



FINE PARTICLES MONITORING (PM) AT A REHABILITATION SITE

A CASE STUDY

PIERRE-YVES GUERNION (RAMBOLL) & AMIEL BOULLEMANT (RIO TINTO)
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SUMMARY

- Site presentation
- Environmental follow-up design
- Continuous monitoring
 - Operating protocol
 - Results
- Perspectives



ABOUT RAMBOLL

- Independent consultancy and engineering firm
- Created in 1945 in Denmark
- 15,000 staff, including 2,500 experts in Environment and Health
- 300 offices in 35 countries
- 4 offices in France: Paris, Lyon, Aix and Bordeaux
- Revenue (2018): €1,500,000k
- 250 experts in air quality
- Air quality services dedicated to solution development for industries, infrastructure and sustainable cities



SITE PRESENTATION

- Former metallurgical site in France:
 - Surface 30 ha
 - 3 landfills on site
- Rehabilitation activity started in 2018, including:
 - Earthworks to create slopes compatible with sustainable management of rainwater while limiting infiltration to the three landfills, as well as ensuring sustainable geotechnical stability
 - Construction of rainwater network
 - Implementation of a bituminous waterproofing complex with passive vents on one of the slag heaps following the remodelling
 - Covering heaps with topsoil and seeding
- Project duration: 18 months



SITE PRESENTATION

- Presence of houses nearby
- Anticipated risk of dust production by rehabilitation works
- Active industrial site (timber industry) included in the perimeter of the site, that also potentially generates dust during specific operations
- Sensitive context relative to environmental impact

Necessary to have a relevant nuisance monitoring to review the impact of these field works

MONITORING PARTICLES AROUND INDUSTRIAL SITES

Monitoring methods used to assess the environmental impact of industries:

- Sampling and offline analysis method for total dust:
 - Deposit plates: dry deposit only
 - Owen gauges (or equivalent): total deposit (dry and wet)
- PM10 online monitoring with reference methods (belonging to ATMO AQ network):
 - Only 31 industrial stations measuring PM10 in France (on main industrial zones generally)
 - Stations managed by local AQ networks
 - Results available online and in real time on AQ networks websites

Expensive and difficult to install

Generally used for site impact monitoring



Strong interest in monitoring solutions, easier and cheaper to install than reference methods, and with on-line results to be able to act if necessary

PM MONITORING USING MICRO-SENSORS

In recent years, many developments have used microsensors for air quality monitoring

PROS

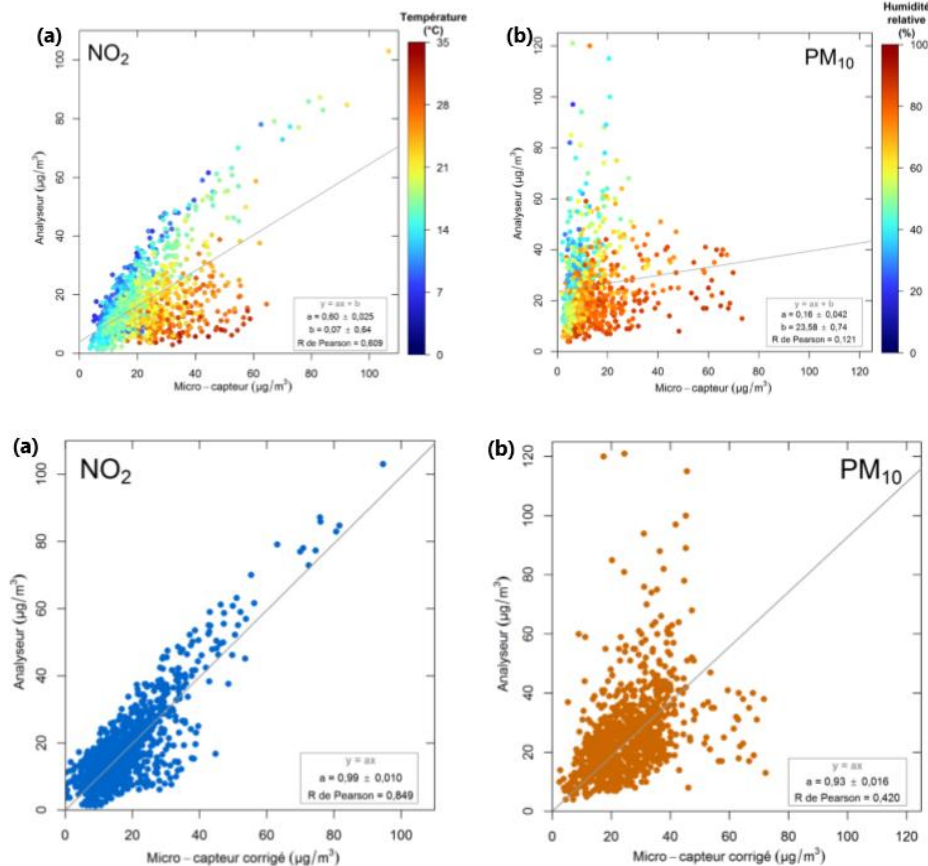
- Easy to install
- Self-sufficient energy-usage, as powered by solar panels
- Easily connected thanks to new technologies (GSM, 4G etc): real-time and online data

