LIFE20 PRE/IT/000004

# LIFE_REMY (Reducing Emission Modelling uncertaintY)

## The project


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CT1, FAIRMODE Technical Meeting

06/10/2021


www.LifeREMY.eu

# Project & Partners

Coordinating Beneficiary

TerrAria s.r.l.

Associated Beneficiaries

CSIC
Consejo Superior de Investigaciones Científicas

idæa
Institute of Environmental Assessment and Water Research

RSE
Ricerca Sistema Energetico

Agenzia Mobilità Ambiente Territorio

IOŚ-PIB
Instytut Ochrony Środowiska
Państwowy Instytut Badawczy

**Duration:** 36 months 1/5/2021 – 30/4/2024

**Financial contribution:** Total cost: 1'538'414 € with EU contribution: 923'048 € (60%)

**Project type: LIFE prepatory project**

*REMY meets the specific need under the Environment sub-programme: "**Support for the compilation of emission inventories to improve air quality modelling**"*

# General Project Objectives

1. Contribute to **a better development, implementation and evaluation of air quality assessment, air quality plans and source apportionment in the framework of the Ambient Air Quality Directives**.

2. Reduction of **most relevant model uncertainties related to emission processing**, thus aiming at providing operational guidelines concerning integration and **harmonization of urban/regional emission inventory**, **emission estimates for most uncertain sources**, **modelling** of emission and formation processes involving primary and secondary organic particulate generation, multiscale modelling in urban and peri-urban areas including both CTM and local modelling also including spatially varied resuspension.

3. Provide updated, comprehensive and harmonized **recommendations to support modelling groups in reducing modelling uncertainties**.

# Modelling Project Objectives

Modelling activities involved:

- **Source apportionment modelling to better constraint key emission sources such as dust resuspension and biomass burning** (CSIC receptor modelling, RSE CAMx source apportionment).
- Integration of **modelling** results at different spatial and temporal scales through different tools (e.g. **CTM/receptor modelling/urban modelling**) testing the results **in three EU cities (Milan, Barcelona, Krakow)** (ALL).
- **Integrated assessment modelling** to see the effect of the emission uncertainty on the air quality plan through the definition of optimal measures through **RIAT+** tool **in Po Valley** (TA).

Use of regional CTM modelling (Po-Valley and Catalonia – RSE, Southern Poland - IEP-NRI), RM - receptor models (Milan, Krakow and Barcelona - CSIC), urban modelling (Milan and Barcelona – TA, Krakow - IEP-NRI), integrated assessment modelling RIAT+ (Po-Valley – TA).

# Regional and urban Study Areas


**SPAIN**

CTM: CAMx (RSE)
RM: Barcelona (CSIC)
UM: UTAQ Barcelona (TA)

**ITALY**

CTM: CAMx (RSE)
RM: Milan (CSIC)
UM: UTAQ Milan (TA/AMAT)
IAM: RIAT+ (TA)

**POLAND**

CTM: GEM-AQ (IEP-NRI)
RM: Krakow (CSIC/IEP-NRI)
UM: GEM-AQ Krakow (IEP-NRI)

