

Air pollution mapping of an urban city using Hysplit

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ABSTRACT

Owing to the severe industrialization and urbanization many cities and its people are suffering from air pollution and its aftermath, analysis of the same is not done for many cities in full scale level. Air pollution modeling tools prevail to analyse the dispersion of air pollution considering various atmospheric parameters. In this work the analysis of quantum of air pollution and the dispersion of air pollution is done for two main monsoon period in Coimbatore (South west monsoon and North East monsoon). During the period of March to May owing to less moisture content wind movement will not be so rapid to ensure proper dispersion. A small comparison is made between two years plot to note the variation between these periods. Results shows the dispersion of pollutant owing to the monsoon variation, field data is not collected for the analysis and only secondary data available is used in this study.

KEY WORDS: Hysplit, Air pollution modeling, dispersion of pollutants.

1. INTRODUCTION

Particulate matters have noticeable affect on human wellbeing, environment and monetary. These toxic pollutants may discharge from anthropogenic or regular sources. On worldwide scale, principle extent of characteristic particulate matter discharge to the atmosphere on account of wind disintegration from dry and semi-arid areas. Wind-blown dust is a compelling element for the transmission of pathogens and contamination furthermore can impact air quality downwind of dust source locales by lessening perceivability, ruining property and bringing on sicknesses. Inhalation of dust particles can bring about heart beat anomalies, heart assaults and respiratory issues, extreme and incessant cerebral pains, serious hypersensitivities and skin disease. Particles, for example, mineral dust, by engrossing UV radiation can hinder brown haze generation, having significant suggestions in the control of air contamination in urban. The fact of inorganic metals in the atmosphere is primarily influenced by vaporization, aerosol formation, wet and dry deposition and hydrolysis.

Moreover, the communications between windblown dust and anthropogenic poisons aggravate the generations of auxiliary mist concentrates. As indicated by a study in Nature, 3.3 million individuals bite the dust rashly from air contamination every year. China and India are among the main two contributing nations, with death rates at 1.36 million and 650,000 for every annum separately. This case has brought about tons of ecological issues. Dust source distinguishing proof and direction reenactment utilizing numerical systems are the primary aim of this study. HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory) dust module and direction reproduction are used in this paper and four different cases such as south west monsoon, North east monsoon, periods during winter and summer season were also analyzed.

2. MATERIALS AND METHODS

2.1. Study Area: Coimbatore is situated at 11.0161N 76.971E. It is encompassed by the Western Ghats mountain run on the West and North, with reserve forests and the (Nilgiri Biospherereserve) on the northern side. The Noyyal Waterway goes through Coimbatore and structures the southern limit of the corporation. The city sits in the midst of Noyyal's bowl zone and has a broad tank framework sustained by the stream and rainwater. The eastern side of the Coimbatore area, including the city is overwhelmingly dry. A western pass to Kerala, prominently alluded to as the Palghat gap gives its limit. Coimbatore is situated at 411 meters above mean sea level, it has mellow winter and moderate summer. During summer the most extreme recorded temperature is 34.7° C, during winter it goes down to max 32.2°C. The measure of precipitation recorded every year is around 61.22 cm. Most rain fall is expected in the month of September and November.



Figure 1: Study area map

3. RESULTS AND DISCUSSION

3.1 Hysplit4: Hysplit is the main software in this venture, which relies on upon NOAA satellites for GDAS data. For recreating the contamination's direction and fixation this software bundle is utilized. This system is used for calculating simple air parcel trajectories to complex dispersion and depositions simulation. The basic algorithm is hybrid between Lagrangian and Eulerian approach. The frame of reference to compute air pollution concentration is three-dimensional grid. Pollutants dispersion is calculated using either puff model or particle model. The default configuration is puff distribution for horizontal and for vertical particle distribution. In puff distribution the puffs will expand and when it exceeds the size of grid, it splits up to several new puffs. Whereas in particle fixed, number of particle is transported by the mean wind field and turbulent components in the fixed model domain. The default configuration gives the accuracy for pollutants distribution. The data which is utilized in this software is 24-h air mass backward trajectory depending on mixing layer height for various time periods in a day. The data set is replicated with local meteorological data similar to GDAS data. The starting heights which are considered are 50, 100, 500, 1000, 1500 meters.