CONS

- Micro-sensors less reliable than reference methods
- Existing bias can interfere with the results
- A lot of micro-sensors, but fewer sensors
- Micro-sensor = “black box”: opacity of algorithms included in the software

PM MONITORING USING MICRO-SENSORS

- **Example of bias:** PM measurement and moisture issue: ATMO Nouvelle Aquitaine experience
 - Measurement comparison between air quality station and micro-sensors NO₂ and PM₁₀
 - Influence found of T (NO₂), and humidity (PM₁₀)
- Data correction *a posteriori*, using comparison with reference measurement



Without correction

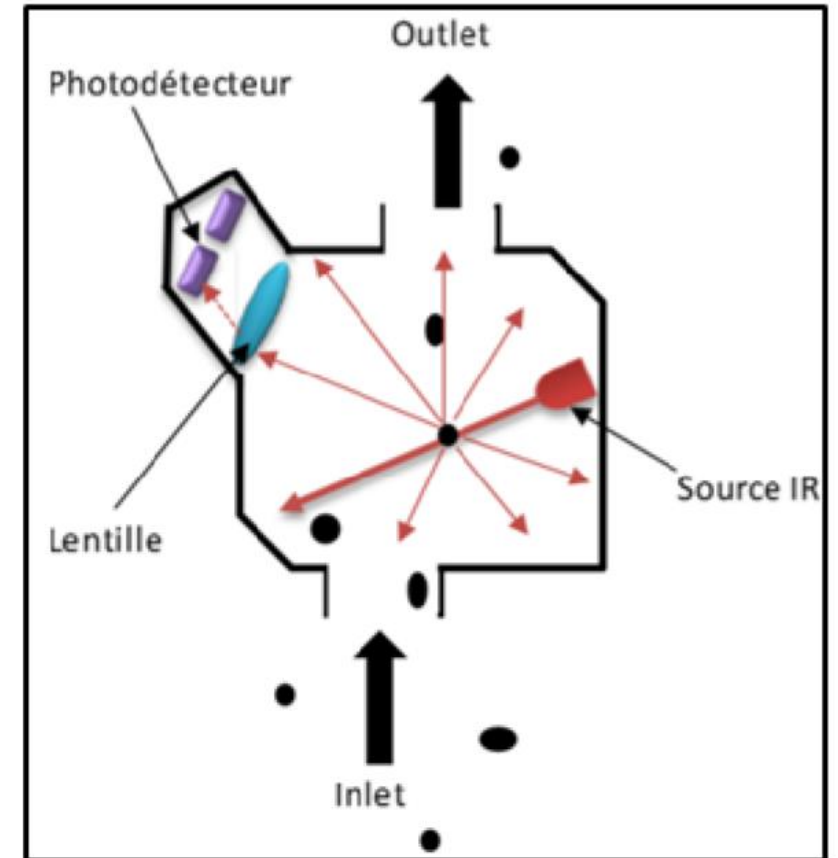
With correction

Source : https://www.atmo-nouvelleaquitaine.org/sites/aq/files/atoms/files/syntheseatmona_urb_ext_17_319_port_bordeaux_micro-capteurs_versionfinale_2018-09-18.pdf

MICRO-SENSOR OPERATING MODE

Micro-sensor principle of operation:

- Fan system: forced air flow in the sensor
- Infrared light source:
 - Signal deviation by particles from PM1 to PM10
 - Signal then focused by a lens on a photodiode
 - 2 different signals PM1-PM10 and PM2.5-PM10 (difference in the signal amplification and residence time)
- 4 minutes sampling and measurement every 20 minutes (battery limitation)
- Valid concentration range:
 - **PM10**: 0-200 $\mu\text{g}/\text{m}^3$ (value under reserve above)
 - **PM2.5**: 0-100 $\mu\text{g}/\text{m}^3$ (value under reserve above)



