

Jaipur Fire and its Environmental effects

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Abstract:

A massive fire broke out at the Indian Oil Corporation depot in Sitapura Industrial Area of Jaipur on Thursday night. This led to an uncontrollable fire which engulfed 12 huge tanks. Nearly one lakh kilolitres of fuel, worth Rs 500 crore just burn out. The flames, had thrown up huge columns of thick, black smoke which blocked sunlight. Officials and firefighters finally decided to wait for the burning fuel to get consumed and for the fire to extinguish by itself, as there seemed to be no other alternative. An area of 5 km radius had been marked as danger zone.

More than 150 persons were admitted in various hospitals for burn and splinter injuries and eight people had been declared dead. The fire was accompanied with several explosions that shook the industrial area while people fled in panic. All educational institutions and industries in the area remained shut through the days. Even train and bus routes plying through the area had to be changed. The Jaipur-Kota highway had been closed down for vehicles and about 20 trains scheduled to pass through the nearby railway line were affected. Nearby villages had also been vacated. Residents of about ten nearby villages, which housed an estimated five lakh people, and inmates of hostels in 10 engineering and technical colleges and a medical college had been evacuated in the wake of the incident after which power supply in the area was cut off.

Over the past years, many countries and regions of the world are experiencing an increase of extremely large and severe fires. This paper deals with the effect of fire, smoke and water pollution. Such fires directly impact lives, human health, safety, livelihoods, material possessions, etc. They cause loss of biodiversity and site degradation at landscape level leading to desertification. The depletion of terrestrial carbon by fires burning under extreme conditions in some vegetation types, including organic terrain in peat land biomes, is a major contributor to global climate change.

About the Author:



Dr. Mukta Girdhar has a specialization in Geographic Information System and Remote sensing System. She is a Faculty in Indian RedCross Society in the course of Disaster Preparedness and Rehabilitation. She has more than ten years experience in the field of Disaster Management. The course participants include professionals from Medical Services, Defense, Supreme Court Joint Registrars, ONGC, IPCL, BPCL, other Govt. Departments as well NGOs. Before this Worked with Guru Gobind Singh Indraprastha University, Delhi as a Lecturer for MBA Disaster Management, and M.Sc. Environmental Science. She has completed several dissertation related to different disasters. Prior to this she has worked for private company and done several project related to GIS. She has published and presented many papers in national and International Journals. She has taken several training course national and International level. She is familiar with ESRI, Map-Info, Illwis software.

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The **Jaipur oil depot fire** broke out on 29 October 2009 at 7:30 PM (IST) at the Indian Oil Corporation (IOC) oil depot's giant tank holding 8,000 kilolitres (280,000 cu ft) of oil, in Sitapura Industrial Area on the outskirts of Jaipur, Rajasthan, killing 12 people and injuring over 200. The blaze continued to rage out of control for over a week after it started and during the period half a million people were evacuated from the area. The oil depot is about 16 kilometers (9.9 mi) south of the city of Jaipur

The incident occurred when petrol was being transferred from the Indian Oil Corporation's oil depot to a pipeline. There were at least 40 IOC employees at the terminal, situated close to the Jaipur International Airport) when it caught fire with an explosion. The Met department recorded a tremor measuring 2.3 on the Richter scale around the time the first explosion at 7:36 pm which resulted in shattering of glass window nearly 3 kilometers (1.9 mi) from the accident site.

The fire was a major disaster in terms of deaths, injury, loss of business, property and man-days, displacement of people, environmental impact in Jaipur, the capital city of the Indian state of Rajasthan and a popular tourist destination. As per eyewitnesses having factories and hotels around Indian Oil's Sitapura (Jaipur) Oil Terminal they felt presence of petrol vapor in the atmosphere around 4:00 p.m. on 29 October 2009. Within the next few hours the concentration of petrol vapor intensified making it difficult to breathe. The Ayush Hotel in the vicinity of the terminal asked all its guests to vacate the Hotel to avert any tragedy. The police, civil administration and fire emergency services were oblivious of the situation developing in Indian Oil Terminal.

Around half past six the staff in the terminal had contained the leak and flow of petrol panicked and reported the matter to nearby Sanganer Sadar Police Station. Within the next 30 minutes the local police chief and District Collector were on the spot along with Indian Oil General Manager, but with no plan to deal with the situation. The nearby industries, which were running second shifts, were cautioned to vacate the area.



