LA12 Fall 2022:
Environmental Science for Sustainable Development

Lab Week 3:
Air Quality

Learning Objectives

1. Compare and contrast the two films, *Inconvenient Truth* and *Under the Dome*.
2. Explore a *global dataset of direct observations + sensor measurement of air quality* over a week time period.
3. Build and compare a *time series* of particulate matter sensor observations on the Berkeley campus versus on a nearby street over a ten-minute period.
4. *Investigate a case study* of air pollution in a city or region of your choosing.

Introduction

Air quality changes in space and time as influenced by sources and circulation of pollutants. Natural sources of pollution include dust storms or radon (invisible), but we humans are responsible for many pollutants, such as heavy metals from coal power plants, or hydrocarbons from oil refineries. In the two films you watched over the last two weeks, you learned more about sources of pollution, including smog and greenhouse gases. In this lab, you will learn how to measure one commonly regulated pollutant, particulate matter.

1. Film Discussion [6 pts]

Discuss Table 1's topics with a classmate. Consider the question: What is each film's central argument? Then, compare the objectives and scope, topics and structure, presentation and communication style. Take notes for filling out Table 1. Submit the completed table for your post-lab assignment. Note the names of the people you worked with during the discussion.

Table 1. Film Comparison Table. (Edit dimensions of table as you need for writing your answers).

		Inconvenient Truth	*Under the Dome*
1	Central Argument		
2	Topics		
3	Objectives + Scope		
4	Structure + Presentation + Communication Style		
5	Application of Science		
6	Learned lessons		

2. Particulate Matter and Air Quality Index.

Air Quality Index (AQI) for Measurement and Regulation of Air Quality

What is AQI? What is the difference between PM concentration (or other pollutant concentration) and AQI, as reported and regulated by the EPA? **[2 pts]**

AQI Categories (Index Values)	Ozone (ppm)		Particulate Matter (µg/m^3)		Carbon Monoxide (ppm) [8-hour]	Sulfur Dioxide (ppb) [1-hour]	Nitrogen Dioxide (ppb) [1-hour]
	[8-hour]	[1-hour]	$PM_{2.5}$ [24-hour]	PM_{10} [24-hour]			
Good (Up to 50)	0 - 0.054 None		0 – 12.0 None	0 - 54 None	0 – 4.4 None	0 - 35 None	0 - 53 None
Moderate (51 - 100)	0.055 - 0.070 Unusually sensitive people should consider reducing prolonged or heavy outdoor exertion.		12.1 – 35.4 Unusually sensitive people should consider reducing prolonged or heavy exertion.	55 – 154	4.5 – 9.4 None	36 - 75 None	54 - 100 Unusually sensitive individuals should consider limiting prolonged exertion especially near busy roads.
Unhealthy for Sensitive Groups (101 - 150)	0.071 - 0.085 People with lung disease (such as asthma), children, older adults, people who are active outdoors (including outdoor workers), people with certain genetic variants, and people with diets limited in certain nutrients should reduce prolonged or heavy outdoor exertion.	0.125 - 0.164	35.5 – 55.4 People with heart or lung disease, older adults, children, and people of lower socioeconomic status should reduce prolonged or heavy exertion.	155 – 254	9.5 – 12.4 People with heart disease, such as angina, should limit heavy exertion and avoid sources of CO, such as heavy traffic.	76 - 185 People with asthma should consider limiting outdoor exertion.	101 - 360 People with asthma, children and older adults should limit prolonged exertion especially near busy roads.

Source: EPA description of AQI. See the complete table in the report in this link.

3. Case study [8 pts]

Create a case study of air quality for a city. Identify a place with poor air quality. The place can be based on the experience of a group member or an exploration of maps. Please follow your interests.

Resources to map and compare air quality include:

- Purple Air
- Air`Now
- IQAir

For your selected location, open a collaborative document and work with your group to report the following:

1. The full names of collaborators in your group
2. City Name
3. City Location – insert a map showing your location (i.e., screenshot of an aerial view from Google Maps, Google Earth, ArcMap, etc.)
4. What air pollutants impact the city?
5. Describe local conditions that could influence air quality. What are the sources of these air pollutants?
6. If you can find information, summarize health concerns in the area that can be associated with air pollution.
7. What (if anything) has been done by the city to address air quality issues.
8. Track and cite your sources. In addition to the air quality maps and resources, you can research and cite reports, newspaper or research articles, or your own local knowledge. Use in-text citations and include a reference section.

4. Air Quality Data Collection. Field Research

In this portion you will use the device called the DustTrak to take particulate matter (PM) measurements at two locations. Select two sites that you think will have different PM concentrations. The DustTrak is an instrument used by air quality researchers regularly to gather this kind of data. We will measure particulate matter using the 2.5-micrometer nozzle, which measures all incoming particles between 0.1 and 2.5 micrometers.

PM is a combination of solids and liquids in the air that range from dust and smoke to much finer chemicals. If particle size is 2.5 micrometers < x < 10 micrometers, it is known as an inhalable coarse particle. Particles less than 10 micrometers can aggravate asthma by becoming lodged in the trachea and bronchial tubes (American Lung Association).[1] If particle size is 2.5 micrometers or less, it is known as a "fine particle." Fine particles are the primary cause of haze (US EPA).[2] Particles that range between 0.1 and 0.001 micrometers are the most clinically relevant because it is this fraction that is deposited in the alveolar ducts and sacs within the lungs, and, if trapped there long-term, can cause chronic obstructive pulmonary disease (COPD) (Ling et al, 2009)[3].

