

Assessment of Groundwater Vulnerability to Landfill Leachate Induced Arsenic Contamination in Maine, US

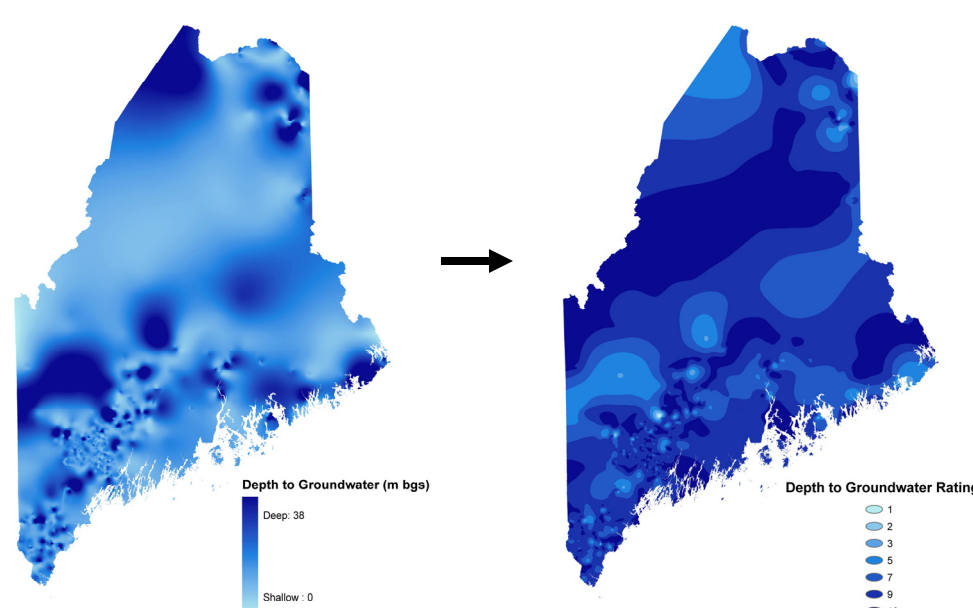
DRASTIC

The DRASTIC model evaluates the Intrinsic Vulnerability (IV) of groundwater by considering factors including Depth to water table, natural Recharge rates, Aquifer media, Soil media, Topographic aspect, Impact of vadose zone media and hydraulic Conductivity:

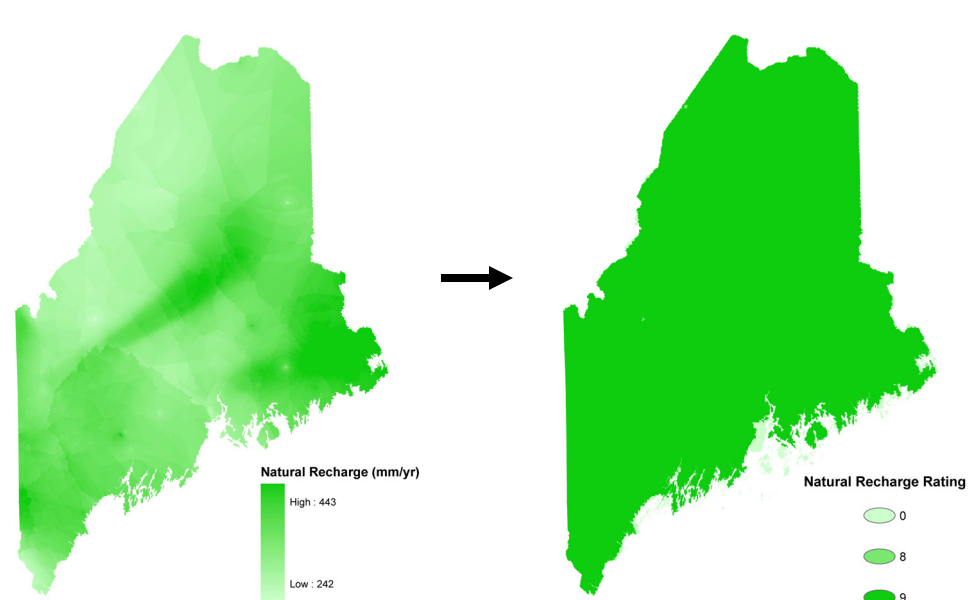
$$DRASTIC\ Index\ (IV) = D_r D_w + R_r R_w + A_r A_w + S_r S_w + T_r T_w + I_r I_w + C_r C_w$$

