February, 2011

Air quality monitoring, emission inventory and source apportionment study for Indian cities

National Summary Report

www.cpcb.nic.in

Central Pollution Control Board

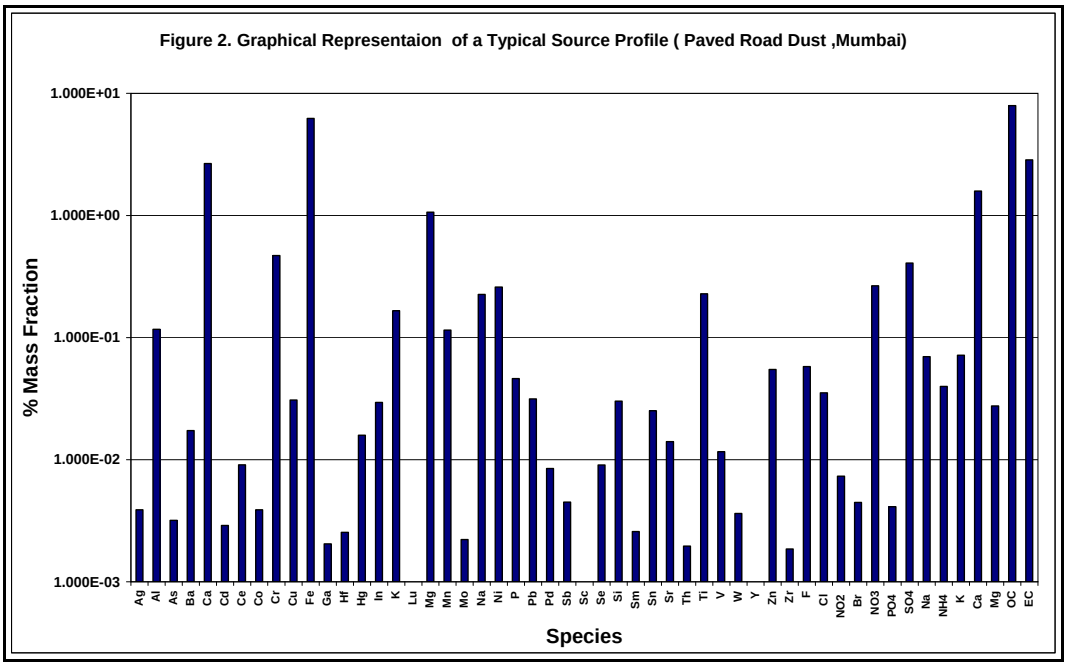


Figure 5.4: A Typical Source Profile (Paved Road Dust, Mumbai)

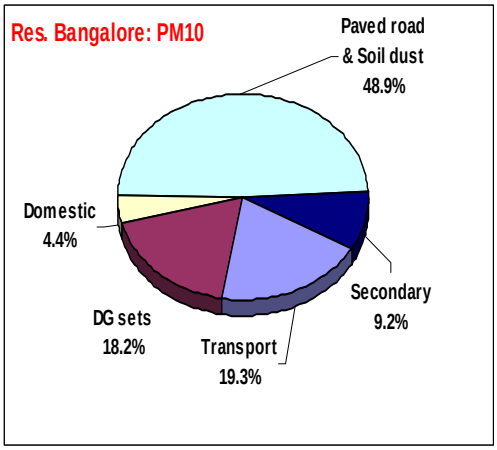
5.8 Contributing Sources based on Receptor Modeling

