iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** VI **Month of publication:** June 2020

DOI: http://doi.org/10.22214/ijraset.2020.6353

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VI June 2020- Available at www.ijraset.com

Spatial Temporal Air Quality Modeling for Lucknow City using Remote Sensing and GIS

Akanksha[1], Pranjal Pandey[2], Dr. Shivangi Somvanshi[3]
[1, 2]PG Student, [3]Assistant Professor, ASET, Amity University, Noida

Abstract: ***Good air quality is essential for good health for living beings including humans. The increase in human population, urbanization and economic growth led to an increase in the consumption of resources. Urban development and advancement in developing countries like India normally occur and simply continue in an irregular way. This unexpected and unregulated urban growth contributes to environmental instability and ecological degradation. In urban area rapid increase of vehicular population as well as road traffic is one of the major source of air pollutants and cause of health hazards. Lucknow, a fast growing city is not an exception to this. In consideration of this, an effort has been made to create a GIS model to help easily collect details on air quality directly from remotely sensed data. The paper highlights the capabilities of Landsat 8 OLI-TIRS satellite imagery to evaluate air quality using RS and GIS approaches. Study shows that model derived from using various Landsat 8 satellite image bands can be accurately estimated for particulate matter ($PM_{2.5}$), while it can not be applied to gaseous pollutants. (NOx, CO, etc).***

Keywords: Landsat OLI and TIRS, Lucknow air Quality, Remote Sensing.

I. INTRODUCTION

The Pollution means that the contamination of air. In air (prevention and control of pollution) Act, 1981, section 2(a), pollution for air is characterized as "any solid, liquid or gaseous substance (including Noise) present in atmosphere in such concentration as may be or tend to be injurious to human beings or other living being or other living creatures or plants or property of environment". There has been a rapid rise in urbanization and industrialization in many cities in India over the past two decades. The phase of urbanization has good and bad impacts on the condition of ambient air in many world cities [8]. Via natural or man-made process various chemicals constantly enter the atmosphere and these substance communicate with the environment to cause disease, pollution, and environment degradation and are known as pollutants. Both developed and developing countries are deeply concerned about balancing their climate issues and economic development. Population and environmental contamination are strongly correlated; environmental damage rises as the population grows[3]. Dreadful environmental condition impact these areas 'biological section of the ecosystem'. With the progress of industrialization and urbanization, the pollution of air has increased in Asian region. Remote sensing and GIS is being commonly used for the application in the fields such as studies of water and air quality. But the atmospheric influences solar radiation satellite images of the surface of earth. So, satellite sensor's signal was the sum of ground and atmospheric effects. By acquiring data, pollutants could be calculated using remote sensing approach. Air pollution work in Lucknow has so far concentrated only on air pollution in the atmosphere [14,4,12,9,13]. Geographical Information System (GIS) has been widely used to assess, inventory, identify, modelling and management of the natural environment GIS-based approach to estimate pollutants using statistical interpolation methods. One of most important environmental issues is air pollution, which is concentrated mostly in urban regions. Burning fuel in any way releases as particulate matter in different types of unburned or waste oil in the environments [8]. Analytical analysis of air pollution is a fundamental problem, particularly with RSPM. Now a days more people are affected by particulate matter (PM) more than any other air pollutant, according to the WHO report. Even low levels of PM were associated with harmful effects on health [1]. With the modern knowledge base accumulation of the health problem effects of tiny particle or pollutants, the issue of particulate matter and gasified emission in the atmosphere is drawn new curiosity. Lucknow is the most populated city and capital of UP, the 2nd largest city in northern and central India. It is one of the fastest growing cities and now a metropolitan city in India and rapidly emerging as a hub for manufacturing, business and retail. Rising population, industrialization, and automobile production are the major cause of air pollution today [5]. Lucknow has inadequate facilities for transport. The use of personalized cars, primarily two wheeler, and intermediate public transport, is growing at a rapid rate due to the increasing urban population[10]. The total population of vehicles is more than 21 lakh with an 9.24% rise in 2018-2019 [7].

The purpose of this study to use Landsat 8 OLI and TIRS satellite data to test the efficiency of our proposed model for mapping air quality parameters. Currently, air quality in Lucknow city is being monitored by the board at 07 locations manually and 01 location by CAAQM (continue ambient air quality monitoring) stations of CPCB (central pollution control board) [7]. The surface instrument were built to track common contaminants (e.g. CO, $PM_{2.5}$,PM_{10},NO_2 etc.) and cannot identify the overall concentration of all pollutants at micro- level. Satellite data and ground truth data have been collected with respect to each other. Further,model has been developed to determine the concentration of different pollutants over the study area.

