Urban Sensing for improving Quality of Life at Redhook, New York City

Identify patterns and anomalies in environmental data, and find potential causal relationships between these indicators and the built environment.

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***Abstract* –Red hook is a growing neighborhood in the Brooklyn borough of New York City. With the locality experiencing huge leaps of development there are several industries causing noise pollution and produce particulate matters that contribute to the air pollution. To measure the measure and identify the signature patterns and anomalies in the environmental data: noise, air quality and light sensors have been installed in four locations across the locality. In this paper, we try to analyze the data obtained from the sensors located in the Red hook neighborhood and compare it with the Complaints received in the region based on 311 data and try to derive a correlation between them.**

Keywords—Noise pollution, Air pollution, Light intensity, Anomalies, Signature patterns.

I. INTRODUCTION

Brooklyn is one of the five boroughs of New York City. It was during WWI & WWII when the borough of Brooklyn flourished the manufacturing industry with very good connectivity globally linked through the harbors and ports. Post WWII the markets slowly shifted towards New Jersey reducing the demand of Brooklyn port. After the rapid growth of the financial district in the 20th century the population in the Manhattan region started shifting towards Brooklyn for affordable housing [1]. But it was mostly the vacant lands that were utilized for new projects and the Brown field projects were never focused by the real estate market. Red Hook is one area that was left behind by the growth of New York city and is still much backwards in terms of the infrastructure and maintenance compared to the reminder of the New York City. It is evident from the below image that majority of the buildings are the ones constructed in the early 20th Century and only a very small portion in the waterfront that was revamped recently.

Figure 1 Age of Buildings in Red Hook Area
(Src: Existing conditions and brownfield analysis of Red Hook area in Brooklyn)

The substantial number of shipyard buildings including warehouses and workshops are still in existence that may be a possible playground for realtors to implement new projects in the city. Considering that NYC is a land resource scarce city, a large neighborhood in the water front may be a very feasible market for large real estate giants to poach on. To bring a change in the quality of life in the neighborhood of Red Hook and to establish a market for Red Hook several initiatives are in progress.

One such initiative is the Red Hook Initiative that aims at empowering the youth in the locality and raising the standard of living for the citizens in the neighborhood. [2] New York University Center for Urban Science and Progress has partnered with Red Hook Wifi, a community led initiative to improve the quality of life in ther region by providing a wireless internet network and training youngsters in the region to empower them become digital stewarts to establish sensors in the region to measure and record Noise, Light and Air Quality levels at several locations in the neighborhood.

Figure 2. Red Hook Wifi Locations
(Src. http://redhookwifi.org/red-hook-wifi-map)

II. LITERATURE REVIEW

There has been a wide focus on the Red Hook region after massive expansion of NYC when there was no place to go after in the city. Several plans have been laid out for urban revival of the region. But this region of NYC has never got any major projects going its way. With heavy vehicular traffic in the

region majority coming from trucks and commercial vehicles the noise and air quality standards have been very poor and not many steps taken to improve the quality has paid off well. An Article published on the Brooklyn South Post in 2010 highlighted the need for electrical plug-in station at Brooklyn's Cruise Terminal. This is a similar set up like that in place at San Francisco where the ships can feed on the electric power while idling in the ship yards. Brooklyn Ship Yard terminal houses most of the cruise ships and cargo ships that enter in to the NYC. It has been reported by the Port Authority of New York and New Jersey that five tons of nitrogen oxides, 6.5 tons of particulate matter, 1,487 tons of carbon dioxide and 99 tons of sulfur dioxide are being emitted by the idling vessels. The most of the emissions from the vessels have been blown by the wind to the red hook area causing a major concern of health issues related to breathing in the region [3]. A Similar Study carried out by NY Times emphasizes the need to install the electric plug to charge the vessels in the port to reduce the emissions in the port [4].

