AIR QUALITY AND HEALTH
IMPACTS FROM THE TRANSPORTATION
SYSTEM IN BARBADOS

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INTRODUCTION

Air pollution can be defined as the release of harmful pollutants into the atmosphere. This can have detrimental effects to both human health and the health of the environment (Mackenzie, 2016). There are two main types of air pollution; this includes smog also known as ground level ozone and soot, which can also be referred to as particulate matter (PM). Smog occurs when emission from the combustion of fossil fuels reacts with sunlight (Mackenzie, 2016). On the other hand, particulate matter is made up of tiny particles either in the form of gas or solids made of different chemicals, soil, allergens or dust. For the purpose of this project report, there will be a focus on air pollution originating from particulate matter. PM 2.5 ranks as the sixth largest overall risk factor for global premature mortality (Apte, Marshall, Cohen, & Brauer, 2015). Moreover, the WHO recommends maintaining a concentration of 10 μg/m3 or less for the annual mean of PM 2.5 and and a concentration of 20 μg/m3 or less annually for PM 10 , these guidelines provide a suitable level to ensure good health in a given population. As more of the human population moves to cities, it is important to define the physical properties of the air and how this might improve or worsen health. This is especially important as urbanization increases in Barbados and as public transportation becomes even more common. The use of diesel powered-engines by transportation vehicles has potential negative effects both on air quality and human health outcomes.

The overall GOAL of the project is to describe the effects of diesel-powered engines in emitting harmful pollutants into the air and the potential health effects this could have on the general Barbadian population. It is the goal of this project to provide concise and useable data to The Future Center trust, a non-governmental organization which is concerned with policy in relation to air quality and Megapower, a private electric car company that promotes the use of electric powered vehicles on the Island. Most importantly, this data will be provided to the new Government of Barbados; the Ministries of Transportation and Health.

PROJECT OBJECTIVES

Our strategy focuses on the following three objectives:

1. Making a functional air quality database. The first objective is to collect air particulate data from select sites in the country. These included two of the three major bus stations and a short list of possible point emission sites. This was done with the aid of a device that measures particulates in the air, more specifically PM 2.5 and PM 10.

2. Relating air quality data to acute asthma events on the Island. The second objective is to retrieve health data pertaining to asthmatic events and examine this information in the light of information collected on air quality. Limited interpretation is possible. However, the data could be indicative of trends.

3. Recommendations for the Ministry of Transportation.

The third objective is to use the air quality and health data to make recommendations to the Bajan Ministries of Transportation and Health on how they could reduce the particulate air pollution generated on the Island and work towards reducing this category of emissions
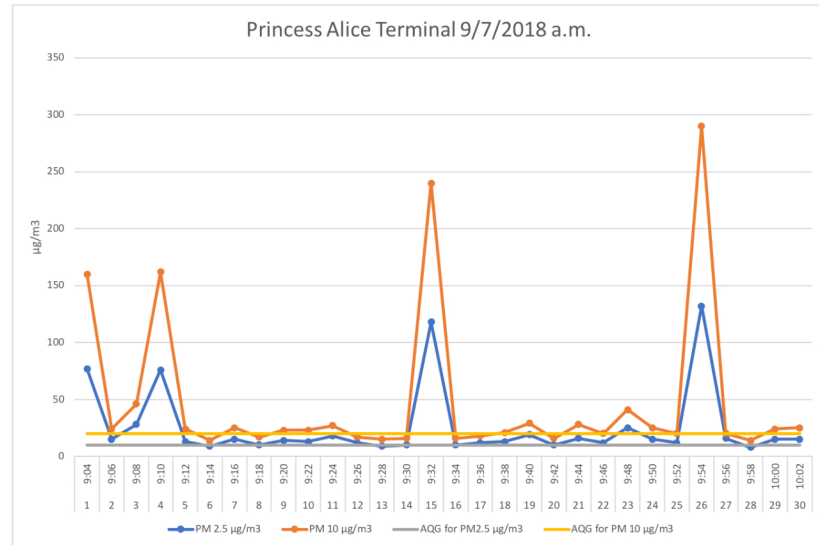
MATERIALS & METHODS

