ISSN: 0975-833X

Available online at http://www.journalcra.com

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

International Journal of Current Research
Vol. 13, Issue, 03, pp.16434-16443, March, 2021

DOI: https://doi.org/10.24941/ijcr.40917.03.2021

REVIEW ARTICLE **OPEN ACCESS**

COVID -19 PANDEMIC PERIOD: TIME TO UNDERSTAND CLIMATIC CHANGES OF CHHATTISGARH STATE, INDIA

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ARTICLE INFO

Article History:
Received 07th December, 2020
Received in revised form
10th January, 2021
Accepted 19th February, 2021
Published online 17th March, 2021

Key Words:

Air Pollution, Covid-19,
Ecosystem,
Green House Gases.

ABSTRACT

This study analyzed the association between COVID-19 and climate indicators in Chhattisgarh State in India. On 19 March, 2020 fast cases of SARS-CoV-2 was recorded in Chhattisgarh, State. On March 24, the Union government ordered a nationwide lockdown for 21 days and then the lockdown has been extended many times with gradual lifting of restrictions. Limiting the movement of people in India as a preventive measure against the COVID-19 pandemic. The climate indicators include the study are Land Surface Temperature, Air temperature, Aerosol optical Depth, Sulfur dioxide, Nitrogen dioxide, Carbon Monoxide, Methane, Ozone. Authors used Satellite Image from online web portal "Giovanni" and "Landsat-8" Satellite Data. Geospatial technology is used to calculate Land Surface Temperature and Web-GIS used to measure air temperature and other Greenhouse gases. Air temperature, AOD, SO2, NO2, CO and O3 concentrations have reduced significantly after commencing lockdown. Only CH4 significantly increased during shut down in Chhattisgarh state in India. The partial lockdown can improve the quality of environment but negative impacts on social aspects. The authors applied statistical and quantitative analysis of the relationship between air pollution and to estimate the impact of the condition, air pollution.

Citation: Aniruddha Haldar and Amit Prakash Multaniya. "Covid -19 Pandemic Period: Time to Understand Climatic Changes of Chhattisgarh State, India.", 2021. *International Journal of Current Research, 13, (03), 16434-16443.*

INTRODUCTION

Today the world is facing an unimaginable problem due to the Corona virus. For that reason, people all over the world face a helpless situation today. The WHO China Country Office was informed of cases of pneumonia unknown etiology (unknown cause) (Atri et al.) detected in Wuhan City, Hubei Province of China On 31 December 2019, (Zhu et al.). On 7th January 2020 The Chinese authorities identified a new type of coronavirus (WHO 2020). At the time of this report writing, worldwide 14 562 550 people had been infected, which had died 607 781(WHO 2020). The first case of COVID-19infection was registered in India on January 30, 2020 in Kerala (Aggarwal et al.), and fast registered case of Chhattisgarh on March 19, 2020 and immediately emergency situation was declared. On 24th march the Union government ordered a nationwide lockdown for 21 days then the lockdown has been extended many times with gradual lifting of restrictions. Since March 25th, 2020 to May 31st 2020 all local and central administrations worldwide have literally put a ban on free movement of their citizens outside their home in order to avoid community transmission. The various mass gathering events like religious, cultural, social, scientific, sport, and political activity are held in abeyance. Most of the industrial activities are not functioning; all types of vehicle movement are restricted. Due to lesser demand of power in industries, use of fossil fuels or conventional energy sources have been lowered considerably. Due to non- operational industries, industrial waste emission has reduced to a large extent. Vehicles movements are barely seen on the roads resultant almost zero emission of green-house gases and tiny toxic suspended particles and because of this improved air quality index is available for inhabitants of town and villages. Ecosystems are being significantly improved (Lokhandwala and Gautam). In many scientific reports shown the inhabitants are experiencing a clear sky for the first time in their lives. The pollution level in environment is also attenuating remarkably (Muhammad et al.) . Ozone layer has been found to have

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invigorated to some extent (Sharma et al.) and (Otmani et al.). The pandemic has displayed its contrasting consequence on human civilization, in the sense that, on one hand it has executed worldwide destruction, but created a very positive impact on the world environment on the other hand. Environment change was reported due to the unusual outbreak of COVID-19, almost every big and small cities and villages in all over the world (Sikarwar and Rani) (Fisher and Wilder-Smith), is under partial of total lockdown for a time period ranging from a few weeks up to a few months(Chakraborty and Maity). In this pandemic period change in air quality reported worldwide. In earlier studies of Covid – 19 periods the amount of Nitrogen decreased throughout China (NASA) and fatality caused by COVID-19 in another study of areas in Italy, Spain, have warned about the PM concentration growth in lower atmosphere due to human activities(Dantas et al.) (Mandal and Pal). Most of study signified the use of Landsat or MODIS products for environmental change with concentration of greenhouse gases like SO2, NO2, CO, PM etc. are considered as dominant causes of temperature rise in atmosphere (Lee et al.)(Bashir et al.)

OBJECTIVE

- To Understand Climatic Condition.
- To Climatic Mitigation major for climate Change.

