

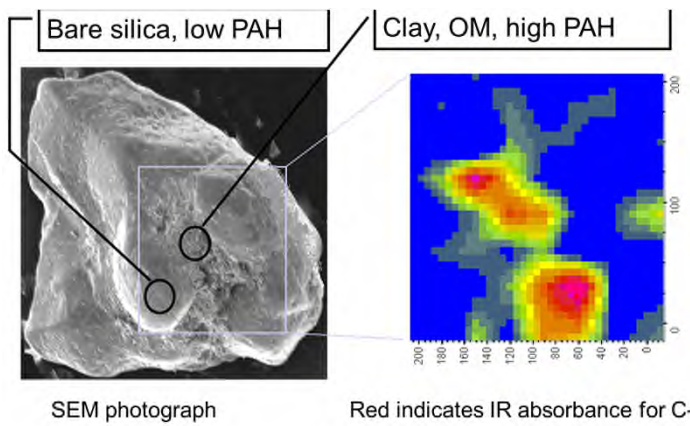
Translating bioavailability science into practice: A brief story of disruptive innovation in sediment remediation

Upal Ghosh, Department of Chemical, Biochemical, and Environmental Engineering, UMBC

Contaminated Sediment Beneficial Use Workshop, Washington, D.C; March 26 and 27, 2024



Focusing on **BIG** sediment problems



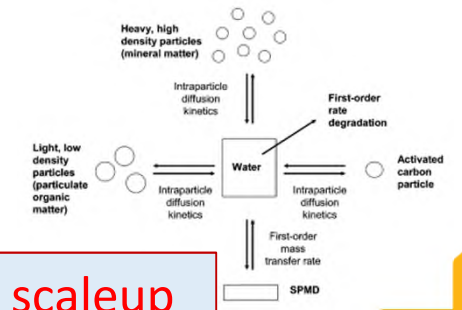
Modeling Polychlorinated Biphenyl Mass Transfer after Amendment of Contaminated Sediment with Activated Carbon

DAVID WERNER,[†] UPAL GHOSH,[‡] AND RICHARD G. LUTHY^{*,§}

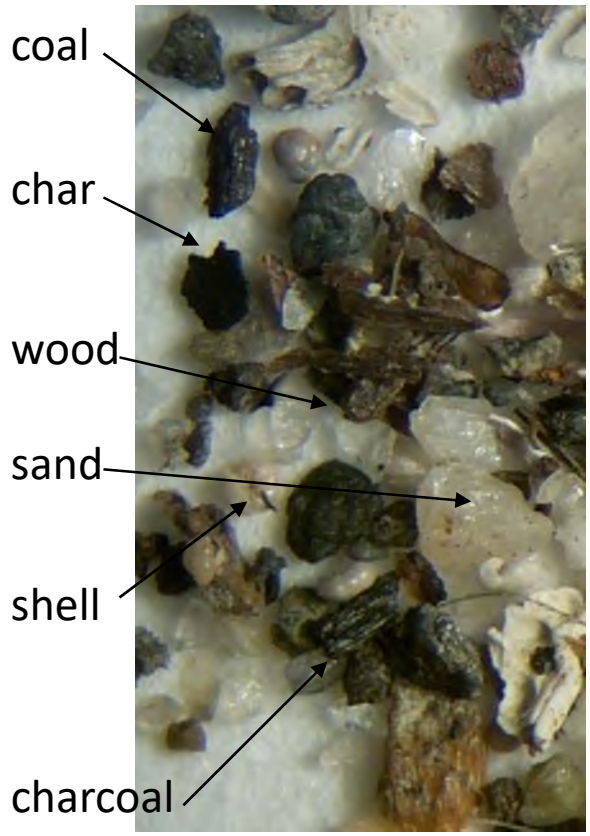
Translation through engagement with practitioners & entrepreneurship

