



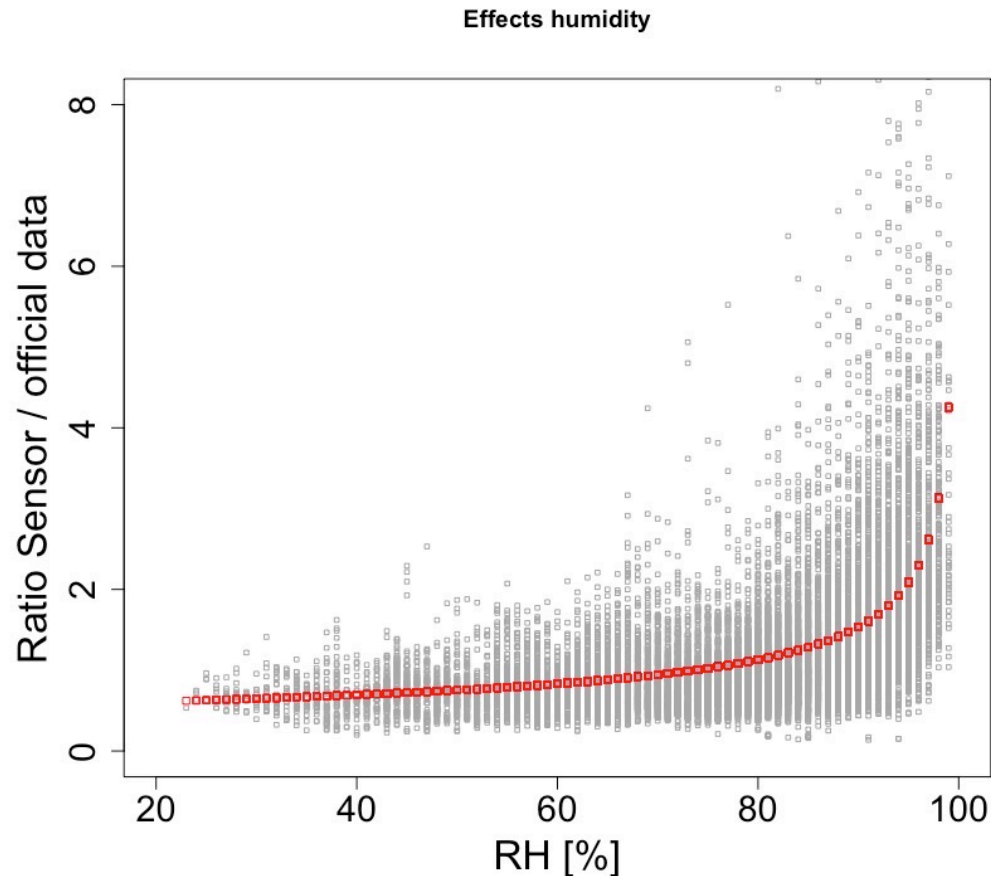
National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Calibration and Data Fusion of PM2.5 sensors in the Netherlands

Joost Wesseling



Calibration: humidity



Fit to the data: $CF = a(100 - RH)^b$

RIVM Sensors | FAIRMODE | Oct 2019

- Most low-cost optical PM sensors are quite sensitive to relative humidity.
- The effects of humidity are quite similar for PM10 and PM2.5.
- There is a large variation in the effect of the humidity → more issues, effect location, housing, ...



Calibration

- In tests with groups of measurements in a number of Dutch cities, we observed that the differences between hourly results of sensors in small areas are quite small, and the average PM gradients are small.





Calibration



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- Idea: compare the average of all sensors located at a short distance around an official measuring station to the official hourly results → local correction factor.
- In practice, the highest and lowest 5% sensor values are an indication of malfunctioning sensors.
- For now, these sensors are not used in the calibration.
- More complex methods are probably needed to prevent excluding valid high or low values.



Calibration



- In tests with groups of measurements in a number of Dutch cities, we observed that the differences between hourly results of sensors in small areas are quite small, and the average PM gradients are small.
 - Idea: compare the average of all sensors located at a short distance around an official measuring station to the official hourly results → local correction factor.
 - Interpolate the correction factors over the country.
 - Use the calibration field to calibrate all individual sensors.
- So, we do not work with individual pre-calibrated sensors, but with the available overall combined₅ data.



