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Putting Next Generation Sensors & Scientists in practice to reduce wood smoke in a highly impacted, multi-cultural rural setting (NextGenSS)

August 2016-July 2019

Tribal Science Webinar Presentation July 11, 2017

Presenters:
Catherine Karr, PI (ckarr@uw.edu)
Elena Austin, Co-investigator
Orly Stampfer, graduate student

Funding: U.S. EPA
STAR Grant #RD83618501 (Air Pollution Monitoring for Communities)

Project Team

DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH SCIENCES

UNIVERSITY of WASHINGTON
School of Public Health

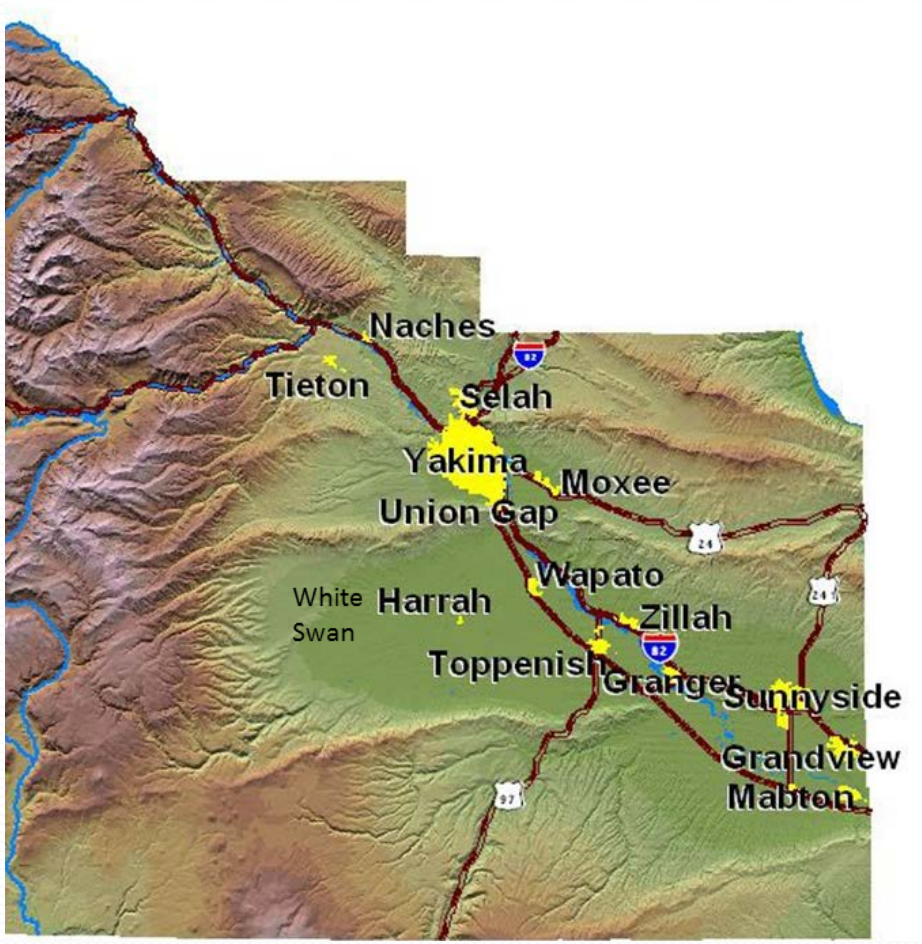
The Center for Native Health & Culture
@ Heritage University

- UW Air Pollution Exposure and Health Science Partners (Seattle, WA)
  - Catherine Karr, Edmund Seto, Elena Austin, Kris Hartin/Maria Tchong, Elizabeth Spalt, Orly Stampfer, Esther Min
- Heritage University Science Education Partners (Toppenish, WA)
  - Jessica Black, EnvironMentors undergraduates
- Educator Partners (White Swan, WA)
- White Swan High School - Mr. Clinton (science teacher), Mr. Castilleja (Principal)

The Project Advisory Committee (PAC)

- School administration
- Regional expertise (Tribal Healthy Homes Network, EPA/ YRCAA)
- Yakama Nation Dept. Natural Resources Program
- Yakama Nation Tribal Council
- Community (El Proyecto Bienestar)
- Indian Health Service
- EnvironMentors
- Project team (UW, Heritage)