◊ r = rating value; w = weight

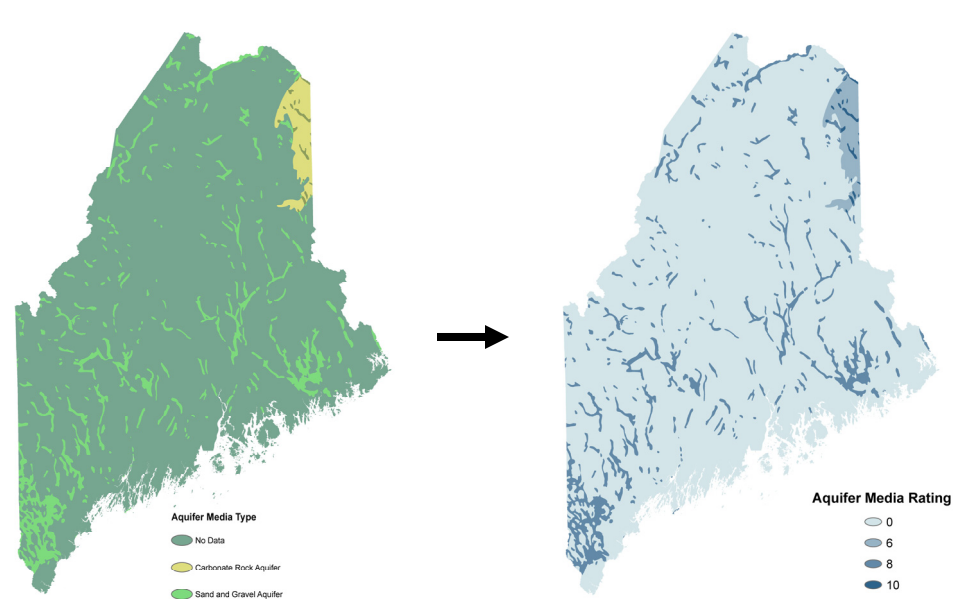
Depth to Groundwater (Weight = 5)



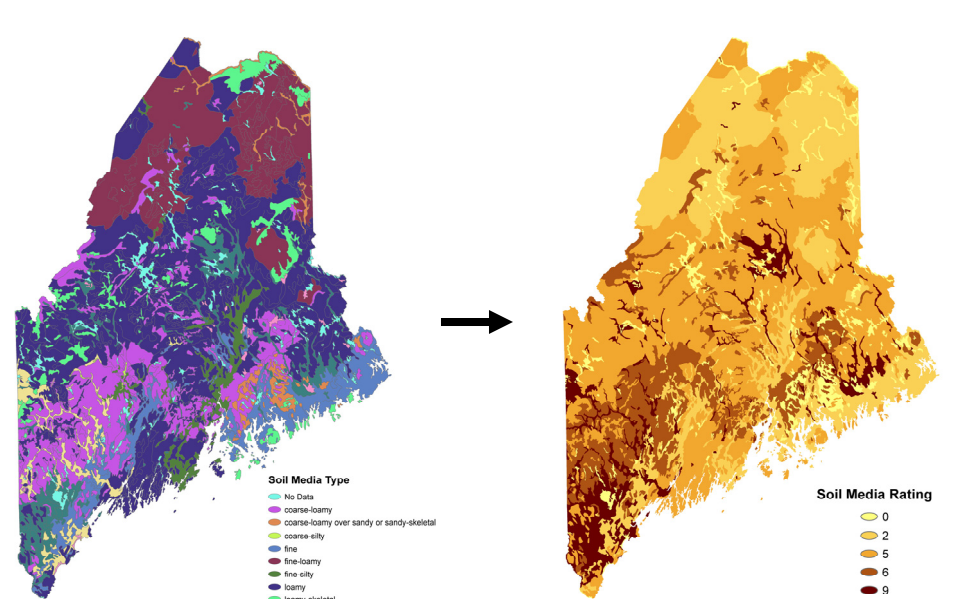
Natural Recharge Rates (Weight = 4)



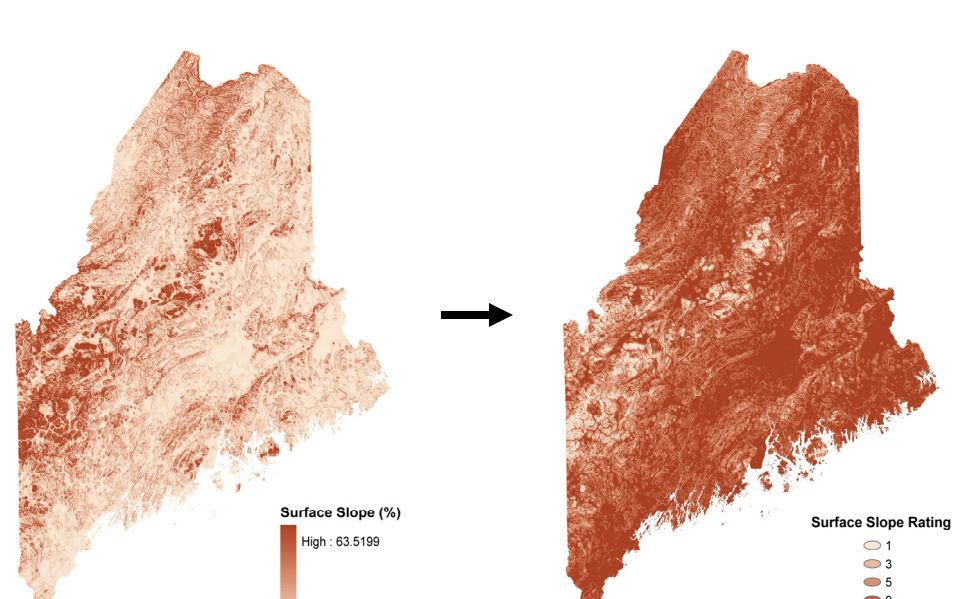
Aquifer Media (Weight = 3)



