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AEROSOL OPTICAL DEPTH IN VARIOUS SEASONS, USING MODIS DATA - A STUDY OF LUCKNOW DISTRICT

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Abstract

Very fine solid or liquid particles which are present in the atmosphere are termed as Aerosols. Measurement of these aerosols particles which is distributed in the column of the air from the earth's surface to the Top of Atmosphere are called Aerosol Optical Depth (AOD). Space monitoring of AOD can serve as a potential human induced activity indicator which pollute the air. The Moderate Resolution Imaging Spectroradiometer (MODIS) data, both Terra and Aqua can help us determine the AOD since 2000.

The present work aims to investigate the seasonal variations in AOD levels in the Lucknow district. The AOD was found to be increasing by 86.5% in the last 20 years in the month of January which was recorded the highest percentage increase in AOD while the lowest was in the month of September -7.5%.

Keywords: **Anthropogenic activity, space monitoring, Aerosols, Aerosol Optical Depth (AOD), MODIS (Moderate Resolution Imaging Spectroradiometer)**

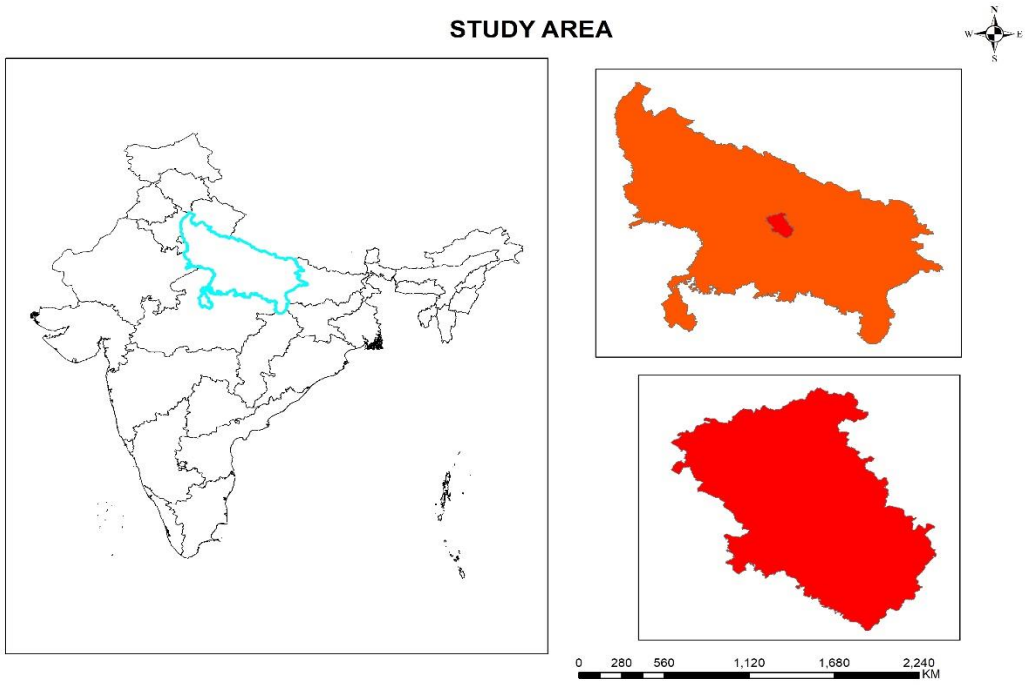
Introduction

Atmospheric aerosols affect the overall energy balance of the earth. They are produced by both natural and man-made processes and get dispersed horizontally and vertically through atmospheric circulation. Due to their brief and momentarily life span of about a week in the lower atmosphere, they exhibit large spatial and temporal variability. Aerosols affect the climate and play a major role in climate change but due to variabilities in characteristics on the regional levels it becomes difficult to predict their characteristics.

MODIS provides both Terra and Aqua satellites to find AOD over land and water bodies. The regional populated tropical areas contribute most to global aerosol surface forcing (Chung et.al,2005). The researchers have begun to explore the potential of MODIS data to estimate air quality(Gupta et.al 2006).The spatial temporal variability occurs by meteorological conditions such as moist air masses and air pollution induced due to anthropogenic activities contributing to increase in AODs.

Study Area

Lucknow is the capital city of Uttar Pradesh situated in North India and is also the administrative headquarters of district and divisions having a population of 2.8 million as per 2011 census, it is one of the most populated cities of Uttar Pradesh. Bounded by the east of Barabanki, on the west by Unnao, on the south by Raebareli and in the north by Sitapur and Hardoi, Lucknow is on the north-western bank of Gomati River. Since this place is a hub for governance, administration, education and tourism etc it has more job opportunities and hence it is widely populated with the migrants of the nearby areas too.



