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Distributional and Developmental Analysis of PM2.5 in Beijing, China

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Abstract : PM2.5 poses a large threat to people's health and the environment and is an issue of large concern in Beijing, brought to the attention of the government by the media. In addition, both the United States Embassy in Beijing and the government of China have increased monitoring of PM2.5 in recent years, and have made real-time data available to the public. This report utilizes hourly historical data (2008-2016) from the U.S. Embassy in Beijing for the first time. The first objective was to attempt to fit probability distributions to the data to better predict a number of days exceeding the standard, and the second was to uncover any yearly, seasonal, monthly, daily, and hourly patterns and trends that may arise to better understand of air control policy. In these data, 66,650 hours and 2687 days provided valid data. Lognormal, gamma, and Weibull distributions were fit to the data through an estimation of parameters. The Chi-squared test was employed to compare the actual data with the fitted distributions. The data were used to uncover trends, patterns, and improvements in PM2.5 concentration over the period of time with valid data in addition to specific periods of time that received large amounts of media attention, analyzed to gain a better understanding of causes of air pollution. The data show a clear indication that Beijing's air quality is unhealthy, with an average of 94.07µg/m3 across all 66,650 hours with valid data. It was found that no distribution fit the entire dataset of all 2687 days well, but each of the three above distribution types was optimal in at least one of the yearly data sets, with the lognormal distribution found to fit recent years better. An improvement in air quality beginning in 2014 was discovered, with the first five months of 2016 reporting an average PM2.5 concentration that is 23.8% lower than the average of the same period in all years, perhaps the result of various new pollution-control policies. It was also found that the winter and fall months contained more days in both good and extremely polluted categories, leading to a higher average but a comparable median in these months. Additionally, the evening hours, especially in the winter, reported much higher PM2.5 concentrations than the afternoon hours, possibly due to the prohibition of trucks in the city in the daytime and the increased use of coal for heating in the colder months when residents are home in the evening. Lastly, through analysis of special intervals that attracted media attention for either unnaturally good or bad air quality, the government's temporary pollution control measures, such as more intensive road-space rationing and factory closures, are shown to be effective. In summary, air quality in Beijing is improving steadily and do follow standard probability distributions to an extent, but still needs improvement. Analysis will be updated when new data become available.

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