CHAPTER 5
CONCLUSIONS AND FUTURE SCOPE

The main objectives of this study were to characterize PM$_{10}$ at Tezpur, a rural receptor site of Northeast India, to see the impact of extraordinary emission day on PM$_{10}$ and to characterize the particles emitted from biomass burning in rural kitchens and to see the dependency of PM$_{10}$ on rural household biomass burning.

The PM$_{10}$ study for two whole years showed higher concentration of PM$_{10}$ during 2008-09 than that of 2010-11. PM$_{10}$ was maximum during monsoon season of 1$^{st}$ year. The probable reasons were low rainfall, subsidence condition of atmosphere and temperature inversion prevailed during that period. However, PM$_{10}$ was maximum during the winter and minimum during the monsoon in the 2$^{nd}$ year. During winter months dry condition, low mixing height, temperature inversions leads to higher PM loading and during the monsoon rain washout removes the particulates from the atmosphere. Average annual PM$_{10}$ was 2.5 times higher than the annual national standard during 1$^{st}$ year and it was within the national standard during 2$^{nd}$ year.

Elemental constituents of PM$_{10}$ was higher during 1$^{st}$ year than that of 2$^{nd}$ year. Cadmium showed maximum enrichment in comparison to other elements. Comparative account of elemental concentration revealed that most of the elements were lower than other Indian studies and higher than studies from abroad. The analysis of PM$_{10}$ for ions and carbon showed that except $F$ and Na$^+$ other ions and all carbon fractions were maximum during the winter. Cation deficient condition was found which indicates possibility of acid rain of the region. Among the ions SO$_4^{2-}$ was the dominant. TC accounts 44% of PM$_{10}$. Very high percentage of SOC in OC and high ratio of WSOC to OC indicates dominance of secondary aerosols along with CCN activity of aerosols of this region. Characteristic ratios and source apportionment of PM$_{10}$ revealed biomass burning as the major source of PM$_{10}$. Other sources were contribution from soil, vehicular emission and coal burning. PCA-MLR revealed 70% source contribution from biomass burning.

PM$_{10}$ characterization during Diwali fireworks of 2009 revealed minimum and short term impact on air quality in the rural Brahmaputra Valley. Marginal increase of associated elements and ions was found. The incremental effect of Diwali was very marginal as compared to the events in the ‘mainland India’. Cation deficient condition
was found during the study. DIE showed marginal increase of elements and ions during the festive days.

Study on atmospheric PM$_{10}$ during meji burning period of 2009 showed incremental effects of meji burning in the Brahmaputra Valley of Northeast India. PM$_{10}$ was 1.5 times higher than the 24-hr national standard with maximum concentration on the meji burning day. During the study period PM$_{10}$ was found to be extremely carbonaceous. PM$_{10}$ was enriched with Br and other elements. PM$_{10}$ and carbon showed nighttime maximum. Studies on back trajectory analysis revealed long range transport of aerosols from the IGP region of India. Atmospheric condition was favorable for low dispersion of pollutants during the later part of the study resulted in the build up of PM$_{10}$.

Detail study on atmospheric PM$_{10}$ during meji burning in the following years was done. Maximum PM$_{10}$ was found on the meji burning day. Except elements, most of the chemical species were maximum on the meji burning day. High concentration of WSOC indicates the CCN activity of aerosols and the presence of smoldering phase during meji burning period. The PAHs diagnostic ratios were similar with other reported biomass burning studies.

Characterizations of BFSPs collected from rural kitchens revealed that CD is the most polluting and SCB is the least polluting biomass fuels in comparison to other biomass fuels studied. Among the measured elements Ca and K were the most dominant in all BFSPs. We found high emission of SO$_4^{2-}$, Cl$^-$ and PO$_4^{3-}$ from all biomass fuels. Carbon and PAHs showed significant seasonal variation. Carbon content of BFSPs was maximum in the winter. High PAHs content during monsoon samples was probably due to incomplete combustion of biomass fuel due its high moisture content. FLA and BaA were the most dominant PAHs of all BFSP samples with higher contribution of 4-ring PAHs. The strong positive relationships between elements and chemical species of PM$_{10}$ with BFSPs showed biomass burning as a major source of PM$_{10}$ of this region. This was further explained by good linear relationship between PAHs of PM$_{10}$ of meji burning period with PAHs of BFSP samples.

To the best of our knowledge characterization of PM$_{10}$ during Diwali and meji were the first study of its kind from Northeast India. We would also like to mention that there was study from South Asia on particulates emitted from rural households biomass burning, yet the method of sample collection employed by us is first of its kind till date.
The present study will work as baseline study especially for the entire Northeastern part of India and could be used for future work.

**Future scope**

Continuous study of atmospheric PM$_{10}$ will enable to know the PM$_{10}$ trends of this region. Detail study on morphology, carbonaceous nature, radiative behavior of aerosols along with meteorological data will assist to know nature and sources of PM.

Characterization of PM$_{10}$ was done during Diwali fireworks of 2009 and did not carry the study further due to its marginal impact on the atmosphere. However, with increase in population celebrations of festivals were also growing. So further study should be planned which may revealed some more interesting findings on emission characteristics during Diwali fireworks. We are continuing with PM$_{10}$ characterization during *meji* burning.

In depth study of indoor air monitoring of rural households and further characterization of BFSPs can be an important task. It will help to understand emission characteristics of biomass fuel. This type of pioneering work will aid in policy formulation regarding health and sanitation by the Government.