# Verification Relationship between Vehicle Data and Air Pollution Index Using Muti-linear Regression Modeling

**SimEnvi**

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## Abstract

- **Introduction**
  - Previous studies pointed out that vehicle emission is related to adverse health effects.
  - Relationship between vehicle data (e.g. vehicle speed ) and air quality data was little examined in previous studies.

- **Objectives**
  - Investigation of relationship between highway vehicle emission and air quality data from AQMS (Air Quality Monitoring Site) near the highway

- **Method**
  - **Datasets**
    - A total of 3110 vehicle detectors (VD) datasets on Taiwan Nation Freeway (each data was recorded by 5 mins).
    - One-year air monitoring data from 10 AQMSs near within 1 km from highway.
  - **Multi-linear regression models (MLR)**

- **Results and Discussion**
  - Air quality was correlated significantly with vehicle counts (p<0.05).
  - Vehicle speed with 50-60 km/hr was estimated with lowest compact on air quality.

## Methods

- **Studying site**: 10 AQMSs near within 1 km from highway. **(Fig 1.)**

- **Studying period**: 8760 hourly-data in 2012

- **Muti-linear Regression Model**

$$Y = \beta_0 + \beta_1 X_1 + \ldots + \beta_n X_n + \varepsilon$$

- Data with down-wind of highway was selected
- **Variables**
  - Y : Concentration of Pollutants (NOx, $SO_2$, $PM_{10}$, $PM_{2.5}$)
  - X :
    - (1) Site data: sampling height (m), distance from highway (m)
    - (2) Environmental factors: RH(%), Wind Speed (m/s), Temperature (°C)
    - (3) Vehicle counts of highway
- **Model Performance (R-square)**
  - $NO_2$: 28.6% , NO: 17.8%, $SO_2$: 9.8%, $PM_{10}$: 25.4%, $PM_{2.5}$: 25.4%

- **Emission Factor Estimation** [1]

$$EF = \frac{\beta_{VC} \times WS \times A}{RL} \times C$$

  - $\beta_{vc}$: Increased conccentration contributed by each vehcile (μg/$m^3$/hr)
  - **WS**: wind speed (m/s)
  - **A**: cross-section area of the highway within 1 km from site ($m^2$)
  - **RL**: total length of the highway within 1 km from site (km)
  - **C**: unit conversion factor

## Results and Discussion

- **Monthly Trend (Fig 2.)**
  - Consistent of vehicle counts and pollutants was observed in most site
  - Due to seasonal meteorological factor (e.g. mixing height, transported pollutants from China), lower pollutant concentration was monitored in summer.