Data

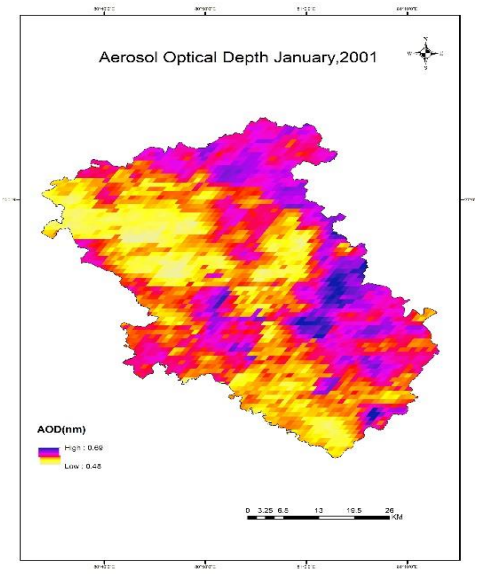
Our approach to estimating the AOD over Lucknow district was based on analysing long-term variations of AOD. To attain the goal, we used AOD data from the MODIS. The band named as Optical_ Depth_047, Blue Band (0.47um) aerosol optical depth over land) was retrieved the AOD data from Google Earth Engine. The AOD was estimated for the year 2001 and 2021 of the January, March, May, July, September, November months. MODIS-Terra, a comparison between the 2001 and 2021 showed similar AOD trends and results.

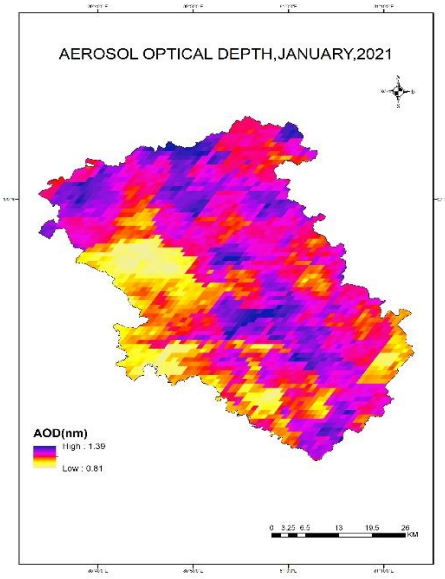
The MCD19A2 V6 data product is a combined Terra and Aqua, Multi-angle Implementation of Atmospheric Correction (MAIAC) Land Aerosol Optical Depth (AOD) gridded Level 2 product produced daily at 1 km resolution. (MAIAC user guide)

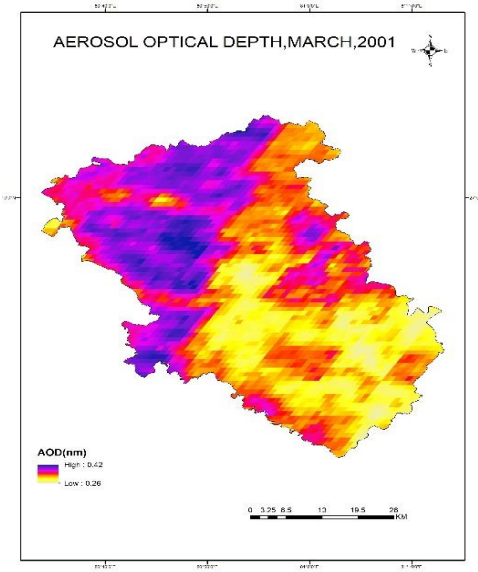
Results

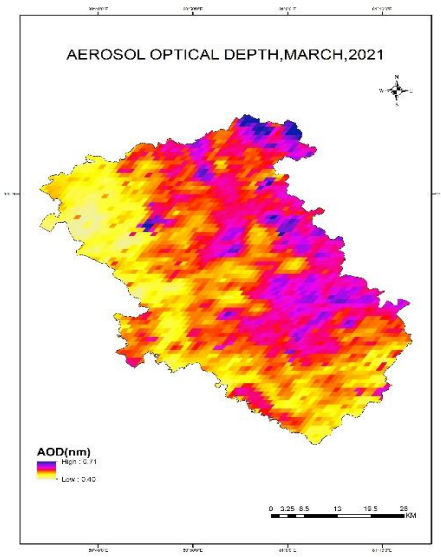
The Maximum Aerosol Optical Depth in 2001 was found to be 0.74 in the month of November while in 2021 the AOD was maximum in the month of November and January respectively. The least AOD was observed in the month of March in 2001 which was 0.34 and in the year 2021 the minimum AOD was observed in the month of September which was post monsoon, followed by the month of March with an AOD of 0.56.

