

Long-Term Visibility Trends in one Highly Urbanized, one Highly
Industrialized, and two Rural Areas of Taiwan

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Abstract

Visibility trends on the island of Taiwan were investigated employing visibility and meteorological (1961 - 2003), and air pollutant (1994 - 2003) data from one highly urbanized center (Taipei), one highly industrialized center (Kaohsiung), and two rural centers (Hualien and Taitung). Average annual visibility (1961 - 2003) was significantly higher at the rural centers. Unlike at the other centers, visibility in Taipei improved between 1992 (6.6 km) and 2003 (9.9 km), and this can be linked to the construction and expansion of a mass transit rail system in Taipei, the use of which has helped reduce emissions of traffic related air pollutants, particles, and NO₂. This has left Kaohsiung with the lowest annual visibility since 1994, despite its 1961 - 2003 average being superior to that of Taipei. Precipitation lowers visibility, as demonstrated by the all-centers correlation coefficient for visibility and precipitation of 0.92. Hence, frequency of precipitation is one of the factors contributing to the average annual visibility number. The poorest air quality category ('episode'), most commonly experienced in Taipei and Kaohsiung, was characterized by relatively high concentrations of PM₁₀ and NO_x at those centers, with comparatively high atmospheric pressure and comparatively low visibility and wind speed. Excepting O₃, pollutant concentrations were slightly higher during weekdays, although there was no consistent, significant difference in weekday - weekend visibility. Principal component analysis demonstrated that visibility was markedly reduced in Taipei, Kaohsiung, and Hualien by increased vehicular emissions, road traffic dust, and industrial activity, but not in Taitung, where visibility was as a result superior to that at the other centers and degradation in visibility was likely a response to long-range transport of pollutants rather than local sources. Optimal empirical regression models

indicated a negative impact on visibility for each of PM10, SO₂ and NO₂, particularly so for PM10, and validity of these models for Taipei, Kaohsiung, and Hualien was confirmed by correlation coefficients of simulated and observed average visibility of 0.63 – 0.72 for daily visibility and 0.85 – 0.88 for monthly visibility. For Taitung these figures were only 0.46 and 0.50, respectively, indicating that simulations for Taitung should include long-range transport as a pollutant source. © 2007 Elsevier B.V. All rights reserved.

Keyword : Visibility deterioration; Air quality; Weekend effect; Principal component analysis; Empirical model