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Emission of Atmospheric Pollutants during IOCL-Sitapur, Jaipur fire 2009, India

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Abstract

In Jaipur on 29 October 2009 around 6.00 pm it was reported a fire accident at Indian Oil Corporation (IOC) located at Sitapur. Due to this huge fire accident a very high fire flames up to 70 ft were seen which results emission of black plumes nearby areas. This anthropogenic fire accident killed few and injured lots of people. It was reported that due to IOCL fire accident some of the people living in the surrounding villages suffered eye irritation, rashes and were also rushed to the nearest hospital for emergency care. The significant effect on the air quality in Jaipur and nearby area of IOCL Sitapur i.e. Pratap Nagar, Delawas, Mathurawala village, Shivdaspura, and Chokhi Dhani had been studied. It was observed that the increasing values of primary pollutants i.e. SPM (Suspended Particulate Matter), RSPM (Respiratory suspended particulate matter) NO_X and SO_2 whereas the rising trend of Total Ozone Column (TOC) and CO mixing ratio support the validation.

Keywords: SPM, RSPM, CO mixing ratio.

Introduction

Based on the properties of air pollution, flow rate and direction, sometimes traces of air pollutants are able to move from one place to other. The air pollutants which can be transport to a long range in the atmosphere and this long range transport of pollutants play an important role in case of forest fire, post-harvest field burning, industrial disaster etc. As day by day there is a rapid industrialization in most of the developing countries and due to this blind race, huge quantities of industrial pollutants start to enter into the environment. The fast and prompt exploitation of perilous chemicals in industries has contributed a very significant role for the increment of dangerous environmental pollutants into the environment. These hazardous chemical used in industries could be precarious at any time by an accident. The gigantic discharge of different types of pollutants into the environment has been significantly increased the many environmental problem[1]. Such types of chemical compounds reside for some time and try to accumulate in the environment and due to their high toxic nature their binding in the environment can cause harsh environmental problems[2]. We already aware about one of major accident due to chemical release i.e. Methyl Isocyanate during Bhopal Gas disaster of 1984- the most horrible chemical calamity in record. Approx 2000 people died and lots of faced different types of decease. Such type of anthropogenic accidents is momentous in terms of injuries, pain, loss of lives and harm of property environment[3]. Air pollution is one of the critical issues now a days and it attracts more and more attention of scientific community. It's must to conclude the point source of air pollutants and accordingly make a preventive planning to take care for this[4]. As per the previous studies it has been well proved that growth in Industrialization and rapid increase of transportation is also contributing a lot for air pollution. To accomplish the goal in order to control the air pollution it is necessary to implement the environmental management system in Industries and explain their objectives[5]. It should be must to specify the standards of different air pollution or contaminants and acclimatizing with standards[6].

The previous studies have been done to study the transport of long range pollutants. Danish Eulerian Model (DEM) in 80's was the first one which was used to study the transport of pollutants via the mathematical modelling[7]. One of the Government undertaking companies i.e. The Indian Oil Corporation situated at Sitapur, Jaipur, is particularly involved in storage and dispatch of different types of petroleum products. A foremost industrial accident occurred at Jaipur IOCL, on Oct. 29, 2009 between 6:30PM to 7:30PM. This huge fire could not control timely and sustained till 6:00 AM on Nov. 11, 2009. During the burning of fuels particularly diesel, coal, and biomass, huge amount of Black Carbon (BC) produced. Black Carbon a most important constituent of fine particulate matter is very dangerous for community healthiness and a small amount of inhale is able to create the serious respiratory exertion. Black Carbon has been used as a sign of exposure to diesel soot[8], which has been classified as a poisonous air pollutant[9] and a suspected carcinogen[10]. From starting many researchers are taking the interest in monitoring the levels of black carbon in the atmosphere because of its negative health effects. As per the testimony submit to Department of Environment, Govt. of Rajasthan, there were 11 petroleum storage tanks in the IOC terminal that included 5 for MS and 3 each for HSD and SKO. As informed by IOC, the fire reportedly started from floating roof tank storing MS and subsequently spread and all other tanks and buildings were overwhelmed. Few nearby places