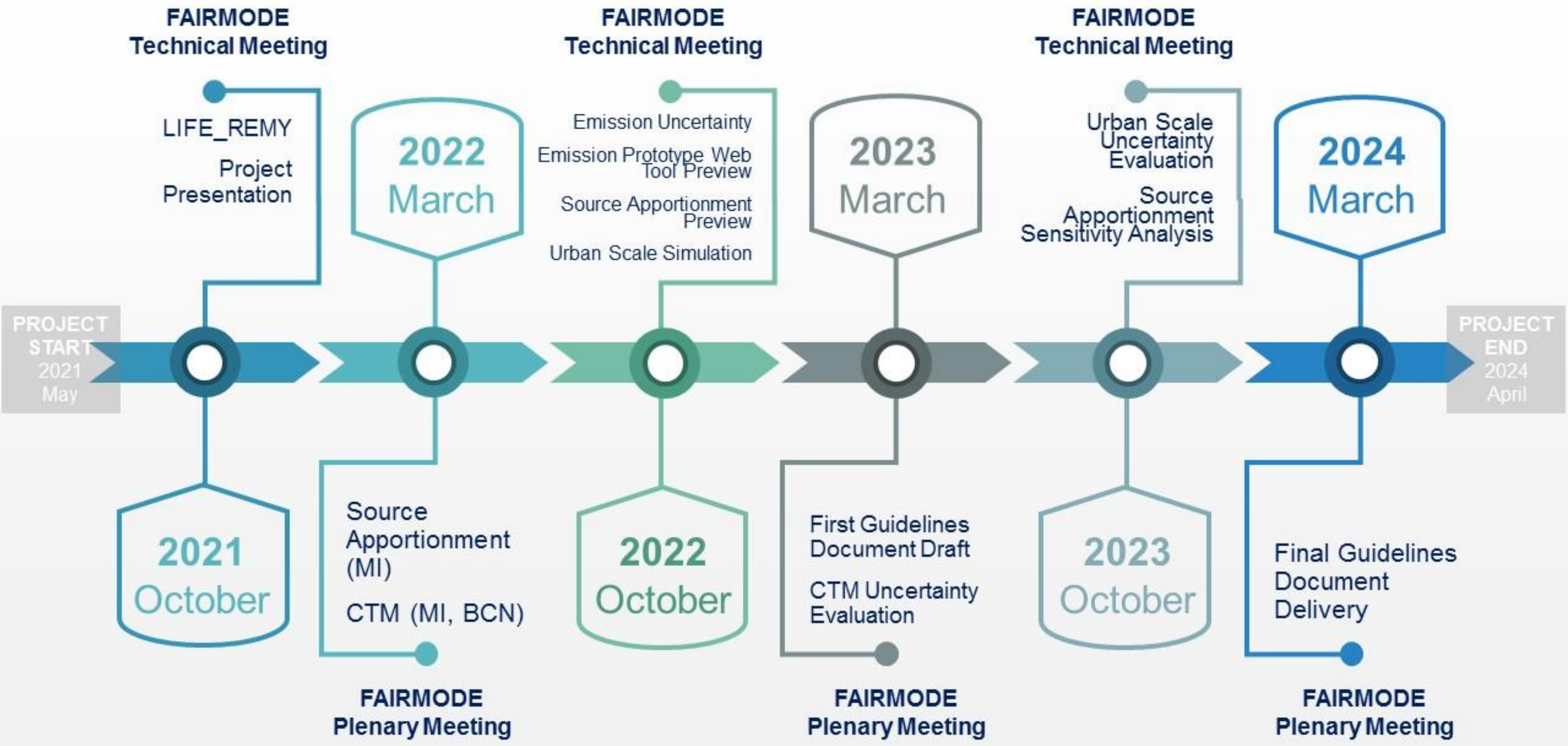
CTM: Chemical Transport Model
RM: Receptor Model
UM: Urban Model
IAM: Integrated Assessment Model