At 7:35 p.m. a huge ball of fire with loud explosion broke out engulfing the leaking petrol tank and other nearby petrol tanks with continuous fire with flames rising 30–35 m (98–115 ft) and visible from a 30 km (19 mi) radius. The traffic on adjacent National Highway No. 12 was stopped leading to a 20 km (12 mi) long traffic jam. The Jaipur International Airport is just 5 km (3.1 mi) away from the accident site.

Both the Army and experts from Mumbai were employed on 30 October 2009 to contain the fire, which started when an oil tanker caught fire at the depot in the Sitapura Industrial Area. The district administration disconnected electricity and evacuated nearby areas to limit the damage.^[10]

The fire still raged on 31 October 2009, in the Indian Oil Corporation Depot, at Jaipur, after a defective pipe line leak that set fire to 50,000 kilolitres (1,800,000 cu ft) of diesel and petrol out of the storage tanks at the IOC Depot.^[11] By then, the accident had already claimed 11 lives and seriously injured more than 150.^[11] The District Administration and Indian Oil Corporation had no disaster management plan to deal with this kind of calamity. The local fire officers were ill equipped to deal with fire accidents of this magnitude. They remained onlookers and no efforts were made to breach the terminal wall to get closer to kerosene and diesel tanks to cool them with water jets.

Inventory

The following products were stored in eleven tanks inside the terminal:

- Petrol (18,810 kl (664,000 cu ft))

- Kerosene (2,099 kl (74,100 cu ft))
- High Speed Diesel (39,966 kl (1,411,400 cu ft))
- Interface (2,809 kl (99,200 cu ft))

Sitapura Industries Association

The SITAPURA INDUSTRIES ASSOCIATION has 1383 units, consisting of 325 garment, 115 jewelers, 110 handicraft, and other units like chemical, cable, manufacturing, IT, BPO, Auto parts, Educational Institutes and Hospitals having an investment of over 75,000 crore. The SITAPURA INDUSTRIES ASSOCIATION has played an important part in shaping the economy of the State of Rajasthan and generation of employment (approximately 1,000,000 direct/indirect workers). The SITAPURA INDUSTRIES ASSOCIATION has played an important role in exports and generation of foreign exchange. That on 29 October 2009 at about 4:00 p.m. some leakage of Petrol started in IOC Terminal and by 6:00 p.m. the fumes had spread far and wide in and around the Indian Oil Corporation terminal. That a huge explosion and fire erupted at 7:35 p.m. and the noise and shock waves were so intense that it gave an impression of an earthquake to the Industries of the area. The neighboring industries adjacent to the Indian Oil Corporation terminal suffered major structural damages, loss of inventory, equipment, and finished goods. As a consequence of the Fire and associated hazards the District Collector, Jaipur declared a 5 km. zone as dangerous area and prohibited entry of the persons and vehicles in the area. The SITAPURA INDUSTRIES ASSOCIATION claims to have lost Rs.400.00 crore worth of property, equipment and inventory instantaneously on 29 October 2009. Thereafter the loss of production, dispatch and consequent loss of goodwill is valued at Rs. 200.00 Crore per day. The industries were allowed free access to their units since 5 November 2009. The total estimated loss is valued at 1800.00 crore. As an EPZ is part of the SITAPURA INDUSTRIAL AREA it houses a number of export-oriented units. The peak season for the export oriented units was at handshake. Due to fire and subsequent pollution and dispersion of carbon soot particles in atmosphere almost 100% finished garments would fail in stringent quality test and would have to be dumped in the domestic market at throwaway prices. As the industries are most likely to falter on their export commitment, the loss of Goodwill will takes years to rebuild. As the Christmas and New Year is approaching it is a major setback to exporting industry that is carrying a huge liability of working capital. Murli Deora gave an adhoc relief of Rs. 50 Crore for SITAPURA INDUSTRIES ASSOCIATION.



Map showing location of Indian Oil Corporation depot at Jaipur and its adjoining areas

Use of Satellite Image

ARC GIS, ENVI used for analysis of the satellite observations taken during the fire incident. To assess the impact of pollution, taking spread of smoke of the fire as visualized through satellite data (900 Kms altitude) While the satellite pictures depict the aerial spread of the plume, the actual concentration of ambient air at ground level determines the impact of various pollutants. Accordingly, ambient air quality data was analyzed.

