Reducing Pedestrian's Exposure to Traffic-Related Air Pollution through Route Choice Decision

2016 International Conference on Transport & Health

UCR | College of Engineering- Center for Environmental Research & Technology

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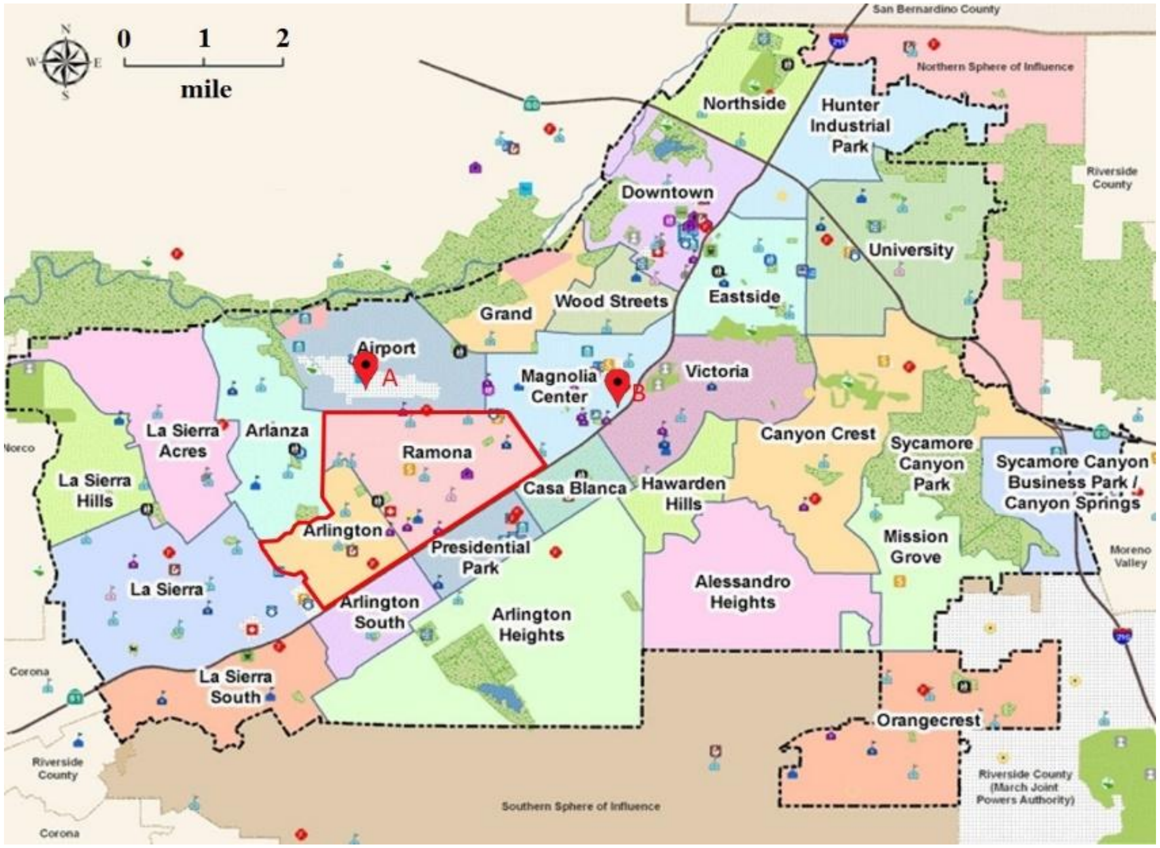
Outline

- Introduction
- Objective
- Method of PM2.5 modeling
- Sidewalk characterization and routing
- Routing results
- Discussion

