A Multi-Observation Model for Quantifying Deployment of Lethal Hexachloroethane by Federal Agents in Downtown Portland, OR, USA

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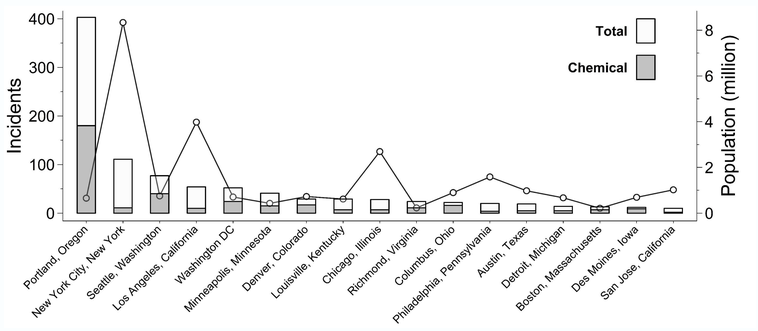
This work would not have been possible without a large community standing up despite the wanton use of chemical weapons to say that Black Lives Matter. Front-line journalists including Alissa Azar, Garrison Davis, Robert Evans, Mariah Harris, Laura Jedeed, Jacob Hanning, Melissa Lewis, Sergio Olmos, Mac Smith, Tuck Woodstock and many individuals who have chosen to remain anonymous due to continuing tensions with law enforcement provided invaluable documentation. Substantial thank you to the Don't Shoot Portland team for documenting, researching, and organizing around use of chemical weapons in Portland; Sarah Riddle for life-cycle documentation; The Recompiler Magazine for aggregated protest news; and Eric Greatwood for standardized video footage. Dr. Mason Fidino, Dr. Nelson Hairston Jr., and Sandy Simonis provided invaluable feedback. All funding was internal to DAPPER Stats; no financial conflicts exist. This research occurred on the lands of the Multnomah, Cowlitz, Clackamas, and Chinook Tribes. I stand in solidarity. Land Back.

Motivation

Law enforcement's use of chemical weapons is a threat to human and environmental health.

Portland, OR reported 34.4% (180/522) of the incidents of police brutality against racial justice protesters involving chemical weapons in 2020, despite having only 0.2% of the total US population:



source:2020 Police Brutality Database

In July, the Department of Homeland Security (DHS) deployed extensive amounts of chemical weapons in downtown Portland, including an unknown agent that burned differently and caused novel mass symptoms:

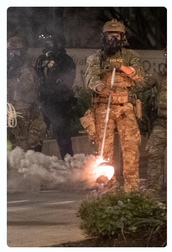


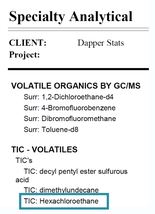
Photo: D. Brown

The weapon was identified as Hexachloroethane (HC) smoke, which produces lethal Zinc Chloride gas:

$$2Al + C_2Cl_6 + 3ZnO \rightarrow 3ZnCl_2 + Al_2O_3 + 2C$$

Photo: J. Noelle

Photo: What Riot



Data

I collated evidence from multiple sources to generate the dataset used in the analyses:

- Text reports from social and print video
- Photos and videos of protests and weapons used
- Recovered canisters
- Analytical chemistry to verify identity of agent

For each night in July, I tallied the total numbers of HC grenades that were observed, recovered, or both. I also estimated the total crowd size and amount of time DHS agents were active on the streets.

Model

I analyzed the data using a hierarchical Bayesian model:

i: day index
d_i: canisters deployed
o_i: canisters observed
r_i: canisters recovered
FT_i: time DHS was out

λ_i: hourly deployment rate
λ^*: intercept
ε_i: stochastic error
σ: error variance
ν: observation rate
ρ: recovery rate

$$\varepsilon_i \sim \text{Normal}(0, \sigma^2)$$
$$\lambda_i = e^{\lambda^* + \varepsilon_i}$$
$$d_i \sim \text{Poisson}(\lambda_i \mathrm{FT}_i)_{c_i}$$

$$o_i \sim \text{Binomial}(\nu, d_i)$$
$$r_i \sim \text{Binomial}(\rho, d_i)$$
$$or_i \sim \text{Binomial}(\rho, o_i)^{r_i}$$
$$\nu = \text{logit}^{-1}(\nu^*)$$
$$\rho = \text{logit}^{-1}(\rho^*)$$

Subscript c_i and superscript r_i indicate truncation

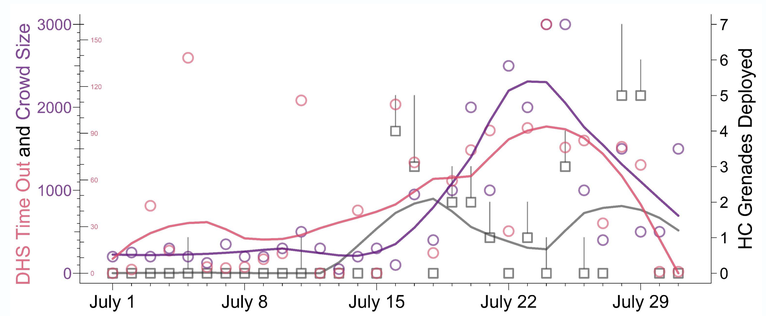
The model assumes no false positives and I used generally uninformative priors on the raw scales.

I fit the model using JAGS (Just Another Gibbs Sampler) via R to generate 40,000 uncorrelated samples across four parallel chains initialized with different values.

All data, methods, results, and citations are available online.

Results

Use of HC by DHS downtown occurred July 16 to July 29 and displayed a bimodality, whereas crowd size and federal presence were unimodal over that time period:



Lines are fitted using local polynomial regression (loess).
HC values are means (points) with 95% posteriors (vertical bars).

The community identified 26 HC cans deployed by DHS:

13 observed, 21 recovered, 8 observed and recovered

The model estimated there was one additional can for a total of a 27.0 cans (95% CI: 26 – 30) deployed at a rate (λ^*) of 0.12 HC cans hr^{-1} (95% CI: 0.03 – 0.39) by DHS.

The observation rate (ν) was 0.48 (95% CI: 0.31 – 0.66). The recovery rate (ρ) was 0.73 (95% CI: 0.58 – 0.85).

Future Directions

Having identified and quantified hexachloroethane use by DHS, we are now tracking the zinc and chloride through the ecosystem to determine their impacts on terrestrial and aquatic urban ecosystems:

Left: *Tilia* exposed to HC at the US courthouse dropping leaves.
Right: Micropterus recovered from culvert where courthouse runoff with HC residue enters the Willamette River.