Figure 3 Brooklyn Ship Yard Pollution by Stalling Cruise (Src: By Joshua Kristal, South Brooklyn Post)

One other study conducted by the New York City Mayor's office of Environmental Remediation in 2014 on the existing conditions and brownfield analysis of Red Hook area in Brooklyn is a document to encourage urban revitalization in the Red Hook region. This report describes the steep decline of the economy of Red Hook area and how the poor connectivity of public transportation to this region was one of the major factors contributing to the declining growth rates in the region. This report also highlights the after effects of industrialization where the machines overtook the work from humans and this lead to a sever unemployment in the region. This was contributing to a hig rate of illegal activities in the region which was attributed to high crime rates including drug abuse & violent murders. But in the late 20th century the situation became much better when several startups were established in the region and when small and medium scale industries played a major role in revitalization of the region. It is to be noted that the unemployment rate in the region is a whopping high 21% which is more than double in that of Manhattan & Brooklyn. [5]

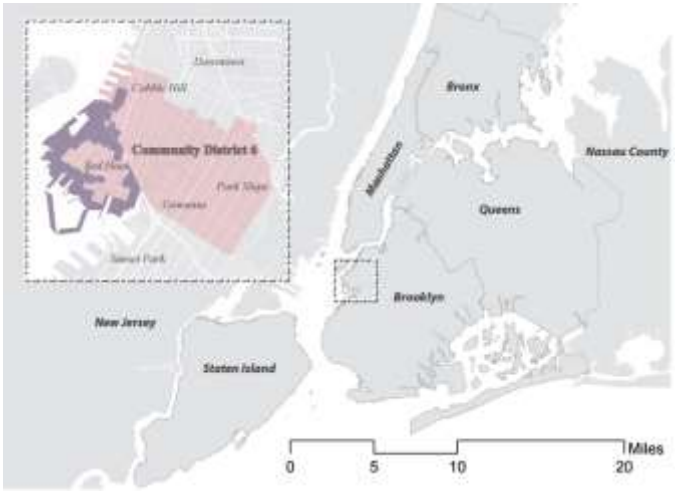

Figure 4 Red Hook Area (Src: Existing conditions and brownfield analysis of Red Hook area in Brooklyn)

Red Hook was one of the mainly hit areas during the Hurricane Sandy in 2012. A lot of rehabilitation work was carried out in the region.

III. URBAN SENSING TECHNOLOGIES AND APPLICATION

Urban sensing technologies have emerged in the recent past and are very useful to measure environmental parameters to promote sustainable living conditions. Internet of things technology is the technology of future where the complete infrastructure of the city would be connected to the internet through sensors and they would be smart enough to communicate with each other and learn based on one others experience. This is a combined methodology involving principles of Machine Learning & Artificial intelligence where the data collected over millions of nodes are analyzed to study and understand the pattern and regular operation of the infrastructure installed in. If there might be any anomaly that is abnormal operation observed by the sensors they are detected as faults and notified by the system as an irregularity in the operation of the infrastructure. Further analysis of the data also helps us identify signature patterns that might be useful to classify the intensity or likelihood of the fault occurrence.

This system has pilot tested across several neighborhoods in the last few years. In fact, the utilities have been the ones who have adapted well to this technology. Smart Grid Is one well defined example of how connected systems can help us mitigate issues and solve problems in the network. Since the inception of smart grids, it has been easy to migrate to distributed generation solution that has focused on a sustainable energy reformation.

IV. DATA AND METHODS

In this research, we have environmental sensors that are connected to the cloud and report and store data at a frequency of every four hours. We have installed four sensors across the Red Hook region that can measure the i. Air Quality by particulate concentration (particle count per 0.01 cubic feet), ii. Luminosity or Light intensity (Lux level) & iii. Noise levels (sound pressure level in dB).

These sensors were installed at four locations in the region:

- **Sensor-0:** RHI roof (at corner of Hicks and W 9th streets, elevation approx. 8m) - 767 Hicks St, Brooklyn, NY **Sensor-0:** RHI roof 11231
- **Sensor-2:** TechLab (at ground level) - 106 Ferris St
- **Sensor-3:** RHI entrance (on Hicks street at street level) - 767 Hicks St, Brooklyn, NY 11231
- **Sensor-4:** PioneerWorks roof (elevation approx. 15m) - 159 Pioneer St, Brooklyn, NY 11231

Figure 5 Location of Sensors installed in Red Hook

For this analysis, we have utilized the data collected from the four sensors over the time period of twenty days ranging from 21st June 2016 to 11th July 2016. This data was analyzed on two temporal ranges one based on the time of the day and the other based on the day of the month. This data was compared with the population data set obtained from the ACS Census tract data, PLUTO data & 311 Data.