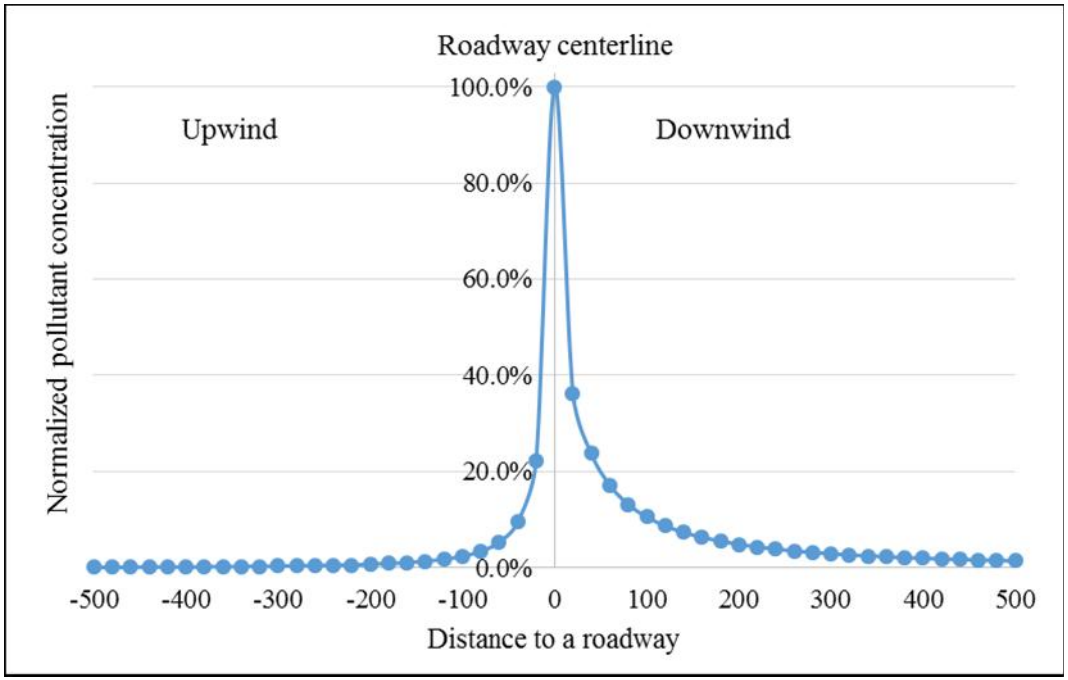
Introduction



Neighborhoods in the City of Riverside, California
Point A: weather station, Point B: air quality measurement station

- Riverside City
  Walkability Improvement Project
- Model mobile-source fine particle concentration within the neighborhoods
- Promote walking and reduce pedestrians' exposure to mobile-source pollutant

Peer research



An illustration of concentration upwind and downwind a roadway

Roadside measurements reveal that concentration of traffic emissions are elevated near roadways (Zhu *et al*., 2006; Hu *et al*. 2009, 2012)

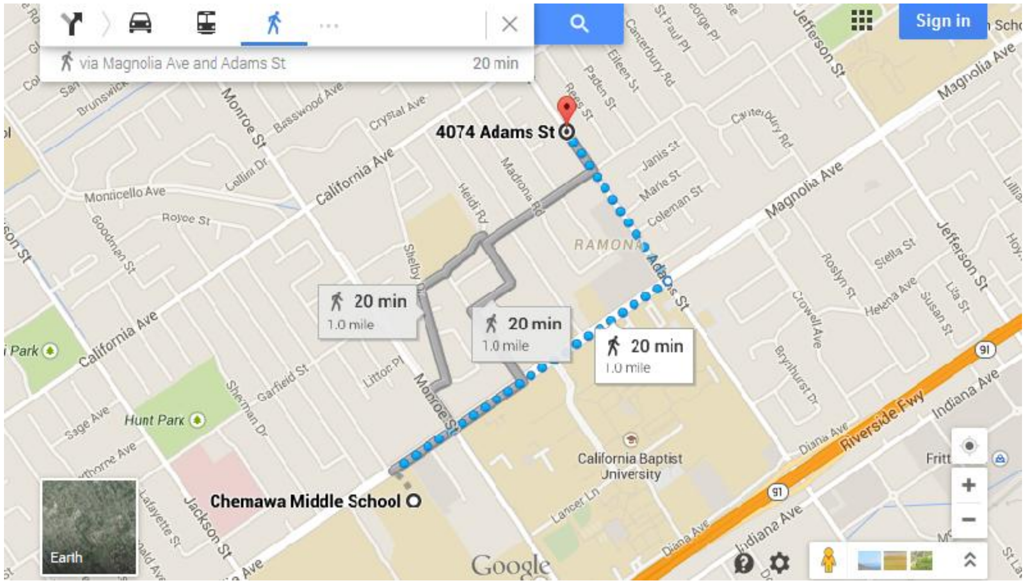
Pedestrians and cyclists face risks of higher exposure to traffic emissions. Exposure duration, breathing rate are both high. (O'Donoghue *et al*., 2007; Briggs *et al*. 2008; Morabia *et al*. 2009)

Neighborhoods in the City of Riverside, California

Objective

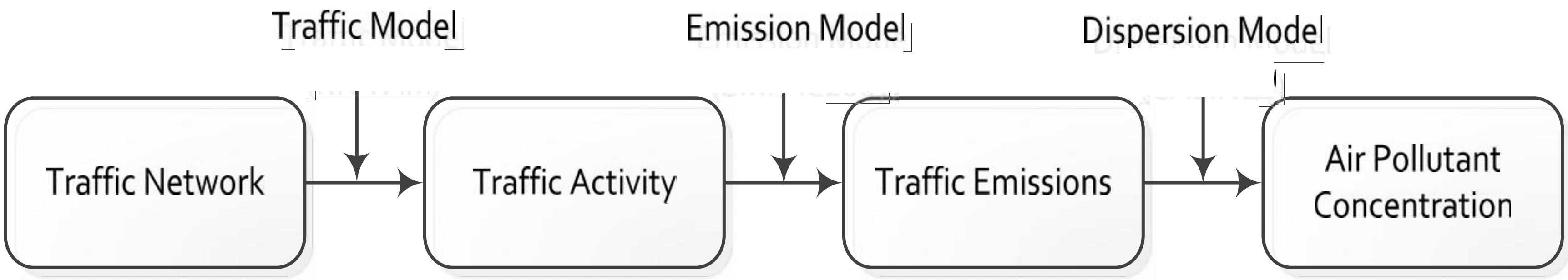
Apply a modeling method to calculate averaged mobile-source PM2.5 concentration distribution for morning and afternoon periods.

Using the PM2.5 map, can route choice decisions help reduce pedestrian's exposure to traffic-related air pollution?