Air pollutants include suspended particulate matter (SPM), respirable suspended particulate matter (RSPM), oxides of nitrogen (NOX), sulphur dioxide (SO₂), carbon monoxide (CO), hydrocarbons (volatile organic carbon (VOCs), polyaromatic hydrocarbons (PAH), etc.), heavy metals, ozone (O₃), etc. These have adverse impacts on health as well as plant productivity, visibility,

materials, etc. The 24 hourly average concentrations of SPM, RSPM, NOX and SO2 across these five special monitoring stations during and after the fire incident are shown in figure 5. It is clearly evident that concentrations of all the four pollutants (SPM/RSPM/ NOX/SO2) are higher during the fire days as compared to those after the fire. The 24-hourly values of SPM and RSPM during the first 4 days immediately following the fire incident exceed the residential area standards. The values of NOX and SO2, though higher during the fire days, are still below the residential area standards. This implies that limited effect of the fire incident was felt on Jaipur city as the wind direction on most of the days was such that it carried away the plume to other areas. The effects of the fire on ambient air quality were significant in the impacted area in the short-term but are unlikely to have any long term effects.

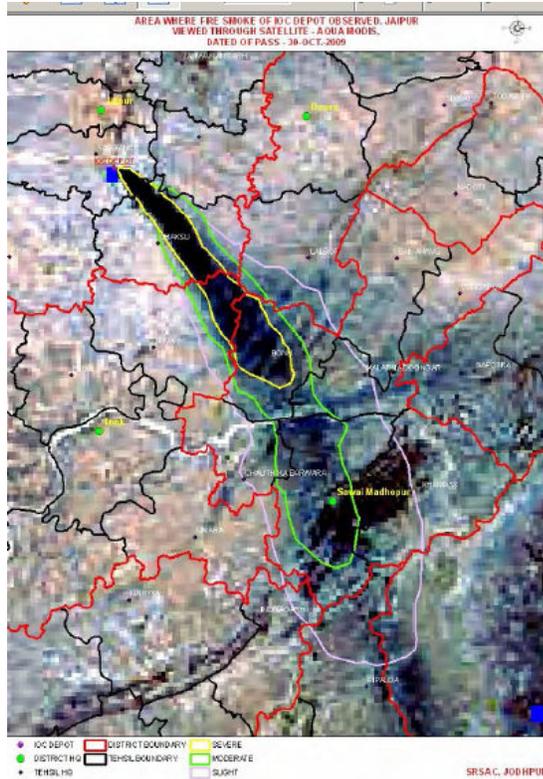


Fig 3 Area where fire smoke of IOC depot observed, Jaipur viewed through Satellite – Aqua MODIS, dated of pass –

30-Oct, 2009 (Source-SASRC)

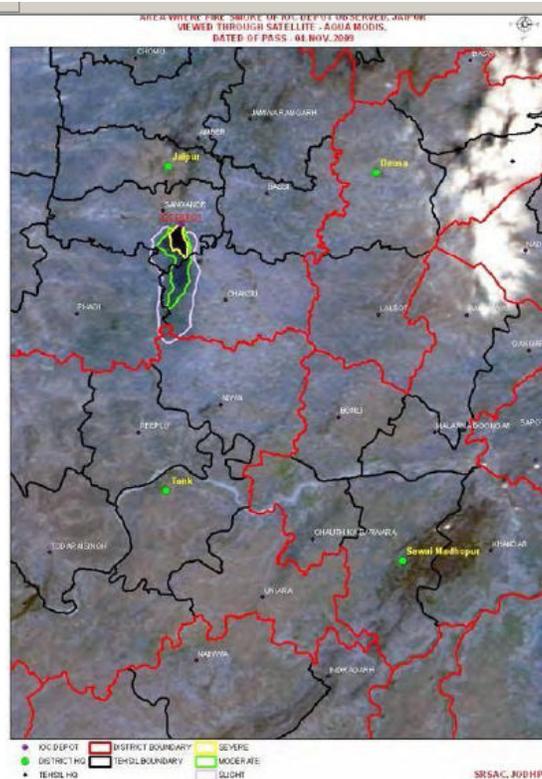


Fig 4 Area where fire smoke of IOC depot observed, Jaipur viewed through Satellite – Aqua MODIS, dated of pass –

