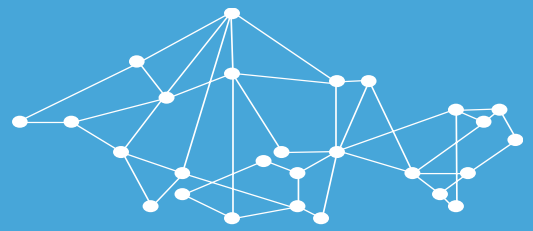
FAIRMODE
Forum for air quality modelling in Europe



ASSESSMENT RECOMMENDATIONS

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Recommendations on assessment

- Modelling Quality Objective *(Update 2019)*
- Fit-for-purpose modelling *(Update 2019)*
- Forecast *(New – CT3)*
- Sensors *(New – CT6)*
- Scope for modelling under the AAQD *(New)*
- Spatial Representativenss of monitoring stations *(New – CT8)*
- Exceedance Situation Indicators of air quality zones *(New – CT8)*

Modelling Quality Objective (§3.3-1 and §7.1.3)

- The FAIRMODE Modelling Quality Objective (MQO) quantifies how well modelling application **are in agreement** with observations.
- The MQO should be used as a **quality control mechanism** to assess whether a modelling based assessment is of sufficient quality for application in the context of the AAQDs.
- **Formulas and parameters** of the MQO have been further specified.
- The MQO is **not sufficient** to ensure fitness-for-purpose. **Other QA/QC tests** are necessary → see CT2 Guidance Document
- **Guidelines for conditions** of application and reporting of MQO shall be published by the Commission/FAIRMODE.

Fit-for-purpose modelling (§3.3-2 and §3.3-3)

- Fit-for-purpose modelling systems are most often a **combination of various modelling tools** designed for different spatial extents. The composition of the modelling chain should depend on the type of application.

- To reduce the **ambiguity of the spatial scale** in the fitness-for-purpose definition, FAIRMODE proposes, as a general guidance, that the spatial scale(s) of the modelling system should be such that **all observations** of pollutant concentration levels within the scope of the application **can be reproduced** within the margin of tolerance of the MQO.

Scope for modelling applications under the AAQD (§7.1.1)

- Clearly **define modelling** as: "output from a modelling system, i.e. from a chain of models and sub-models, including all necessary input data, and any post-processing."
- Clarify and extend the range of possible use of **modelling methods**:
  - Assessment purposes: Assessment of air quality levels, identification of hotspots, estimation of the extent of exceedances and of the (averaged) population exposure and/or exposure reduction targets.
  - Forecasting and public information purposes: Providing current and short-term forecast and the development/application of Air Quality Indexes.
  - Source apportionment purposes: Identification of the most relevant air pollution sources, quantify their contributions and provide a knowledge basis for planning mitigation strategies.
  - Planning purposes: Development and assessment of plans and measures to improve and ensure good air quality to meet air quality standards

Scope for modelling applications under the AAQD (§7.1.1)

- Support the use of modelling in the **establishment of zones and agglomerations**. Relate the use of zones and agglomerations as basis for all air quality assessment and air quality management purposes.
- Support the use of modelling in the **monitoring site selection** and **monitoring network design**. Secure that there is a minimum number of sampling points to allow model validation in the specific zone and agglomeration.
- Revise the possibility of **reducing** the required minimum number of **fixed sampling points** when supplementary techniques of assessment are allowed. The revised AAQDs should secure **enough measurements** to be used for **model validation** purposes.
- Recommend to make **modelling** and/or indicative measurements **mandatory** above the upper assessment threshold. This is in line with the AQUILA WG3 recommendation and would support a better understanding and assessment of situations with high level concentrations.