Three walking route options for a home-to-school trip in Riverside

Method of PM2.5 modeling

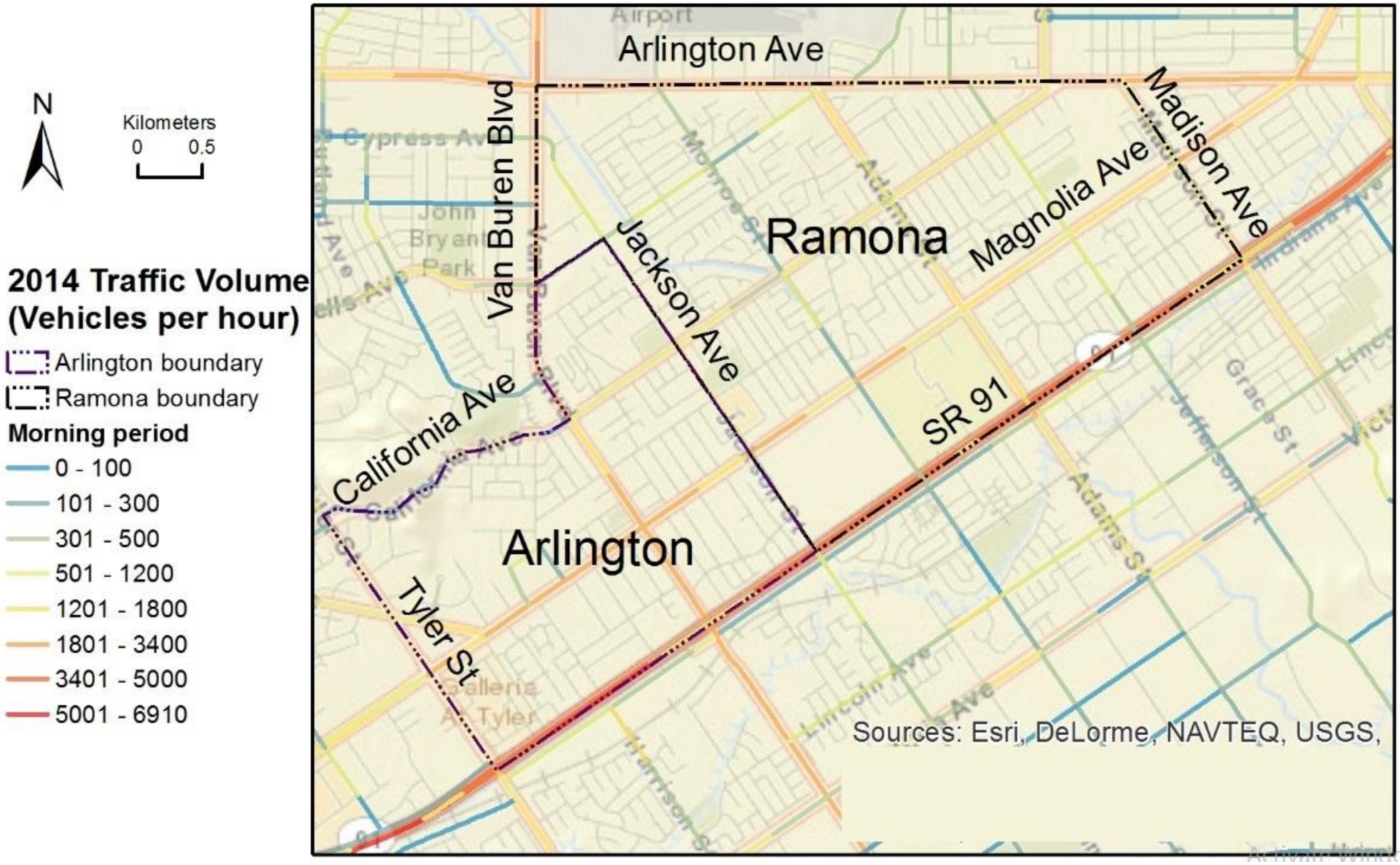


Riverside County Transportation Analysis Model