The project was divided into four categories. The first section comprised of air particulate matter data collection. Air quality data was collected at Princess Alice terminal in Bridgetown and at the Oistin bus depot. Data was collected 2 days out of every week for 3 weeks and conducted at two distinct times of the day; early morning and early afternoon. Data was collected by use of the Air Quality Particle Counting Meter PCE-RCM 10. The individual taking the data stood about 5 feet from the exhaust of the bus and took readings for PM 2.5 and 10 every 2 minutes. The instrument was held at waist level (figure below). In the absence of any bus in the terminal, data was collected in the middle of the terminal. Section two of the project was the collection of respiratory health data. A database query has been conducted pertaining to health statistics on asthma occurrences for the last 3 years. Section three of the project was an investigation looking into the transportation system in Barbados. The last section consists of raising awareness of the Bajan population towards the air quality issue in Barbados. A video documentary was made on Barbados air pollution and the local transport system.

RESULTS

For each particulate matter data collection event, a graph was made illustrating the varying levels of particulate matter in the bus terminal. A graph is shown here as an example.

Graph 1. Princess Alice Terminal 9/7/2018

All the exposure levels were calculated as the average over specific time periods that each type of population was exposed to based on our estimations. Based on observations, a typical tourist would spend approximately 30 minutes at the bus station as they are usually unfamiliar with the environment. This could be during rush hour or non-rush hour solely according to their choices of time. On the other hand, commuters would usually spend 20 minutes twice a day at the bus station and mostly at rush hours. For the bus drivers, the amount of particulate matter they are exposed to largely depends on their bus route. For calculation purposes, it was estimated that a bus driver on the Bridgetown to Speightstown bus route would go through a bus station at least 7 times on average with at least twice during rush hours. A vendor at a kiosk would experience two one-hour rush-hour periods in the morning and afternoon and 6 hours during non-rush hours.

Data pertaining to the number of asthma attacks encountered at the Queen Elizabeth Hospital from 2015 to 2017 was provided by the hospital. Additionally, data of concentrations of PM 2.5 in Barbados coming from the Sahara Desert dust was provided by the Caribbean institute of meteorology and hydrology. A comparative graph was made in order to see if there was a relationship between the number of asthma attacks and the concentrations of PM 2.5 provided by the Sahara desert.

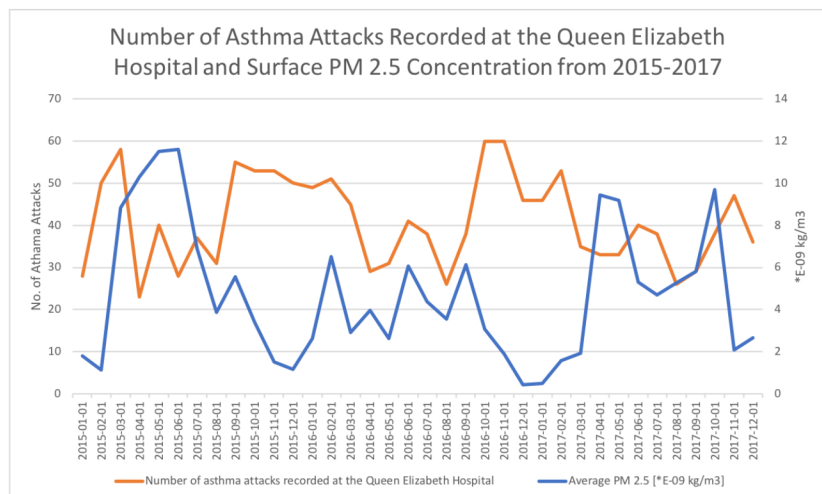### Graph 2. Number of Asthma Attacks Recorded Compared to PM 2.5 Levels

Table 1. Estimated Exposure Levels for Different Populations at Princess-Alice Terminal

Types of Population	Estimated Exposure Time [minutes]			Rush Hour		Non-Rush Hour	
	Rush Hour	Non-Rush	Total	PM 2.5 [µg/m3]	PM 10 [µg/m3]	PM 2.5 [µg/m3]	PM 10 [µg/m3]
Tourists	30	30	30	142	293	27	47
Commuters	20*2	-	40	195	410	-	-
Bus Drivers	25*2	25*5	170	215	439	28	50
Kiosk vendors	60*2	60*6	480	94	195	44	83

DISCUSSION

One main conclusion discovered in the study was the role of non-exhaust emissions in increasing fine particulate matter. In fact, non-exhaust emissions account for over 90 % of PM 10 and 85 % of PM 2.5.

