Bioavailability of metals and metalloids – A research overview

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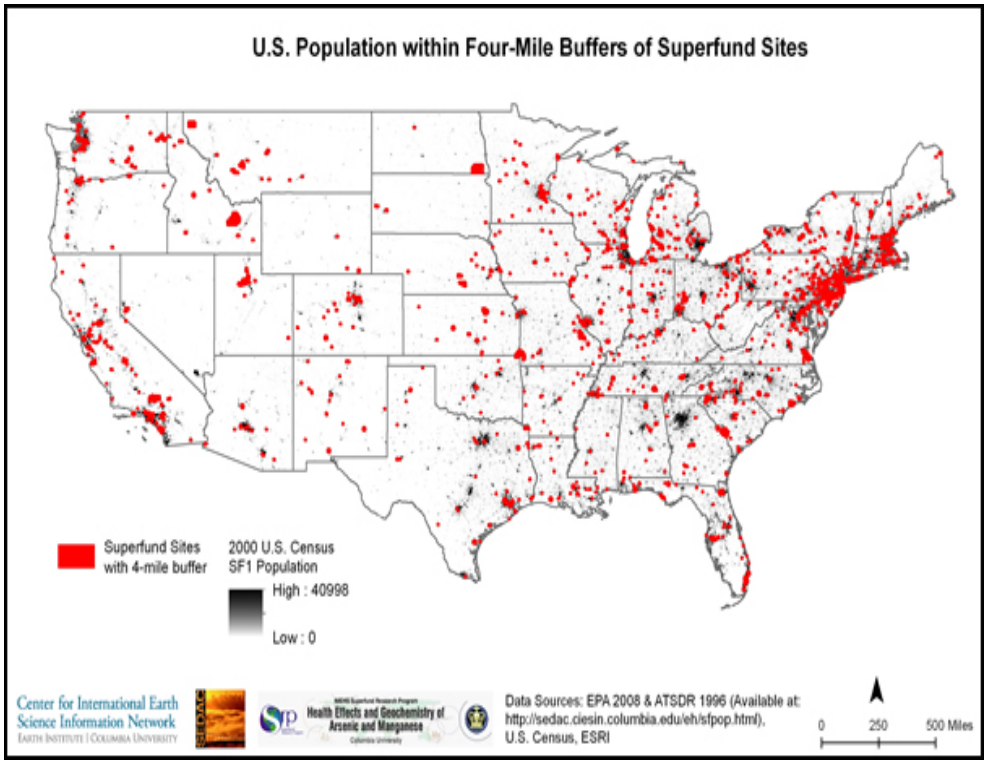
Potential exposure to toxicants at contaminated sites



2007 Priority List of Hazardous Substances

1 ARSENIC
2 LEAD
3 MERCURY
4 VINYL CHLORIDE
5 POLYCHLORINATED BIPHENYLS
6 BENZENE
7 CADMIUM
8 POLYCYCLIC AROMATIC HYDROCARBONS
9 BENZO(A)PYRENE
10 BENZO(B)FLUORANTHENE

Metals and metalloids are important contaminants with significant potential for exposure. Exposure to metals can result in long term retention and evolution of disease processes over many years. For some metals or metalloids, there may be significant variation in susceptibility over the life cycle.

Improving dosimetry for metals and metalloids present in the environment

Often estimates of dose-response relations for a given toxicant are based on the relation between the concentration of the toxicant in some environmental medium and an observed biological response. This approach does not accurately measure the true dose which will be determined by a variety of processes that relate to the transfer of the toxicant from the environmental to the receptor organism.

Measurement of the bioavailability of a metal or metalloid in an environmental medium will refine the estimate of dose and improve the accuracy of any estimated of a dose-response relation.

Ultimately, a risk assessment should include an estimate of the bioavailability of the metal or metalloid in the environmental medium of interest (e.g., a site-specific soil)

- Typically express bioavailability relative to some reference material
- Absolute Bioavailability is the ratio of the absorbed dose to the ingested dose
- Relative bioavailability is the ratio of bioavailabilities in soil and reference material
- Estimates of exposure can be adjusted for relative bioavailability

Want better (cheaper and faster) estimates of bioavailability

Approaches

In vivo

- Shared physiological properties of humans and test species
- May be costly and time-consuming

In vitro

- Extraction tests measure bioaccessible fraction
- Quick and inexpensive

Mineralogical/characterization/speciation studies

- Physical and chemical characterization
- Correlation between physical and chemical properties and estimates of bioavaiablility and bioaccessibility

CORRELATIONS ACROSS EXPERIMENTAL APPROACHES

In vivo

- Reasonably good correlation between test species (mouse, swine, monkey)

In vitro

- Method can be applied in many labs
- Good correlation between *in vivo* and *in vitro* estimates of bioavailability

Physical and chemical methods

- Properties of mineral matrix can be used to estimate bioavailability and bioaccessibility
- Approach provides rational basis for understanding differences among soils

THE FUTURE

- Bioavailability research can help refine dose estimates
- Bioavailability research reduces uncertainty by identifying sources of interindividual variation that modify risk of exposure