Outdoor Air Pollution in Rural North India

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January 29, 2018

Draft

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Exposure to air pollution has important consequences for public health. High levels of air pollution can kill infants and older people, get in the way of healthy child development, and contribute to heart and lung disease (Pope and Dockery 2006). According to data compiled by the WHO, 13 of the 20 cities in the world with the highest mean levels of $PM_{2.5}$ – meaning particles with a diameter less than or equal to 2.5 micrometers – are in India (WHO 2014). However, urban Indians are not the only ones exposed to hazardous levels of pollution. Although the government does not systematically monitor outdoor pollution in rural areas, estimates based on satellite data suggest that outdoor air quality in rural India is poor enough to harm human health.

In January 2017, we visited Reusa, a block in Uttar Pradesh, to investigate pollution-generating activities and the policies that aim to mitigate them in rural areas. We found many sources of outdoor pollution in Reusa, including burning biomass for cooking and heat, crop-burning, and rural industry and electricity generation. Some of these pollution-generating activities have not been addressed by policy at all, and the policies that do exist have either not been designed effectively, or are not implemented well.

The findings of this study suggest that people living in rural areas could be exposed to high levels of ambient air pollution. Indeed, variation in polluting activities and policy implementation across places is likely. To better understand the threat posed by ambient pollution in rural India, and ultimately to better address it, more research on human exposure and ground-level monitoring in rural areas is urgently needed.

We begin by presenting what we know about rural ambient air pollution and the policy context. Then we outline our research methods. The third section presents our findings. Finally, we conclude with a discussion of the research and policy implications of this work.

India's rural ambient air pollution blind spot

Indoor air pollution caused by burning dung, wood, or crop residue for cooking has long been recognized to pose a health risk for rural women and children. But the problem of outdoor air pollution in rural India has been rarely acknowledged, even though burning biomass for cooking contributes to it too when the smoke from *chulhas* – or cook stoves – drifts outdoors.

Until now, concern and action regarding ambient air pollution in India have mostly focused on Delhi and other urban centres. However, satellite images show the rural parts of Punjab, Haryana, Uttar Pradesh and Bihar, a region that is home to 30% of Indians, falling under a cloud of smoke every winter (NASA Earth Observatory 2014).

The task of monitoring and preventing air pollution in India goes to the Central Pollution Control Board (CPCB). As part of its National Air Quality Monitoring Programme, the CPCB has set up more than 620 air quality monitoring stations in over 260 cities and towns. Based on available information, though, none of these stations have been set up in rural areas.

What is known about rural ambient air pollution in India mostly comes from estimates that researchers have compiled by applying modeling techniques to aerosol concentration data

gathered from satellite monitors (van Donkelaar et al. 2016, van Donkelaar et al. 2015, Boys et al. 2014). Although these estimates do not capture the same level of detail that on-the-ground monitors do, they are indicative of the scale and severity of the problem.

Figure 1 maps estimates of $PM_{2.5}$ using these techniques and shows that air quality throughout the Indo-Gangetic plain, in both urban and rural areas, is estimated to be worse than all other regions of India (van Donkelaar et al. 2016). According to the air quality standards set by the CPCB, the permissible average annual ambient concentration of $PM_{2.5}$ is 40 micrograms per cubic meter (Central Pollution Control Board 2009). Figure 1 shows that in 2016, the most recent year for which data are available, the estimated average ambient pollution across the Indo-Gangetic plain was above the annual Indian standard, and in many places in the region, it was as high as two to three times the standard.

Methods

We carried out field work in Reusa block of Sitapur district, Uttar Pradesh, in January 2017. We selected Reusa because of its distance from urban centres: it is roughly 40 kilometers from Bahraich, 60 kilometers from Sitapur, and 80 kilometers from Lucknow. Distance from other cities means that ambient pollution in the block is less likely to be influenced by urban sources. Van Donkelaar et al.'s estimates indicate that Sitapur's average $PM_{2.5}$ in 2015 was 91 micrograms per cubic meter (2016), more than double the CPCB guidelines.