4 Nov, 2009 (Source-SASRC)

Area where fire Smoke spread date-30 oct-2009

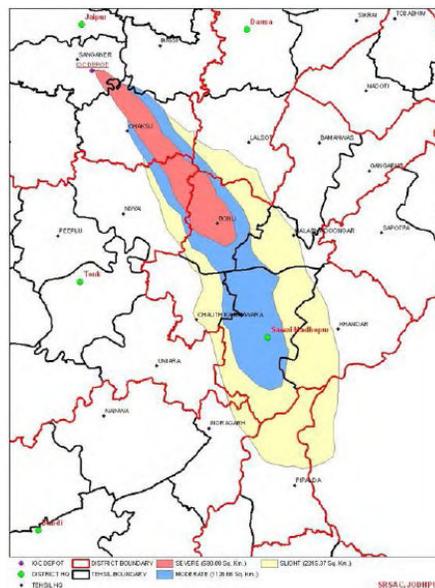
Hydrocarbon analysis

Benzene soluble fraction is an indicator of organic contents measured in ambient air particles (PM10). The analyses data at 6 locations around Jaipur indicate that except Mathurawala village, at all other locations the values were on normal side indicating little or no impact. The relatively higher values at Mathurawala village may be due to the prevalent wind direction. The analytical data of Volatile Organic Carbon's (VOC's) indicate that the maximum value of Benzene was observed at Sriram ki Nangal while the maximum value of Toluene was observed at Chokhi Dhani. Also, the presence of toxic Benzo(a)Pyrene and Polyaromatic Hydrocarbons (PAHs) is found across the study area. Mathurawala village (about 5 Km away from the site) shows the presence of PAHs in the range of 36 to 38 ng/m³ and B(a)P in the range of 6.01 to 6.12 ng/m³ during October 30, 2009 to November 02, 2009, clearly indicating the impact of fire. The maximum concentration of total PAHs (81.39 ng/m³) was observed at Chokhi Dhani, while B(a)P was maximum at STP Delawas (11.55 ng/m³). Thus, the presence of volatile and semi-volatile hydrocarbons in the downwind surrounding areas indicates lateral or local distribution (refer CPCB report).

The above mentioned parameters such as Benzene and BenzoPyrene have been notified by the MoEF on 16 November, 2009 as part of the National Ambient Air Quality Standards. Thus, it is suggested that RSPCB should initiate steps to monitor these two parameters as part of their regulatory requirements.

Disaster Management Plan

ARC GIS used to select the spread area of fire smoke then overlay on cadastral map to know how many villages affected and what are the near by school, shelter and hospital .THE DISASTER MANAGEMENT ACT, 2005 envisages that each revenue District must have a Disaster Management Plan. While 31 revenue Districts of Rajasthan had placed the Disaster Management Plan on Rajasthan Government website Jaipur District did not have any Disaster Management Plan. A Disaster Management Plan for Jaipur District has been put on Internet on 17 November 2009 i.e. 20 days after the accident took place on 29 October 2009. In the mean while Jaipur suffered two more disasters when Swine Flu infected a number of school children prompting Government to order closure of schools, and derailment of a Train **Mandore Express** killing six persons and injuring more than 50 persons.



Water and soil environment related Impact

The team made extensive visits to the sites that could possibly have the highest impact due to the IOC fire. There was only one water body within this area, namely, the Chandlai Talab (a lake measuring about 1 x1 Km in the South East direction of the IOC terminal). Though there were some signatures of the impact of fire, like the presence of some flakes showing metallic sheen (probably the aluminum paint peeled off from the surfaces of IOC tanks storing the fuel) and agglomerated carbon particles, their presence was too scanty to have any measurable impact on

water. It was tried to dissolve the flakes in acids and alkalis and they showed a low solubility in both. The solution in acid was further analyzed for some metals and showed the presence of Copper, Zinc, Lead, Chromium and Iron in concentration of 57.29, 14.32, not traceable, 144.87 and 13185.76 mg/Kg, respectively. These are perhaps the peels of the metallic paint from the storage tanks and since they do have a low reactivity, thus they are not expected to cause any significant harm to the soil or water environment. The carbon agglomerates indicated the spatial extent to which the soot particles reached and these being mostly elemental carbon particles, in the observed concentration cannot have any measurable impact on soil or water. Water sample from the lake was collected and analyzed at RSPCB Laboratory for routine parameters which did not indicate any abnormal values with pH being highly alkaline at 8.74. The water sample was also sent to CPCB for the analysis of hydrocarbons and a sample of algal mat observed near the shores of the lake was collected and sent to CPCB for analysis of hydrocarbons.

