Chapter 24
Synergy Between Air Quality, Various Urban Forms, and Land Surface Temperature: A Case Study of Kolkata Metropolitan Area

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ABSTRACT

This chapter studies spatio temporal trends of air quality, its relation with urban forms, and Land Surface Temperature (LST) in Kolkata Metropolitan Area, the world's 55th most polluted city according to the World Health Organization. Air quality data were procured from 34 monitoring stations operated by West Bengal Pollution Control Board for 2005-18. Trend analysis showed declining NO_2, SO_2 values but a rise in PM10 concentration. Interpolation analysis showed high concentration of pollutants along the Hugli industrial belt, Dhulagarh, and Kolkata Municipal Corporation Area. Urban forms such as built-up density, distances from water bodies, parks, and bus stops demonstrated their reasonable influence on air pollution condition. LST generated from Landsat Thermal Infrared bands showed increase in temperature conditions from 2005-2018. Positive Correlation was identified between Land surface temperature and air pollution. Their relationship was assessed to have become stronger over the decades.

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INTRODUCTION

Air quality issues are a matter of global concern because it is the prime driving force for climate change. Air pollution not only contaminates the natural composition of the atmosphere but also hampers the health of the entire biota. Research works on air pollution has advanced tremendously since the analysis of the Los Angeles smog in 1952 conducted by Haagen-Smit (Haagen-Smit 1952). He and his fellow researchers determined that the major component of the smog was tropospheric ozone formed by the chemical reaction between NO2 (Nitrogen dioxide) and VOC (Volatile Organic Compounds) in the presence of sunlight (Baklanov et al.,2016). Many studies have taken consideration of the most preliminary research objective, that is to understand the spatiotemporal variation of the air quality parameters of their study area (Tian et al., 2002; Yahaya et al., 2018; Gurjar et al., 2007). World Health Organization (WHO, 2018) reports that developing Asian countries, especially that of India and China have their cities ranking in the topmost polluted cities in the world. Research work have highlighted that air pollution is not only observed in megacities but also in smaller urban centers with a population ranging from 150,000 to 1.5 million (IAQP, 2010).

Air quality is a source for concern in India, especially in cities. According to the World Health Organization (WHO), 37 cities from India rank in the top 100 world cities with the worst PM10 pollution though the national ambient standard for CO is better than the WHO guideline. Air pollutants including particulate matter (PM), sulfur dioxide (SO2), nitrogen oxides (NOx), carbon monoxide (CO), and ozone (O3) are monitored by Central Pollution Control Board. The pollutant concentration often surpasses the National Ambient Air Quality Standards (NAAQS). The NO2, SO2, and O3 standards though mostly stay at par with the NAAQS guidelines but the concentration for PM10 and PM2.5 are way beyond the desired limit (CPCB, 2010). Subsequent to the understanding of the spatiotemporal dynamics of air quality of a region, it becomes imperative to look into the causal factors. It was found that consequential to population growth was urban sprawl around industrial growth nuclei had led to environmental degradation (Reddy and Venkataraman., 2002; Khandelwal et al, 2017). The decline in air quality parameters formed one of the key components of environmental degradation. In most literatures, the process of urbanization and associated anthropogenic activities were identified as liable for depleting air quality. After performing a comparative study among 249 European cities Rodríguez et al., 2016 concluded that urbanization had led to air pollution. Studies carried out for Budapest, Hungary showed transport as the dominant source of emissions, contributing 57% of the oxides of nitrogen, 80% of Lead, 81% of CO and 75% of HC emissions Even in India urban sprawl, industrialization, increasing built-up density because of the population flux in the cities were identified as the principal cause of deterioration of ambient air quality (Ravindra et al. 2001).

Post independent India attempted to accelerate the socio-economic condition but it happened at the cost of its environmental condition. Manufacturing units of heavy machinery, fertilizer, cement, brick kilns contributed approximately 36% SO2 (Sulphur dioxide), 19% NO2 (Nitrogen dioxide) in the Indian cities (Garg et al, 2001). Brick kilns alone were assessed to have added 70% of the ambient PM10 (Particulate Matter) and 60% of the ambient PM2.5 in different regions of India (Azkar et al., 2012). In order to meet the escalating demands of the teeming millions, coal-fired power plants for electricity generation were being established as well. These units supplied 50% of the total SO2 and 30% of the total NO2 in the air (Garg et al., 2006; Lu and Streets, 2012). According to Amann et al., 2017 and vehicular emission contributed to over one-third of the PM 2.5 in the ambient air. Ghose et al., 2004 have assessed that usage of fuels with poor environmental performance, congested transportation system enhanced vehicular

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