

Community Perceptions and Experiences Related to Household Air, Water, and Soil Testing after the East Palestine Train Derailment

Joseph Toland,¹ Andrew Whelton,² Clayton Wukich³ and Lauryn A. Spearing⁴

¹ joseph.toland@tufts.edu; PhD Candidate; Civil and Environmental Engineering Department; Tufts University; 200 College Avenue, Medford, MA 02155, USA.

² awhelton@purdue.edu; Professor; Department of Civil Engineering, Environmental, and Ecological Engineering; Purdue University; 610 Purdue Mall, West Lafayette, IN 47907, USA.

³ r.wukich@csuohio.edu; Associate Professor of Public Administration; Maxine Goodman Levin School of Urban Affairs; Cleveland State University; 2121 Euclid Ave. UR 349, Cleveland, OH 44115, USA

⁴ lauryn.spearing@tufts.edu; Assistant Professor; Civil and Environmental Engineering Department; Tufts University; 200 College Avenue, Medford, MA 02155, USA.

RESEARCH PROBLEM AND PURPOSE

The February 2023 East Palestine, Ohio chemical spill and fires—triggered by the derailment of a Norfolk Southern freight train carrying hazardous material—brought on a regional environmental crisis [1]. After the train derailment, hazardous material was observed contaminating local creeks. On February 6, 2023, responding agencies conducted a controlled vent and burn of the remaining material, depositing soot throughout the surrounding area [1]. After the crisis, community members were concerned about their safety, the extent of environmental contamination, and what protective actions to take. For example, gaps in identifying and communicating the long-term risks to private wells and the lack of indoor safety assessments left community members unsure how to respond [2]. In turn, residents became worried with the limitations of air, water, and soil sampling procedures, the communication of testing results, and the subsequent lack of adequate safety information to inform household decision-making [3].

Such issues emphasize the importance of evidence-based, protective action recommendations (PARs) provided by responding agencies in a crisis, which help to steer public behavior in a manner consistent with risk [4]. In the absence of PARs, community members are likely to proceed out of an abundance of caution—taking actions that may or may not be consistent with the potential hazard—based on individual perceptions of risk [4]. At best, this may result in unnecessary action which could increase demand for emergency resources. At worst, households may not act, even when such action is necessary to ensure health and safety [4-5]. While previous work has investigated the adherence to PARs and the effectiveness of risk communication in a water crisis [6-8], there is limited research on protective actions during industrial crises, where

complex sampling and testing may be required, as household guidelines, for example, on indoor air quality, may be lacking [9].

Here, we seek to understand people’s experiences with air, water, and soil sampling and testing, one pathway through which households seek more information in industrial disasters. Specifically, we identify connections between people’s perceptions and experiences and if they requested sampling and testing after the East Palestine chemical spill. To do so, we conducted a community survey in Ohio, Pennsylvania, and West Virginia (n = 259). We investigated relationships between household sampling requests and: 1) environmental impacts (e.g., the presence/absence of soot or smells in the home), 2) information about risks (e.g., whether households were told by responding agencies to evacuate), 3) perceptions about response (e.g., perceptions of trust and expert knowledge), and 4) respondents’ degree of community engagement. It is imperative to study the factors that motivate requests for sampling and testing, as this can reveal policy leverage points that ensure households have adequate safety information for decision-making, and that households are treated equitably in their requests for information.

METHODS

We conducted a community survey to understand people’s perceptions and experiences related to water, home, and air impacts after the East Palestine chemical spill and fires. To participate, people must have been 18 years or older and lived or worked in one of the eligible counties on or after February 3, 2023, the start of the crisis (see Figure 1).

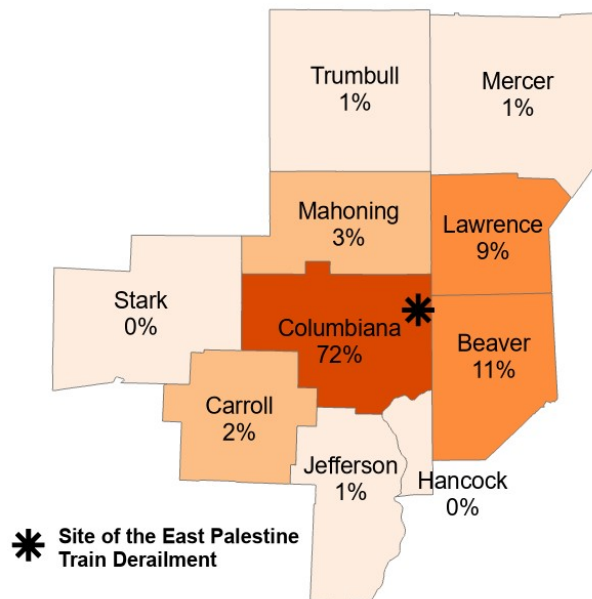


Figure 1. East Palestine train derailment survey geographic area. Percent shows the makeup of respondents from each county.

