Policy Brief*

Citizen Science as a Tool and Collaborative Approach to Address Air Pollution

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Abstract

Air pollution is one of the biggest challenges of our times. The problem is extreme in populous and industrial areas such as the National Capital Region (NCR). Citizen science-based methodology can overcome drawbacks of traditional scientific data collection methods with greater spatial and temporal spread, reduced monitoring expense, and higher citizen awareness of the subject. A participatory approach such as citizen science can identify sources of air pollution and allow citizens to pitch solutions to the government, thus democratising and enhancing the quality of science.

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Introduction

Citizen science is a process of addressing scientific issues using a bottom-up approach to science, providing opportunities to citizens to identify questions of interest and relevance to them, and then use a systematic protocol of pursuing them following established tenets of science, with or without the aid of a scientific adviser on the team. Participation of citizens can help identify relevant and crucial problems, seeing them from multiple perspectives and addressing them at a root level. There are numerous subject areas where citizen science programs can be highly effective, such as natural resource management, astronomy, environmental science, wildlife ecology, and conservation. Volunteers engaged with a citizen science project typically participate at various levels in scientific processes ranging from identifying and defining a problem, data collection, analysing and interpreting data and providing policy inputs in their areas of interest. Amongst other benefits, this process allows the democratisation of science and makes science accessible to all alike.

The emerging economies of South Asia have led to many cities with poor air quality[1]. This is particularly true in the case of the Indo-Gangetic Basin, which along with the Himalayan Range, forms one contiguous airshed[2] and impacts the entire region. Air pollution is a measure of the release of contaminants into the atmosphere, which is detrimental to the survival of living organisms. As per the World Health Organization, ambient air pollution is estimated to cause about 4.2 million deaths per year globally[3], with more than 90% of the global population living in areas where concentrations exceeded the 2005 WHO air quality guideline for long term exposure to PM 2.5[3]. While air pollution is influenced by long-range pollution factors such as forest fires and volcanic eruptions, it is more strongly affected by local emissions and weather patterns[4], fluctuating each day on an hourly basis[5].

Science-backed information and tools are fundamental to addressing the issue of air pollution. Boosting education, training, public awareness, and public participation are some of the relevant actions for maximising the opportunities to achieve the targets and goals for a challenge like environmental pollution that can be best addressed by collective effort. The technical coordination and overseeing of India's operational air quality forecasting services have been entrusted to the Environment Monitoring and Research Center (EMRC), the India Meteorological Department (IMD) division. India Meteorological Department, in collaboration with the Indian Institute of Tropical Meteorology (IITM) and National Centre for Medium-Range Weather Forecasting (NCMRWF), is in the process of installing an Air Quality Early Warning System to predict extreme air pollution events and give timely alerts to take necessary steps as per Graded Response Action Plan of the Government of India. The objective of this system is to enable and provide air quality forecasting and information services in a globally harmonised and standardised way tailored to the needs of society and policymakers.

1. Krishna, Bhargav, et al. "Tackling the health burden of air pollution in South Asia." bmj 359 (2017).
2. Chauhan, Akshansha, and Ramesh P. Singh. "Poor air quality and dense haze/smog during 2016 in the Indo-Gangetic plains associated with the crop residue burning and Diwali festival." 2017 IEEE International Geoscience and Remote Sensing Symposium (IGARSS). IEEE, 2017.
3. World Health Organization. "WHO global air quality guidelines: particulate matter (PM2. 5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide." (2021).
4. Vernier, J-P., et al. "Major influence of tropical volcanic eruptions on the stratospheric aerosol layer during the last decade." Geophysical Research Letters 38.12 (2011).
5. Simon, Heather, et al. "A Direct sensitivity approach to predict hourly ozone resulting from compliance with the National Ambient Air Quality Standard." Environmental science & technology 47.5 (2013): 2304-2313.

The National Air Quality Monitoring Programme (NAMP) is a nationwide campaign launched by India's Central Pollution Control Board (CPCB) to monitor primary pollutants (SO2, NO2, PM10 and PM 2.5) levels in urban and semi-urban areas[6]. Apart from the above government agencies, the Central Pollution Control Board actively monitors air quality, particularly in the Delhi NCR region, using installed machines.

While there are existing structures to monitor air quality in Delhi NCR using automated machines, there are gaps in these traditional systems. Traditional data collection methods limit the scope of involving people with low spatial and temporal coverage. Conventional scientific approaches are also highly centralised, with no participant stake in data collected or output generated, and with data often becoming inaccessible to the general public. Hence, local people are often unaware of existing scientific endeavours, information about current air pollution in their area, how and data is collected, reducing their faith in the data. Including a citizen science component to the existing air-quality monitoring, infrastructure can enhance public participation. This can improve public faith in the data, making citizens more aware of air pollution, scientific methods and science. Another advantage of citizen science over traditional air pollution data collection methods is expanding spatial and temporal coverage. This collaborative approach can empower people to contribute to air quality that directly affects them, making the overall process more democratic. Hence, citizen science can be used as an effective tool for monitoring air pollution and finding ways to mitigate problems emanating from it. As part of this document, we focus our attention broadly on the issue of air pollution in the Indo-Gangetic region, and specifically within the Delhi - National Capital Region (NCR), and suggest ways of addressing this, with emphasis on citizen science.