Calibration

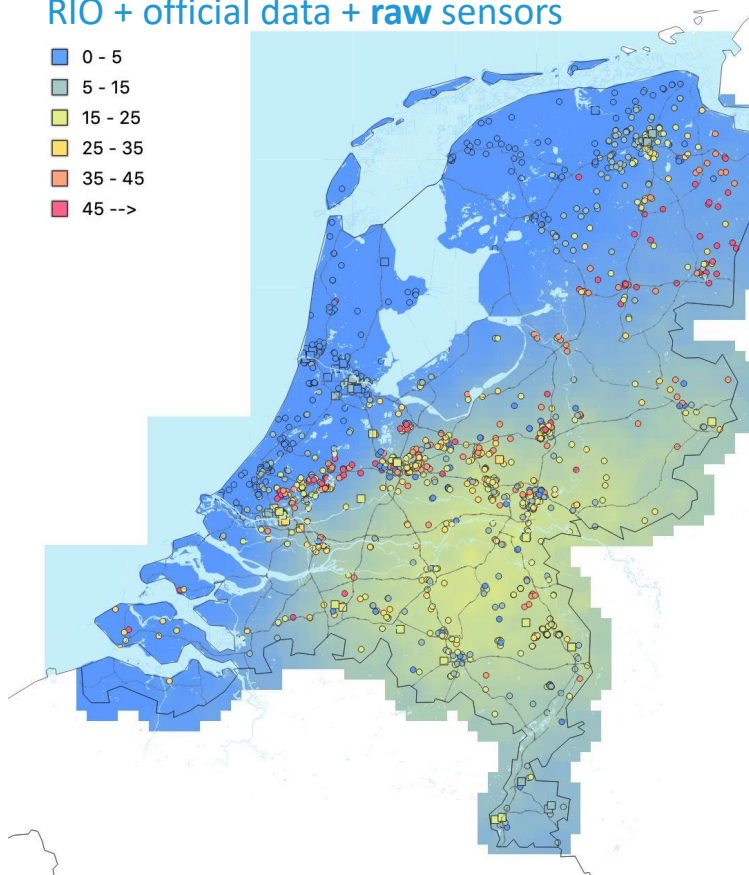
RIO + official data

- 0 - 5
- 5 - 15
- 15 - 25
- 25 - 35
- 35 - 45
- 45 -->



RIO + official data + raw sensors

- 0 - 5
- 5 - 15
- 15 - 25
- 25 - 35
- 35 - 45
- 45 -->



Shown on the left are the results of **official PM2.5 measurements** for November 26, 08:00. The concentrations modelled using the Belgian RIO model are also shown (ug/m3).

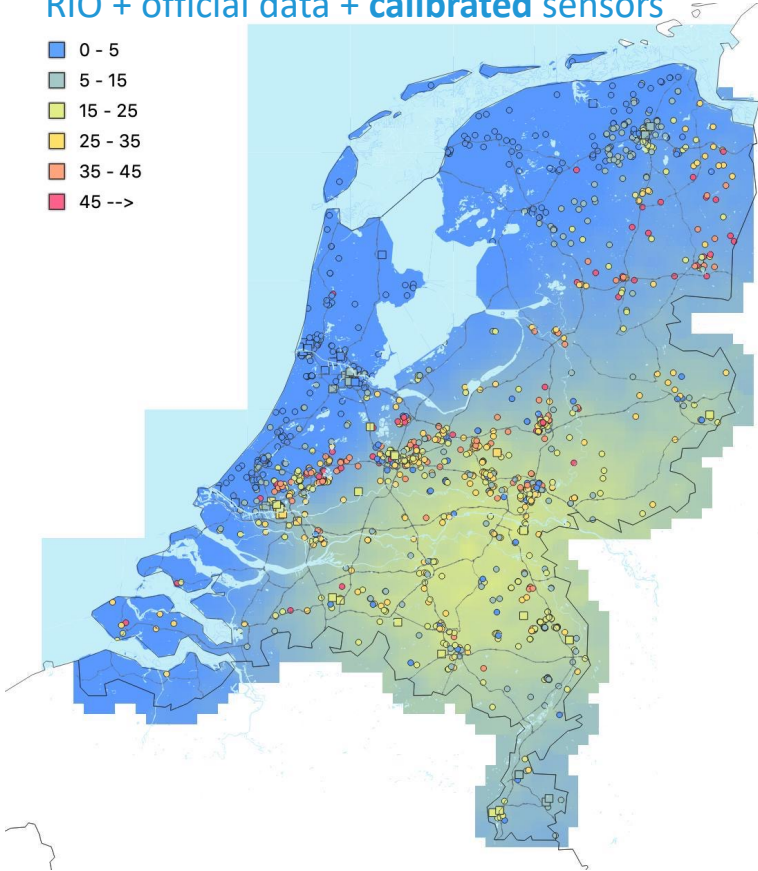
The figure on the **right** shows the **raw** sensor data.



