How Much Will Air Quality Improve Thanks to the San Joaquin Valley Agricultural Burning Ban?

Joel Ferguson

In 2003, the California State Legislature passed a bill mandating the phaseout of agricultural burning in the San Joaquin Valley in an effort to improve air quality. The California Air Resources Board (CARB) plans to enforce this ban by 2025. Studying the effects of current agricultural burning practices—as regulated by CARB—on air pollution can give us a sense of the benefits this ban may have. I find that one additional agricultural fire within a 50 km radius of a monitoring station increases fine particulate matter (PM) concentration by about one-sixth of the Environmental Protection Agency's (EPA's) 24-hour standard.

Agricultural burning produces substantial amounts of fine particulate matter, which is especially harmful to human health.

Photo Credit: Ed Dunens

Multiple crop production systems in California use agricultural burning as a cost-efficient method of agricultural waste disposal. This practice allows farmers to avoid costs associated with other forms of disposal, such as mulching. Burning has additional benefits for particular production systems, such as killing pests and weeds that affect rice, or controlling pathogens from diseased trees in orchards.

California has a relatively sophisticated system of agricultural burning regulations in place. Individuals are required to hold a permit in order to burn agricultural waste, and days when permit holders are allowed to burn are chosen to minimize the impact of the pollution generated. Despite these mitigating measures, agricultural burning has proven contentious due to air quality concerns. The Sacramento and San Joaquin valleys, where agricultural burning is concentrated within California, suffer from notably poor air quality.

In an effort to reduce air pollution in the San Joaquin Valley, the California State Legislature passed SB 705 in 2003, which mandated a phaseout of agricultural burning in the San Joaquin Valley from 2005 to 2010. However, the law allowed the San Joaquin Valley Unified Air Pollution Control District to postpone the phaseout if the California Air Resources Board (CARB) agreed special circumstances outlined in the bill were met. The district took advantage of this opportunity multiple times, arguing that there was no economically feasible alternative to burning. In 2021, CARB set the goal of enforcing SB 705 and effectively banning agricultural burning in the San Joaquin Valley by 2025.

The question of whether there is a reasonable alternative to burning is an important one. An effective agricultural burning policy should seek to balance the economic benefit to farmers of reduced labor costs, with the damages caused by pollution generated by agricultural burning. With agricultural labor costs expected to rise substantially in California in the coming years, a ban on agricultural burning could be a serious financial hit to producers in the San Joaquin Valley.

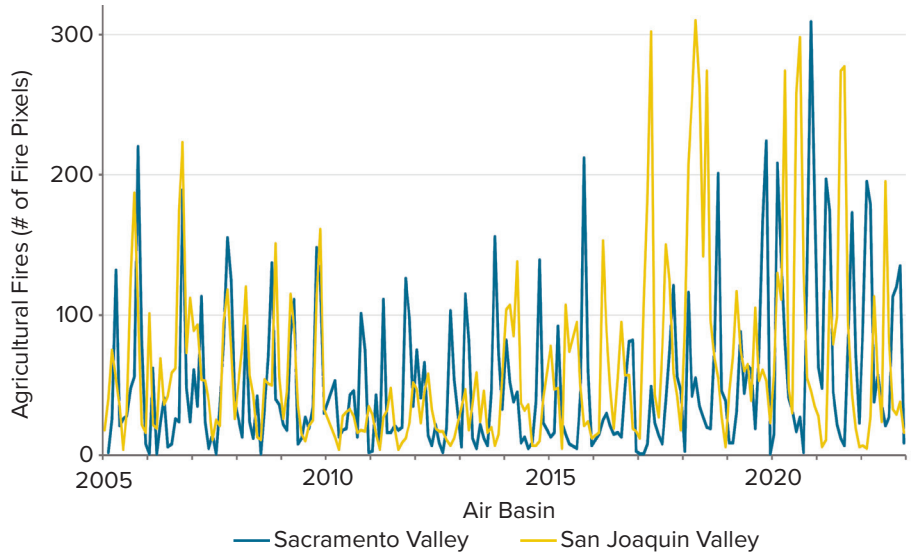
Given that burning is already heavily monitored, one might wonder how air quality would improve under a ban on burning, relative to current regulations. In order to answer this question, I studied the effects of agricultural burning on air pollution. In the Sacramento Valley, CARB makes daily, public decisions using well-defined criteria on whether agricultural burning can take place, and the amount of burning permissible, along with key meteorological data used to inform the decision.