EMFAC2011

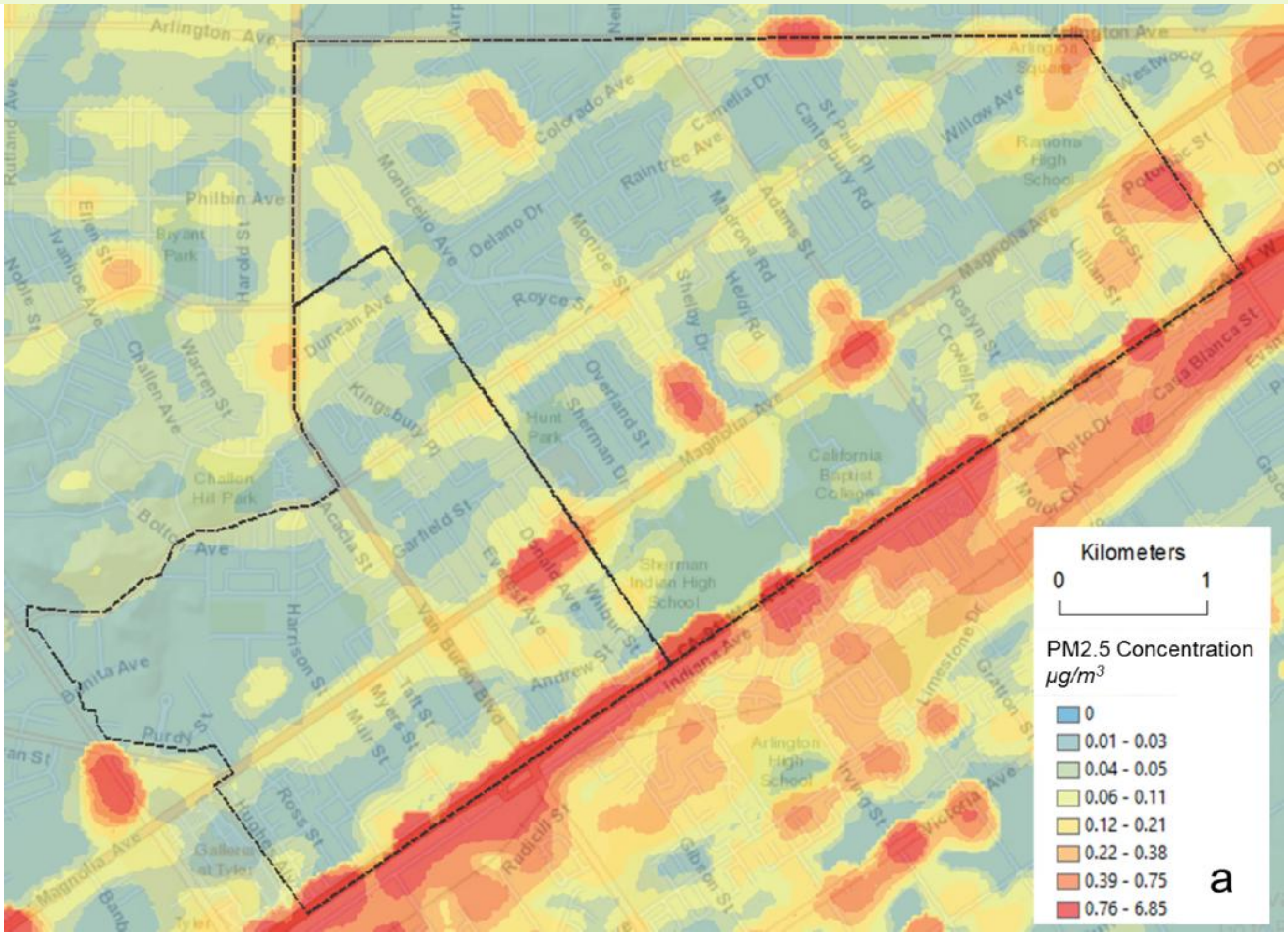
CALINE4

Map of traffic activity



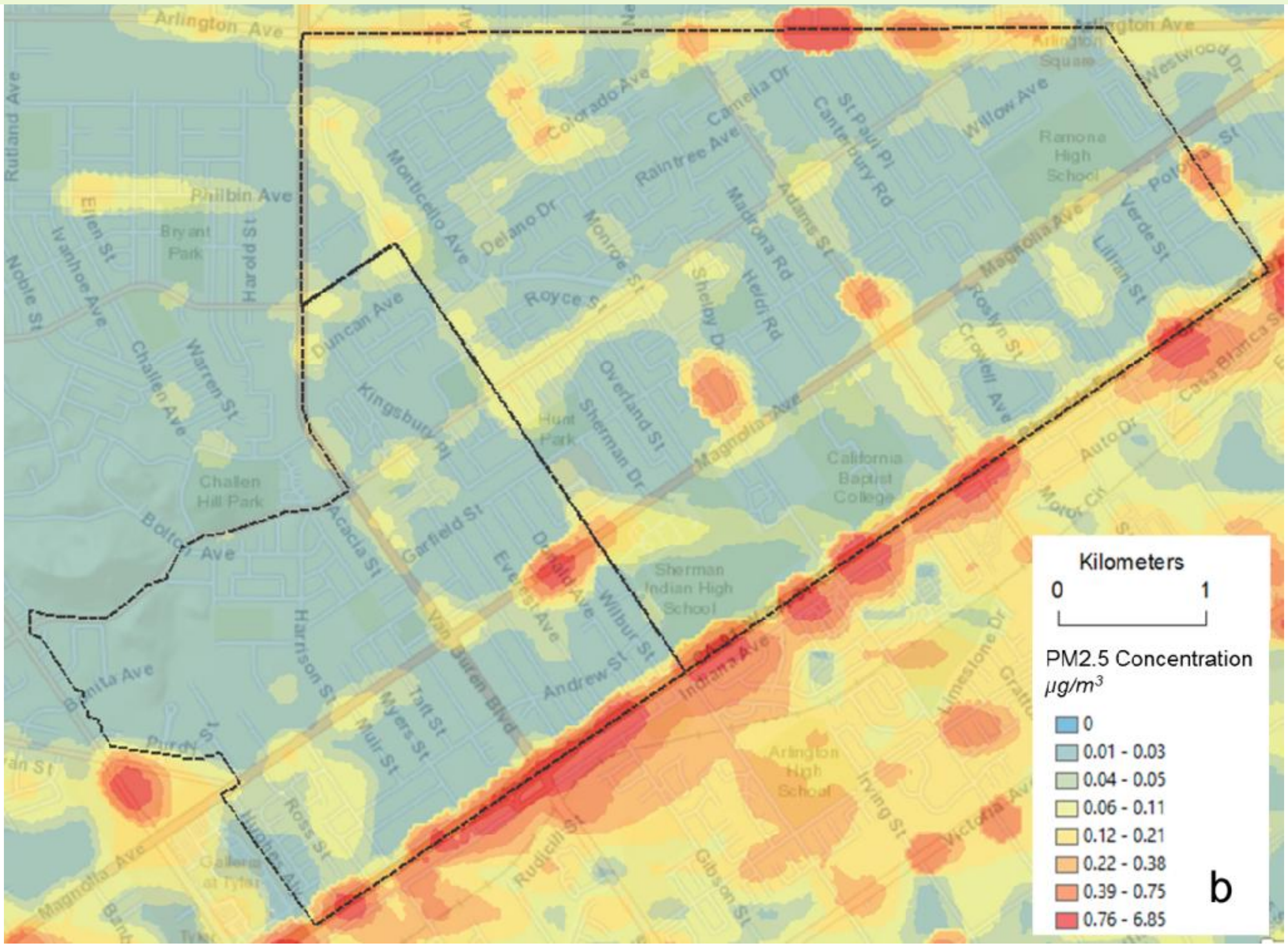
Total flow (vehicles per hour) for morning periods.

