FAIRMODE CT8 exercise on assessment of Spatial Representativeness of monitoring stations

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on behalf of the FAIRMODE-CT8 community

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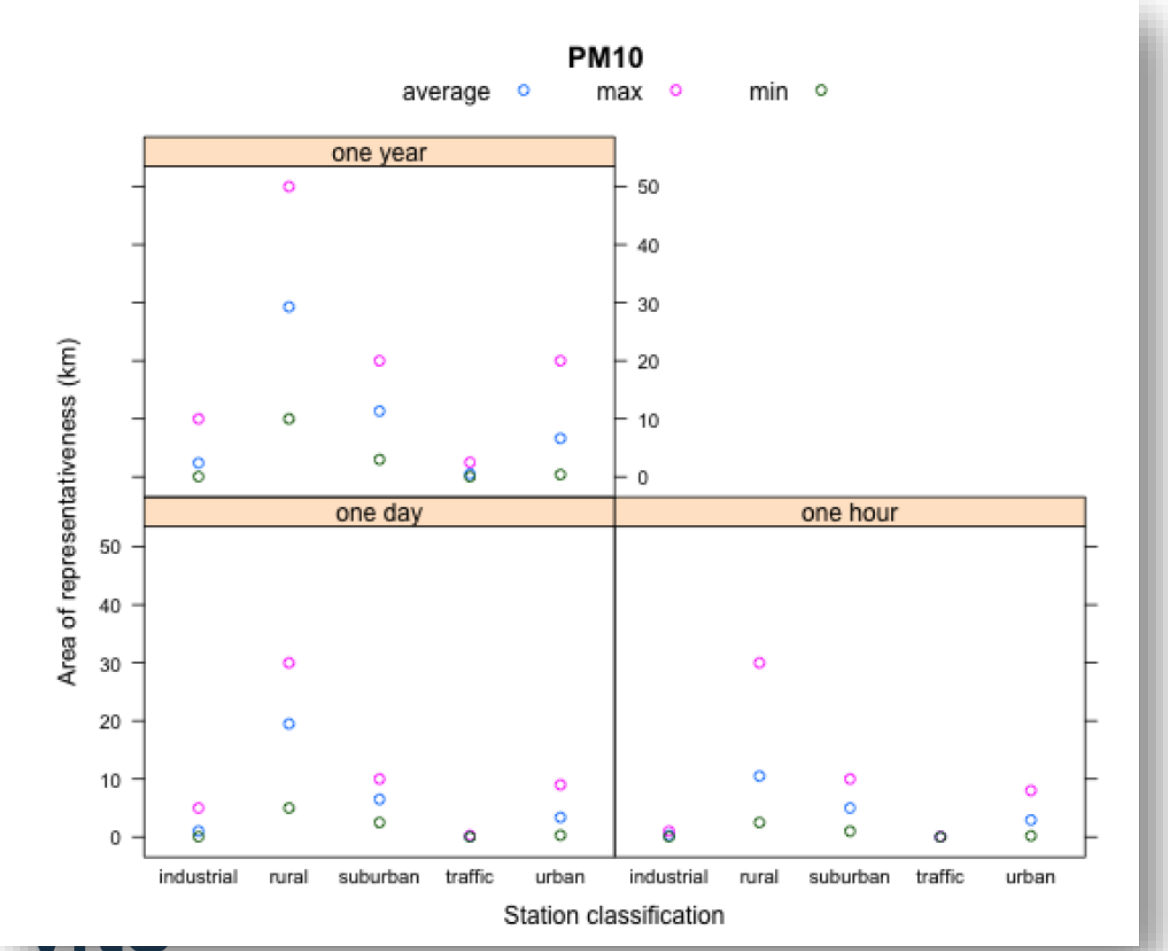
Motivation

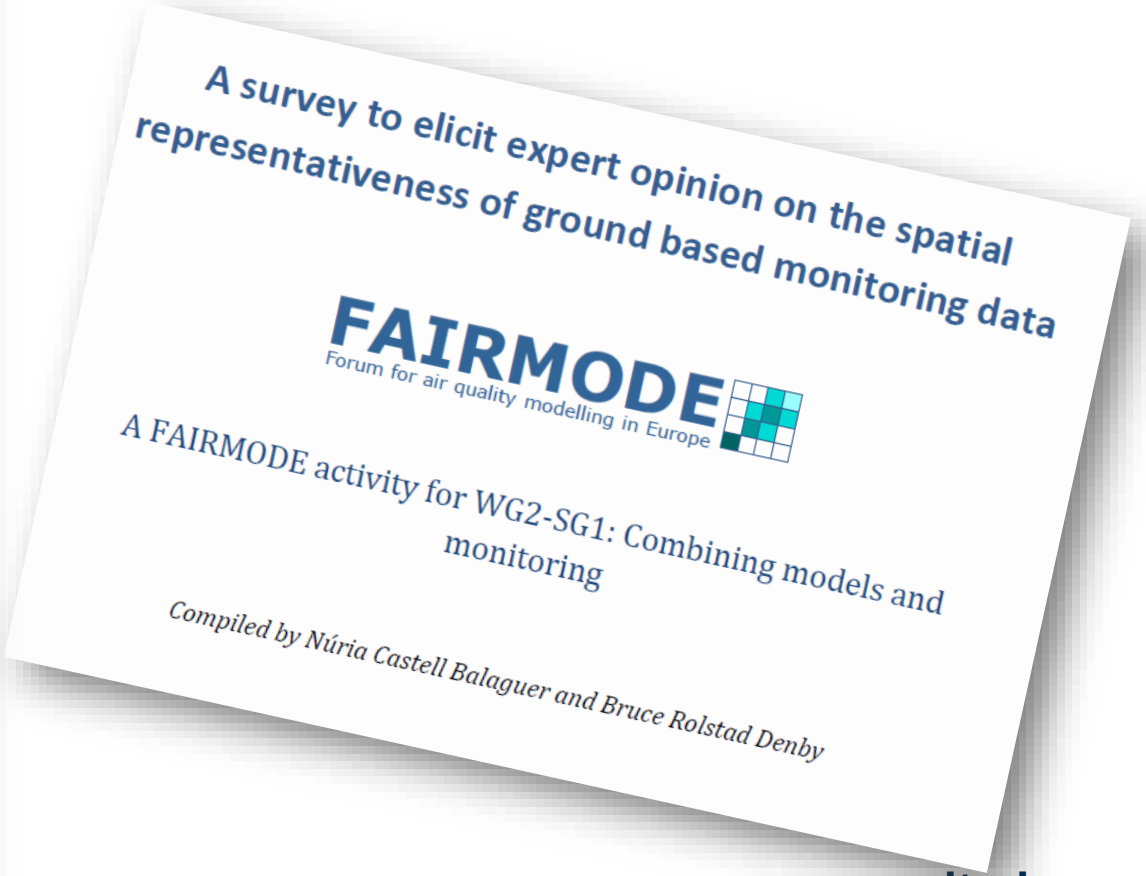
- **Spatial representativeness** (SR) is an essential indicator of any monitoring site

