MONTCLAIR STATE UNIVERSITY

BROOKHAVEN NATIONAL LABORATORY

DOE- BNL Visiting Faculty Program Colloquium

Urban Coastal Environmental Contamination and Restoration Study for Sustainable Development

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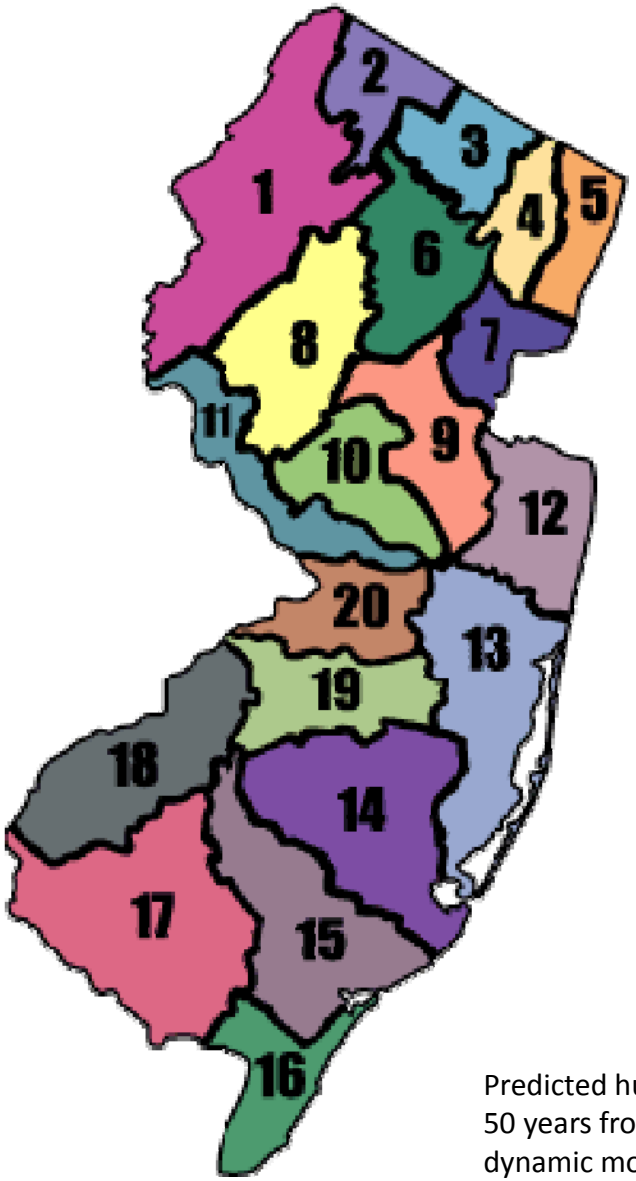
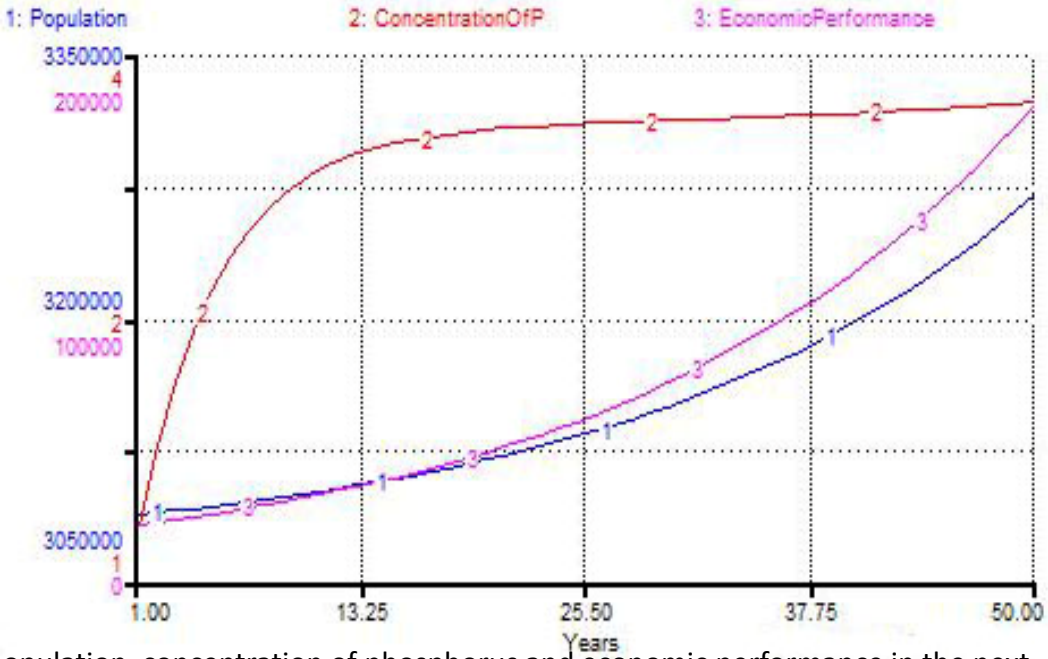
Collaborator: Michael McGuigan