Air Quality & Yakima Valley WA State



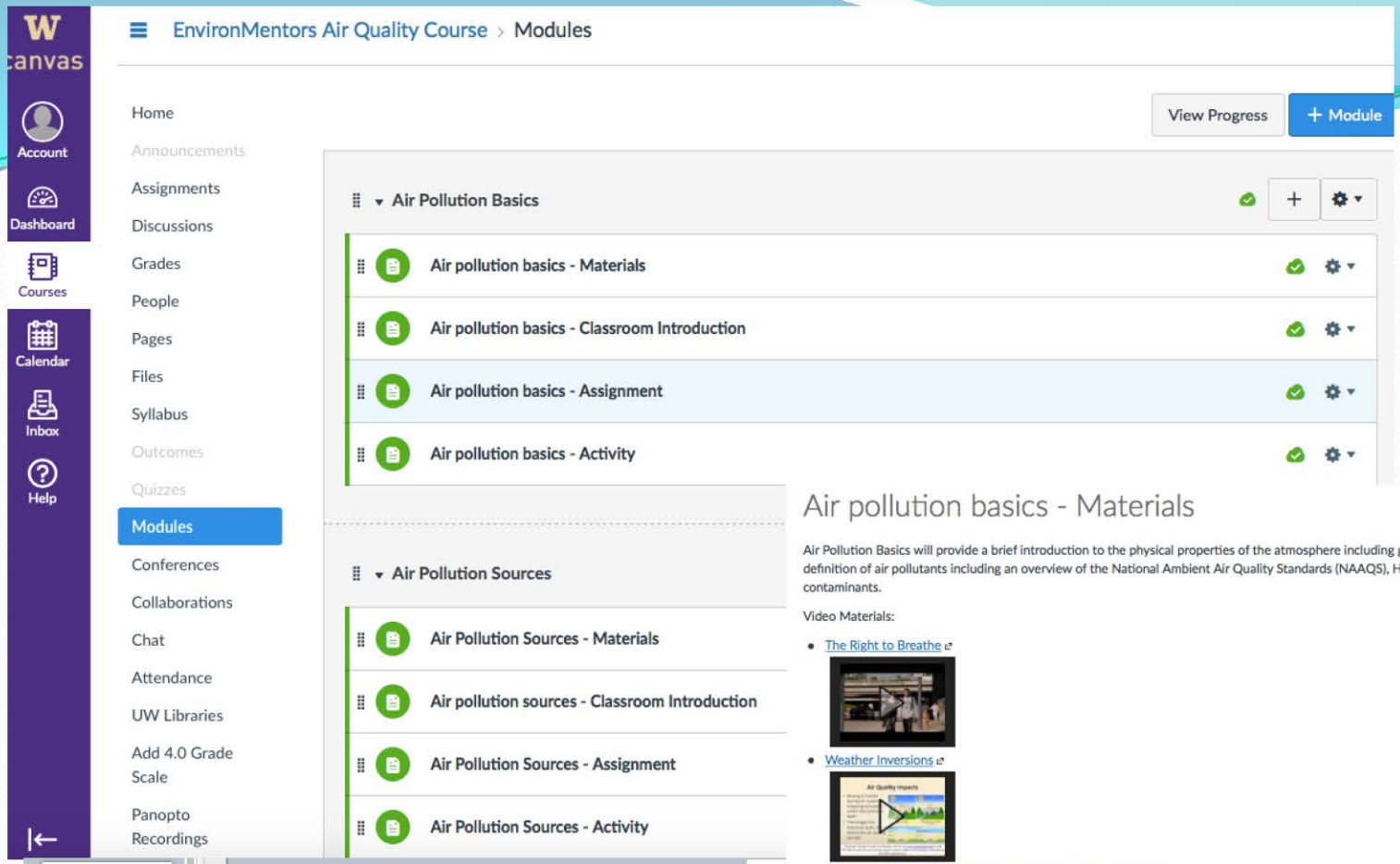
- Air pollution levels (PM) are a concern for many in lower Yakima Valley
- Wood burning is an important contributor
- Impacts are often highly localized (air pollution varies a lot in space and time)
- Limited research on air pollution in rural communities
- Regulatory monitor in Toppenish, White Swan (Yakima)

