ENVIS-IITM NEWSLETTER

Indian Institute of Tropical Meteorology, Pune

Acid Rain and Atmospheric Pollution

(The project of Ministry of Environment & Forest, Govt. of India)

EXTREME POLLUTION EVENT

EDITORIAL TEAM

Dr. Gufran Beig, (Envis Co-ordinator)

Ms. Neha S. Parkhi, (Senior Program Officer)

Mr. Gaurav P. Shinde, (Information Technology Assistant)

Volume 13 Issue 2 April - June 2014

"Talking about pollution, nobody's holy.
They who pollute, sinned against nature."
– Toba Beta

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EDITORIAL

India's air quality is deteriorating faster in metropolitan cities and slower in rural areas. Pollutants are added to the environment through emissions of various natural as well as anthropogenic sources like transport, industries, energy, biomass, road dust etc. Air pollution is a major environmental health problem affecting everyone and increases the risk of respiratory and heart diseases. The biggest air pollution related burden to health is observed in developing countries. The lack of knowledge of the health impacts from pollution is a big obstacle in defining and applying the appropriate actions. An exposure to air pollutants is largely beyond the control of individuals and requires action by public authorities at the national, regional and even international levels.

Our present issue deals with Extreme Pollution Events in terms of air pollution. It is mainly focused on the air pollution caused during the festival of Diwali which is an important festival and celebrated across the country displaying a huge amount of fireworks. We hope our attempt to convey scientific information in simple language will help to create awareness amongst the common public which is the first step towards safeguarding our environment.

-Dr. Gufran Beig

EXTREME POLLUTION EVENTS

Extreme pollution events are the episodic events in which the pollution either suddenly shots up or continuously increases to a severe or poor level. The pollution can double or triple within a short span of time or increase upto 100% overnight. Extreme Pollution Events can be categorised into 2 types, known pollution events and sudden pollution events. In sudden pollution events meteorology plays the major role. These events are caused purely due to erratic weather conditions such as sudden fall in temperature by 4-6°C in 1-2 days, unusual monsoon progression, dust storms etc. Dense smog observed in Delhi in the year 2013 is the example of sudden pollution event.

Sudden Pollution Events




Whereas known pollution events are driven by known emission source. In these events the emission sources are known and sudden increase in the pollution level in a short period of time (1 or 2 days) can be attributed to that specific pollution source. Such known pollution events have been experienced by all of us on special occasions such as Diwali, Holika dahan, Dasahara, new year eve etc. during which concentration of various health hazardous pollutants increases because of burning of firecrackers and other related activities.

Known Pollution Events




DIWALI CELEBRATIONS & AIR QUALITY



Diwali is the biggest festivals of Hinduism, Jainism and Sikhism. The festival is celebrated for five continuous days, were the third day is celebrated as the main Diwali festival or festival of Light. It is the national holiday in India and all people celebrate it with great enthusiasm across the country. The festive fever start few days before Diwali day, people start buying new cloths, gifts, different household items, even automobiles due to lucrative schemes offered by different companies and shops. People decorate their houses, shops and even public places by lightning the small clay lamps or Diyas filled with oil. The shopping places, malls, markets get crowded till Diwali day. This is the occasion when people visit each other's house to share gifts and sweets.



Unfortunately these activities results in the increased traffic load in the city, increased cooking activity, increased burning of bio-fuel and fossil fuel which emit lots of health hazardous pollutants

There's so much pollution in the air now that if it weren't for our lungs there'd be no place to put it all.

- Robert Orben

in to the air prior to Diwali day and on Diwali day specifically at night the pollution source get shifted towards burning of fire crackers. It is observed and supported by many research studies that during Diwali the concentration of gaseous as well as particulate pollutants in the air increases rapidly as compared to other normal days reaching the highest values in the record particularly in case of particulate matter, causing threat to the health of individuals along with the plants, animals, birds etc. We can witness the increased pollution levels by reduced visibility, dense brown clouds of smoke, sore throat and eye irritations. Now we have to think that which factor is responsible for such undesired conditions in our celebration and how we can prevent ourselves from them.

FIRECRACKERS THREAT TO OUR ENVIRONMENT

Fireworks generally consist of a paper or pasteboard tube or casting filled with the combustible material such as pyrotechnic stars i.e. pellets or simply pieces of pyrotechnic composition which may contain metal powders, salts or other compounds. Six basic elements used to prepare fireworks are fuel, oxidising agent, reducing agent, colouring agent and binder. Black powder (75 % potassium nitrate, 15% charcoal and 10% sulphur) is the most common fuel used in fireworks. Nitrate, chlorates and per-chlorates used as oxidising agents; produce oxygen which is needed to burn the mixture inside the firework. Commonly used reducing agents are sulphur and charcoal; these react with the oxygen provided by oxidising agents to form hot gases, SO_2 and CO_2 respectively. Metals are added in to the mixture to regulate the speed at which the reaction is going on. Metals like zinc, titanium used to produce smoke effects, silver sparks etc. Another important component of firework is binder which is used to hold the mixture of firework together in a paste like mixture. Most commonly used binder is dextrin, a type of starch which holds the composition together. Usually we enjoy different colours and light coming out of firecrackers but do you know what it contains and from which material it is prepared and its associated health consequences. You will find all details about it in Table-1.