- SR is relevant for various applications under the AAQD:
  - Assessment of **population exposure** based on monitoring data
  - Assessment of **exceedance situations** based on monitoring data
  - Monitoring **network design**
  - Use of monitoring data for **model validation** and **data fusion**

SR: an open issue for a long time…

FAIRMODE survey on expert opinions… (2011 – 2012)

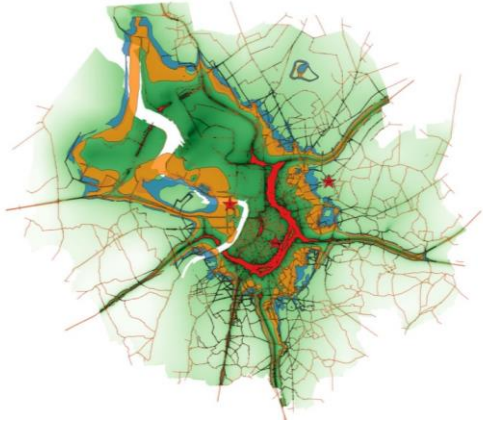


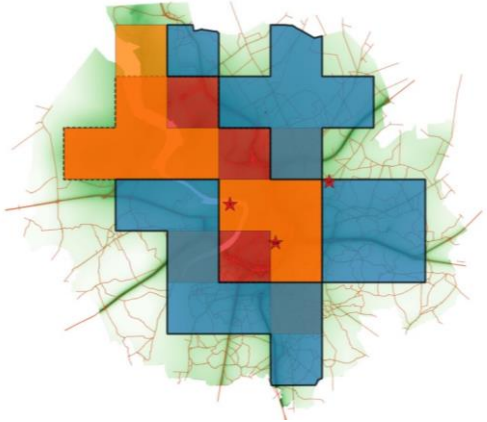


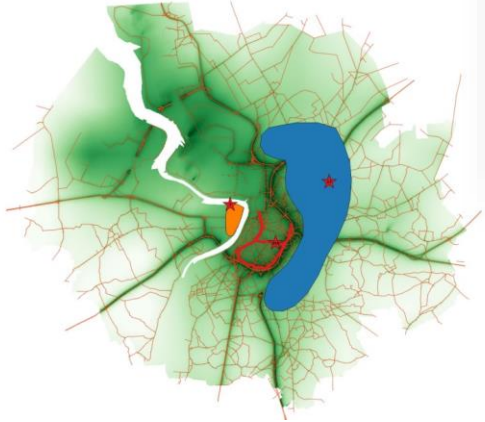
SR: an open issue for a long time…

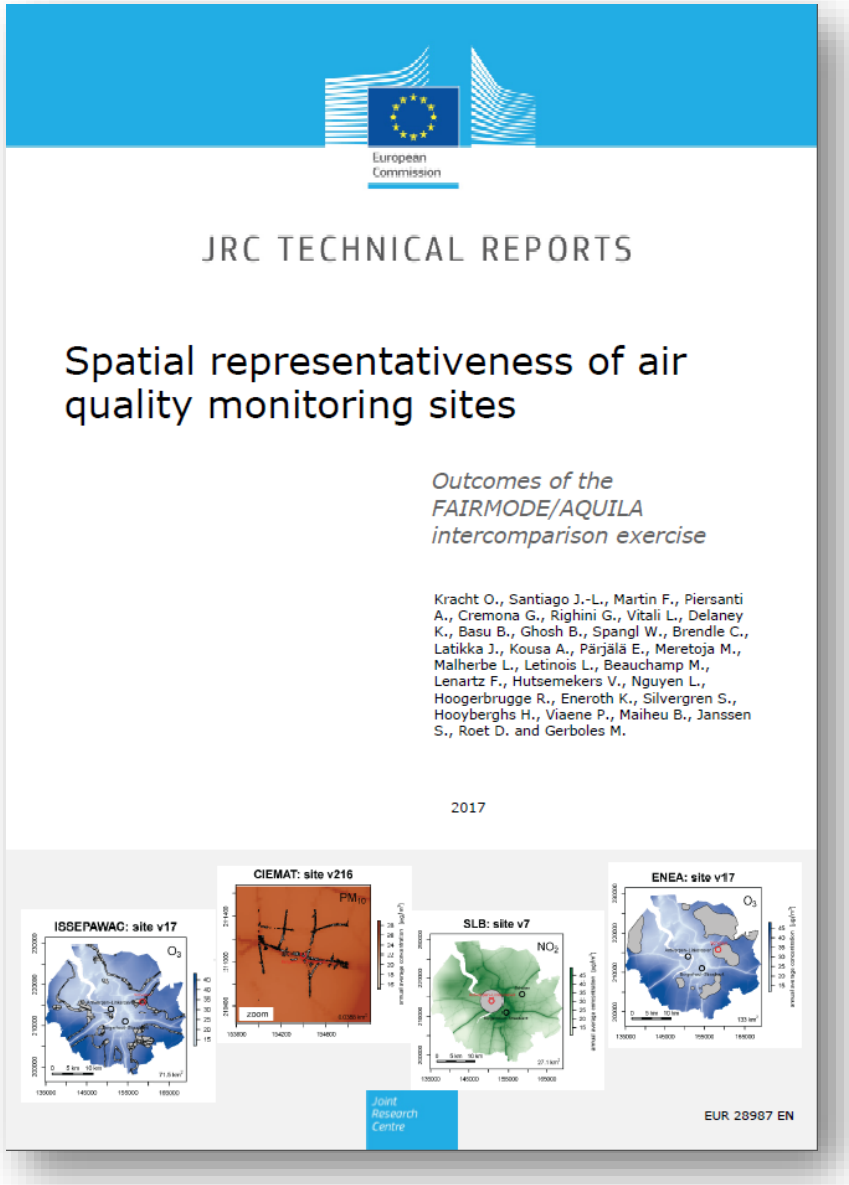
FAIRMODE intercomparison: One of the bigger attempts to clarify the subject:

- SR inter-comparison exercise:
  - SR assessment of 3 stations in Antwerp
  - By 11 European teams
  - Over period 2015 – 2017
  - Supervised by the JRC (Oliver Kracht)
- Conclusions:
  - Concept of **SR area** seemed to work well