Map of PM2.5 concentration



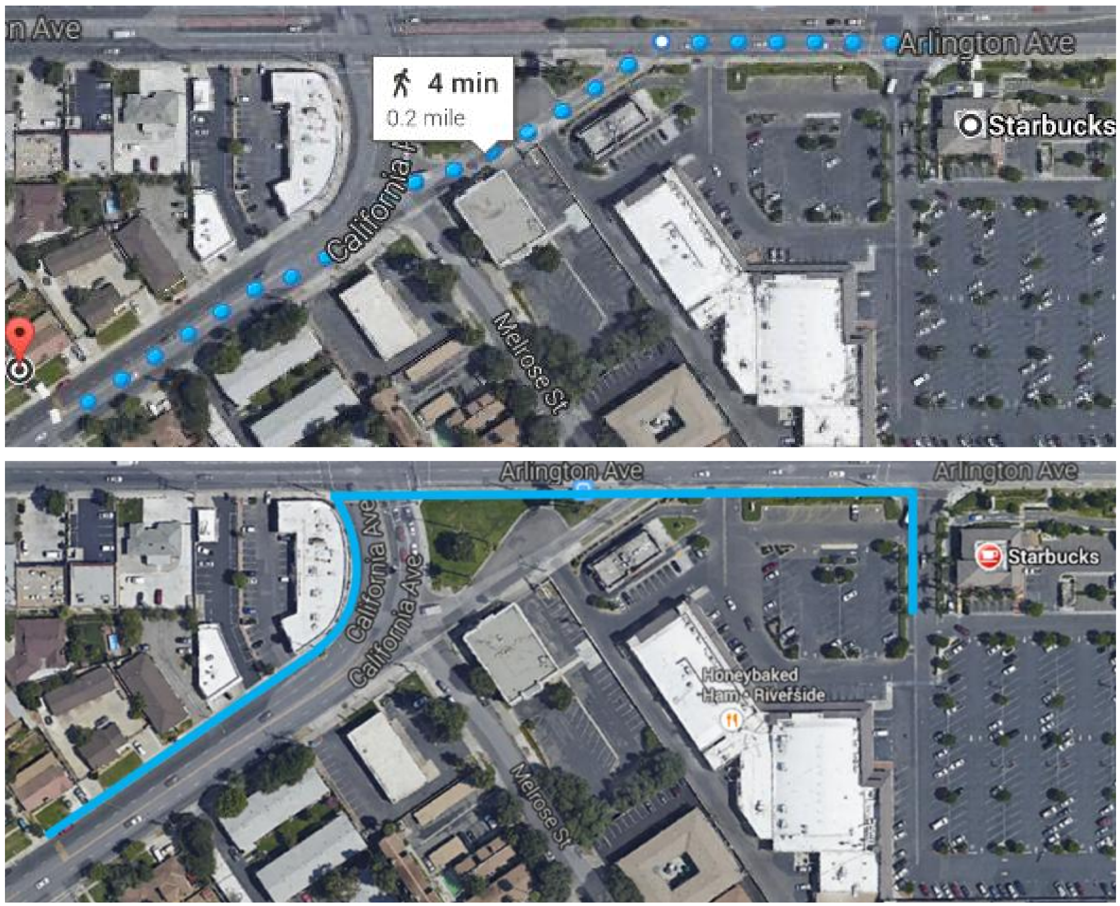
Mobile-source PM2.5 concentration in the morning

Map of PM2.5 concentration



Mobile-source PM2.5 concentration in the afternoon

Sidewalk characterization

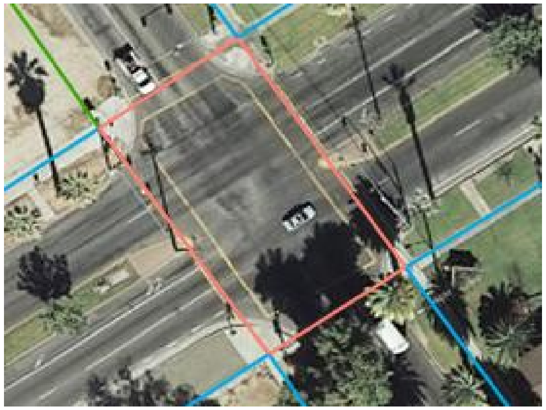


Contrast between roadway map (a) and sidewalk map (b) for pedestrian routing

Sidewalk characterization

a section of paved sidewalk (blue line)

a section of landscape/lawn sidewalk (green line)