# Expected Results

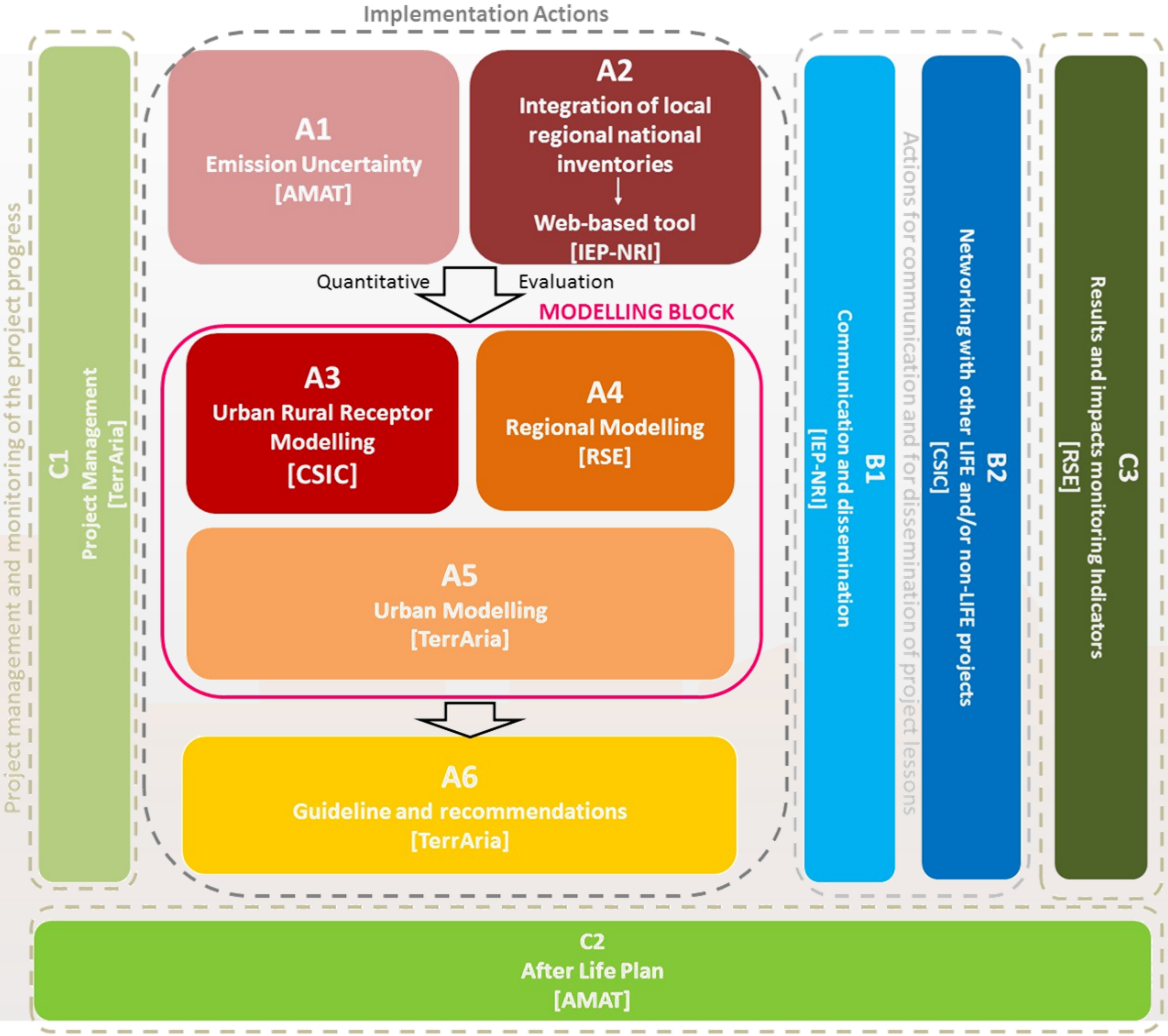
- **Quantitative** results on the impact of the **emission uncertainty on air quality estimates and related performances in three areas**: Po-Valley/Milan, Southern Poland/Krakow, Catalonia/Barcelona (regions and urban areas).
- Uncertainty estimated on both the **BASELINE** and the **COVID19 (diagnostic scenarios)**, evaluation of the sensitivity to the **uncertainty in emission inventories before and after the application of project recommendations (sensitivity scenarios)**.
- Quantitative estimations of the **model performance**, mainly based on **FAIRMODE indicators.**
- **Operational recommendations to support the compilation of emission inventories and to reduce air quality and consequent air planning uncertainty** (based on previous estimates on different model tools and on the stakeholder requirements, suggestions and contributions).

# Stakeholders: FAIRMODE

Stakeholders' involvement on the whole REMY project is fundamental and in particular in the sharing of the results on the uncertainty and of the recommendations to be included in the guideline.



# Project Action’s Structure



# Action A1 - Identification of the uncertainties related to emission factors for selected activities

- Responsible Beneficiary: **AMAT**
- Quantification of the uncertainties for some of the most uncertain emission sources, such as:
  - **Road dust resuspension** – NOx and primary PM uncertainty related both to the method for estimating emission factors and to their spatial and temporal variability
  - **Domestic heating systems** - determined measuring the real emissions of several heating plants (natural gas, gas oil, biomass – pellet) in Milan under normal operating conditions
  - **Domestic waste combustion and open burning** - on the base of the available scientific literature and the results of specific projects, including the European Parliament Pilot Project WASTE and pilotless drones equipped with thermographic cameras
  - **Wood combustion** (sources different from domestic heating, e.g. pizzerias)
  - **NMVOC emissions due to the solvent use sector** - in-depth analysis of the NMVOC emissions and speciation for the main emitting sources
- Expected results: a set of PM emission factors from road dust resuspension (MI, B), a set of NOx and primary (solid) PM emission factors from different domestic heating systems, a first estimation of the uncertainty related to the activity indicators of open waste burning, a first direct estimate of the PM wood oven pizzerias emission factor, an estimate of NMVOC speciated emissions from solvent use sector (MI), an update of NMVOC chemical speciation from road transport and biomass burning