II. STUDY AREA

The capital city of UP, Lucknow lies between 26.30 & 27.10 N latitude and 80.30 & 81.13 E longitude. The district area of Lucknow is 2528 km^2. City area is quit small covers 350 km^2 and which is selected for study and its covering 404 km^2 in this work. The city is situated about 123 meters above mean sea level with average annual rainfall of 1001 mm approx. City's climate sees three different seasons throughout the year that are summer, monsoon, and winter. The max temperature rises to 48 ° C during May and June, and the min temperature remains at 6 ° C during the winter season [16].

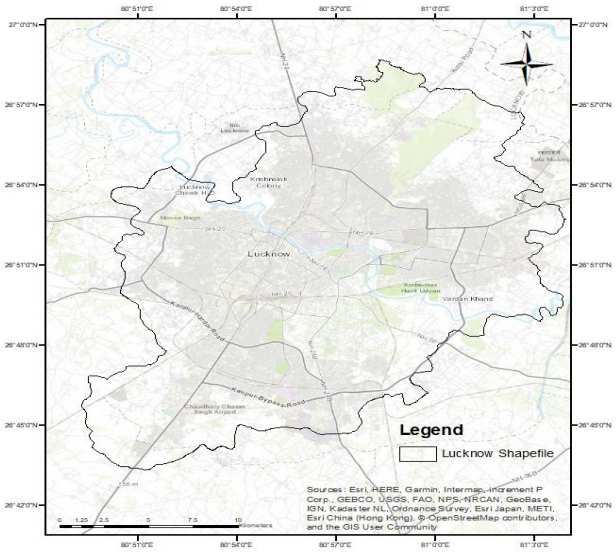


Fig.1 Study Area

III. MATERIALS AND METHODS

A. Air Quality data

For this study the ground truth air quality parameters is collected from CAAQM (continuous ambient air monitoring quality monitoring) stations of CPCB (central pollution control board) and UPPCB (UP pollution control board). There are four monitoring stations at different places (industrial, commercial and residential areas) in Lucknow city which are monitoring air pollutants continue on daily basis.

Table 1

Pollutant	Sources	Major effects
$PM_{2.5}$	Vehicular emissions, agricultural waste burning, fuelwood burning	Respiratory problems, liver fibrosis, lung/liver cancer, heart stroke, bone problems Visibility reduction, haze
Carbon monoxide	Incomplete fuel and wood burning, smoking	Anoxemia leading to various cardiovascular problems. Infants, pregnant women, and elderly people are at higher risk Visibility reduction, haze

B. Field Data Extraction

The GPS coordinates of specific monitoring stations were extracted using Google earth and then connected them to sub-sets of satellite images using Arc Map**.**

Table.3 List of Monitoring Stations with their coordinates.

Monitoring Station Name	Longitude	Latitude
Nishant Ganj, Lucknow - UPPCB.	80.5659	26.5201
Talkatora District Industries Center, Lucknow - CPCB.	80.5347	26.4959
Lalbagh,Lucknow-CPCB	80.5629	26.5045
Central School, Lucknow - CPCB.	80.5552	26.5255

C. Satellite Data

This study has been done using multi-temporal and remotely sensed data Landsat 8 OLI & TIRS data TM/ETM in geo-tiff format. Data has been obtained from USGS earth explorer. For analysis ArcGis 10.3 software is used. The satellite images has been taken on 25 Feb 2019. Geometric correction is done of all the images. Sample locations were located on the images.

