A Comparison of Particulate Matter Concentrations in West Oakland and Berkeley, California

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Introduction

Particulate matter (PM) is composed of carbon, nitrogen and sulfur compounds. In high concentrations PM adversely affects individuals who suffer from upper respiratory disease, asthma, and various cardiovascular diseases. Major PM sources in our Oakland and Berkeley, California study area include trucks, ships, and trains, which all have diesel fuel burning engines. One of our primary study areas was West Oakland, which is an area with high truck, train and ship traffic due to its proximity to the Port of Oakland. A Pacific Institute study (2003) shows that West Oakland residents are exposed to 9.4 pounds of PM/person/ year compared to Alameda County residents who are exposed to 1.3 pounds of PM/person/year. In addition, data obtained by the Alameda County Department of Health indicates that West Oakland residents suffer from disproportionately high rates of blood clotting and heart disease when compared to other areas of Alameda County. These two diseases previously have been linked to high PM concentration (Peters, 2005). Previous research in West Oakland (Bui, 2010) has shown high levels of PM near a Post Office mail distribution center that experiences high levels of truck traffic on a daily basis (at the intersection of 7th and Wood streets). While Port of Oakland going trucks recently have been required by law to install PM filters that reduce emissions by as much as 85%, Post Office trucks have not had to meet this requirement.

Given air quality policy changes at the Port of Oakland and at the State level, we wanted to see how PM levels in West Oakland compared to Berkeley, California, a city about 5 miles north of West Oakland. Berkeley has a higher amount of green space, lower rates of respiratory and circulatory diseases, and less industrialization overall. Using two different mobile data collection devices, we measured ground-level PM concentration levels in air in residential, commercial and industrial areas of West Oakland and North/Central Berkeley in order to make the comparison.

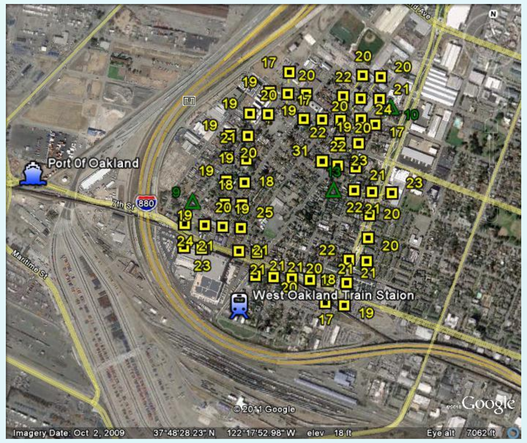

Figure 1: Average PM Concentrations in West Oakland

Results

On average, based on data collected using the Dustrak instrument, PM concentration levels along the West Oakland sampling route were within the EPA's AQI "Moderate" range (15 - 40 µg/m^3). Dustrak- derived values obtained along the route in Berkeley were between 10 µg/m^3 and below, which suggests that the air quality in this area is "Good" according to the EPA AQI. However, PM concentration levels measured with the same instrument at the Berkeley BART station and near a community college close by were found to be in the moderate range (~ 20 µg/m^3). In West Oakland, the highest average PM concentration level (31 µg/m^3) was measured with the Dustrak instrument at the intersection of 12th and Peralta Streets (Figure 1). Data obtained using the Fluke instrument in the same locations as those where the Dustrak equipment was used indicates a similar trend. On average, values as high as 74.07 particles per liter were obtained throughout West Oakland, compared to 37.69 particles per liter in Berkeley for PM size 5µm (Figure 6). Furthermore, average PM concentration levels measured in West Oakland were found to be higher than those found in Berkeley for all particle sizes.

Dustrak instrument data was also collected while researchers traveled on the BART train from West Oakland to Berkeley (Figure 3). Data collected in this manner indicates that higher average PM concentration levels occur in air on the train than those found at most outdoor sample locations (~68 µg/m^3). On Tuesday July 19, 2011 PM values as high as 1370 µg/m^3 were measured, which represents extremely unhealthy air (Figure 4)! In addition, researchers used the Dustrak instrument to measure concentration levels within the Port of Oakland. In an area located very close to cranes offloading an idling ship, Middle Harbor Park (See Figure 5), a PM concentration value of 299 µg/m^3 was recorded. Other high PM concentration levels were measured along 7th Street in West Oakland near Henry Street, where a great deal of earthquake retrofit construction along the elevated train tracks was occurring during the time of data collection.