Defining problems correctly with science

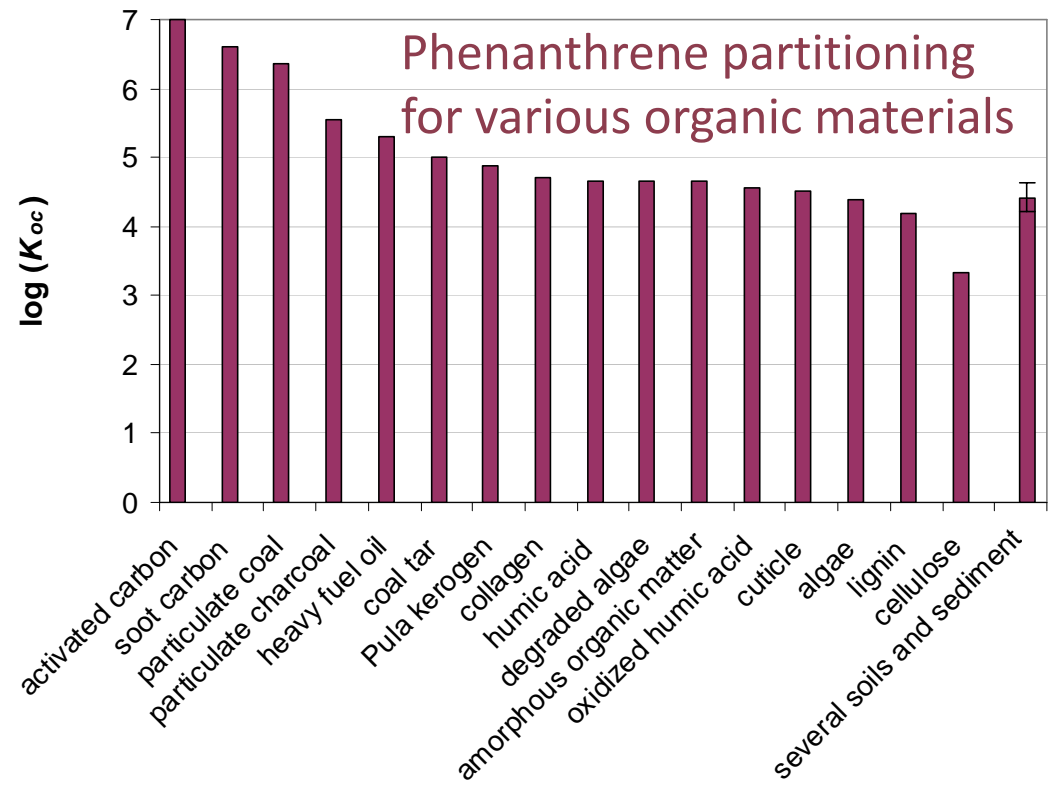
Quantitative descriptions & engr. scaleup



Pollutant sorption controls biouptake



- Science behind pollutant bioavailability was maturing two decades ago
- However, sediment remediation largely relied on disruptive sediment removal
- Key innovations:
 - Define bioavailability with appropriate metric – dissolved concentrations
 - Engineer sediment geochemistry to alter bioavailability – AC amendment

