# Effectiveness of Various Control Measures on Ambient $PM_{2.5}$ Concentration in Taiwan

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Fine particulate matter ($PM_{2.5}$) issue has being concerned around the world and is the hot topic in Taiwan. Taiwan Environmental Protection Administer (TEPA) adapted the ambient air quality standard and developed a preliminary control plan to improve the ambient concentration by reducing the emissions of primary and secondary $PM_{2.5}$. This study investigates the improvement of ambient $PM_{2.5}$ concentration by various control measures in this plan.

Emissions of primary $PM_{2.5}$, SOx, and NOx under various scenarios were estimated according to the contents of control measures. Three scenarios have been evaluated in this study, which include basic case and two controlled cases. Basic case scenario represents business as usual. Case A is the scenario of the adapted plan which designed to adapt more stringent emission standards for stationary sources and on-road mobile sources, eliminate the high-polluting aged vehicles, and promote the electric vehicles. Case B scenario assumed to conduct more control measures beyond the case A, including eliminate the 2-stroke motorcycles, promotion of hybrid vehicles, promotion of electric buses, and encouraged to use natural gas in power plants. Community Multi-scale Air Quality modelling system (CMAQ) v4.6 along with the fifth-generation Pennsylvania State University - National Center for Atmospheric Research Mesoscale Model (MM5) ver. 3.7 were used this study to simulate the ambient concentration of PM2.5 in Taiwan. The grid resolutions in the modelling work are 81 km × 81 km for domain 1 (covers East Asia), 27 km × 27 km for domain 2 (covers Southeast China and Taiwan), and 9 km × 9 km for domain 3 (covers Taiwan). Total number of grid cells is 70 × 80.

Emission estimation shows a clear tendency of decreasing primary $PM_{2.5}$, NOx, and SOx emissions from case A and case B. Table 1 shows the emissions of air pollutants in different scenarios. The emission reductions would be 13,870 tons/year ($PM_{2.5}$), 17,900 tons/year (SOx), and 158,220 tons/year (NOx) in case A. The vales would be 18,760 ton/year ($PM_{2.5}$), 59,500 tons/year (SOx), and 200,210 tons/year (NOx) for case B.

The results of $PM_{2.5}$ concentration simulation for three cases are shown in Figure 1. Annual average concentration of basic case is 14.2 μg/m$^3$ in northern Taiwan, 28.4 μg/m$^3$ in central Taiwan, and 29.9 μg/m$^3$ in southern Taiwan. The annual average concentration of $PM_{2.5}$ would be reduced by 13.6-23.1 % and 19.5-32.9 %, respectively, for cases A and B. The composition of airborne $PM_{2.5}$ is also shown in Figure 1. For the base case, the concentrations of $NO_3^-$ are 1.22 / 4.64 / 5.58 μg/m$^3$ in northern, central, and southern Taiwan, respectively. The values are 0.91 / 2.99 / 3.77 μg/m$^3$ for case A, and 0.80 / 2.49 / 3.13 μg/m$^3$ for case B. Both control scenarios show a clear improvement on airborne nitrate concentration. It is implied that control NOx emissions may result in significant improvement on airborne $PM_{2.5}$ concentration in Taiwan. However the result also indicates that the preliminary control plan could not attain the air quality standard. More control measures to reduce much more emissions from various emission sources should be developed in the future.

Table1 Emission scenarios of $PM_{2.5}$, NOx, and SOx in this study.

| Scenarios | Emissions (tons/year) | | |
|---|---|---|---|
| | PM2.5 | SOx | NOx |
| Base Year (2014) | 73,540 | 121,280 | 404,480 |
| Case A (2020) | 59,670 | 103,380 | 246,260 |
| Case B (2020) | 54,780 | 61,780 | 204,270 |

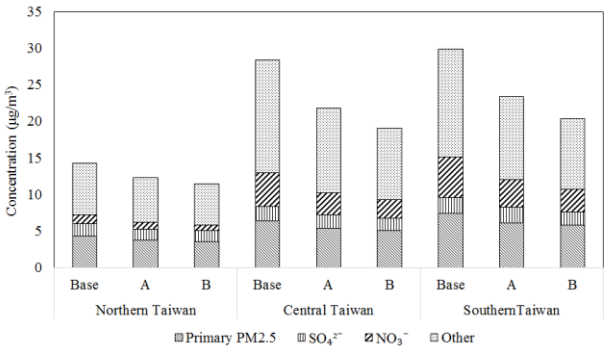


Figure1 Simulated concentrations of $PM_{2.5}$ in different regions in Taiwan under various control scenarios.

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