# Action A2

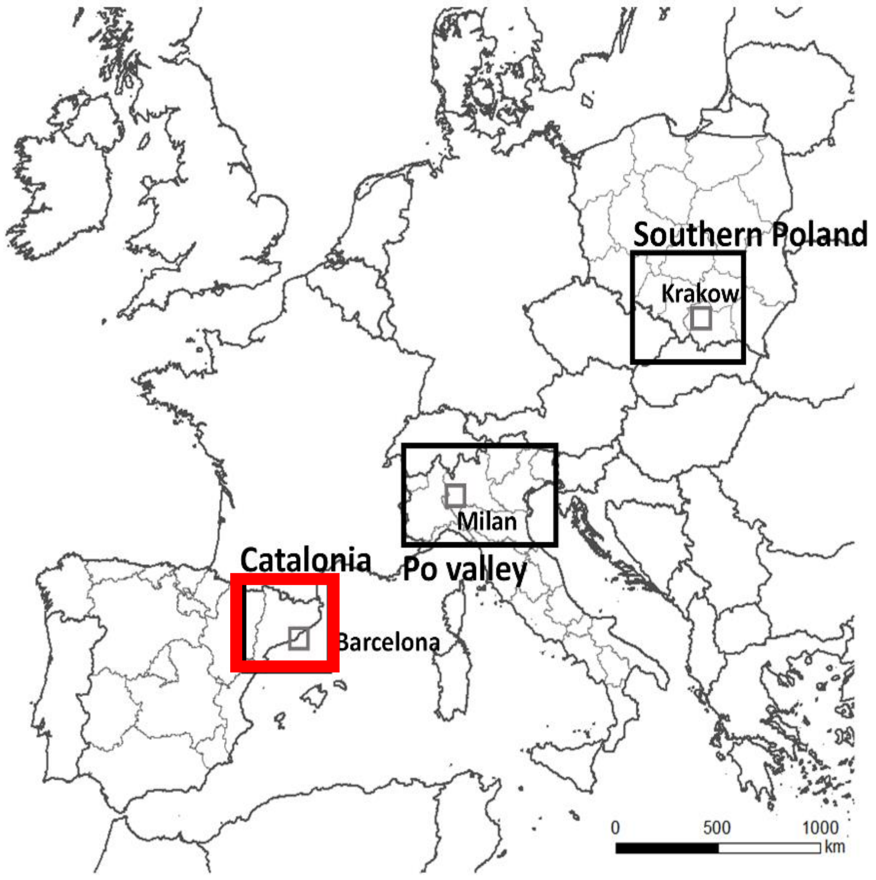
- Responsible Beneficiary: **IEP-NRI**
- Overview of the available Top Down (TD) and Bottom Up (BU) in geographically distributed regions of interest (Southern Poland, Barcelona and Po Valley) inventories, as well as the **comparison of TD and BU approaches and their combination** that could lead to artefacts on the boundaries and unrealistic sharp gradients of transboundary impact;
- Apply a relocation methodology developed earlier to low-resolution emission datasets for outer regions in order to combine with high-resolution local inventory. Design of an **on-line web-based tool** with the purpose of refining (relocate) low-resolution inventories and further to combine with high-resolution inventories
- Tests using local inventories provided by Project Partners. Air quality modelling application in action A4 to confirm the improvement of the modelling results with the combined/relocated emission dataset

# Action A3 Receptor Modelling (RM) as a support for uncertainty analysis and reduction

- Responsible Beneficiary: **CSIC**
- Comparison between the **source apportionment (SA)** information obtained by source-oriented dispersion modelling (**SMs**) and **receptor modelling (RMs)** and their maximum possible integration in order to increase the level of knowledge reducing the existing uncertainties of the SMs approach
- **Milan, Barcelona and Krakow** for the baseline year
- Use of the Positive Matrix Factorization (PMF) for RMs, with accurately selected input datasets for each geographical area
- Use of the same receptors and the same temporal coverage for both RMs and SMs approaches
- Both source profiles and contributions time series comparation with particular attention to linking factors in RMs and source categories in SMs, re-aggregation of sources and source apportionment methods
- **Further use of PM chemical speciation datasets from rural stations**, as close as possible to the cities involved