  - Considerable **range of dissimilarity** in results!









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SR: an open issue for a long time…

DG-ENV study with recommendations based on current practcies in Europe:

- A TIER-ed approach for SR assessment…

TIER level	Method
TIER 1	Expert judgement
TIER 2a	Proxy data
TIER 2b	Sampling campaigns
TIER 3	**Fit-for-purpose modelling**
TIER 4	**Combination of modelling & measurement campaigns**

→ Models are representing our best possible understanding of atmospheric disperson

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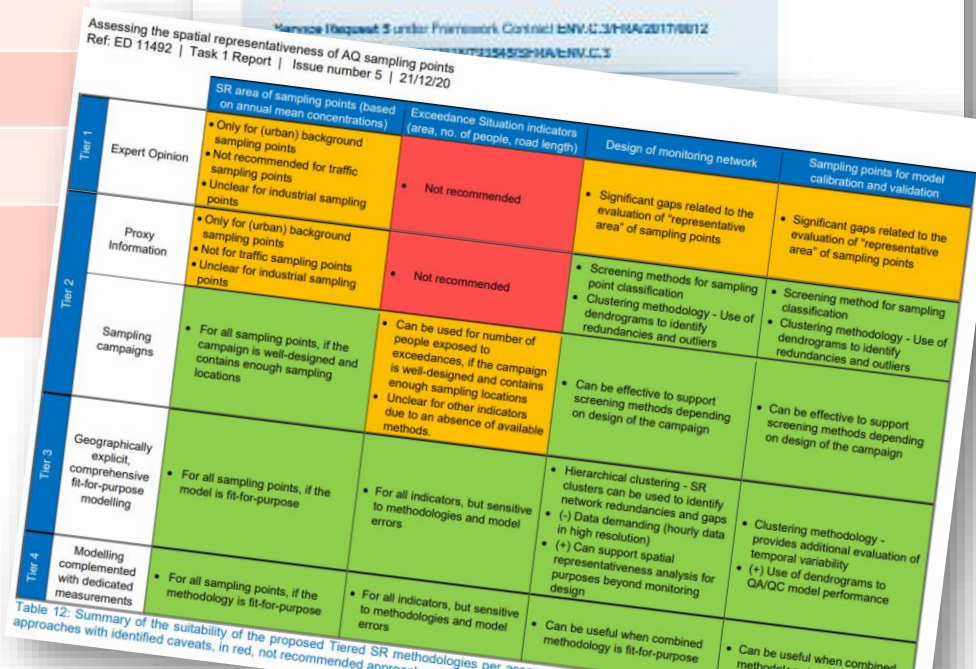
Assessing the spatial representativeness of air quality sampling points

Application of siting criteria and sampling point classification – Task 3 report



Assessing the spatial representativeness of AQ sampling points
Ref: ED 11492 | Task 1 Report | Issue number 5 | 21/12/20

