

Aerosol optical depth measurement has Bangalore cornered

A recent article¹ in the *American Journal of Climate Change* created media waves in India^{2,3} as Bangalore featured prominently in its findings. In the study conducted at Tel Aviv University, Israel, the scientists used data generated by the sensors (two wide angle and one multi-angle imaging spectro-radiometers) mounted respectively on three NASA satellites which provided the aerosol optical depth (AOD) over cities worldwide on almost a daily basis¹. This novel venture in documenting air pollution could potentially supplement traditional methods of air-pollution monitoring, especially in identifying trends. However, this method is currently limited to (indirectly) measuring the concentration of 'aerosols'. Air pollution is not restricted to aerosols (such as particulate matter PM_{2.5}, PM₁₀, dust and pollen) and includes sulphur dioxide, nitrogen oxides, ground-level ozone, carbon monoxide, volatile organics and lead⁴. It can be argued that a level of correlation exists between concentration of aerosols and other air pollutants (especially with respect to pollution created by fossil-fuel combustion) and so mathematical models could potentially be developed to provide information on all aspects of air pollution based on AOD. The scientists also claim that the level of natural aerosols remains relatively stable in an area and hence any changes in AOD would reflect a change in the anthropogenic contribution¹. This is important as Bangalore is known for relatively high ambient pollen levels⁵. A need to further address technical issues, such as making measurements during cloudy days and the degree of correlation between various sensors, has been expressed¹.

The findings of this paper were misinterpreted to a certain extent by some Indian newspapers which stated that Bangalore was found to be the second most polluted city³. The journal article reports 'AOD tendencies', defined as the difference in AOD averages between the periods 2006–2010 and 2002–2006 expressed as percentage for 189 of the largest cities in the world. This outcome measure is a trend and the paper does not report any absolute levels of pollution in the various cities. Bangalore's AOD tendency was reported as an increase of 12.9% to 66% (34% average) over the study period, the second highest amongst all cities in the world¹. Interestingly, the

findings for the American cities of Portland, Oregon (which has the highest AOD tendency at 52% average increase) and Seattle (which came third with 32% average increase) have been attributed largely to wildfires in the region during the 2006–2010 period of the study⁶. From this, we could interpret that Bangalore has the fastest growing rate of anthropogenic air pollution among all cities in the world. While the newspapers were wrong in stating that Bangalore is the second most polluted city in the world³, they are correct to be alarmed at the findings as Bangalore could well be on its way to claiming that spot.

This sharp rise in air pollution over the eight-year study period is worrisome from the public health perspective, especially with respect to the respiratory and cardiovascular health of vulnerable populations such as the elderly, children and the large and increasing urban poor population, who are the most exposed group. Even short-term increases in air pollution are associated with increased mortality⁷, besides the effects of long-term exposure on respiratory and cardiovascular morbidity and mortality^{8,9}. The findings from these studies from the UK and the US apply to Bangalore too. A Central Pollution Control Board (CPCB) commissioned report on Bangalore's air pollution largely implicates traffic pollution (42%) and dust from roads (20%) and construction industry (14%) for majority of Bangalore's particulate matter pollution¹⁰ (which primarily comes under the jurisdiction of the Regional Transport Office (RTO) and Municipal Corporation (BBMP) respectively). CPCB, as the centre which regularly monitors Bangalore's air pollution through seven monitoring stations, should proactively keep RTO, BBMP and the Health Department informed on the levels and trends of pollutants, especially as further increase can be expected with the city's growth. Also, the recipient departments should use this information meaningfully. It should not be forgotten that the main purpose of monitoring is the protection of public health. The Health Department needs to be more proactive in preventing ill-health through positive engagement with CPCB, BBMP and RTO towards reducing pollution and not waiting for the levels to rise above 'acceptable limits'. The relation between risk of illness and air pollution

is an exponential one and any increase in levels is associated with a corresponding exponential increase in risk of illness for the population. The RTO and CPCB should consider this as a matter of critical importance and re-look transportation policy and regulation in Bangalore. Strong decisions need to be taken now to prevent the large burden of ill-health and mortality associated with air pollution in Bangalore.

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ADITHYA PRADYUMNA

*Society for Community Health Awareness
Research and Action,
SOCHARA Annexe, No. 359, 1st Main,
Koramangala 1st Block,
Bangalore 560 034, India
e-mail: adithya.pradyumna@gmail.com*