caused loss of life, economic loss and serious environmental concern due to this major accident. The burning of petroleum product, produces heat and smoke that disrupts the fire fighting system, destroys vegetation and causes loss of habitat particularly local flora and fauna. Serial blasting of storage tanks due to fire damages the buildings and properties besides spreading of metal flakes in surroundings and nearby areas. Two enormous blasts were heard before the fire ignited and within few minutes the fire rapidly spread. The combustion ignited most of the department, including every oil storage unit at IOCL. Vast flames blasted into the air and due to the huge smoke many peoples in the villages around the depository feared and ran away from their houses. The fire also stretched up to some industrialized units in around a radius of approximately 3 kms completely destroying them. The fire actually broke out when the petrol was transferring from the fuel repository to a pipeline. A drip in pipeline is actually alleged to be the cause of the rage. Air pollution across Jaipur crossed the maximum allowed limits when the Indian Oil Corporation (IOC) was caught fire and almost approx 60,000 kilolitres of Petrol (18,810Kl), Kerosene (2,099 Kl), High Speed Diesel (39,966 Kl) and Interface (2809 Kl) in 11 storage tanks went up in flames on the evening of Oct 29. It was expected that pollutants appeared due to fire may lead to environment hazards including acid rain. It is already reported that after the IOC fire, the pollution level in terms of Nitrous oxide, Sulphor dioxide, and Particulate matters like Suspended Particulate Matter has significantly increased in nearby area. Nearly villages are badly affected by the fire and villagers are complaining irritation in their eyes along with rashes on their skin and respiratory problems. The increasing trend of Total Ozone Column and CO Mixing Ratio also supports the finding and effect of this massive fire on the atmosphere. The suspended particles in the air, which are responsible for health problems did not move away due to steady air movement, and in turn affected many people, who are prone to allergy, Asthma and Heart deceases. During the period of 10 days after (29 Oct 2009) at least 50 Lakh kilos of sulphur oxide has suffused the air along with several other lethal gasses within a 10~20 Km radius. Thought there were no chances of rain around that time of the year, expert was feared that if unseasonal rain does come, it would bring acid with it.

Methodology

The atmospheric pollution for which growing population, vehicular pollution and day by day increasing energy demand are mainly responsible[11]. To see the effect of fire already many studies have been done in many urban cities and found anomalous increase in Ba, K, Al and Sr[12]. During incineration progression some of the air pollutants are free to move into the atmosphere and show their effect but some of them are not directly destruct the air quality but actually they convert into secondary pollutants with the variability of meteorological parameters. Those pollutants which create the negative impact on air and change the normal compositions of air are termed as primary pollutants. The excess amount of the harmful component emitted during fire cases, negatively affects the ecosystem and public health. IOCL fire accident Jaipur city on 29 October 2009 around 6.00 PM contributed a large amount of pollutants into the atmosphere which basically disturbed the normal air compositions.

The enormous fire at IOC depot has shown many unfavorable effects on the atmosphere[13]. Now a day's many of the countries are trying to create the awareness about an increase of extremely large pollutants. In our current research we tried to study the changes in total Ozone column and co mixing ratio during the case of fire and the effect of fire into the atmosphere as well as on human health. The main selected location for this study was Jaipur and nearby area like Pratap Nagar, Delawas, Mathurawala village, Shivdaspura and Chokhi Dhani.

To observe the effect of this IOCL fire, Level- 3 AIRS (Atmospheric Infrared Sounder) and MODIS (Moderate Resolution Imaging Spectroradiometer) satellite daily data has been acquired from NASA Giovanni website (http://daac.gsfc.nasa.gov/giovanni). The detailed investigation of MODIS, AIRS were carried out with the support of AIRS Online Visualization and Analysis at IRS Global at 1.0° x 1.0° resolution. Numerous atmospheric (Total Ozone Column) and CO mixing ratio over this region also been studied to see the impact of this fire on the environment. We have also studied various surface and atmospheric parameters over Jaipur and nearby cities with the support of RCPCB. Times series of various parameters at different pressure levels are analyzed before and after occurrence of fire. Various parameters show significant changes due to the fire. Jaipur is located at 26°55′N 75°49′E & 26.92°N 75.82°E. It has an average elevation of 432 meters (1417 ft). Jaipur lies at a distance of 260 km from Delhi (south of Delhi), and about 225 km west of Agra city. The IOCL depot (Jaipur Terminal of Marketing Division) is situated in Sitapura industrial area which is in south west of Sanganer Airport at about 6.7 Km distance by road. The fire broke out on 29th October, in the evening hours and completely ceased in the early morning hours (06.00 am) on November 11, 2009.

Results and Discussion

In our study we tried to analyzed some of the primary pollutants like NO_x, SO_2 which play an very important role for the formation of Secondary pollutants and SPM, RSPM which creates an adverse effect on human health in terms of respiratory disease like asthma, lungs cancer etc. For our analysis the variation of Total Ozone column and Co Mixing ratio has also been analyzed over the region of Jaipur.