# A3: Receptor modelling in Catalonia - Barcelona

LIFE-REMY'S REGIONAL AND URBAN EVALUATING AREAS

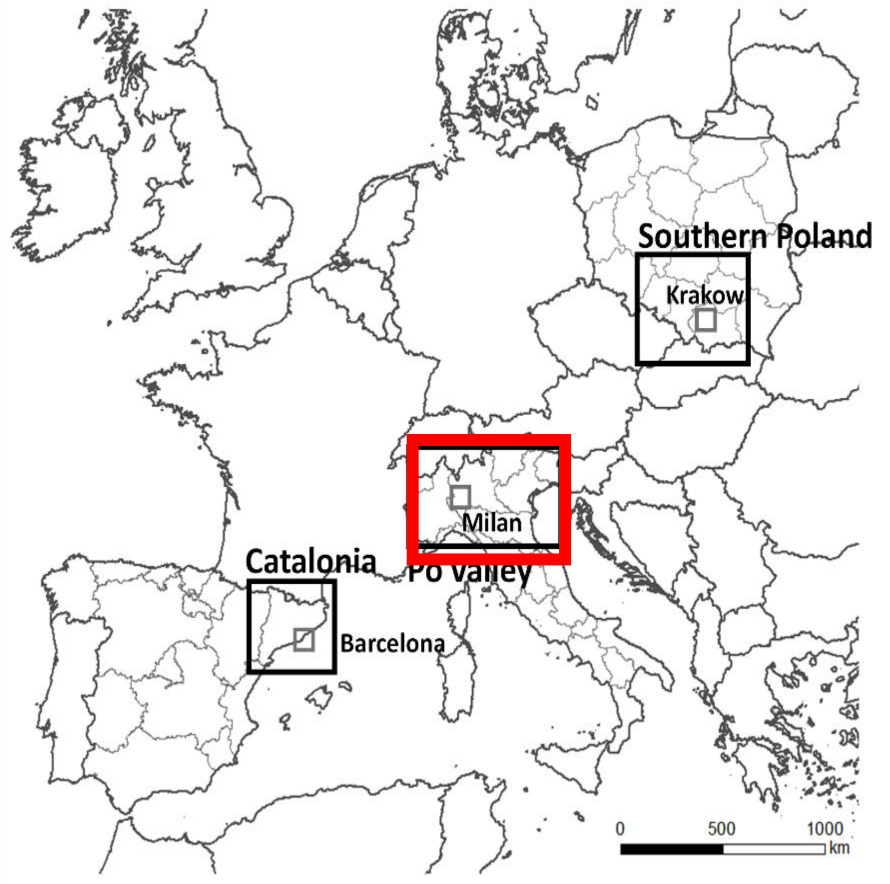



**SPAIN (PM10 and PM2.5):**

| | Years | Metals | Ions | OC/EC | Light absorption | Non-refractory submicrometric |
|---|---|---|---|---|---|---|
| Barcelona (urban) | 2017 2018 and COVID lockdown | 24 h | 24 h | 24 h | 1 h | 30 min |
| Montseny (rural) | | | | | | NA |

# A3: Receptor modelling in Po Valley - Milan

LIFE-REMY'S REGIONAL AND URBAN EVALUATING AREAS




ITALY (PM10)

| | Years | Metals | Ions | OC/EC | Sugars |
|---|---|---|---|---|---|
| Milan Pascal | 2017-2018 and COVID lockdown | 24 h | 24 h | 24 h | 24 h |
| Schivenoglia | | | | | |
| Bologna | | | | | |
| Torino | | | | | |
| Vicenza | | | | | |