- **Emission Factor Compared with TEDS (MT2 & AP-42) (Fig 3.)**
  - Averaged vehicle speed of 50-60 km/hr was founded with lower impact compared with lower (<50 km/hr) or higher speed (>60 km/hr).
  - Compared with TEDS (Taiwan Emission Data System), difference of emission factor may be due to assumption of gasoline S% content or deterioration of vehicle efficiency.
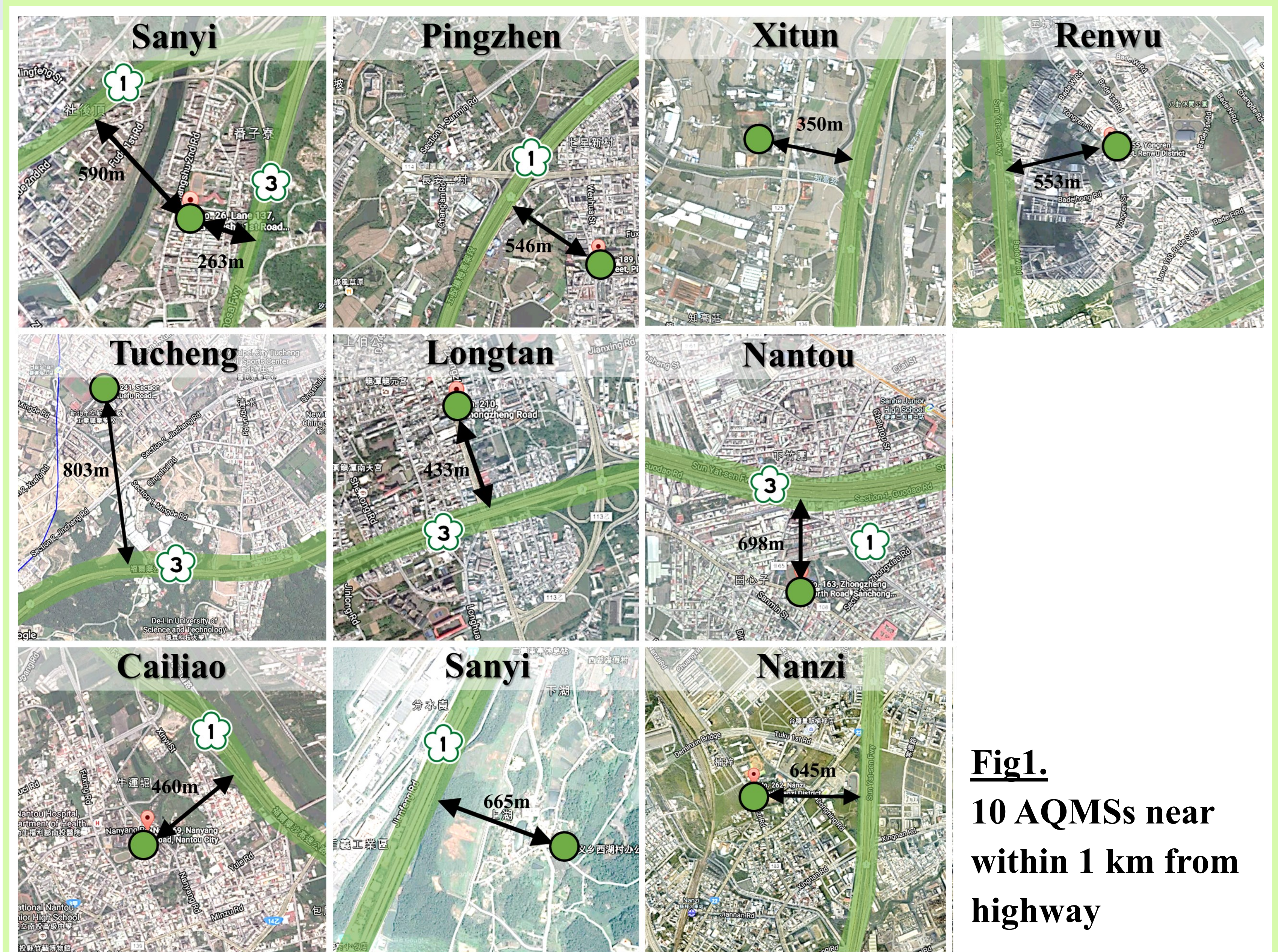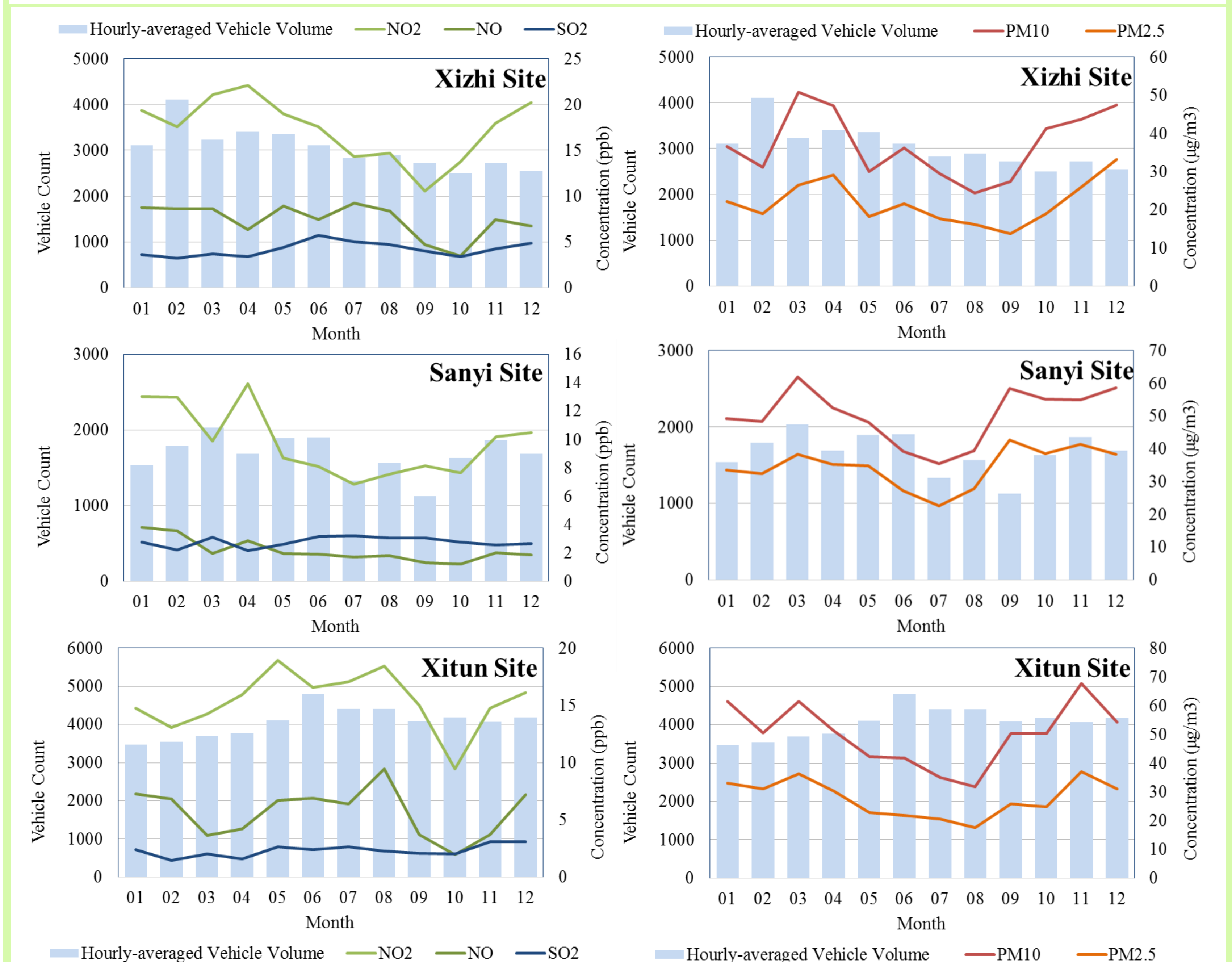