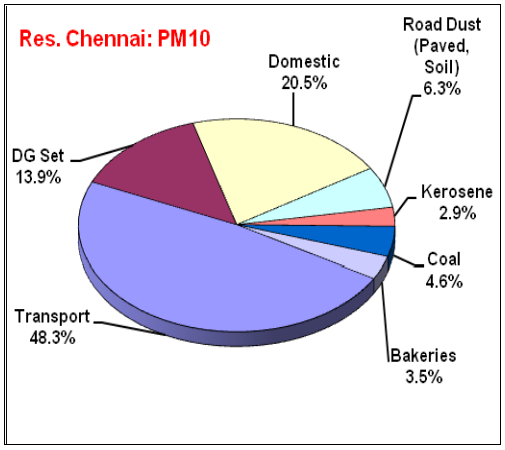
Factor analysis and Chemical mass balance (CMB8.2) models were used to apportion contribution of source groups in ambient particulate matter (PM_{10} & $PM_{2.5}$). The Varimax rotated factor analysis technique based on the principal components was initially used to determine the dominance of sources contributing to various receptors. The information on indicative source dominance along with data on chemical speciation of PM_{10} & $PM_{2.5}$ were subsequently, used in CMB8.2 model to get quantitative contribution of sources. The CMB model was run for each day of sampling (at the location) for each location and in all the three seasons. There have been seasonal as well as day-to-day variations in the prominent sources that contribute to PM_{10} and $PM_{2.5}$. Therefore, the source contribution estimates of all the seasons were averaged for locations of similar land use (e.g. data for two residential locations were pooled together). This helped in preparing overall source - receptor linkages. The overall results of source – receptor impact relationship in terms of percent contribution (excluding unidentified sources, which are explained in the mass closure plots – Figures 3.25 – 3.30) of various sources at residential, kerbside, industrial locations in all the six cities in respect of PM_{10} are presented in Figures 5.5 – 5.7.

In residential locations, re-suspension of road dust & soil dust emerged as prominent sources of PM_{10} in the cities of Pune (57%), Bangalore (49%), Mumbai (47%) and Delhi (15%). Vehicular sources (15 – 48%) contribute significantly in Bangalore, Chennai, Delhi and Kanpur. Other prominent sources include DG sets in Bangalore, Chennai and Delhi; and Garbage burning in Delhi, Kanpur and Mumbai. Construction activities (22%) are another major source contributing to higher PM_{10} levels in Delhi.

The kerbside locations in all the cities, except Kanpur, show resuspension of road/soil dust as the most prominent source (27- 75%). Higher contributions at these locations clearly indicate that the dust on paved/unpaved roads get airborne due to movements of vehicles. Transport sector, as expected, is a major contributor in almost all the cities. Other sources show city specific dominance (domestic – Chennai & Kanpur; garbage burning – Delhi & Kanpur; secondary particulate (SO_4^{--}, NO_3^- and NH_4^+) – Bangalore & Kanpur; and construction – Delhi).

In case of industrial locations, contributions of industries are reflected in Bangalore (27%), Kanpur (19%) and Delhi (9%). Dominance of other sources like re-suspension of road dust, transport, garbage burning, etc. exhibit trends more or less similar to residential and kerbside locations.