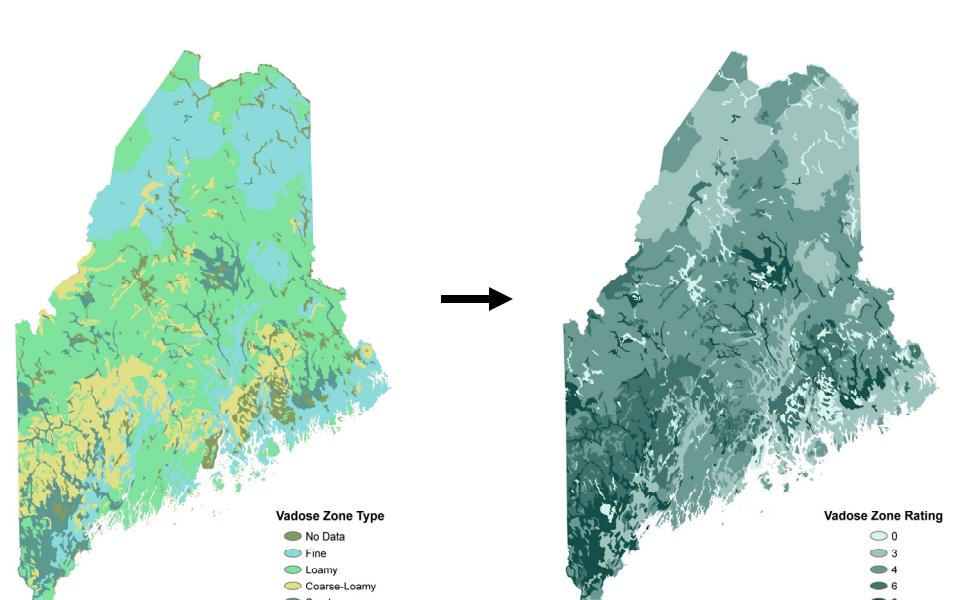
Soil Media (Weight = 2)



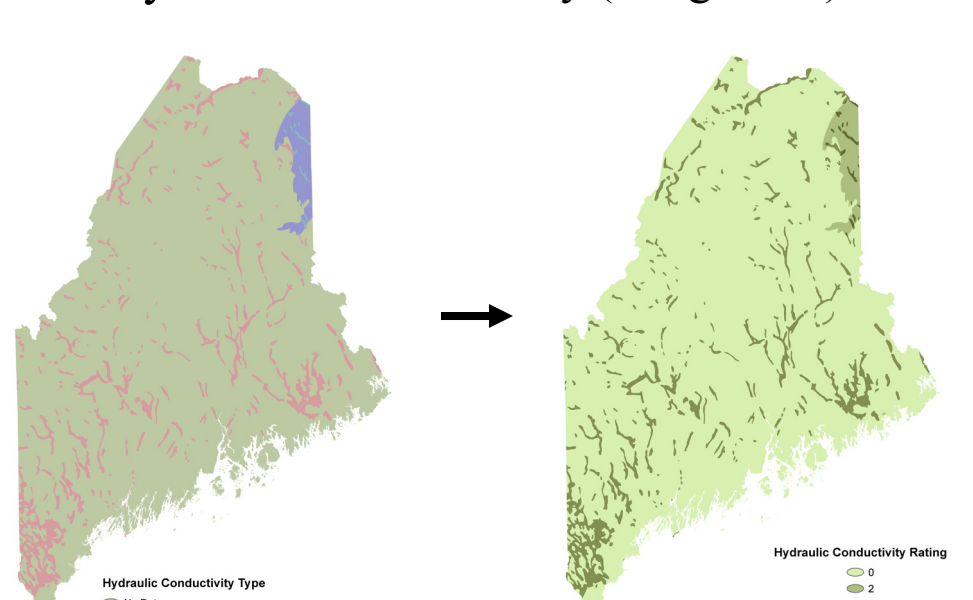
Topographic Aspect (Weight = 1)



