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Aerosol Mapping over the Small City Using Remote Sensing - Gulbarga City

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Abstract:-From the past decade to till now aerosol detection and monitoring by remote sensing i.e, satellite observations have been continuously developed. Several retrieval techniques provide aerosol properties at global scale but high spatial detail that is suitable for urbanized area is unavailable because most of the satellite products are at high resolution. In India AERONET (AErosolROboticNETwork) station is not available in all city of the state. So, somehow it's very difficult to get data for small developing city like Gulbarga to know the growing aerosol over the year. If we find out the changes in the quality of air from the past decades, then it will be easier to stop or decrease the activities which are creating the air pollution. Because of the unavailability of the AERONET station and inaccessibility of air quality measurement instrument in this city, it is very difficult to measure the quality of air throughout the city. So to get rid of this problem I used MODIS data and compared with the urbanisation of the images to get out with result of aerosol present in the Gulbarga atmosphere. The justification of the technique is to first estimate the aerosol reflectance by crumbling the TOA (Top Of the Atmosphere) reflectance from the surface reflectance and Rayleigh path reflectance. A good correlation is made with AOD (Aerosol Optical Depth) and impervious layer. This study demonstrates a method for aerosol retrieval at fine resolution over urbanised area, which can assist the study of aerosol spatial distribution. So this paper may be helpful to study the condition of aerosol of developing city with the unavailability of AERONET station and also unavailability air pollution data.

Keywords: *Aerosol Optical Depth, MODIS, AERONET, Top of the atmosphere, surface reflectance, Rayleigh Path Reflectance*

I. INTRODUCTION

Atmospheric aerosols are defined as suspended particles in the atmosphere in liquid or solid phase. They have different size distributions, shapes, and residence times and originate from different sources. Aerosol retrieval from satellite remotely sensed images is well developed, and it basically aims to distinguish the attenuated radiation by aerosols from that of reflection from the surface. The procedure is complex because ground surface reflectance are difficult to distinguish from the total satellite received signal. The estimation of surface reflectance is thus the key factor in aerosol retrieval which attempts to differentiate the aerosol signal from that of the surface. Information on aerosol type is crucial for improving our understanding and assessment of anthropogenic influences of aerosols on climate. Particulate matter (PM), especially particles with aerodynamic diameter < 2.5 μm, have known health impacts, such as cardiopulmonary diseases (Schwartz and Marcus, 1990; Saldiva et al., 1995). More generally, aerosol size information is of value for particulate matter air quality assessment. The spatial and temporal distribution of aerosol microphysical and optical properties is heterogeneous in nature and is caused by the wide variety of aerosol sources around the globe and relatively short atmospheric lifetime.Nothorough air quality study was done in Gulbarga city. Because of the unavailability of the AERONET station and inaccessibility of air quality measurement instrument in this city, it is very difficult to measure the quality of air throughout the city. So to get rid of this problem I used MODIS data and compared with the urbanisation of the images to get out with result of aerosol present in the Gulbarga atmosphere. The justification of the technique is to first estimate the aerosol reflectance by crumbling the TOA (Top Of the Atmosphere) reflectance from the surface reflectance and Rayleigh path reflectance. A good correlation is made with AOD (Aerosol Optical Depth) and impervious layer. This study demonstrates a method for aerosol retrieval at fine resolution over urbanised area, which can assist the study of aerosol spatial distribution.

II. STUDY AREA &DATA USED

Gulbarga which was previously known as Kalaburagi is one of the industrially backward districts of the state. It is called the Tur Bowl of Karnataka with a number of around 500 Dall Mills in and around the district. Further, the Lime stone deposits in the district attracted as many as seven Large Cement manufacturing units in the district. It is located in the North Eastern part of Karnataka bordering Maharashtra in the North and Andhra Pradesh in the East, Bijapur District in the West, Yadgir district is in the South, which was recently bifurcated from the existing Gulbarga district. It is situated on the Deccan Plateau at an altitude of 472m above Mean Sea Level. Lime stone suitable for port land Cement and Shahabad stone used for flooring are the major minerals**.**

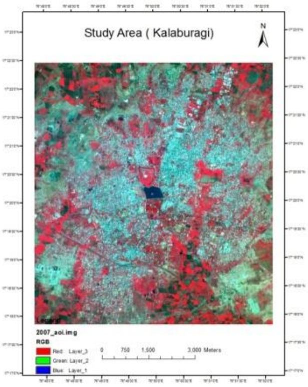


Fig:01 Study area

MOD09A1 provides MODIS band 1-7 surface reflectance at 500 m resolution. It is a level-3 composite of 500 m resolution MOD09GA. Each product pixel contains the best possible L2G observation during an 8-day period as selected on the basis of high observation coverage, low view angle, absence of clouds or cloud shadow, and aerosol loading.A MOD09A1 RGB image composed of surface reflectance data measured by bands 1 (red), 4 (green) and 3(blue)

III. METHODOLOGY

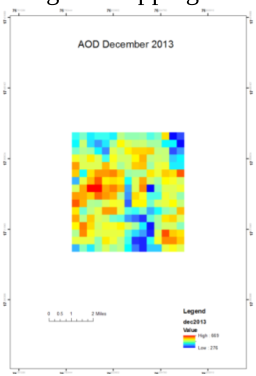
The rationale of the proposed aerosol retrieval algorithm is to determine the aerosol reflectance by decomposing the top-of-atmosphere (TOA) reflectance from surface reflectance and the Rayleigh path reflectance. The TOA reflectance

$$p_{TOA} = \rho_{Aer} + \rho_{Ray} + \frac{\tau_{Tot}(\theta_o).\tau_{Tot}(\theta_s).\rho surf}{1-\rho_{surf}.r_{Hem}}$$

Where, $\theta 0$ and $\theta s$are the sun and satellite zenith angles. ρAer, ρRay, and ρSurf are aerosol, Rayleigh, and surface reflectances. ΓTot($\theta 0$) and ΓTot(θs) are the total atmospheric transmittances, containing both direct and diffuse transmissions for sun illumination and satellite viewing geometry. The total transmittances include Rayleigh scattering and aerosol extinction, which can be given as ΓTot = ΓRay· ΓAer. rHem is the hemispheric reflectance.The first step is to drive aerosol reflectance from the images. The second step is to drive the AOD i.e. aerosol optical depth. And the last step is to compare the AOD of the random pixel of the two images of the year 2013 and 2015.Interpolation of the data for showing the clear standing of the aerosol.

IV. RESULT

The figure 2& 3 is showing the mapping of dispersion of air pollution in Kalabuagi city.



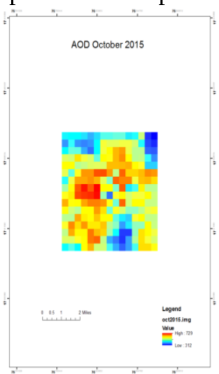


Fig:02-mapping of dispersion Fig:03- mapping of dispersion

of air pollution in 2013of air pollution in 2015
The determination of Rayleigh path reflectance is based on the computation of spectral dependence of the Rayleigh optical depth and phase function. The following equation was adopted for calculating the Rayleigh scattering optical thickness
(ROT)

$$\tau\text{Ray}(\lambda) = A \cdot \lambda^{-(B+C\lambda+\frac{D}{\lambda})} \cdot \exp(\frac{-z}{8.5})$$

where *A*, *B*, *C*, and *D*are the constants of the total Rayleigh scattering cross section and the total Rayleigh volume scattering coefficient at standard atmosphere. *Z*is the height in kilometers, and 8.5 is the exponential scale height of the atmosphere. A digital elevation model (DEM) in MOD03 geolocation data was used for estimating the height *z* and for calculating the pressure for each pixel. By using the ROT, the Rayleighpath reflectance can be obtained in the following equation:

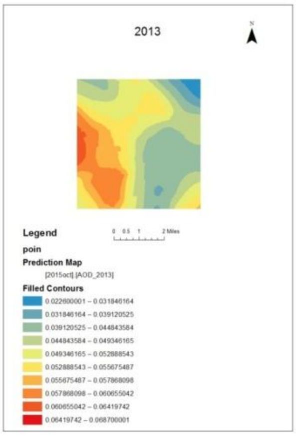


Fig:04 Interpolation map of Gulbarga city of the year 2013

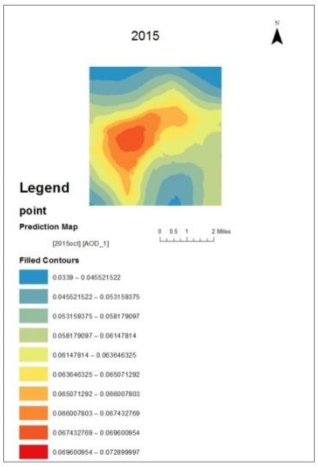


Fig:05 Interpolation map of Gulbarga city of the year 2015

Table 01: Ambient Air Quality, Gulbarga(Source, KSPCB)

Location of monitoring Station	**Land use Type**	**RSPM**	**SPM**	**SO2**	**NOx**	**Cause for Criticality**
Standard sensitive area to residential-industrial			70-350 mg/m3	1.5-8 mg/.m3	1.5-8.0 mg/m3	
Standard-Residential			140	6	6	

Government Hospital	Sensitive Zone	91	250	2.8	10.5	Emission of Hydrogen sulphide

The main pollutant in ambient is SPM. Suspended particulate matter is mainly emitted by dust and physical characteristic of area. The area is mainly under deccan trap where latterite soil persists. The adhesiveness of soil is less and most of the area is unpaved. As a result the SPM level is also high in residential and commercial area rather industrial premises. Another pollutant in ambient is NOx. Mainly NOx is formed by combustion process in automobile emission by diesel. All public vehicles are running by diesel driven motors and as result the total emission rate is more than the permissible limit and deteriorating the condition of the area. SO2 is characterized from industrial pollution from Hydrogen sulphide use. The concentration of Sulphur dioxide is mainly found more than a range. There are several industries unit are producing this kind of effluent in this regard.More harmful is SPM which is leading to bronchitis or asthma and is carcinogenic. Maximum concentration is noticed in commercial area, where air pollution buffering or protecting measures are to be taken care of.In areas that are not covered by dense vegetation, the reflectance in the blueband (i.e.,412 nm) is relatively higher than that over vegetated areas. However, this reflectance is still relatively low, allowing AOD retrieval at a reasonable precision when the surface reflectance can be accurately determined over this type of surface.

V. ACKNOWLEDGEMENT

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