FAIRMODE WG8 workshop on spatial representativeness, webinar 29/01/2024

This was the second of two workshops (following the first on 14th Dec 2023) that were arranged within FAIRMODE WG8 for participants to present results from further testing of the proposed methodology for defining spatial representativeness (SR) that has been developed during the last few years within the working group. A checklist to guide the testing and a document with key remaining issues was circulated before the workshop and four country contributions were presented during the workshop. This document provides a short summary of the contributions and the main conclusions from the discussion. The presentations from the workshop have been uploaded to a Teams folder that all WG8 participants have access to, and are also available to download from the FAIRMODE website for WG8.

Comparison of Criteria for Representativeness based on Modelling data from Austria, Wolfgang Spangl

Wolfgang Spangl (Environment Agency Austria) presented results from testing of the various criteria for defining SR areas for various stations in the cities of Salzburg and Graz, as well as in some smaller towns and rural environments in the province of Styria (Austria). The results showed that SRAs of stations were relatively similar when using ±10% for background stations and ±20% for hotspot stations or using ±15% for all station types, adding weight to the argument to use a uniform tolerance level. The results also showed the relevance of using a lower cut-off, in order to avoid very small SRAs and large gaps between the SRAs of stations in the low concentration range. A lower cut-off of ±2 µg/m³ for PM10 provides good coverage of AQ zones by the SRAs of the existing network. For NO_2 ±2 µg/m³ leaves frequent gaps between suburban and rural stations; a cut-off of 4 µg/m³ would be needed to ensure an almost complete coverage of the AQ zone by SRAs of the existing stations. Lower cut-off values of ±1 µg/m³ for PM2.5 and ±0.2 ng/m³ for B(a)P were also recommended. A question was also raised on how to handle cases where suburban or urban stations have similar concentrations to areas in the vicinity of rural motorways when defining SR areas.

SR tests from Germany, Stefan Feigenspan

Stefan Feigenspan (UBA, German Environment Agency) presented updated results from further testing following initial results presented during the first workshop in Dec 2023. The same urban and regional-scale background model (2x2 km^2 resolution) was used for the different zones in Germany for 2022.

The SR areas of rural background stations were now limited to NUTS1 level, rather than the zone level, following discussions at the previous workshop, which seems to address some of the problems that existed in previous testing with significant gaps in certain zones that do not have rural background stations. In general, the SRAs of existing monitoring stations showed a good level of coverage throughout DE, even using the lower alternatives for tolerance levels and cut-offs. Areas in DE that were not covered

by SRAs were mostly areas with low concentrations, below the assessment threshold. The question of the need to cover such areas was also raised since the proposed revision of the AAQD only requires SRAs to be defined for sampling points in zones above the assessment threshold. Results for SO2 were also presented and showed very good coverage using a tolerance level of ±10 % and a lower cut-off of 2 µg/m³ (±1 µg/m³). The data fusion datasets were found to give smaller SRAs than the raw datasets since they increase pollutant concentrations.

It was concluded that higher tolerance levels and cut-off values may lead to over-representation and increased overlapping in SRAs and the recommendation was therefore to opt for lower values.

Spatial representativeness – street canyons – Berlin, Dr. Andreas Kerschbaumer

Dr. Andreas Kerschbaumer (City of Berlin) presented results from testing of SRAs for NO2 annual means at street canyon stations in Berlin. A street canyon model was used for the analysis with data from 2015, providing results for road sections from junction to junction and no bias adjustment was used. An analysis was also done with modelled data for 2020 and 2025 (using 2015 meteorology).

Berlin has a relatively large number of urban traffic sites located around the city (6 automatic stations and 22 passive samplers), and the combined SRAs of these sites show a good level of coverage of major roads across the city. Streets with lower levels of NO2 are not well represented by the traffic stations, since the aim of the network is to provide representative data in hotspot locations and provide data for evaluating the impacts of AQ measures. There was little difference found in the SRAs using different tolerance levels (±15% or ±20%) or for the different years assessed. There was significant overlap in SRAs since the stations are placed at points where high values are expected, but this was not seen as a major issue since it is in line with the monitoring objective to assess AQ at hotspots throughout the city and evaluate measures. The results indicated that fewer kerbside stations would be sufficient and the importance of intelligent monitoring network design and use of fit-for-purpose models for assessing SRAs was emphasised. Street canyons that are not heavily polluted are not covered by representative street measurements, as this is not the aim of measurements at street locations. A recommendation was that the analysis of spatial representativeness performed when applying street canyon model applications at street sites should focus on heavily polluted streets. Tests were not conducted for PM10 and PM2.5, but considering the different spatial patterns of PM compared to NO2 in Berlin (NO2 has much steeper concentration gradients in traffic sites), it is anticipated that SRAs would be quite different and require different considerations.