The data was obtained from sensors every four hours for six times a day at 12:00:00 A.M., 04:00:00 A.M., 08:00:00 A.M., 12:00:00 P.M., 04:00:00 P.M. & 08:00:00 P.M. This data was cleaned and analyzed using Python, Tableau & Excel on the basis of the sensors, Time of Day, Date and the recorded values at the sensors.

V. RESULTS

The below map shows the Spatial distribution of the classification of buildings in the Red Hook region. It is to be noted that the Sensor 2 is located in an industrial area whereas Sensor 4 is located in a residential area and Sensors 0 & 3 are located in the Red Hook Initiative building that is on the road that has high flow of truck traffic.

Figure 6 Land Usage Pattern
(Src. PLUTO Data)

It is expected that the sensors in the industrial area is to be recording a maximum air and noise pollution but from the data obtained from the sensors there is no significant difference in the level of pollution between the industrial and residential areas. In fact, at certain points the value in the residential region is higher than that of the industrial area.

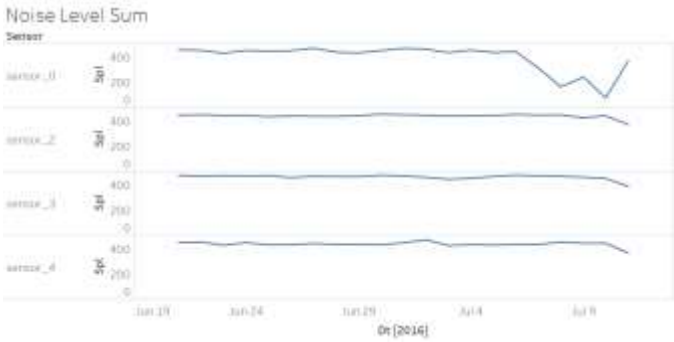

Figure 7 Sum of Noise recorded at individual sensor locations

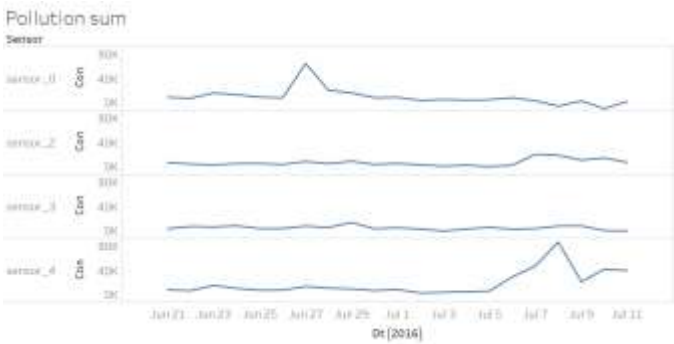

Figure 8 Sum of Particulate matter recorded at individual sensor locations

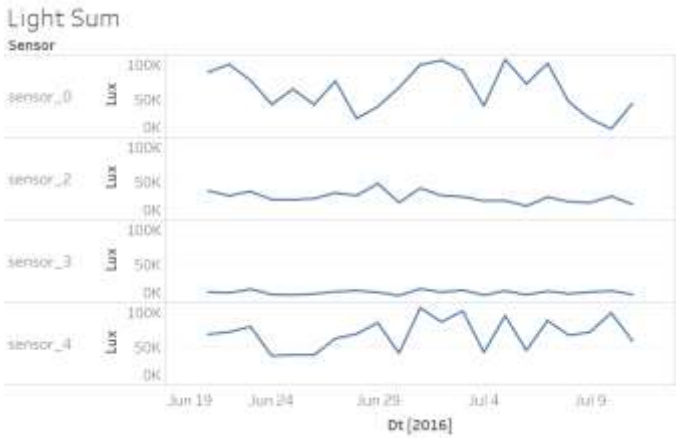

Figure 9 Sum of Light Intensity recorded at individual sensor locations

This might be attributed to the high population density in the region where Sensor 4 is placed. It can be observed from the data obtained from the US Survey data that the population in the residential region is high and that may be attributing to the increase in noise and air pollution levels. We could observe a few peaks in the sum of particulate matter that gradually increase in July 8 at sensor location 4. We will see later in this paper that there is a correlation between this peak data and the complaints made in 311 regarding air pollution.