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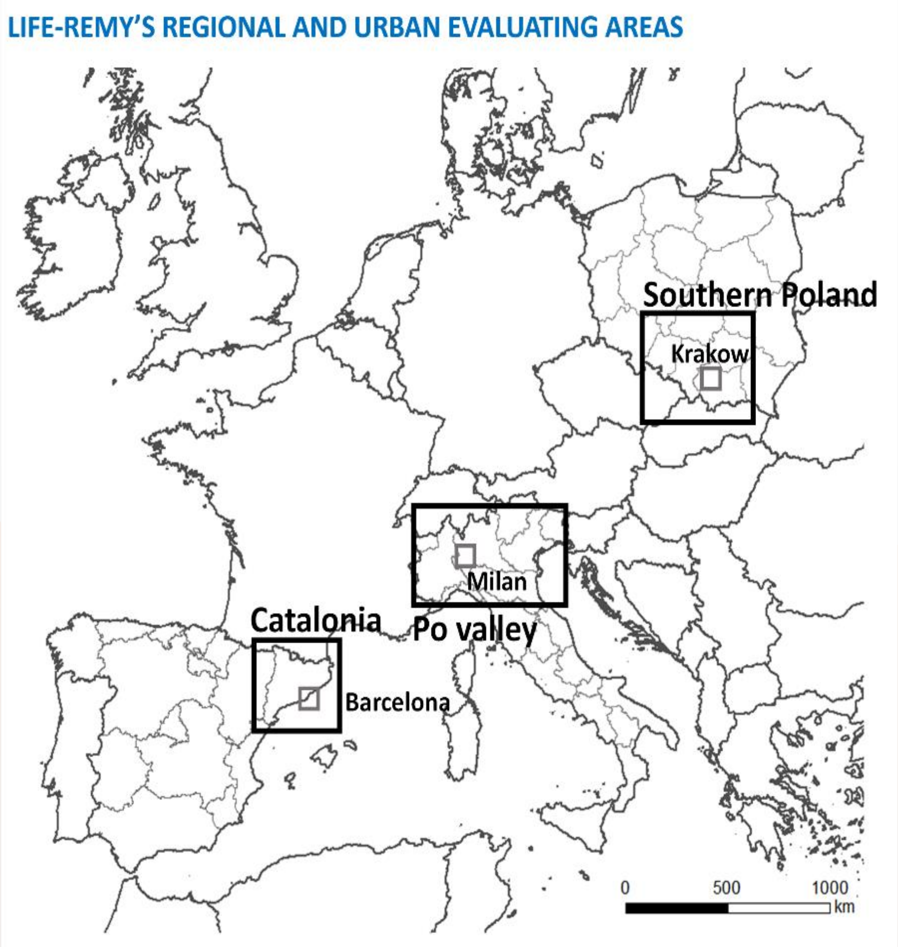
# A3: Receptor modelling in South. Poland - Krakow




## POLAND (PM10)

| | Years | Metals* | Ions* | OC/EC | PAHs* |
|---|---|---|---|---|---|
| Skawina (urban) | 2019-2021 | 7 days | 7 days | 24h | 7 days |
| Raciborz (rural) | | | | | |

*lab analysis are ongoing

**INSTITUTE OF ENVIRONMENTAL ENGINEERING**
**POLISH ACADEMY OF SCIENCES in Zabrze**

# Action A4 Sensitivity analysis in regional modelling on both BASELINE and COVID19 scenario

- Responsible Beneficiary: **RSE**
- **Diagnostic analysis – Air quality modelling assessment at regional scale**

  Air quality assessment - A Model Performance Evaluation of will be carried based on key indicators (e.g. FAIRMODE methodology) and specialized measurements in order to quantify and explain discrepancies between observed and modelled concentrations
- **Diagnostic analysis – Source apportionment - planning at regional scale**

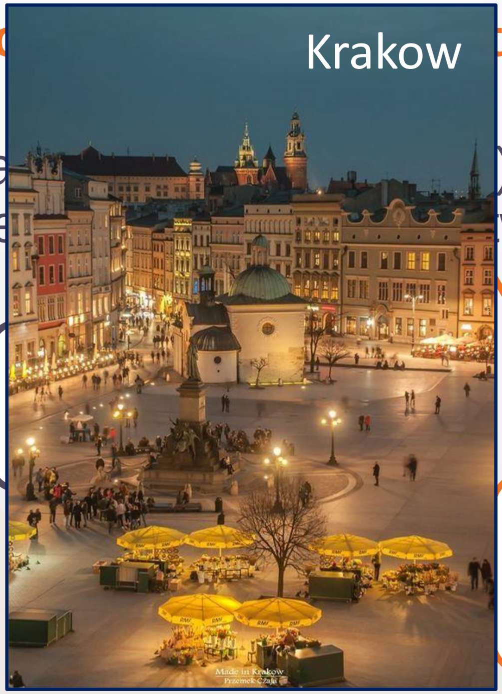
  Source apportionment and planning – different modelling techniques (e.g. tagging and brute force methods) will be compared in order to point out differences and application limits. This activity will be performed also in coordination with action A3
- **Sensitivity analysis – Air quality modelling assessment at regional scale**
- **Sensitivity analysis – Source apportionment - planning at regional scale**

