As Diwali nears, how can India harness tech for clean air?

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OPINION

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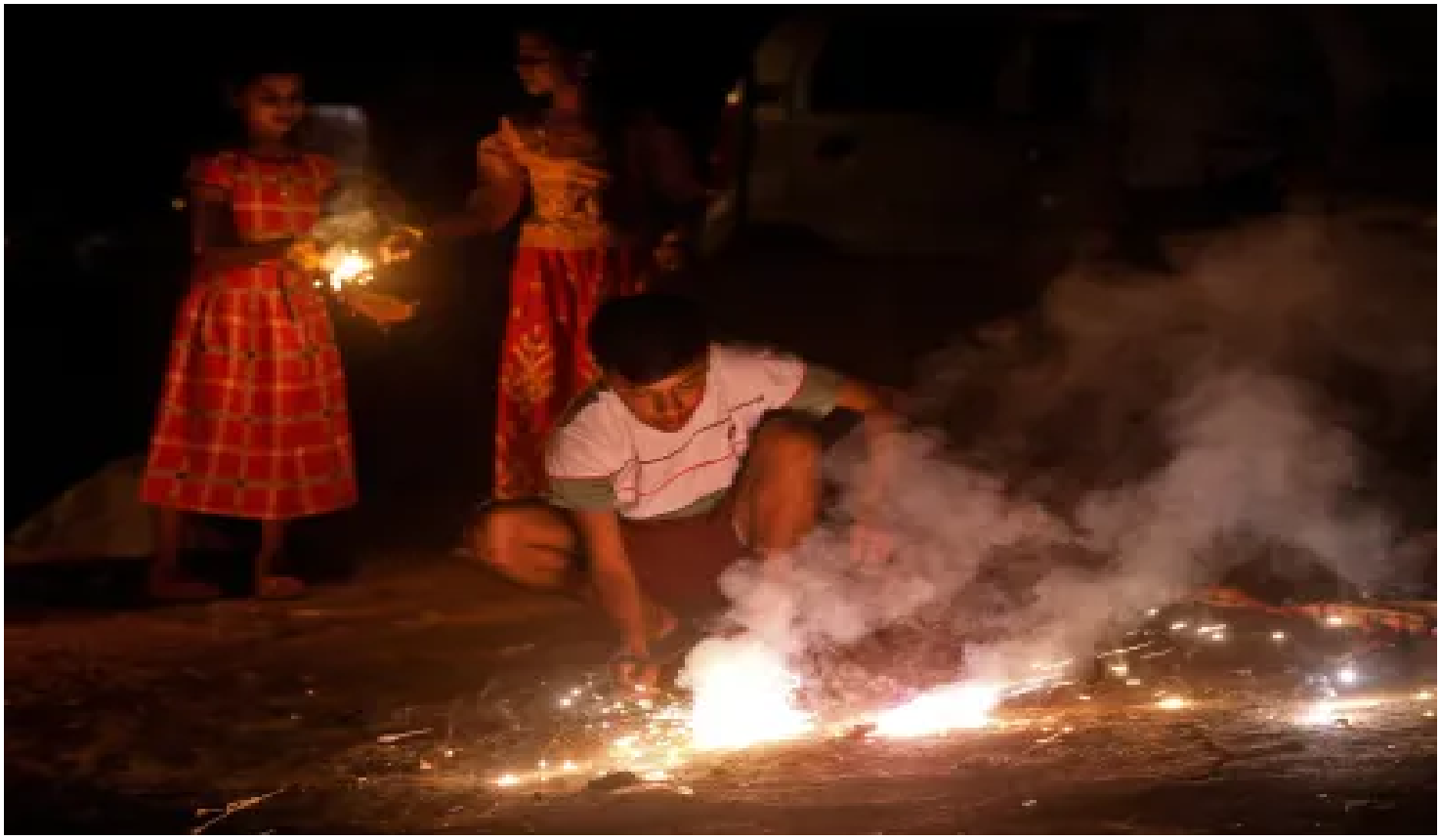

People light fireworks to celebrate Diwali, the Hindu festival

As many in India celebrate Diwali, pollution and other climate concerns loom overhead. Can India turn

of lights, in Mumbai, India, October 24, 2022. REUTERS/Niharika Kulkarni

to tech to improve the air?