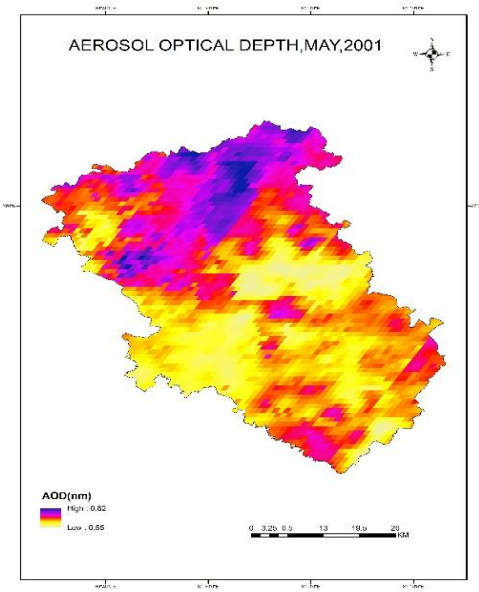
MONTH	2001 AOD mean	2021 AOD mean
JANUARY	0.58	1.10
MARCH	0.34	0.56
MAY	0.69	0.78
JULY	0.69	1.16
SEP	0.52	0.48
NOV	0.74	1.20

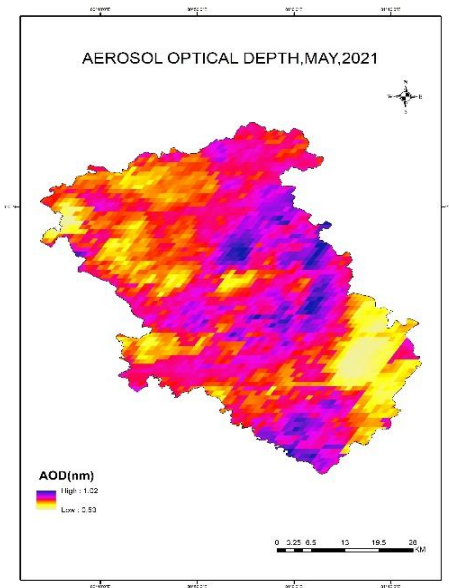

Aerosol Optical Depth January,2001
AOD(nm)
High : 0.69
Low : 0.48
0 3.25 6.5 13 19.5 26
KM