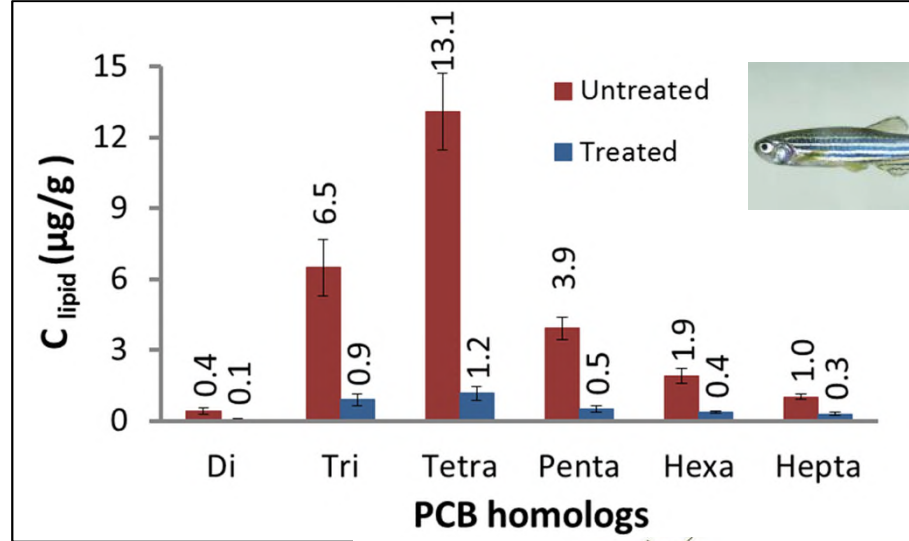
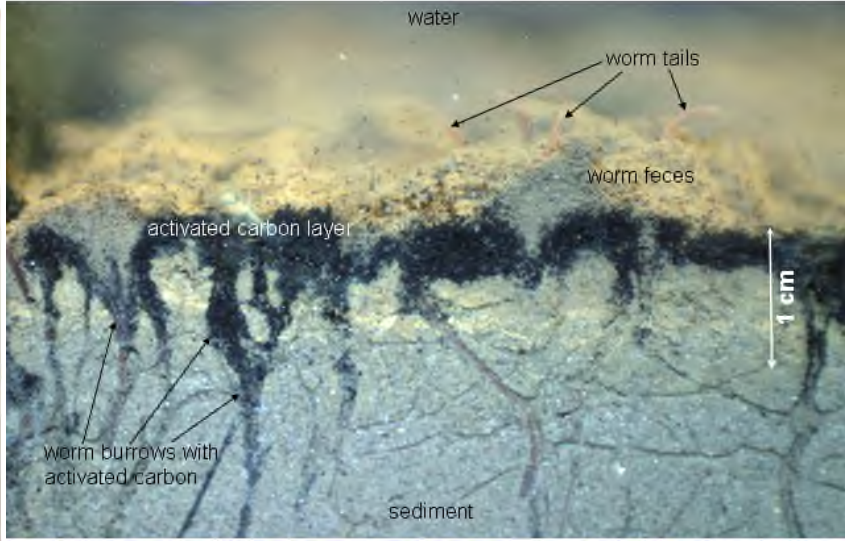


Moving from total concentration to Freely dissolved concentration as a key metric for risk assessment

Petrography images



From: Ghosh et al. Environ. Sci. Technol. 2003



- Initial laboratory studies demonstrated reduction of PCB biouptake after AC or biochar amendment
- Surface application is worked into sediments through bioturbation
- Reduction translates up the food web to fish
- Led to several pilot-scale demonstrations

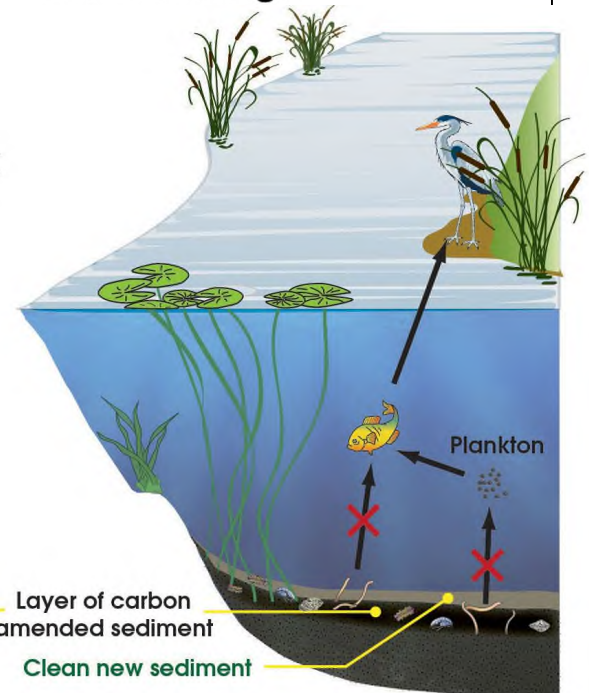
Need to explain empirical observations mechanistically and quantitatively through modeling



