Representation of air quality index and various air pollutants with GIS for the city of Mumbai

ES 216 Project Seminar - G5

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Introduction

Rapid degradation of urban air quality has become a major health concern worldwide in recent decades. Infrastructure development in urban areas including high rise buildings, flyovers and reduced green cover has resulted in poor air circulation within cities. The rapid growth of cities like Mumbai and Delhi, India, in the 21st century can be attributed largely to rural–urban migration. Urbanization or population growth has large negative impact on quality of air, water, and soil. Regulatory and research institutes have installed air quality monitoring networks in urban regions to assess deteriorating air quality levels. . Monitoring concentrations at several locations in a study area is usually resource intensive, difficult or expensive. Monitoring represents air pollution level for a particular point.

Spatial interpolation techniques are used to create a surface grid or contour map. Interpolation processes estimate concentrations in the study area using known concentrations at fewer points.

A geographic information system (GIS) is a software tool to store, analyze, manage, and present all types of spatial or geographical data, which, along with the expert judgment of the GIS user or analyst, produces solutions to spatial problems. GIS techniques have been applied by various researchers primarily to analyze the spatial and temporal distribution of pollutants.

The spatial interpolation techniques have not been used for mapping of air quality in Mumbai city before this. Even epidemiological studies have been conducted for exposure assessment due to air pollution by Ryan and Lemasters (2008) but air quality mapping was not included.

Furthermore, the economic cost of health impact assessment was not estimated due to the prevalence of different concentrations of air pollutants.

A series of control measures with sustained efforts was undertaken by authorities due to public pressure. As a result, improvement in air quality was witnessed for 1991–2003. Mumbai city is once again deteriorating (National Environment Engineering Research Institute [NEERI], 2004–2013).

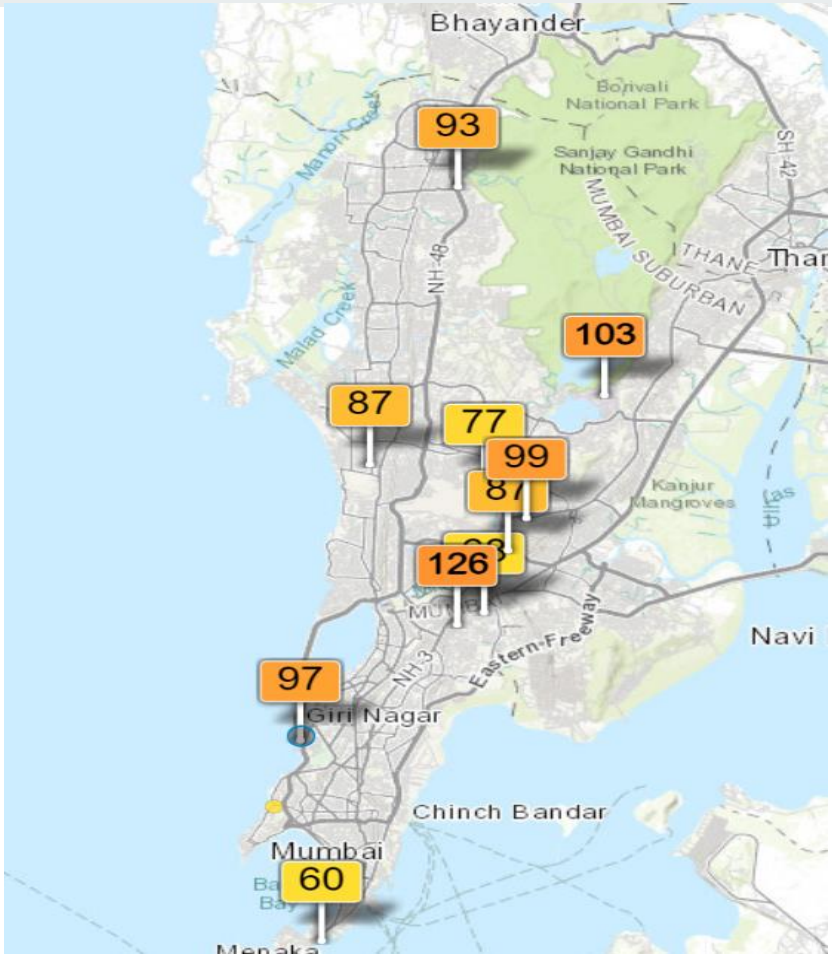
The National Environment Engineering Research Institute (NEERI) has reported that the levels of suspended particulate matter (SPM) and PM10 are much higher than the standards provided by the Central Pollution Control Board (CPCB). The standards for SPM and PM10 are 140 and 60 µg/m3 , respectively, for residential area. n investigation of air pollution in megacities

Study area mumbai

With 12.7 million people, Mumbai is the most densely populated city in India and the fifth most populated city in the world. The 438 km2 area is divided into 24 wards for the purpose of administration. Mumbai is one of the largest centers of commerce in terms of financial flow, generating 6.16% of India’s gross domestic product (GDP) and accounting for 25% of industrial output, 70% of maritime trade in India, and 70% of capital transactions to India’s economy. Mumbai city is now one of the most polluted cities in India.