Calibration

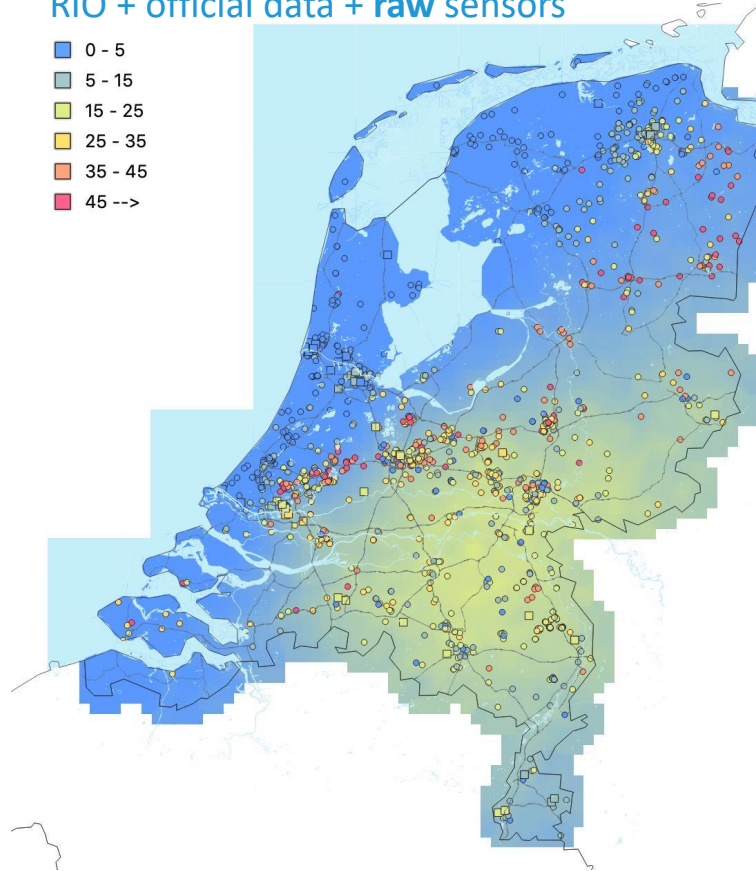
RIO + official data + **calibrated** sensors

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RIO + official data + **raw** sensors

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The figure on the **left** shows the sensor data after the **calibration** has been estimated and applied.

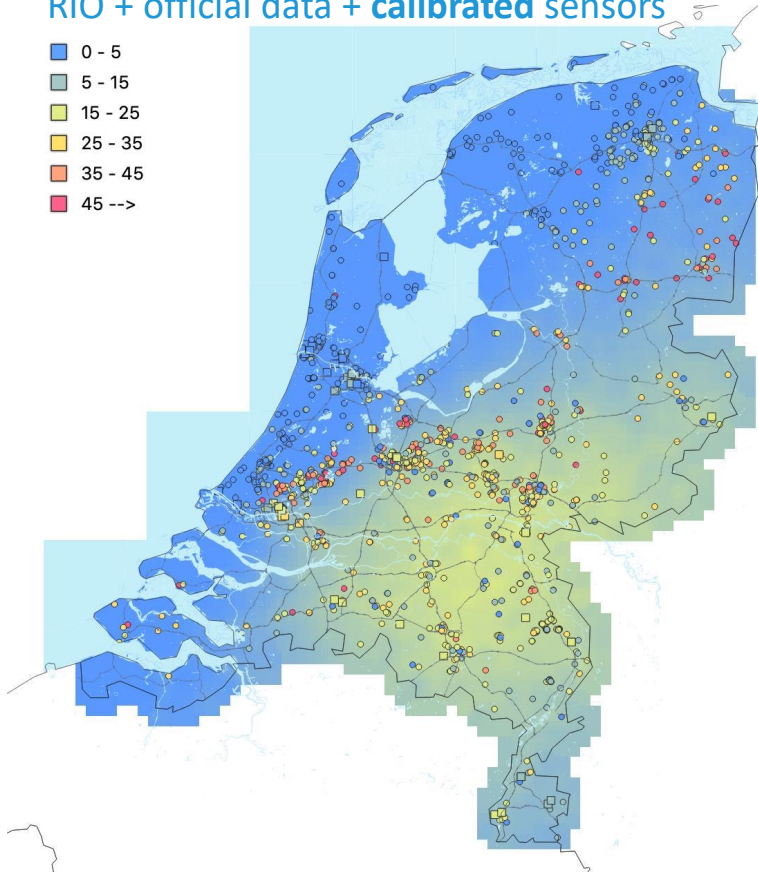
The figure on the **right** shows the **raw** sensor data.