FAIRMODE PROPOSED CHANGES IN THE LEGAL PROVISIONS

Proposal on the FAIRMODE Recommendations – AAQD revision

AAQD	Revisions recommended by FAIRMODE
Definitions	Define modelling ("output from a modelling system, i.e. from a chain of models and sub-models, including all necessary input data, and any post-processing.").
	FAIRMODE recommends to use modelling for following applications: • **Assessment purposes:** Assessment of air quality levels, identification of hotspots, estimation of the extent of exceedances and of the (averaged) population exposure and/or exposure reduction targets. • **Forecasting and public information purposes:** Providing current and short term forecast of air quality levels and development/application of Air Quality Indexes. • **Source apportionment purposes**: Identification of the most relevant air pollution sources, quantify their contributions and provide a knowledge basis for planning mitigation strategies. • **Planning purposes**: Development and assessment of plans and measures to improve and ensure good air quality to meet air quality standards. Use of models is essential for this application.
	Recognition of FAIRMODE network in same terms as AQUILA

FAIRMODE PROPOSED CHANGES IN THE LEGAL PROVISIONS (II)

Proposal on the FAIRMODE Recommendations – AAQD revision (II)

AAQD	Revisions recommended by FAIRMODE
Art 6.2, 6.3 and 6.4.	Clarify and extend the range of possible use of modelling methods, regardless of the upper or lower assessment thresholds, provided a quality assurance framework comparable to the one already defined for measurements is included. **FAIRMODE recommends to make modelling and/or indicative measurements mandatory above the upper assessment threshold.** This is in line with the AQUILA WG3 recommendation and would support a better understanding and assessment of situations with high level concentrations.
Annex I - MQO	**Model Quality Objectives (MQO)** are mentioned in Annex I: "Data Quality Objectives". FAIRMODE recommends using the standardized Modelling Quality Objective (MQO), as defined by FAIRMODE. This would imply the following changes to Annex I. • Remove information related to model uncertainties in Annex table. • Update (as proposed below) the existing definition of the overall model uncertainty (intended here as; model + input + configuration).

FAIRMODE PROPOSED CHANGES IN THE LEGAL PROVISIONS (III)

Proposal on the FAIRMODE Recommendations – AAQD revision (III)

AAQD	Revisions recommended by FAIRMODE
Article 4	Support the use of modelling in the **establishment of zones and agglomerations** (art. 4). Article 4 can be rephrased to allow Member States to combine results from previous measurements, previous measurement campaigns and modelling applications when they are to establish zones and agglomerations throughout their territory. It is also important to relate the use of zones and agglomerations as basis for all air quality assessment and air quality management purposes
Annex III.D	Support the use of modelling in the review of monitoring site selection (annex III.D) and **monitoring network design**. The site-selection procedures can be facilitated with the use of modelling by providing information on the representativeness of the monitoring site. In addition, there is a need to revise site selection requirements to secure that there is a minimum number of sampling points to allow model validation in the specific zone and agglomeration. These two aspects should be considered in a possible revision of Annex III.

FAIRMODE PROPOSED CHANGES IN THE LEGAL PROVISIONS (IV)

Proposal on the FAIRMODE Recommendations – AAQD revision (IV)

AAQD	Revisions recommended by FAIRMODE
Art 7.3, Art 10.3, Art 14.2.	Revise the possibility of reducing the **required minimum number of fixed sampling** points when supplementary techniques of assessment are allowed. The current text of the AAQDs allows for a reduction of the number of fixed measurements when indicative measurements or modelling approaches are used instead. However, an extended use of modelling also requires a better assessment of the quality of the modelling applications, namely though model validation with the use of measurements. The revised text of the AAQDs should allow for the revision of the minimum number of fixed measurements to secure enough measurements to be used for model validation purposes. Therefore, any reduction of the required minimum number of sampling points should be revised to consider the potential risk of such a rule would it drastically limit opportunities for modelling validation

Low-cost sensors (§3.3-6)

- Low-cost sensors are an emerging technology that opens new opportunities for assessment. Therefore:
  - FAIRMODE recommends, in addition to using individually calibrated low-cost sensors, to calibrate/validate groups of **low-cost sensors in a network setting**.
  - FAIRMODE recommends to further develop a **QA/QC procedure** for low-cost sensor networks. Sensors in a sensor network are expected to be qualified as indicative measurements for specific pollutants under the AAQDs.
  - FAIRMODE recommends, once the QA/QC procedure is developed, to integrate sensor data in modelling results via **data fusion or data assimilation** techniques to improve the overall quality of the air quality assessment methodologies.