Measuring Agricultural Burning and Its Impacts

This study combines several data sources, from regulatory agencies (such as CARB) to "remote sensing" sources (such as satellite imagery). To measure agricultural burning, I started with NASA's Fire Information Resource Management System (FIRMS), which combines data from multiple satellites equipped with sensors capable of detecting agricultural burning. These satellites typically capture one image of any given point daily and have been operating continuously since 2001. I combined the daily FIRMS data with the U.S. Department of Agriculture's (USDA's) Cropland Data Layer (CDL) to restrict the data to fires on agricultural land. The result is a daily dataset of agricultural fires from 2001–2022.

To determine the impact of agricultural fires on air quality, I used data from the EPA's Air Quality System (AQS), which houses data from all of

Figure 1. Agricultural Burning Over Time



Source: Author's calculations using NASA Fire Information and Resource Management System data and USDA Cropland Data Layer.

Note: The Y axis measures the number of fire pixels in NASA FIRMS MODIS satellite images that are on land that is cultivated, according to the USDA CDL.

the organization's monitoring stations. Different stations take measurements with differing frequencies and may come into or out of service at different times, but measurements of fine particulate matter ($PM_{2.5}$), which is particularly harmful to human health, are available within the Sacramento Valley Air Basin nearly continuously between 2006 and 2022, the period I studied.

Agricultural Burning in the Sacramento and San Joaquin Valleys

Despite their differences in crop composition, agricultural burning in the Sacramento and San Joaquin Valleys is strikingly similar. Figure 1 shows that the seasonality of burning is roughly the same in the two air basins and that the number of agricultural fires in each basin tends to be similar at any point in time. Interestingly, burning in the San Joaquin Valley has not been noticeably declining in recent years in anticipation of the upcoming ban. On the contrary, burning in both basins has risen from a low of less than 400 fires per year in the early 2010s, when the ban was intended to take effect, to over 1,000 fires per year in 2020. Only in 2022, when the San Joaquin Valley Unified Air District imposed numerous new restrictions on the amount of burning permitted, has there been a marked decrease.

A major cause of the increased burning in the San Joaquin Valley since 2010 is drought. Limited water availability threatens the health of orchards and vineyards, and burning provides a convenient and cheap method to dispose of dry and dying or dead crop matter. With drought conditions in the state expected to worsen in coming years, and groundwater regulation beginning to take hold, there is speculation that more orchards and vineyards will be taken out of production, increasing the demand for burning.

Alternatives to burning include chipping or mulching to incorporate agricultural waste into the soil, off-site re-use (e.g., industrial composting), and air curtain burning—a technology that reduces the pollution generated by agricultural burning. All of these alternatives are subsidized in the San Joaquin Valley through the Ag Burn Alternatives Grant Program. In addition to reducing the potential harms caused by air pollution exposure, mulch that is incorporated into the soil can also increase moisture retention, providing direct benefits to producers. Of course, all of these alternatives impose greater costs than burning, so ensuring they're economically viable, both for producers and the state, will be key to making the grant program successful.

Agricultural Burning Allocations in the Sacramento Valley

Agricultural burning in the Sacramento Valley is directly regulated by CARB. Every morning, a CARB meteorologist analyzes data on weather conditions and air quality from the early hours of the day and decides the basin's "allocation"—the amount of land which is allowed to be burned that day. I compiled a daily data set of these allocations and the information used to make them from forms posted online by CARB covering the period 2006–2022. Aside from generating readily available data, there are a number of natural experiments embedded in this allocation determination process that allow me to determine the effects of agricultural burning on air quality.

Here, I focus on a natural experiment that arises because different meteorologists make different decisions, even given the same information. Since only one meteorologist decides the allocation for a given day, some days will have a more lenient meteorologist who sets a greater allocation than a stricter meteorologist. This allows me to look for days with similar weather conditions and air quality in the morning, but different amounts of agricultural burning because of the meteorologist who was on duty that morning.