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Diwali season in India should be a time for joy and happiness.

Unfortunately, it is also "pollution season" due to a combination of unfavourable weather, stubble burning in some states, and bursting of firecrackers to celebrate Diwali - over and above the environmental consequences of rapid urbanisation in India.

The fight against air pollution is perennial but hardest at this time of the year, leading to novel attempts like smog towers and artificial rain.

While these or other technologies may appear to be backed by science, determining their effectiveness through trial and error can be an expensive yet fruitless endeavour.

Recent technological developments in the areas of air quality monitoring and modelling can be used to evaluate potential solutions and track their success after implementation, if used responsibly.

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Tech in monitoring

You cannot manage what you do not measure.

Air pollution measurements help us quantify the extent of the problem, but traditional methods, such as continuous ambient air quality monitoring stations - or CAAQMS - are expensive to own (about $100,000–150,000 each) and operate, requiring an air-conditioned shelter and weekly or fortnightly quality assurance checks by trained technicians.

India currently faces a huge shortage of air pollution data, hindering our ability not only to identify hyperlocal hotspots in cities, such as due to firecrackers, open waste-burning, or traffic jams, but to quantify the problem in rural areas, and effectively track the progress of air quality policies.

Air sensors cost a fraction of a CAAQMS, are portable, require only semi-annual or annual calibration, do not require air-conditioning, and can provide indicative measurements to identify hyperlocal hotspots and air quality trends.

Verified air sensor data can be used to implement neighbourhood-scale control measures and protect

outdoor workers like traffic police and street vendors by alerting them to times when the use of protective equipment such as N95 masks can be beneficial.

The direct exposure of air sensors to varying temperature and humidity conditions can lead to wrong readings as they are not in an environment-controlled shelter.

For example, a sensor can erroneously report high particulate matter (PM) readings in humid conditions, which is common in rainy seasons.

Machine learning algorithms can correct such errors to improve data quality from air sensors.

However, data providers need to be transparent about their methods to avoid even the appearance of data manipulation.

Independent verification of sensor performance will also improve confidence in sensor data, as shown by the Air Quality Sensor Performance Evaluation Center (AQ-SPEC) programme in California.

We have started a similar initiative called the India Sensor Evaluation and Training (Indi-SET) programme, with the first Indi-SET centre at the Center for Study of Science, Technology and Policy, in the southern IT hub of Bengaluru.

Tech in air quality modelling

Air quality management starts with knowing how much emissions are emitted where, called an emissions inventory.

However, air quality over a city is also influenced by regional sources.

For example, air pollution in Delhi is partly due to stubble burning emissions from neighbouring states of Punjab and Haryana. Further, gaseous pollutants can undergo chemical reactions in the atmosphere to form PM.

Hence, leading air quality management programmes in the United States and the European Union are

underpinned by state-of-the-art air quality modelling called chemical transport models (CTMs).

Air quality modelling is a method that uses mathematics and computer programmes to predict air pollution concentrations and assess their impact. These modelling results are validated against ground measurements and satellite data.

A CTM combines emission inventories, hourly meteorological data such as wind speed and direction, and atmospheric chemistry to simulate realistic air pollution.

However, the use of CTMs to develop air quality management plans is not routine in India as CTMs take weeks or months to run on high-performance computing clusters for each scenario such as baseline or with each proposed intervention.

A new class of "reduced complexity models" - or RCMs - can overcome this hurdle.

Solutions to air pollution should have long-term, sustained impact. So, their effects need not be modelled at the hourly scale as CTMs do, but rather we wish to model their impact on annual or seasonal average air pollution.

RCMs can also be run quickly on an ordinary laptop so that a variety of potential interventions can be evaluated and compared within a week or two.

By modelling the impact of different interventions like reducing on-road vehicles and curtailing industry operations before these measures are implemented, governments can identify and implement only the most effective control measures to preserve funding.

This will also prevent unnecessary hardship to ordinary citizens and unneeded economic burden on industry. Like air sensor data verification, RCM performance must be benchmarked against traditional CTMs.

The journey to clean air in the United States and the EU took decades, partly due to the reliance on

traditional monitoring and air quality modelling.

However, technological advances in the field of air sensors and RCMs offer India and other Global South countries the opportunity to use data-driven decision-making and move much faster towards clean air for all.