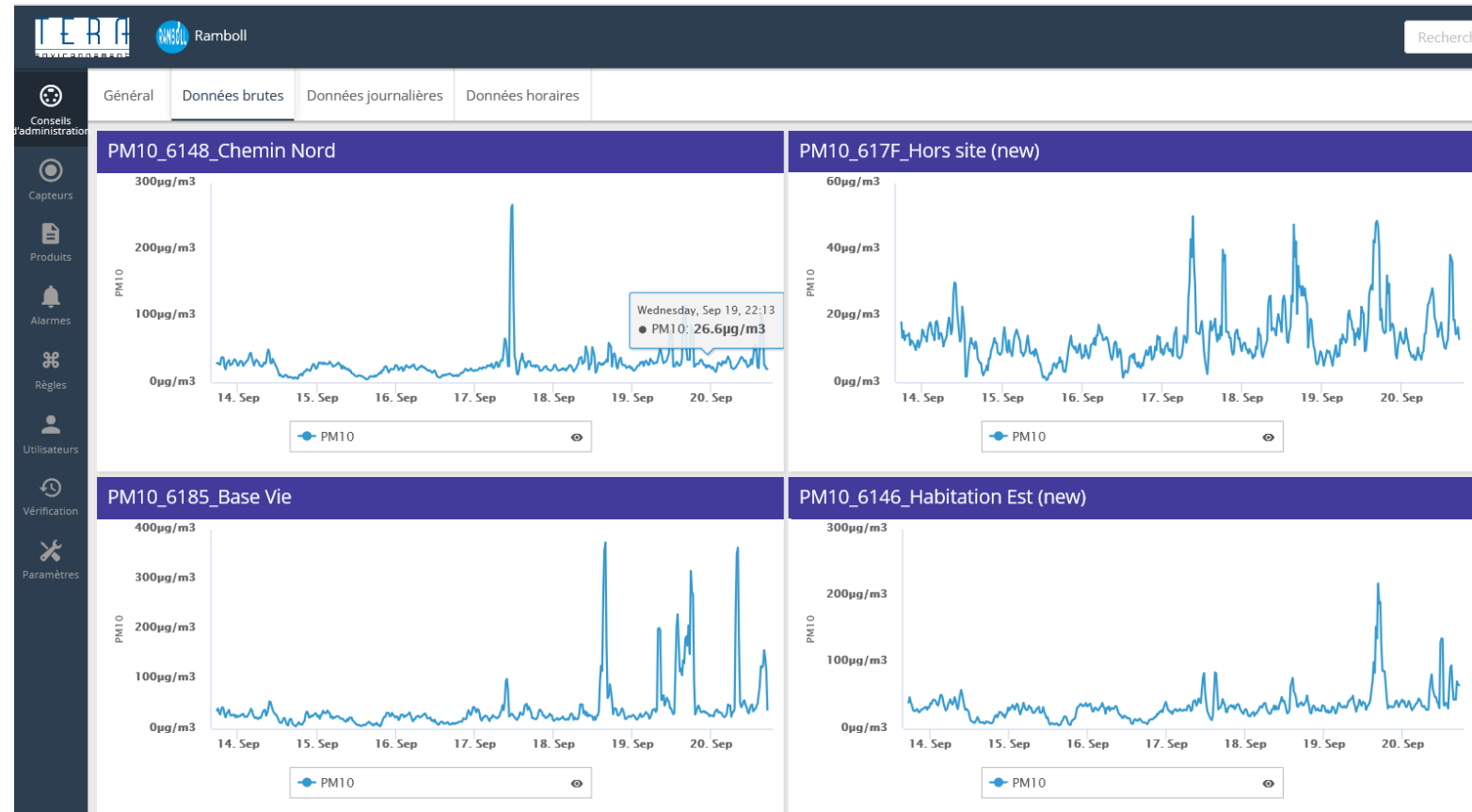
REHABILITATION SITE ENVIRONMENTAL MONITORING DESIGN

- Indicative follow-up in place using micro-sensors to:
 - Have dust data at the site
 - Have near real-time data to identify site impact and conduct remediation action if necessary
- Monitoring design
 - 4 measurement points:
 - 3 points on site in different activities areas
 - 1 point off site chosen taking into account wind direction and technical constraints
 - Baseline measured before operations began (from week 6 to 8 2018)
 - Site follow-up starting week 9
- Meteorological parameters measured to facilitate data interpretation
- Atmospheric deposition survey completed using plate deposit measurement device