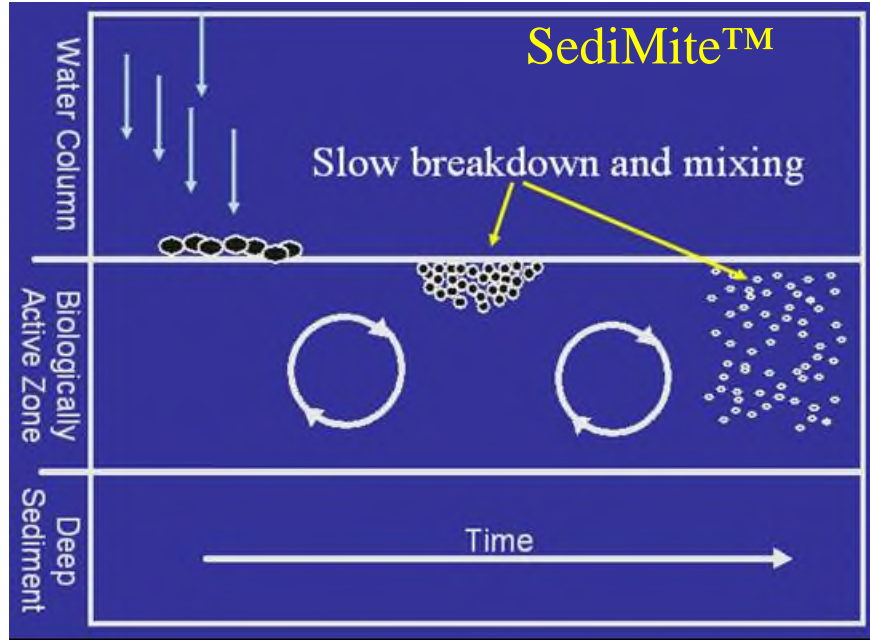
Effect of PCB Bioavailability Changes in Sediments on Bioaccumulation in Fish
 Hilda Fadaei,[†] Aaron Watson,[‡] Allen Place,[§] John Connolly,^{||} and Upal Ghosh^{*†}



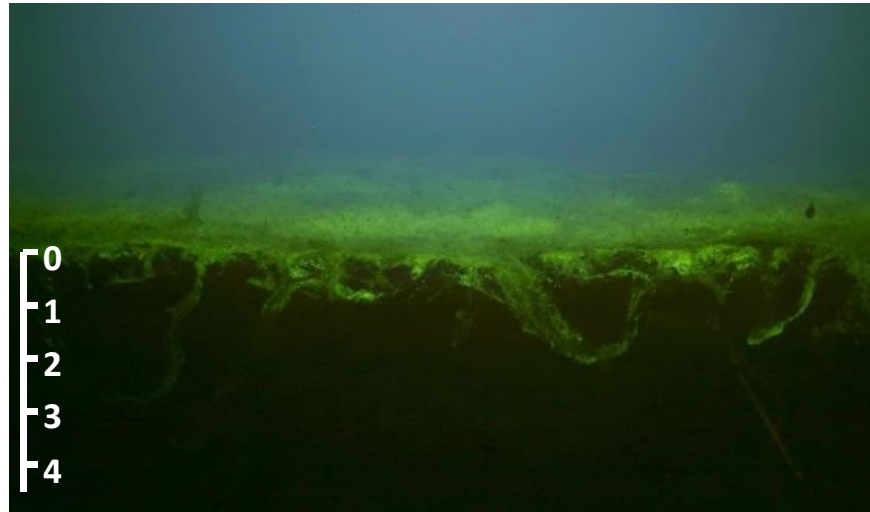
In-situ Sorbent Amendments: A New Direction in Contaminated Sediment Management[†]
 Upal Ghosh^{*}
 University of Maryland Baltimore County, Baltimore, Maryland 21250, United States
 Richard G. Luthy
 Stanford University, Stanford, California, United States
 Gerard Cornelissen
 Norwegian Geotechnical Institute, Oslo, Norway; University of Life Sciences, Ås, Norway; Stockholm University, Stockholm, Sweden
 David Werner
 Newcastle University, Newcastle upon Tyne, United Kingdom
 Charles A. Menzie
 Exponent, Alexandria, Virginia, United States