Human health impacts

As can be seen from the detailed analysis of environmental samples, the possibility of having any significant adverse impact on humans due to pollution of water and soil is negligible. The results of air samples show that some adverse effects can be perceived respiratory health of the people residing in the impacted zone. Since the fuels burnt were conforming to Euro II /Euro III standards, the sulfur content of these was low and SO₂ emissions were not very high. This is corroborated by the fact that the concentration of SO₂ was below 12 µg/m³ at all the sites, which is well below the permissible ambient standards. The presence of NO_x in air was below 61 µg/m³, being well within the permissible ambient standards. The major parameter of concern was RSPM, which exceeded the allowed standards substantially and could cause acute symptoms like cough, wheezing in certain susceptible individuals and burning sensation in mucous surfaces (especially eyes) and throat irritation in general. The fine particles can reside in air for a long time, however, the showers observed on 12/ 13 Nov. 2009 were beneficial in flushing out lot of these particles from the atmosphere and expected to provide substantial relief to all. A committee of experts set by Principal & Controller, SMS Medical College met on 4.11.2009 and reviewed the

Environmental health hazards of the IOCL Fire. The committee's observations on impact on human health were as under [Report of the committee on IOCL fire incident regarding smoke and its health hazards, dt. 4.11.09]:-

1. Because of the extreme heat during burning and the dry and hot weather conditions, the smoke of fire usually goes high up and does not spread into the adjacent areas. The gases get diluted high up in the atmosphere and the carbon particles fall back as black soot, mostly in crystalline form, which has no short or long term effect on the respiratory system.
2. At the site of fire, it will lead to injuries due to burn and asphyxia. In the adjacent areas it may cause mild irritation of eye & nose in normal persons but in patients having pre-existing COPD/Asthma, it may cause mild exacerbations of the disease. It is unlikely to cause any long term health hazards.
3. So far the records of SMS Hospital and Chest & TB Hospital, Jaipur does not indicate any injurious health hazards of the above fire. The local health authorities should compile their OPD data and may submit the same to the experts for valuation even though the possibility of long term health hazards is minimal.
4. The minimal immediate ill effects on nose, eye, skin and stress related could be easily managed on symptomatic basis by the local health authorities and people need to be reassured about the very unlikely possibility of chronic illnesses.

Thus, it can be surmised that though the immediate effects on respiratory system were reported among susceptible individuals for the surrounding localities, which corroborated well with the dominant wind directions prevailing on those days transporting the plume to such locations, the possibility of any long term effects are very low especially after the scavenging of air by the showers on two consecutive days.

The health data of the region during 2-week periods before, during and after the incident have also been provided by the Health Department, Government of Rajasthan. These indicate that there was a marked increase in the number of cases reporting of respiratory, eye and skin problems during the period of fire compared to those of pre-incident period. The post-fire scenario (after the showers) indicates a trend towards normalcy at all locations except for Vatika and Pratap Nagar sector 6. At Vatika, though the percentage increase in cases was significant, the absolute number of cases was relatively low. It was surprising to note that there was spurt only in the cases of respiratory illness in Pratap Nagar Sector 6, without a single case of eye or skin problems being reported. Normally the residuals of fire persisting in air should affect adversely the respiratory system along with ill effects on corneal region. Besides, there was no evidence of higher prevalence of respiratory problems in any of the adjoining areas and hence these observations at Pratap Nagar are inexplicable based on available evidence. There may be a role of some local problem in this aggravation.