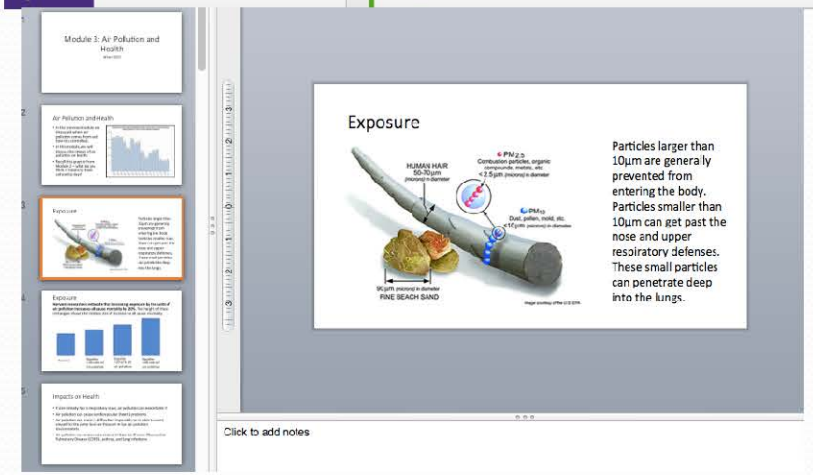
NextGenSS Goals

- Develop an adaptable web based air pollution ***curriculum***
  - UW →HU EnvironMentors → High School Students
- Equip ***students to generate, use, and apply data*** from air pollution monitoring equipment
- Traditional and low cost emerging technology
- Evaluate sensor effectiveness in community studies
- Identify effective mechanisms for ***dissemination of data*** collected.
- ***Understand local wood smoke/air quality concerns***
- Devise solutions in a culturally competent framework that may benefit this region and be an example to share with others

The Curriculum (version 1.0)

- Air Pollution Basics
- Air Pollution Sources
- Air Pollution & Health
- Experiment Design & Planning – using sensors in community





Air pollution basics - Materials

Air Pollution Basics will provide a brief introduction to the physical properties of the atmosphere including gaseous composition, principal layers of the atmosphere, definition of air pollutants including an overview of the National Ambient Air Quality Standards (NAAQS), Hazardous Air Pollutants (HAPS), and other possible air contaminants.

Video Materials:

- The Right to Breathe

- Weather Inversions

- President Obama Explains How Pollution Affects Our Planet

Interactive Web Material:

- EPA annual trends report summary

Written Materials:

- Introduction to the Atmosphere
- Understanding Units of Measurement
- Plain English Guide to The Clean Air Act
- Major Air Pollutants

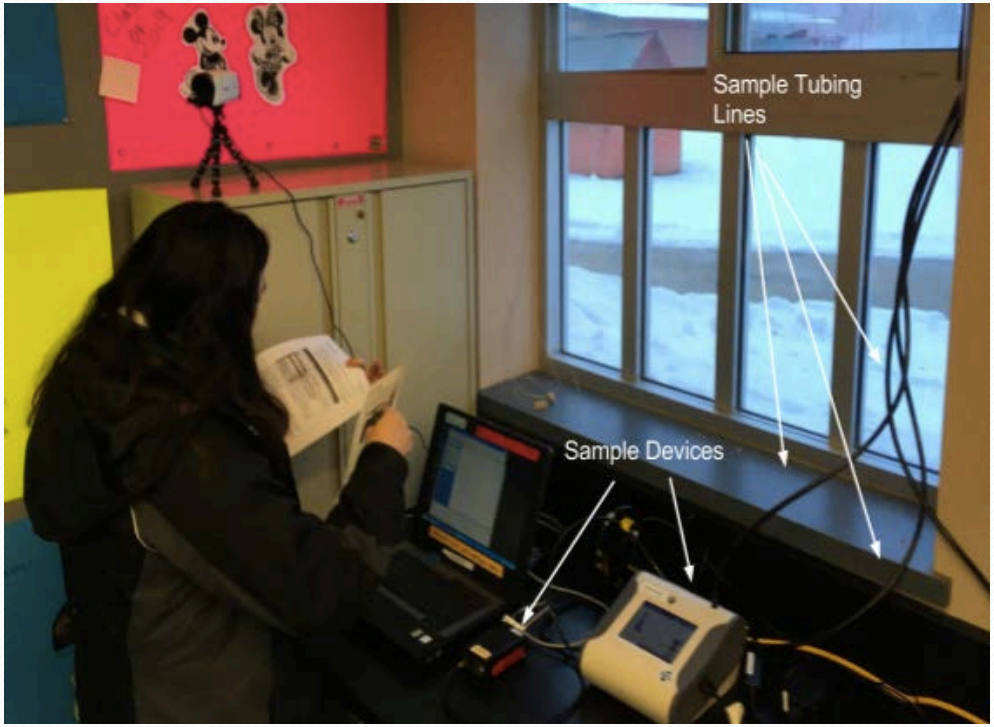
Peer Reviewed Publications:

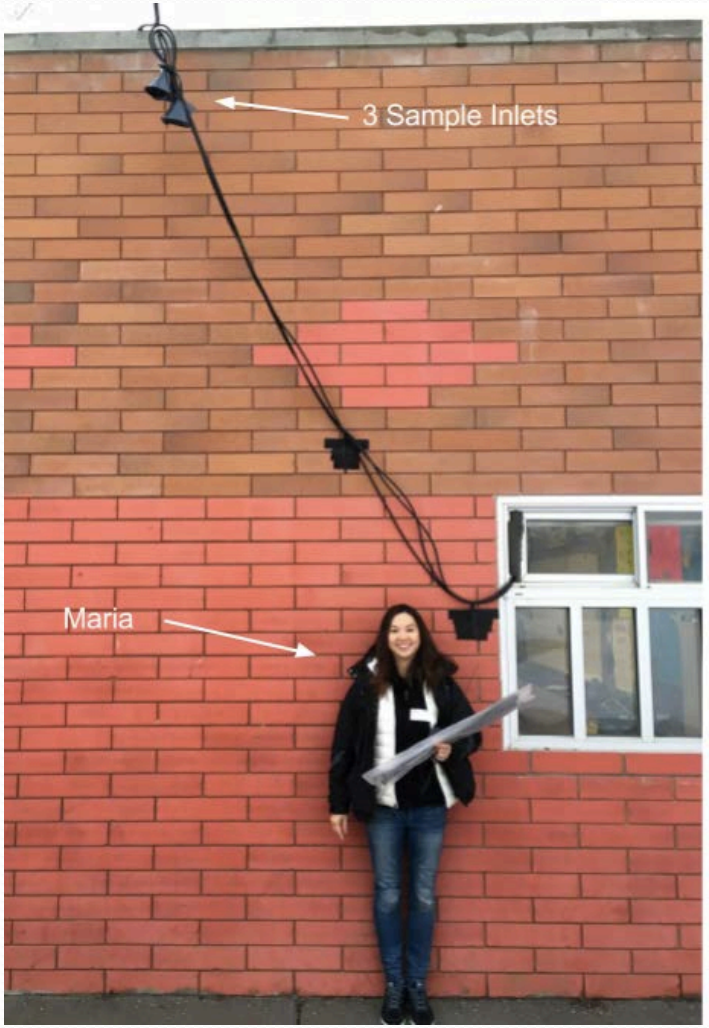
- A Retrospective Assessment of Mortality from the London Smog Episode of 1952: The Role of Influenza and Pollution
- Ambient Ammonia Exposures in an Agricultural Community and Pediatric Asthma Morbidity

WSHS air sampling

Image 1: Aerial view of White Swan High School including proposed NextGenSS ambient sampling location adjacent to Mr. Clinton's classroom and location of Yakima Tribe nephlometer site.

Sampling at WSHS





Sampling Equipment

Optical Particle Counter

TSI 3330

- Measures number of particles in 16 different particle size bins
- Can be converted to a particle mass measurement.
- Provides data in 1 minute intervals.

Micro-Aethalometer

AethLabs AE52

- Measures color of PM2.5
- The color of a particle is related to its source
- Measures the light absorbed at two different wavelengths
- The difference between the measurements at two different wavelengths is associated with WOOD SMOKE in the air.

Operating Summary

Optical Particle Counter
TSI 3330

- Deployed from 12-07-2016 until 05-14-2017
- Measured data every MINUTE
- There were 55 time periods with ***missing data***. Data is missing for 5 hours on average per missing period. The maximum time period missing is 72 hours.

Micro-Aethalometer
AethLabs AE52

- Deployed from 12-09-2016 until 02-27-2017
- Measured data every MINUTE
- There were 36 time periods with ***missing data***. Data is missing for an average of 15 hours. The maximum time period missing is 10 days.

Data Summary (2016-2017)

Current year (Dec-Feb)

- Regulatory Monitor (nephelometer):
  - Mean: 6.3 (6.2) µg/m^3
  - Max: 37.7 µg/m^3
  - # hours >35 µg/m^3 : 13 hours
- Optical Particle Sizer
  - Mean: 6.2 (7.2) µg/m^3
  - Max: 39.5 µg/m^3
  - # hours >35 µg/m3 : 16 hours
- Aethalometer (microAeth AE52)
  - Black Carbon
    - Mean: 279.0 (268.8) ng/m^3
  - Wood Smoke
    - Mean: 88.2 (152.7) ng/m^3