		SR area of sampling points (based on annual mean concentrations)	Exceedance Situation indicators (area, no. of people, road length)	Design of monitoring network	Sampling points for model calibration and validation
Tier 1	Expert Opinion	• Only for (urban) background sampling points • Not recommended for traffic sampling points • Unclear for industrial sampling points	• Not recommended	• Significant gaps related to the evaluation of "representative area" of sampling points	• Significant gaps related to the evaluation of "representative area" of sampling points
Tier 2	Proxy Information	• Only for (urban) background sampling points • Not for traffic sampling points • Unclear for industrial sampling points	• Not recommended	• Screening methods for sampling point classification • Clustering methodology - Use of dendrograms to identify redundancies and outliers	• Screening method for sampling classification • Clustering methodology - Use of dendrograms to identify redundancies and outliers
	Sampling campaigns	• For all sampling points, if the campaign is well-designed and contains enough sampling locations	• Can be used for number of people exposed to exceedances, if the campaign is well-designed and contains enough sampling locations • Unclear for other indicators due to an absence of available methods.	• Can be effective to support screening methods depending on design of the campaign	• Can be effective to support screening methods depending on design of the campaign
Tier 3	Geographically explicit, comprehensive fit-for-purpose modelling	• For all sampling points, if the model is fit-for-purpose	• For all indicators, but sensitive to methodologies and model errors	• Hierarchical clustering - SR clusters can be used to identify network redundancies and gaps in high resolution) • (-) Data demanding (hourly data in high resolution) • (+) Can support spatial representativeness analysis for purposes beyond monitoring design	• Clustering methodology - provides additional evaluation of temporal variability • (+) Use of dendrograms to QA/QC model performance
Tier 4	Modelling complemented with dedicated measurements	• For all sampling points, if the methodology is fit-for-purpose	• For all indicators, but sensitive to methodologies and model errors	• Can be useful when combined methodology is fit-for-purpose	• Can be useful when combined

Table 12: Summary of the suitability of the proposed Tiered SR methodologies per ... approaches with identified caveats, in red, not recommended approa...

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Participants CT8.1

Name	Country/Region/City
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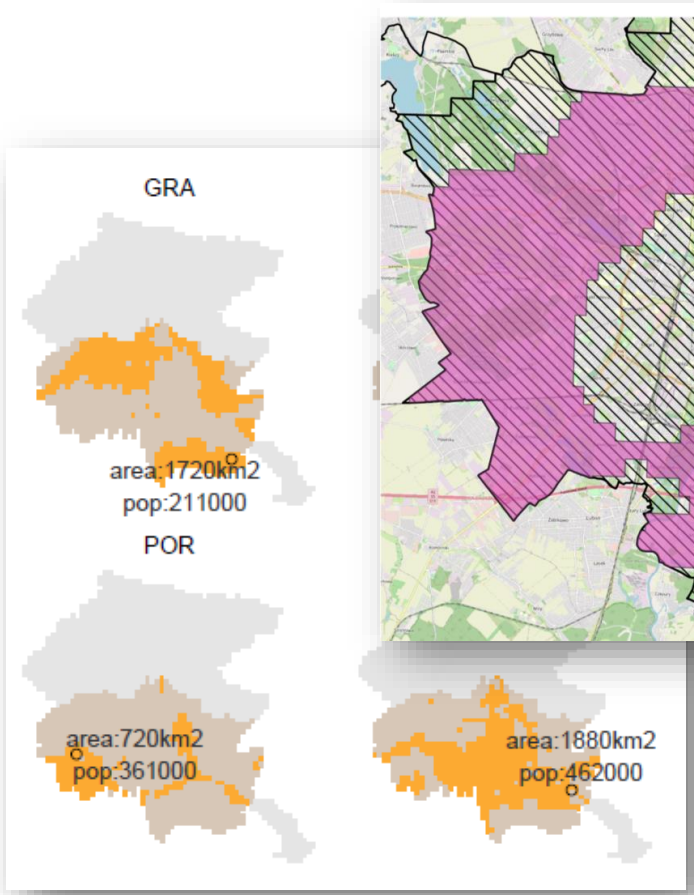
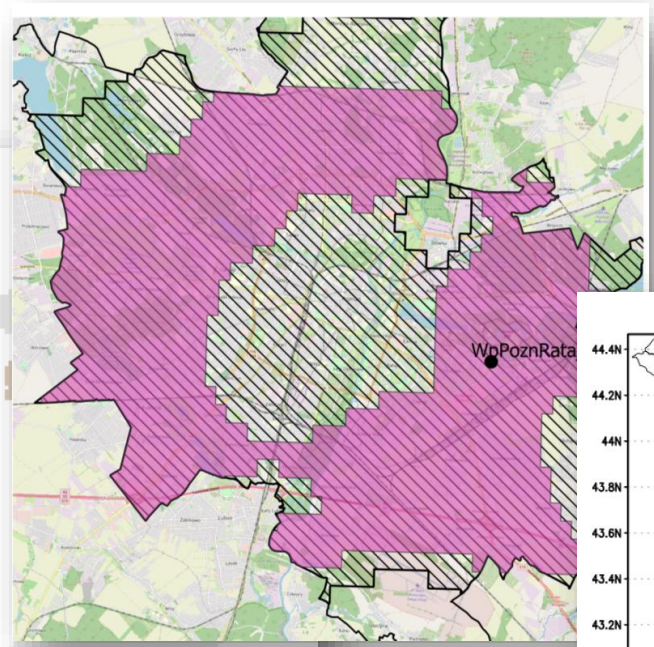
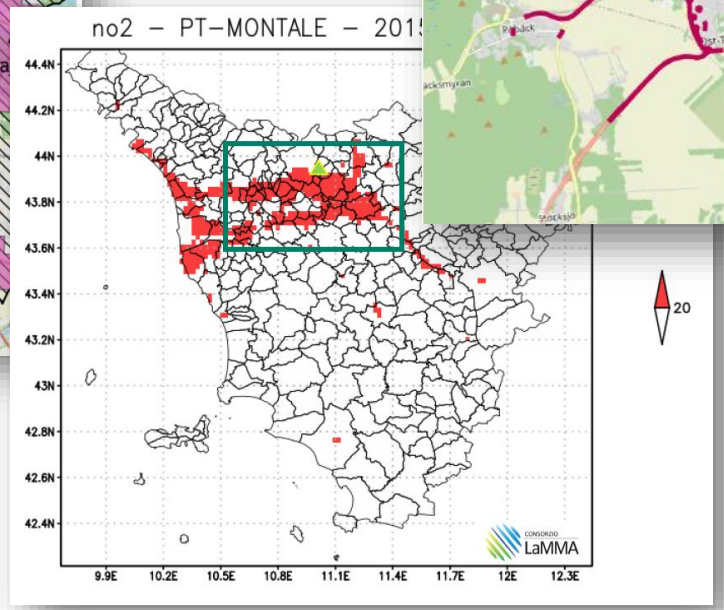
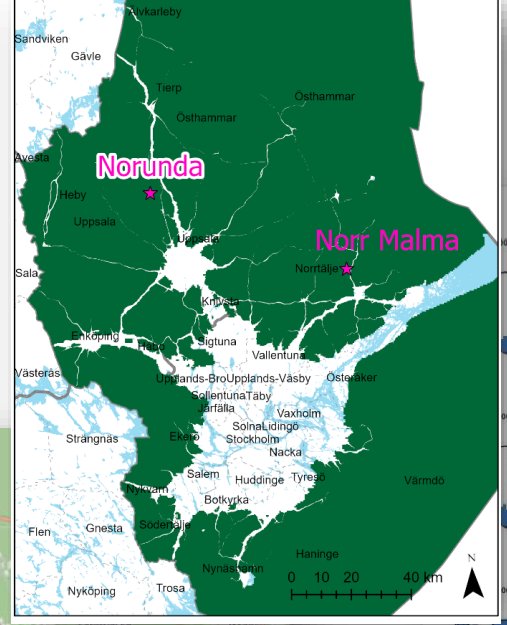
CT8 exercise on SR