Hence the by product of firework combustion depends upon the mix of ingredients used during the manufacturing process i.e. amount of black powder used, type of oxidizer, colouring agent etc. along with the launched method

FIRECRACKERS AND YOUR HEALTH

Burning of Firecrackers emit smoke, gaseous pollutants, green house gases and particulate matter in to the air which are found to be dangerous to human health and environment. Barium, copper, cadmium, lithium, antimony, strontium, lead and potassium nitrate are commonly used to produce different colours and effects even though some of them are poisonous and radioactive and most of them have potential to cause respiratory and health problems. Burning of these elements release gases such are CO, NOx, SOx even ozone in to the air. Ground level Ozone is

Table-1 : Various compounds used in firecrackers to generate different colours and associated health effects.

Firework Colour	Compound	Health Effects
RED	Strontium salts, lithium salts lithium carbonate, Li_2CO_3 = red strontium carbonate, $SrCO_3$ = bright red	Sr causes skin rashes or other skin problems. Li inhalation causes burning sensation, cough, shortness of breath, sore throat, redness of skin, burns, pain, blisters, redness of eyes.
ORANGE	Calcium salts calcium chloride, $CaCl_2$	Too much calcium in the bloodstream may increase risk of fatal prostate cancer.
YELLOW	Sodium salts sodium chloride, NaCl	Irritation of the mucous membranes of the nose, throat and respiratory tract.
GREEN	Barium compounds + chlorine producer barium chloride, $BaCl_2$	Barium causes breathing difficulties, increased blood pressures, heart rhythm changes, stomach irritation, muscle weakness.
BLUE	Copper compounds + chlorine producer copper(I) chloride, CuCl	Cu dust fumes when inhaled may cause irritation in the respiratory tract, nose, mouth and eyes, headaches, stomach-aches, dizziness, vomiting and diarrhoea, liver and kidney damage and even death.
PURPLE	Mixture of strontium (red) and copper (blue) compounds	Sr causes skin rashes or other skin problems. Cu dust fumes when inhaled may cause irritation in the respiratory tract.
SILVER	Burning aluminium, titanium, or magnesium	Al dust is an eye and respiratory tract irritant in humans. Mg dust may irritate mucous membranes or upper respiratory tract. Titanium long-term exposure may result in mild fibrosis (scarring of the lungs).

believed to be caused by ultra-violet light released by metals present in the mixture of fireworks at high temperature. In addition to the gases, smoke from fireworks contains sulphur-coal compounds, traces of metals and particulate matter. Studies have revealed that high air pollutant levels due to fireworks displays for Deepavali celebration causes acute air quality health hazards every year in urban India. Inhalation of fumes emitted by firecrackers not only makes one cough, sneeze, go breathless and have irritation in the throat, but also worsens pre existing conditions such as asthma, bronchitis and pneumonia. Firecrackers can cause hearing loss, high blood pressure, sleeping disturbances and sudden exposure to loud noise can cause temporary or permanent deafness or even result in heart attack. Firecrackers make noise more than the allowed decibel limit for human

When the earth is sick and polluted, human health is impossible... To heal ourselves we must heal our planet, and to heal our planet we must heal ourselves.

- Bobby McLeod

being. Studies have also revealed that there are excess numbers of total cardiovascular and respiratory mortalities and hospital admissions during the Deepavali season. Children and the elderly with lung disease are more vulnerable. High levels of PM can cause discomfort to healthy individuals as well. Sometimes, rocket-crackers set fire to huts, heap of dry grass etc. Every year there are cases of burns or injuries caused due to unsafe practices performed while bursting the crackers. Especially, burns on the hands and legs are commonly seen in children and young individuals. In addition it also deposits physical litter on the ground and in to water bodies in the surrounding area.

WHY TO TAKE RISK

Pollution caused from firework is a subject of debate because large-scale pollution from other sources makes it difficult to measure the amount of pollution that comes specifically from fireworks but sudden increase in the levels of air pollutant during Diwali day especially after bursting the firecrackers at Diwali night shows this is a significant source of air pollution and has to be addressed properly.

Study conducted by IITM, Pune, under the project System of Air Quality Weather Forecasting & Research (SAFAR) over Pune and Delhi reveals emissions from firecrackers push up PM into unhealthy level; a drastic rise in PM was noted in different parts of the city. In Pune the air pollutant levels shot up twice their permissible limits in various parts of the city on the main Diwali day. In 2013 there was 50 to150% increase in air pollution level observed due to bursting of firecrackers. A study conducted by Chest Research Foundation (CRF) found that the level of Sulphur dioxide, a toxic gas produced by the burning of firecrackers in residential areas reached levels more than 200 times above the safety limits prescribed by World Health Organization.

