to inherent spatial resolution constraints. Copernicus data are often complemented with commercial data to increase resolution or deploy new resources for data collection. Yet the **reuse** of already generated and freely available data from **GEOSS** is not always employed.

The **EIFFEL Horizon2020** project will offer the ground-breaking capacity of **exploiting existing GEOSS** and external datasets to produce **five** different **CC-related pilots**.

Pilot 1
Water & Land-Use Management
Regional Scale & Cross-border

Pilot 2
Sustainable Agriculture
National Scale

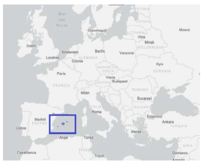
Pilot 3
Infrastructure & Transport Management
Regional Scale

Pilot 4
Sustainable Urban Development
Local / Regional Scale

Pilot 5
Disaster, Resilience. Drought, forest fire & pest risk assessment
Regional / National Scale

Pilot 3: USE OF SATELLITE IMAGES OF GEOSS AND ARTIFICIAL INTELLIGENCE FOR THE CARBON FOOPRINT MITIGATION OF THE PORT ACTIVITY OF THE BALEARIC PORT AUTHORITY (SPAIN)

LOCATION



https://www.portsdebalears.com/en

CO Monóxido de Carbono	NO2 Dióxido de Nitrógeno	O3 Ozono	SO2 Dióxido de Azufre	PM10 Partículas 10	LAeq Ruido
0.32	44.31	33.48	4.30	12.09	0.00
mg/m3	ug/m3	ug/m3	ug/m3	ug/m3	dB(A)
Excelente	Mal	Excelente	Excelente	Excelente	---

DATASETS

PORT DATA
25 in-situ sensor stations (250 sensors):SO_2, NO_2, O_3, CO, PM_{10} and $PM_{2.5}$.
Temperature, pressure, rainfall, wind speed and wind direction.

REGIONAL LEVEL DATA
Air quality stations at regional level (GOIB), AEMET and
GEOSS Portal

CITY DATA
25 Traffic intensity map (IMD), Industries, Thermal Power Plants, Population registered in the different areas and the influx of pedestrians, Traffic-City Council.

USES CASES

1. **Analysis of atmospheric pollution in Palma**
Study of the correlation between the port activity and city/port pollution episodes (SO_2, NO_2), wind and traffic in port/city and areas nearby. Once a pollution episode has been detected, its origin will be analyzed (city/port/other).

2. **Atmospheric Emissions study in The Freus**
Monitoring of emissions from vessels (SO_2, NO_2) in the Freus area (Formentera). Focus on the traffic of the regular line Eivissa-La Savina (Formentera).

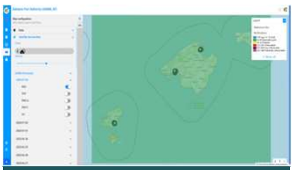
3. **Berths allocation optimisation**
Prediction of pollution episodes for decision making in the optimization of berth allocations.

Intermediate outcomes

Sentinel-5P TROPOMI mission provides air quality data for **NO_2, SO_2**, and **O_3** with a spatial resolution of 5.5x3.5 km and within 3 hours after sensing. Access to these products has been achieved through the **Umbrella Sentinel Access Point.** The interpretation of **Sentinel-5P** data is complex and pixel data with quality parameter *qa_value > 0.75* has been used for areas with no sensor in-situ data as "informative values" but cannot be compared with in-situ data.

CAMS (Copernicus Atmosphere Monitoring Service) through the product **CAMS (Regional Forecasts, Model Ensemble)** has been used for air pollution predictions with a spatial resolution of 10x10 km. These data is been used to extrapolate historical data in areas "out of the port" and to compare results with predictions coming from AI in-situ pollution models.

Pilot 3 also uses **CAMS** to offer **AQI forecasts** defined by **EEA** for case use 2. The data used for its calculation were some points of interest that covered offshore areas with no in-situ sensor data available.



CAMS images in the WebApp

AQI from CAMS in WebApp

NO_2 forecasts from sensor in-situ data

Artificial Intelligence (AI) plays a major role in the pollution prediction models. Some Machine Learning algorithms have been applied over the 25 sensor in-situ data focusing on NO_2, SO_2 and O_3 air pollution parameters.

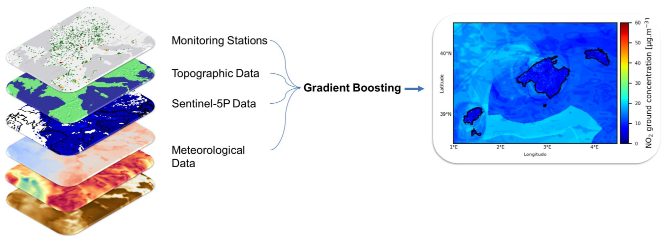
Different **LSTM-based neural networks** were designed to predict pollutant levels.

The **CC WebApp** is being developed with an **easy-to-use interface** with **maps, KPIs** and **alarms.**

The pilot 3 expects to provide complete results for the three uses cases within this year.

Sentinel-5P Super resolution

The modelling of the **spatial distribution of air pollutants** is complex to obtain due to the sparse network of ground-level air quality monitoring stations. **Sentinel-5P** mission can frequently map most locations on Earth and provide information about the vertical column density of air pollutants, which is a different physical quantity than the ground concentrations measured by ground stations.



Sentinel-5P augmentation & fusion tool

The **spatial distribution of ground-level concentrations** can be estimated by **fusing Sentinel-5P** and other proxy data such as **ERA5 meteorological and GTOPO30 topographic data** through **training machine learning models** with in-situ ground measurements. We demonstrated that the **extreme gradient boosting (XGBoost)** model can generate **ground-level concentration maps for various air pollutants (NO_2, O_3, SO_2 and CO)** at **1 km spatial resolution** by utilizing hourly concentration measurements (07/2022-05/2023) acquired by more than 3300 stations and available through the **European Environmental Agency's Air Quality e-Reporting database**. The model can infer ground-level concentrations at arbitrary locations where no ground monitoring stations are available and can **capture up to 61% of NO_2** variation with a **mean absolute error of 3.6 μg/m^3.**

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101003518