Understanding the Interconnectivity between Intersection Traffic Congestion, and Outdoor Air Quality for Smart Cities

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INTRODUCTION

Traffic emissions continue to be a prevalent source of air pollution worldwide. Those in high traffic urban areas are at higher risk for repository health problems. Stopped traffic allows for higher concentrated emissions at intersections. Table 1 shows pollutants of concern in ambient air pollution. Polycyclic Aromatic Hydrocarbons (PAHs) deposited on PM particles are of particular concern due to their relation to a variety of health problems. We developed a traffic model to study an intersection in Camden. NJ

Table 1. Pollutants and regulatory limits

Pollutant	Regulation	Health Concern
$PM_{2.5}$	12 µg/m^3 24-hr	aggravation of cardiopulmonary diseases[3]
PM_{10}	150 µg/m^3 24-hr	
NO_2	100 mg/m^3 1-hr	respiratory diseases, and the development of asthma[4]
PAHs	0.1 mg/m^3 10-hr mean for B(a)P	cardiopulmonary disease and various cancers[1,2]

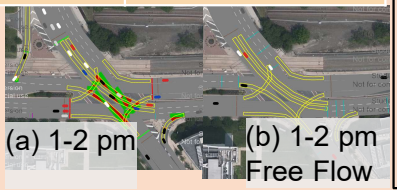


Figure 2. VISSIM simulation results

METHODS

Vissim model was created for the intersection of Haddon Ave & Dr. M. L. King Jr Blvd, Camden, NJ using the traffic count and classification data, lane geometry, and traffic signal timing. The model was used to predict traffic volumes for 1-2 pm, 2-3pm and Avg. Peak Hour during March and April.

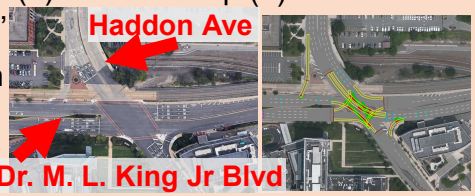
Case 1: Baseline volume was determined from NJDOT 48 Hour Traffic Count Data for Haddon Ave, Dr. M. L. King Jr Blvd, & N 7th St.

Case 2: Traffic controls were removed to simulate free flow conditions.

Case 3: Vehicle input was doubled for future conditions

Link length, volume, avg. speed, and source type fraction from Vissim was input into MOVES3 to find emissions.

(a) Satellite Map (b) Vissim Model



DISCUSSION

- $PM_{2.5}$ and PM_{10} slightly higher in April
- Generally increased emissions correlated to increase in link traffic volume

Case 1 to Case 2

- 18 to 24% decrease in $PM_{2.5}$ & PM_{10}
- 5% decrease in No_x for 1-2pm & 2-3pm
- 0.1% decrease in No_x for Peak hour

Case 1 to Case 3

- 31 to 59% increase in $PM_{2.5}$ & PM_{10}
- 33 to 59% increase in NO_x

Month	Case	$PM_{2.5}$ (g/hr)	PM_{10} (g/hr)	No_x (g/hr)
March 1-2 pm	1	0.852	0.948	36.582
	2	0.648	0.726	34.674
	3	1.350	1.512	58.308
April 1-2 pm	1	0.864	0.966	36.912
	2	0.660	0.738	34.968
	3	1.374	1.536	39.582
March 2-3 pm	1	0.706	0.882	34.656
	2	0.606	0.678	32.712
	3	1.176	1.314	53.094
April 2-3 pm	1	0.804	0.894	33.000
	2	0.618	0.690	31.29
	3	1.194	1.338	50.544
March Peak	1	0.954	1.068	41.598
	2	0.78	0.87	41.574
	3	1.254	1.404	55.404
April Peak	1	0.972	1.086	41.964
	2	0.792	0.888	41.922
	3	1.272	1.428	55.884

ONGOING STUDIES

- Complete the chemical analysis for PAH concentrations
- Find correlation between PM and PAH emission
- Simulate emissions model using AERMOD with Vissim data and compare emissions output to the MOVES3 output
- Apply the model to other intersections in NJ
- Use the model to help city planners reduce emissions at intersections

References: [1]Motorykin et al. 2013; [2]Kim et al. 2013; [3]California Air Resources Board; [4]EPA; [5]NIOSH