**Fig1. 10 AQMSs near within 1 km from highway**



**Fig2. Hourly-averaged Vehicle Count vs. Pollutant Concentration**
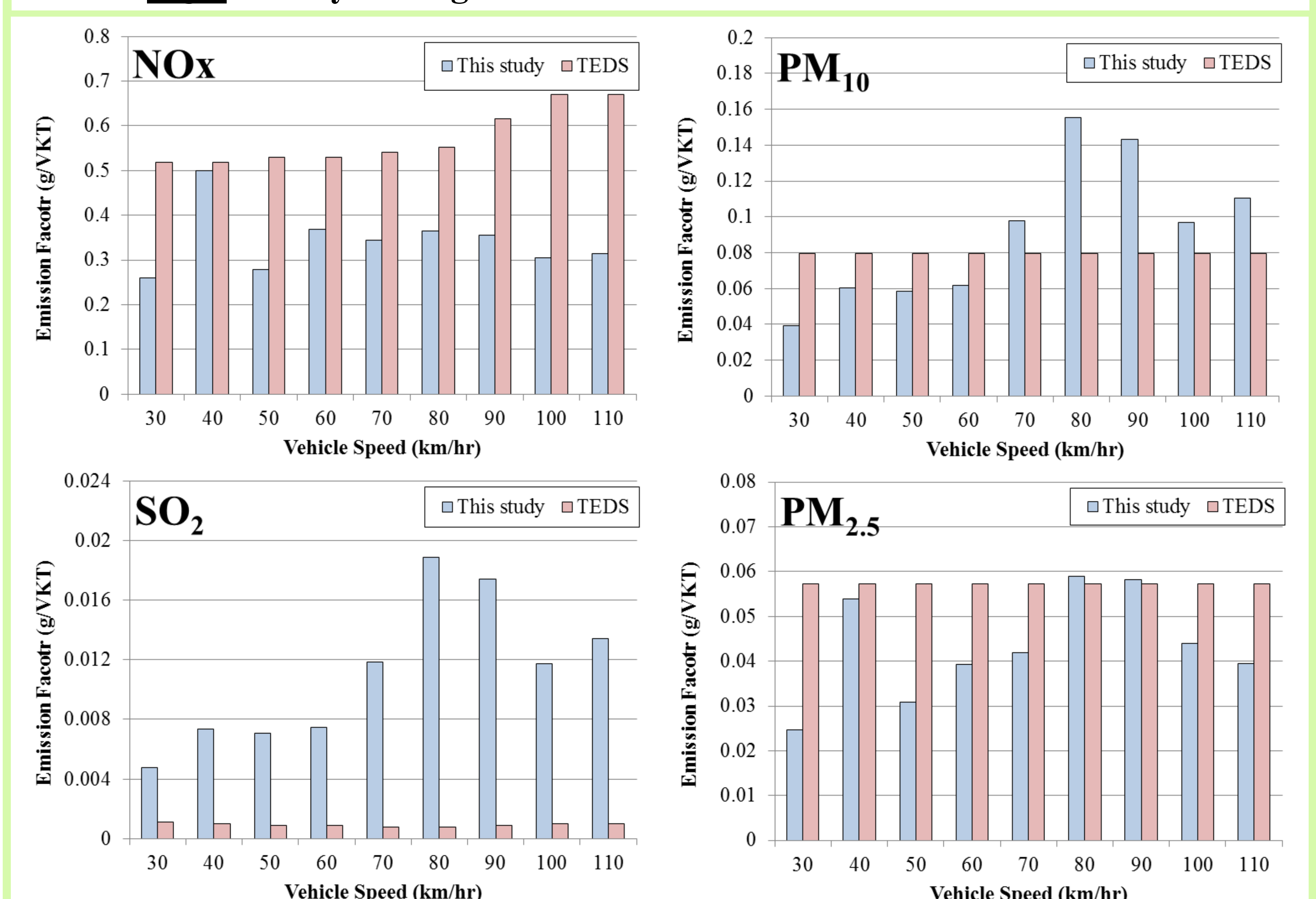


**Fig3. Estimated Emission Factor of Vehicle compared with TEDS**

[1] Chiang, H.-L., Hwu, C.-S., Chen, S.-Y., Wu, M.-C., Ma, S.-Y., and Huang, Y. S.: Emission factors and characteristics of criteria pollutants and volatile organic compounds VOCs) in a freeway tunnel study, Sci. Total Environ., 381, 200–211, 2007.