AQI presently in different sections of mumbai

In Mumbai, the problem of air pollution is relatively new and has spiked only in the last decade. Mumbai has the highest concentration of PM10 among the 24 major cities of peninsular India. The particulate concentration rose exponentially over the last few years which has made it the most polluted city out of the three prominent coastal cities (the others are Kolkata and Chennai)



	id	Name	AQI	AQ
1	1	Colaba	60	mod
2	2	Worli	97	mod
3	3	Bandra	126	High
4	4	Sion	76	mod
5	5	Kurla	99	mod
6	6	Airport	80	Mod
7	7	Ville Parle	93	mod
8	8	Powai	93	Mod
9	9	Borivali East	90	mod

Changes in AQI of Mumbai in different stages of lockdown

With the easing of lockdown rules and vehicles being back on the roads in the city, the Air Quality Index (AQI) marked a slight increase after May – it stood at 55, which is ‘satisfactory’. On June 4, Mumbai had recorded its best AQI for this year at 17. For April and May, the AQI ranged between 17 and 29.

An AQI from 0 and 50 is considered ‘good’, 51 to 100 ‘satisfactory’ and 101 to 200 as ‘moderate’. An AQI between 201 and 300 is considered ‘poor’, 301 to 400 ‘very poor’ and 401 to 500 ‘severe’, while AQI above 500 falls under the severe plus category.

“The first two weeks after the lockdown rules were relaxed were rainy days, which washed away particulate pollutants. Also, the difference between the ‘good’ and ‘satisfactory’ category of AQI is very small and doesn’t pose a health risk. Overall, the good to satisfactory category is expected to continue during monsoon,” said Gufran Beig, director, System of Air Quality Weather Forecasting and Research (SAFAR).

According to the analysis by SAFAR, Mumbai witnessed a 60 per cent increase in nitrogen dioxide (NO2) levels (from vehicular emissions and fossil fuel burning) compared to levels recorded during the fourth phase of the lockdown. NO2 levels are mainly controlled by its major source of emissions — vehicular traffic. SAFAR compared pollution levels between June 1 and June 14 with those recorded between May 18 and May 31, for Mumbai, Pune, Ahmedabad and Delhi.

A sharp decrease of 77 per cent in NO2 levels was observed during the lockdown period (March 25 to April 19), compared to the week before the lockdown came into force.

In the same period (June 1 to June 14), Particulate Matter 2.5 — the tiny particulate matter which is less than 2.5 microns in diameter and can enter deep into the lungs and even the bloodstream – saw a reduction. Pune recorded the highest decline (40 per cent) followed by Mumbai (35 per cent), Ahmedabad (20 per cent) and Delhi (5 per cent).

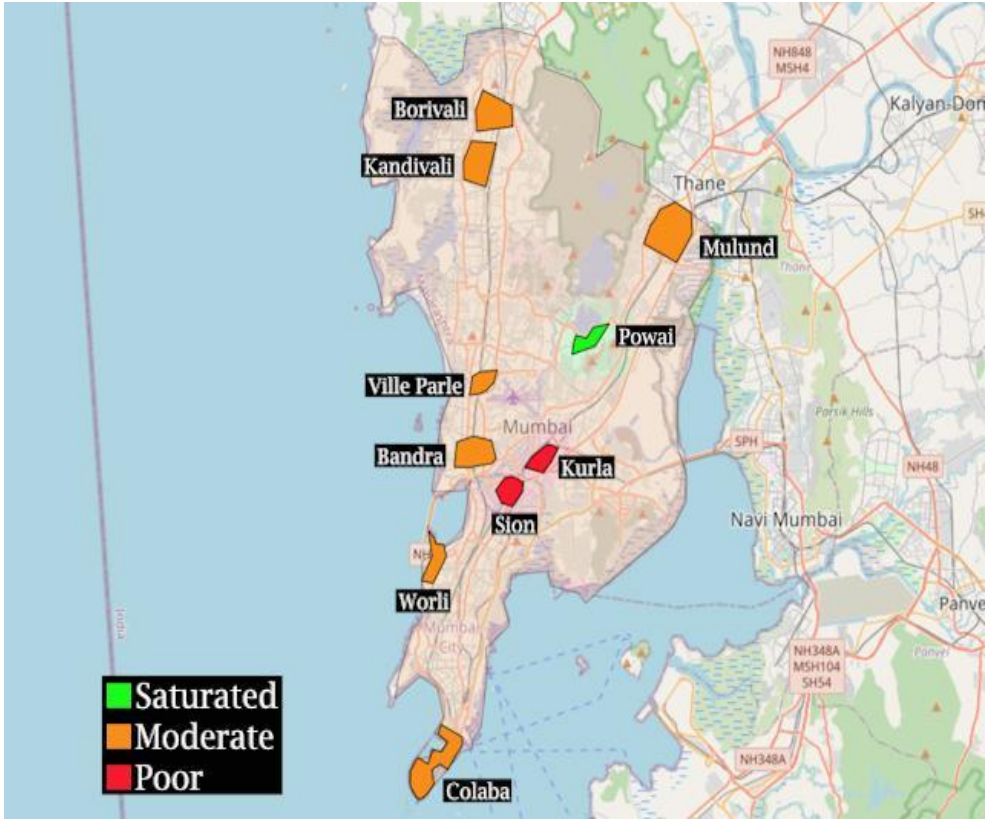
Here is the average data annually from years 2001 to 2009