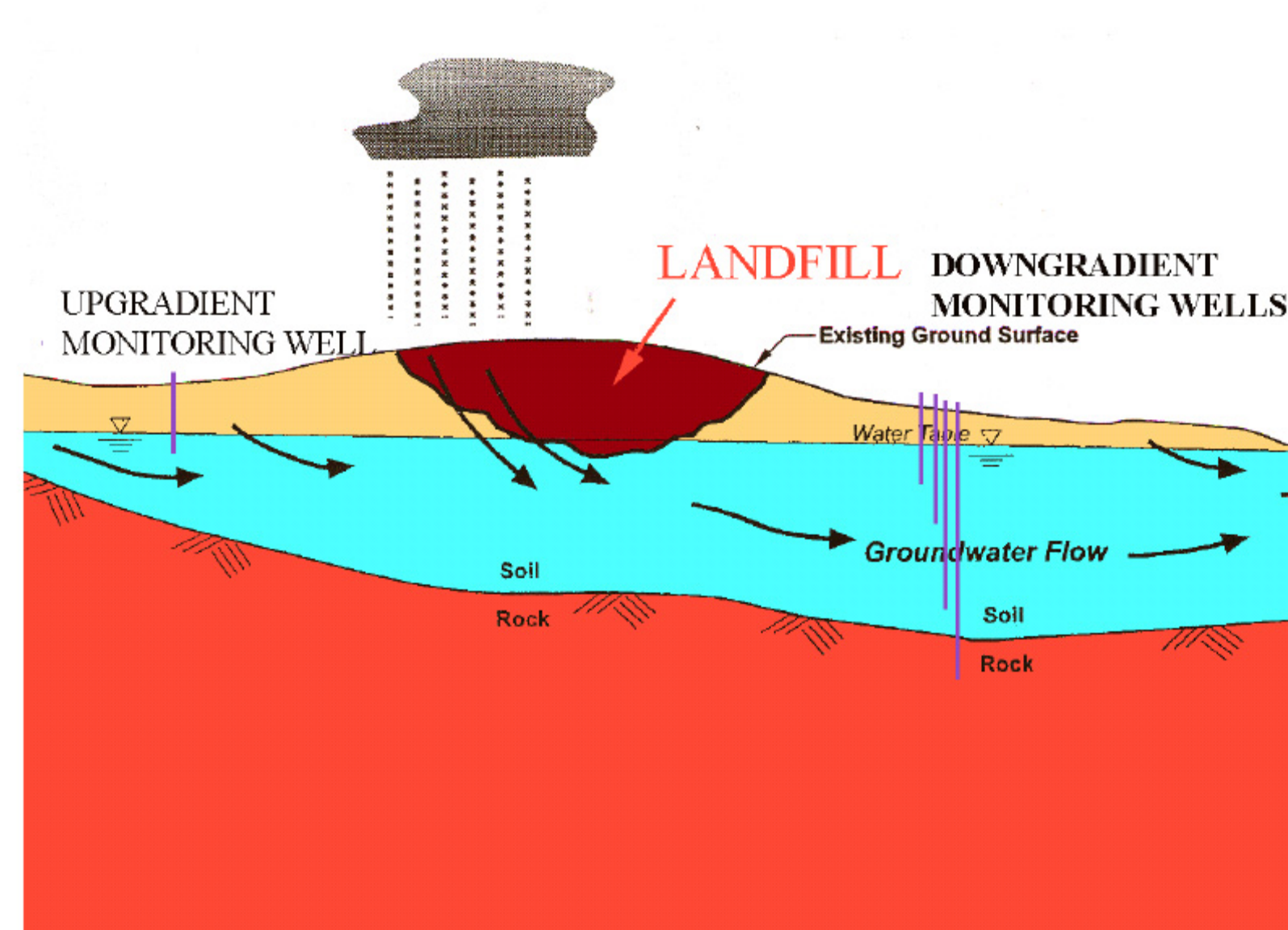
Impact of Vadose Zone Media (Weight = 5)



Hydraulic Conductivity (Weight = 3)

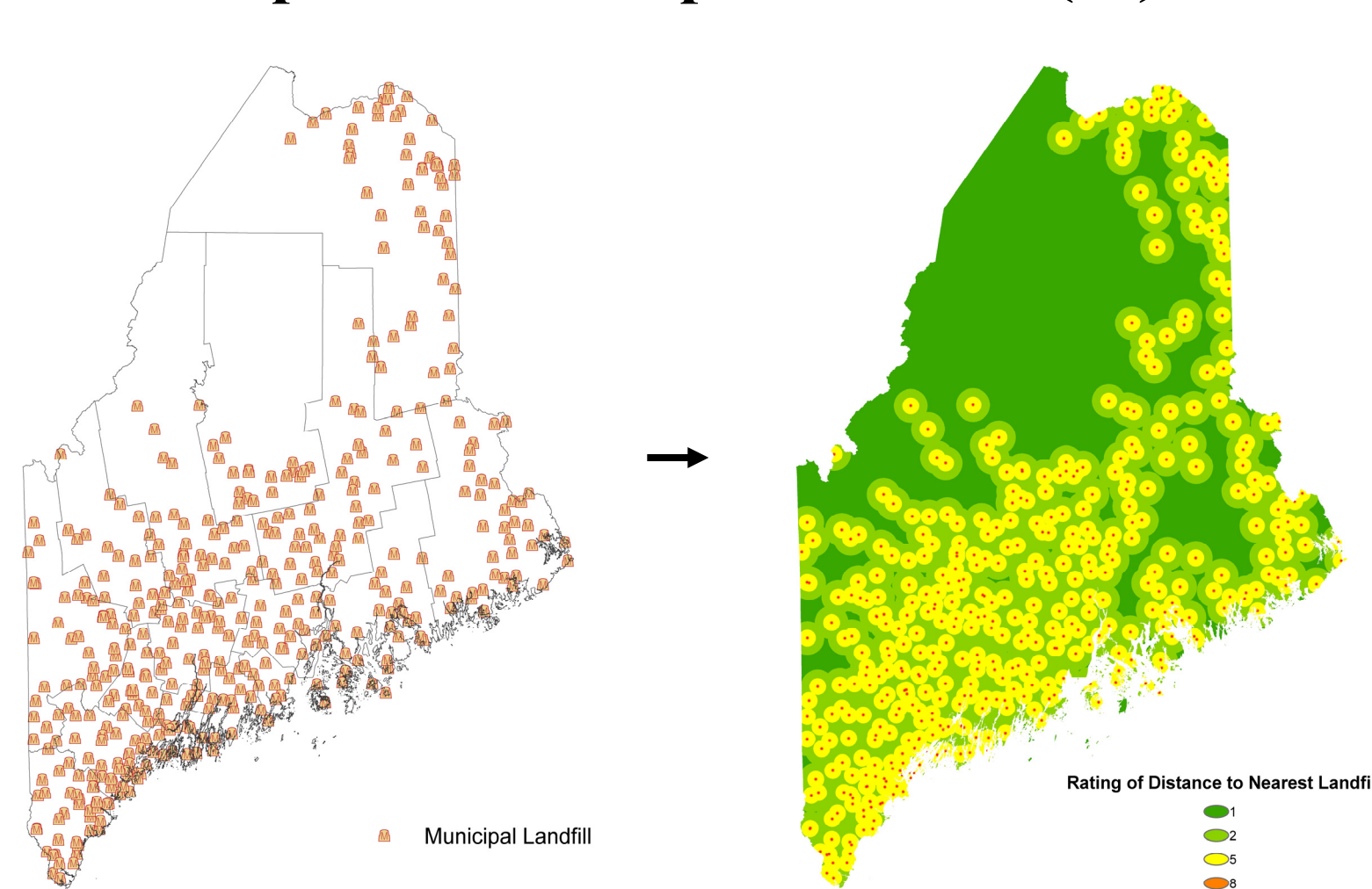


Leachate Induced Arsenic Mobilization from Aquifer Solids

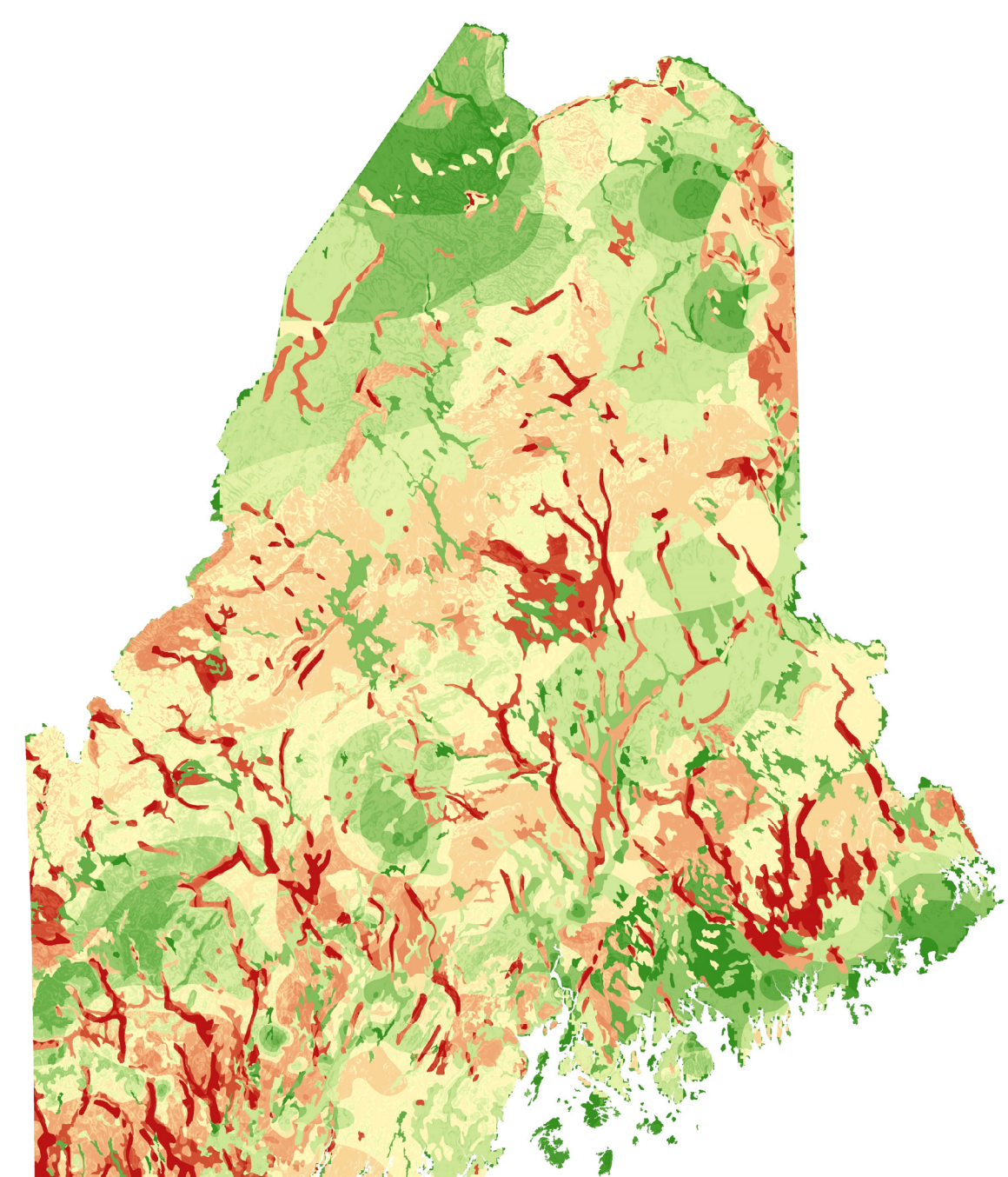


Source: Keimowitz (2007)

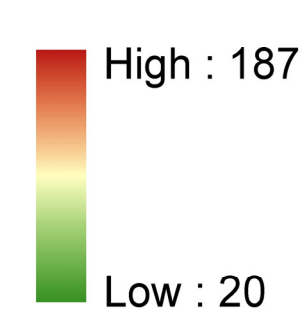
Impact of Municipal Landfills (IL)



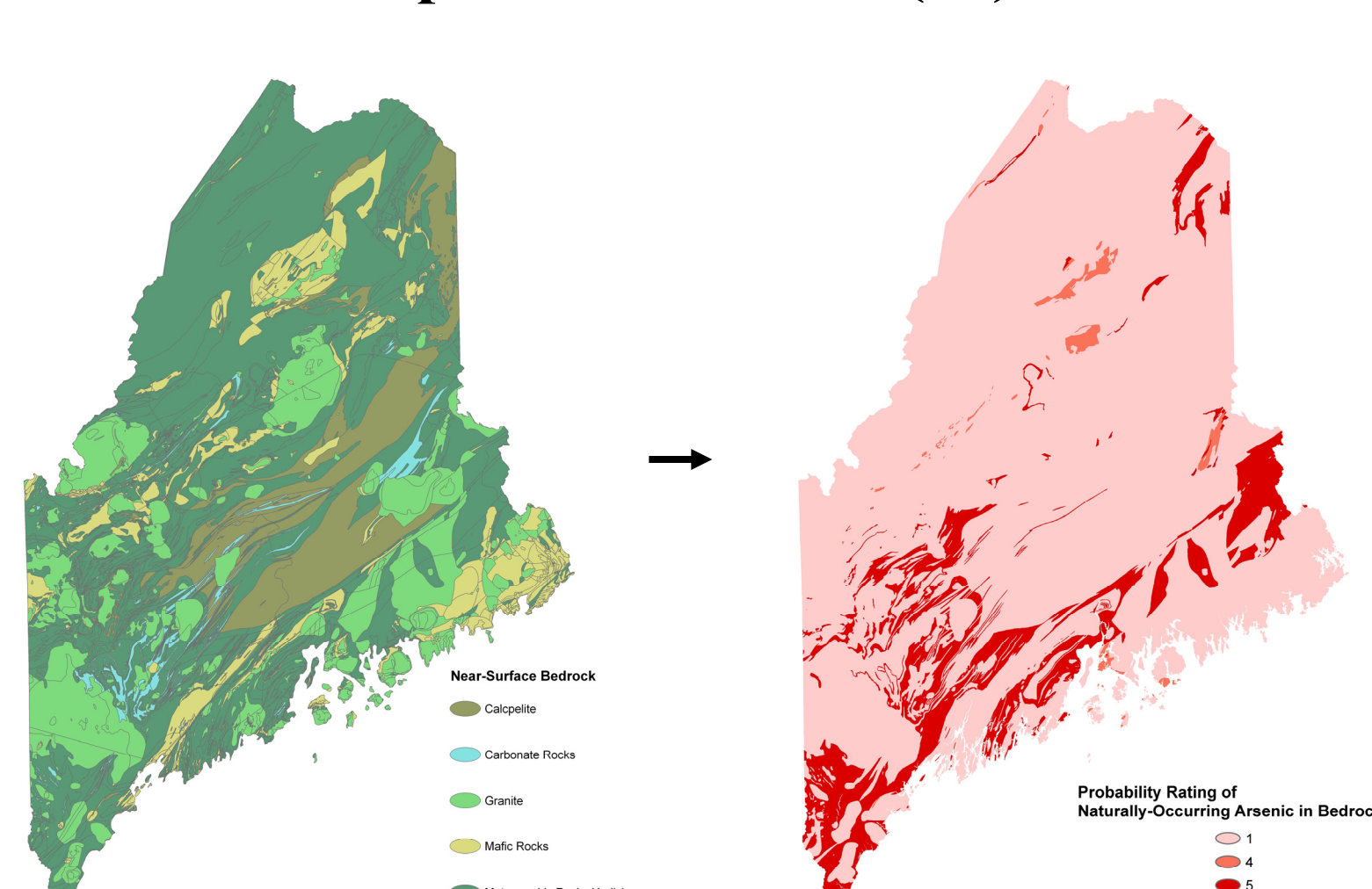
DRASTIC Intrinsic Vulnerability (IV)



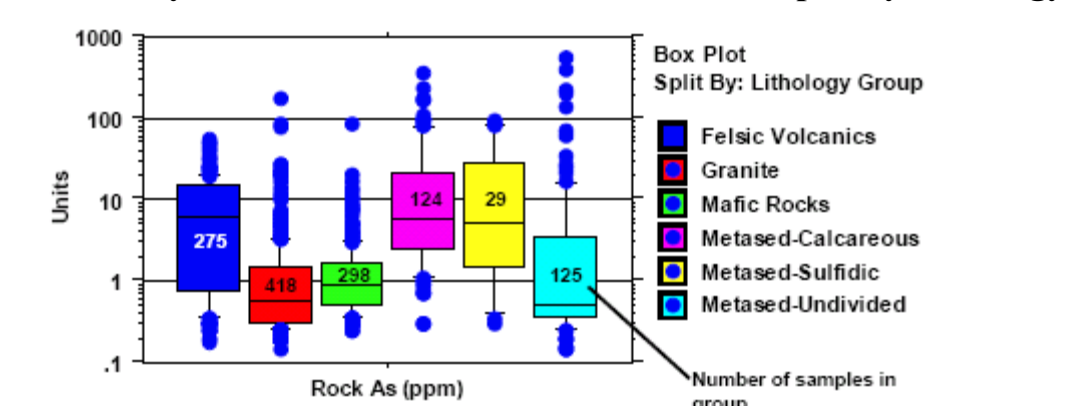
Intrinsic Vulnerability Index



Impact of Bedrocks (IB)



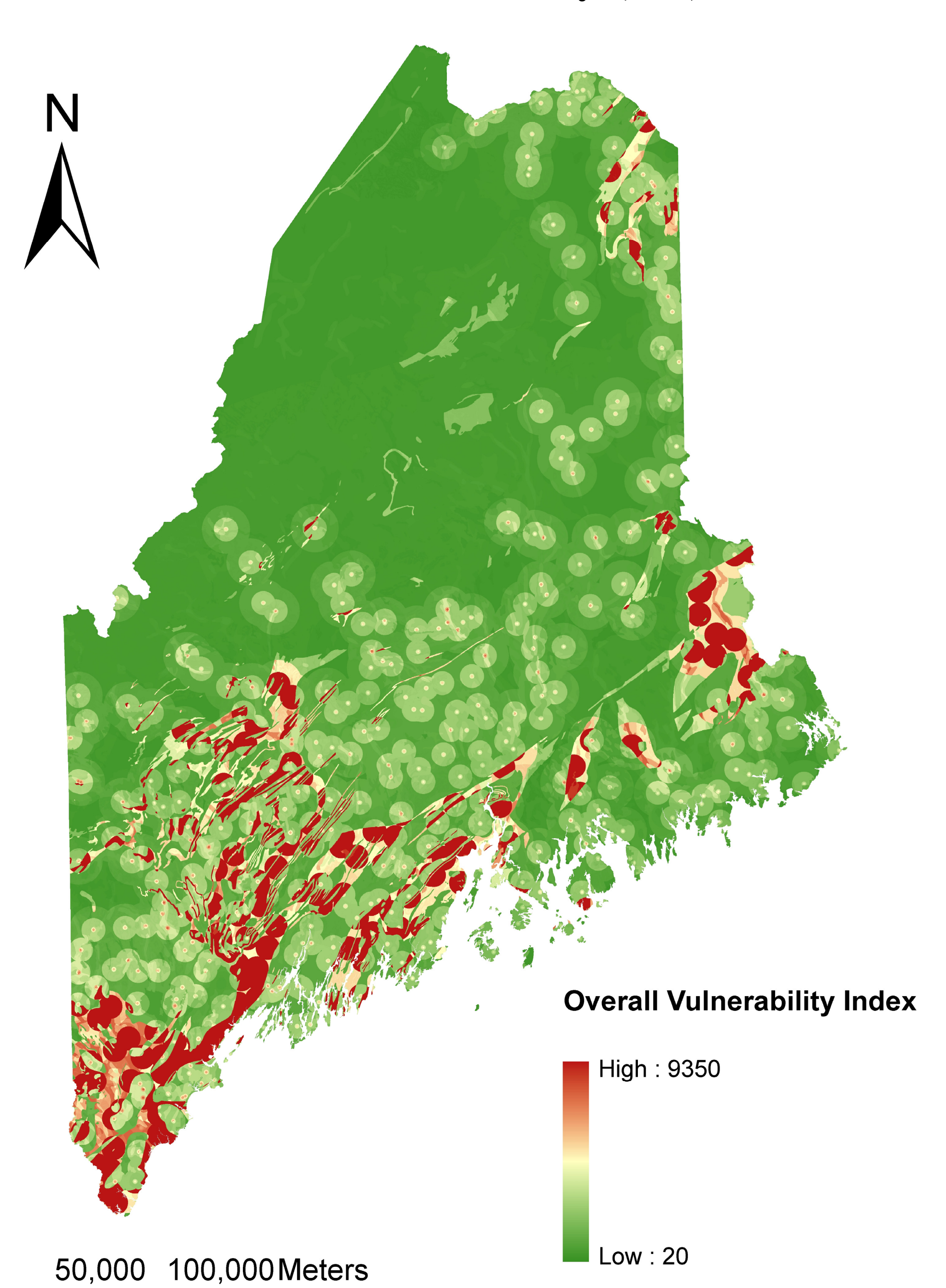
Summary Statistics for Rock Arsenic Data Grouped by Lithology