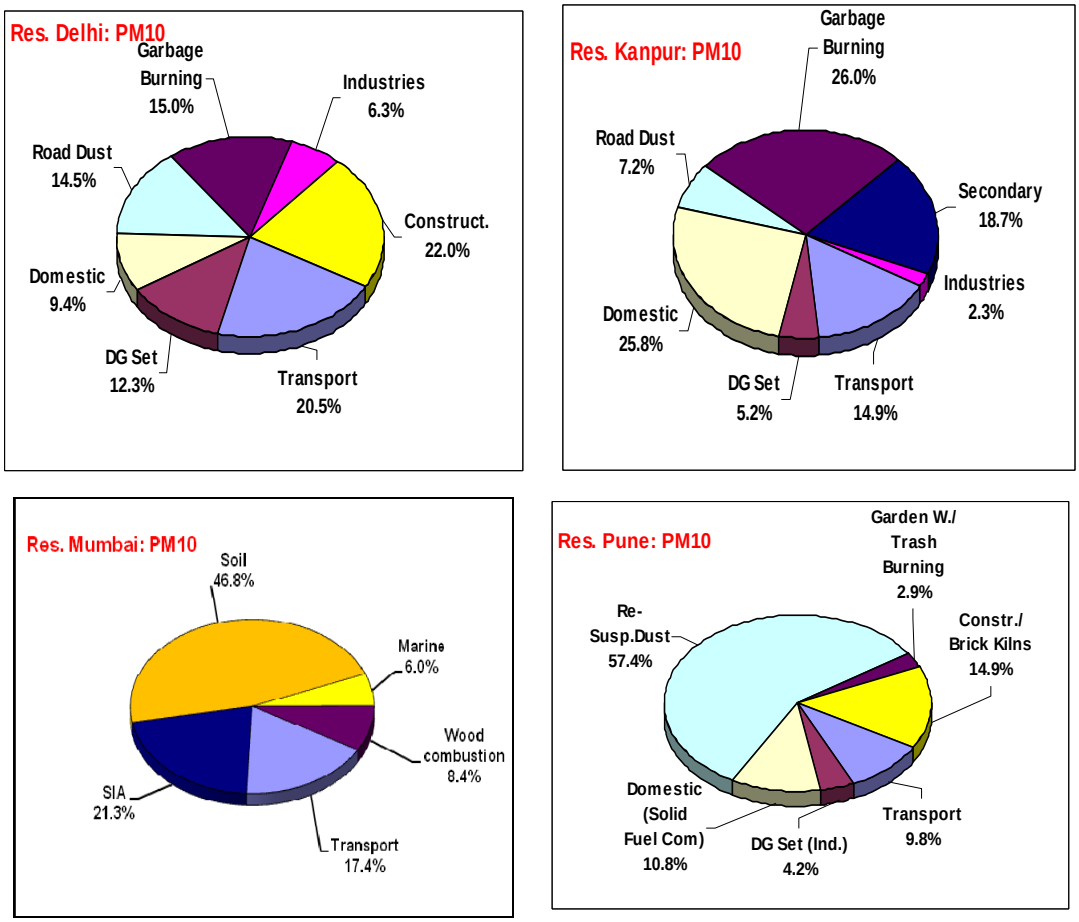
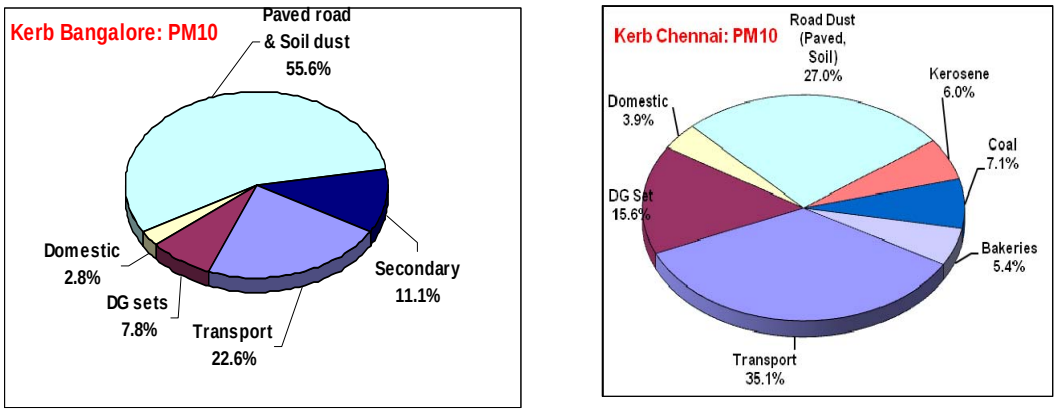