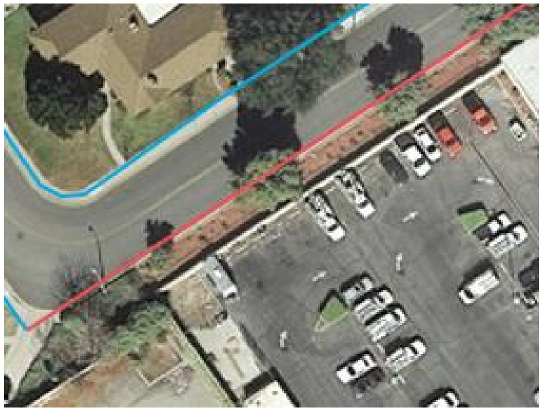


a crosswalk (coral line)

Digital sidewalk categories defined by the author

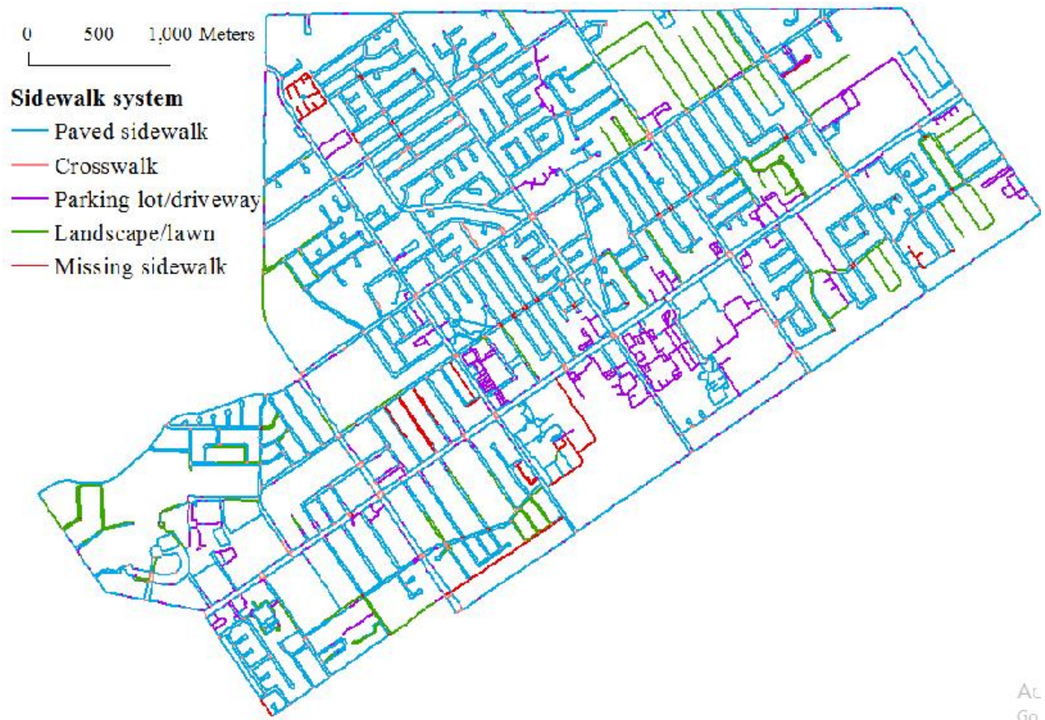
Sidewalk characterization

a section of driveway/parking-lot (purple line)



a missing sidewalk (red line)

