Science News *from research organizations*

Southeast Asia could prevent up to 36,000 ozone-related early deaths a year by 2050 with stricter air pollution controls

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Summary: A study has found that implementing robust air pollution control measures could mean Southeast Asian countries prevent as many as 36,000 ozone-related premature deaths each year by 2050.

A study by scientists at Nanyang Technological University, Singapore (NTU Singapore) has found that implementing robust air pollution control measures could mean Southeast Asian countries prevent as many as 36,000 ozone-related premature deaths each year by 2050.

Ozone-related premature deaths refer to fatalities caused by prolonged exposure to harmful ground-level ozone. The pollutant worsens asthma, heart disease, and other chronic conditions -- particularly among the elderly and vulnerable groups.

Drawing on pollution data from international databases tracking emission sources, the NTU research team employed detailed atmospheric models to understand how ozone concentrations might evolve under different pollution scenarios by 2050.

Researchers then estimated the potential number of premature deaths from prolonged ozone exposure by combining the pollution levels with health risk models, population data, and disease mortality rates.

Under a business-as-usual scenario their model predicts that by 2050, annual ozone-related deaths in Southeast Asia could drop by 22,000 due to planned NOx cuts from power plants, factories, and transport, especially in Indonesia, the Philippines, Vietnam, and Thailand.

If countries went greener and followed a scenario of stringent emission reduction measures, Southeast Asia could avoid up to 36,000 annual ozone-related premature deaths by 2050.

Conversely, under a high-emission scenario in which fossil fuel consumption continues to rise, annual ozone-related premature deaths could be 33,000 higher annually by 2050.

Ozone is a key air pollutant formed when nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in sunlight. In urban environments, major sources of these emissions include motor vehicles, industrial processes, and energy generation.

Exposure to elevated levels of ozone can lead to serious health problems, including respiratory illnesses, cardiovascular diseases, and premature death. In 2018, pollution from fine particulate matter and ozone in Southeast Asia was estimated to have caused 899,000 premature deaths.

The NTU research team notes that ozone pollution is an escalating concern in the region, driven by rising human activity linked to economic development -- particularly in the transportation, industry, and fuel combustion sectors. The researchers hope their findings underscore the urgent need for stronger mitigation efforts.

Ozone sensitivity varies across the region

In the study, published in *Environment International*, scientists from NTU's Centre for Climate Change and Environmental Health (CCEH), Earth Observatory of Singapore (EOS), Asian School of the Environment (ASE), and Lee Kong Chian School of Medicine (LKCMedicine) employed advanced computer models to examine how nitrogen oxides (NO_x) and volatile organic compounds (VOCs) -- key pollutants driving ozone formation -- interact with emission sources across Southeast Asia. The researchers also evaluated potential outcomes under various future pollution scenarios.

Emissions from road traffic, shipping, and industrial activities contribute the bulk of NO_x pollution, while VOCs are naturally occurring gases primarily emitted by vegetation.

The study revealed that in major urban centres such as Singapore, Jakarta, Kuala Lumpur, Bangkok, and Ho Chi Minh City, ozone levels are affected by both NO_x and VOCs. As such, reducing both pollutants in tandem is crucial to effectively lowering ozone concentrations in these cities.

Conversely, in rural areas and coastal regions such as Kalimantan in Indonesia and Malacca Strait, ozone formation is more strongly influenced by NO_x levels. In these areas, targeted reductions in NO_x emissions would be the most effective strategy for mitigating ozone pollution.

According to the NTU research team, measures to reduce ozone pollution could include stricter regulations on industrial emissions, enhanced transport policies, and focused efforts to curb emissions from shipping and biomass burning.

Lead author of the study, Associate Professor Steve Yim, Director of CCEH said: "Ozone reduction is not straightforward, as it requires careful regulation of its precursors -- nitrogen oxides and volatile organic compounds -- rather than direct removal from the atmosphere. The tropical conditions in Southeast Asia also make ozone formation different from that in other parts of the world."

"We believe our research fills a critical knowledge gap by examining how ozone behaves specifically in Southeast Asia, a region that has received relatively little attention in this context," added Assoc Prof Yim, who is also affiliated with ASE, LKCMedicine, and EOS.

The researchers believe a deeper understanding of how ozone is formed and controlled in Southeast Asia will enable policymakers to develop more targeted and effective air pollution reduction strategies.

Co-author, Distinguished University Professor Joseph Sung, NTU's Senior Vice President (Health and Life Sciences) and Dean of LKCMedicine, highlighted the urgency of action: "Ozone is an invisible yet harmful pollutant. Our study shows that by taking decisive steps now, we can significantly reduce the region's health burden and improve air quality. This research reinforces the vital role of air quality management in protecting public health. The links between ozone exposure and respiratory illness are well-established, and our findings offer robust evidence to inform policy decisions that will protect the well-being of millions across Southeast Asia."

This study reflects NTU's commitment to advancing climate science and supporting global sustainability goals.

Looking ahead, the research team intends to expand their work to explore how climate change and land-use patterns may further influence ozone pollution.

These insights will also form the basis for collaboration with policymakers, industry stakeholders, and international environmental organisations to design and implement sustainable air quality management strategies.