

A SYSTEMATIC APPROACH FOR PRIORITIZING LANDFILL POLLUTANTS BASED ON TOXICITY

Edited by Elizabeth Rogers

Working Party 5 Science Brief

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Rationale

Landfills in the United States represent an important potential source of water pollution, generating millions of liters of leachate every day. Such pollution can negatively impact human health if leached offsite. Therefore, many actions, from preventative measures to reactive remediation activities, are taken to decrease the risks associated with landfill pollution. However, thousands of potentially harmful contaminants can exist within leachate, making it difficult to objectively determine which contaminants at a site to target with remediation activities. In addition, the composition of landfill leachate is dynamic, changing over time and space due to chemical, physical, and societal factors. Therefore, there is a need for a method to quantitatively prioritize landfill contaminants for remediation.

Objectives

- Quantitatively prioritize landfill leachate contaminants using a novel prioritization scheme
- Describe possible modifications to the scheme
- Provide recommendations on broader applications

Methods

- Over 500 landfill leachate contaminants were identified from the literature
- Compound toxicity values were collected from three publicly-available databases (ECOTOX [1], ToxCast [2], and CTV Predictor [3])
- Compounds were prioritized using the Toxicological Prioritization Index (ToxPi) [4]
- Options for prioritization scheme customization were investigated
- Data were collected on whether the contaminants are included in regulatory lists

“It is not feasible nor economically viable to monitor and remediate all possible contaminants. Prioritization schemes that incorporate numerous sources of toxicity data, such as those described here, provide the means for cost-effective identification of contaminants most relevant to community priorities and concerns.”

- Rogers et al. (2021)

Key Points

- The prioritization scheme systematically prioritizes landfill contaminants based on toxicity
- The scheme is easily customizable according to community and research needs



Dumping site of municipal and industrial waste (background) and retention pond (foreground)

Photo by Ryan Vinhal



Remediation planting (foreground) at a municipal solid waste landfill (background)

Photo by Ron Zalesny

Conclusions

It is not feasible to remediate all possible landfill contaminants. The scheme presented here is a time- and cost-effective tool to prioritize landfill contaminants for subsequent remediation. In addition, this scheme is easily customizable for meeting community and research objectives. Such a scheme allows for a more comprehensive approach to landfill pollutant mitigation than has previously been possible.

Implications for the Future

- Researchers, engineers, site managers, and other industry professionals can utilize this scheme to systematically prioritize landfill contaminants for remediation activities.
- The scheme can be easily integrated with global metabolomics profiling to establish a comprehensive understanding of contaminants at the site level.
- Further, this scheme may help to identify newer classes of contaminants at landfills that have yet to be included on regulatory lists.

Sources

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3. Wignall, J.A., Muratov, E., Sedykh, A., Guyton, K.Z., Tropsha, A., Rusyn, I., and Chiu, W.A. 2018. Conditional Toxicity Value (CTV) Predictor: an *in silico* approach for generating quantitative risk estimates for chemicals. *Environ. Health Perspect.* 126 (5), 057008. <https://doi.org/10.1289/EHP2998>.
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5. Detection monitoring program. 1991. 40 C.F.R. §258, p. 54.
6. Assessment monitoring program. 1991. 40 C.F.R. §258, p. 55.

Findings

General Scheme

The top 40 most potentially toxic compounds identified by the general scheme are used in a diverse range of products. Specifically, the top 40 contained: pesticides, fungicides, or their metabolites; pharmaceuticals; industrial byproducts/ cigarette ingredients; coolants and lubricants; flame retardants; and multi-use compounds.

Scheme Customizations

Two main options for scheme customization were presented: the use of 1) additional datasets and 2) different weighting schemes. Weighting schemes were more effective at identifying compounds specific to research or community objectives than simply incorporating data from additional datasets. Possible weighting schemes were presented for identifying carcinogens, endocrine disruptors, and contaminants with the greatest potential risk to flora and fauna.

Comparison to Regulatory Lists

Less than 64% of the top 40 contaminants identified from any of the schemes tested are included in regulatory lists (i.e., Appendix I and II of Title 40, Part 258 of the Code of Federal Regulations) [5,6].

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