Agricultural and related impacts

Effects on soil

Past research has identified many fire-related impacts on soil conditions. These have been divided into the following categories: Physical and Chemical Properties, Nutrient Properties, Soil Temperature, Soil Moisture, and Soil Biota. In general, when compared to the impacts felt by other ecosystem components, fire effects on soil are typically minor, are often short-lived and can be either positive or negative, with degree of impact increasing with increased fire severity. However, all these effects are of concern only in the immediate vicinity of fire. There is no agricultural farm in the zone affected due to high temperature of fire and hence the above parameters are of no concern in the present context. In fact, the affected zone is within IOC campus, where an immediate effect on vegetation was observed but the soil parameters can be altered to the desired degree to support whatever plantation exists in the area or proposed to be grown in future. The soil samples collected from the nearby villages after the event showed pH in a range of 8.5-9.0 indicating no impact of the event on this parameter. Further, it was found that in the samples taken by the Agriculture Department, GOR and tested at Durgapura Laboratory, the presence of organic matter in soil was in a range of 0.1-0.3% in the villages at Chandlai, Mathurawala, Shri Ram Ki Nangal and shooting range, which is the usual range for these soils and as such no loss of organic matter is indicated due to the fire in these surrounding villages.

Effects on agriculture

To study the impact of fire due to IOC incident on crops, a committee of eight members was constituted consisting of scientists from Agriculture Research Station, Durgapura and officers from Agriculture department. Zonal Director Research, ARS, Durgapura was the chairperson of this committee. The committee visited 17 villages in the radius of 20-25 Km from the Sitapura terminal. After analyzing the observed situation in different villages it was found that after the incident the temperature did not have much effect on crop growth. Early Wheat sowing was found in some villages by some farmers, which was too early than the recommended sowing time i.e. around 15th November, hence the sprouted Wheat was showing little moisture stress at some of the places. The 20 to 30 days old Mustard crop was found to be normal except some effect of insect- pest which was observed along with improper intercultural operations like hoeing and weeding. Similarly early blight, Leaf curl and Leaf minors affect was found in the crops of Tomato & Chilies. Looking to the present prevailing conditions in the area and observation on growth attributes no clear effect of fumes and pollution was observed on the crops, but increased density of carbon monoxide, carbon dioxide, sulphur dioxide and oxides of

nitrogen in the atmosphere may have some adverse effect on crops in future, if rain occurs, but it will depend on the intensity and period of raining. Probable deposits of carbon particles on leaves may have slight effect on stomata openings affecting transpiration and photo synthesis activities up to some extent. To assess the situation, again a field study was done after one month period (on 8.12.2009) and it is reported that there was no significant change in the opening of stomata, photosynthetic activity and the growth of plants was also normal. Apparently, there was no effect of possible accumulation of carbon particles on the physiology of plants.

Effects on Trees and Shrubs

At the IOC campus and immediately surrounding area, total burn out of trees and bushes was evident as they took the brunt of extensive heat generated. Some vegetation in the surrounding area near IOC campus which is still leafy is very likely to loose leaves in times to come when physiological damage will show. However, the new leaves would reappear as the trees and bushes are not physiologically dead.

Effects on Birds

In general, fire effects on birds are typically secondary in nature. Direct effects are typically dependant on season, fire uniformity, and severity. Due to their mobility, mortality of adult birds is usually considered minor. If the fire occurs during nesting however, nestling and fledgling mortality will occur. Severity also determines whether or not nests are damaged. During the survey undertaken by the committee it was observed that pigeons and doves were roosting in the campus itself as well as on the bridge

near the highway. Although no carcasses of birds were observed possibility can't be ruled out. What was surprising is the total absence of house sparrows from the area under observation. No nests were observed within the campus but fire-impervious bird species like pigeons and egrets were seen flying very close to smoke plume. Some of these have also been photographed and clearly show that there were no poisonous gases in the area. Birds have traditionally been used to detect poisonous gases in coal-mines because of their ability to detect poisonous gases. They are the best biological indicators of air quality.

Effects on animals

A team from the Department of Animal Husbandry visited the area surrounding the IOC depot and covered many villages and Dharies. At all these sites, the general health of the animals was found to be normal and there were no signs of any respiratory problems or digestive disorders. There was no cattle death reported due to IOC fire, and the availability of fodder was also plenty.

Other impacts

Visibility

Based on the meteorological data available, a decrease in visibility level was noticed on the day immediately following the accident. On Oct. 30, 2009 the visibility at 0830 hrs and 1130 hrs was just 1500 m and 2500m. On Oct. 31, the visibility at these hours was 2000 m and 4000 m, respectively. However, the daytime visibility increased to 4000 m on Oct. 31. The night time visibility during this period did not show any significant change. Thus, the likely impacts of the fire on visibility were short-term and were experienced over a couple of days before it returned to normal.