Sidewalk characterization



More than 166 miles of sidewalk, 70% are paved sidewalk

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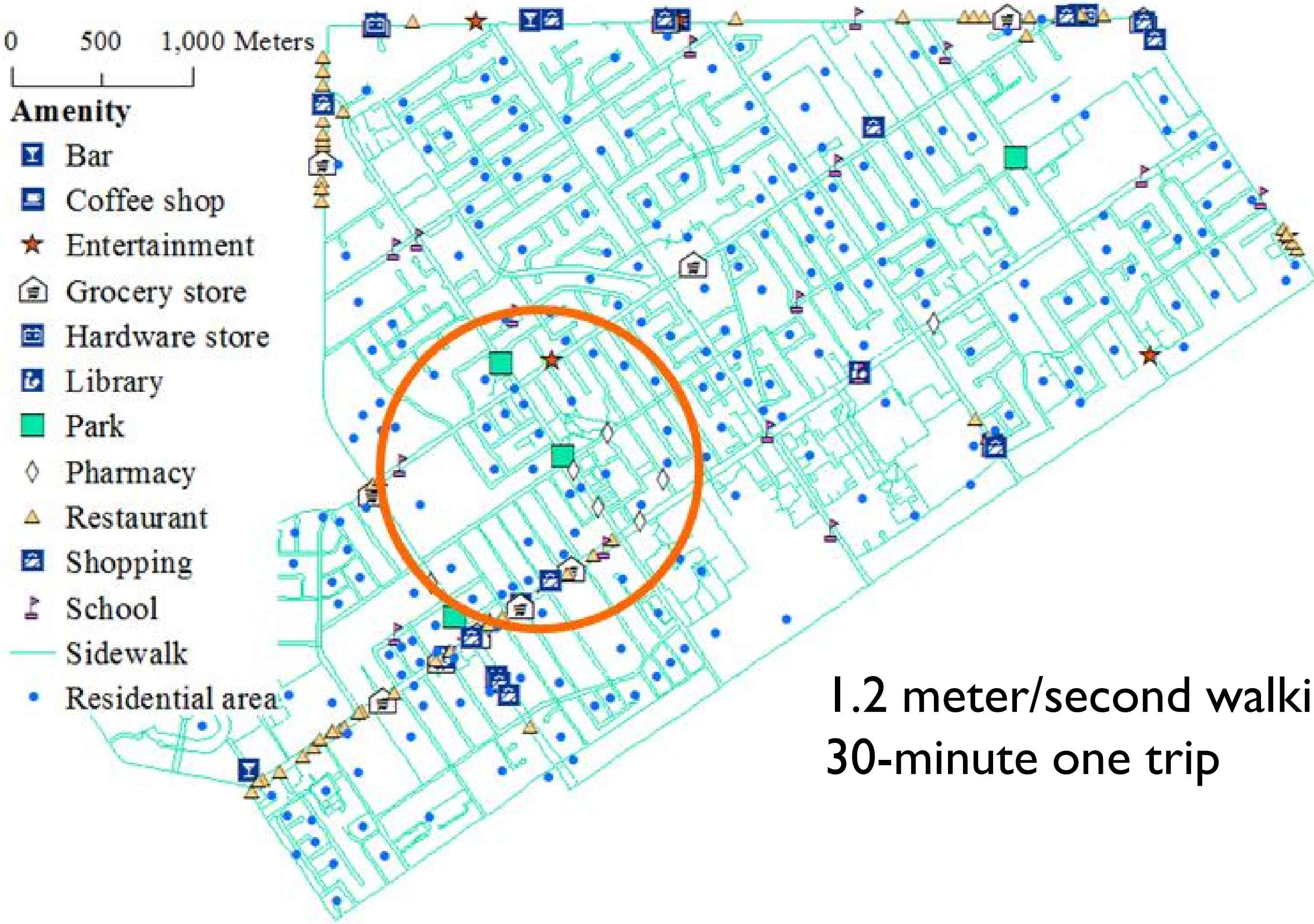
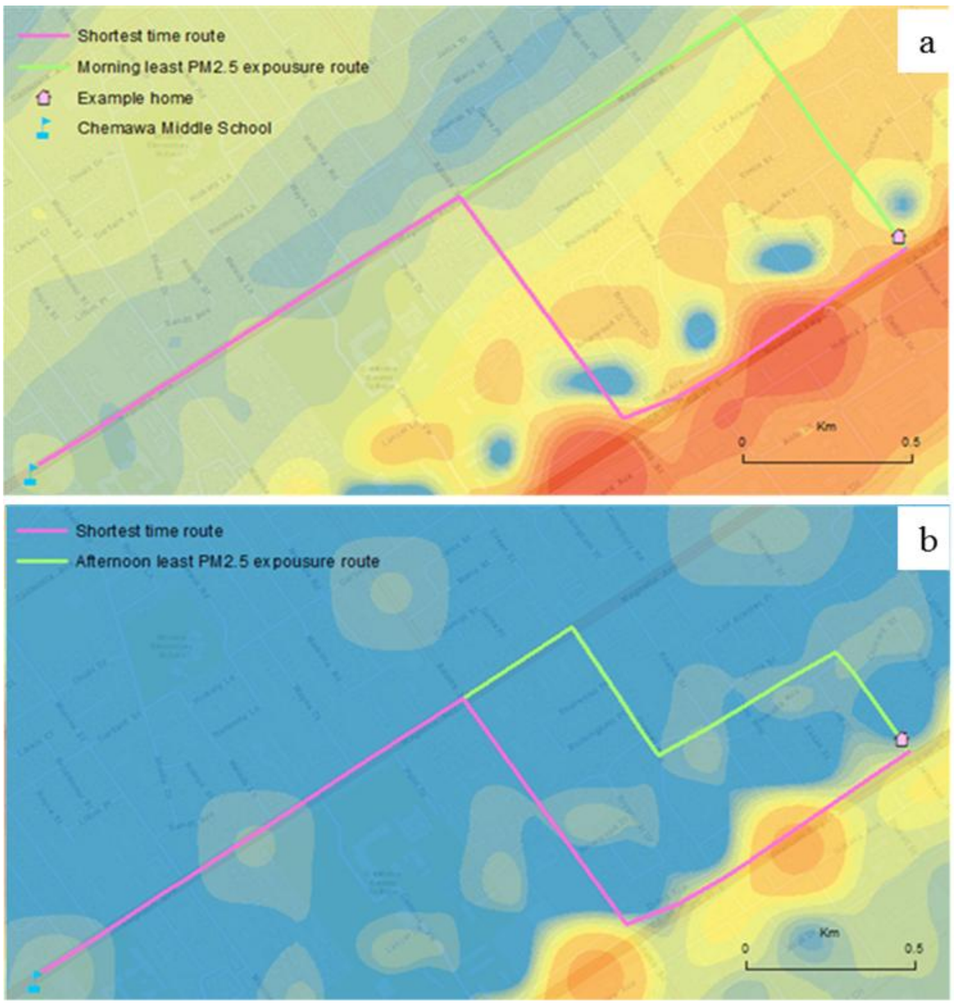
Routing experiments