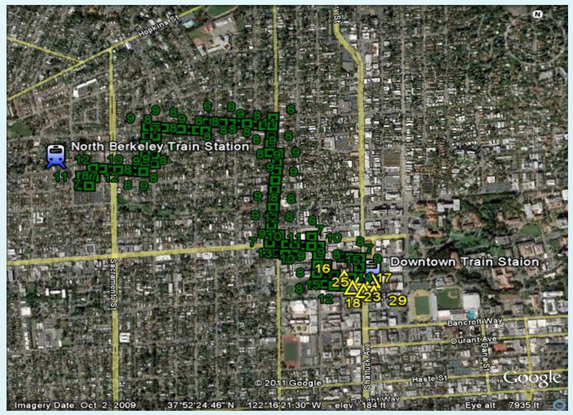

Figure 2: Average PM Concentrations in Berkeley

Discussion + Conclusion

Preliminary analysis of data collected during this study indicates that PM concentration levels found in West Oakland are generally higher than those found in North Berkeley. Berkeley did have one area of higher average PM concentration levels, which was located in and around the Downtown Berkeley BART station at Shattuck Avenue and Center Street. This may have been due to the generally high PM concentration levels of in and around

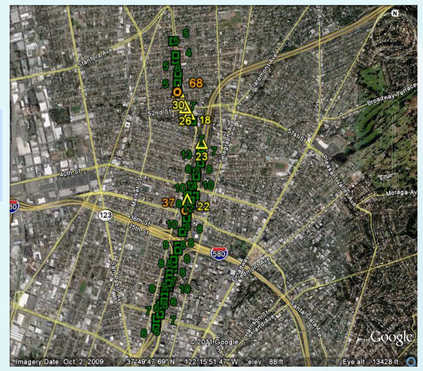

Figure 3: Average PM Concentrations on BART

the BART train throughout Berkeley and Oakland. Overall, the fact that PM concentration levels found in West Oakland are comparatively higher than those measured in Berkeley is largely due to the fact that West Oakland is located so close to the Port of Oakland. As a result, West Oakland's air is correspondingly "moderate" despite the Port's efforts to decrease PM emissions from diesel-fuel burning trucks. This condition is compounded by the fact that there are no legal requirements in place to lower PM emissions of other key diesel-fuel burning equipment used in Port operations (e.g., ships, cranes, etc.), as well as the fact that West Oakland is significantly devoid of green space (particularly when compared to most Berkeley neighborhoods).

West Oakland data indicates that an area of high average PM concentration (31 µg/m^3) occurs at the intersection of 12th and Peralta Streets. However, no significant PM source was observed. Continuing to work in this area, which is significantly residential, will hopefully reveal why higher PM concentration levels are/were found there.

The question of why such high PM concentration levels are found in underground Bart stations and on Bart trains remains largely open to speculation. To address this question we intend to conduct a Bart specific study in the future, which will include holding discussions with engineers and maintenance crews.

Overall, the City of Oakland should adopt other approaches to ensuring higher air quality among West Oakland citizens. These might include planting more vegetation, including species such as bamboo, which is fast growing and acts like a dense filter of PM (Bucknum 2010). Furthermore, we also believe that PM reduction efforts that target the Port itself will help reduce PM concentrations throughout West Oakland. For example, development of shore side power to reduce engine idling associated with docked ships will certainly reduce a major source of PM. Also, cleaner fuels and increased use of PM filters for port equipment will also help decrease PM concentrations.

The following are potential sources of error in our results: 1) Route deviations on two separate days; 2) Remaining at sample location for an extended period of time while using the Dustrak instrument, which would result in skewing a given average since more samples would be collected at that location compared to others. Despite these, we are extremely confident in the results of this study, given that the frequency of these mishaps was extremely low and the volume of data collected was very high.