Addressing the issue of air pollution using citizen science

The Indo-Gangetic plains, particularly Delhi - NCR, accounts for a large percentage of mortalities due to poor air quality[7]. We propose a citizen science program in the Delhi - NCR region to monitor air pollution, identify polluting units, and collect air quality data. The aim would involve participants from a large spatial area and encourage data from different temporal periods.

The program can be implemented using several steps beginning with wide publicity using the aid of print, social media, local civic agencies and community centres such as schools and health centres. This can be followed up by workshops to press the importance and need for the project and the necessity for systematic and accurate data collection. The next phase would involve training in data-collection protocols such as mobile-based applications and air quality monitoring kits. Easy to use, low-cost air quality monitoring kits can allow crowdsourcing and active public engagement. Using an air quality monitoring kit, one can measure tropospheric ozone, NO2 emissions, CO emissions, VOC detection, methane concentration, continuous monitoring levels of PM 10 and PM 2.5 concentrations and secondary air pollutants.

6. Rangarajan, Rajesh. "Air Quality Monitoring Regime in India." An Overview Pollution Monitoring Series: Briefing Note 1 (2009).
7. Pollution, Air. "Health in India: A review of the current evidence and opportunities for the future July 2017." Public Health Foundation of India/Centre for environmental Health, India: 1-64.

Similar kits are currently used across many participatory air-monitoring programs globally[8]. During interactions with participating citizens in workshops, a collaborative plan for data collection can be built by improvising on the existing plan, wherever necessary and providing access to the application and measurement devices to participating citizens.

When citizens collect data on the ground, the precise location of citizens contributing to data can be mapped by a GPS enabled mobile application, which after that can be linked to air deterioration contribution by specific pollution units/geographies, possible reasons behind poor air quality like industries or agricultural practices or signals in the area and geographical zones. Data obtained can also be eventually analysed for variations across seasons and generate easy to comprehend visualisations. A successful citizen science project can generate large volumes of data that can create accurate predictive models with rapid scaling of such data possible at a nominal or no cost. Our proposed methodology suggests that data will be collected via a freely downloadable mobile application. To ensure inclusivity and accessibility, the application will be made available in Hindi (common language in Delhi), apart from English. Also, one point of contact in every district of Delhi will be assigned for assisting/supporting participating citizens and organising meetings if and when required.

All the collected data can be stored on a publicly available website and made available to the general public free of cost. The website will be user friendly and visual and allow third-party applications to access and exchange data. Data updating on the website will happen in real-time. The website will also feature tools like 'maps' search by 'keywords', enabling easy access to data to anyone interested. While citizens will be using mobile applications to input/store data, the data will get updated on the website in real-time. The website will also have a discussion forum wherein the citizens will discuss their challenges, data analysis, interpretations and conclusions, thereby building a community of active and responsible citizens. Overall, a sense of ownership, transparency and belief will be created by using this approach.

Archiving the data and other sub-region by sub-region action plan will be formulated by tying up with the Central Pollution Control Board, which is already working on air pollution. Every month, data wetting will be done by random sampling and cross-checking of the air quality levels from specific citizens' locations. Hence, properly using this methodology, the fundamental issues about collecting data on existing levels of air pollution will be addressed. Post data collection and analysis, pinpointing specific polluting industries or other sources will be done, and relocation or specific methods to address pollution will be done to the government.

Some interesting past examples of citizen science to address air-quality issues include the European Environmental Agency (EEA) report 'Assessing air quality through citizen science' that presents successful use of simple, low-cost devices to measure local air pollution levels. Similarly, in New York, residents used buckets and vacuums to collect air samples in the past, which, when evaluated, showed alarmingly high levels of benzene (IQAir, July 7 2021). In another case, the European CAPTOR (Collective Awareness Platform for Tropospheric Ozone Pollution) project launched in 2016 in Italy, Spain and Austria employed citizen scientists to monitor tropospheric ozone.

The proposed methodology of using citizen science to collect data and monitor air

8. Benabbas, Aboubakr, et al. "Measure particulate matter by yourself: data-quality monitoring in a citizen science project." Journal of Sensors and Sensor Systems 8.2 (2019): 317-328.

pollution can be used as a pilot model for Delhi - NCR in its first phase. Detailed feedback from the participating citizens will be collected. Based on the success of this model in Delhi - NCR, it will be expanded to other cities. To begin with, since people contribute to the data with much more enthusiasm, the data will be reliable with higher temporal and spatial spread. Sustained participating citizens will also be incentivised by providing air-purifying plants at the end of phase one.

The challenges towards the proposed program include building an initial interest among the citizens of Delhi - NCR. For this, publicity via multiple modes will be crucial. High-quality training to use the air quality monitoring device and adding data to the mobile application will be a challenge given highly varied literacy rates among the residents of Delhi - NCR. The support personnel will use English and Hindi as a mode of communication while training and follow-up support to participants. Another challenge will be to sustain the motivation of citizens over time. For this, a communication strategy throughout the program's tenure will be built to share updates and all necessary information to the stakeholder and participating citizens.

Conclusion and Recommendations

Citizen science provides a unique opportunity for the public and government to work towards problems like air pollution collaboratively. Air pollution is a transboundary issue, and citizen science can play a significant role in collecting data, monitoring and providing solutions to address the issue. This method is inclusive and democratic and overcomes shortcomings of presently used air quality monitoring methods. For the citizen science based approach to be truly successful, it is crucial to get backed up with accurate air quality devices, robust hardware and software interface and an interactive user website. As a long term impact, we hope that this program will help influence local and national level air quality policies since the data and suggestions will come from the citizens via a collaborative approach.

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