The pollution concentration spatial distribution along highway during rush hours

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Abstract

With the development of tourism grown rapidly in Ilan County, traffic pollution is increasingly serious. The vehicle exhaust emission has become one of the major sources of air pollution in the suburban area. Because of the deteriorating air quality, the impact of people's health exposure to the air pollutants has becoming a primary topic of concerns. The main purpose of this study is to estimate spatial distribution of the traffic volume and the traffic emissions in Ilan City in Taiwan. The concentration of mobile sources traffic-related air pollutant exposure is simulated with using CALINE4. It is also very important to investigate the differences of air quality between rush hours and normal traffic condition.

The emission rate in the databank of Taiwan EPA TEDS8.1 shows that NO_X (nitrogen oxides), CO (carbon monoxide) and NMHC (non-methane hydrocarbons) are the major pollutants, which accounted for 43%, 80% and 19% of mobile source emissions, respectively, during normal traffic condition. Therefore, it is necessary to analyze the air pollutants contribution from mobile source during rush hours since the air quality become worst in the period. The effects of traffic volume on air quality are also required to be investigated. The influential ranges of each air pollutant, where the air quality beyond standard, are also assessed.

Methods

The air pollutant concentration along high way during rush hours and normal traffic periods was predicted with Caline4. The nearest ambient monitoring station data, including CO, NOx, NMHC, $PM_{2.5}$, PM_{10} concentrations and weather information, were used for comparing the measured and predicted results and revising the parameters in Caline4. The spatial concentration was also estimated at high and low population density area. Different emission control strategies, such as adopting low emission vehicles, limiting the traffic volume, admitting the high passengers pass, were also assessed to improve air quality. According to the different kinds of road and air pollutant emission rate, the parameters of the model and meteorological conditions are necessary to be set to assess the incremental impact of the pollutant concentration from transport simulation with Caline4.

Results

The estimated air quality depended on temporal and spatial variations. The results were incorporated into exposure assessment for comparing the data in ambient monitoring station and understanding the exposure of each air pollutants. The distribution of pollutant emission rate was affected by street density, road type and traffic composition. In addition, traffic volume and pollutant emissions rate become higher during rush hours. The air quality becomes worst along highway centerline, as shown in Table1 and Figure 1. The air quality is below standard during normal traffic periods. In contrast, the air quality is beyond standard during rush hours periods.

Table 1. The predicted air quality along the highway

Species Distance(m)	TSP (μg/m^3)	PM_{10} (μg/m^3)	$PM_{2.5}$ (μg/m^3)	SO_2 (ppb)	NO_2 (ppb)	CO (ppm)
-50	0.54	0.42	0.35	<0.1	0.32	0.0044
-40	0.62	0.48	0.40	<0.1	0.36	0.0051
-30	0.73	0.57	0.48	<0.1	0.43	0.0060
-20	0.91	0.71	0.60	<0.1	0.54	0.0075
-10	1.29	1.01	0.85	<0.1	0.78	0.0104
0(West)	2.33	1.84	1.57	<0.1	1.48	0.0177
0(East)	2.18	1.73	1.47	<0.1	1.39	0.0164
10	1.12	0.87	0.74	<0.1	0.68	0.0089
20	0.81	0.63	0.53	<0.1	0.48	0.0065
30	0.65	0.51	0.43	<0.1	0.38	0.0053
40	0.56	0.44	0.37	<0.1	0.33	0.0045
50	0.49	0.38	0.32	<0.1	0.29	0.0040
Background	—	—	—	1.7	3.9	0.53
Standard	—	—	—	250	250	35

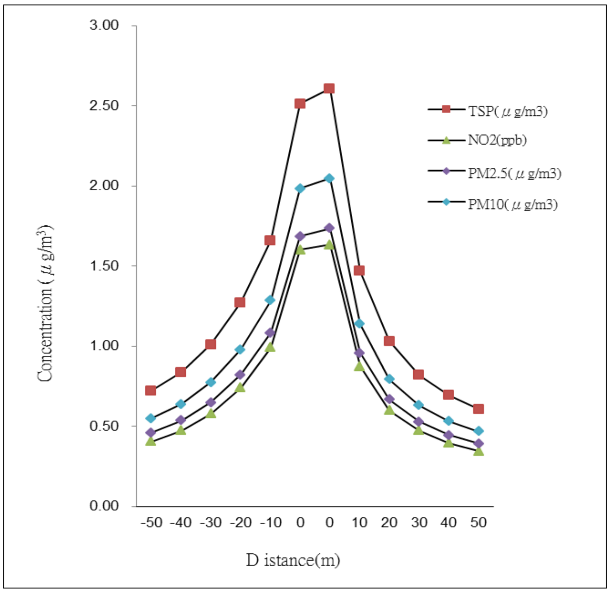

Figure 1. The predicted results of hourly air pollutant concentration simulation

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