Urban Air, Rural Air, Where's the Cleanest Air of All?

By

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Introduction

There is a lot of discussion about the quality of our air these days. First, it was the water, now it is the air. So many things are changing and it is important to discover the reasons behind it so that a balance can be restored and everyone can breathe again. Especially during the summer, the atmosphere is always talked about during the weather report. Things like "Ozone action day" and "bad air quality" seem to be mentioned everywhere. They ask you to "fill your car up with gas at night" and "mow your lawn on another day" and it leaves one wondering if the air could be cleaner outside of the urban areas.

An Air Quality Index (AQI) has been developed to help us decide at what level is the air considered unsafe for breathing for long periods of time. It sets standards, based on medical issues and human health, that inform the general public whether they should consider staying indoors or take a chance on going outside for the day. Basically, it is a way for us to measure the amount of pollution in the air. The AQI tracks ozone (smog) and particle pollution so we know when we should breathe safely.

Daily AQI Color	Level of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and Higher	Health warning of emergency conditions: everyone is more likely to be affected.

(Source: [AQI Basics | AirNow.gov](https://www.airnow.gov/aqi/aqi-basics/))

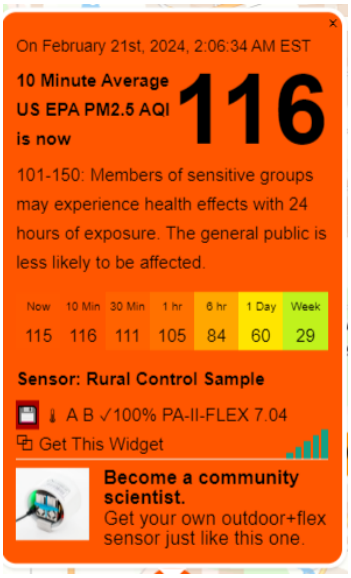
The EPA has placed air quality monitors around the country to monitor the amount of pollution and determine where the sources of high pollution are located. These can be accessed on a real time map by the general public if they are interested in learning more. Other groups, including one called PurpleAIr have done the same, only these sensors can be obtained by the general public and are connected, if so desired, into the national sensor network. So, the question still asks: where is the cleanest air? Should we be moving outside of the urban areas, or attempt to remove the source of the pollutants? How do we find the cleanest air quality?

The purpose of the research is to monitor a system of air quality monitors placed in three cities around Lake Erie to determine where the cleanest air might be located. Each of these cities will also have a monitor placed in the rural area so both types of places can successfully be monitored. For this research, PurpleAir AQI monitors were used. For the control variable, one was placed outside my home as the urban control and another outside my teacher's home as the rural control. In the other two cities, random locations were chosen and their data accessed for this research. The cities monitored were: Detroit, Michigan, Toledo, Ohio, and Cleveland, Ohio. All three areas are located around Lake Erie which eliminates the "lake effect" since all three cities experience it.

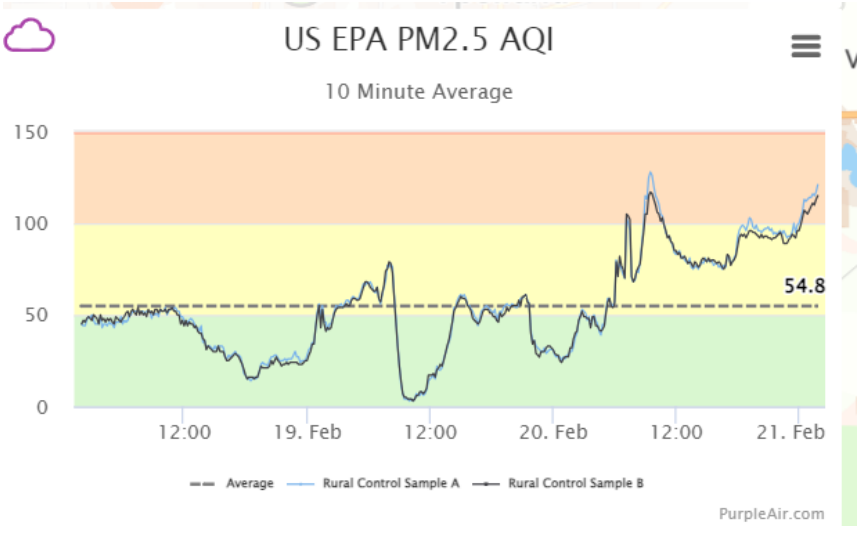
The hypothesis tested stated that the rural areas would have the cleaner air because they did not have the number of factories emitting particles into the air, or sewer gases leaking, or vehicle emissions like urban areas did. They have less people so should have less emissions from things that would heat up the atmosphere.