1.2 meter/second walking speed,
30-minute one trip

Location of homes and amenities used in route choice evaluation

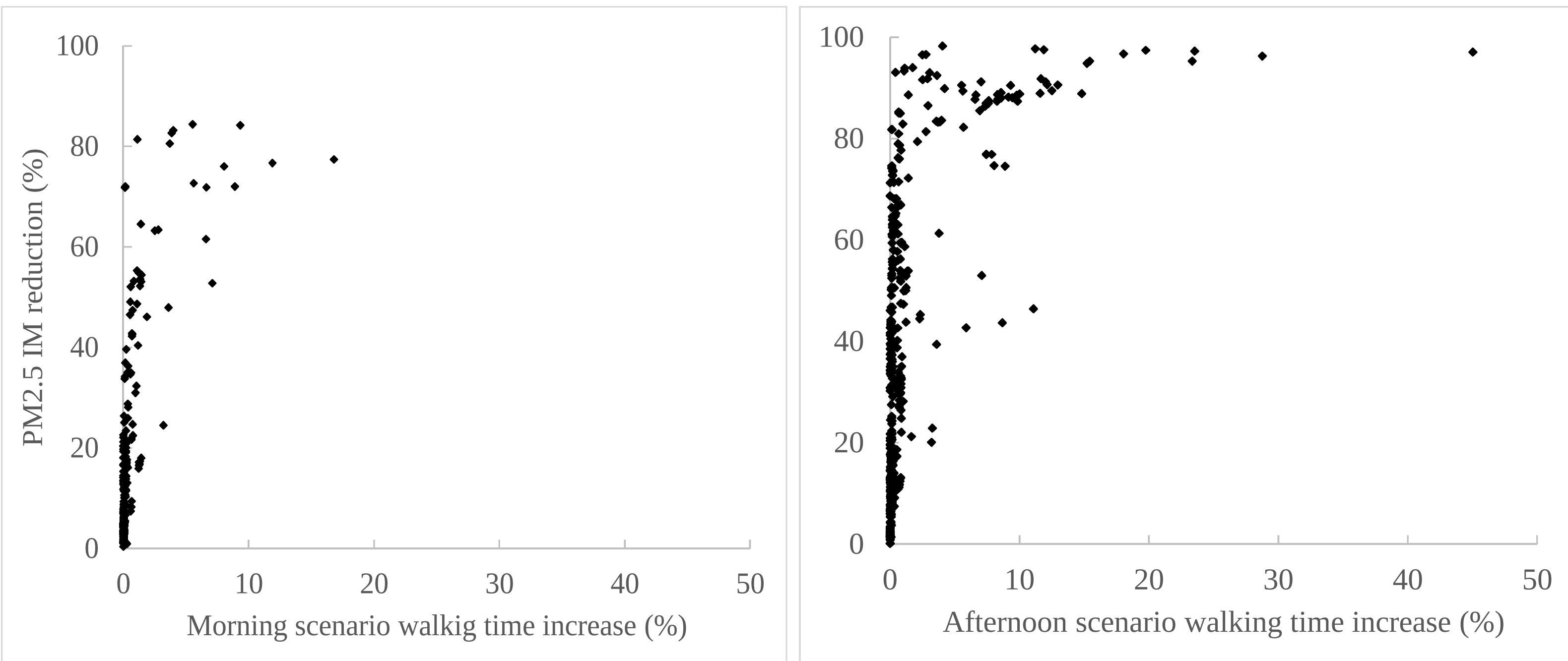
An example trip



Time Period	Morning	Afternoon
Walking time increase	1%	0.3%
PM2.5 Inhale Mass decrease	72%	92%

Statistics of routing results

Analysis Period	Trips under 30 minutes	Improved Trips		$PM_{2.5}$ Exposure Reduction (%)			Walking Duration Increase (%)		
		Trips	%	Max	Median	Mean	Max	Median	Mean
Morning	7223	367	5.1	84.4	5.2	13.8	16.8	0.04	0.5
Afternoon	7223	697	9.6	98.2	17.7	32.0	45.0	0.1	1.1



Reduction in $PM_{2.5}$ exposure versus increase in walking duration for improved trips

Conclusions and discussion

A low exposure route could be found for 5.1% of the walking trips in the morning, and 9.6% of the trips in the afternoon.

On average, the low exposure routes would reduce the pedestrian exposure to $PM_{2.5}$ during the morning period by 24% while increasing the walking duration by only 1%.

During the afternoon period, the low exposure routes would reduce the pedestrian exposure to $PM_{2.5}$ by an average of 32.0% while increasing the walking duration by 1.1% on average.

Digital sidewalk network improves the reliability of pedestrian routing.

Future improvements

Collect real-time meteorology and traffic activities, develop the real-time mobile-source pollutant modeling system.

Validate modeling results with instrumental measurements.

Automate sidewalk digitization process.

Apply the digital sidewalk system to support safe routes calculation for active travelers. For example, a route with more paved sidewalk sections.

Acknowledgments

California Department of Transportation

County of Riverside

Riverside Transit Agency