REHABILITATION SITE PM MONITORING

- Legislation reminder: PM10 (CAFE Directive 2008/50/CE and French decree 21/10/10)
 - Annual limit value 40 $\mu\text{g}/\text{m}^3$
 - Daily limit value 50 $\mu\text{g}/\text{m}^3$ not to be exceeded more than 35 days/yr
 - Daily limit value 50 $\mu\text{g}/\text{m}^3$ corresponding to information threshold (French decree)
- Based on the initial state, indicating background levels around 15 $\mu\text{g}/\text{m}^3$ in PM10 (in accordance with local AQ network data):
 - Definition of an e-mail alert for concentrations $> 120 \mu\text{g}/\text{m}^3$:
 - Prevention actions on the highest concentrations
 - Objective: to limit daily values over 50 $\mu\text{g}/\text{m}^3$
- Real-time data uploaded and checked on the cloud

REHABILITATION SITE PM MONITORING



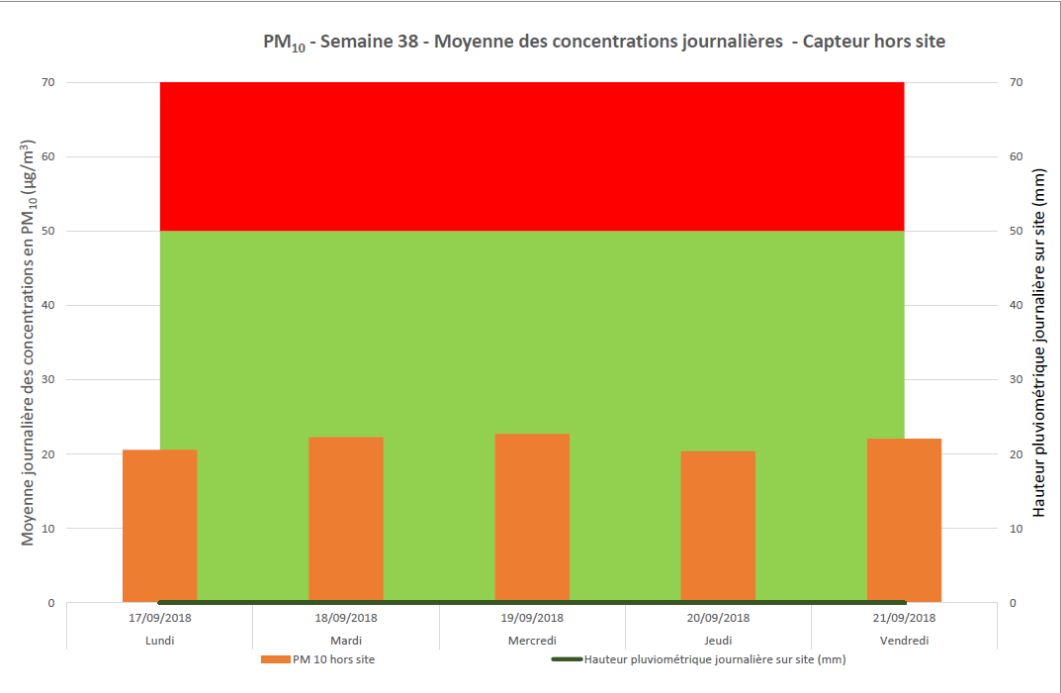
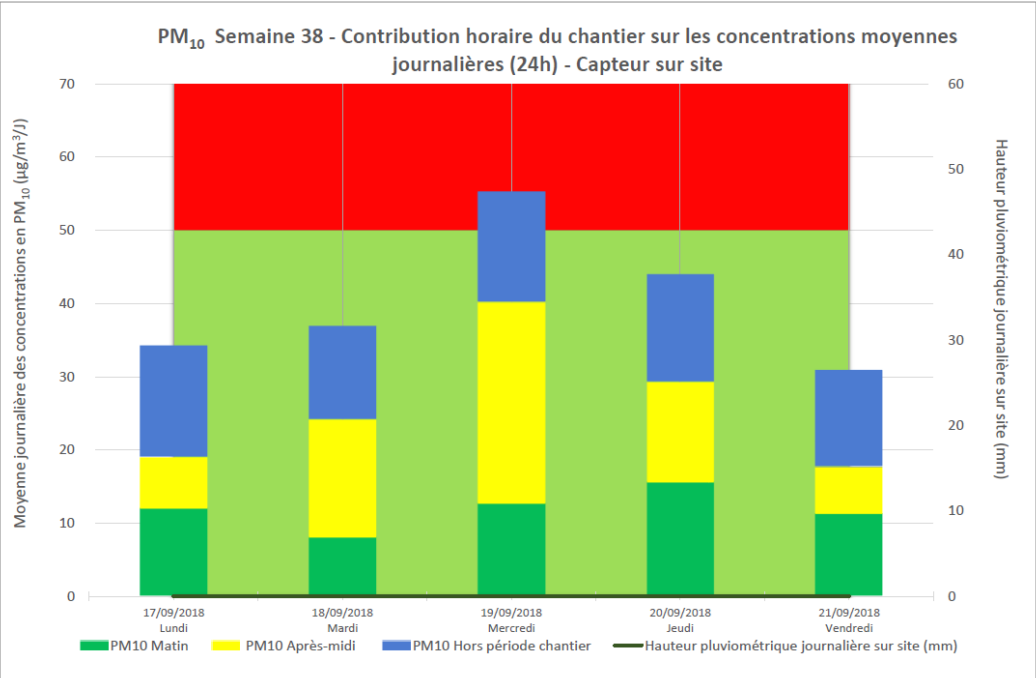
REHABILITATION SITE PM MONITORING