Experimental Design

For a one-month period, Purple Air monitors were accessed in three cities to collect data necessary for this research. Air temperature, pollution index and atmospheric conditions were gathered and recorded. Air temperature was taken both with an IRT (non-contact thermometer) and the PurpleAir monitor. Weather underground sensors were also accessed for any data not covered by the PurpleAir sensors. This included historical data needed from before the installation of the PurpleAir ones. Atmospheric data was uploaded using the NASA GLOBE Observer app which includes cloud cover, temperatures, land cover, precipitation. These data points are also uploaded into NASA's data base for use by all citizen scientists. Two points of data were selected daily and recorded for use in this research. This was the same time daily from all sensors.



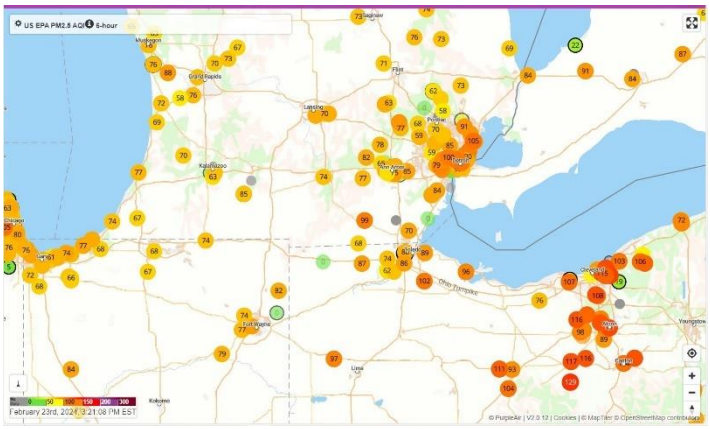
This data was taken from the rural control and shows an interval which can be stretched and downloaded for even more data, if necessary.



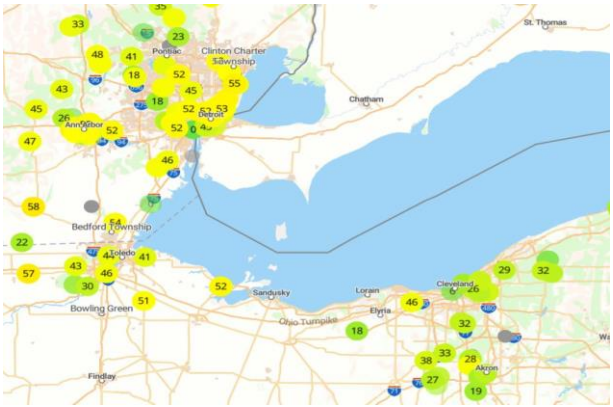
These data points will be analyzed to determine which area might be the cleanest air for human respiratory systems.

Results

The results were completely unexpected: it seems another hypothesis might be necessary and further study is needed to examine the data more thoroughly. There was no one place monitored that showed it was the ideal place for cleaner air. The air in urban areas was quieter and cleaner during the evening hours. There was a definite spike in air quality when the morning commutes would be happening; the AQI index consistently increased dramatically. In the evenings, rural air showed a much higher AQI number, making it more unsafe for breathing. Most days, the cities all showed higher, more dangerous breathing levels during the day but it moved toward the rural areas at nighttime. In the evenings, it appeared to head out over the lake and the cycle began again the next day.

