

# New studies say urban pollution and irrigation canals are to be blamed for the increasing fog in north India

**E**VERY time you are drive through a blanket of dense fog or wait for your flight to take off at the Indira Gandhi International airport, this question must be crossing your mind: what is the cause of this phenomenon which is occurring with greater vigour every year.

Scientists investigating this yearly climatic phenomenon have got some leads, though they do not yet have conclusive answers. One of them, for sure, is the increasing level of air pollution. What's new is the finding that pollution is not only leading to more foggy mornings but is also making Delhi nights much colder. Scientists have also come across an unlikely factor for the fog in north India — the green revolution.

Fog is a result of interplay of several parameters — temperature, availability of moisture in the air, wind conditions, presence of organic molecules or pollutants, solar radiation and so on. In winters, when temperature dips and relative humidity goes up, fog is formed. In Delhi, the abundance of organic molecules from various activities — automobile exhaust, burning of wood, dried leaves and coal, industrial pollution — is the reason for the dense fog in the months of December and January.

This is true for most urban areas in north India. But in rural areas, where pollution level is minimal, fog is due to increase in moisture either in the soil or due to overnight rainfall. The moisture could be coming from heavily irrigated agriculture fields. Farmers in Punjab, Haryana and Uttar Pradesh depend on irrigated water for winter crops of wheat and vegetables. While deforestation may have decreased water vapour flow in the atmosphere, irrigation is contributing to moisture content.

When relative humidity touches 100 per cent, pollutants in the air begin absorbing moisture from the air. This makes particulate matter larger in size, yet they remain light. These molecules then form clusters and individual particles begin absorbing radiation from the sun. Because of the temperature difference between the surface and along the vertical gradient, the moisture-laden pollutant molecules get trapped just above the surface, resulting in poor visibility on the ground. The dense fog cuts down solar radiation, making day temperatures in Delhi plummet. An analysis of hourly fog data as well as the minimum and the maximum temperatures in Delhi during 25-year period from January 1981 to December 2005 by scientists at the Indian Meteorological Department (IMD) has revealed alarming trends.

In the early 1980s, the average duration of dense fog in January was 30 minutes per day. This grew to one hour over the next 15 years. After 1995, fog duration during January rose to two-three hours per day. This began causing severe problems in movement of aircraft at the IGI airport. The average hours of clear visibility at the airport fell from 5.7 hours in 1980s to nearly zero in 2005. An accompanying change was seen in the temperatures recorded at the airport — a fall of 3 degrees in maximum temperature between 1988 and 2005.

A separate study of the fog phenomenon by scientists at the National Physical Laboratory (NPL) has thrown up strange findings. A study of temperature at various points — below the earth's surface, on the ground and at various points up to 30 meters above the surface — has shown variation of seven to eight degrees. "Normally, the temperatures below the ground and on the surface are lower than the temperatures a few meters above. But what we have observed in Delhi is the opposite — temperatures above the earth are lower in winters and this is cooling the surface," says S.C. Garg, Scientist Emeritus at NPL.

Another phenomenon that NPL scientists have observed is "double entrapment" of pollutants just above the ground in Delhi. "Pollutants remain trapped between two inversion layers with the above layer acting as a lid," explains Garg. If only pollution is to be blamed for fog in Delhi, then how can one explain the thick blanket of fog seen in most parts of north India? Experts believe it is the same pollution factor at play. "The occurrence of fog extends to the entire Gangetic basin. Several factors — meteorological, radiation and pol-



Vehicular pollution is largely to blame for the dense fog in Delhi, which in turn obstructs traffic flow.

