Prescribed burns may introduce new atmospheric toxins

May 7 2020, by Adam Dove

Professor Jen and CAL firefighter standing next to the airborne smoke collection drone during prescribed burns at Blodget Forest Research Station 2017. Credit: Dr. Coty Jen

In many of the world's forested regions, wildfires are an unavoidable fact of life. From the forests of Portugal, to the woods of California, to the recent devastation of the Australian bushfires, widespread fires are often a regular, annual concern. Worsening climate conditions only

continue to make these fires more prevalent, and more deadly. For researchers, firefighters, and policymakers working to address this problem, the goal is to minimize damage as much as possible—both to the environment, and to the people living nearby.

One of the best ways to minimize the probability of large-scale fires is through the use of prescribed burns. Through the natural lifecycle of a forest, tree branches, dried leaves, and other organic debris build up on the forest floor. When wildfires do break out, it is this debris that serves as some of the primary fuel, helping the fires to spread more quickly. By using prescribed burns, forest managers can go into an area and eliminate this organic fuel with smaller, low-temperature fires, so that when the next wildfire starts up, it has less fuel to burn, and can be contained much more easily.

But while these burns have been shown to help reduce the physical damage done by the fires themselves, Coty Jen is concerned that using these burns might just be trading one kind of damage for another.

"Prescribed burns are currently the most effective method we have to manage forests in the western United States," says Jen, an assistant professor of chemical engineering. "But burning such a large amount of built-up fuel—feet of duff and tree litter on the forest floor—will significantly impact the regional air quality. My group is interested in understanding how the smoke from managing the unmanaged forest is different in chemical composition from that of the wildfires themselves. Is it more toxic to human health? We are working with forest managers to understand this difference."

Part of the problem is that not all forest litter is created equal. Depending on the makeup of a particular area of forest, a wide variety of debris could be present, from fallen branches to different shrubs or grasses. As Jen's research has discovered, the presence of different

organic fuels can lead to very different outcomes.

"We've so far found that certain types of fuel produce way more organic smoke—white smoke as opposed to black, sooty smoke—than other fuels," says Jen. "We also found that certain plants produce more toxic compounds. One example being manzanita, a common shrub in coastal California, just spews unhealthy hydroquinone when burned. Unfortunately, the vast majority of compounds we found in smoke have not previously been studied for health impacts, so understanding just how toxic these compounds are to humans has to be the next step."

While the differences between these toxic compounds are still unclear, the negative health impacts of burning organic material have been known for a long time. Certain atmospheric particles known as organic aerosols—particles released when organic materials like trees and other plant matter are burned—have been linked to an increased risk of heart disease, and even death.

In addition, we know that chronic lung diseases like COPD and asthma, which can be brought on or exacerbated by wildfire smoke inhalation, are risk factors that could potentially make one more susceptible to contracting a more severe case of COVID-19. This ongoing crisis makes research in this area more important than ever, and Jen and her lab are beginning to look into how best to ensure wildfires don't make the problem worse.

Next, Jen and her research team intend to travel to the forests of California, working with the University of California to study these different emissions in the field, and characterize the different compounds present in the smoke from these prescribed burns, in both previously managed and unmanaged forests.

"Overall, we know that these prescribed burns are the best way we have

to mitigate the spread of wildfires, and they should be done," says Jen. "What we need to do now is figure out where and how to prescribe these burns to best manage the forest while minimizing the human health risks posed by the smoke."

Provided by Carnegie Mellon University, Department of Chemical Engineering