DOMAIN - 3D GRID OF CELLS

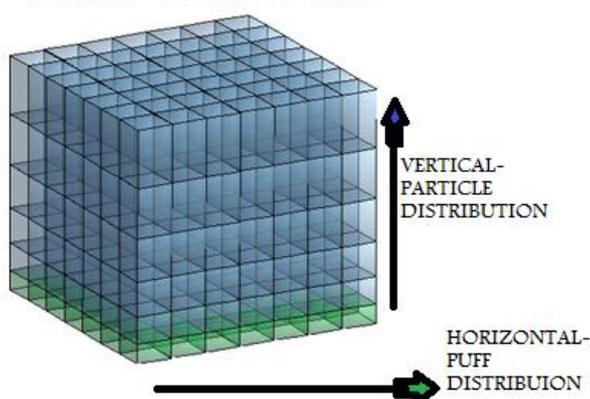


Figure 2: 3-D grid for trajectory and concentration simulation in Hysplit

The two main monsoon periods in Coimbatore is South west monsoon and North East monsoon. Then the hot weather prevails from March to May where there is no much moisture wind in this area after this city enjoys winter period during January and February. This chapter tells about the pollution movement and dispersion in accordance with the different climatic period. A small comparison is made between two years plot to note how much variation is there between those periods.

3.2 South West Monsoon: South west monsoon starts from Arabian sea and travel towards north east. Rain fall is expected to be more in this period. The period of south west monsoon is between June to September. Due to industrialization the expected rainfall from the monsoon varies in each year. During these period the wind has some noticeable moisture content in it. Let us investigate the Pollution movement and its dispersion during this period. Wind direction during south west monsoon is almost towards North East. So during this period along with the wind movement the pollutants travel and spread its effects accordingly. The monsoon fetches the pollutants along with its moisture from Kerala and sheds the polluted rain water in various part of Coimbatore and also in districts of Kerala. If we consider pollutants originate from Coimbatore they have their course of movement in near by districts like Erode, Dharamapuri, Tirupur, Salem. On considering the concentration plot of July 2014 and 2013 we have about 7427.586 sq.km polluted area during July 2013 and during July 2014 it is 6,099.092 sq.km. This is due to earlier start of monsoon period. By considering the figure, the direction of concentration plot moved north from July to September. Hence we can conclude that the concentration plot of July 2013 is equivalent to August 2014.

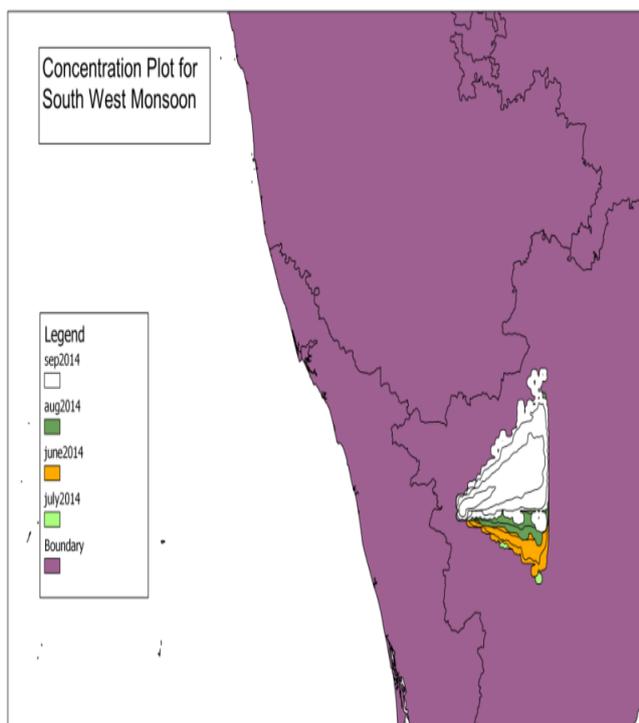


Figure 3: Concentration Plot for South west monsoon (2014).

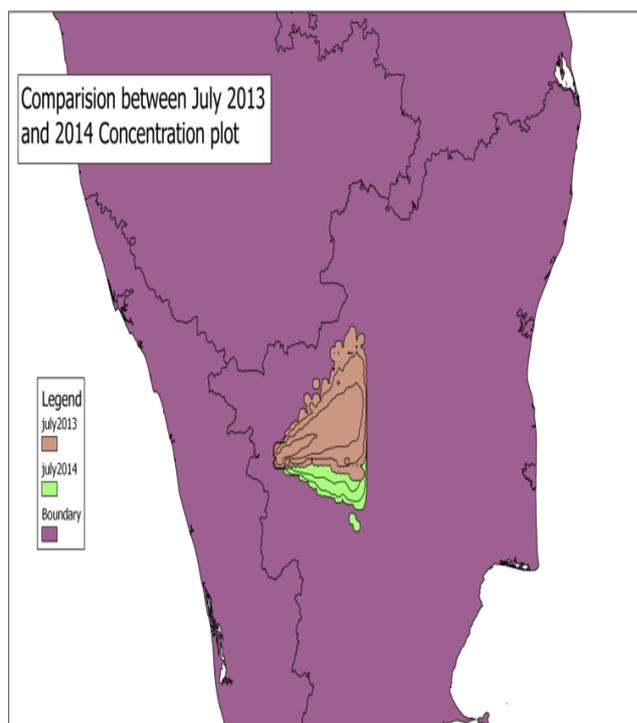


Figure 4: Concentration plot comparison between July 2013 and July 2014.