Figure 10 Population Distribution in Red Hook
(Src. American Community Survey data – 2010)

Below is the measure of the average values of the i. Air Quality by particulate concentration (particle count per 0.01 cubic feet), ii. Luminosity or Light intensity (Lux level) & iii. Noise levels (sound pressure level in dB) measured across the twenty days period. It is observed that as the time progresses in the day the air pollution value increases. This might be attributed to the activities carried out during the day. The Light intensity increases in the day because of sunlight and the noise level almost remains constant during the entire cycle, but for a small increase in the day time that might be attributed to the vehicular noise produced in the region.

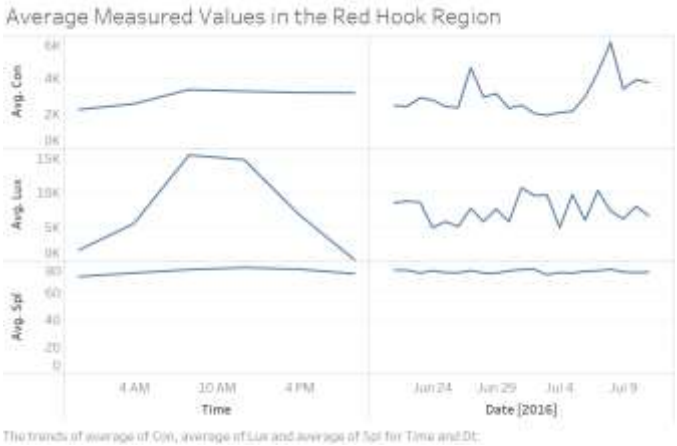

Figure 11 Average Measured values obtained from sensors in Red Hook region

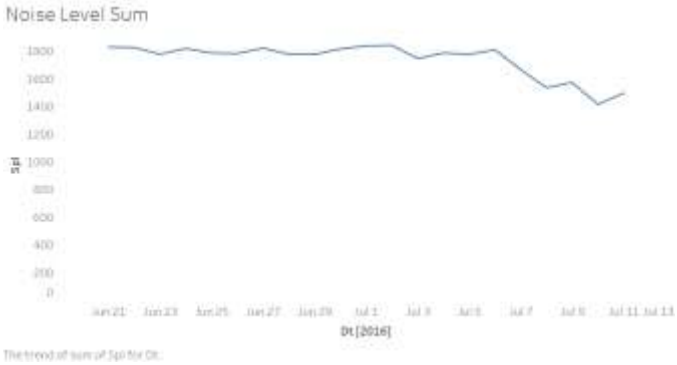

Figure 12 Sum of Noise Levels measured by Sensors

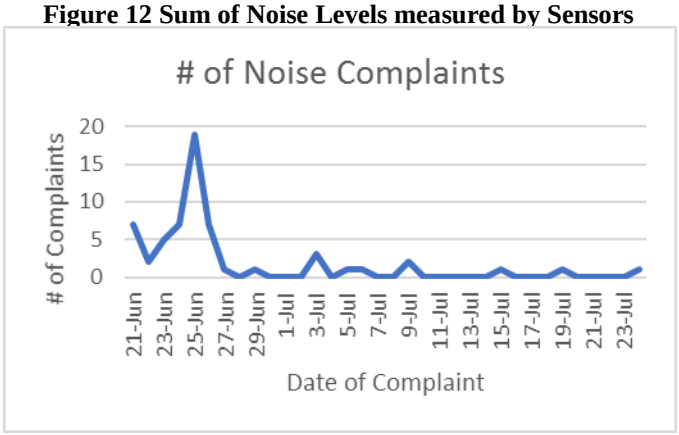

Figure 13 311 Database from complaints received in the Red Hook region

It is noted from the above graph that the noise complaints were maximum un the date range of 23rd to 26th Jun. However by observing the graph that shows the total sum of noise we do not observe any correlation. So it was tried to identify the region of noise complaints and it was found to be near the park close to Verona street and Columbia Street where most of the complaints have come from. So when we tried to see the variation in the noise levels it was observed that there was a steep increase in the noise levels on the date.

