ABSTRACT

The continuous population growth and the subsequent economic expansion over centuries have been the primary drivers of land use land cover (LULC) conversion resulting in an increase in urban areas, which now inhabit 55% of the world's population. The National Capital Region (NCR) of India has shown a considerable growth of urban and built up area during the recent decades over (17 fold increase in the urban extent). There is a significant amount of research in mesoscale meteorology, yet our understanding of how urbanization affects the meteorology and air quality parameters is far from complete. LULC data are an essential input for numerical weather model prediction as they determine the exchange of momentum, moisture and energy fluxes. Thus, for modeling applications periodic updates of land cover are necessary to urban development and various other changing land use patterns.

With this background, the prime objective of this thesis is towards understanding the effects of LULC changes on meteorological parameters and consequently the changes on the ambient air quality. The study employs the use of state-of-the-art technologies of satellite remote sensing and numerical models towards the study of LULC changes and subsequent impacts on meteorology and air quality in NCR of India.

The LULC over the NCR of India is examined using the images obtained from various sensors onboard different Landsat missions for five years 1972,1981,1993,2003 and 2014, representative of five decades. Almost 17 fold increase in the urban and built up areas mainly in Delhi and its satellite cities (Noida, Ghaziabad, Gurugram and Faridabad) during the half century period was observed while green areas like Sariska National Park showed a decrease of about 33%. A significant conversion of land use mainly from dry croplands to irrigated croplands and mixed croplands is noted.

Sensitivity studies has been carried out for nesting grid ratio (NGR), continuous run versus time-split simulations and optimum time period of simulation for realistic model performance

evaluation.Statistically there is no significant difference found in the simulated results on varying the NGR. The smaller time split simulations (2 days and 4 days schemes) show significant improvement in performance compared to longer time runs (8 days and 16 days continuous).

Next, the effect of changes in LULC over the National Capital Region (NCR) of India over a span of fifty years on various meteorological variables like surface temperature (AT), Land Surface Temperature (LST), Relative Humidity (RH), precipitation, heat island intensity, thermal stress, convective parameters and winds were examined. It is found that wherever and whenever urbanization happened during half a century, a corresponding increase upto 3-5 °C and 2-4 °C in LST and AT respectively is observed while surface winds have decreased by 2 m s^{-1}.There is an increase in both surface and ambient heat island intensity of around 2 °C and 1°C in the urbanized localities during daytime and a small amount of cooling/decrement (0.25 to 0.5 °C) in the heat island intensity is observed during morning time. Also, a sharp decrease in the comfortable hours and significant increase in extremely uncomfortable hours is observed with increased urbanization. Further, the pockets of high intensity precipitation increased and 'urbanized' stations show higher convective available potential energy (CAPE) and convective inhibition (CIN) values than their 'cropland' counterparts during select episodes of thunderstorm.

Furthermore, the WRF-Chem model has been used to analyse various air quality parameters such as ozone, NOx, $SO_2$and PM in context of increase in urbanization. Ozone values show an increase in urbanized areas while PM_{10} showed decrease at the surface. However, a significant increase is observed in PM_{10} concentrations aloft. Thus, present study has shown quantification of the impacts of land use changes particularly urbanization on routine meteorological variables, air quality and thunderstorm based on numerical model simulations.