MATERIAL AND METHODS:

Study Area:

The state of Chhattisgarh is located in the east-central part of India. It is bounded by the other Indian states viz. Uttar Pradesh and Jharkhand in north, Odisha in east, Telangana in south and Maharashtra and Madhya Pradesh in west. The state divided in 3 Agro Climatic zone viz. Northern Hill, Chhattisgarh plane, and Baster plateau. As per census of India 2011 total population of Chhattisgarh 25,540,196. (*Census of India 2011*). Chhattisgarh is the 10th largest state of India, with an area of 135,191 km2, with a population of 3.22 cores as of 2020. Chhattisgarh is the 16th-most populated state in the country(*Census of India 2011*.) The total forest area in the state is 55,610.57 sq km which is 41.14 % of total geographical area in Chhattisgarh. Temperature ranges 30^0C to 49^0c in summer period Chhattisgarh and average rainfall 1,292 millimeters.

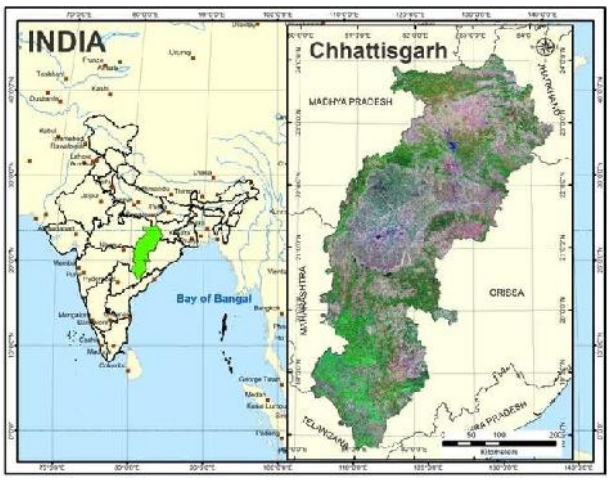

Figure 1. Location Map of Chhattisgarh

Material: In this study, uses different sensors data to measure the concentrations of Aerosol Optical Depth, Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2), Methane (CH_4), Carbon Monoxide (CO) and Ozone (O_3) for lockdown period. Aerosol Optical Depth, Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2), Methane (CH_4), Carbon Monoxide (CO) and Ozone (O_3) concentration levels were obtained from the "giovanni" public air quality monitoring network (giovanni.gsfc.nasa.gov). We also collected Landsat-8 (OLI/TIRS) satellite data from USGS earth explorer to calculate the land surface temperature. Data have been collected from March 24th to 30th March 2020 and the same period in previous years. Additionally, the air quality was compared within 2020 between the periods lockdown (24th march to 31st march 2020 and the same period in previous years) and after unlock-1 (1st June to 7th June 2020 and the same period in previous years).

Table 1. Data used for study

Data	Satellite /Sensor	Sources
Thermal Image	Landsat-8/(TIRS)	earthexplorer.usgs.gov
Nitrogen Dioxide (NO_2)	OMNO2d	//disc.sci.gsfc.nasa.gov/giovanni
Methane (CH_4)	AIRS	
Carbon Monoxide (CO)	AIRS	
Ozone(O_3)	AIRS	
Sulfur Dioxide (SO_2)	MERRA-2	
Air Temperature	AIRS	
Aerosol Optical Depth	MODIS	

Landsat-8/ (TIRS): The Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) (U.S. Geological Survey)are instruments onboard the Landsat 8 satellite, which was launched in February of 2013. The satellite collects images of the Earth with a 16-day repeat cycle, referenced to the Worldwide Reference System-2, The approximate scene size is 170 km north-south by 183 km east-west (106 mi by 114 mi) (Landsat Mission 1972). The spectral bands of the OLI sensor provide enhancement from prior Landsat instruments, with the addition new infrared channel (band 9) for the detection of cirrus clouds. Two thermal bands (TIRS) capture data with a minimum of 100 meter resolution, but are registered to and delivered with the 30-meter OLI data with 16-bit data product.

OMNO2d: The OMI/Aura Level-3 Global Gridded (0.25x0.25 deg) Nitrogen Dioxide Product "OMNO2d" is released (NASA 2013) OMNO2d File Specification to the public from the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC). The OMNO2 (Level-2) and OMNO2G (Level-2G, binned) processed earlier (in 2012) are also available from GES DISC. Nitrogen dioxide is an important chemical species in both, the stratosphere where it plays a key role in ozone chemistry and in the troposphere where it is a precursor to ozone production (Krotkov et al.). In the troposphere, it is produced in various combustion processes and in lightning and is an indicator of poor air quality. This sensor provide Total column NO2 and Total Tropospheric Column NO2, for all atmospheric conditions, and for sky conditions where cloud fraction is less than 30 percent. OMNO2d data are stored in EOS Hierarchical Data Format (HDF-EOS). Each file contains data from the day lit portion of the orbit (~14 orbits)(NASA, "Ozone Monitoring Instrument (OMI) Data User's Guide"). The average file size for the OMNO2d data product is about 6 Mbytes. (Follette-Cook and Gupta)