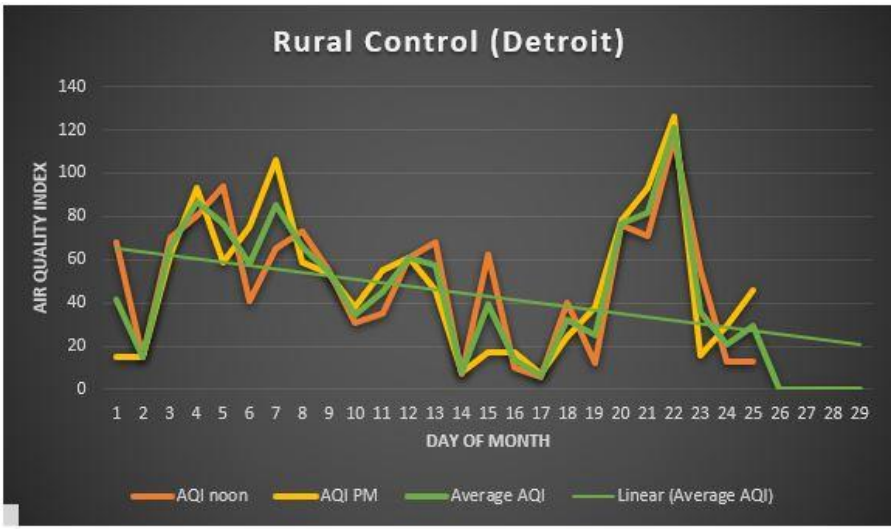


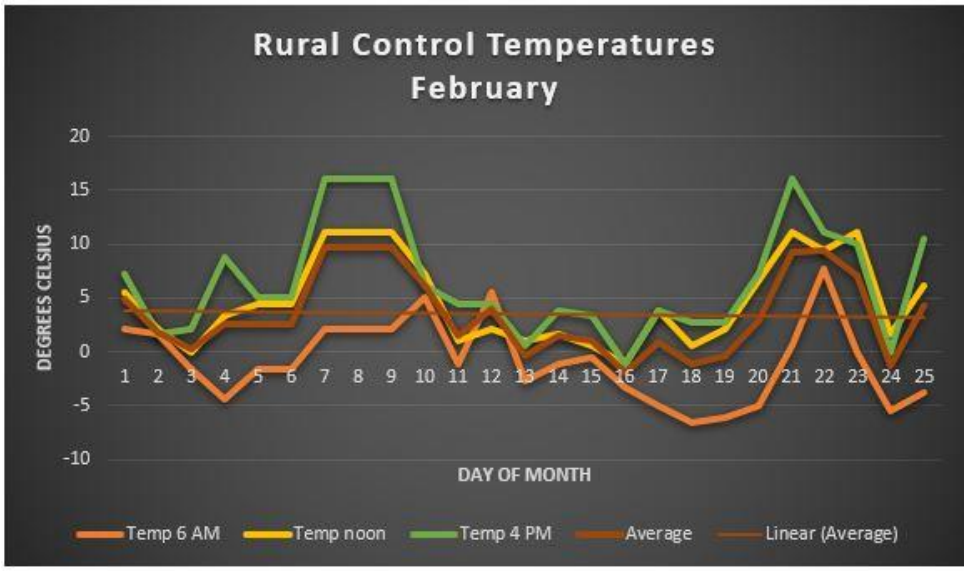
Another thing noticed was that the cities were either all having a ‘bad air day’ or a ‘good air day’. You did not notice one city having unsafe air without the others as well.



This opened up more questions: why were the cities behaving this way? Were they somehow linked? Instead of one type of place being different, it seemed like they were cycling through a pattern. It was expected that the rural areas would always stay cleaner than the urban areas but instead they seemed to take turns having good air and bad air.

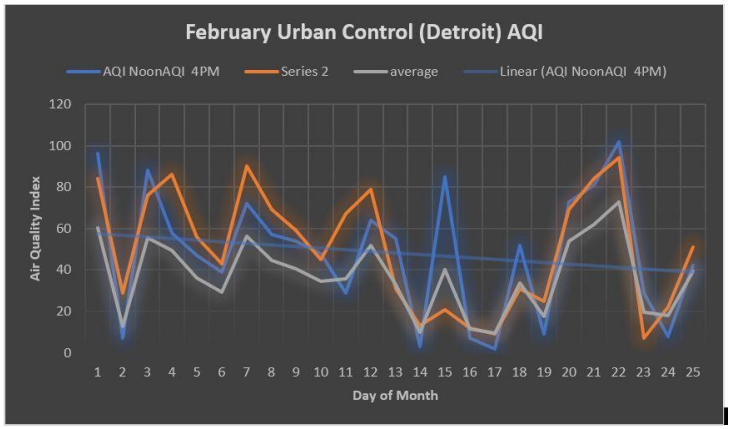
Once the data was presented in graph form, definite trends appeared. It seems temperature may also play a part in this rather interesting change of events. One example is the rural control. It seems the colder temperatures brought the AQI levels downward, which is the desired effect.



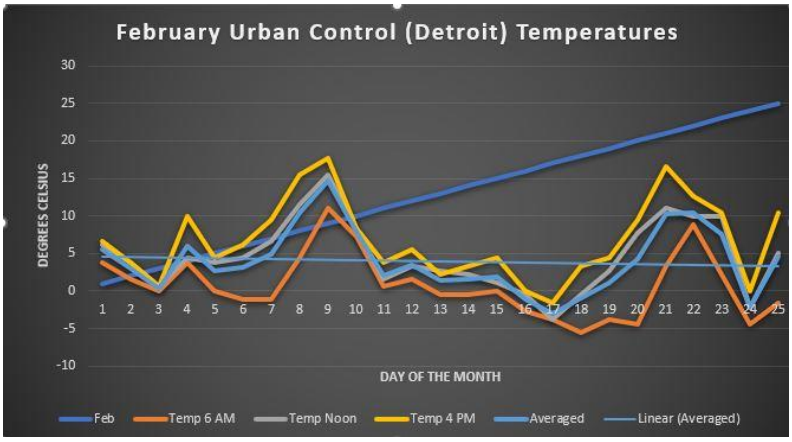


This would indicate that pollutants are warmer and since hot air rises, perhaps that partially explains why it seems to travel with the air currents in the atmosphere.