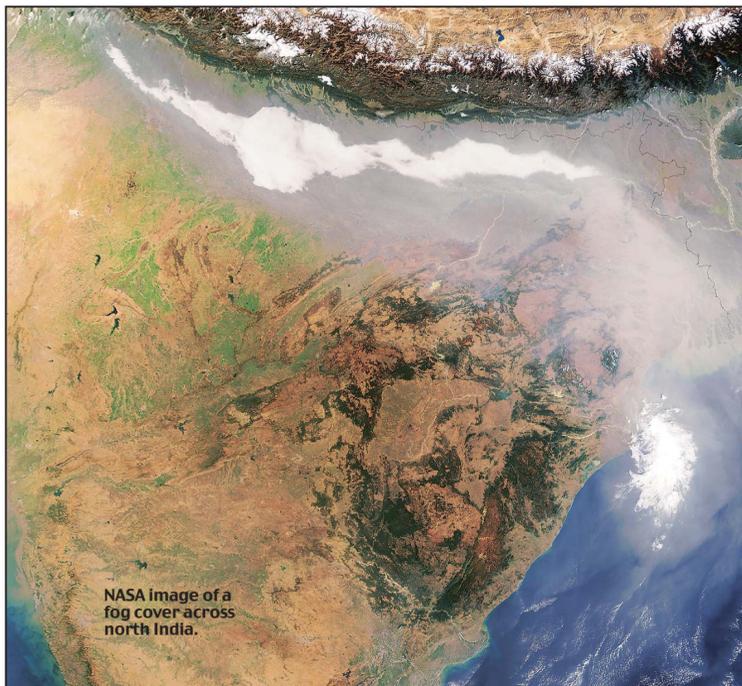
# DISSECTING DELHI'S DARKNESS AT NOON

by Dinesh C. Sharma

lutation (particulate or aerosol) — contribute to fog formation and its persistence," says Sachida Nand Tripathi from the Indian Institute of Technology, Kanpur.

**T**HIS does not explain the occurrence of fog in rural areas or areas where pollution load is zero. The IMD study points out that fog in such areas is due to increase in moisture either due to overnight rainfall or due to moisture in the soil or moisture availability from storage tanks, ponds and canals. It could also be coming from heavily irrigated agriculture fields in the *rabi* season. The irrigated land in north India has expanded by almost 20 times since 1965 when the wheat revolution was heralded. Large irrigation projects and extensive river canal system has taken water to new areas, thus changing the hydrological cycle. This has induced an overall cooling in long-term surface temperatures in the region, a group of American scientists led by India-born Shouraseni Sen Roy had reported recently. These observations, taken along with IMD study and other findings, indicate that greater availability of moisture in the air due to extensive irrigation systems is one of the chief causes of fog in north India.

But there is complete apathy at the government level, with the Central Pollution Control Board denying any significant link between Delhi fog and pollution. There is no coordinated scientific effort to analyse the problem and pinpoint the causes.



NASA image of a fog cover across north India.

## WHAT BLINDS YOUR VISION

**FOG**  
FOG is formed due to condensation of water droplets suspended in the atmosphere in the vicinity of the earth's surface under certain conditions, such as low temperature and high relative humidity. The source of water vapour in the air is the moisture in soil, plant leaves, surface water bodies, irrigation canals, and transportation of water in clouds due to prevailing weather conditions. According to international definition, fog reduces visibility below one km. Fog differs from cloud only in that the base of fog is at the earth's surface while clouds are above the surface.

**SMOG**  
THE pollution of fog with smoke particles is known as smog. With the dip in temperature, the smoke particles cannot move up in atmosphere and cause reduction in visibility. The smoke mainly comes from industrial air effluents, vehicular exhausts and other polluting sources. It envelops the area and does not allow sun rays to reach the ground.

**HAZE**  
IT IS also a kind of suspension carrying mixtures of aerosols and photochemical smog. It reduces visibility by scattering light. The size of aerosols increases with increasing humidity, thus reducing visibility further. Haze often creates a bluish or yellowish tint in the atmosphere depending on the background. This effect distinguishes haze from mist, which yields only a gray obscuration, since particle sizes are too large to yield appreciable differential scattering of various wavelengths.

## Fog harvesting can reduce water scarcity

FOG, considered nuisance by most city dwellers and frequent fliers, can actually be a source of water. In some experimental projects in Chile, Yemen, Guatemala and Nepal, fog is being harvested to get water, using low cost techniques. The earliest experiment at fog harvesting was initiated in the early Nineties by the International Development Research Agency. Fog harvesting is similar to rain water harvesting which has gained popularity in India and elsewhere.

### The fog-tapping technique works best in hilly areas

The fog harvesting technique is simple: rectangular panels of fine-meshed nets and bamboos are erected in the direction of the wind. As fog passes through these nets, the water vapour in it gets collected on the net. When this volume of water droplets grows, water starts dripping. This dripping water is collected in the plastic channels attached at the bottom of the net using principals of gravity flow. A series of such collectors can be arranged in a row, in fog-prone regions. Depending on quality of water, it can be used either for agricultural or other purposes. Scientists say it can be used for humans for drinking purpose only after proper chlorination. Fog harvesting can be an additional source of water in hilly areas which do not have piped water supply and natural sources of water. The technique, experts say, works best in hilly areas and coastal regions. The collectors need to be placed only after proper study of topography, wind direction and other natural conditions. The fog harvesting experiments carried out in Nepal and the state of Uttarakhand in India have yielded good results, but the technique is yet to become popular. The Indian Institute of Technology-Kanpur has acquired a scientific instrument, fog collector, in order to study chemical composition of fog. This could help in understanding the source of aerosols that are a leading cause of dense fog formation in Kanpur and other regions in the Gangetic basin. Can fog harvesting technique be used to tap fog around airports and improve visibility? This has not been attempted anywhere, so scientists remain non-committal about efficacy of such a measure.

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The expanding irrigation network and moisture from water bodies contribute to formation of fog, especially in rural parts of north India.