Figure 5.5: Contribution of Sources in PM_{10} in Residential Locations



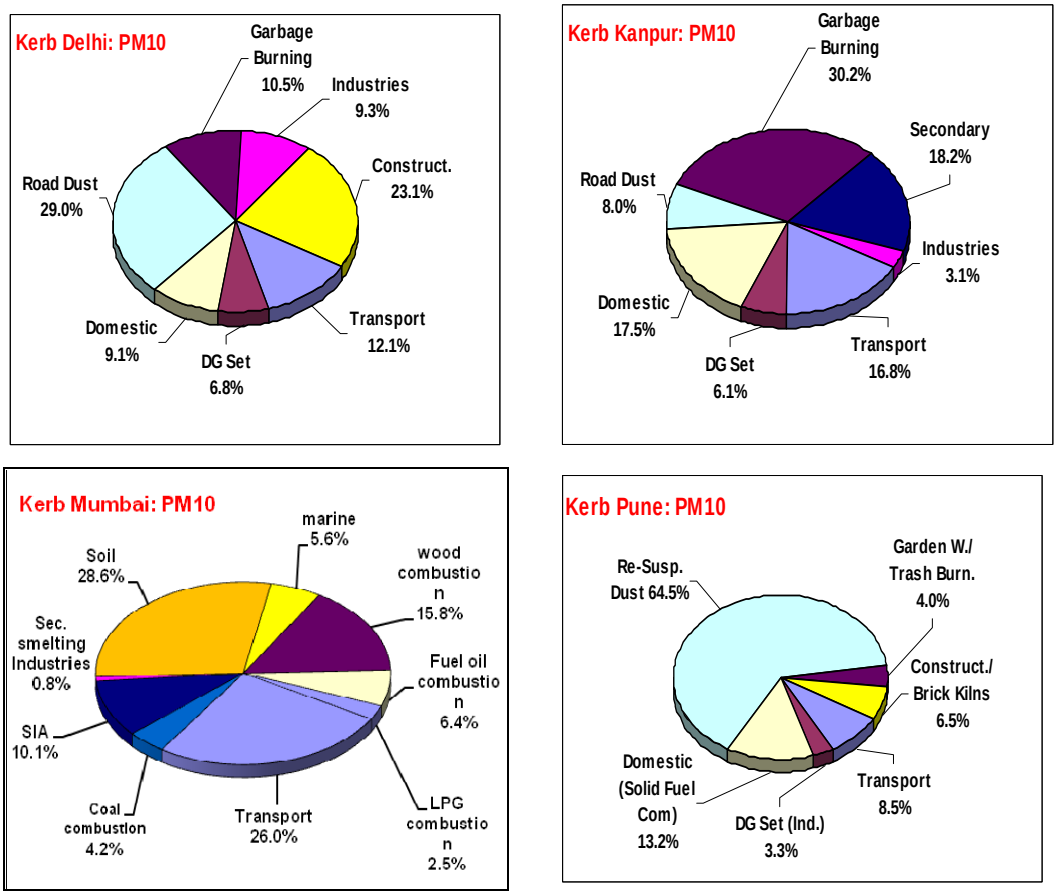
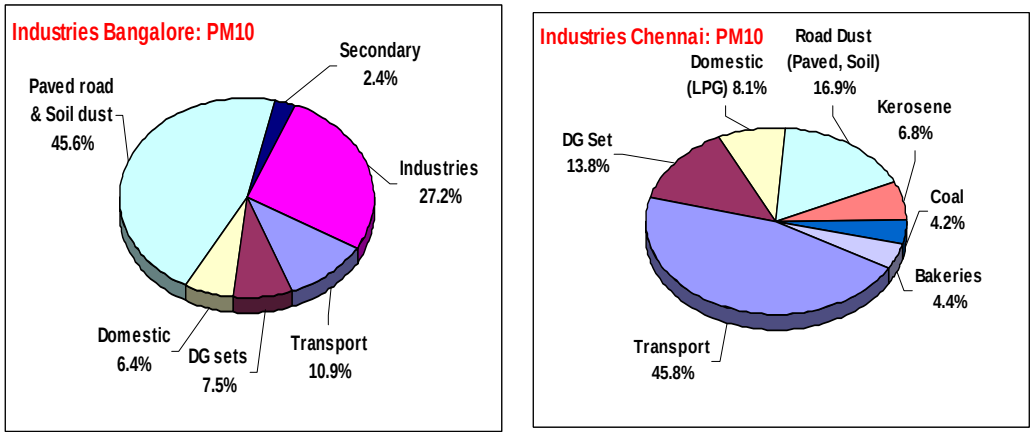