To see the impact of this huge IOCL fire accident on the environment, the air quality analysis in terms of the parameters such as particulate matter (SPM/RSPM), NO_X and SO_2 that were analyzed before and after the accident by using the RSPCB (Rajasthan State Pollution Control Board) data. We tried to

analyse daily 24 hours data for Suspended particulate matter, Respiratory suspended matter and showing the increasing pattern during this incident. The higher concentration values of all primary pollutants i.e. SPM/RSPM/NO_X/SO_2 showing the impact of this huge fire on nearby areas. As these PM particles (SPM/RSPM) are mainly responsible for the respiratory problem in the human's beings. First four days of the IOCL accident shows that the range of pollution standards exceed the limit of residential area standards. It is clear that during the fire on 31 October, the maximum concentration of Suspended Particulate Matter was noticed which was approx 250 microgram/m^3 i.e. higher then standard limit of 200 µg/m^3 of residential area. Respiratory Suspended Particulate Matter (RSPM), identified pollutants which is mainly responsible for the respiratory disease was noticed at higher concentration during 31 October 2009.

The higher and increasing trends of NO_X and SO_2 have been observed during the fire days. The highest values of NO_X and SO_2 (approx 40 µg/m^3) and (approx 10 µg/m^3), respectively have been reported during 30 Oct-2 Nov 2009, are still below the residential area standards of 80 µg/m^3.