The survey was conducted from approximately July 20 to September 20, 2023. Community members were able to complete the survey online or by hand. To recruit participants, flyers were distributed to businesses and mailed to residents. We received 259 valid survey responses. The majority of respondents were from Columbiana County, Ohio (72%), where the derailment occurred. Most participants were homeowners (80%). The median household income of respondents was between \$50,000-\$74,999 and the median age of respondents was between 45-55—similar to the median age and income in the counties of interest [10]. The study was reviewed by the Institutional Review Boards at the University of Illinois Chicago, Purdue University, and Cleveland State University.

To investigate the relationships between requests for sampling and testing with household impacts, perceptions, and experiences identified above, we performed: 1) chi-squared tests of independence for categorical (binary) variables and 2) Spearman’s rank correlation for the ordinal variables (see Table 1 for variable information). The p-values below $\alpha = 0.05$ were considered a statistically significant association.

Table 1. Selected variables for chi-square tests of independence and categorical comparisons

| Group | Name | Type | Categories |
|-----------------------------------|--|-------------|---|
| Outcome of Interest | Requested sampling and testing | Categorical | Yes, No |
| Environmental Impacts/Cues | Told there may be contamination inside home | Categorical | Yes, No |
| | Noticed a new smell inside home | Categorical | Yes, No |
| | Noticed soot inside home | Categorical | Yes, No |
| Information About Risks | Told to evacuate by officials | Categorical | Yes, No |
| | Perceptions of risk communication effectiveness (e.g., if guidance was explicit and clear) | Ordinal | Likert (average): Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree |
| | Told that staying in home was unsafe | Categorical | Yes, No |
| | Told drinking water was unsafe | Categorical | Yes, No |
| Perceptions About Response | Perceptions of trust (e.g., in agencies, media, or community groups) | Ordinal | Likert (average): Very Low, Low, Medium, High, Very High |
| | Perceptions about expert knowledge (e.g., officials, media) | Ordinal | Likert (average): Not at all, Very little, Neutral, Somewhat, To a great extent |
| Community Engagement | Perceptions of equity and fairness (e.g., if decision-making was fair) | Ordinal | Likert (average): Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree |

| | | |
|--|-------------|---------|
| Level of community engagement (e.g., community meeting attendance) | Categorical | Yes, No |
|--|-------------|---------|

KEY FINDINGS AND IMPLICATIONS

The results of the community survey (n = 259) show that half (50%) of the respondents requested air, water, or soil sampling. Of those who requested sampling, 62% received the sampling and results. Of those who received results, 73% found them hard to understand and 75% lacked trust in the results. Predictably, requests for air, water, or soil sampling services originated mostly from the zip code that includes East Palestine, OH (44413; 73%). Table 2 shows results of the chi-squared tests and Spearman's rank correlation.

Table 2. Results for chi-squared tests of independence and Spearman's rank correlation with requests for air, water, or soil sampling and testing (* indicates significance using a 0.05 level)

| Name ¹ | P-Value | Correlation |
|---|----------|-------------|
| Physical Impacts | | |
| Told there may be contamination inside home | 0.00025* | NA |
| New smell inside home | 0.00027* | NA |
| Noticed soot inside home | 0.00215* | NA |
| Information About Risks | | |
| Told to evacuate | 0.00010* | NA |
| Perceptions of risk communication effectiveness | 0.00001* | -0.323 |
| Told that staying in home was unsafe | 0.21793 | NA |
| Told drinking water was unsafe | 0.44226 | NA |
| Attitudes Towards Response | | |
| Perceptions of trust | 0.01417* | -0.182 |
| Perceptions about expert knowledge | 0.00885* | -0.194 |
| Community Engagement | | |
| Perceptions of equity and fairness | 0.00000* | -0.406 |
| Level of community engagement | 0.00023* | NA |

¹ Categorical (binary) variables (Table 1) report chi-squared test p-values; ordinal variables (Table 1) report Spearman's rank correlation p-values and correlation, both with requests for sampling and testing categorical (binary).

