Measuring Dust for a Better Control of Fugitive Emissions

White Paper by

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Background

Particulate Matter (PM) is one of many pollutants that pose risks to the environment and to human health. Exposure to these particles can cause a range of health problems, including aggravated cardiac and respiratory diseases such as asthma, bronchitis, emphysema, and various forms of heart disease. While some PM can occur from natural sources (e.g., wildfires), a considerable proportion of PM is the direct result of human activities including fugitive emissions of dust produced by mining activities, windblown agricultural soil, demolition sites, road and construction dust and numerous industrial processes [1].

Industries are mandated to control their fugitive emissions of dust in line with criteria imposed by air quality regulations in order to gain approvals for their projects. This entails putting in place dust attenuation strategies which are proportionally matched to the predicted impact of the processes on ambient air quality. The US EPA provides resources for making such evaluations in its AP-42 compilation of air emission factors. An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere to an activity associated with the release of that pollutant. Emission factors are plagued with uncertainties that are process and site specific, and the EPA does "not attempt to evaluate or provide guidance on the application of emissions factor uncertainty in making environmental decisions" [2]. In this context, for safety reasons, conservative approaches leading to an overestimation of the impact of the emissions are almost inevitable. Too often, this ends up reducing the profitability of projects due to disproportionate dust control investments.

Direct Measurements as a Strategy for More Profitable Projects

Direct emission measurements represent an alternative method for optimizing expenses associated with air quality management. Other Test Methods have been defined by the EPA for some such processes. For instance, direct emission measurement can be performed using several point sensors distributed at strategic locations (OTM-32)[3] , or more efficiently by deploying a scanning LiDAR (Light Detection And Ranging) system. INO has developed a method utilizing a medium range 3D mapping device called Aeromap to measure emissions in and around industrial sites. Based on LiDAR technology, INO's device measures the absolute PM concentration as a function of distance. By rapidly scanning the beam, a full 3D map of the PM concentration can be obtained and emission flux can be quantified, allowing for determining real, context-specific emission factors. This yields more realistic air quality predictions at the point of impact, which can translate into sizeable CAPEX and OPEX savings for the control of fugitive emissions of dust.

1 http://conferenceboard.ca/hcp/provincial/environment/PM10-emissions.aspx? (accessed 2019-02-25)

2 https://www.epa.gov/air-emissions-factors-and-quantification/basic-information-air-emissions-factors-and-quantification (accessed 2019-02-25)

3 https://www3.epa.gov/ttnemc01/prelim/otm32.pdf (accessed 2019-02-25)

Aeromap – Using Laser Light to Map Fugitive Dust Emissions

Aeromap is a scanning LiDAR system that uses an eye-safe, near-infrared, pulsed laser beam. It is a portable, tripod-mounted instrument that measures laser light that is back-scattered by diffusive targets. As the beam travels through an emission site, PM scatters part of the laser beam back to a time resolved detection system. By analyzing the returned signal, the distance to targets is calculated from the laser pulse time-of-flight and the relative concentration of dust is determined from the signal intensity. Conversion to absolute concentration is accomplished through calibration using a single point sensor connected via Wi-Fi. The whole optical head is mounted on a Pan & Tilt Unit (PTU) to scan the area and to deliver 2D or 3D maps of dust concentration. In a coming version, connectivity with a weather station will allow for mapping dust emission flux in real time (see Figure 1). Aeromap also includes a context camera that can be used to set up the instrument, visually identify dust generating processes and produce context-specific images for reporting purposes.