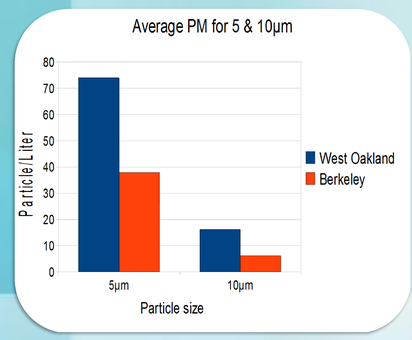

Figure 6

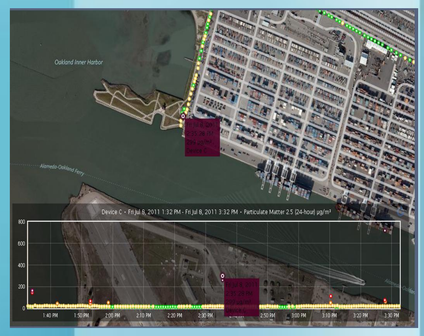

Figure 5: Port of Oakland, Middle Harbor Park PM concentrations

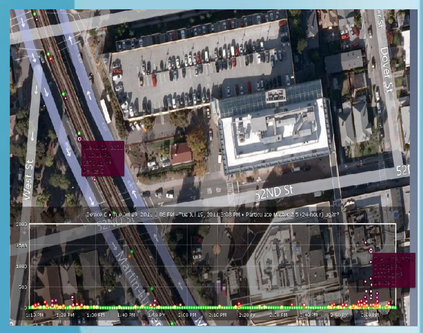

Figure 4: BART train PM Concentrations

Methods

Throughout this study measurements were made using a Fluke 983 Particle Counter, and a Dustrak II 8530 Aerosol Particulate Concentration Monitor. The Fluke device was used to collect one liter air samples, and then measure concentration levels of particles contained within each sample that are 0.3, 0.5, 1, 5, and 10µm in size. The Dustrak device was used to measure PM mass concentrations (µg/m^3) of particles that are up to 2.5µm in size, once per second. Portable G.P.S. devices were used to track our geographical locations during sampling. The Google Earth mapping application was used to correlate PM concentration and geographical data. Data was collected in July 2011, Mondays through Fridays from 1:00-4:00pm. Three separate groups from our research team worked on collecting data from West Oakland, Berkeley and at the intersection of 7th and Wood Streets (location of the mail distribution center) in West Oakland. Each group contained 3-4 members.

All three groups began the data collection process at the same location, namely the corner of 14th and Wood Streets so that data in Berkeley and Oakland could be compared under similar times and conditions. This process consisted of initiating the GPS devices to ensure accurate geocoding later, and then turning on the Dustrak and Fluke devices to begin PM counting. Following this process data collection proceeded along routes (See Figure 1 and 2) that research groups traveled on foot, which consisted of a loop around West Oakland, a transect in Berkeley, and a stationary sampling station at the intersection of 7th and Wood Streets. The West Oakland loop moved East toward Mandela Parkway along 14th Street, then South on Mandela Parkway toward 7th Street, then West toward Wood Street, and then back to 14th Street along Wood Street (See Figure 1). Our Berkeley route also began at 14th Street and Wood Street, but instead the team traveled on foot to the West Oakland Bay Area Rapid Transit (BART) train station, then by train to the North Berkeley station, then again by foot toward the East along Cedar and Virginia Streets toward Martin Luther King Jr. Way. At MLK Way groups traveled South toward University and Center Avenues, wherein they headed East again toward the Downtown Berkeley BART station (Figure 2). At that point they traveled by train back to West Oakland. At various intersections along each route groups measured PM concentration levels of one liter air samples collected using the Fluke device. Upon return to their headquarters in West Oakland, researchers uploaded all Dustrak and GPS data to a website maintained by the Intel Corporation to aid community-based environmental health organizations in the visualization of air quality data. At the end of each data collection day, researchers used an averaging software which, after averaging the PM concentration within a one block radius, facilitated the categorization of values that fell into three distinct groups based on United States Environmental Protection Agency (EPA) Air Quality Index (AQI) values of 0-15 µg/m^3 (Good), 16-40 µg/m^3 (Moderate), and 41-65 µg/m^3 (Unhealthy for Sensitive Groups).

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