- Weekly reports according to defined format, taking into account:
 - Sensor data
 - Distinction between morning/afternoon/out of activity period for on-site sensors
 - Alerts assessment $> 120 \mu\text{g}/\text{m}^3$
 - Identification of daily values over $50 \mu\text{g}/\text{m}^3$
 - Meteorological data
 - PM10 measurement by AQ network on the nearest stations
 - Events associated with the site (especially during alert periods)



REHABILITATION SITE PM MONITORING

Example of a week lean board

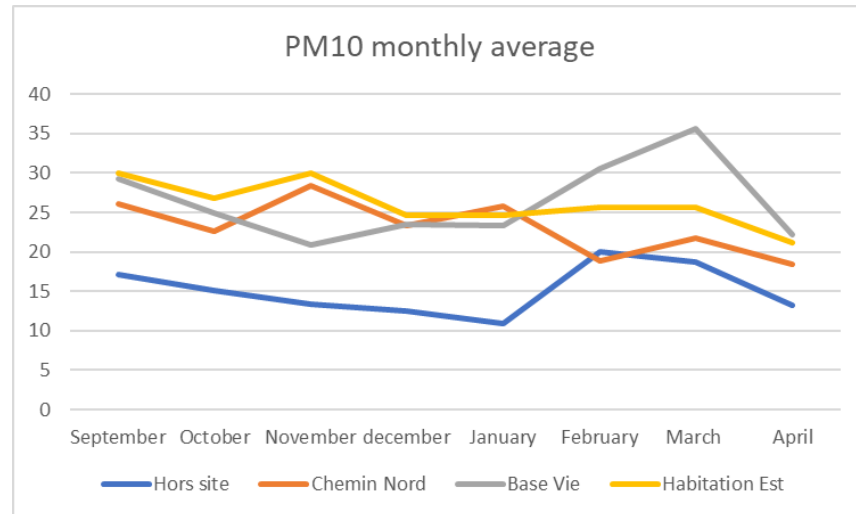


REHABILITATION SITE PM MONITORING RESULTS

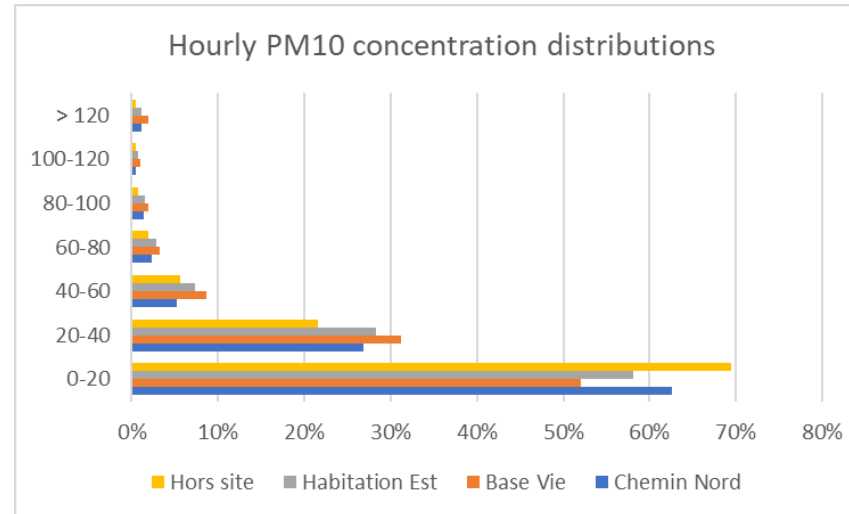
Data summary

- PM10 average:

- On site: 25 $\mu\text{g}/\text{m}^3$
- Out of site: 15 $\mu\text{g}/\text{m}^3$



- Number of values $> 120 \mu\text{g}/\text{m}^3$ fluctuating according to weeks
 - On site : 1.3% of hourly values $> 120 \mu\text{g}/\text{m}^3$ (2% for lifebase point)
 - Out of site : 0.4% of hourly values $> 120 \mu\text{g}/\text{m}^3$



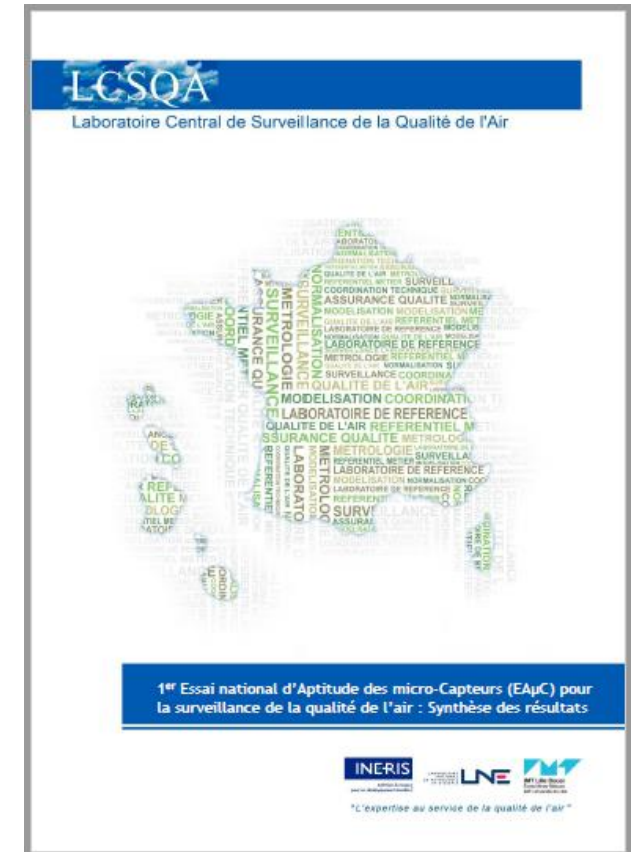
REHABILITATION SITE PM MONITORING RESULTS

- Alert management
 - Identification of peak impacts limited in time
 - Movement of machines and vehicles on site
 - Possible identification of longer peak periods, associated with the site activity
 - In that case, roads and paths watering, limitation of activity if necessary
 - Significant impact of meteorological conditions on site dust carriage, even when the activity on site is limited
 - Wind speed > 4-5 m/s
 - Long dry periods
 - Water carts failure



FEEDBACK

- PM micro-sensors useful for rehabilitation site work management
- Nevertheless, even if it seems to be a “plug-and-play” solution, it stays very important to have a critic eye on the results :
 - Really be aware that these are “indicative measurement” (cf. LCSQA conclusions)
 - Specific attention to existing bias
 - Intercomparison of sensors is a good exercise to carry out on site
 - Importance of keeping an expert eye on these data, including a data validation step
- Communication issues can also be faced out
- Rapid technological evolution in this sector, thus, it is necessary to stay well informed about evolutions (new sensor test for eg)



CONCLUSION

- Micro-sensors rehabilitation site follow-up:
 - Useful to have an online solution on sensitive sites
 - Able to react in real-time when alert limit is exceeded
- Keep in mind that this is an indicative method
 - Expert-eye needed for data validation
 - On-site staff useful for sensor management
- Important to have a significant baseline before starting work:
 - Minimum: sensors inter-comparison in one single point to identify/quantify discrepancies
 - Comparison to AQ network data for initial calibration/validation
- Approach applicable to other activities (construction sites monitoring in urban areas etc)

Strong management of relationship with neighbours, keeping disturbance to a minimum