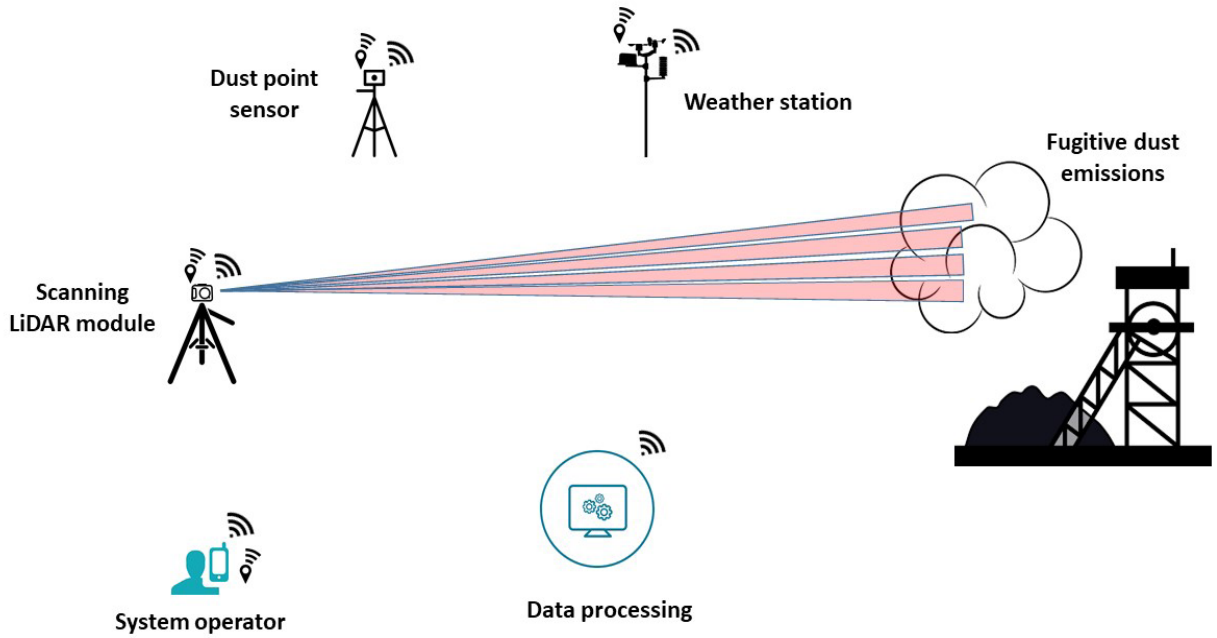

Figure 1 – Conceptual representation of the fully deployed Aeromap system.

Aeromap can detect all types of dust particulate such as coal, silica and lime stone, with the ability to measure PM concentrations down to 50 µg/m³ over a range of 150 m, with a typical range resolution of 75 cm. It is therefore equivalent to hundreds of point sensors located along the line-of-sight. Aeromap comes complete with a software displaying 2D maps in real-time. Alarms can be automatically generated upon detection of dust events above a programmable concentration threshold (Figure 2). The selected wavelength of 905 nm makes the measurements insensitive to sunlight so that the instrument performs well during day and night, and since Aeromap is eye-safe, it can be used safely in the presence of workers. The flexible scan head can be configured to scan in multiple orientations with a 0.7° field-of-view, directed by the PTU at scan speeds of up to 60°/s. Horizontal scanning allows measurement of dust emissions rising vertically in the air, while vertical scanning can be used to perform fenceline monitoring. In fenceline mode, Aeromap can capture clouds of dust that are travelling several meters above the ground, above where traditional point sensors are typically positioned. As a result, Aeromap can capture fugitive emission events that would not be detectable using a network of point sensors.