ROLE OF METEOROLOGY

Diwali generally falls in the months of October/ November. During this period the temperature is generally warm and the winds are moderate so the extra emission load of pollutants is dispersed over a short period of time. But the condition can worsen if the meteorological conditions change, such as if the temperature suddenly falls below the normal and the winds remain calm and the mixing height is low, the pollutants can remain stagnant in the atmosphere for a longer period. Thus, meteorological conditions also play a major role in deciding the air quality. Recent study reveals that the concentration of pollutants also depends on weather conditions, the amount and the quality of crackers used which ultimately influence the air quality. In Delhi during Diwali period 2013 there was a sudden dip in temperature by $6^{o}C$ which resulted in sharp lowering of the boundary layer height upto 47m as compared to normal height of 75-100m. This led to trapping of pollutants close to the Earth's surface. The average wind speed (0.36m/sec) was found lower which trapped the pollutants in air instead of dispersing them. Thus, the temperature was cool and the winds were calm which hampered the dispersal of pollutants and slowed down the mixing from surface to upper

part of atmosphere and the pollutants accumulated near the earth's surface creating the haze (smog) like situation in the post Diwali period. Thus, thick smog of pollutant hung over the city and people were exposed to unhealthy air quality.

LEGAL RESTRICTIONS

The Supreme Court of India observing that "the right to peaceful sleep is a fundamental right of the citizens", has banned firecrackers between the hours of 10 p.m. and 6 a.m. during the Dasehra and Diwali festivals. Considering the effects the Central Pollution Control Board of India has banned firecrackers with a decibel level of more than 125 at a distance of 4 meters from the bursting point. Bursting of fire crackers are prohibited at hospitals, educational institutions, places of worship.

YOUR SIMPLE INITIATIVE CAN MAKE A CHANGE

As it has been discussed, pollution problem during Diwali is a result of increased human activities such as shopping, cooking, travelling, enjoying by bursting firecrackers etc. which adds more pollution load in to the air which is already receiving tonnes of pollutants from different processes. At least by restricting or minimising these activities during the specific period of Diwali one can minimise the excess load which cause a severe problem to the health as well as to other animals, plants and cause imbalance in the environmental processes.

- **Say No to firecrackers:** Burning of firecrackers release different toxic chemicals which not only cause air pollution but also affect health of individuals seriously and have adverse impact on birds, animals and plants etc. Ideal solution to tackle this problem is to say "NO" to fireworks.
- **Use eco friendly firecrackers:** Eco-friendly crackers are made up of recycled paper and they emit coloured lights and are of very low decibel sounds. Fireworks propelled with compressed air are an example of eco-friendly product the use of it can be encouraged.
- **Bursting firecrackers in community centres:** Instead of bursting firecrackers individually in front of each home in the city, one can celebrate this occasion by gathering together in nearby open area such as ground, this will increase festivity and bonding along with minimising adverse impact on the air.
- **Restrict Bursting of firecrackers to one day:** Bursting of firecrackers can be done only on main Diwali day instead of before and after Diwali.
- **Other Measures:** Use gen-set which operates on plant oil/LPG/hydrogen instead of using diesel based, decorate houses, work places and public places with lighting the oil lamps in earthenware or clay lamps, to reduce increased load on power generation, make floral decorations, Green plantations to enhance ambience which also help to reduce air pollution.
- Sensitization of the issue of the air pollution caused especially during the festive season like Diwali is the urgent need of today. This can be generated only through awareness using various modes to reach out to the mass population. We hope the information shared will provide awareness to the public at large for control and safe use of fire crackers to make a happy and eco friendly DEEPAWALI.

If we are to go on living together on this earth, we must all be responsible for it.

- Kofi Annan

OUTDOOR AIR POLLUTION -A LEADING ENVIRONMENTAL CAUSE OF CANCER DEATHS

On 17 October 2013 – The specialized cancer agency of the World Health Organization, the International Agency for Research on Cancer (IARC), announced that it has classified outdoor air pollution as carcinogenic to humans. Particulate matter, a major component of outdoor air pollution, was evaluated separately and was also classified as carcinogenic to humans.

DO YOU KNOW?

- A study by Chest Research Foundation (CRF) in Pune revealed that 25% of population is affected adversely by the fumes emitted by firecrackers during Diwali.
- Around 20% of lung cancer patients who eventually die in Hyderabad are exposed to high levels of air pollution.
- WHO estimated that outdoor air pollution caused 1.2 million premature deaths in China in 2010.
- Worldwide it is estimated that 2 million people, more than half of them in developing countries die every year from air pollution.
- During international fireworks competition in Montréal, Canada, Joly et al. (2010) have reported PM2.5 level up to 10000 µgm-3 over short time scale (roughly 1000 times to background level) at human breathing height and it was sustained at level of 1000 µg/m3 over a fireworks display period (~ 45 min).

All queries and feedback regarding this newsletter should be addressed to:

Dr. Gufran Beig

ENVIS-Coordinator

Indian Institute of Tropical Meteorology,

Dr. Homi Bhabha Road, Pashan,

Pune – 411 008, India

Telephone: +91-20-2590-4200, Fax: +91-20-2586-5142

E-mail: pollution@tropmet.res.in & iitm-env@nic.in

Website: http://envis.tropmet.res.in & www.iitmenvis.nic.in