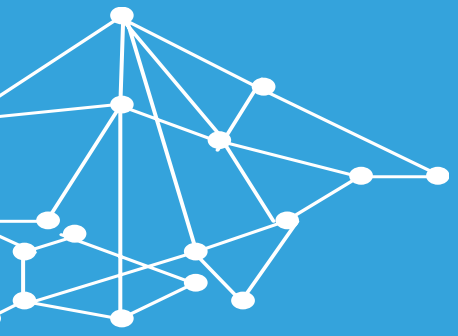
Forecast (§3.3-7)

- Regarding modelling applications for forecasting, FAIRMODE recommends **additional features** to be assessed when a forecasting application is evaluated (see tomorrow's presentation and the revised *Guidance Document on Modelling Quality Objectives and Benchmarking*, soon online).
- Even if reporting of modelled data and related indicators is currently not mandatory for forecasting applications, Member States and scientific community are encouraged to use the proposed methodology.

Spatial Representativeness (§3.3-4) & Exceedance Situation Indicators (§3.3-5)

- Recent FAIRMODE-CT8 joint exercises resulted in a draft CT8 Guidance Document
- CT8 delivers a proposal for:
  - **Spatial Representativeness** (SR) of monitoring station
  - **Exceedance Situation Indicators** (ESI) for air quality zones

→ Methodology presented in the next sections is open for discussion



Spatial Representativeness

SR purpose and application domains

- 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**

→ Concept of Spatial Representativeness **area** serves many of these application needs

A TIER-ed approach for SR assessment…

- 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**

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 • (-) 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 methodology is fit-for-purpose

Table 12: Summary of the suitability of the proposed Tiered SR methodologies per assessments purpose. In green, recommended approaches, in orange, approaches with identified caveats, in red, not recommended approaches for specific assessment purpose. More details are provided in the main text.

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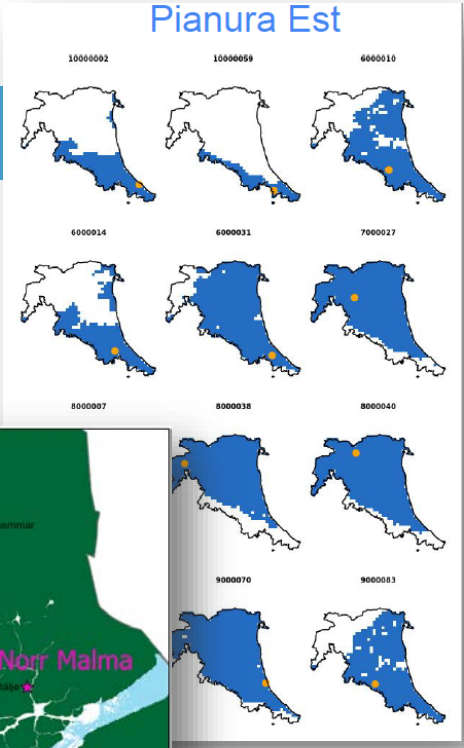
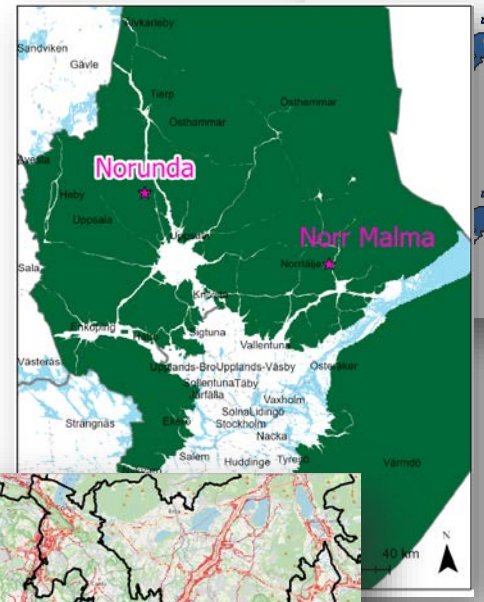
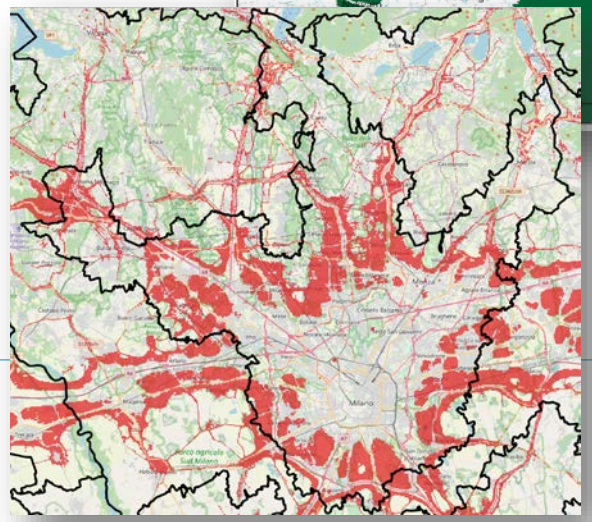
The good news:

- Spatial Representativeness is essential information of a monitoring station and links to many elements in the AAQD
- Models become fit-for-purpose to assess SR at all spatial scales and all station types
- FAIRMODE has a much more harmonized view on the subject than few years ago
- So… we made significant progress. Eventually!

→ thanks to all the enthusiastic participants for their contributions

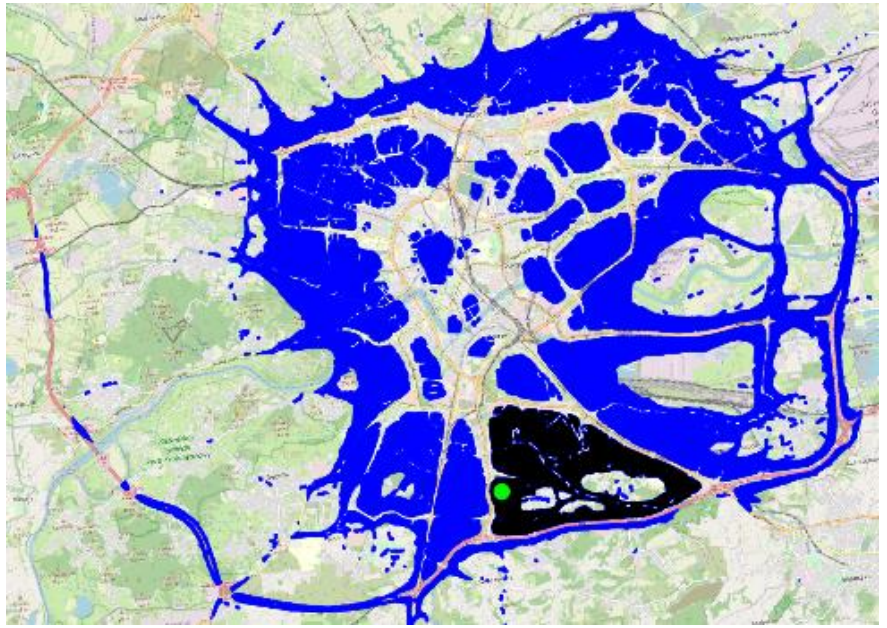






The recipe…

- **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:
  - ± 10% for rural & urban background stations
  - ± 20% for traffic stations
  - Absolute lower cut-off of 2 µg/m³
- Tested for NO_2, PM_{10}, $PM_{2.5}$, O_3
- Use modelled concentrations at station location (assuming bias is small → fit-for-purpose model)



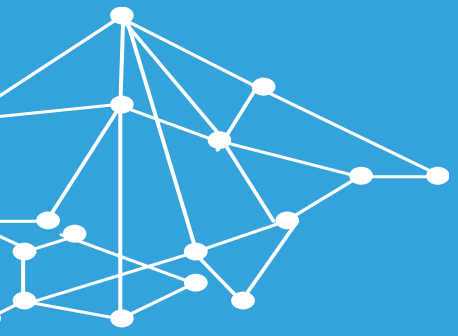
Further refinements…

- Evaluate the effect of different **lower cut-off values**
  - Especially relevant for rural stations
- 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 analysed 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”!