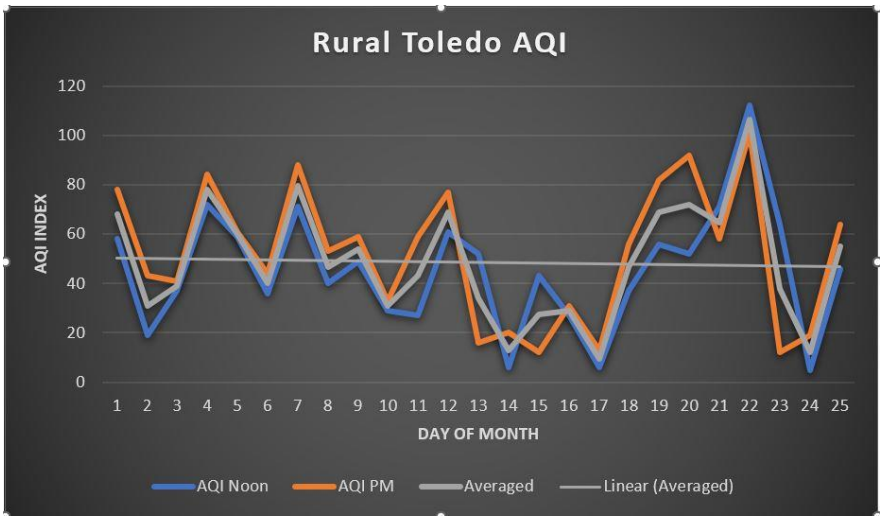
The next charts show similar behavior in the urban control data. The



data still trends downward, indicating the possibility that temperatures do affect the AQI. As the AQI lowers, which is a good thing, the temperatures also lower, possibly forcing the warmer, polluted air to rise upward in the higher atmosphere.

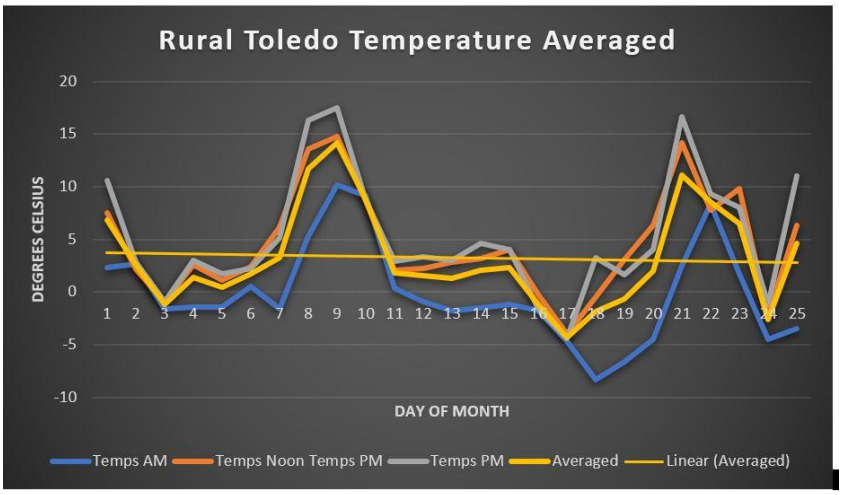


These charts from the Toledo sensors utilized show much the same



as the others. One seems to follow the other, being cyclical as was the Detroit units. It almost looks the same as the Detroit model! When it is compared with the temperature chart, one can see that the trends still move downward,

indicating again, that lower temperatures seem to bring better AQI numbers.



In conclusion, the hypothesis was neither proved nor disproved by this research; rather it opened the door for more possibilities and further research. It seems apparent that if the answer to this question is to be discovered, then a longer period of study and a larger sampling from the cities should also be included.

These limitations served to entice further study as the results were totally unexpected. It was thought that we should look for a country home but this does not seem to be the case. At least not using this data, as it does not support this concept. The short time frame and small sample was not enough for my family to consider such a move.

Next steps would be to increase the sample size, which is possible once you have access to the sensors. A study that would include all seasons might also be in order. It may be that these indexes change with the seasons, like the temperatures do. It is not possible to tell unless further study is completed.

Real world interest would be generated from all areas of life. Those who want to find a place to breathe freely, who already suffer from heath

issues, medical personnel, city planners, even national offices, would all benefit from these types of studies.

Further study is necessary and who knows what it will produce?

References

www.purpleair.com

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Using Air Quality Index | AirNow.gov

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