Figure 14 Variation in Noise levels in the region where Sensor 3 is installed

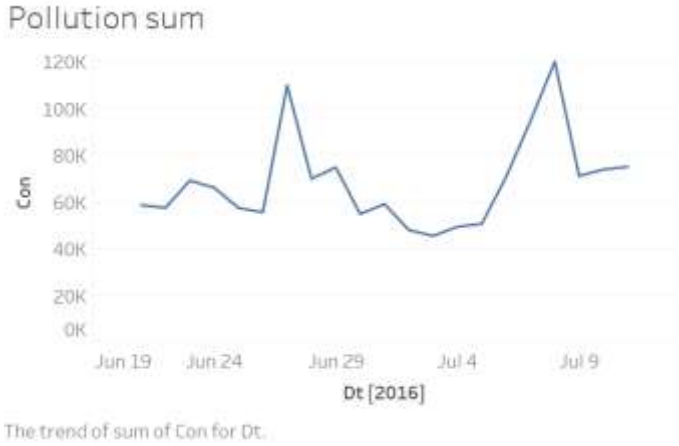

Figure 15 Sum of Particulate Concentration values recorded by the Sensors

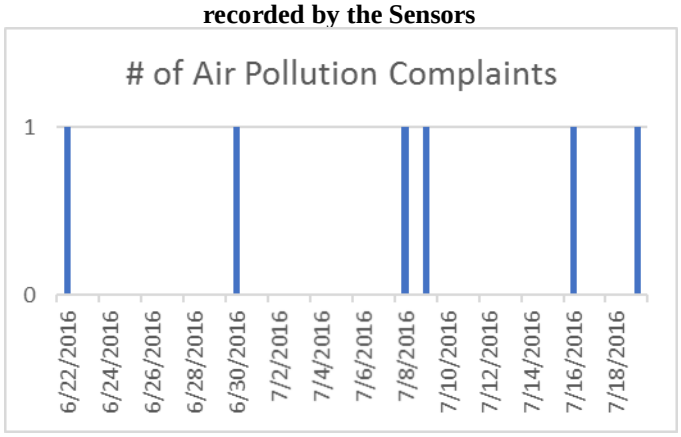

Figure 16 311 Complaints received for Air Pollution related complaints in the Red Hook region

There is no particular correlation between the first peak and the complaint history and there have not been many complaints of air pollution reported as the people in the Red Hook region have learned to Co-exist with it. It can be observed that during the second peak on 7th July there are two complaints recorded in the region that shows that there could have been some heavy air pollution in the locality.

Figure 17 Sum of Light intensity recorded in the Red Hook region

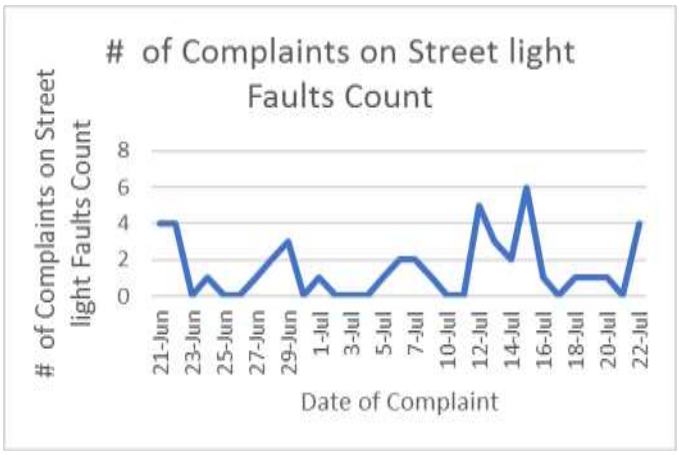

Figure 18 311 Database from complaints received in the Red Hook region

It is again evident that the complaints flow in if there is a reduction in light intensity, which might be mainly caused due to failure of street lights. It can be seen that the light intensity was recorded low on the 6th & 11th of July and that is when maximum number of complaints have been recorded.

VI. Discussion and Conclusion

The performed analysis shows that there is a correlation between the data that we collected from the sensors, PLUTO Data, ACS Data and 311 Data. Further analysis could be carried out trying to correlate the values of Asthma records in the city and studying the effect of air pollution in the region. One other analysis that could be carried out can be linking the crime rates to the Light intensity in the region.

Such analysis carried out can help in improving the quality of life in the Red Hook region. This shall also improve the real estate value in the region where a major development like Hudson yards could be carried out.

So, this gives us a very good platform to test a pilot Work Order management system based on the data obtained from the sensors. If the system reports low intensity of light for instance then the system could be automated to immediately create a work order automatically and send crew to rectify the issue.

This shall be the next steps taken to make a well-connected community at the Red Hook region.

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