Furthermore, our data also showed numerous peaks indicating bursts of PM 2.5 and PM 10. One major factor was the presence and absence of buses in both stations. Precipitation also played a role as it washes off aerosols and fine particulate matter (Blanco-Becerra et al., 2015).

Moreover, higher concentrations of particulate matter were observed in the private buses than in government buses. Yellow buses are privately owned and do not have strict cleaning regulations. They were also less likely to shut off their engines when waiting at the terminus for passengers to board which lead to the release of more PM.

According to our estimated exposure times for different populations who use the Barbados transportation system, Kiosk workers at the bus terminal seem to be at an elevated risk of having an asthma event. Kiosk workers at the bus terminal would be situated in an environment with high emission concentrations for 8 hours or more. During rush hour, they would then be consistently exposed to average concentrations of PM 2.5 measuring 94 μg/m3 and PM 10 concentration 195 μg/m3. During non-rush hours, these workers would be exposed to concentrations of PM 2.5 measuring 44 μg/m3 and concentrations of PM 10 measuring 83μg/m3. It is important to note that the WHO recommends maintaining a concentration of 10 μg/m3 or less for the annual mean of PM 2.5 and and a concentration of 20 μg/m3 or less annually for PM 10. Tourists are also receiving high amounts of PM 2.5 and PM 10. PM 2.5 exposure levels range anywhere from 27 μg/m3 to 147 μg/m3. The high exposure of fine particulate matter that tourists could potentially face could prove detrimental to the growth of the tourism economy in Barbados.

Data was also provided by the Queen Elizabeth hospital and was graphed along with baseline fine particulate matter coming in from the Sahara desert. In looking at the graph 2, the month November seemed to consistently have the highest incidences of asthma attacks being reported at Queen Elizabeth hospital. This is in agreement with the conclusions of our data which submits that rain is an important factor in clearing up pollutants present in the atmosphere. November falls in the dry season. Finally, there did not seem to be a linear relationship between the amount of fine particulate matter coming from the Sahara and asthma events recorded at Queen Elizabeth Hospital. This could be due to the fact that there are very low levels of fine particulate matter coming into Barbados from the Sahara, one might see a linear relationship if fine particulate matter originating from all possible sources were plotted against the amount of asthma events recorded.

OUR TEAM

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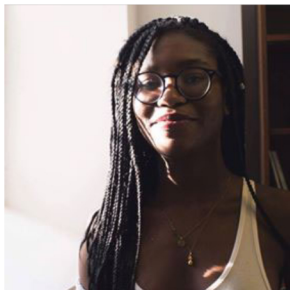
RECOMMENDATIONS

Non-exhaust

1. The Barbados Ministry of Transportation can create maximum limits for non-exhaust emissions and encourage innovation on reducing vehicle weight

2. There is a needed investment in brush trucks which can clean roads and decrease the amount of resuspension particles in the atmosphere.

Exhaust

1. The Barbados Ministry of Transportation needs to be more diligent in requiring both private and public buses to have their diesel exhaust being cleaned.

2. The Ministry of Transportation should be encouraged to renew their fleet and take the older ones off the roads first.

3. Signs need to be made to ensure that bus drivers are not leaving their buses idling for long periods of time.

Health

1. During dry seasons, health professionals should take extra precaution to account for increased amounts of asthma events.

2. A database should be made which details air pollution levels for each parish in order to give ample warnings to susceptible populations. The Montreal Air pollution: Real time air quality index could act as a reference for this database.

CONCLUSIONS

The main conclusion from this research project is that while exhaust emissions are important to eliminating the health effects caused by vehicle emissions, it is also important to notice and highlight the effects of non-exhaust emissions coming from vehicles present on the road. It is the hope that the results of our study as well as the recommendations in the above paragraphs act as first steps to improving the air quality in Barbados, in an attempt to make Barbados a better and healthier environment to live in.

ACKNOWLEDGEMENTS

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