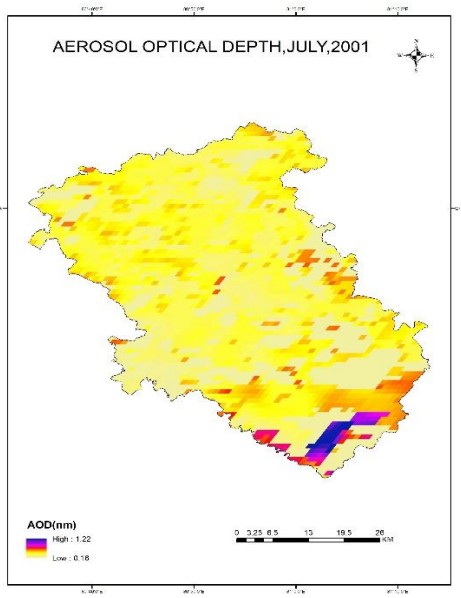

AEROSOL OPTICAL DEPTH,JANUARY,2021
AOD(nm)
High : 1.39
Low : 0.81
0 3.25 6.5 13 19.5 26
KM

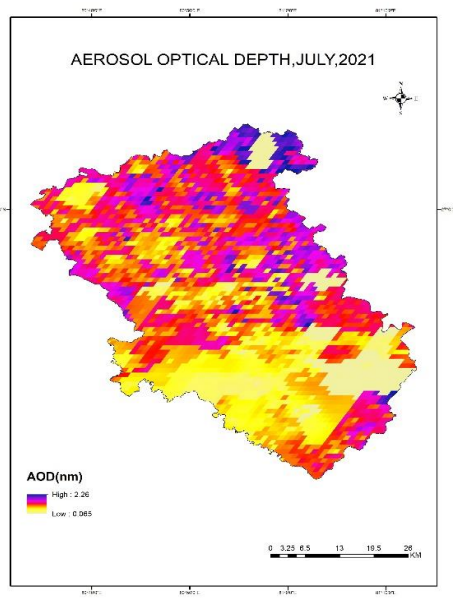

AEROSOL OPTICAL DEPTH,MARCH,2001
AOD(nm)
High : 0.42
Low : 0.26
0 3.25 6.5 13 19.5 26
KM

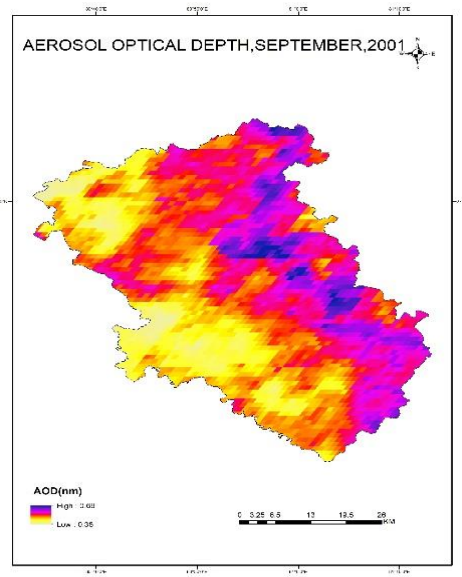

AEROSOL OPTICAL DEPTH,MARCH,2021
AOD(nm)
0 3.25 6.5 13 19.5 26
KM

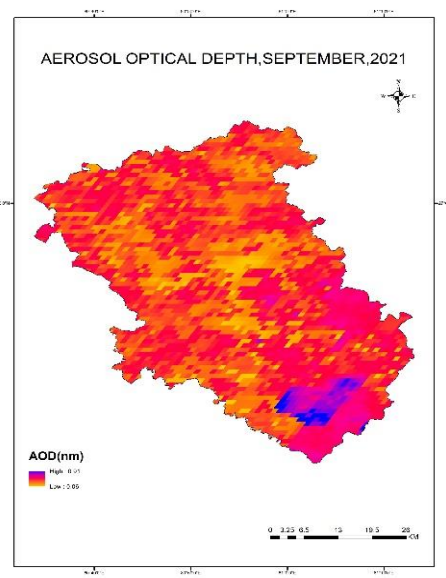

AEROSOL OPTICAL DEPTH,MAY,2001
AOD(nm)
High : 0.82
Low : 0.55
0 3.25 6.5 13 19.5 26
KM

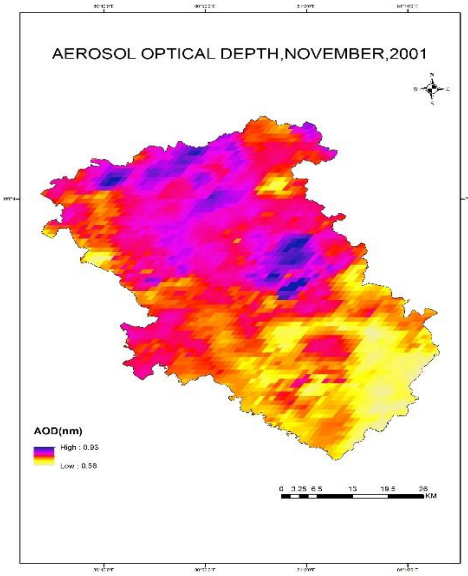

AEROSOL OPTICAL DEPTH,MAY,2021
AOD(nm)
High : 1.02
Low : 0.53
0 3.25 6.5 13 19.5 26
KM

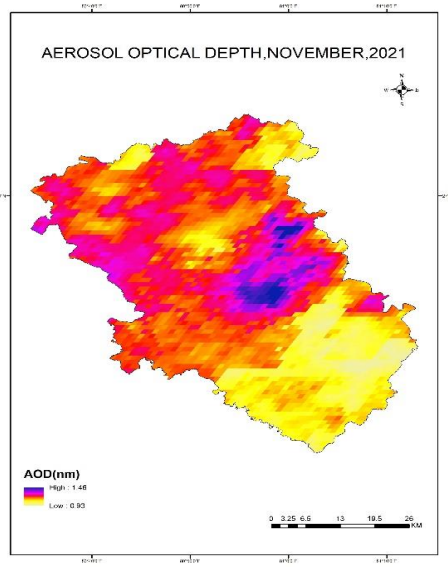

AEROSOL OPTICAL DEPTH,JULY,2001
AOD(nm)
High : 1.22
Low : 0.16
0 3.25 6.5 13 19.5 26
KM

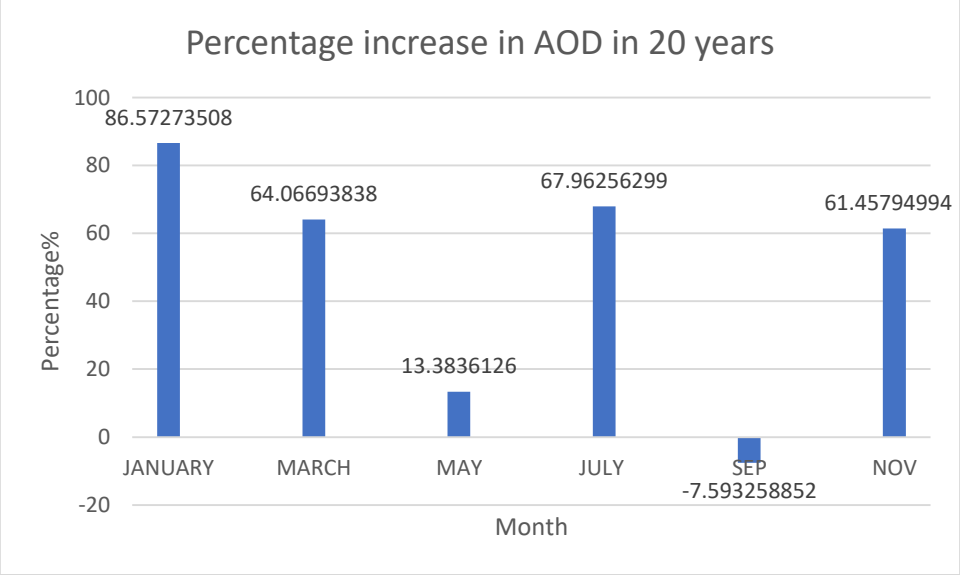

AEROSOL OPTICAL DEPTH,JULY,2021
AOD(nm)
High : 2.26
Low : 0.085
0 3.25 6.5 13 19.5 26
KM


AEROSOL OPTICAL DEPTH,SEPTEMBER,2001
AOD(nm)
0 3.25 6.5 13 19.5 26
KM


AEROSOL OPTICAL DEPTH,SEPTEMBER,2021
AOD(nm)
0 3.25 6.5 13 19.5 26
KM


AEROSOL OPTICAL DEPTH,NOVEMBER,2001
AOD(nm)
High : 0.93
Low : 0.58
0 3.25 6.5 13 19.5 26
KM


AEROSOL OPTICAL DEPTH,NOVEMBER,2021
AOD(nm)
High : 1.46
Low : 0.93
0 3.25 6.5 13 19.5 26
KM



Conclusion

Aerosols have increased leaps and bounds in the past 20 years due to immense consumption of energy. In the month of January, the maximum AOD was 0.69nm and 0.48nm while the minimum AOD recorded was 0.48nm and 0.81nm in 2001 and 2021 respectively. This accounts for an increase of 86.5% increase in the levels of aerosol optical depth in the last 20 years. In the month of September which is the month after the heavy south western monsoon has already taken place in this region, the AOD was quite less. Although an increase was noticed in the maximum AODs of the September month in 2001 and in 2021. The main city area of the Lucknow district remained full of aerosol particles in the winter months (November and January) thus making the air more polluted and difficult for breathing especially for the people who suffer from lung and respiratory diseases. An increase of around 61.45% was also recorded in the month of November.

Discussion

Increased energy consumption of fossil fuels, stubble burning and burning of fire-crackers etc have been prominent reasons for the increased AOD levels in the month of November. Due to atmospheric conditions prevailing in the Northern India, the Aerosols level remain high during the winter month. When there is onset of summer around the month of March, the AOD levels slowly decrease due to widespread dust storms commonly named as “loo”. Due to increased consumption of fossil fuels and industrial effluents, the aerosols again rise into the atmosphere but soon after the May month ends, the monsoon hits Lucknow and the AOD levels become comparatively low. Again, in the month of November due to several reasons, the AOD level rises.

The only way to combat rising levels of AOD is to cut down on sources which causes dust, smoke and pollution which means use of eco-friendly use of transportation, capacity building of farmers to not be inclined towards Shifting agriculture.

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