Fast-growing parts of Africa see a surprise: less air pollution from seasonal fires

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Intentionally set fires are a major source of air pollution in Africa, but they are declining in at least part of the continent. Here, a Kenyan farmer manages a fire. Credit: Kyu Lee/Earth Institute, Columbia University

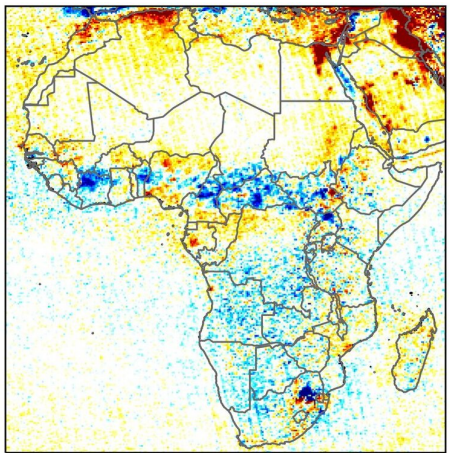
Often, when populations and economies boom, so does air pollution—a product of increased fossil-fuel consumption by vehicles, industry and households. This has been true across much of Africa, where air pollution recently surpassed AIDS as the leading cause of premature death. But researchers have discovered at least a temporary bright spot: dangerous nitrogen oxides, byproducts of combustion, are declining across the north equatorial part of the continent. The reason: a decline in the longtime practice of setting of dry-season fires to manage land.

The study, along with previous research, links the decline to increasing population densities, along with switches from animal herding to row-crop agriculture and other pursuits. Shifting weather patterns also seem to have played a role. The research was published this week in the *Proceedings of the National Academy of Sciences*.

People in many parts of Africa have long set fires during dry seasons to clear land and release mineral nutrients held in vegetation back into the soil—so much so that in many years, the continent is home to about 70 percent of global burned areas. The practice is especially prevalent in north equatorial Africa, spanning some 15 countries from Senegal and Ivory Coast in the west, to South Sudan, Uganda and Kenya in the east. Here, many people live as nomadic herders amid vast expanses of savanna and grasslands, and they traditionally set fires during the November-February dry season.

However, recent years have seen steady population growth, and the conversion of savanna into villages and plots for crops, along with growth in incomes. Thus, say the researchers, fewer people are setting fires, in order to protect infrastructure and livelihoods. As a result, from 2005 to 2017, the region saw a 4.5 percent overall decrease in lower-atmosphere concentrations of nitrogen oxides (known for short as NO_x) during the dry season—the time when fires normally combine with urban pollution to make this the worst time of year for air quality. The NO_x decline has been so strong that it has more than offset a doubling of emissions from fossil-fuel use in vehicles, factories and other sources coming mainly from urban areas.

Previous research has also attributed part of the decline to temporary cyclical changes in winds coming from the Indian Ocean. In some years, these shifts have caused dry seasons to become a little wetter, dampening fires, or caused rainy seasons to become a little drier, reducing the amount of new vegetation that can subsequently serve as fuel. But the human factor has been steady.



A dark blue band spanning north equatorial Africa shows where November-February density of polluting airborne nitrogen oxides have been declining. (Lighter blue areas to the south show lesser declines, but these are due more to to phaseouts of coal-burning power plants.) Yellow and red areas show increases in nitrogen oxides. Credit: Adapted from Hickman et al., PNAS 2021

"It's nice to see a decline occurring when you'd expect to see pollution increasing," said the study's lead author, Jonathan Hickman, a researcher at the NASA Goddard Institute for Space Studies, an affiliate of Columbia University's Earth Institute. The flip side, says Hickman: Overall NOx pollution has continued to increase during the rainy season, when fires are not a factor. "In the rainy season, we see a straight increase related to economic growth ," he said.

The density of NO_x compounds is considered by many scientists to be a proxy for overall air quality. They are linked directly to asthma and premature death, and once in the air, they are involved in chemical reactions that produce an array of other dangerous pollutants, including low-level ozone and aerosols that can damage both crops and human health.

Satellite data has enabled researchers to measure NO_x in the air over time, and the authors of the new study took advantage of this. They also used satellite imagery to document trends in burned land. Combining both sets of observations, they found that they were tightly linked. Furthermore, economic and demographic data showed that declines in NO_x matched areas where population density and economic activity have increased.

That said, Hickman says that as population continues to grow and urbanize, more and more people will almost certainly be subjected to concentrated urban pollution, and this could cancel out the benefits of decreased fires. "The projections in this regard are not optimistic," he says. While some efforts to expand monitoring of urban air quality are underway, most African cities don't currently even measure air pollution, much less do much to curb it.

Historically, economic booms elsewhere have led to similarly rampant problems, usually followed by an inflection point, where governments finally rein things in. London's Great Smog of 1952, which killed some 10,000 people, was followed by some of the world's first clean-air standards. After World War II, booming U.S. industries poured pollutants into the air virtually unchecked, until the EPA was created in 1970. In the early 21st century, China was the world's air-pollution capital, until reforms in 2013 started easing the problem. Along with Africa, India is now undergoing a boom in emissions, with few rules in place.

"Hopefully, this one seasonal bright spot gives African nations a little opportunity to avoid the mistakes made by other countries," said Hickman.

More information: Jonathan E. Hickman el al., "Reductions in NO2 burden over north equatorial Africa from decline in biomass burning in spite of growing fossil fuel use, 2005 to 2017," *PNAS* (2021). www.pnas.org/cgi/doi/10.1073/pnas.2002579118

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