Table.2 Landsat 8 bands

Bands	Wavelength (µm)	Description	Resolution (m)
B1	0.435-0.451	coastal/aerosol	30
B2	0.452-0.512	blue	30
B3	0.533-0.590	green	30
B4	0.636-0.673	red	30
B5	0.851-0.879	NIR	30
B6	1.566-1.651	shortwave IR-1	30
B7	2.107-2.294	shortwave IR-2	30
B8	0.503-0.676	PAN	15
B9	1.363-1.384	cirrus	30
B10	10.60-11.19	TIR – 1	100
B11	11.50-12.51	TIR – 2	100

D. Atmospheric Coefficient of reflection Calculation

Using basic formulas, digital numbers conversion to atmospheric radiance and reflectance of sensor. The measured reflectance in the case of Landsat 8 OLI & TIRS [17].

$$\rho\lambda = (m_p * q_{cal} + A_p)/ cos(\theta_{sz})$$

where
$\rho\lambda$ = TOA planetary reflectance
m_p = band-specific multiplicative rescaling factor from the metadata
A_p = band-specific additive rescaling factor from the metadata
q_{cal} = quantized and calibrated standard product pixel values (DN)
θ_{sz}= local solar zenith angle

E. Pre-Processing Of images

In image pre processing, the image quality measures are essential to get perfect images for analysis [2]. The strategies for pre-processing of images include procedures that need to be executed for getting the correct features and data from the downloaded raster image.Using Arc GIS 10.3, the satellite image is subsetted to the study area shapefile. The satellite image and the city shapefile are transmitted as arcmap layers. Using Arc Map's "Extract by Mask" tool, the Lucknow area was clipped of the picture of the satellite.

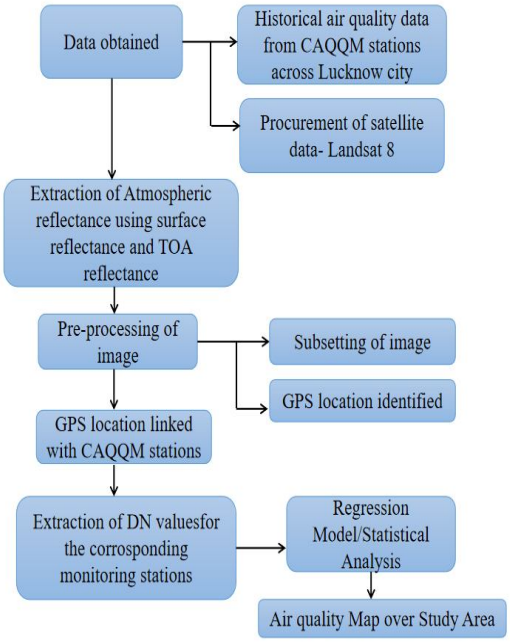


Fig.2 Methodology Flowchart

F. Extraction of DN Values with GPS Coordinates

After the GPS coordinates have been connected to the subset objects for all Monitoring tracking places of concern, DN values or pixel values are collected for the related GPS positions. This is achieved using software in Arc Map's spatial observer toolbox to "extract Multi values to Points."

G. Correlation and Regression Modeling

Correlation is a statistical method which indicates the correlation of two variables to each other. Parameter are varies from zero to infinity symbolized as “R” in multiple linear correlation. Parameters of air quality was correlated with atmospheric reflectance. Higher correlated band was selected and developed multiple regression model. However, several linear regression models were used to measure the relationship among the different parameters of quality of air and the most correlated Landsat 8 OLI and TIRS band values. The regression model was developed separately in the form below for every parameter [17].

$$Y = ß_0 + ß_1B_1 + ß_2B_2 + ß_3B_3$$

Where, $ß_0$,$ß_1$,$ß_2$, and $ß_3$ are the coefficients B_1,B_2, and B_3 are the most correlated bands.

IV. RESULT AND DISCUSSION

The very first model is combining bands 2,3 and 5 is the best for $PM_{2.5}$ prediction. The R^2 for this band is 0.60 which shows that estimated and predicted relationship is good for $PM_{2.5}$ and it means that the model can explain 60% of variation in $PM_{2.5}$. Second model, on the other side, mixing band 5 and 7, provided the best match for predicting CO with 0.74 R^2. the validation of proposed data is done using the atmospheric reflectance of satellite images obtained on 25 February 2019 with the corresponding ground truth information.The results of the validation showed that models built using Landsat OLI & TIRS data were appropriate for particulate matter, whereas the satellite data listed can not be used reliably to predict gaseous pollutants.