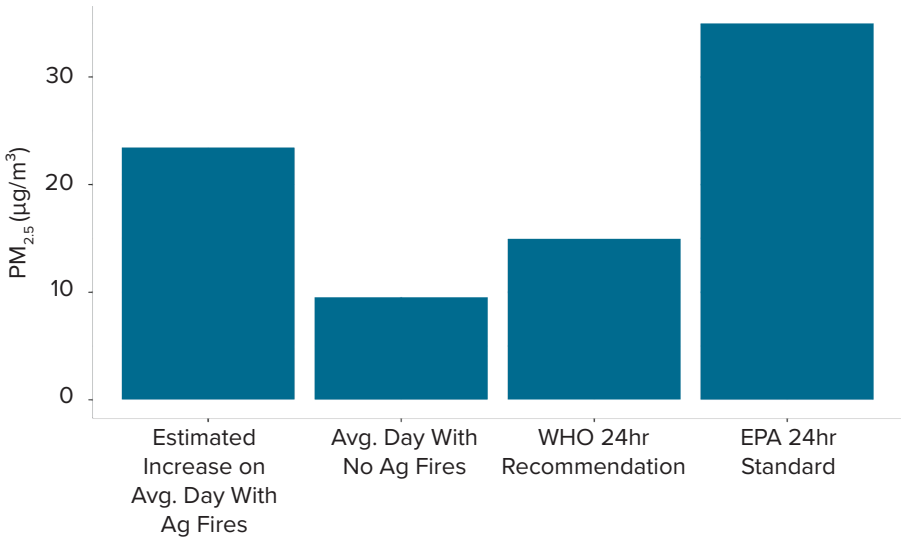
Effects of Agricultural Burning on Air Quality

I find that agricultural fires have a large negative impact on air quality. On days with any agricultural fires burning nearby, there are an average of 3.4 agricultural fire pixels burning within a 50 kilometer (km) radius of the monitoring stations. Results based on comparing days with similar morning weather conditions but different allocations (assigned by more or less lenient meteorologists) suggest that one additional agricultural fire pixel within this 50 km radius of a monitoring station increases $PM_{2.5}$ concentrations by 6 micrograms per cubic meter ($\mu g/m^3$). To put this number in perspective, the pollution generated by these fires on an average day, when any agricultural fires are burning, reaches over half the EPA's 24-hour standard for $PM_{2.5}$ (35 $\mu g/m^3$) and exceeds the World Health Organization's (WHO's) 24-hour maximum recommendation (15 $\mu g/m^3$). This comparison is shown graphically in Figure 2.

A large collection of recent research suggests that even at low concentrations, fine particulate matter has negative effects on general health, mental faculties, and farm labor productivity. An estimate published in the *American Economic Review* by Tatyana Deryugina and co-authors suggests that exposing a million Medicare beneficiaries to the pollution generated by one agricultural fire would be expected to increase emergency room spending by almost $100,000.

Overall, it appears that the proposed ban on agricultural burning in the San Joaquin Valley Air Basin will lead to appreciable improvements in air quality, even given the sophisticated regulations currently in place. However, understanding the total impacts of this policy will require a lot of additional work. First, understanding how many people are exposed to the pollution generated by agricultural fires and what their risk factors are is important for estimating the costs of burning in terms of worsened health and productivity. Second, understanding the costs to agricultural producers is necessary for weighing the tradeoffs and adequately valuing subsidies for burning alternatives. Finally, it's likely that the people who will benefit from improved air quality are different from those who will have to pay the costs of adapting to an agricultural burning ban, and this may have environmental justice implications.

Figure 2. Effects of Agricultural Burning



Source: Author's calculations using data from NASA Fire Information and Resource Management System data, USDA Cropland Data Layer, EPA Air Quality System data, and CARB daily agricultural burning decisions.

Note: The first bar shows the estimated effect of 3.4 additional agricultural fire pixels as measured in the NASA FIRMS MODIS imagery on $PM_{2.5}$ concentration. The second bar shows the average $PM_{2.5}$ concentration on a day with no agricultural fires. The third bar shows the WHO's recommended daily maximum $PM_{2.5}$ exposure. The fourth bar shows the EPA's 24-hour standard for $PM_{2.5}$ concentration, the level for which a designated area becomes subject to Clean Air Act regulation if the 98th percentile of daily concentrations is in excess.

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For additional information, the author recommends:

Becker, Rachel. 2021. "Air Board Tells San Joaquin Valley Growers to Phase Out Burns by 2025." *Cal Matters*. Available at: https://bit.ly/3o3fZlI.

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