Correlation 0.71

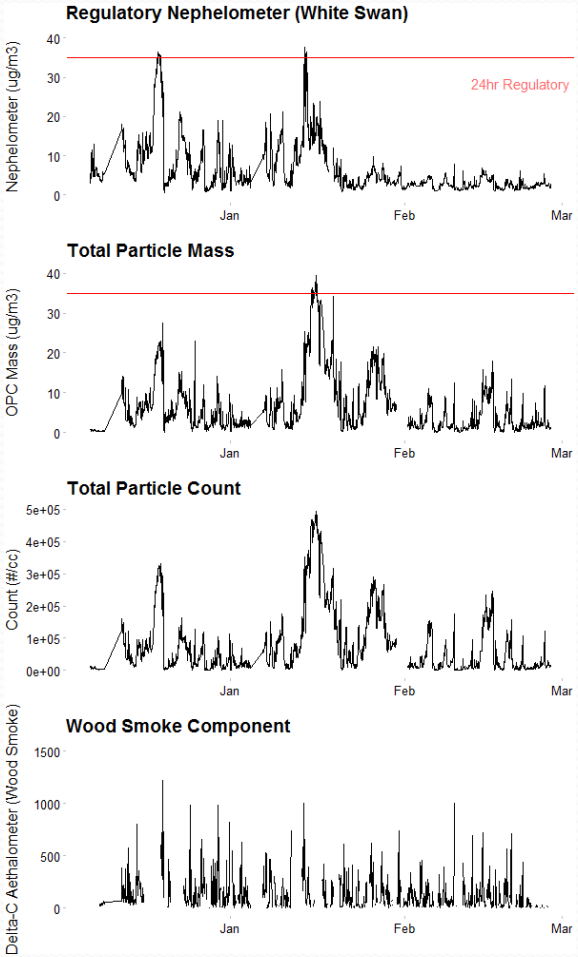
Previous year (Dec-Feb)

- Regulatory Monitor (nephelometer):
  - Mean: 8.1(9.5) µg/m^3
  - Max: 60.5 µg/m^3
  - # hours >35 µg/m^3: 67 hours

Reflection:

How do the regulatory data from the current year compare to the previous year? Are they higher or lower? Which numbers do you use to compare?