3.3 North East Monsoon: North East monsoon starts from Himalayas and also due to westerly depression then it travel towards south West. Finally end up in Indian ocean and also in Arabian sea. The period of North East monsoon is between October to December. The wind originating from Himalayas mostly end up in Indian ocean. The wind because of westerly depression losses its moisture at North western part of our country and while reaching to Tamil Nadu and Kerala the expected amount of rainfall is very low. Pollution dispersion due to North East monsoon can be analyzed in this section.

During the North east monsoon period the wind direction is not uniform since this period is also influenced by Indian ocean. The dry wind from the north travel towards the Indian Ocean there they may pick up the moisture and turn the course of action towards the North west. Because of this reason the concentration plot for November 2014 is towards North west. In the month of October there might existed remains of south west monsoon. So the Concentration plot is similar to South west monsoon. December month shows the exact North east monsoon direction. On analyzing the comparison of concentration plot between November 2013 and 2014, we can conclude that the south west monsoon has existed till November in 2013 and the speed also high when compared to November 2014. The area of pollutant spread during November 2013 is 6397.285 square kilometer, during 2014 is 2,924.997 square kilometer. Variation in affected area is due to severity of wind during 2013 was high. Similarly

during December 2013 and 2014 the wind was towards Arabian sea. There is slight variation in the wind direction(angle)due to pressure. Polluted area during December 2013 is 8378.473 square kilometer, and during December 2014 is 9091.839 sq.km.

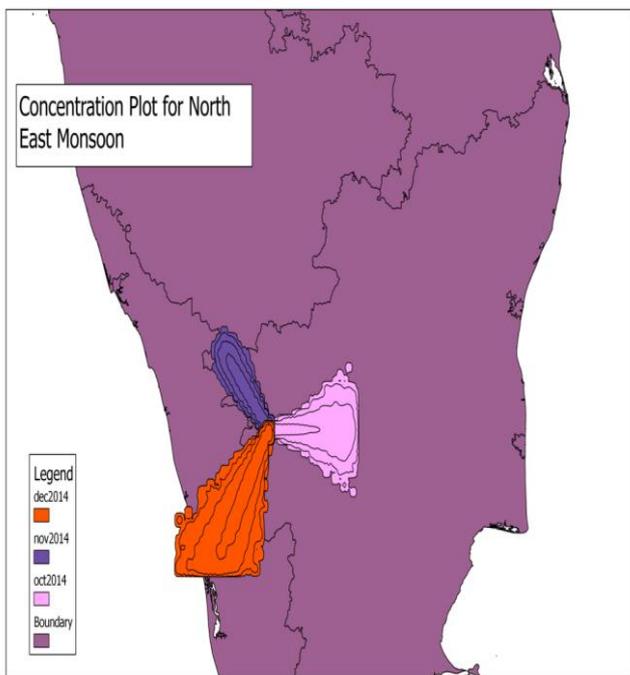


Figure 5: Concentration Plot for North East Monsoon (2014)

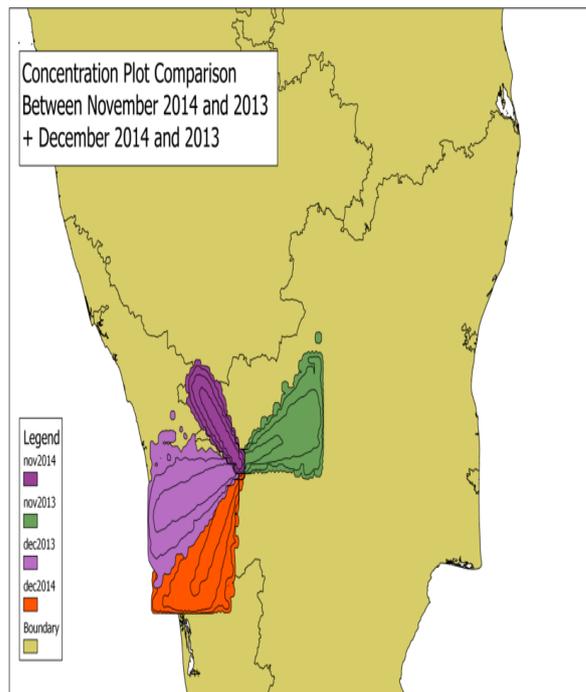


Figure 6: Concentration plot comparison between November , December (2013 and 2104)

3.4 Winter Season: Coimbatore district experiences winter period during the month of January and February. The pollutant level which is high in Coimbatore is PM10 which has worse effect in this season. Impacts of air contamination can be amplified in winter months because of temperature reversals in the air layers of air in which temperature increments with height. These air pollutants closer to the surface of the earth and lead to higher convergences of air contamination. It is pretty much as imperative to consider our own particular effect on air contamination in winter as in summer. Hurtful components including lead, zinc and polycyclic aromatic-hydrocarbons were found to be available in high focuses amid winter season.