Unsurprisingly, results show a significant association between households that were told to evacuate (about 53% of participants) and requests for testing and sampling. Household impacts such as noticing soot or a new smell inside their home were associated with requests for sampling and testing. We also found being told by responding agencies that there may be contamination inside one's home (10%) was associated with requesting sampling and testing. In this case, individual experiences provide evidence consistent with risk. However, only 62% of those

participants that requested sampling and testing based on these experiences received it, indicating that gaps in the frameworks for sampling and testing may have impacted the detection of hazards. Community engagement was also found to be significantly associated with sampling and testing requests. Half of the respondents (50%) attended community meetings, where about 15% gave public comments. Concerns voiced at community meetings may have driven testing requests [e.g., 11].

Many respondents indicated that they perceived low risk communication effectiveness. Communication effectiveness was measured by the extent to which respondents perceived that official guidance addressed their questions about: 1) the specific risks involved; 2) the location of impact; 3) specific safety guidance; 4) the timing for these recommended actions; and 5) whether an authoritative source was cited [4]. The perceptions of ineffective risk communication were correlated with requests for sampling and testing. When people indicated they requested sampling and testing, they most frequently indicated they disagreed or strongly disagreed that risk communication was effective. Furthermore, lower perceptions of equity, fairness, and trust also presented a statistically significant correlation with requests for sampling and testing.

Unexpectedly, these results show that respondents who requested sampling and testing categorically felt that both risk communication effectiveness and equity and fairness were poor in comparison with those that did not request these services (see Figure 2). Further investigation of these connections of risk communication effectiveness with perceptions of equity and fairness may reveal leverage points for policy interventions to ensure equity in environmental disaster response.

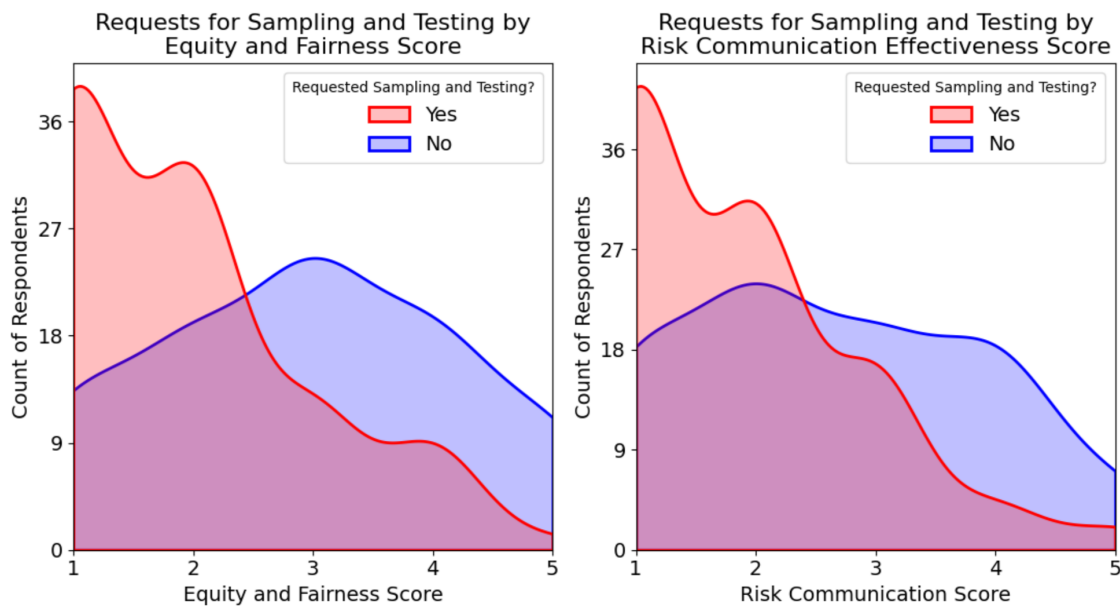


Figure 2. Categorical relationships between perceptions of equity and fairness and effective risk communication from Table 3 and associated requests for sampling and testing. Perceptions of

“equity and fairness” in crisis response and “risk communication effectiveness” scores range from (Likert Scale): Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4, Strongly Agree = 5. e.g., respondents “disagree” that risk communications were effective, or “disagree” that the crisis response was equitable and fair.