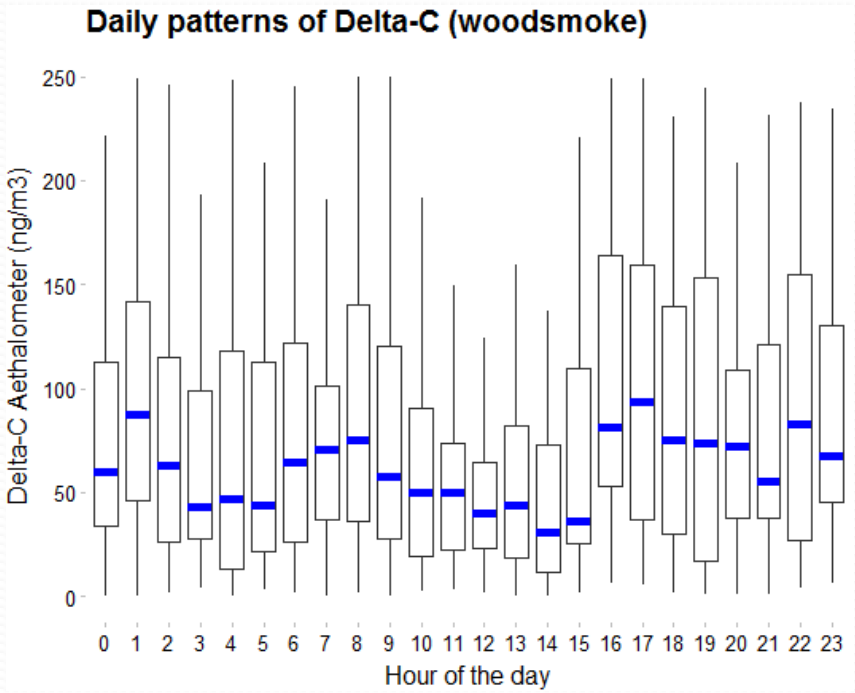
Time Series Plot

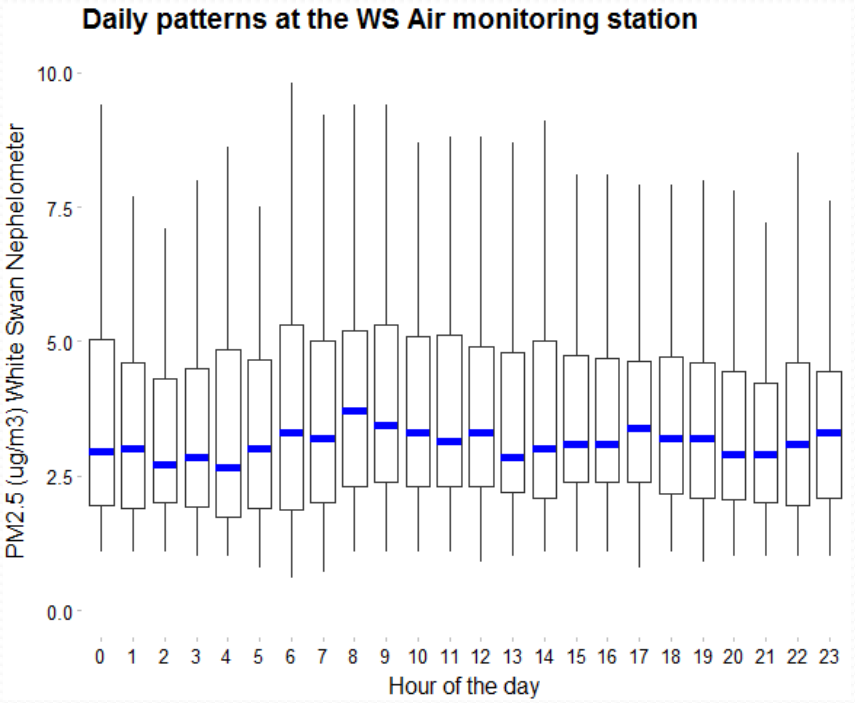


Reflection:

- How many times does the air pollution level go above the regulatory standard based on the Nephelometer?
- How many times does the air pollution level go above the regulatory standard based on the OPC instrument?
- Does the wood smoke data look different than the data from the other instruments?

Daily Patterns





Reflection:
Do the daily patterns in woodsmoke and particle concentration look the same?
What could explain any differences in woodsmoke measurements throughout the day?

Student projects and posters

- Opportunity to deploy Dylos Air Particle Counters at school & test hypothesis
- 4 students presented in Washington, DC at the EnvironMentors National Fair - July 2017

Air Quality in White Swan, WA

[1]Jason Grajales, [2]Briana Rhode
[1]White Swan High School, White Swan, WA [2], Heritage University, Toppenish, WA

Abstract

Air is considered to be polluted when gases or particles suspended within it become harmful to health. This may include industry, transportation, agriculture, and natural sources. Pollution particles with a size of 2.5 micrometers or less (referred to as PM2.5) are considered to be the most harmful to human health, due to the ability to penetrate deep into the lungs. The air quality in South Central Washington is heavily impacted by agricultural activities and associated cultural practices that take place throughout the region. Activities like these can lead to degraded air quality, which can have a significant impact on the health of those living in the surrounding communities. Understanding how the air becomes polluted and to what extent is an important first step in realizing how costly anthropogenic activities are to the health of local communities, and how to mitigate these effects to provide clean, healthy air.

Introduction

White Swan, Washington (Figure 1) is a small, rural community on the Yakama Reservation where residents rely upon agriculture and industry for their livelihoods. Air pollution in White Swan, WA is leading to increased occurrence of respiratory illnesses in community members because the activities associated with the area are releasing harmful particles into the air

Figure 1: Location of White Swan, Washington
Image courtesy of Wikipedia

By examining the health risks associated with air pollution in White Swan, perhaps local entities and businesses can begin the process of working together to reduce pollution sources and improve air quality in the area

Methods

- TSI 3330 aerodynamic particle sizer and associated AethLabs AE52 microaethlometer setup and deployed December 12th, 2016 by UW in Mr. Clinton's classroom on the White Swan High School Campus (Figure 2)

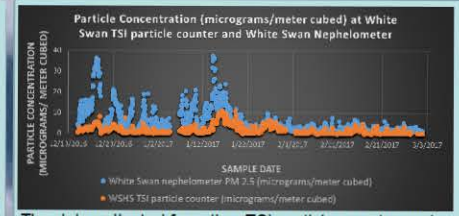
Figure 2: Location of White Swan High School TSI and White Swan Nephelometer

- TSI 3330 was set up on countertop adjacent to window to allow for tubing to extend through the window, along the brick wall, to the top of the building to collect air (Figure 3)
- Each Monday morning, Wednesday midday, and Friday afternoon during the experiment AE52 filters strip was replaced and data was downloaded and saved sent to representatives at University of Washington for review
- Instruments at White Swan High School collected data from December 15th, 2016 to March 1st, 2017
- Regulatory monitor data from the White Swan Nephelometer (Figure 4) was acquired from via the internet from a publically available data set from December 15th, 2016 to March 1st, 2017 by University of Washington representatives
- Data from TSI and Nephelometer during the experimental period were compiled and transformed by UW, and sent to White Swan EnviroMentors Mentors in a Microsoft excel document to be distributed for analyzation. Data was analyzed using graphing tools in excel

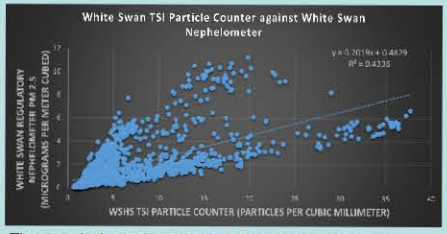
Figure 3: Instrument Set up at White Swan High School
Image courtesy of University of Washington

Figure 4: Nephelometer
Image courtesy of M903 Nephelometer Operating Procedure

Results



The data collected from the TSI particle counter and White Swan High School and the Nephelometer in White Swan seem to follow a similar trend over the sample time. Overall, the peaks and valleys occur simultaneously for both instruments.



