SACHCHIDA NAND TRIPATHI

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Prof. Sachchida Nand Tripathi was born in Varanasi, Uttar Pradesh. He obtained his B.Tech. from the Indian Institute of Technology, Benares Hindu University (1992), M.Tech. from the National Institute of Technology, Allahabad (1995), and Ph.D. from the University of Reading, UK (2000). After two post-doctoral stints at Bhabha Atomic Research Centre and Oxford University, he joined IIT-Kanpur in 2003, where he is a professor in the Department of Civil Engineering and Sustainable Energy Engineering. The Council for Scientific and Industrial Research of the Government of India awarded him the Shanti Swarup Bhatnagar Award for his outstanding contribution in the field of Earth, Atmosphere, Ocean and Planetary Sciences in 2014. Prof. Tripathi is an elected fellow of major sciences and engineering academies of the country and also holds the J. C. Bose Fellowship of the Department of Science and Technology.

ENGINEERING & COMPUTER SCIENCE

The Infosys Prize 2023 in Engineering and Computer Science is awarded to Prof. Sachchida Nand Tripathi for the deployment of large-scale sensor-based air quality network and mobile laboratory for hyper local measurements of pollution, data generation and analysis using artificial intelligence and machine learning for effective air quality management and citizen awareness, and for the discovery of new pathways of aerosols formation and growth that provide mechanistic understanding of haze formation.

SCOPE AND IMPACT OF WORK

Air pollution is one of the high priority problems in India. Mitigating air pollution requires a scientific understanding of the causes of pollution, its origin and sources. Measuring pollution and understanding its source requires networks of inexpensive sensors. Prof. S.N. Tripathi deployed such a sensor network in 1,400 locations, and a mobile laboratory to collect and transmit data automatically for analysis.

Prof. Tripathi applied greedy and genetic algorithms to find critical locations for sensor placement while meeting twin requirements of citizens' satisfaction and resource conservation. He used existing self-supervised Machine Learning (ML) techniques on vast data sets to develop correction factors for collocated and non-collocated sensors. The field data is further corrected by Graph Neural Networks (GNN) to fill missing values. Prof. Tripathi is using a range of techniques such as dynamic time wrapping and hierarchical clustering to figure out airsheds, which are defined as regions with similar air pollution patterns. This may help develop effective air quality management. The vast amount of data allows for in-field fault-detection of sensors, development of air quality forecasting systems, citizen awareness and understanding of disparities between rural and urban air quality.

One of the fundamental findings of Prof. Tripathi is that condensation of vapor drives the formation and growth of nanoparticles which quickly grow into sizes responsible for haze formation in Delhi, and it happens at night without photochemistry. We need such sensor networks and scientific understanding for proper mitigation of air pollution.

CITATION BY THE JURY

Prof. Sachchida Nand Tripathi has been selected as the winner of the Infosys Prize 2023 in Engineering and Computer Science for his fundamental research in the atmospheric aerosols including the mechanisms of winter haze formation. He showed that the key differences between Delhi and other places like Beijing are much faster particle growth rate in Delhi as it happens even at night without photochemistry. This finding is useful for mitigating air pollution.

Prof. Tripathi has also helped deploy large-scale sensor-based air quality network and mobile laboratory for hyper local measurements of pollution needed for effective air quality management and citizens awareness. A pilot scale plant built by Prof. Tripathi is being used by Indian atomic energy agencies for safety evaluation of their nuclear plants. The plant can also be reconfigured to measure aerosol leakage from chemical industries for environmental safety analysis.

Congratulations Prof. Sachchida Nand Tripathi for being selected as the winner of the Infosys Prize 2023 in Engineering and Computer Science. Your fundamental research and its deployment in the field has deepened the understanding of the winter haze formation in Delhi by characterizing precisely the atmospheric aerosols using the nanoscale single-particle analyzer. You have shown that carbonaceous aerosol deposition has caused the discoloration of Taj Mahal's marble surfaces. We need such scientific understanding to come up with proper mitigations.

Arvind

THE AIR THAT WE BREATHE

According to the World Air Quality Index Report 2023, there are an estimated 7 million deaths every year that can be directly attributed to air pollution. A WHO report says that environmental risks cause 12 per cent of the global disease burden, and air pollution ranks first. In November 2023, the government of Delhi sounded the alarm about a catastrophic fall in air quality, leading to school closures and advisories for citizens to remain indoors. The national capital was facing one of the worst environmental disasters unfolding as winter set in.

Air quality and its management has been a topic of intense discussion as more and more Indian cities face a crisis of air pollution. The factors that lead to the pollution caused by human activity are many including biomass burning, increased vehicular pollution, industrial emissions and others. The aerosols and their precursor gases from these pollutants then create haze which exacerbates the pollution. Air quality becomes important especially for vulnerable sections of the population such as the very young and the elderly, sections of the population with chronic illnesses and others. Trying to find solutions to such problems begins with understanding how the problem happens in the first place.

Prof. Sachchida Nand Tripathi's lab studied the process of haze formation in Delhi and how this differed from other cities in the world such as Beijing. What they discovered is that while in Beijing the aerosols forming the haze grew during the daytime in the presence of sunlight i.e. with photochemistry, in Delhi the growth took place in the night in the absence of photochemistry. Along with identifying how the haze particles worked, Tripathi then needed to identify the most polluted areas. This would help in increasing citizen awareness and implement better air quality management measures.

While air quality management is becoming a global issue, in resource-limited countries such as India, there are additional challenges. Prof. Tripathi placed air quality sensors chosen by algorithms. The locations were chosen keeping in mind resource conservation and citizen satisfaction. Starting with a few sensors, they eventually placed 1,400 sensors across the Indian states of Uttar Pradesh and Bihar. These sensors helped identify the worst polluted locations in these places.

The vast amounts of data from the sensors were analyzed using artificial intelligence and machine learning. Prof. Tripathi and his team identified areas known as airsheds, which are areas with similar patterns of air pollution. This data will help in the development of effective air quality forecasting systems, citizen awareness, exposure analysis for health assessment and understanding of differences in air quality in rural and urban areas.

It isn't just human beings and other living things who are affected by bad air quality and air pollutants. Prof. Tripathi was the first to prove that the Taj Mahal's pristine white marble was turning yellow because of the carbonaceous aerosols in the air from industrial emissions in the area. As a result of the study, policies were implemented to move industries away from the monument and protect an icon of India's cultural heritage.