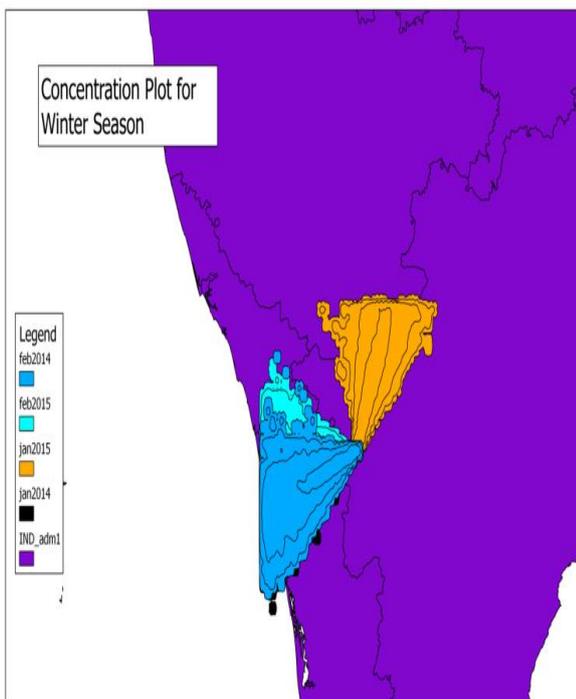


Figure 7: Concentration Plot for Winter season.

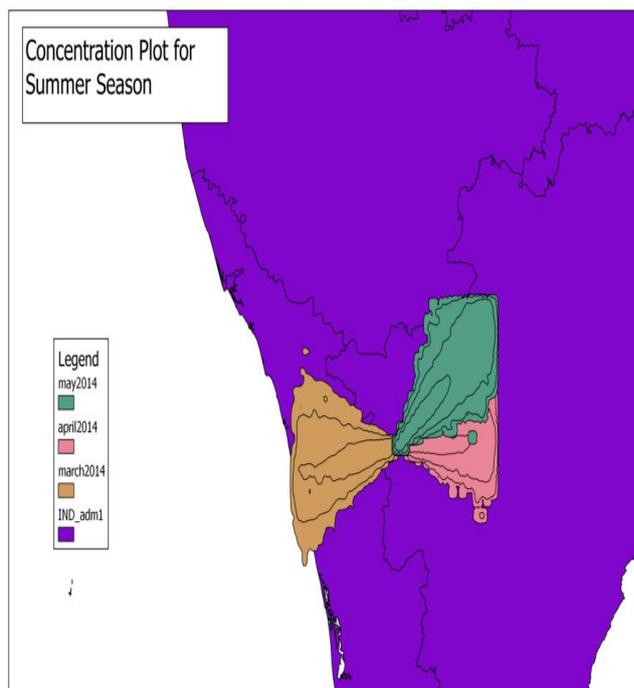


Figure 8: Concentration plot for Summer season.

The study said the particles are connected with respiratory ailments, for example, asthma and bronchitis, and they can likewise bring about aggravation and fuel cardiovascular diseases. The concentration of pollutant in winter season is found to be nearly 8.5×10^{-13} in January 2015 but during the 2015 the North East monsoon was there till January so the pollutant concentration was 5.8×10^{-13} . During winter season the concentration of pollutant is high (only after withdrawal of North East monsoon). The area of pollutant spread depends on the wind speed and its direction. 6.5 Summer Season Coimbatore experiences summer during the month of March, April, May. During this month's pollutants like photochemical oxidants like ozone causes worse effect. Dry air blows through this city during these months. PM10 concentration spread can be given as below diagram. Since these period doesn't belong to any monsoon period the direction of wind is random in nature.

4. CONCLUSION

In this study it's shown that the seasons are not occurring in the proper timing recently which may be owing to several atmospheric reasons, the pollutants are also getting affected due to the same. The effects due to the pollutant concentration will be more worse during the summer season, if the seasons occur properly the prediction can be more effective. Further studies using field data in the recent years is highly suggested by the authors to confirm the present scenario in the city.

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