	KALBADEVI			PAREL			WORLI		
YEAR	SO2	NO2	SPM	SO2	NO2	SPM	SO2	NO2	SPM
2001	10	25	233	12	27	236	13	29	244
2002	9	19	220	9	20	230	9	19	224
2003	8	22	214	8	19	215	8	23	227
2004	6.58	19.67	255.25	6.58	18.33	228.75	8.17	15.9	243.17
2005	9	27	222	7	21	202	7	19	243
2006	10	33	258	10	29	231	11	25	279
2007	12	40	251	12	35	251	11	33	191
2008	10	44	253	7	36	274	8	38	251
2009	9	54	339	8	53	401	39	55	277

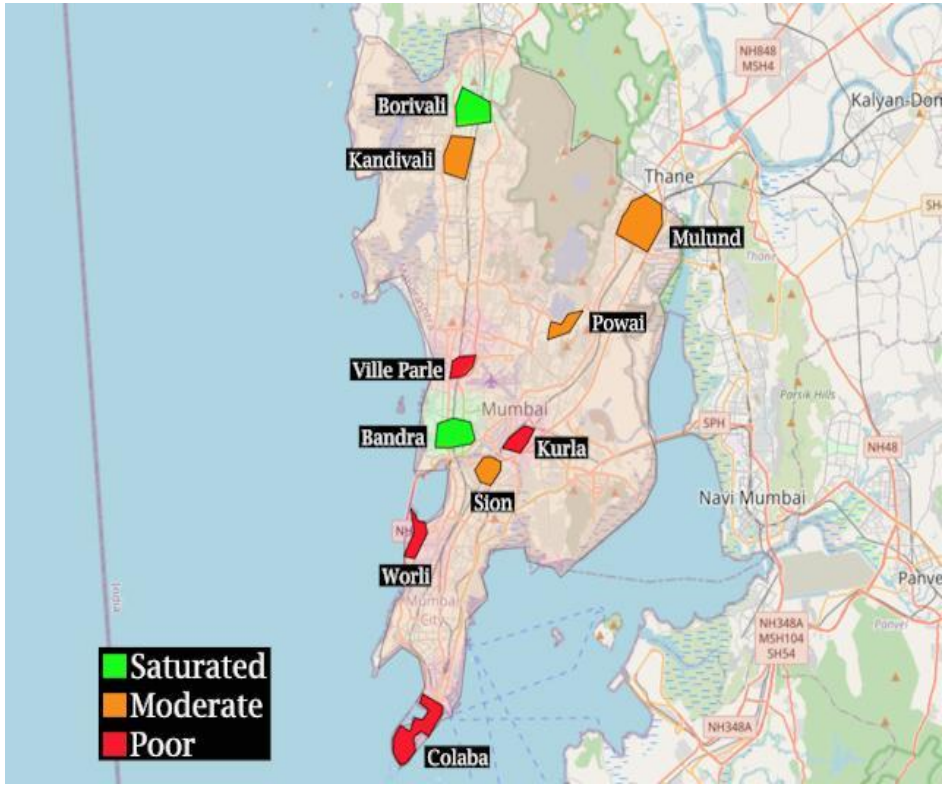
Effects before and after Diwali

Mumbai recorded high **pollution** levels during **Diwali**, when the AQI was 204 (poor) and 319 (very poor) the next day. In 2019, an AQI of 278 (poor) was recorded on **Diwali** and 315 (very poor) the day after.

