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Featured Research Review: Gonzalez et al. (2021): Upstream oil and gas production and ambient air pollution in California

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In previous research, we have seen how proximity to shale gas development can lead to adverse health outcomes. In a prior study, for example, Gonzalez et al. found proximity to wells was associated with higher preterm birth risk. While epidemiological studies have found indications of increased adverse health outcomes, ambient air pollution levels related to oil and gas operations have not been measured relative to distance from a source. It is speculated that some adverse health outcomes could be related to these emissions occurring during well development and production.

The goal of the new 2021 study was to understand how upstream oil and gas preproduction and production could affect ambient air quality and how far out from the emitting source the pollution levels would remain high before returning to background levels. To test this theory, Gonzalez and colleagues examined air data from over 300 monitors in the EPA (Environmental Protection Agency) Air Quality System in California from 2006 to 2019. The data specifically focused on five commonly monitored ambient air pollutants including: particulate matter 2.5μ ($PM_{2.5}$), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and volatile organic compounds (VOCs). The EPA considers all five of these to be criteria air pollutants—pollutants that are found all over the U.S. and can cause issues for public health and the environment. The study also looked at data on oil and gas preproduction and production operations to encompass wells in all stages. To prevent any bias from other external sources that could have an impact, the researchers controlled for geographic, seasonal, temporal, and meteorological factors such as wildfires or wind direction.

The study discovered increased concentrations of $PM_{2.5}$, CO, NO_2, O_3, and VOCs at monitors that were downwind of wells in preproduction and production stages. Amounts of $PM_{2.5}$ were notably higher on days when the well was in preproduction. On these days, amounts of $PM_{2.5}$ were higher at monitors within 3 km (1.9 miles) of the well and even higher at monitors within 1 km (0.6 miles) of the well. Also on these days, concentrations of NO_2 were higher at monitors within 2 km (1.2 miles) of the well and even higher at monitors within 1 km (0.6 miles) of the well. For CO, the study discovered increased concentrations at monitors within 3 km (1.9 miles) of wells during preproduction days.

During both preproduction and production activity, concentrations of O_3 increased at monitors located between 1 and 4 km (0.6 – 2.5 miles) from wells. Ozone forms through photochemical reactions of CO, NO_x (of which NO_2 is part), and VOCs—all of which were found to be present in this study. Lastly, concentrations of VOCs were higher when production volume increased within 1 km (0.6 miles) of the monitor. In this study, VOCs were comprised of non-methane organic compounds including acetaldehyde, benzene, ethylene, and formaldehyde. All criteria

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pollutants the researchers looked at returned to background levels at distances greater than 4 km (2.5 miles) from the source.

One problem of concern that was raised by the authors was EPA monitor placement. Monitors were not necessarily placed in areas that would capture emissions from oil and gas development. In fact, the authors were unable to report on preproduction VOCs, as no preproduction wells were within 1 km (0.6 miles) of a monitor.

The authors noted that using proximity as a metric of exposure to upstream oil and gas production appears to adequately capture exposures to chemical contaminants. Results indicate that even when adjusting for certain factors—geographic, meteorological, seasonal, and temporal/time base—it is still clear that the closer one lives to oil and gas wells, in both preproduction and production, the higher the exposure to ambient air pollution.

To learn more about this study topic, explore these links:

- Gonzalez et al. (2021): Upstream oil and gas production and ambient air pollution in California. *Science of the total Environment*, 806, part https://www.sciencedirect.com/science/article/pii/S0048969721053754
- Environmental Health Project (2020). Health Outcomes Associated with Exposure to Shale Gas Development from Peer-Reviewed Epidemiological Literature. https://7bd2bc49-dce3-4599-9d04-024007410045.filesusr.com/ugd/a9ce25_d265699067214d5d94408b9102b37c72.pdf
- Li, L., Blomberg, A.J., Spengler, J.D., Coull, B.A., Schwartz, J.D., Koutrakis, P. (2020). Unconventional oil and gas development and ambient particle radioactivity. *Nature Communications*, 11, 5002. https://www.nature.com/articles/s41467-020-18226-w
- Zoya Banan & Jeremy M. Gernand (2018): Evaluation of gas well setback policy in the Marcellus Shale region of Pennsylvania in relation to emissions of fine particulate matter. *Journal of the Air & Waste Management Association*, pgs. 988-1000. https://doi.org/10.1080/10962247.2018.1462866

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