The graph doesn't seem to follow any clear trend, however this is demonstrating the data in a scatter plot format and a trend line can be seen between the Nephelometer and the TSI.

Discussion

- Because the data from the TSI and the Nephelometer seem to follow each other throughout the sample period, when we compare the data recorded from the TSI and the nephelometer, from both instruments and glean information on the state of air quality in White Swan, WA.

Discussion (Continued)

- When we compare the TSI data directly to the Nephelometer there seems to be a slight correlation. This means that the concentration of one is not completely dependent upon the other, but as one measurement increases, it is likely that the other measurement will increase as well. As well as there being a trend within both locations and therefore have data that help solidify that concentration of particles suspended in the air in White Swan.
- Limitations of the study include: Variances in location, assumptions made during calculations could be incorrect, and more

Conclusion

It is important to study the concentrations and sources of pollution in my community to understand if the air we breathe is leading to degraded health in community members. If we can pinpoint sources of air pollution in the community (i.e., wood smoke, agriculture, industrial, etc) then measures can be taken by to avoid and, potentially mitigate, these sources and associated health hazards.

While we can't tell from the data if the air pollution in White Swan is leading to higher occurrences of respiratory illnesses, this data shows that there are pollution sources in the area emitting dangerous particles that can have adverse health effects on the community. Moving forward, I would like to use the information that was gathered during this research, present it to my community and work towards reducing air pollution in my town.

Acknowledgements

I would like to thank my mentor, Briana Rhode, EnviroMentors advisor, Jessica Black, representatives from University of Washington, White Swan High School Science Instructor Mr. Clinton for his assistance, and my peers that helped create this poster and programed the devices that gathered data on the atmosphere of White Swan.

Funding: U.S. Environmental Protection Agency STAR Grant #RD83618501 (Air Pollution Monitoring for Communities)

The Air Particles At White Swan High School, WA

[1]Alexa Sapphire Weaseltail, [1]Judy Bergevin and [2]Cristy Fiander
[1]White Swan High School, White Swan, WA, [2]Heritage University, Toppenish, WA

Abstract

We want healthy air quality in our school and in our region. The first step in becoming knowledgeable about the indoor air quality in our school is to compare White Swan High School air quality in Mrs. Owen's classroom to the Main Office. Concentrations of 2.5 micrometer air particles in two of the most heavily used rooms in the school were measured and result analyzed. Results indicate air quality can be improved through replacement of old rugs and more regular cleaning of air ducts.

Introduction

We considered the amount of people that are in the Main Office working and visiting. We also considered that door opens directly to the outdoors and more often in office overall. Mrs.Owens' classroom will have the doors shut or open most of the period and the only one moving around would be the teacher or students walking in and out of the classroom.

Observation 1: We have seen on the local news programs and heard a lot of discussion about the poor outdoor air quality in Yakima County. Therefore, we believe a room with more direct exposure to the outdoors will have poorer air quality.

Hypothesis 1: If an indoor room is exposed more often to the outside air (door to outside opening more often), then the room with have greater 2.5 µm particles in it.

Observation 2: The school offices and classrooms all have fans and air vents in the ceilings throughout the rooms. We can feel the air movement from these fans. Therefore, we believe these fans to have a large potential impact on air particle concentrations in these rooms.

Hypothesis 2: If a room has ceiling fans or air vents (such as AC or heating), then there will be an increase in 2.5 µm air particles.

Methods

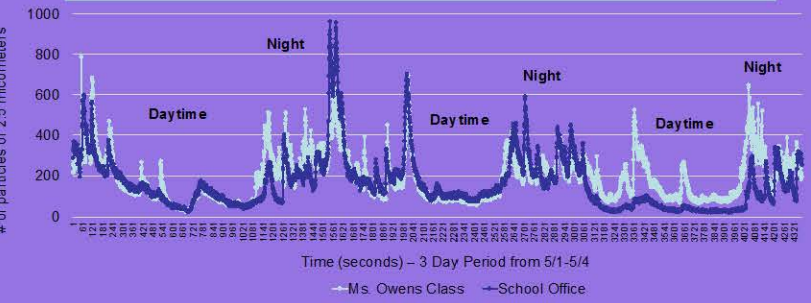
- Selected sampling location
- Fill out log sheet
- Draw diagram
- Deploy Dylos
- Monitor Dylos
- Download data
- Analyze data

Figure 1. Dylos Air Particle Meter

Figure 2: Location of White Swan High School TSI and White Swan Nephelometer

Results

Figure 3. 2.5 µm particles from two rooms at White Swan High School over a 3-day period in May



We learned that with in our school the indoor air quality is not only different from out door air quality, but it can vary from room to room.