Change in AQI Before diwali

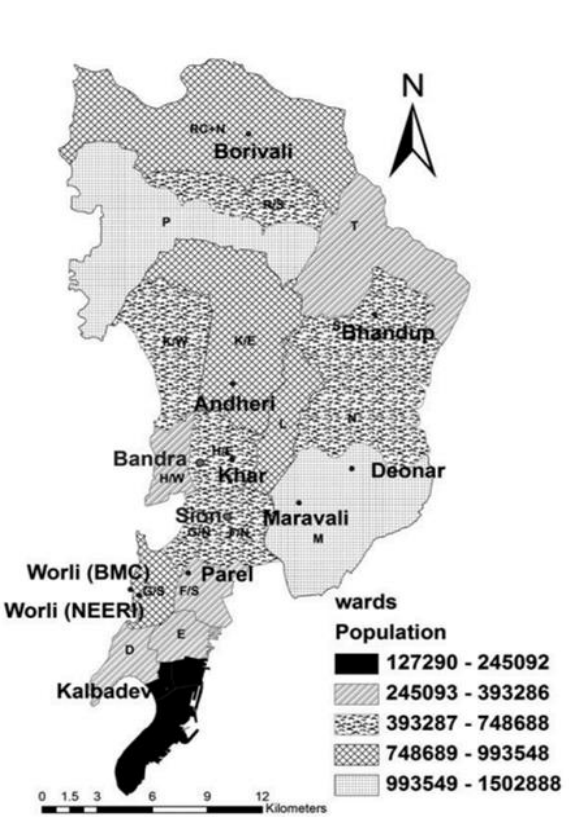


Change in AQI after diwali



Effects on population

According to the United Nations, as of 2018, Mumbai is the second-most populous city in the country after Delhi and the seventh-most populous city in the world with a population of roughly 20 million . As per Indian government population census of 2011, Mumbai was the most populous city in India with an estimated city proper population of 12.5 million living under Municipal Corporation of Greater Mumbai. Mumbai is the centre of the Mumbai Metropolitan Region, the sixth most populous metropolitan area in the world with a population of over 23 million.[



Population exposed

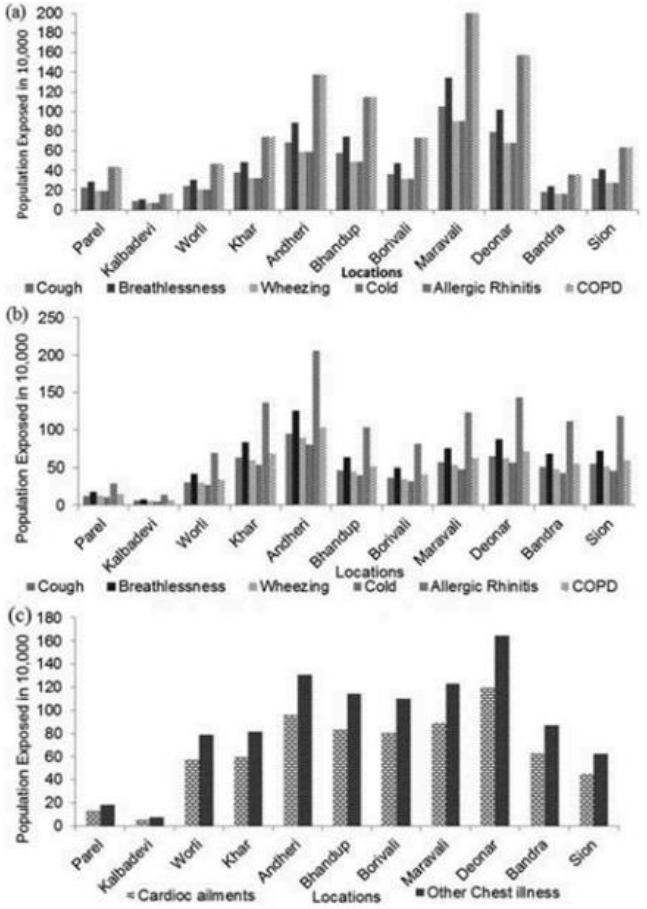


Figure 8. Population exposed by (a) PM_{10}, (b) NO_2, and (c) SO_2 at various locations.

Seasonal average concentration and standard deviation in the seasons

Table 1. Seasonal average concentration and standard deviation in the seasons.

Pollutants	Winter	Premonsoon	Monsoon	Postmonsoon	Std. dev.	Annual
SO_2	15.7	9.0	7.5	14.7	3.6	11.7
NO_2	52.3	33.1	26.8	51.1	11.1	35.2
SPM	379.3	346.8	191.7	265.9	73.0	260

Reference

Air quality mapping using GIS and economic evaluation of health impact for Mumbai City, India

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