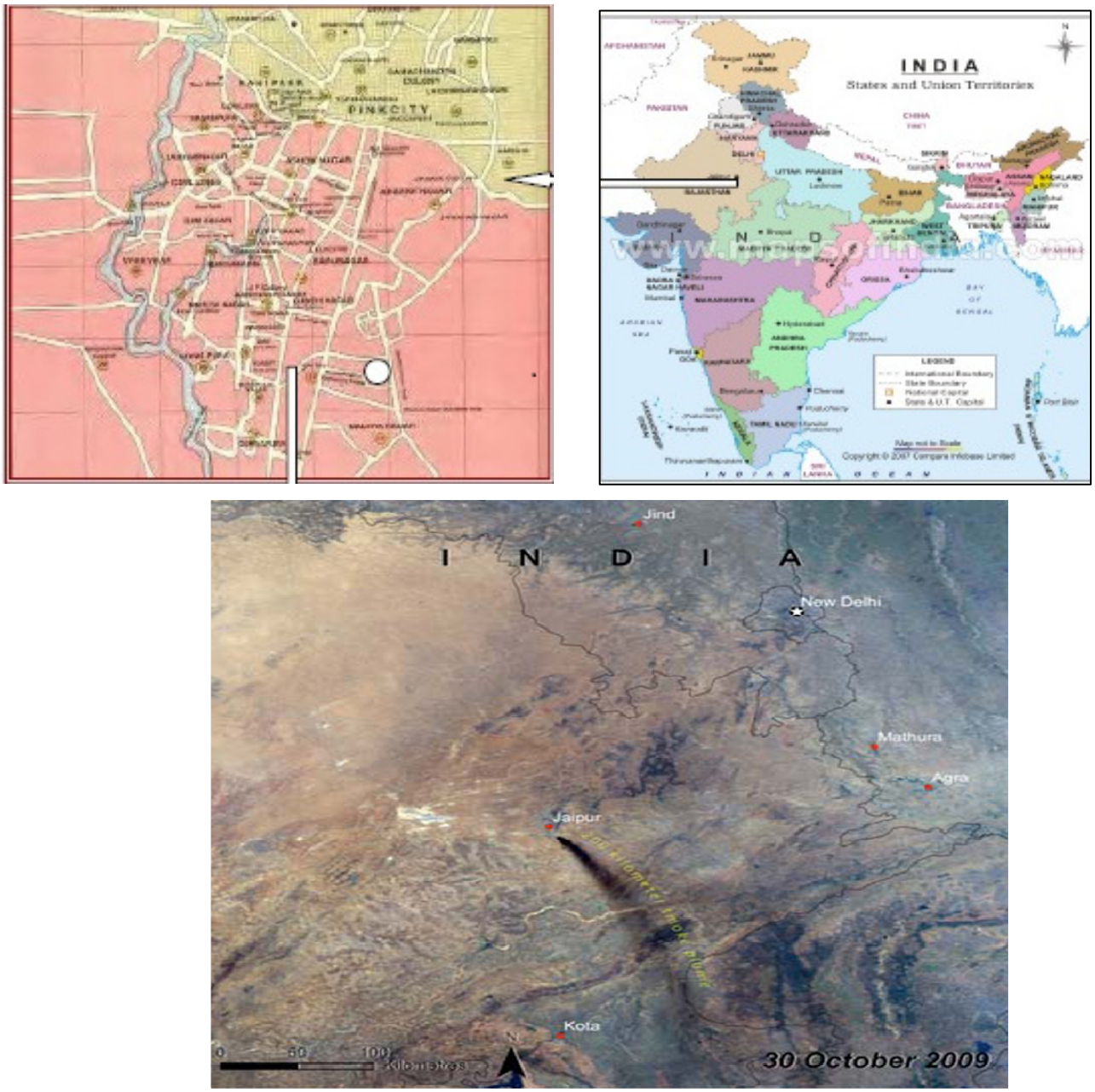

Figure-1
The location of IOCL-Sitapur Jaipur

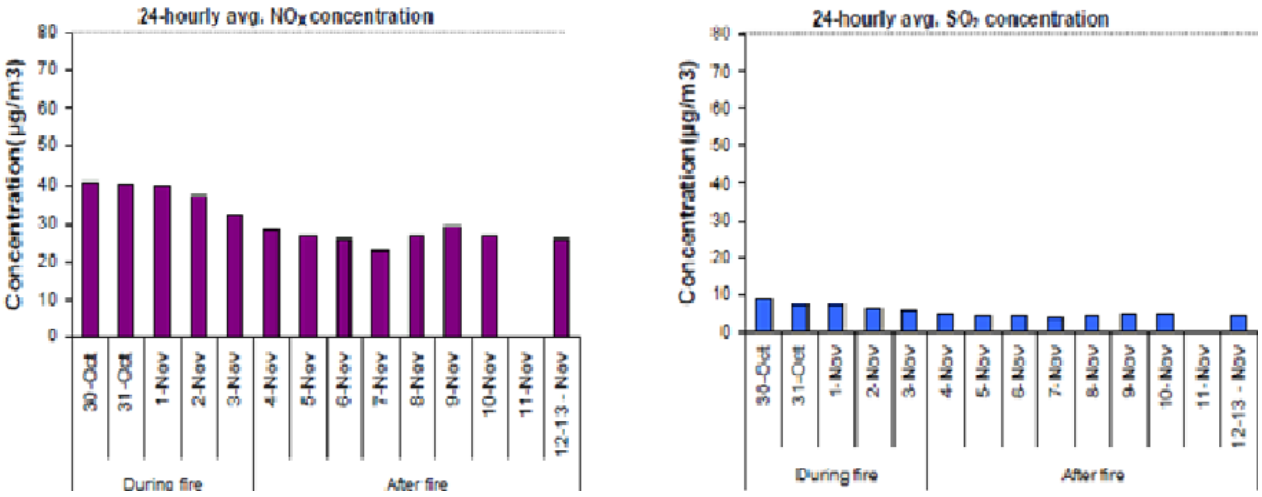

Figure-2
24-hourly average concentration of NO_X and SO_2
(Data Source: Report on Environmental Effect Due to IOCL fire submitted to Rajasthan Government by a Committee)

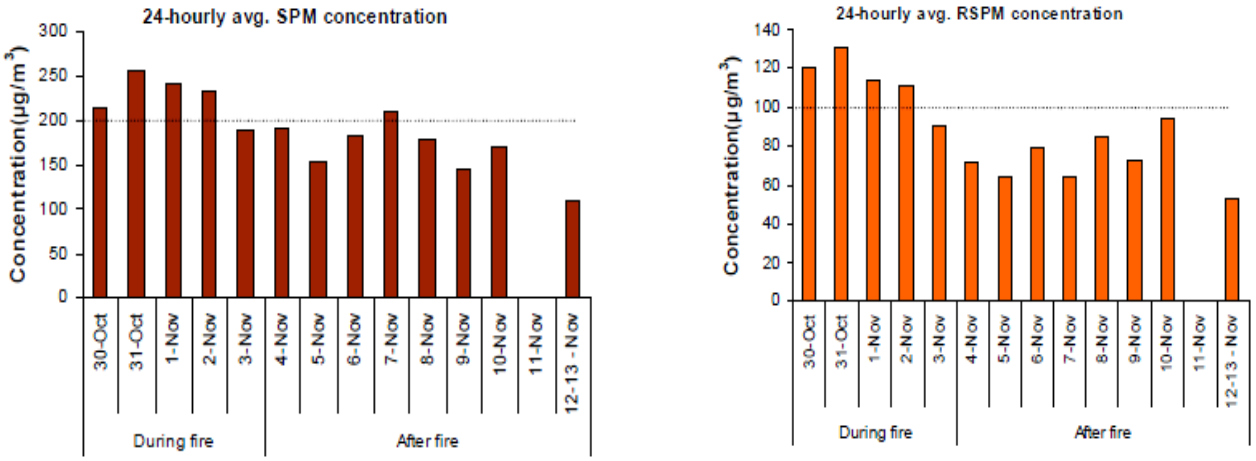

Figure-3
Daily average concentration of Total Ozone Column (DU) and CO mixing ratio over Jaipur city during IOCL fire accident