Table.4 Model for air quality parameters

Pollutants	Best correlated bands	Regression Model
$PM_{2.5}$	B2	$=\beta_0+(\beta_1*B2)+(\beta_2*B3)+(\beta_3*B5)$ Where, $\beta_0=60.393,\beta_1=0.0368,\beta_2=(-1.355),\beta_3=1.184$
	B3	
	B5	
CO	B5	$=\beta_0+(\beta_1*B5)+(\beta_2*B7)$ Where, $\beta_0=101.89,\beta_1=(-1.0473),\beta_2=0.34$
	B7	

V. CONCLUSION

It is observed from this study is that Remote sensing and GIS technology is capable of providing valuable air pollution information.Another key finding of the report is that Landsat 8 OLI & TIRS information will be beneficial for modelling, predicting, developing maps and estimating pollution levels of suspended particulate matter ($PM_{2.5}$). on the contrary the satellite data described above is suitable for analytical analysis of gaseous pollutants. Based on this study the results shows that most of the urban region of Lucknow city is facing $PM_{2.5}$ concentration ranging from 87 to 357 $mg/m^{3.}$.This analysis would help us to derive air quality from a number of sources, each efficiently calculated at different resolution, with different error mechanisms and different uncertainty levels. It will lead to risk management to a more accurate measurement of air quality.