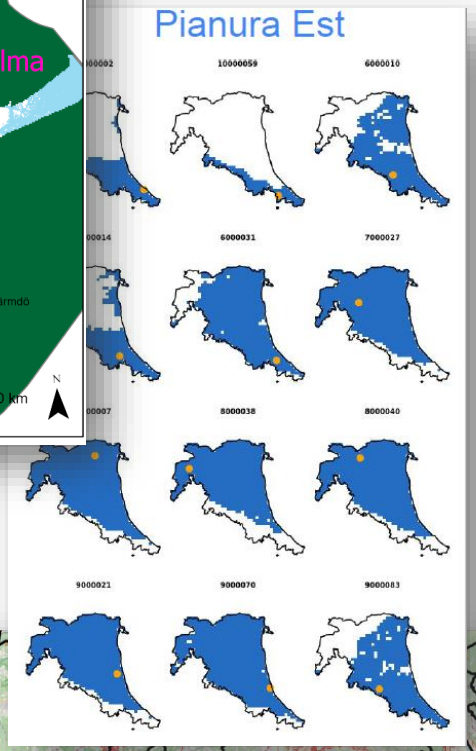
- Models become fit-for-purpose to assess SR at all spatial scales and all station types

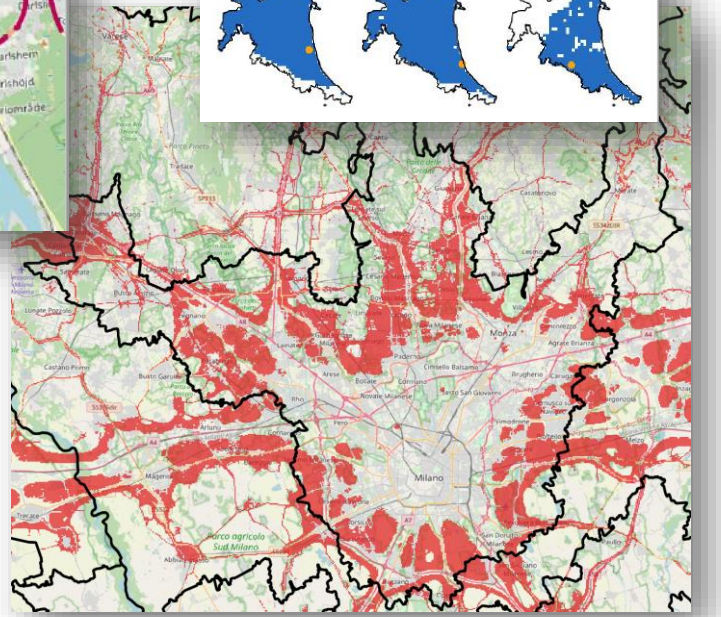








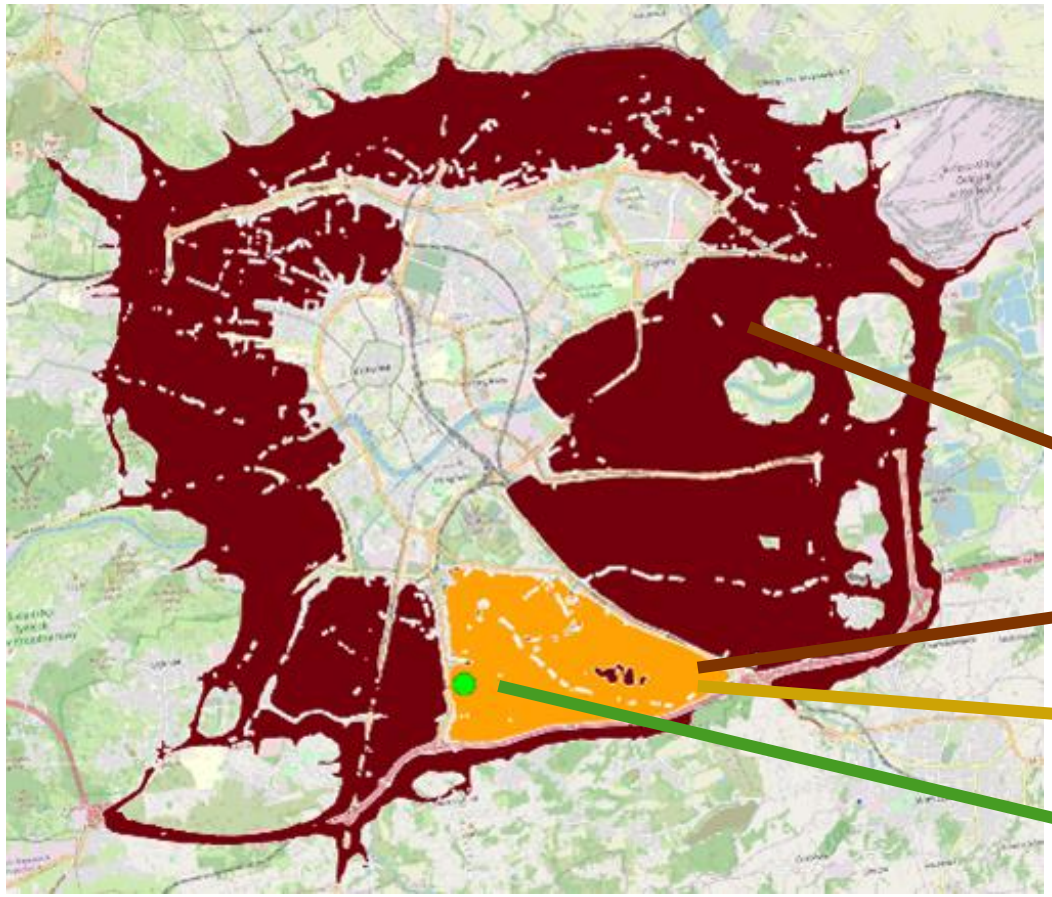


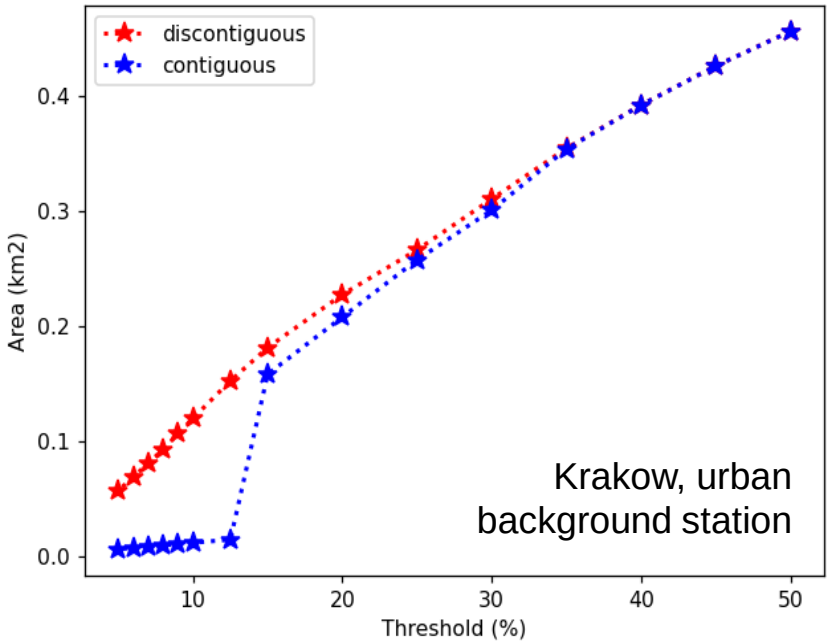


Ingredients of an SR concept