SCALE UP: EPA-SBIR; SERDP/ESTCP; NIEHS

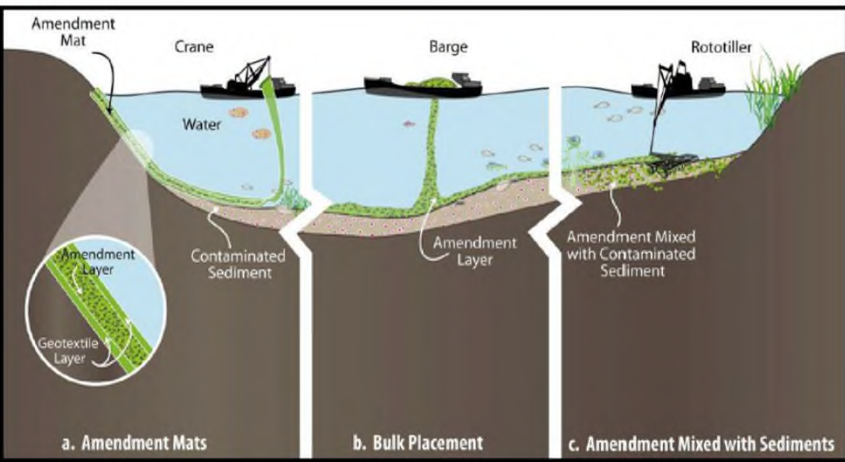


1. Agglomerates delivered from water
2. Sinks to sediment surface and resists resuspension of fine AC
3. Breaks down slowly; mixed by bioturbation
4. Binds contaminant and reduces uptake in the aquatic food web
5. Opens new opportunities for both:
 - In-situ management of contaminated sediments
 - Beneficial use of contaminated dredged sediments



Use of Amendments For In-situ Remediation Of Superfund Sediment Sites

USEPA OSWER Directive 9200.2-128FS; April 2013



Paradise Creek, Norfolk, VA, 2022



Grasse River, NY



EPA and MPCA Announce \$6M Sediment Cleanup in the St. Louis River Area of Concern in Scanlon, Minnesota

August 23, 2021
 Contact Information
 Taylor Gillespie (tgillespie.taylor@epa.gov)
 812-276-3635

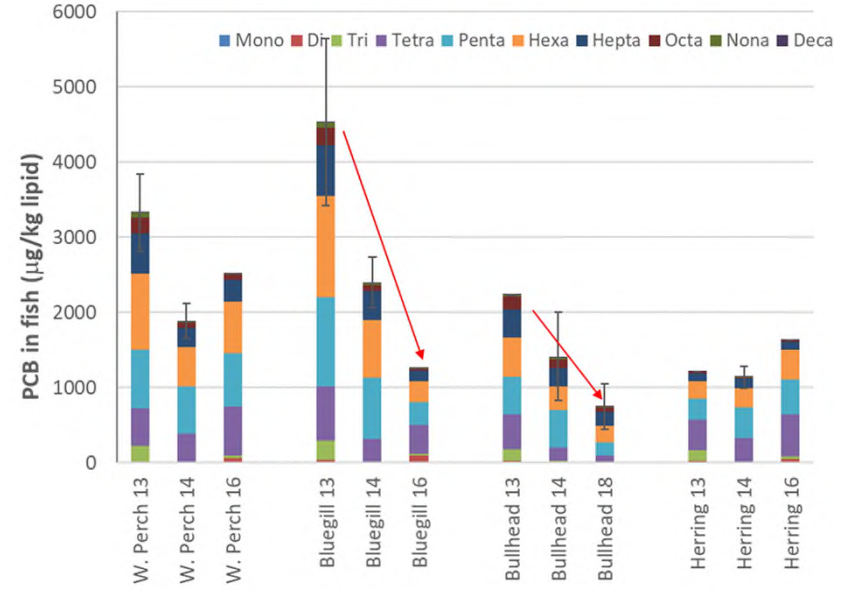
CHICAGO (August 23, 2021) - U.S. Environmental Protection Agency and Minnesota Pollution Control Agency have signed a \$6 million agreement to address and clean up contaminated sediment in the Scanlon Reservoir in Scanlon, Minnesota. Slated to begin this fall, the project will employ new remediation technologies to improve the habitat for fish and wildlife.

"Our long-standing partnership with MPCA is crucial to cleaning up and restoring the St. Louis River area of concern," said acting EPA Regional Administrator Cheryl Newton. "We're committed to restoring the Great Lakes and preserving this incredible resource for future generations."

Under the project agreement, MPCA will contribute up to \$2.1 million of the total estimated project cost of \$6 million and EPA will fund the rest. The U.S. Army Corps

EPA researchers prepare to take samples at Scanlon Reservoir to understand environmental conditions. Photo credit: U.S. Environmental Protection Agency

Mirror Lake, DE



An enabling environment where new approaches can be tested for improved problem definition and solution

"a thin layer of carbon applied across 14 acres"