We collected 29 in-depth, semi-structured interviews in five randomly-selected villages in the block. In each village, we interviewed an informal doctor, if one was available, and randomly-selected households. We also spoke with a representative from Indane, one of the agencies implementing the Ujjwala Yojana. The interviews focused on understanding perceptions of air pollution, the activities that contribute to it, and how the policies that aim to mitigate these activities, if any exist, are implemented and perceived in the rural context.

Findings

Burning biomass for cooking

By January 2017, the Ujjwala Yojana, a government scheme that subsidizes liquid petroleum gas (LPG) connections, was sweeping across Reusa in advance of elections in the state. Under the program, the government provides a free gas cylinder, regulator, and pipe. Loans are given to households for the stove and the gas in the first cylinder. Over time, these loans are supposed to be paid back incrementally as beneficiary households pay the total unsubsidized rate for refills until the loan is paid off. As of January 2017, it could take nine refills before the loan is paid off, but this number varies based on the subsidy amount. Refilling a cylinder costs almost half the average monthly per-capita expenditure in rural India, and rural households often go through a cylinder each month (National Sample Survey Organization 2013). After the first cylinder had run out of gas, a number of the respondents we interviewed had not gotten it refilled, citing the expense.

The scheme identifies beneficiary households based on indicators of deprivation identified from the 2011 Socio-Economic Caste Census. In the villages we visited, many households had received a cylinder and stove through Ujjwala, but many poor households had also been left out. The Ministry of Petroleum and Natural Gas estimates that 100 million households did not use LPG before Ujjwala started, and the program aims to reach only half of these households.

Although a few of the women we spoke to mentioned that cooking with LPG is easier and takes less time than biomass, many people believe that food cooked on a biomass *chulha* is tastier and healthier than food cooked using LPG. One woman, a teacher in a private school, explained: "On the *chulha*, cooking something is a pain in the neck. It also takes more time. It is easier to cook on gas. But some men here say that the *chulha* is better than gas. Food gets cooked properly on a *chulha*. For example, everyone says that on gas the *roti* remains raw, it does not cook properly. Instead, if you cook it in a *chulha*, the heat in there cooks it slowly and fully."

Larger surveys have found similar attitudes. In a household survey covering over 3,200 households in five states of north India, 88% of respondents reported that using cow-dung for cooking fuel was better for child health than using kerosene (r.i.c.e. 2014). It is also common for households to use both types of cooking fuel: the wife of a wealthy landowner we interviewed made us *chai* using LPG, so that she could serve it to us quickly, while she cooked rice on the *chulha* using biomass, because it tastes better.

New quantitative evidence finds important health externalities associated with cooking with biomass: lung function is worse on average among women who cook with biomass, but lung function for all adults is worse in villages in which a greater fraction of households cook with biomass (Gupta 2017). Since many households will not receive LPG through the Ujjwala Yojana, and many beneficiaries continue to use biomass even after receiving LPG, the negative health impacts associated with cooking with biomass may persist even despite the government program.

Burning biomass for heat

Every morning and evening, households were burning fires made from crop residue that they had brought from their fields. Respondents universally reported that they would burn fires for heat from Diwali until Holi, a period of about five months. In Reusa, we saw no evidence of the implementation of policies that aim to curtail the burning of biomass for heat.

Even rich households who live in *pacca* houses and have plenty of warm clothes and blankets burn fires for heat. One respondent happened to be the *pradhan* – village leader – and, although everyone in his family was wearing thick sweaters and shawls, he had an even bigger fire than other households in the village. For households who own at least some land, crop residue costs no more than the labor required to remove it from the field and bring it home. It is therefore relatively easy for households to burn fires, even though they may not be necessary for survival.

Burning fires in north Indian cities is less common during the winter, although some households still do it. One reason urban households are less likely to burn fires could be because, in cities, it is more difficult and costly to acquire materials to burn and there is less space for making fires.