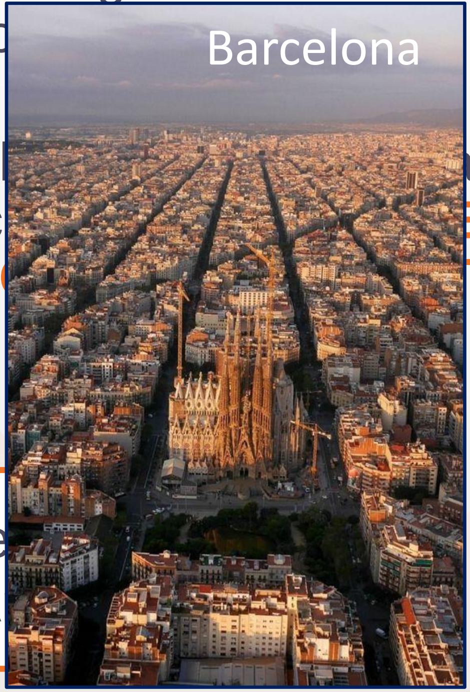
  The sensitivity analysis will cover the key uncertainties in emission factors considered in A1, the influence emission inventory scale considered in A2, also taking advantage of the ad hoc emission tool, the main outcomes of Receptor Models result in A3.

  The application of a subset of sensitivity analysis also to the COVID19 case study will allow the test the influence of uncertainties and corresponding recommendation also in a “real world” emission reduction scenario (mainly focused on road transport).

# Action A5: Sensitivity analysis in urban modelling on both BASELINE and COVID19 scenario

- Responsible Beneficiary: **TerrAria**
- **Urban** modelling using the results of A4 as boundary/background concentration and … **ation c** … **tions** c … A1 to A3 a … scale
- App … e Urba … ) in Mi … t high resc … ) mode … wo sc … **E and COV** … **2020)** … **NOSTI** … **IVITY** app…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✔ Basecase simulation for BASELINE and COVID19 scenarios with evaluation of the main existing uncertainties

✔ Quantitatively evaluation of the recommendation obtained from A1, A2 and A3 for air quality assessment, source apportionment and planning applications.

# Action A6: Guideline and recommendations on the compilation of emission inventories

- Responsible Beneficiary: **TerrAria** in cooperation with all partners
- Provide a **state-of-the-art guidance document with the recommendations** (supported by quantitative estimates based on Actions A1-A5 results) on the compilation of emission inventories to reduce the impact of their uncertainty and of air dispersion models on the air quality planning
- Focus on :

I. **Integration and harmonization of urban/regional emission inventories**
II. Emission estimates for **Resuspension Emissions**, **Solid (waste&wood) residential combustion**, **open waste burning** and **Resuspension**
III. **Modelling of emission and formation processes** involving primary and secondary organic particulate generation
IV. **Multiscale modelling** in urban areas based on both CTM and local modelling

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# THANK YOU!

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RSE Ricerca Sistema Energetico

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Institute of Environmental Protection
National Research Institute

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# A3 Focus – Comparison with SMs

**Comparison complexity due to:**

- RM provide source fingerprints as **measured at the receptor** (not at the release point), after reactive species underwent physico-chemical reactions and secondary particles are formed. Such processes may be not well implemented in the SM.
- It will be necessary to **re-aggregate sources** such as dust sources, or fuel-resolved sources for the same activity, that are often mixed in PMF due to their collinearity
- **Secondary inorganic aerosol (SIA)** which are usually handled by RMs as aggregated class called “SIA” unrelated to the source categories emitting the corresponding precursors (e.g. Transport, heating, agriculture)
- For **secondary organic aerosol (SOA)**, RMs can provide more detailed information about the origin of the precursors, for example being able to distinguish the role of natural biogenic sources and anthropogenic sources, where the latter can be also distinguished with respect to the fuel (e.g. biomass vs fossil fuel). SMs, on the other hand, can always tag both primary and secondary compounds to a corresponding emission source because, in case of secondary pollutants, they can tag the corresponding precursors.