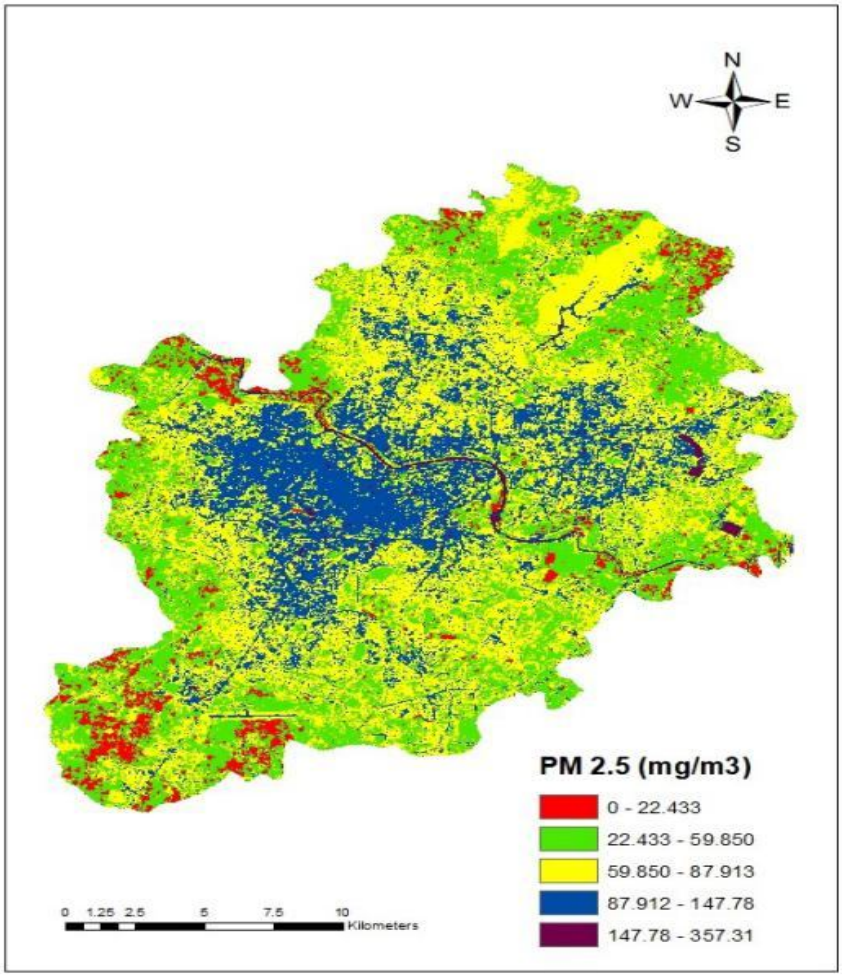


Fig.3 Concentration of $PM_{2.5}$

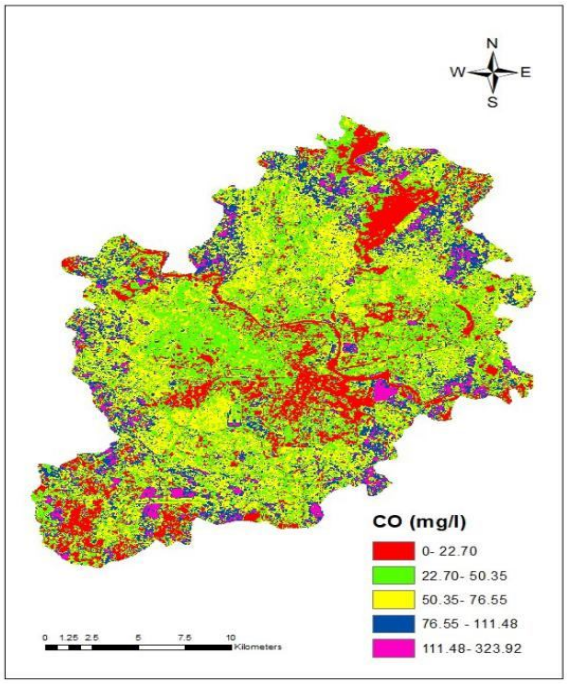


Fig.4 Concentration of CO

REFERENCE

[1] Agarwal S. Effect of indoor air pollution from biomass and solid fuel combustion on prevalence of self-reported asthma among adult men and women in India: findings from a nationwide large-scale cross-sectional survey. J Asthma 2012;49(9):989.

[2] Akanksha, Pranjal Pandey, and Shivangi Somvanshi. "COMPARITIVE ANALYSIS OF DIFFERENT VEGETATION INDICIES FOR THE ASSESSMENT OF TEA GARDENS."Journal of Agroecology and Natural Resource Management 92 p-ISSN:2394-0786, e-ISSN:2394-0794, Volume 6, Issue 3; April – June, 2019, pp. 92-98 © Krishi Sanskriti Publications http://www.krishisanskriti.org/Publication.html

[3] Barck C, Lundahl J, Hallden G, Bylin G. Brief exposures to NO2 augments-the allergic inflammation in asthmatics. Environ Res 2005:58–66

[4] Barman SC, Kumar N, Singh R, Kisku GC, Khan AH, Kidwai MM, et al. Assessment of urban air pollution and its probable health impact. J Environ Biol 2010;31(6):913–20

[5] Bell ML, Davis DL, Gouveia N, Vector HBA, Cifuentes LA. The avoidable health effects of air pollution in three Latin American cities: Santiago, Sao Paula, and Mexico City. Environ Res 2006;100:431–40

[6] Census of India, 2011 Census of India Provisional population totals Registrar General & Census Commissioner, Ministry of Home Affairs, Government of India,India,NewDelhi(2011).

[7] Indian Institute of Toxicology and Research (IITR), Lucknow. Assessment of ambient air quality of Lucknow City during pre-monsoon. 2018 — a report; 2019

[8] Khan AH, Ansari FA, Patel DK, Siddiqui H, Sharma S, Ashquin M, et al. Indoor exposure to respirable particulate matter and particulate-phase PAHs in rural homes in North India. Environ Monit Assess 2010;170(1–4):491–7.

[9] Kim YS. A literature review on indoor air quality in Korea. J Korean Public Health Assoc 1992;18:147–65

[10] Kisku GC, Pradhan S, Khan AH, Bhargava SK. Pollution in Lucknow City and its health implication on exposed vendors, drivers and traffic policeman. Air Qual Atmos Health2012.http://dx.doi.org/10.1007/s11869-012-0190-7

[11] LawrenceA,FatimaN,Urban air pollution & its assessment in Lucknow City—These condlargest city of North India,Sci Total Environ(2013),http://dx.doi.org/10.1016/j.scitotenv.2013.10.106

[12] Pandey P, Khan AH, Verma AK, Singh KA, Kisku GC, Barman SC. Seasonal trends of PM2.5 and PM10 in ambient air and their correlation in ambient air of LucknowCity, India.BullEnvironContamToxicol2012;88(2):265–70