- (Dis)contiguity
- Similarity criterion
- Tolerance (or threshold) level

Discontiguous versus contiguous areas





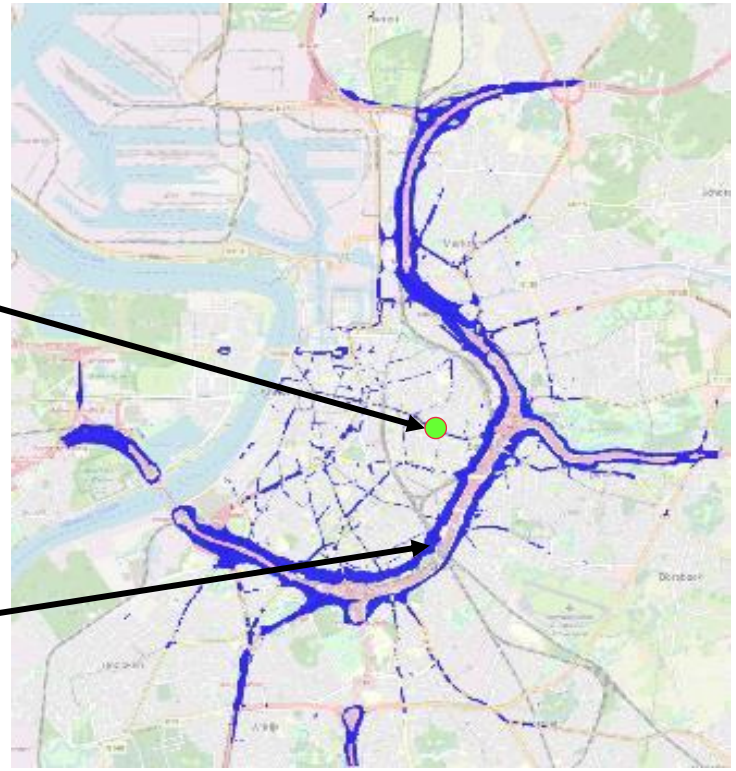
SR area in **discontiguous** approach

SR area in **contiguous** approach

Measurement station

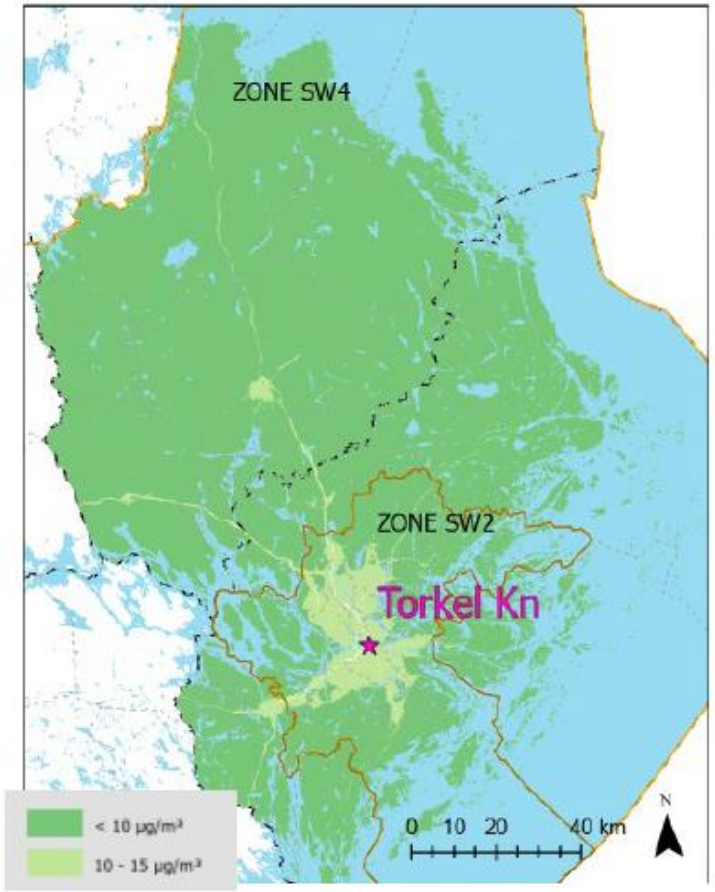