Data Fusion

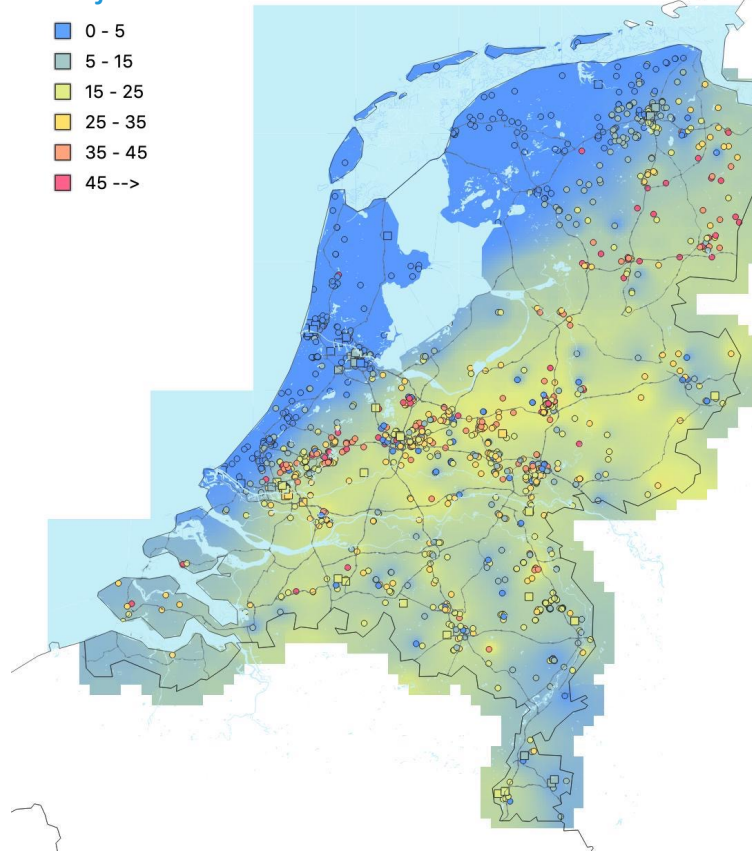
RIO + official data + **calibrated** sensors

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- 45 -->



Adjusted RIO + official data + **calibrated** sensors

- 0 - 5
- 5 - 15
- 15 - 25
- 25 - 35
- 35 - 45
- 45 -->



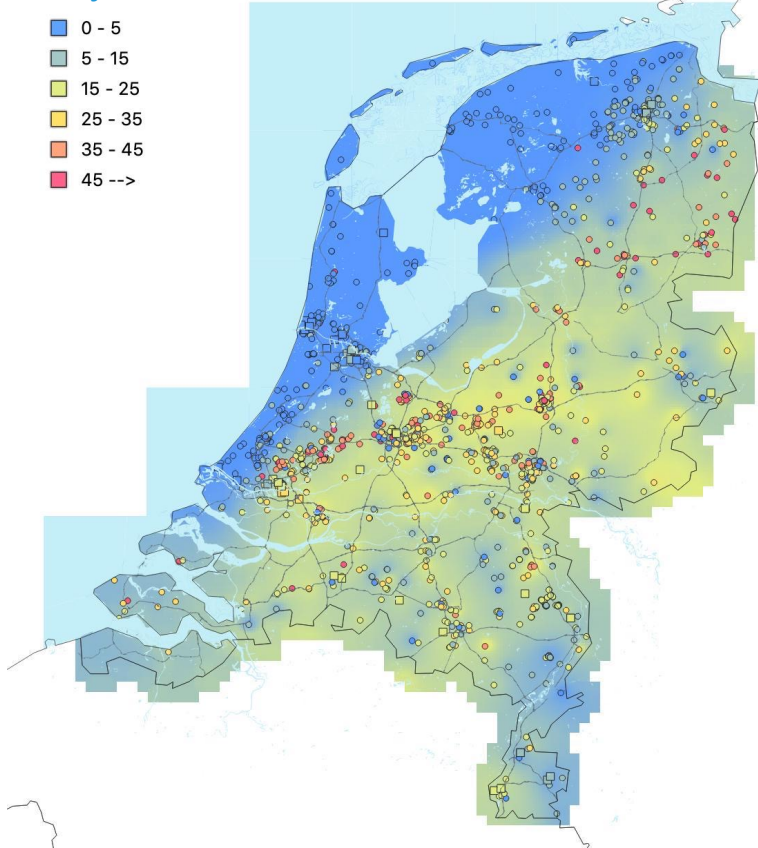
The figure on the left shows the sensor data after the calibration has been estimated and applied.

The figure on the right shows the adjusted global concentration field after the official measurements, calibrated sensor data and RIO concentrations have been combined.



Adjusted RIO + official data + **calibrated** sensors

- 0 - 5
- 5 - 15
- 15 - 25
- 25 - 35
- 35 - 45
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The figure shows the adjusted global concentration field after the official measurements, calibrated sensor data and RIO concentrations have been combined.

- The systematic uncertainty of the sensor calibration is estimated using a bootstrap, taking the number of sensors and the number of official measurements into account.
- The random uncertainty of the sensors is not (yet) taken into account.
- The uncertainty in the RIO field is combined with that of the sensors to estimate an new, data fused, concentration map.
- There are many options that still need to be investigated.



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Questions ?