Figure 5.6: Contribution of Sources in PM_{10} in Kerbside Locations



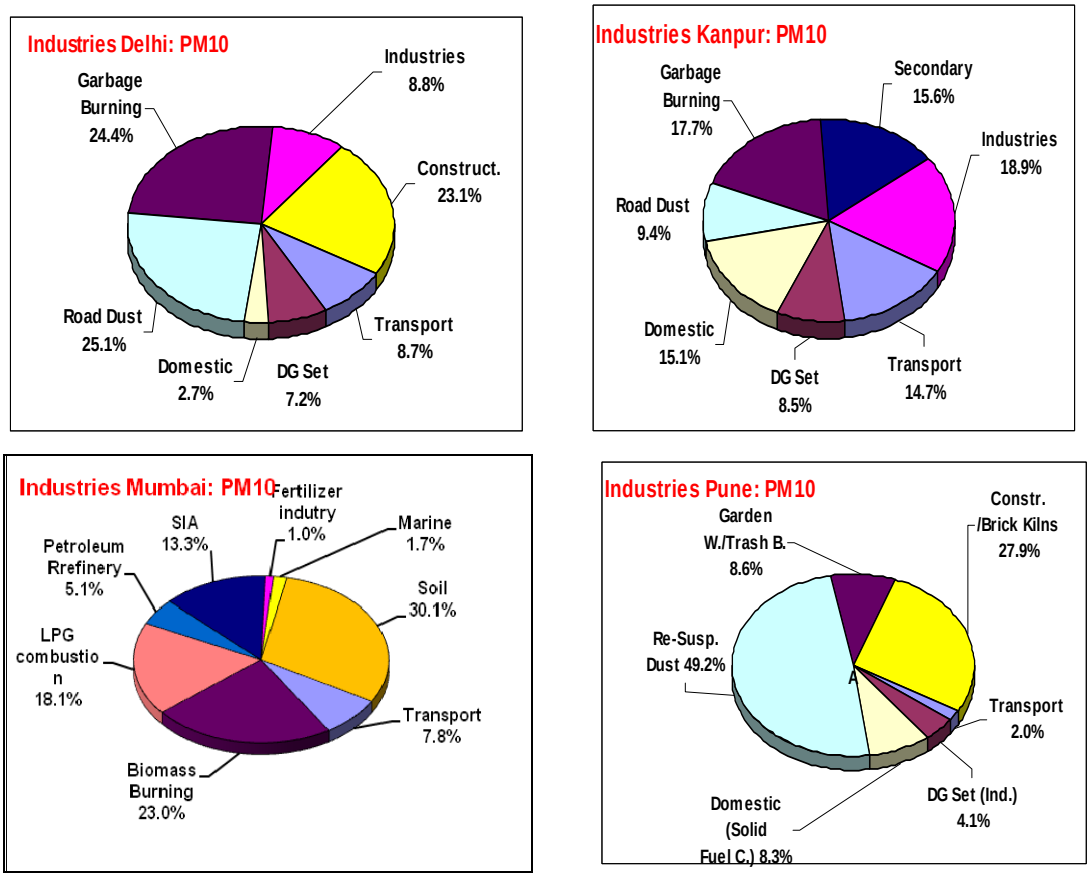


Figure 5.7: Contribution of Sources in PM_{10} in Industrial Locations

CMB8.2 results of $PM_{2.5}$ are presented in Figures 5.8 – 5.10. CMB 8 could not be applied for $PM_{2.5}$ in Mumbai. The following emerge from analysis of data:

- Contribution of resuspension/soil dust (mostly in coarser fraction range i.e. $PM_{2.5-10}$) drops down (about 5% against 15 – 60% in PM_{10}) drastically at all the locations in all the cities.
- The contribution of combustion sources including transport (20 – 60%), DG sets (8 – 28%) is much higher as compared to their contribution in PM_{10}. Domestic source contribution is quite high in Delhi (48 – 89%), Kanpur (21 – 27%) and Pune (about 15%).
- Secondary particulates, which are not directly emitted but formed through atmospheric processes, have significant contributions (14 – 60%).
- While vehicles contribute significantly at all the locations, their contributions at kerbside locations are much higher (e.g. Bangalore has 61% contribution from vehicles at kerbside locations against 48% at residential location).

- Other city-specific sources include industries (at industrial monitoring sites in Bangalore and Kanpur), Coal (Chennai) and domestic fuel combustion Delhi).
- The contribution of transport sector was observed in Delhi at residential sites more than the kerb sites. This indicates that road network and vehicular sources are widespread and dense, and do not exhibit typical land use based variations. Besides, presence of molecular markers such as hopanes and Steranes at all the locations confirm contribution of vehicular sources.

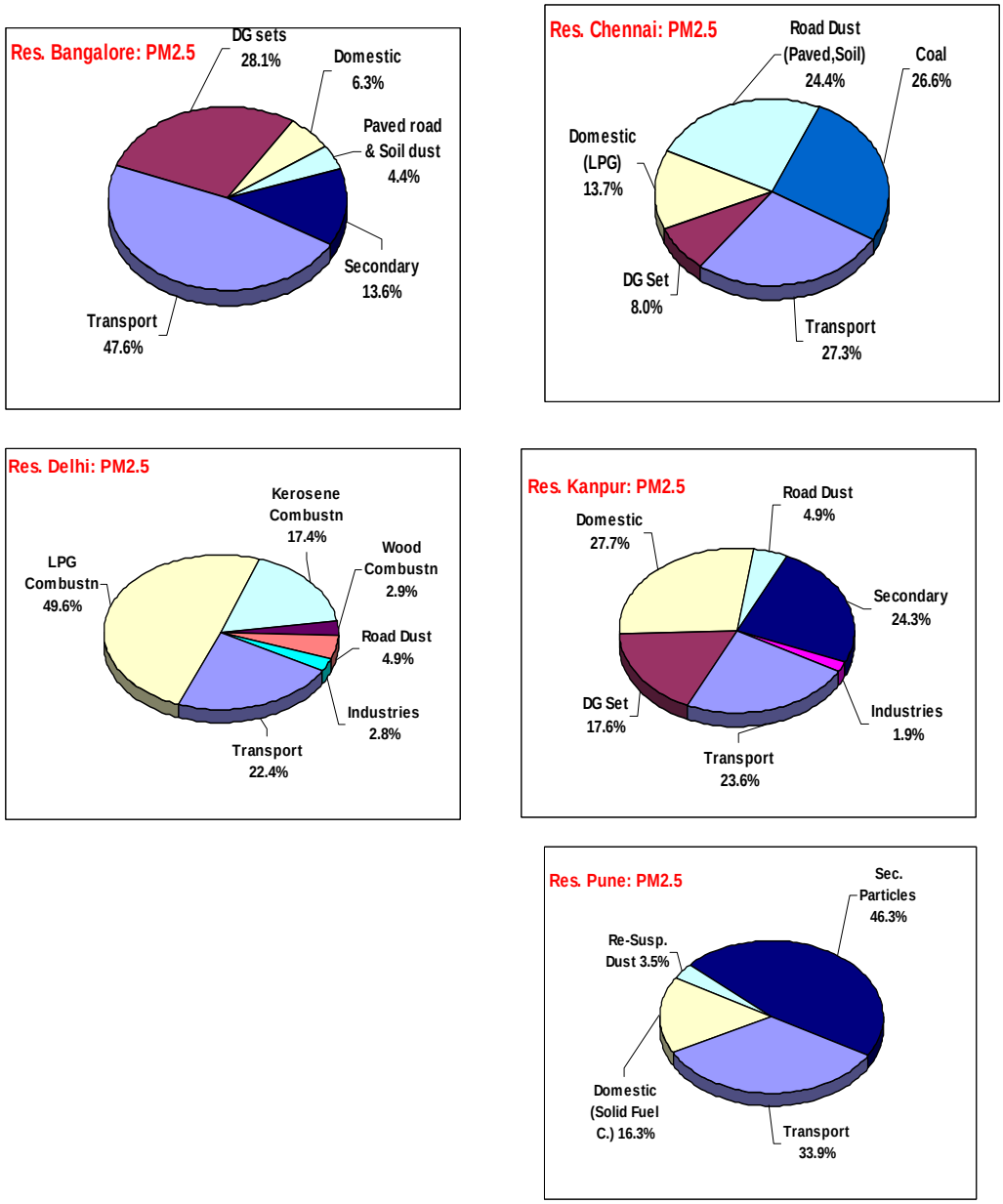
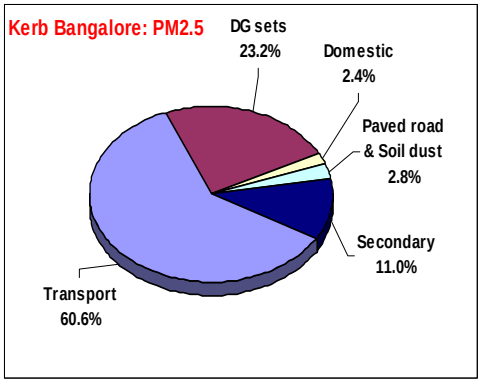
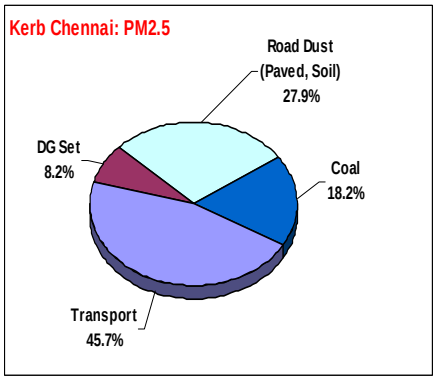
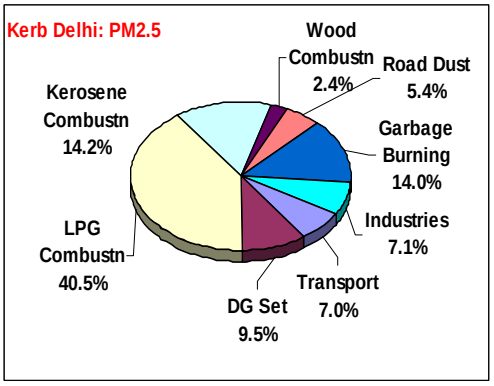
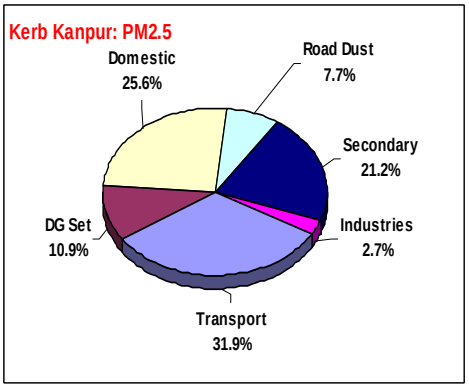