Another reason could be because urban households are richer and more likely to have warm clothes, better-insulated homes, and heaters, although this probably does not fully explain the difference.[1]

Crop-burning

The crop residue that is not fed to animals, burned for heat, or used as fuel for cooking, is burned on the field. In December 2015, the National Green Tribunal banned crop-burning in several north Indian states, including Uttar Pradesh. Yet, many farmers still burn their fields without facing punishment. In practice, there is no ban. No respondent brought it up, nor were any shy to talk about what they burned on the field. This indicates that there is either little awareness of the ban, or a general understanding that it is not implemented.

Crucially, the ban is impractical for farmers because clearing fields requires hiring labor, a cost that, in most places, does not make sense to incur because the cleared residue cannot be sold. An informal doctor, who also farmed land, explained, "Once sugarcane is cut, too much residue is left behind. It has many leaves. So collecting those leaves would cost money. One will have to hire labourers for collecting the leaves, after which the person would get his field tilled. So instead, the leaves are burnt in the field itself."

Biomass-based power plants, which generate electricity from crop residue, have been identified as a solution to the problem because they generate a market for the product. However, data from the Ministry of New and Renewable Energy show that biomass-based capacity made up only 1.6% of India's total capacity as of April 2016. The government also offers subsidies for machines that help farmers plant new crops without having to remove the dry stalks from the previous harvest, but despite subsidies, these machines are still too expensive for most.

Rural industry and electricity generation

Small-scale industries are scattered throughout Reusa. In January 2017, small factories had been set up to produce *gur* – jaggery – from the harvested sugarcane. These factories use for fuel the dried sugarcane pulp that is left over after extracting the juice. Brick kilns, which use coal, were also in operation. Emissions from small factories like these, and larger ones, occur across rural India.

State pollution control boards, among their other functions, must inspect factories and power plants to ensure compliance with emissions standards. But enforcement is lax. For instance, a 2011–2012 survey of 47 coal plants by the Centre for Science and Environment, a research and advocacy organisation, found that roughly two-thirds of them, in both urban and rural areas across 16 Indian states, had visible particulate matter emissions, suggesting that they were violating particulate matter emissions norms.

Discussion: more monitoring and research needed

Pollution estimates based on satellite data suggest that rural air quality in north India is often high enough to make people sick. The polluting activities we saw in Reusa in January provide

several examples of the types of activities that could be leading to poor air quality in rural north India. Certainly, variation in the factors that contribute to ambient pollution across place and time is likely. That rural ambient pollution could significantly contribute to poor health among rural Indians points to the need for more research on human exposure, and more comprehensive government monitoring policies.

Research: Research investigating human exposure to indoor pollution generated from cooking with biomass has contributed significantly to our understanding of the consequences of using traditional *chulhas*, but much less is known about exposure outdoors. How much pollution are rural Indians exposed to, both indoors and outdoors, and what are the biggest sources of exposure? Research investigating the answers to these questions would not only inform policy priorities, it would also help to contextualize the potential impact of interventions.

Government policy: The findings of our fieldwork suggest that the government policies that aim to curtail pollution-generating activities in rural areas are either not designed effectively, or not implemented well. A first step towards spurring better policy design and implementation would be to monitor rural ambient pollution in order to better understand variation in air quality over time and space. That there are significant externalities associated with pollution-generating activities indicate that air quality should be a policy priority.

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[1] Data from 2002, the most recent available, show heater ownership in urban Punjab, Haryana, Uttar Pradesh, and Bihar to be double that in the rural parts of the same states (National Sample Survey Organization 2005). Heater ownership was nevertheless uncommon, though; only about 6% of urban households in these states owned a space heater in 2002.