Similarity criterion

- Start with **annual mean** concentrations (for the time being…)
  - Easy to implement and provide guidance
  - Consequence: mixing of different type of locations (sources/typology) in the same SR area

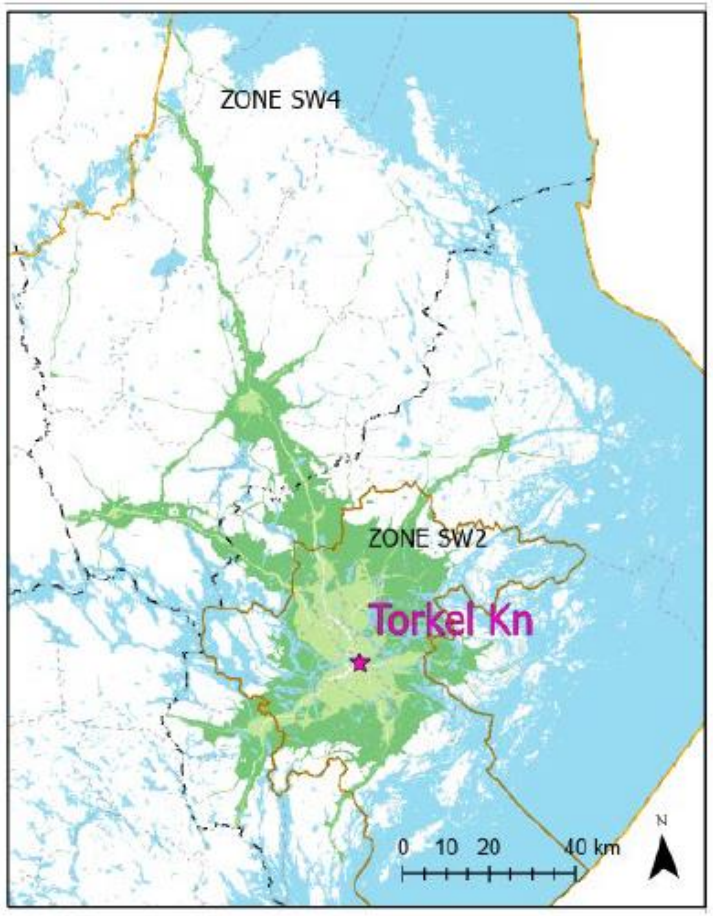


Tolerance level: what works in practices?

