CHAPTER 6

SUMMARY AND CONCLUSION

Atmosphere is a thin blanket of life giving air around the earth. Air, in other words, means life. But human activity is making it difficult for the living beings to survive in it. We have started polluting atmosphere by injecting harmful gases into it. Pollution is a relative concept. The problem of air pollution came into focus only when air pollution disasters took place during the present century. The main anthropogenic sources of air pollution are industrial processes, combustion of fossil fuels and motor vehicles. Geographically the pollutants have three types of impact: impact at the point of origin, impact along a line when pollution spreads in a linear fashion and the regional impact when pollution spreads over space. There have been thousands of pollutants in the atmosphere, but only SO_2, NO_x and SPM are considered the best indicators of the overall level of ambient air pollution and thus are dealt with in the present study which pertains to a spatio temporal analysis of ambient air quality in Indian cities from 1988 to 1994. The air in most Indian cities is becoming heavily polluted and in this study an attempt is made to present a spatio-temporal analysis of air pollution in selected Indian cities.

The sources of air pollution are automobiles, industries and combustion of fossil fuels for different purposes. These are mostly point sources but the air pollution generated by them spreads both in a linear and regional fashion. Air pollutants are transported by wind. Some pollutants react with atmospheric gases and produce secondary pollutants which might be more harmful. Both the primary and secondary air pollutants can lead to meteorological changes like global warming and could also lead to health-related problems among humans and other living things. It is only the lowest about 30 km of the atmosphere that holds the major portion of these pollutants. Temperature inversion plays an important role in keeping the air pollutants near the earth's surface.

The present analysis has been done in three parts- (1) A Temporal analysis in which data on SO_2, NO_x and SPM levels of 72 recording stations located in 28 Indian

cities have been analysed in terms of identification of trends over time; (2) A Spatio-temporal analysis in which the data are analysed using maps of the country showing annual averages, six-monthly averages, and three-monthly or seasonal averages; and (3) A Comparison with standards set by the Central Pollution Control Board of India. This comparison is done by using a well known statistical technique. Temporal trends of SO_2 and NO_x values at residential locations show overall positive trends. SPM values show decreasing trend at most of these locations. The main sources of pollutants at these locations are use of pesticides, cement plants in the vicinity, stone quarrying, general engineering works and, the most important, the vehicular traffic. The values of NO_x show steep increase at some places. The reason for higher values of NO_x is the fact that the number of small industries has increased considerably over the last few years. Analysis of SPM values shows that there has been a negative trend overall in the period of analysis. The regression analysis shows that at certain locations the values of SPM have been increasing sharply. The reason for lower values of SPM may be attributed to the fact that heavier particles settle down on surface and smaller ones remain suspended in air near the surface of the earth. When recording stations are at locations far above the earth's surface, they are not able to catch the appropriate air samples.

At industrial locations all the three pollutants show an increasing trend in their concentration. The slopes of the regression line for SO_2 and NO_x are appreciably positive in most cases. The main sources of air pollutants at these locations are the industrial and automobile activities which have increased manifold over the present century and the period of present analysis is no exception.

The analysis of the data at three sensitive locations shows that the SO_2 level is increasing at Taj Mahal only and NO_x data show a negative trend and SPM data show a positive trend at Borkhera and Taj Mahal. The main reason for higher concentration of SO_2 at Taj Mahal is the presence of Mathura refinery and other small industries located in the areas.

The Spatio-temporal analysis of yearly averages shows that the levels of SO_2 show higher values along east-west ridge, the higher values being reported at Howrah and Ahmedabad and along the western axis extending from Kota to Pune through Surat. The gradient is towards the north and the south, the former being gentler. The south has had low levels of SO_2 concentration throughout the period of analysis.

The spatio-temporal analysis of oxides of nitrogen reveals that at first there has been a general decrease in the values from north to south but in the later period of analysis the trend changes to a meridional trend in which gradient is from east to west and north to south. The values of NO_x have increased two-folds in the later half of the period.

The spatio-temporal analysis of the values at SPM show that the northern part shows higher values and the south shows lower values with the exception of 1994 when north-west and south show higher values. The maps showing the distribution of six monthly averages of SO_2, NO_x and SPM show that the northern half of the study area consistently has higher concentration of pollutants than the southern half of the area. The prominent peaks were in the west and east. The northern part of the study area has higher pollutant concentrations than the southern half and there is decreasing trend towards the southern part. Almost similar trends are also found in the distribution of three monthly averages. It is revealed by this analysis that during the Autumn and Winter seasons the values of the pollutants are higher than during the spring and rainy/summer seasons. This could be due to greater propensity of the development of meteorological conditions suitable for temperature inversion in autumn and winter seasons. On the other hand during spring and rainy/summer season both blow out and wash out effects are prominent.

Delhi, the national capital of India is considered to be one of the most polluted cities of the world. The analysis of pollutant values reveals that higher values are at Sahazada Bagh, Shahdara and Nizamuddin during the period of analysis. Overall it seems the hub of Delhi's air pollution is at Sahazada Bagh.

The analysis of comparison of recorded air pollution values with standards of Central Pollution Control Board of India identifies Jharia, Dehradun and Agra as problem cities. The values of SPM in these cities are above the prescribed limit for all the years under study. The number of stations whose limits of pollutants exceed the prescribed limits has increased to nine in 1994 from four in 1988. Only at Howrah during the last two years of the period of analysis the level of NO_x has gone above the prescribed limit.

In the final analysis it has been concluded that the hypotheses proposed in the first chapter of the thesis mostly stand vindicated by the present spatio-temporal analysis of ambient air quality in Indian cities. The first hypothesis which states that the overall pollution levels have been increasing over the years mostly holds true in the present analysis. In most cases pollution has been increasing through the period of analysis. Exceptions have been in cases where considerable gaps of data are existing or in cases where meteorological conditions do not favour excessive build-up of air pollution. The second hypothesis which states that pollution is much more in industrial town than in non-industrial towns, also stands vindicated. Howrah, Ahmedabad, Surat, Pune, Kota, Ludhiana, all of which are prominent industrial towns have been highlighted as peaks of pollution concentration through the period of analysis. It needs be pointed out that a better comparative analysis could have been done if more non-industrial locations were included. The third hypothesis which says that the SPM concentrations are more than those of SO_2 and NO_x, holds true for all stations throughout the period of analysis. SPM is a natural component of atmosphere and its concentration near the earth's surface is obvious. As far as the last hypothesis, which states that of SO_2 and NO_x is more, is concerned, the period of analysis and data coverage does not seem to be enough to either prove or disprove. A much longer period of analysis for much larger number of recording stations would be required for this.