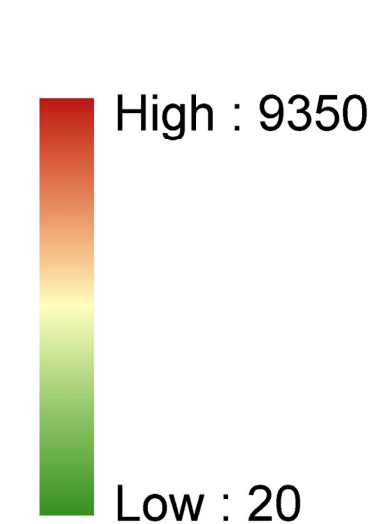
Source: Robinson and Ayotte (2007)

Naturally-occurring arsenic is often found to be bound to iron oxide minerals in soil and bedrocks in the New England area of US. Only in recent years have people found out that the degradation of organic-rich leachate migrating from municipal landfills may cause the reductive dissolution of iron oxide minerals and subsequently the release of sorbed arsenic to groundwater (Stollenwerk 2003; deLemos et al. 2006). A groundwater vulnerability study was conducted for this specific contamination scenario in Maine, US, using an index and overlay method that combines the classical DRASTIC model (Aller et al. 1987) with the potential impacts from municipal landfills as well as natural bedrocks in a Geographic Information System.

Overall Vulnerability (OV)



Overall Vulnerability Index



$$OV = IV \times IL \times IB$$

Conclusions

The results provided a preliminary screening tool to identify potential areas with high risks of arsenic contamination in groundwater induced by the degradation of municipal landfill leachates. The proposed methodology can also be applied to groundwater vulnerability studies for other contamination problems in regional scales.

References

- Aller, L., T. Bennett, et al. (1987). DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings. Ada, Oklahoma, U.S. Environmental Protection Agency.
- deLemos, J. L., B. C. Bostick, et al. (2006). "Landfill-Stimulated Iron Reduction and Arsenic Release at the Cookley Superfund Site (NH)." *Environ. Sci. Technol.*, 40(1): 67-73.
- Keimowitz (2007). Older Landfills and Arsenic: Can Triage Assessments Help Focus Limited Resources? Presentation at the Federation of New York Solid Waste Associations 2007 Conference, The Sagamore, Lake George, NY.
- Robinson, G. R., Jr. and J. D. Ayotte (2007). Rock-Bound Arsenic Influences Ground Water and Sediment Chemistry Throughout New England, U.S. Geological Survey: 16.
- Stollenwerk, K. G., Coleman, J.A. (2003). Natural remediation potential of arsenic-contaminated ground water. *Arsenic in Ground Water: Geochemistry and Occurrence*. A. H. Welch, Stollenwerk, K. G. Boston, MA, Kluwer Academic Publishers: 351-379.

Data Sources*:
USGS, 2008; USDA NRCS, 2008
Maine GIS, 2008; Maine DEP, 2008
Projection: NAD 1983 UTM Zone 19N

* Detailed descriptions of data sources and procedures can be found in the project report, which is available upon request.

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