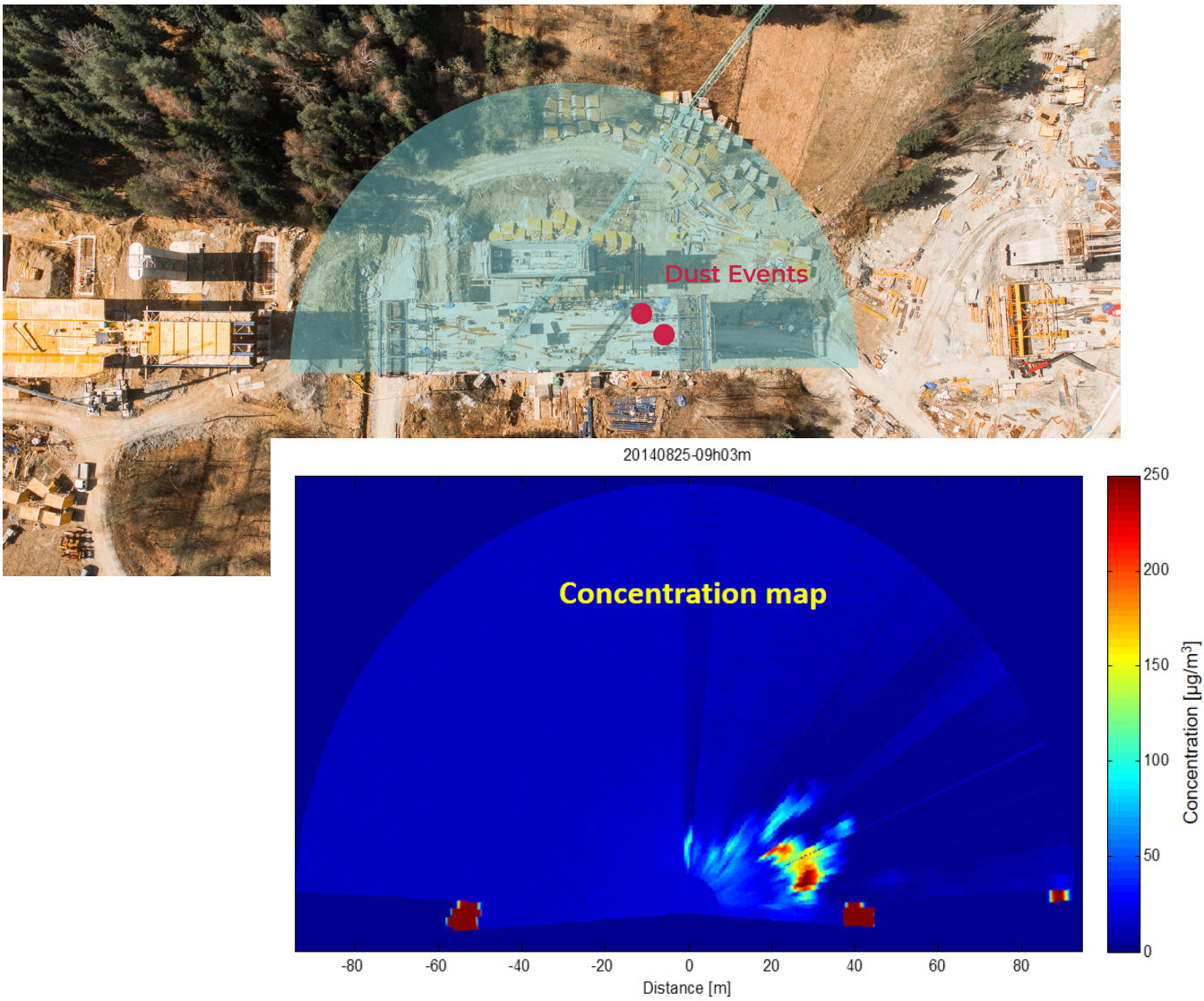

Figure 2 – Aeromap can be programmed to generate alarms upon detection of dust events.

Aeromap is suitable for outdoor monitoring as well as indoor monitoring. Outdoor, Aeromap is the perfect tool to monitor dust over large areas. When stockpiles or dust generating processes are enclosed or indoors, controlling the dust is no less important. In fact, an increase of the PM concentration becomes an occupational safety hazard and can impact negatively the health of the workers.

Conclusion

Aeromap is a turnkey solution that can be used to quickly diagnose PM emissions and presents an attractive alternative to conservative models for evaluating the impacts of industrial processes on air quality.

About INO's Remote Sensing Program

We are a team of experts focusing on the application of LiDAR technologies in industrial contexts. Over the years, we have acquired a sound understanding of the relevant technical challenges in this space, and are focused on developing customer focused technological solutions. Once a solution is sufficiently mature, INO works with the customer in the field, generating data that helps the customer to perform diagnosis, validation and impact studies.

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