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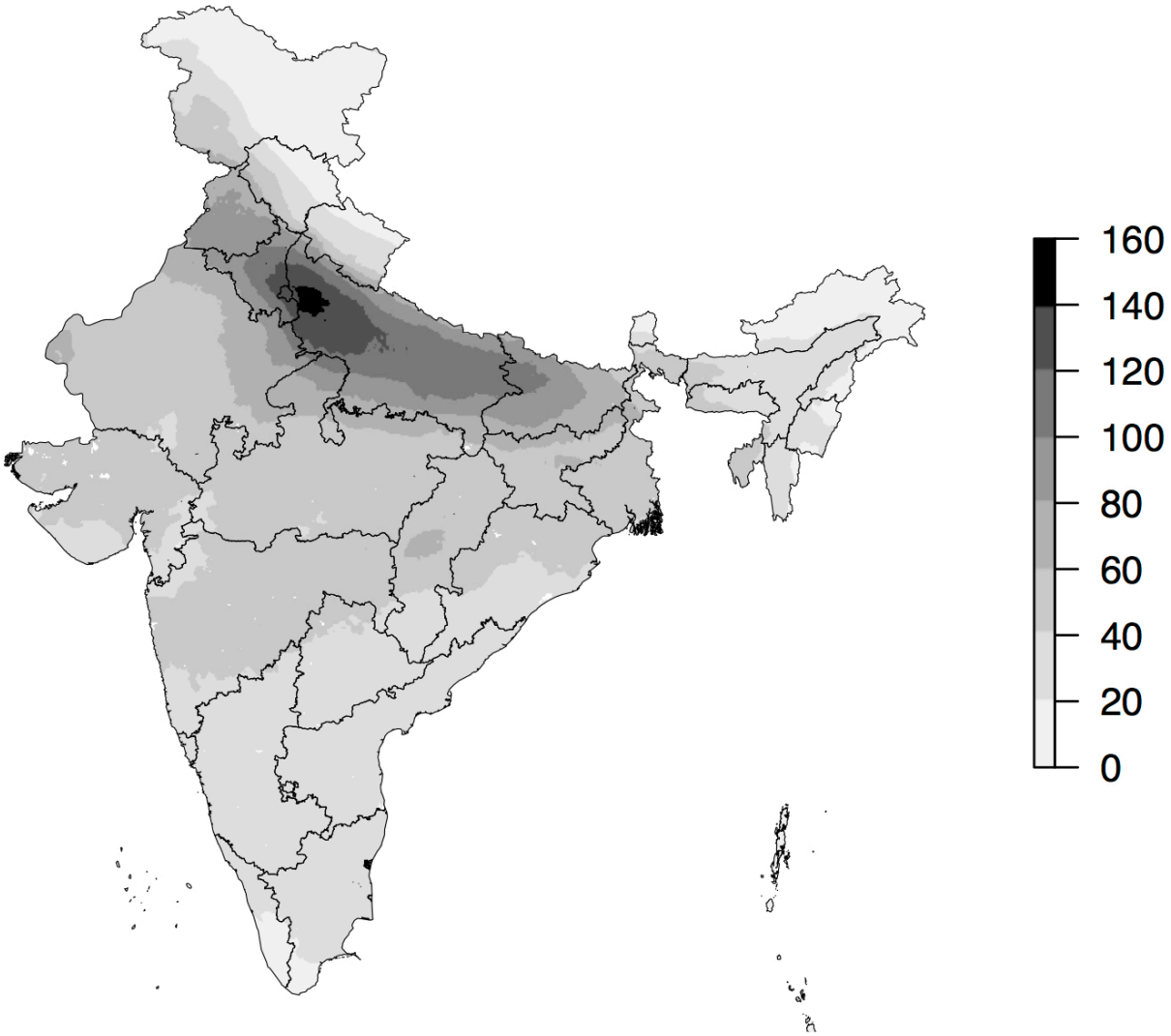
Figure 1: Estimated average annual $PM_{2.5}$ in 2016 (micrograms per cubic metre)



Visualization by Sujoy Bhattacharya, data from van Donkelaar et al. (2016).