- The 2.5µm air particles spiked at night, rather than during the day.
- During school hours, the 2.5 µm air particles had a low and steady concentration
- Overall the 2.5 µm particles are different in the main office from Mrs.Owens' classroom during the night when the data spikes
- During the school hours the 2.5 µm particles were similar in both rooms

Discussion

Hypothesis 1: We thought that the result we going come out differently. We hypothesized that the main office was going be significantly different from Mrs.Owens' classroom. However, the results were similar at many points. In addition, we thought that the office was going have more particles than Mrs.Owens' classroom. However, based on the 2.5 µm particles detected in both rooms the outside air particle concentration does not affect the air particle concentration inside.

***Hypothesis 2**: The highest most variable air particle concentration were during the night rather than during school hours. During the night the doors in both rooms we closed and locked. The only source of air particles or air movement comes from the ceiling and vents. The air vents do seem to have an affect on the 2.5 µm air particle concentration inside rooms.*

Both rooms have old carpets that are at least 30 years old and only shampooed once a year. The air ducts at WSHS are likely not cleaned regularly. One teacher believes that the ducts have not been cleaned in many years. Therefore we do not know where the air particles are coming from - ducts or rugs.

Conclusion

This project is important in starting to become aware of air quality and becoming aware and assess the air quality in our school. I would like to see the school cleaned more often and the rugs replaced. We should be thinking about all the students in WSHS and their health. I know of many students who have asthma.

Acknowledgements

Thank you Jessica Black and the HU Environmentors, Thank you to the UW team.

Funding: U.S. Environmental Protection Agency STAR Grant #RD83618501 (Air Pollution Monitoring for Communities)

Pre- survey of project participants

- PAC members (7), Heritage University EnvironMentors (4), WSHS students (7)
- Purpose: understand community members' and stakeholders' perspectives, knowledge, and recommendations for addressing local air quality concerns (or other environmental priorities)

Air pollution knowledge and concern

- PAC and Heritage University students got the majority of knowledge questions correct (on average about 65%)
- Less than half of the high school students got the knowledge questions correct (on average about 44%)
- PAC and Heritage University students on average were “considerably” interested/concerned about the environment, while high school students were “moderately” interested/concerned

Top environmental concerns

- PAC: Quality of Drinking Water, Global Warming/Climate Change, Air Pollution
- Heritage University students: Sustainable Hunting and Fishing Practices, Acid Rain, Contaminated Lands
- High school students: Trash, Sustainable Hunting and Fishing Practices, Air Pollution

Wood smoke concern

- PAC on average thought that wood smoke was more of a health concern compared to other pollutants
- Heritage University students thought it was about the same level of concern
- High school students were in between
- Each group's top wood smoke health concerns were:
  - Can irritate the eyes, nose, and lungs
  - Can make asthma worse
  - Can cause or make infections worse (ear, lung)

Desired community resources

- Funds for replacing or repairing wood stoves *(PAC, Heritage University students)*
- Access to low-moisture, clean burning woodstove fuels *(PAC)*
- Access to culturally-relevant pamphlets and flyers about clean burning practices *(PAC, high school students)*
- Funds to install in-home ventilation *(PAC, Heritage University students)*
- Assistance in building a wood-banking system (facility to store and dry wood for families) *(Heritage University students, high school students)*
- Research specific to my community showing how wood smoke exposure affects my community's health *(Heritage University students, high school students)*
- Technical assistance to monitor air quality in homes that burn wood *(high school students)*

Year 1 reflection

- Important foundational work and productive first year despite late start in classroom based activities (IRB x 3 institutions, funding start time when school had begun)
  - Curriculum, classroom monitoring data, basic student projects accomplished, pre survey input
- Excellent support from the school community
- New partner in nursing program – enhanced capacity for projects/mentorship with health component
- Challenges to navigate optimal PAC meeting schedule (distance, busy people)

Next steps (Year 2)

- Review Year 1 progress/lessons learned with PAC members
- Engage EM students early in the academic year
- Introduce monitors that can be deployed in outdoor locations
  - Foster student directed studies on ambient air pollution levels throughout the community
- Involve HU nursing program faculty leader and interested students
  - Administer an asthma prevalence survey for area middle/high school students Fall 2017

Thank You

Questions or Comments?