Figure 5.8: Contribution of Sources in $PM_{2.5}$ in Residential Locations









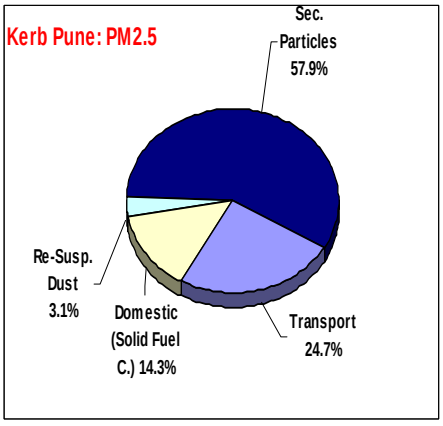
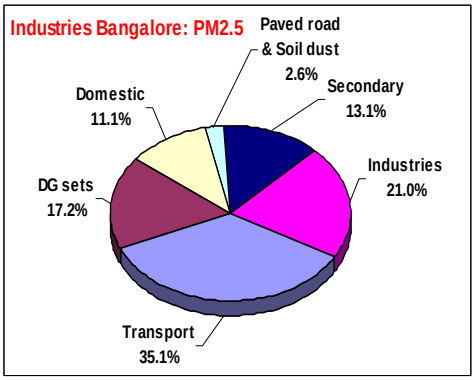
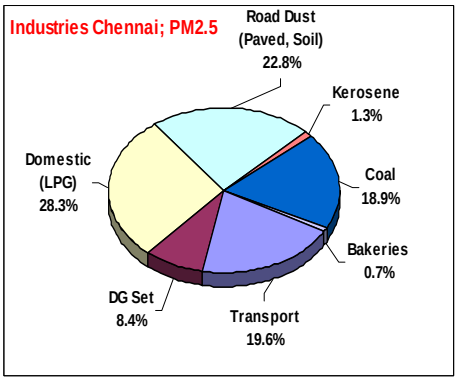
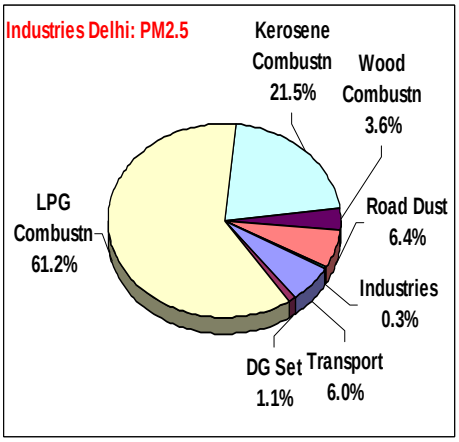
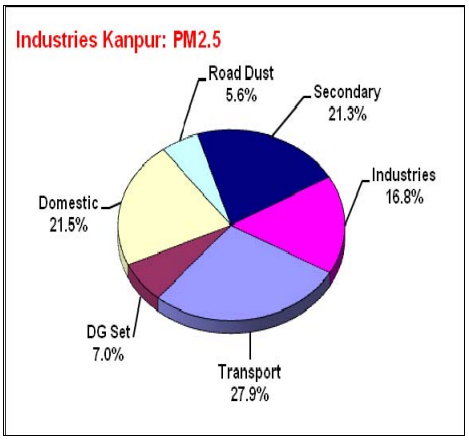


Figure 5.9: Contribution of Sources in $PM_{2.5}$ in Kerbside Locations









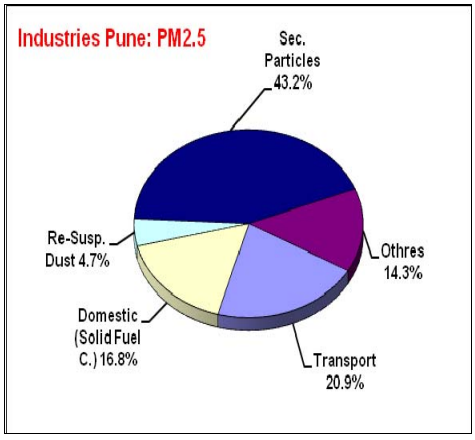


Figure 5.10: Contribution of Sources in $PM_{2.5}$ in Industrial Locations

The contribution of various source categories in respect of PM_{10} and $PM_{2.5}$ are summarized in Table 5.5.