Activity Steps:

1. Select two locations on campus (or nearby) that you think will differ in terms of air. Formulate a hypothesis about the differences.
2. Go to your sampling location
3. Press the ON/OFF key to power the DUST TRAK monitor
4. There are some start up tests that the monitor runs, wait about 1 or 2 minutes
5. **Note:** When doing this on your own, you must zero calibrate the DUST TRAK but in the interest of time this has been done for you.
6. You should be in survey mode. If you are, the monitor will show real-time measurements
7. If you are not in this mode and it says "log" then press SAMPLING MODE key
8. Take a 5-minute sample recording data every 30 seconds. Splits tasks among the group members as follows:
    a. Dust Trak Operator
    b. Time tracker (i.e. using stopwatch in cellphone)
    c. Measurement recorder
9. Turn off device & go to second site and repeat steps above

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1 http://www.lung.org/our-initiatives/healthy-air/outdoor/air-pollution/particle-pollution.html

2 https://www.epa.gov/pm-pollution/particulate-matter-pm-basics

[3] Ling SH, van Eeden SF. Particulate matter air pollution exposure: role in the development and exacerbation of chronic obstructive pulmonary disease. *International Journal of Chronic Obstructive Pulmonary Disease*. 2009;4:233-243.

Table 2. Air Quality Data Collection. **[2pt]**

	Location 1 at ...	**Location 2 at ...**
Time	**PM2.5 concentration Units:**	**PM2.5 concentration Units:**
0:30		
1:00		
1:30		
2:00		
2:30		
3:00		
3:30		
4:00		
4:30		
5:00		

4.1. Create a time series graph for concentrations of particulate matter at each of two the sites you measured them. **[4 pt]**
Here a list of steps, you help in the process of creating a figure, and an example is given in Figure 1.

a. Enter the values of table 2, including the times, into a spreadsheet. It can be done either in Google Sheets or Excel or any other application, where we can produce those line plots.
b. Plot PM 2.5 (**ug/m3**) in the Y-axis against time, X-axis.
c. Label axes, including units.
d. Add a legend for each line, with the name of the location where PM2.5 was measured.

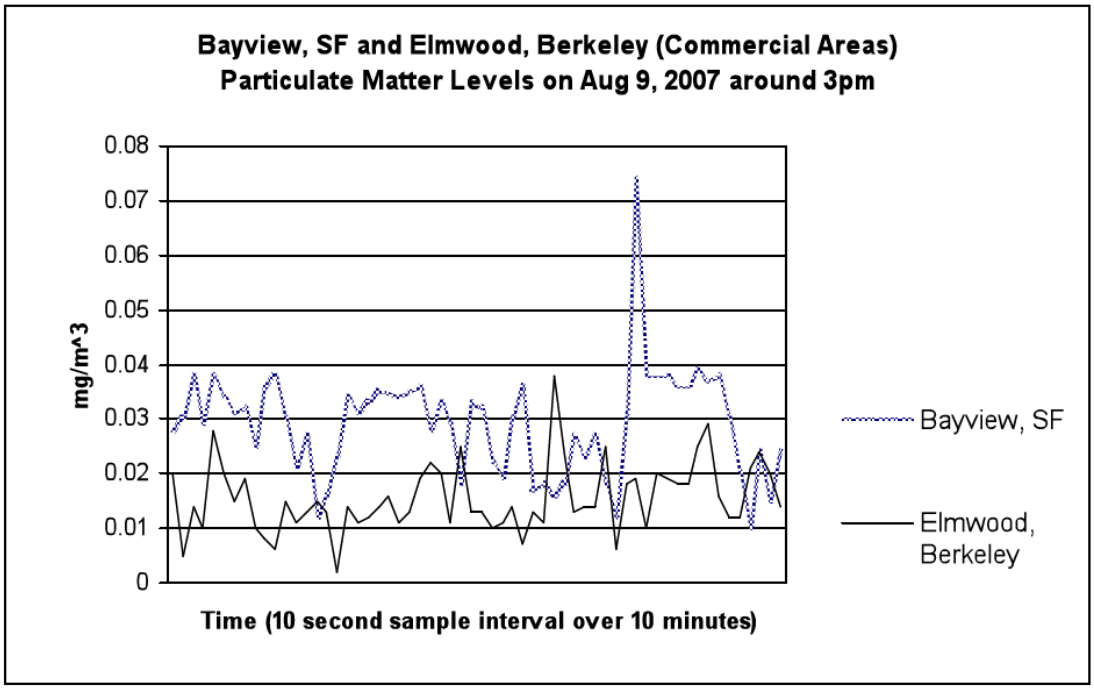

Figure 1. Time series plot of particulate matter concentration on August 9, 2007 in Bayview, San Francisco versus the Elmwood neighborhood of Berkeley with a 10 second sampling interval over ten minutes.

4.2. What was the PM2.5 max, min, and average concentrations for each site in (ug/m3)? **[2 pt]**

4.3. What are the main differences in air quality between the two sites you conducted the measurements of PM 2.5 concentrations? **[2pt]**

4.4 What are plausible reasons for similarities or differences? **[2 pt]**

4.5 Convert the calculated mean PM2.5 measurements, for each site, to the EPA's air quality index (AQI). Use this calculator https://www.airnow.gov/aqi/aqi-calculator-concentration/. **[2pt]**

4.6. How do those measurements compare to the AQI in Berkeley today? Make sure you are comparing the same units of measurement. And how your measurements compare to air quality measurements from purple air sensors on campus (make sure that you check if those purple air sensors are indoor or outdoor sensors). **[3 pt]**

4.7 What are the advantages and limitations of point source measurements in comparison with the other data sources mentioned above? **[3pt]**

Post-Lab Final Submission

Answer all the questions in this guide. Submit your assignment response as PDF.
One point will be deducted for answers not typed or not readable answers.