Results for B(a)P in Slovakia, Jana Matejovicova

Jana Matejovicova (Slovak Hydrometeorological Institute, SHMU) presented results from testing of SRAs for an urban background station in Jelšava for B(a)P, PM10, PM2.5 and NO_2. Results were based on modelling of road traffic with the AtmoStreet model at 10 x 10 m and modelling of point sources and domestic heating with the CALPUFF modelling system at 250 x 250 m interpolated to 10 x 10 m.

Concentrations of B(a)P are relatively high and above the current target value and the modelling shows clear hotspots with elevated concentrations, including in the vicinity of the station in Jelšava. The calculated SRA of the station was considered relatively small even using a tolerance level at ±20 %. The SRA ranged from 1.5 km^2 using a tolerance level of ±10 % to 3.5 km^2 using ±20 %. The SRA was clearly representative of hotspots areas where there are high contributions from domestic heating, whereas the surrounding areas with lower concentrations were not covered by the SRA. This raises an interesting question on potential issues with the current station classification system. This station is correctly classified as an urban background station according to the current classification system but is clearly representative of hotspot locations with significant contributions from domestic heating. This issue gives further weight to the argument to use a uniform tolerance level, since it is not clear if ±10 % or ±20 % would be the relevant tolerance level to use for this station if different levels for different station types are to be used.

Results showed similar, but slightly larger SRAs, for PM10 and PM2.5, whereas SRAs for NO_2 were significantly larger. Plans for further testing are to carry out bias correction, check changes to the SRA during the year and test SRAs for the SMOG warning system.

Discussion of results and key open issues

The discussion focused on some key open issues:

- **AQ zone limitation for SR areas:** There is agreement within the group on the removal of the AQ zone limitation for rural background stations. Further discussion is needed on alternative ways to limit the SRAs of these stations. One option would be to use NUTS1 areas as the maximum limit instead, as applied during DE's testing. The point was also made that different limits can be relevant for different countries. 100 000 km^2 would seem reasonable in ES, but smaller limits can be relevant in other countries.

- **Tolerance levels:** There was general agreement within the WG that a uniform tolerance level of ±15 % should be used for all types of stations. Results from testing have shown that the different tolerance levels tested generally produce quite similar SRAs and the use of a uniform tolerance level has the additional benefit of simplicity. It was also pointed out that the tolerance level for background sites may be less sensitive since the lower cut-off becomes dominant anyway when concentrations are low.

- **Lower cut-off:** There is now a common understanding within the group regarding the interpretation of the lower cut-off, and it is suggested to add clarity by using "±" and therefore formulating the cut-off in the same way as the tolerance level is formulated. There was a general agreement on defining the lower cut-off values as follows:

    - ± 2 µg/m3 for PM10, NO2, O3
    - ± 1 µg/m3 for PM2.5

± 0.2 ng/m3 for B(a)P has also suggested by AT and ± 1 µg/m3 for SO2 has been used in testing by DE, but further consideration/discussion is needed on these levels to ensure there is agreement within the WG. A suggestion was also made to investigate whether measurement uncertainties around zero could be relevant to use for the pollutants for which we do not yet have concrete suggestions for the lower cut-off.

- **Handling of overlapping SR areas:** There was little time to further discuss issues relating to overlapping SRAs. The point was however made that overlapping SRAs does not always indicate that there is redundancy in the monitoring network, since two stations may have similar annual mean concentrations but very different source apportionment. This links to previous discussions on the potential use of source-related criteria for further refining SRAs.

- **Other issues raised:**
    - It would be good to provide guidance/recommendations on minimum model resolution to assess SRAs for different station types.
    - How to deal with cases where we have two different types of modelling (e.g. regional and local scale models) that cover the same area?
    - On-going negotiations on the revision of the AAQD are highly relevant and could have some consequences for the application of SRAs. The results of the negotiations need to be carefully studied and discussed once they are available.

Development of a technical guidance document on monitoring network design, Joana Soares

Joana Soares (NILU) informed the WG on plans to produce a technical guidance document on monitoring network design. This activity is a follow-up to the joint FAIRMODE & AQUILA monitoring network evaluation exercise using the MoNET tool during 2022/2023. A draft outline of the planned guidance document was presented and contributions from countries that participated in the evaluation exercise will be requested in the coming weeks. A first draft of the document is planned during March, with a final document in March – April. The document will provide important input to the SR9 guidance document and the chapter on spatial representativeness and monitoring network design which is being developed during 2024 and will be published at the beginning of 2025.