AIRS, the Atmospheric Infrared Sounder: AIRS is a high-resolution infrared sounder with its central purpose being to obtain atmospheric temperature and humidity profiles from the surface upward to an altitude of 40 km (NASA,2001). As a thermal infrared sounder that has been very stable since its launch and of which is still under operation, AIRS on the EOS/Aqua satellite was launched in polar orbit (13:30 local standard time, ascending node) in May 2002(Zou et al.). It has 2378 channels covering 649–1136, 1217–1613, and 2169–2674 cm−1 at high spectral resolution (λ/Δλ = 1200) [8] and the noise in the equivalent change in temperature (NeΔT) at a reference temperature of 250 K ranges from 0.14 K in the 4.2 μm in the lower troposphere sounding wavelengths to 0.35 K in the 15 μm in the upper troposphere sounding region. The spatial resolution of AIRS is 13.5 km at nadir and in a 24-hour period, AIRS nominally observes the complete globe twice(Krotkov et al.). Data collected for off-nadir locations will have coarser resolutions. The AIRS instrument is expected to provide substantial improvements, especially in the temperature measurements, over any previous sounder flown in space (Aumann et al.) (Fishbein et al.)

MERRA-2: The Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) (Bosilovich et al.).provides data beginning in 1980. In this work the data provided through MERRA-2 -Modern-Era Retrospective Analysis for Research and Applications version 2- were used MEERA-2 is an update to its proceeding intended to provide an ongoing climate analysis that goes beyond the MERRA's terminus, while addressing it's known limitations Unlike in MERRA, all data collections from MERRA-2 are provided on the same horizontal grid (Eltahan et al.) . This grid has 576 points in the longitudinal direction and 361 points in the latitudinal direction, corresponding to a resolution of 0.625°×0.5°. The longitudinal resolution of the data is changed from 0.667° in MERRA and the latitudinal resolution remains unchanged (0.5°)(Manney et al.). One of the recent studies that use MERRA-2 and shows that regionally averaged time series of the Moderate Resolution Imaging Spectroradiometer (MODIS) observed CDNC of low, liquid-topped clouds is well predicted by the MERRA2 reanalysis near-surface sulfate mass concentration over decadal timescales (McCoy et al.). A multiple linear regression between MERRA2 reanalyzes masses of sulfate (SO4), black carbon (BC), organic carbon (OC), sea salt (SS), and dust (DU) shows that CDNC across many different(Michou et al.) regimes can be reproduced by a simple power-law fit to near-surface SO4, with smaller contributions from BC, OC, SS, and DU (Daniel T. McCoy, 2018).

MODIS: The scientific instrument moderate-resolution imaging spectro-radiometer (MODIS) was on board of the Terra and Aqua satellites in 1999 and 2002 respectively. Many and different products were retrieved from MODIS. Its aerosol products monitor optical properties like aerosol optical depth (AOD) (Levy et al.) and single scattering albedo (SSA) over Land and Oceans.Level-3 data with resolution (1^o degree) from MODIS is used in the benchmark over the MENA domain that conducted to evaluate AOD product(Eltahan et al.). Collection-6 of aerosol product is used for AOD Calculations, that merges together both algorithms of dark target (DT) and deep blue (DB).

Method: From the geospatial point of view, the "surface" is anything which is visible and looks through the space to the ground. During the day, the Sun's rays warm Earth's lands. Some of this warmth rises into the air where gases catch and hold the warmth near the surface. These gases (called greenhouse gases) also help to warm Earth's land surface and it also influences weather and climate patterns. Chemical constant of greenhouse gases indicates the role of in climatic conditions. We can use a thermometer to measure the temperature of any single place. Likewise, many scientific organizations can measure the temperature of the whole world from space using instruments carried on satellites. Mapping the earth surface temperature helps to better understand our environment condition (WHO,2003). In this study two type of data sets were used: i) Land surface temperature; ii) Air quality assessment.

Land Surface Temperature: Land Surface Temperature (LST) is a fundamental aspect of climate and biology, affecting organisms and ecosystems from local to global scales (Mildrexler). Land surface temperature illustrates how warm or cold an object is the earth surface in particular location. Land surface temperature is not the same as an air temperature that is include daily weather report (Mutiibwa et al.). LST measures the emission of thermal radiance from the land surface where the incoming solar energy interacts with and heats the ground (Valizadeh Kamran *et al*, Jeevalakshmi *et al*and (Rajeshwari et. al.), or the surface of the canopy in vegetated areas. Zero percent cloud cover Satellite dataset of Landsat-8OLI/TIRS (day time, level-1G product) were used for Chhattisgarh state of lockdown period 24th march to 31st march and first week of unlock-, 1st June to 7th June 2020 and same time data of pervious year has been used in this study. Methodology of LST analysis is shown in Figure 2.

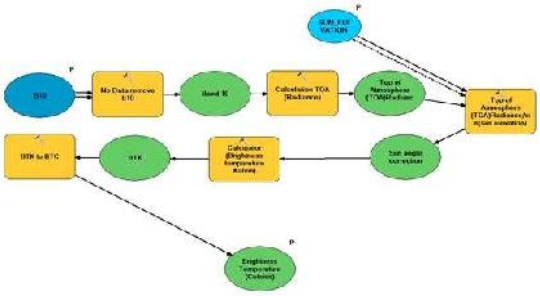

Figure 2. Flow diagram for LST estimation

Top of Atmospheric Spectral (Radiance): Landsat Level-1 data can be converted to TOA spectral radiance)using the radiance rescaling factors in the MTL file:

$$L\lambda = ML*Qcal + AL \quad (1)$$

Where,

Lλ- Top of Atmospheric Radiance in watts/ (m2*srad*μm)
ML - Band specific multiplicative rescaling factor (radiance_mult_band_10)
Qcal - Band 10 image Landsat 8
AL - Band specific additive rescaling factor (radiance_add_band_10)