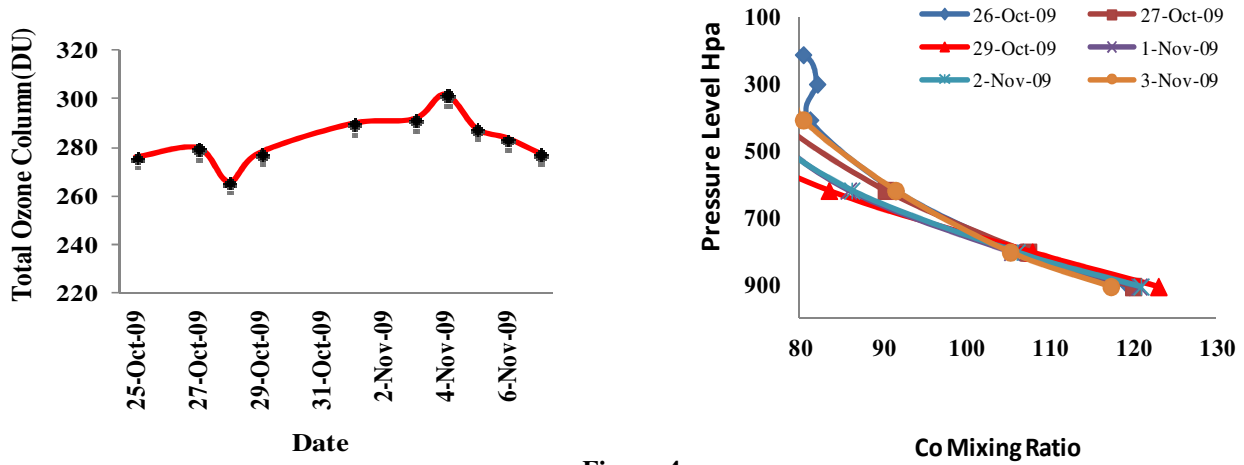

Figure-4
Daily average concentration of Total Ozone Column (DU) and CO mixing ratio over Jaipur city during IOCL fire accident

Ozone which is a secondary pollutants is basically formed in the course of photochemical transfer of oxygen or with the reaction of CO in presence of oxygen i.e. $\mathbf{CO + 2O_2 \rightarrow CO_2 + O_3}$**.** The presence of ultra violet sunlight with primary pollutants support for the formation of Ozone in the outside air. Ozone also plays an important role for the configuration of smog and also contributes to different types of acidification and climate change. In fig. 4 we can see the increasing value of Ozone and the higher values of carbon monoxide. After the fire accident on 29 October 2009 the concentration of Ozone has suddenly started to increase and maximum concentration of 300 DU was observed. The presence of Ozone at troposphere can creates many types of human health related problems like penetration of the respiratory tract, irritation of the eyes etc.

Conclusion

The highest values of NO_X and SO_2 (approx 40 µg/m^3) and (approx 10 µg/m^3), respectively have been reported during 30 Oct-2 Nov 2009, are still below the residential area standards of 80 µg/m^3. It is clear that during the fire on 31 October, the maximum concentration of Suspended Particulate Matter was noticed which was approx 250 microgram/m^3 i.e. higher then standard limit of 200 µg/m^3 of residential area. After the fire accident on 29 October 2009 the concentration of Ozone has suddenly increased and maximum concentration of 300 DU was observed. As this type of anthropogenic accidents are major threat for the environment and we should try to make some full proof precautions to avoid such type of incidents.

Acknowledgement

We as authors would like to thank the NASA MODIS/AIRS support team for processing data via the Giovanni website (http://giovanni.gsfc.nasa.gov/) for providing the Total Ozone Column and CO mixing ratio datasets. We especially thankfully acknowledge the specific inputs/reports from multiple Government Department especially Health, Meteorology, Science and Technology and Central Pollution Control Board. We also thankful to Rajasthan State Pollution Control Board (RSPCB) and Government of Rajasthan for comprising a team for accessing the report on this massive IOCL accident.

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