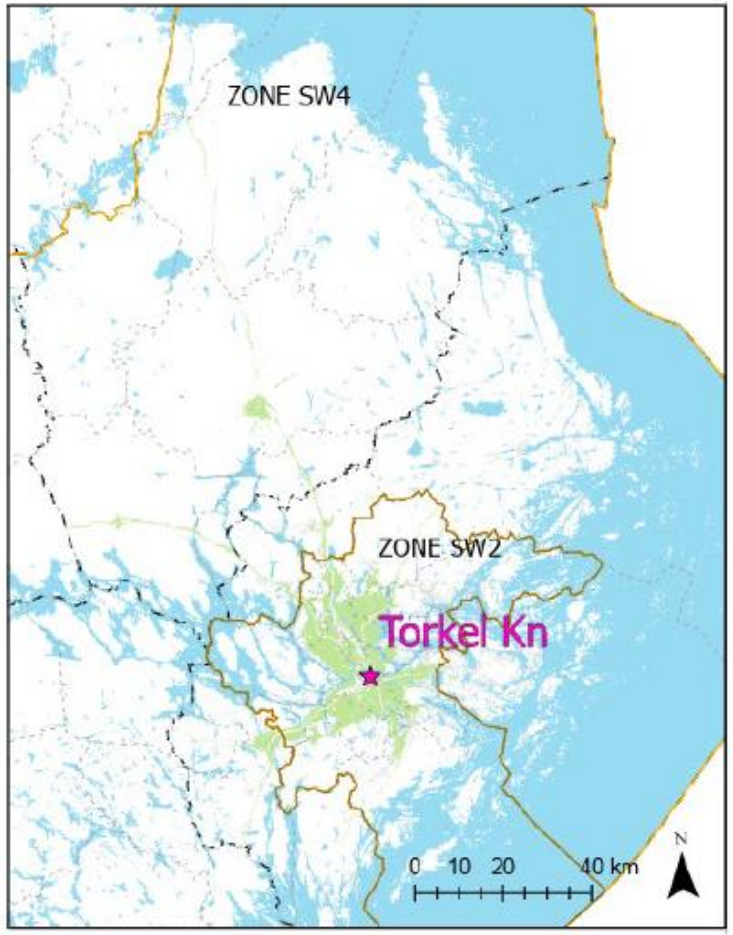
Torkel Kn, Stockholm
- PM10 yearly mean: 11.2 µg/m³
- MQI: 7.5 – 14.9 µg/m³



Torkel Kn, Stockholm
- PM10 yearly mean: 11.2 µg/m³
- ± 20 %: 8.9 – 13.4 µg/m³



Torkel Kn, Stockholm
- PM10 yearly mean: 11.2 µg/m³
- ± 10 %: 10.1 – 12.3 µg/m³



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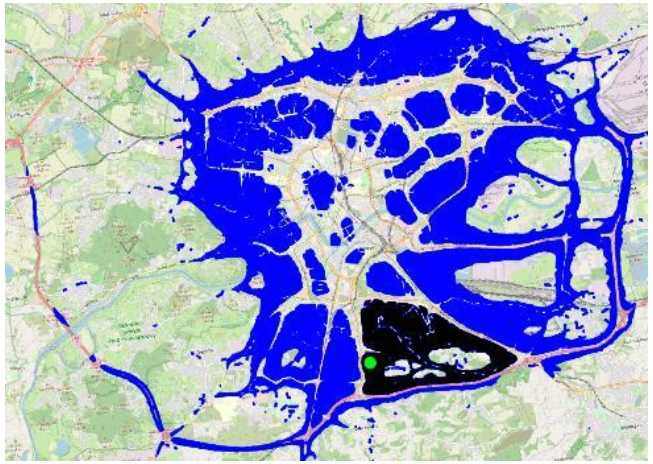
FAIRMODE SR recipe

- **Discontiguous** SR area, limited by the IPR AQ zone
  - If needed the area can be reduced (e.g. based on expert opinion)
- Similarity criterion: **annual mean concentrations**
- **Tolerance** level (tested for NO_2, PM_{10}, $PM_{2.5}$, O_3):
  - ± 10% for rural & urban background stations
  - ± 20% for traffic stations
  - Absolute lower cut-off of 2 µg/m³



- Use **modelled** concentrations at station location (assuming bias is small → fit-for-purpose model)

Further refinements…

- Evaluate the effect of different **lower cut-off** values
  - Especially relevant for rural stations, some pollutants (e.g. O3)
- SR similarity criterion based on annual mean concentration (for the time begin), but:
  - Develop similarity criteria for **percentiles** → important for AAQD limit values
  - Test the possibility of a **source specific SR** → important for e.g. AQ planning
- SR **inter-annual variability** (e.g. due to meteo effects) is a reality, but:
  - Relevance depends on the application domain → more testing to assess the impact
- SR of **industrial sites** only poorly analyzed for now
- SR assessment requires a fit-for-purpose model with low model basis
  - What is an **acceptable bias** at individual station location?
- SR area can be reported as a shape file in the **e-Reporting**
  - Realistic to request from MS under the IPR? (is already “mandatory, if available”!)

Conclusions

- FAIRMODE has proposed a simple and robust **recipe for SR assessment** based on **modelling** results
- This recipe:
  - has been (extensively) tested in various regions in Europe
  - is applicable for all type of stations and the core pollutants under the AAQD
- Further refinements are needed… but at least some of the longstanding "confusion" about spatial representativeness seems to haven been resolved

Thank you

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