Top of Atmospheric Spectral Radiance with a correction for the sun angle is

$$L = \frac{L\lambda'}{\cos(\theta S)} = \frac{L\lambda'}{\sin(\theta S)} \quad (2)$$

Conversion to Top of Atmosphere Brightness Temperature

$$T = \frac{K2}{L\ (\frac{K1}{L}+1)} \quad (3)$$

Where:

T = Top of atmosphere brightness temperature (Kalvin)
Lλ =TOA spectral radiance (Watts/ (m2 * srad * µm))
K1 = Band-specific thermal conversion constant from the metadata (K1_CONSTANT_BAND_x, where x is the thermal band number)

K2 = Band-specific thermal conversion constant from the metadata (K2_CONSTANT_BAND_x, where x is the thermal band number)

Conversion of Kelvin to Celsius.

Brightness temperature ^{0}C= (T - 273.15)(4)

Air Quality Assessment: Climate change can impact air quality and, conversely, air quality can impact climate change. Changes in climate can result in impacts to local air quality. Atmospheric warming associated with climate change has the potential to increase or decrease air quality in many regions. The impact of climate change on air pollutants, such as Nitrogen dioxide, Sulfur dioxide, Carbon Monoxide, Methane (CH4) and Ozone (O_3), are less certain, but previous research is underway to address these uncertainties.

Emissions of pollutants into the air can result in changes to the climate. Satellite data of atmospheric pollutants are becoming more widely used in the decision-making and environmental management activities of public, private sector and non-profit organizations (Barn et al.) (Sicard et al.) (Belhout et al.). A decision support modeling tool of NASA Giovanni system has provided access to a wide variety of NASA remote sensing data and other Earth science data sets. This web based analysis systems allow different kinds of air quality data to apply in this research topic (NASA) (William et al.). For air quality analysis during the lockdown period air quality data has been downloaded from Giovanni web page: http://disc.sci.gsfc.nasa.gov/giovanni and following steps are made for peer analysis:

- Generating Maps of Air Quality Products
- Spatial Selection on a map for research area
- Parameter Selection
- Temporal Selection for time period for study
- Visualization of data set
- Download the data sets for further analysis

RESULT AND DISCUSSION

To compare the results, two different time period data of seven years of Chhattisgarh areas were chosen according to the availability. In the Study, the satellite image was taken between lockdown period 24th march to 31st march and first week of unlock- 1st June to 7th June for all the seven year. Lands at-8/ (TIRS) Satellite imagery based LST

Land Surface Temperature (LST): Land surface temperature is an important factor in many areas, such as global climate change, geo-hydrological, biophysical and urban land use / land cover (Avdan and Jovanovska). In this study, the TIR band 10 was used to estimate brightness temperature (10) (Guo et al.). After downloading the satellite images from http://earthexplorer.usgs.gov/, LSTs were retrieved in image processing software using the algorithm presented in this paper. The differences between the retrieved LSTs and the recorded data were observed approximately ±2°C. Satellite imagery corroborates that the land surface temperatures of March, 2020 and June, 2020 have been significantly below the last six years average temperature of 38°C and 40°C respectively. This indicates that in the year 2020, there has been a plummet in temperature due to controlled industrial and other development activities (Figure 3).

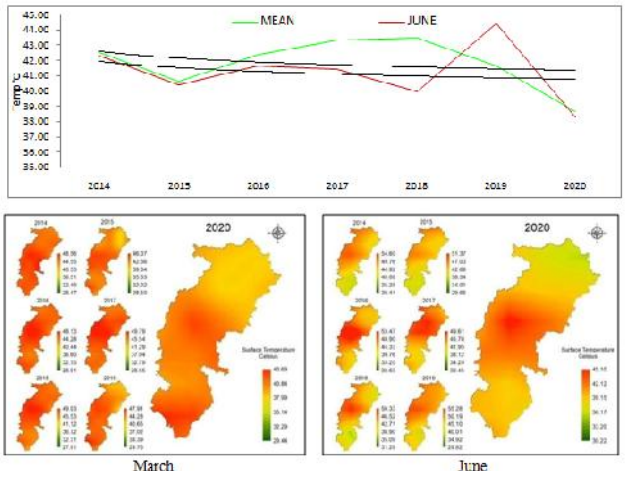

Figure 3. Land Surface Temperature

Giovanni web tool based Air Quality analysis: Giovanni is a tool that displays Earth science data from NASA satellites directly on the Internet for analysis. Giovanni is an acronym for the Goddard Earth Sciences Data and Information Services Center, or GES DISC, Interactive Online Visualization and Analysis Infrastructure (Leptoukh et al.). This Giovanni application allows us to visualize selected geophysical parameters. In the first step in the workflow is to call the data retrieval service. The second step in the workflow calls a calculator service to compute a pixel by-pixel average over the range of the retrieved data. The final step in the workflow is an Image Renderer that produces a plot of the area-averaged data.

Air Temperature: Air temperature is the measurement of the atmospheric kinetic energy at a given location in the atmosphere(Mohseni et al.) . The atmospheric temperature measured at the top of a cloud. Accurate information on cloud top temperature is needed to properly retrieve many atmospheric and surface properties (Menzel et al.). It also plays an important role in the net Earth radiation budget. NASA's Aqua satellite, gathers infrared energy emitted from Earth's surface and atmosphere globally by ARIS instrument (Platnick). Its data provides measurements of temperature and water vapor through the atmospheric column along with a host of trace gases, surface and cloud properties(Wagner et al.). After downloading the Air temperature data from Giovanni web tool (http:// disc.sci.gsfc.nasa.gov/giovanni) geo coded and reclassify in GIS platform. ARIS instrument data substantiate that the air temperatures of March, 2020 and June, 2020 have been notably less than last six years average temperature of 32°C. This indicates that in the year 2020, there has been a fall in temperature due to restricted emission activities (Figure 4).

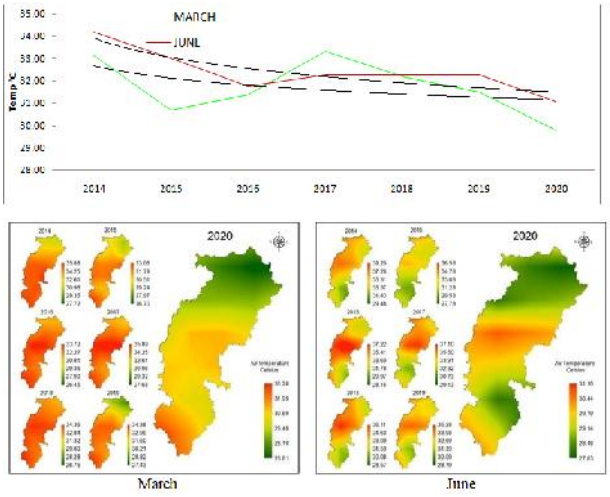

Figure 4. Air Temperature

Aerosol Optical Depth (AOD) retrieval

Tiny solid and liquid particles suspended in the atmosphere are called aerosols. Windblown dust, sea salts, volcanic ash, smoke from wildfires, and pollution from factories are all examples of aerosols. Depending upon their size, type, and location, aerosols can either cool the surface, or warm it. They can help clouds to form, or they can inhibit cloud formation. Out of 36 different wavelength channels, seven (between 0.47 and 2.12 μm) are used for the aerosol retrieval of MODIS data. (Long et al.). The uncertainty of the MODIS AOD measurements is expected to be 1AOD=±0.05±0.15×AOD over land.(Hashim et al.) (Remer et al.).

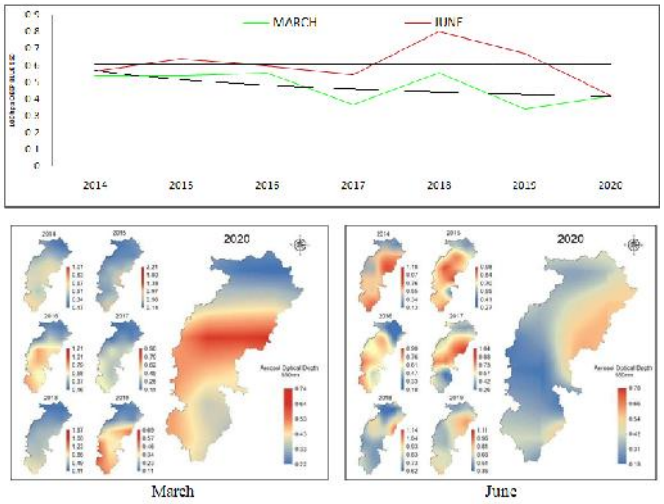

Figure 5. Aerosol Optical Depth (AOD)

The MODIS instrument data shows that the average of mass concentration for AOD takes place in March with a value of .48 and the average of mass concentration for AOD at June with value 0.64. However the mass concentration for AOD takes place in March 2020 and June 2020 with value 0.42.

There is significant change in air quality trend in the month of March and June of 2020 and map show gradual decrease in Chhattisgarh during lockdown period less emission of AOD in air due to shut down of industrial and transportation activity (Figure 5).

Sulfur dioxide

Sulfur dioxide is a gas which is invisible and has a nasty, sharp smell. About 99% of the sulfur dioxide in air comes from human sources (Padmavathi and Visva). The main source of sulfur dioxide in the air is industrial activity that processes materials that contain sulfur, e.g. the generation of electricity from coal, oil or gas that contains sulfur(Roy and Sardar). Some mineral ores also contain sulfur, and sulfur dioxide is released when they are processed. In addition, industrial activities that burn fossil fuels containing sulfur can be important sources of sulfur dioxide(Azimi) and (Fioletov et al.). Sulfur dioxide is also present in motor vehicle emissions, as the result of fuel combustion. In the past, motor vehicle exhaust was an important, but not the main, source of sulfur dioxide in air.

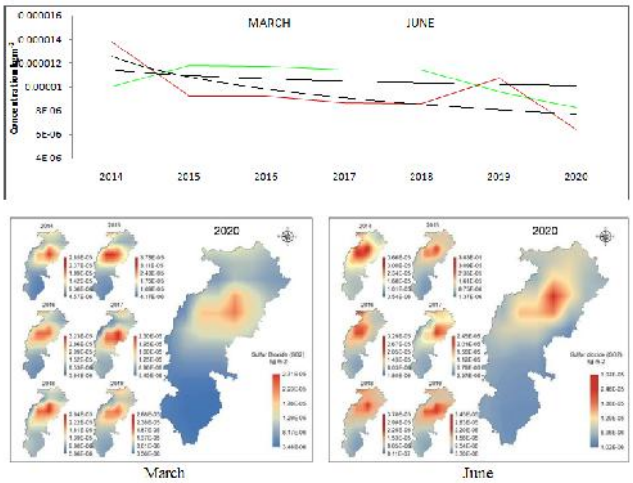

Figure 6. Sulfur dioxide

In this study, the recent spatiotemporal distribution and trend of the mass concentration of SO2, were analyzed over the region of the Chhattisgarh are from Modern Era-Retrospective Analysis for Research and Applications version 2 (MERRA-2) reanalysis data shown in Figure 6. The SO2 data used in these analyses are obtained from (MERRA-2) with a resolution of 0.5˚× 0.625˚throughout a period of lockdown period with same time of six year data. It is shown that the average of six year concentration for SO2 takes place in March with a value of 1.10248E-05 and the average of six year concentration at June with value 1.00873E-05. However the mean concentration for SO2 takes place in March 2020 with a value of 0.000006421and the mean mass concentration for SO2 at June 2020 with value 0.000008256.

There is significantly tailed off in air quality trend for 2020 shown from this time series trend. There is significant change in 2020 air quality trend in comparison of six year data, map show gradual decrease in of So2 due to less emission in air during shut down of industrial and transportation activity (Figure 6). The map of July 2020 shows that the amount of so2 has increased due to the onset of industrial activity from the local power plant smoke stacks around Korba district of Chhattisgarh. (https://scitechdaily. com/sulfur-dioxide-concentrations-drop-over-india-during-covid-19/)

Nitrogen dioxide: Nitrogen dioxide is a combination of nitrogen oxide and nitric acid. Nitrogen Dioxide (NO2) is one of a group of highly reactive gases known as oxides of nitrogen or nitrogen oxides (NOx).

Other nitrogen oxides include nitrous acid and nitric acid. NO2 is used as the indicator for the larger group of nitrogen oxides. NO2 primarily gets in the air from the burning of fuel. Nitrogen dioxide (NO2) is a yellow-brown gas that is a common emission from vehicles, power plants and industrial activity and off-road equipment. This analysis derived from Level-3 daily global gridded (0.25x0.25 degree) Nitrogen Dioxide Product (OMNO2d). OMNO2d data product is a Level-3 Gridded Product where pixel level data of good quality are binned and "averaged" into global grids. This product contains Total column NO2 and Total Tropospheric Column NO2, for all atmospheric conditions, and for sky conditions where cloud fraction is less than 30 percent(NASA,2012).

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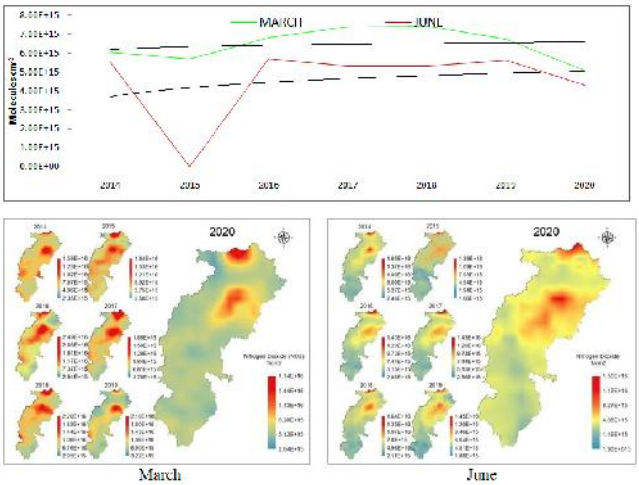

Figure 7. Nitrogen dioxide

The emission of the nitrogen dioxide pollutant has gone down significantly in the 2020, in entire Chhattisgarh. The average six year value of mass concentration for NO2 takes place in March with the value of 6.68389E+15 and in June 2019 with the value of 4.57681E+15 Molecules cm^{-2}. However the concentration for NO2 takes place in March 2020 with a value of 5.08E+15 and in June with value of 4.31E+15 Molecules cm^{-2}. The nitrogen dioxide map showed the most dramatic reductions in March 2020 due to lock down activity (Figure 7).

The main reason of increasing NO2 levels in June 2020 is associated with resuming the infrastructure development, such as new coal burning power plants in the Chhattisgarh region of India.

Carbon monoxide: Carbon monoxide is a gas and is found in air. High levels of carbon monoxide are poisonous to humans and, unfortunately, it cannot be detected by humans as it has no taste or smell and cannot be seen. The natural concentration of carbon monoxide in air is around 0.2 parts per million (ppm), and that amount is not harmful to humans. Natural sources of carbon monoxide include volcanoes and bushfires. The main sources of additional carbon monoxide are motor vehicle exhaust and some industrial activities, such as making steel. Tobacco smoke is one of the main indoor sources of carbon monoxide (WHO 2010).

ARIS instrument data corroborate that the Carbon monoxide concentration in environment of March, 2020 is significantly higher side (43.37) than the average six year comparative data i.e. 41.83 and June, 2020 have been notably less (45.46) than last six years average concentration i.e. 46.06. This indicates that in the year 2020, there has been a fall in concentration due to restricted emission activities (Figure 8).

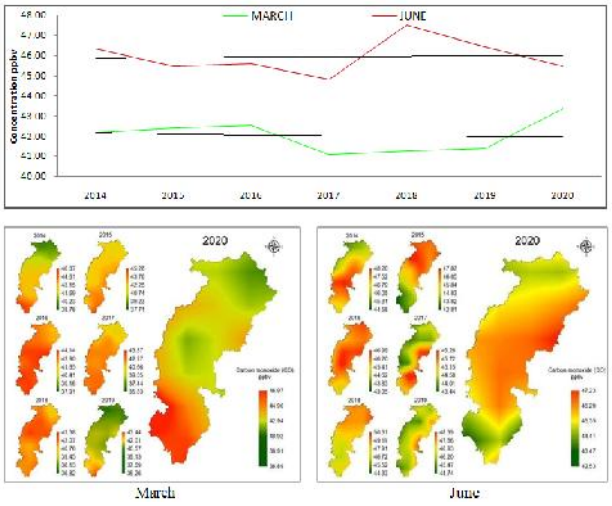

Figure 8. Carbon monoxide

Methane: Natural gas, which primarily consists of methane, is the cleanest burning fossil fuel. When methane is produced from non-fossil sources such as food and green waste, it can literally take carbon out of the air. However, methane that is released into the atmosphere before it is burned is harmful to the environment. Because it is able to trap heat in the atmosphere, methane contributes to climate change. Methane lifespan in the atmosphere is relatively short compared to those of other greenhouse gases. In order to retrieve CH4 in both clear and partially cloudy scenes, nine AIRS fields-of-views (FOVs) within the footprint of the Advanced Microwave Sounding Unit (AMSU) are used to derive a single cloud-cleared radiance spectrum in a field-of-regard (FOR), which is then used to retrieve profiles with a spatial resolution of approximately 45 km.

The atmospheric temperature profiles, water vapor profiles, surface temperatures, and surface emissivity are required as inputs to simulate the clear radiances in the CH4 absorption band, and these inputs are retrieved from AIRS using different channels. The differences between the computed radiances and the AIRS measured radiances for clear pixels or the derived cloud-cleared FOR radiances for partially cloudy pixels are used to derive he change of CH4 profiles. Then, 50–60 CH4 absorption channels near 7.66 μm band were selected for the retrieval.

The AIRS retrieval algorithm is a sequential retrieval method with multiple steps in which the temperature and water vapor profiles were retrieved using its own sensitive channels in previous steps before CH4 retrieval, thus the quality of the CH4 retrievals strongly depends on the AIRS retrieved temperature and moisture profiles as well as surface temperature and emissivity products(X. Xiong et al.).The most sensitivity of AIRS to atmospheric CH4 is in the mid–upper troposphere(Xiaozhen Xiong et al.). We can clearly see the significant increase of CH4 in Chhattisgarh and the increase is up to 1775-1800 ppbv in most regions. The emission of the Methane has gone up significantly in the 2020, in entire Chhattisgarh. The average six year value of mass concentration for CH4 takes place in March 2020 with the value of 1784.51 and in June 2020 with the value of 1750.69 ppbv which is slightly higher side with comparison of six year average vale i.e. 1751.72 and 1747.39 respectively.

Ozone

Ozone (O3), a powerful bleaching, poisonous oxidizing agent with a pungent, irritating odor, is formed naturally from diatomic oxygen (O2) by electric discharge in air or exposure to ultraviolet radiation. The ozone layer in the stratosphere absorbs UV radiation that shields the Earth surface from incoming harmful UV radiation. In the troposphere, the ozone is mostly a result of anthropogenic pollution, and therefore higher concentrations are found in urban areas.

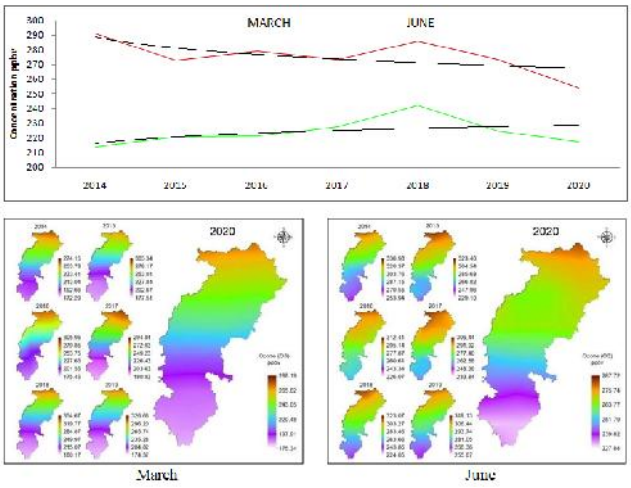

Figure 10. Ozone

NASA satellites ARIS instrument data based Giovanni tool supports that the Ozone of March, 2020 have been significantly high than June, 2020 and unstable. The difference of mass concentration between minimum and maximum in March and June, 2020 is 112.85 ppbv and is 59.88 ppbv respectively for Chhattisgarh state. Last six years average concentration of Ozone in March and June is 241 ppbv and 274 ppbv respectively. Data clearly indicates that in the year 2020, there has been a drop in mass concentration due to controlled anthropogenic activities (Figure 10).

Table 2. Mean concentration and relative change of greenhouse gases

Air pollutant	Six-year monthly mean (2014–2019)		Mean of March 2020 during lockdown	Mean of June 2020 during unlock period	Relative Change	
	March	June			A	B
Land Surface Temperatures (LST)(^{0}C)	42.35	41.72	38.70	38.34	3.65	3.38
Air Temperatures (^{0}C)	32.05	32.16	29.80	32.09	2.25	0.07
Aerosol Optical Depth (AOD) (100hpa DEEP BLUE 550)	0.4830	0.6387	0.4167	0.4207	0.07	0.22
Sulfur dioxide (SO_2)	1.1025 E-05	1.0087 3E-05	0.0000 08256	0.000006421	0.00	0.00
Nitrogen dioxide (NO_2)	6.6839 E+15	4.57681 E+15	5.07587 E+15	4.31406 E+15	1.61 E+15	2.63 E+14
Carbon monoxide (CO)	41.832	46.035	43.377	45.468	-1.55	0.57
Methane (CH_4)	1751.720	1747.397	1784.518	1750.696	-32.80	-3.30
Ozone (O_3)	0.4830	0.6387	0.4167	0.4207	0.07	0.22

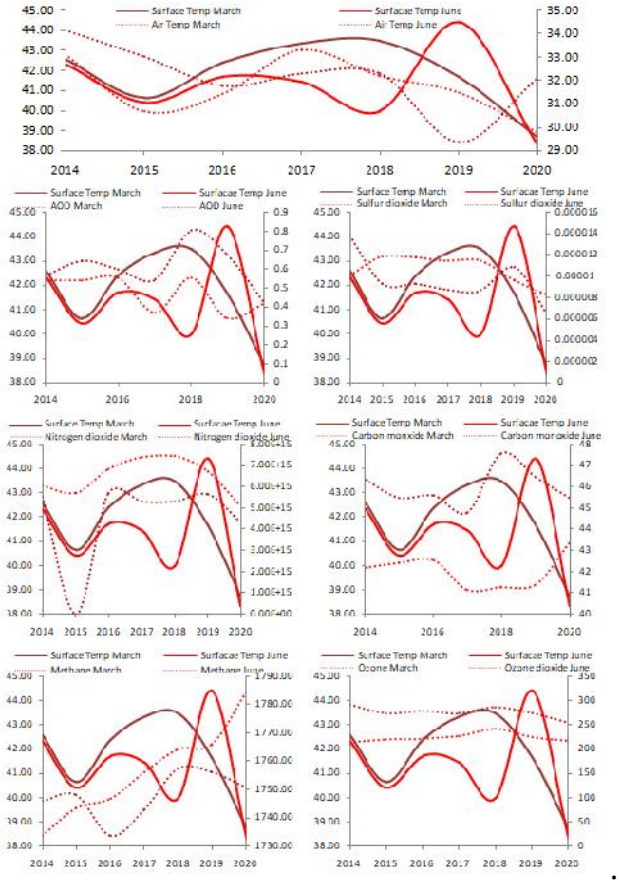

Figure 11. Average concentrations of greenhouse gasses against surface temperature

CONCLUSION

The entire world including Chhattisgarh state is following lockdown with a different level of stringency to combat COVID-19. The CoV virus infection has emerged as a deadly infectious disease causing the greatest pandemic in the planet and halts the economic activities. However On the other hand, it is noticed as an “Unsolicited Favor and Blessing” where reduction of human dominancy in environment is resulted in a

drastic climate change. Mostly due to shutdown of industries and restriction of vehicular traffic study results clearly exhibits that LST, Air temperature, AOD, SO_2, NO_2, CO and O_3 concentrations have reduced significantly after commencing lockdown. Only CH_4 significantly increased during shut down in Chhattisgarh state. Prior to lockdown when all the industrial units are in operational state, the effect is recorded dangerous to environment mechanism in general and human health. Continuous emission of dust particles due to stone crushing in mining activity and emission of greenhouse gasses due to vehicle movement and industrial activity continuously add huge volume of dust and gasses into the atmosphere to contaminate the quality of air. Table 2: Mean concentration and relative change of greenhouse gases in Chhattisgarh, India. Six-year monthly mean (2014–2019) and mean of during lockdown (24th march to 31st march 2020) and start of unlock period (1st June to 7th June 2020):

ACKNOWLEDGEMENT

This research was supported by Dr. N. K. Baghmar, HOD School of studies in Geography, Pt. Ravishankar Shukla University. Raipur, Chhattisgarh who provided a great opportunity and guidance. We thank our colleagues from Pt. Ravishankar Shukla University who provided insight and expertise that greatly assisted the research, although they may not agree with all of the interpretations/conclusions of this paper analyses and visualizations used in this study were produced with the Giovanni online data system, developed and maintained by the NASA GES DISC. We acknowledge the mission scientists and Principal Investigators who provided the data used in this research effort.

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