CONCLUSIONS AND NEXT STEPS

Our results indicate that gaps in sampling and testing may have impacted the detection of contamination and subsequent protective action guidance. The results of our study help to shed light on what factors are associated with people seeking environmental sampling. Findings can inform guidelines and resources to aid responding agencies as they design, conduct, and communicate sampling plans to communities experiencing industrial disasters. Future work will expand on these results to model multiple protective action responses, including use of air purifiers/replacement of filters and relocation. We will also investigate connections to post-disaster water insecurity [12] in industrial crises and drivers of emergency water resource needs [13-14]. As with any study, there were limitations. About 19% of responses were incomplete and about 14% had missing values, and so final analysis excludes these records. Lower technology adoption rate among older, rural community members may limit survey response. To mitigate this issue, we used hardcopy survey mailers as well as online survey tools. Further, we also conducted more than 50 semi-structured interviews with community members to understand stories and experiences in more detail, minimizing technological issues inherent to surveys.

ACKNOWLEDGEMENTS

This work was funded by the National Science Foundation under Award #2329409.

REFERENCES

[1] U.S. Environmental Protection Agency. 2023. “Ensuring the People of East Palestine Are Protected Now and in the Future”. EPA Report Submitted Pursuant to Section 2(b) of Executive Order 14108, October 20, 2023. US EPA Region 5, Chicago, IL.

[2] Kekatos, M. 2023. "Did the train derailment in East Palestine affect its water supply? Experts say more testing is needed." ABC News. Available Online: <https://abcnews.go.com/Health/train-derailment-east-palestine-affect-water-supply-experts/story?id=97384973> (Accessed December 2023).

[3] Sullivan, B. 2023. "What to know about the train derailment in East Palestine, Ohio". National Public Radio, WBEZ Chicago. Available online: <https://www.npr.org/2023/02/16/1157333630/east-palestine-ohio-train-derailment> (Accessed December 2023).

[4] Mileti, D S, and Sorensen, J H. 1990. "Communication of emergency public warnings: A social science perspective and state-of-the-art assessment". Report ORNL--6609: Prepared for the Federal Emergency Management Agency, Washington, D.C.

[5] Hyman, A., Arlikatti, S., Huang, S.-K., Lindell, M. K., Mumpower, J., Prater, C. S., & Wu, H.-C. (2022). How perceptions of risk communicator attributes affect emergency response? An examination of a water contamination emergency in Boston, USA. *Water Resources Research*, 58, e2021WR030669.

[6] Lindell et al. 2015. "Exposure Path Perceptions and Protective actions in Biological Water Contamination Emergencies". *Environmental Health Insights*, 2015:9 13–21.

[7] Lindell, M., Mumpower, L., Huang, S., Wu, H., Samuelson, C., & Wei, H. 2017. "Perceptions of protective actions for a water contamination emergency". *Journal of Risk Research*, 20:7, 887-908.

[8] Lindell, M., Huang, S., and Prater, C. 2017. "Predicting Residents' Responses to the May 1-4, 2010, Boston Water Contamination Incident". *International Journal of Mass Emergencies and Disasters*, 35(1): 84-114.

[9] Lukacs, L., Sawe, N., and Ulibarri, N. 2017. "Risk, Uncertainty, and Institutional Failure in the 2014 West Virginia Chemical Spill". *Case Studies in the Environment*, 1 (1): 1–7.

[10] U.S. Census Bureau. 2023. "QuickFacts: various counties". U.S. Department of Commerce. Available online: <https://www.census.gov/quickfacts> (Retrieved September 20, 2023).

[11] Bottar, A. 2023. "Emotions spill over in East Palestine in contentious public meeting". National Public Radio, WVXU News. Available online: <https://www.wvxu.org/ohio-news/2023-03-03/east-palestine-contentious-public-meeting-norfolk-southern-epa-train-derailment> (Accessed December 2023).

[12] Young, S., Boateng, G., Jamaluddine, Z., et al. 2019. "The Household Water InSecurity Experiences (HWISE) Scale: development and validation of a household water insecurity measure for low-income and middle-income countries". *BMJ Global Health* 2019;4:e001750.

[13] Toland, J., Wein, A., Wu, A., and Spearing, L. 2023. "A conceptual framework for estimation of initial emergency food and water resource requirements in disasters". *International Journal of Disaster Risk Reduction*, Volume 90.

[14] Toland, J. and Spearing, L. 2023. "Water Utilities and Equity in Disasters: A Systematic Literature Review". Proceedings of ASCE INSPIRE 2023 Conference. Arlington, Virginia, November 16-18, 2023.