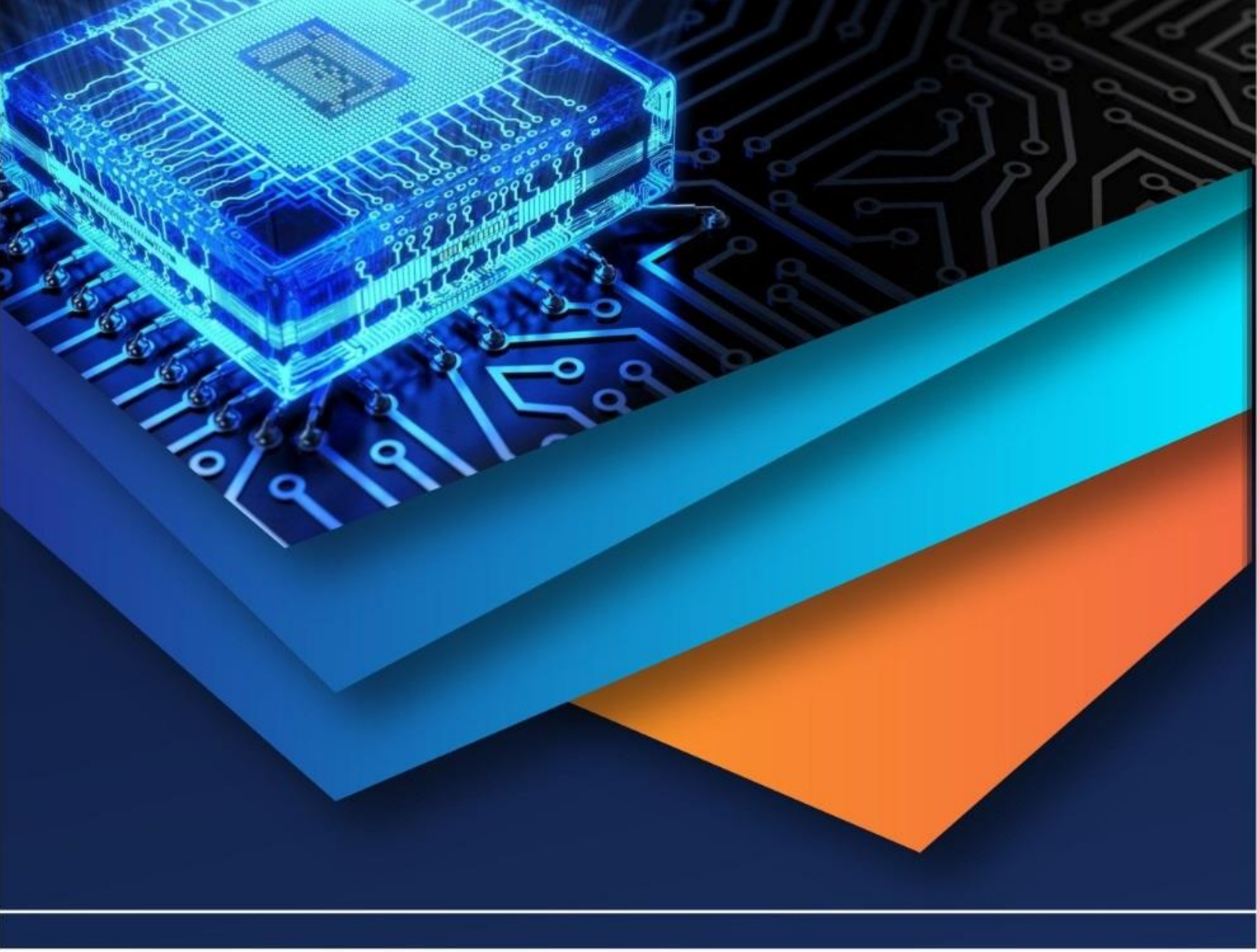
[13] Pandey P, Khan AH, Verma AK, Singh KA, Kisku GC, Barman SC. Seasonal trends of PM2.5 and PM10 in ambient air and their correlation in ambient air of Lucknow City, India. Bull Environ Contam Toxicol 2012;88(2):265–70.

[14] Pandey P, Patel DK, Khan AH, Barman SC, Murthy RC, Kisku GC. Temporal distribution of fine particulates (PM2.5, PM10), potentially toxic metals, PAHs and metal-bound carcinogenic risk in the population of Lucknow City, India. J Environ Sci Health 2013: 730–45. http://dx.doi.org/10.1080/10934529.2013.744613

[15] Sharma K, Singh R, Barman SC, Mishra D, Kumar R, Negi MPS, et al. Comparison of trace metals concentration in PM10 of different locations of Lucknow City, India. Bull Environ Contam Toxicol 2006;77:419–26.

[16] Shukla, A., & Jain, K. (2019). Critical analysis of rural-urban transitions and transformations in Lucknow city, India. *Remote Sensing Applications: Society and Environment, 13*, 445-456.

[17] Somvanshi S.S., Vashisht A., Chandra U., Kaushik G. (2019) Delhi Air Pollution Modeling Using Remote Sensing Technique. In: Hussain C. (eds) Handbook of Environmental Materials Management. Springer, Cham.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY