Measuring Airborne Particulate Concentrations in Two Wisconsin Towns Hosting Frac Sand Facilities

Ben Kleist, Ken Braunling, Ethan Fuhrman, Jacob Kentnich, Maryanne Cowart, Peter Husnik, Dr. Crispin Pierce

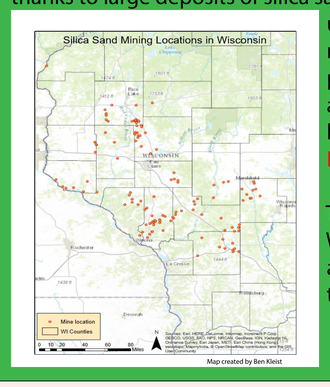
•Environmental Public Health Program, University of Wisconsin - Eau Claire•

Abstract

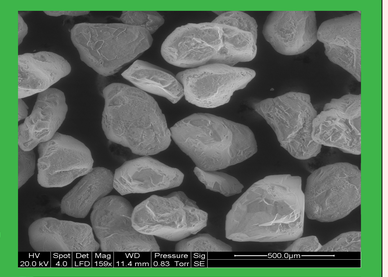
Airborne particulates (dust) include the PM2.5 fraction and its larger counterpart, PM10, and are subject to National Ambient Air Quality Standards under the Clean Air Act. Health effects associated with chronic exposure to PM2.5 include cardiovascular issues and lung disease (including lung cancer). The proximity of these and mine facilities to population centers has raised concerns about human exposure to airborne pollutants, especially PM2.5 and respirable crystalline silica. Two EPA-certified dichotomous (PM2.5/PM10) federal reference method filter-based samplers were set up in the town of Cooks Valley/Bloomer and the town of Dovre/New Auburn. In Bloomer, an average PM2.5 concentration of 7.41 ug/m3 and PM10 level of 24.2 ug/m3 over a two-year period were measured; in New Auburn, an average PM2.5 level of 22.7 ug/m3 and PM10 level of 49.0 ug/m3 over 10.5 months were found. Both sites had statistically significant elevations of PM2.5 compared to concurrent background Department of Natural Resources measurements. The average and 98th percentile PM2.5 levels, and second-highest PM10 level in New Auburn were higher than corresponding EPA standards.

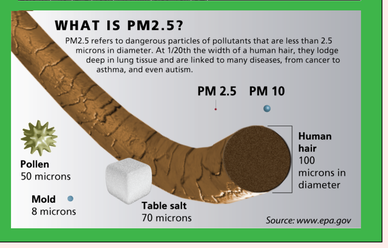
Introduction

Silica sand is a special type of sandstone which is a main component in many everyday objects, and a major player in the extraction of subterranean gas through a method known as fracking. The state of Wisconsin exports more silica sand than any other state, thanks to large deposits of silica sandstone throughout the state. Silica sand is so widely used because the sand grains are uniform in size, and resistant to high pressure. The process of mining, processing, and transporting the sand produces airborne particulates (dust) which can be dangerous to human health. Particulates fall within 2 size ranges, PM10 and PM 2.5, with PM 2.5 being more dangerous.



There are currently 92 active industrial sand mines in Wisconsin, but only 16 (17% total) report PM10. There are currently no facilities that report levels of PM2.5 to the DNR.





Health Effects

Long-term (Chronic) exposure to airborne particulates are linked to serious health effects such as silicosis, lung cancer, and other pulmonary diseases. Although both size fractions are easily inhailed, PM 2.5 poses a greater threat to human health .

How Does Airborne Silica Degrade Human Health?

- Once inhailed, small crystals travel through upper respritory track and arrive at the alveoli.
- Immune system cells (macrophages) try to destroy the crystals by absorbing them, but are unable to.
- The macrophages fill up with crystals over time, until they enter the walls of the lungs and die.
- Scar tissue surrounds dead macrophages in the walls of the lung, decreasing lung functionality.

Diseases such as silicosis and lung cancer are chronic diseases, which is caused by exposure to low levels of particulates over long periods of time. Alternatively, exposure to very high levels of particulates can cause adverse health effects in a short period of time.

History

The UWEC Environmental Public Health frac sand research team has been measuring levels of airborne particulates for years under the direction of Dr. Crispin Pierce for 6 years. Most recently, the research team has been measuring air quality in New Auburn and near Bloomer WI to compare to DNR background levels .

Hypothesis

We expect to find significant elevations in both locations for PM10 and PM2.5 compared to background levels.

Methods

Our laboratory is using EPA-certified federal reference method monitors to measure the levels of PM10 and PM2.5 particulate matter currently in Bloomer, New Auburn and Hixton, WI. The monitoring sites were chosen based upon EPA siting criteria, the Andersen or Thermo-Fisher dichotomous samplers were calibrated before and after each sample using a Tetracal calibrator, and pre- and post-weight filter weights were recorded on a Cahn 25 microbalance. Results from these 24-hour samples were compared to EPA standards, the State of California/World Health Organization PM10 standard, and the concurrent 24-hour averaged hourly PM2.5 values reported by the Eau Claire DNR regional monitor.

Air Quality Standards

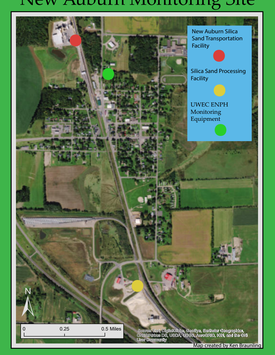
PM10- USEPA has set an higher ambient limit of 150 ug/m3 (2nd highest annual value).

PM 2.5- Annual Average- 12 µg/m3
98th percentile- 35 µg/m3

Bloomer Monitoring Site

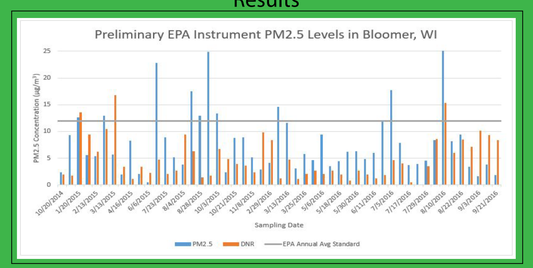
Monitoring equipment was deployed south of a large silica mine at (45°05'19"N 91°35'53"W) in Chippewa County, WI. The mine itself was inactive from Fall of 2015 until August of 2016. Data has been recorded at this location for about 3 years .

New Auburn Monitoring Site

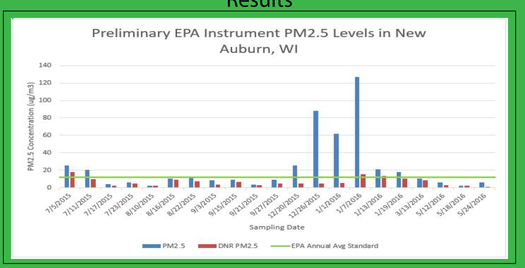


Monitoring equipment was deployed southeast of a large transfer facility in the village of New Auburn at (45°12'28"N 91°33'44"W) in Barron County, WI. An industrial sand processing plant works in conjunction with a large rail spur approximately 3/4 mile away.

Results



Results



Bloomer Results

- PM 2.5 levels in Bloomer averaged 7.41µg/m3, with PM10 levels averaging around 24.2 µg/m3 were measured over a 2 year period.
- Although the average PM2.5 levels were below that of the EPA standard, it was consistently seen that PM2.5 measured in Bloomer was higher than the concurrent PM2.5 levels measured at the DNR located in Eau Claire. It can be concluded that populations exposed to industrial sand facilities are exposed to greater concentrations of PM2.5 in comparison to an area that has no mine.

New Auburn Results

- New Auburn experienced average PM2.5 levels at 22.7 µg/m3, and PM 10 levels of 49.0 µg/m3 over a 10.5 month period.
- Levels of PM2.5 observed in New Auburn (average of 22.7 µg/m3) were well above the EPA's annual standard of 12 µg/m3. In addition, the levels of PM2.5 measured were greater than the DNR's background of 6.57 µg/m3. It can be concluded that the citizens of New Auburn have been exposed to higher levels than deemed permissible by the EPA, and it should be further investigated.

Equipment

Dichotomous Sampler

A dichotomous sampler is used to measure concentrations of PM 10 and PM 2.5 airborne particulates. Air is pulled through 1 of 2 chambers and filtered, which are later weighed. Dichotomous samplers are EPA certified instruments.

Cahn 25 Microbalance

A Cahn 25 Microbalance is used to weigh the PVC filters used by the Dichotomous samplers before and after sampling takes place. The scale is sensitive enough to measure changes as small as 0.1 micrograms.

BGI Tetracal Calibrator

A Tetracal Calibrator was used to calibrate each dichotomous sampler when filters were collected. The samplers rely on two intakes sucking air in at a specific rate to differentiate between the PM 10 and PM 2.5 particulates. Uncalibrated samplers produce unreliable results which may skew the data.

Conclusion

In Bloomer, an average PM2.5 concentration of 7.41 ug/m3 and PM10 level of 24.2 ug/m3 over a two-year period were measured; in New Auburn, an average PM2.5 level of 22.7 ug/m3 and PM10 level of 49.0 ug/m3 over 10.5 months were found. Both sites had statistically significant elevations of PM2.5 compared to concurrent background Department of Natural Resources measurements. The average and 98th percentile PM2.5 levels, and second-highest PM10 level in New Auburn were higher than corresponding EPA standards.

Moving Forward

- Co-locate our monitors with the WI DNR monitoring equipment
- Monitor air quality on campus during the Garfield Ave construction
- Begin monitoring in Albertville WI
- Incorporate cameras to provide contextual data

References

- Airborne Particulates near Frac Sand Operations; Pierce, Crispin H, Kristin Walters,,, Jeron Jacobson, and Zachary Kroening; PM2.5 J Environ Health, Featured article Nov. (2015). Journal of Hazardous Materials 132 (2006) 14–25
- Airborne Respirable Silica near a Sand and Gravel Facility in Central California: XRD and Elemental Analysis To Distinguish Source and Background Quartz ; Ryojishiraki and Britta. Holmean *, Department of Geology, University of California, Davis, California 95616, and Civil and Environmental Engineering

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