Proposal on the FAIRMODE Recommendations – IPR GUIDANCE document revision

The methodology proposed by FAIRMODE CT8 on the assessment of a spatial representativeness area of a monitoring station should be referred to in the IPR GUIDANCE document

The methodology is based on modelled annual averaged concentrations varying within a specific margin of tolerance. The spatial representativeness area is defined according to a discontiguous approach within the boundaries of the air quality zone. The full description of the proposed methodology is given in the CT8 Guidance Document on Exceedance indicators and Spatial Representativeness.



Exceedance situation indicator

CT8 activities in 2021 and 2022

- CT8 working group reviewed current practices in estimating and reporting Exceedance Situation Indicators (ESI)
- Contributions from Sweden, Poland, Italy, German regions, Portugal, Belgium
- Conclusion: more guidance and harmonization is needed!

EXCEEDANCE SITUATION INDICATORS

Context

- Exceedance Situation Indicators:
  → Additional information about **extent and severity** of the observed exceedances
  → Purpose is dual: compliance checking & input for health impact & AQ planning

- Exceedance Situation Indicators (year X) reported via e-Reporting Data Flow G in September X+1
  → **Too early** for a comprehensive analysis in many MS

EXCEEDANCE SITUATION INDICATORS

New proposal

- Proposal for a 2 staged approach:
  - **Flagging ESI**: qualitative indicator to flag the severity of the exceedance (compliance purpose) → year X+1
  - **Planning ESI**: quantitative indicator that identifies all the hot spot areas in the air quality zone (planning purpose) → year X+2

EXCEEDANCE SITUATION INDICATORS

Definition of Flagging ESI

- Qualitative additional information about severity of the observed exceedance
- **Class based** indicator that can be easily assessed
- Assessment based on **available data sources** (e.g. existing modelling results)
- Can be reported in **year X+1** via Data Flow G
- Assessment method should be documented via Data Flow D

Ranges require reality check!

Class	Fraction of area/population in exceedance in the AQ Zone [%]	Description
1	< 1%	A **few exceedances** are estimated in the AQ zone
2	1% - 10%	A **significant number of exceedances** are estimated in the AQ zone
3	10% – 50%	A **large part** of the AQ zone is in exceedance
4	> 50%	**Very widespread** exceedances in the AQ zone

Definition of Planning ESI

- Comprehensive and quantitavie indicator
- Provides **full understanding** of the exceedances in the air quality zone
- ESI for **area** (km²) and **population** (#residents) in exceedance
- Assessment based on fit-for-purpose **modelling**
- Input for the design of an **air quality plan**
- Reporting via e-Reporting Data Flow H-K
- Timing: **year X+2** → Too late?

Considerations & Open issues

- Model resolution:
  - Spatial: what about **street canyons**? → mandatory for e.g. NO_2?
  - Temporal: time aggregation given by the limit value (annual, percentile…)
- Input data:
  - **Resolution** of population data should be **aligned** with the model resolution
  - Can be extended with info on **sensitive groups** (info for AQP)
- Concerns:
  - If exceedance occur only in a (few) street canyons → **road length** might still be useful
  - A binary threshold indicator is very sensitive to methodology and input data → be aware of it
- Include this proposal in the **Recommendations** or only refer to the CT8 Guidance Document which can be further refined?

Proposal on the FAIRMODE Recommendations – IPR decision and IPR Guidance revision

FAIRMODE recommends the development of a new 2 stages approach for the estimation and reporting of the exceedance situation indicators (ESI). The current timing of the reporting under IPR is posing challenges for many MS resulting in a proposal for a 2 stages approach. A first qualitative Flagging ESI can be easily assessed and expresses the severity of the exceedance in the air quality zone.

This information could be reported under data flow G on the attainment of environmental objectives. The second Planning ESI requires a more comprehensive assessment approach and is used as the starting point of the air quality planning process. Reporting could take place under data flow H-K. A full description of the proposed methodology is given in the Guidance Document on *Exceedance indicators and Spatial Representativeness*.