

Levels of PM, VOCs, and PAHs in Residences Post-2023 Maui Wildfire: Exposure and Mitigation Assessment

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SUMMARY

Wildfire smoke can affect chronic health conditions for years. There is a lack of understanding on longer-term impacts of wildfires on residential exposures, and viable exposure-reduction strategies that are effective, reliable, and affordable. Many studies have examined indoor-outdoor pollutant concentration ratios, but these have typically been limited to PM. Furthermore, most studies only examined portable air cleaners (PACs) use and effectiveness over relatively short periods. In this study, we (i) measured the concentrations and constituents of three categories of target air pollutants inside and outside residences in Lahaina, Maui, and nearby regions affected by the Maui Wildfire; (ii) determined the portion of outdoor-origin air pollutants that infiltrated inside the residences; and (iii) assessed the short and long-term reductions in the indoor levels of target air pollutants (PM, VOC, and PAHs) from outdoor sources using PACs.

KEYWORDS

Wildfire, Residential Exposure, Portable Air Cleaners

1 INTRODUCTION

In August 2023, the Maui Wildfire caused evacuations, extensive destruction, >110 deaths, and >1,100 missing in Lahaina town [1]. The Lahaina fire is now contained but the health and wellbeing of people in and around the damaged regions will continue to be affected in numerous ways [1]. Wildfire smoke can affect chronic health conditions like heart or pulmonary diseases for years [2]. Considering the average North American spends ~70% of their time in their private residence, understanding wildfire-related indoor air exposures and the effectiveness of reduction strategies are fundamental to enhancing human health in affected communities [3].

2 METHODS

Our measurement period is divided into two sections. The first period lasts about two weeks for each home (one week before deploying PACs and one week after that) and will involve monitoring the indoor and outdoor levels of PM, VOCs, and PAHs and their constituents using a combination of low-cost consumer-grade and lab-grade high precision instruments. The second period lasts about 3 months and involves leaving the low-cost consumer-grade air quality monitors in volunteers' residences to monitor the levels of PM_{2.5} and TVOC in real-time. The measured levels of target air pollutants will be compared to existing EPA standards based on health considerations. Next, we adopt two experimental approaches for determining the origin of target air pollutants. Our first approach is based on the real-time indoor and outdoor concentrations of air pollutants for PM_{2.5} and TVOC, and the second approach is based on using

specific chemical species as surrogates of indoor air pollutants of outdoor origin for all target air pollutants. We also collect local weather data and building characteristics to be able to explain potential differences in outdoor concentrations of air pollutants and their infiltration rates to indoor spaces.

To assess the performance of PACs in reducing the indoor levels of outdoor-origin air pollutants, we deploy a PAC with new HEPA and activated carbon air filters inside each volunteer home to provide an additional 300 cfm of clean air delivery rate (CADR) to indoor spaces after one week of measuring the background levels of target air pollutants. New gravimetric PM and passive VOC samples are placed inside the residences after deploying the PACs. After another week, we collect PM and VOC samples and take new PAH surface and air samples. Next, we change the air filters of the PACs and keep the old filters for additional analysis. This additional analysis includes taking several samples from the used air filters to measure the portion of heavy metals and sulfate in captured PM and portions of outdoor-origin (surrogates) PAHs in total collected PAHs. We will ask the volunteers to continue using the PACs for the next three months while we monitor the indoor and outdoor levels of PM_{2.5} and TVOC using the Airthings View Plus Air Quality Monitors. To be able to record the use time of PACs during the measurement period, we will plug PACs in smart plugs sending us use time data automatically.

3 RESULTS AND DISCUSSION

At the time of composing this Extended Summary, our project is ongoing, and we are currently in the process of collecting data. Given the significance of this issue for the people of Hawaii and the concurrent occurrence of the Indoor Air 2024 conference in Hawaii, we have opted to submit the extended summary. We anticipate completing the data collection by the end of January 2024. Our main hypotheses are: (1) People in fire-influenced regions of Maui are currently exposed to critical levels of target air pollutants from outdoor sources. (2) The target air pollutants from outdoor sources will comprise a significant portion of total detected air pollutants in both air and on surfaces inside residences in Lahaina, Maui; however, the infiltration rate of outdoor-origin air pollutants would be different depending on the building location and characteristics as well as local weather conditions. (3) PACs equipped with new HEPA and activated carbon filters would be able to reduce the concentration of outdoor-origin PM and VOCs in the indoor air; however, their effectiveness for removing target pollutants deposited on indoor surfaces would be significantly lower. (4) During the 3-month continuous monitoring period, the effectiveness of PACs for removing PM_{2.5} and PM₁₀ would remain approximately consistent; however, their effectiveness for reducing indoor TVOC levels would reduce over time.

4 CONCLUSIONS

Studying the Maui wildfire provide us a unique opportunity to, for the first time, explore a comprehensive range of factors influencing people's exposure to wildfire air pollutants and intervention strategies for improving indoor air quality during and after such catastrophic events. Our research will inform engaging communities in Maui about the risks of fire-related air pollutants and mitigating approaches.

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6 REFERENCES

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