Program Manager: Noel Blackburn

June 29, 2015

New Jersey Watershed Management Area, USA

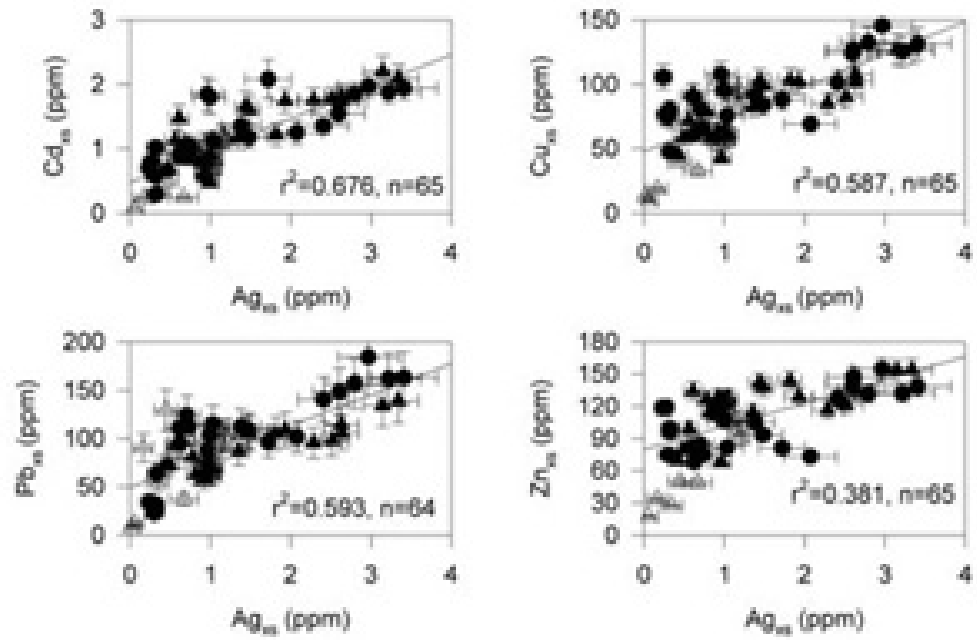


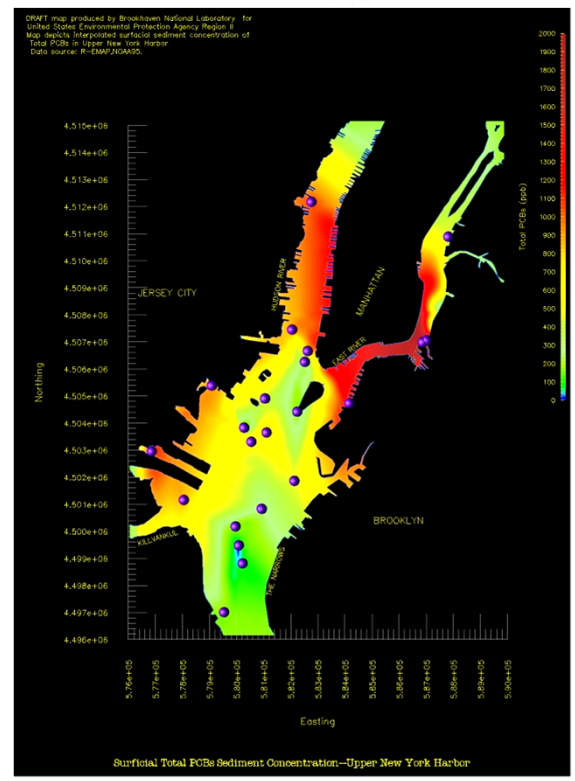


Predicted human population, concentration of phosphorus and economic performance in the next 50 years from 1987 in northern New Jersey (WMAs 4-7). The results are generated by a system dynamic model developed in this study. Data used in this model are from various available sources with some arbitrary assumption.

Coastal Pollution

NY/NJ Harbor, USA



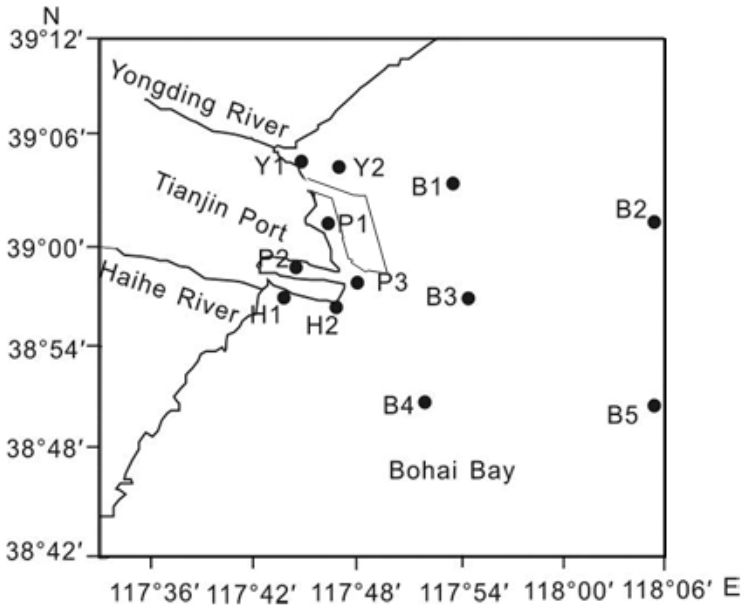


Right: PCB in NY/NJ Harbor Sediments.

Tianjin -China

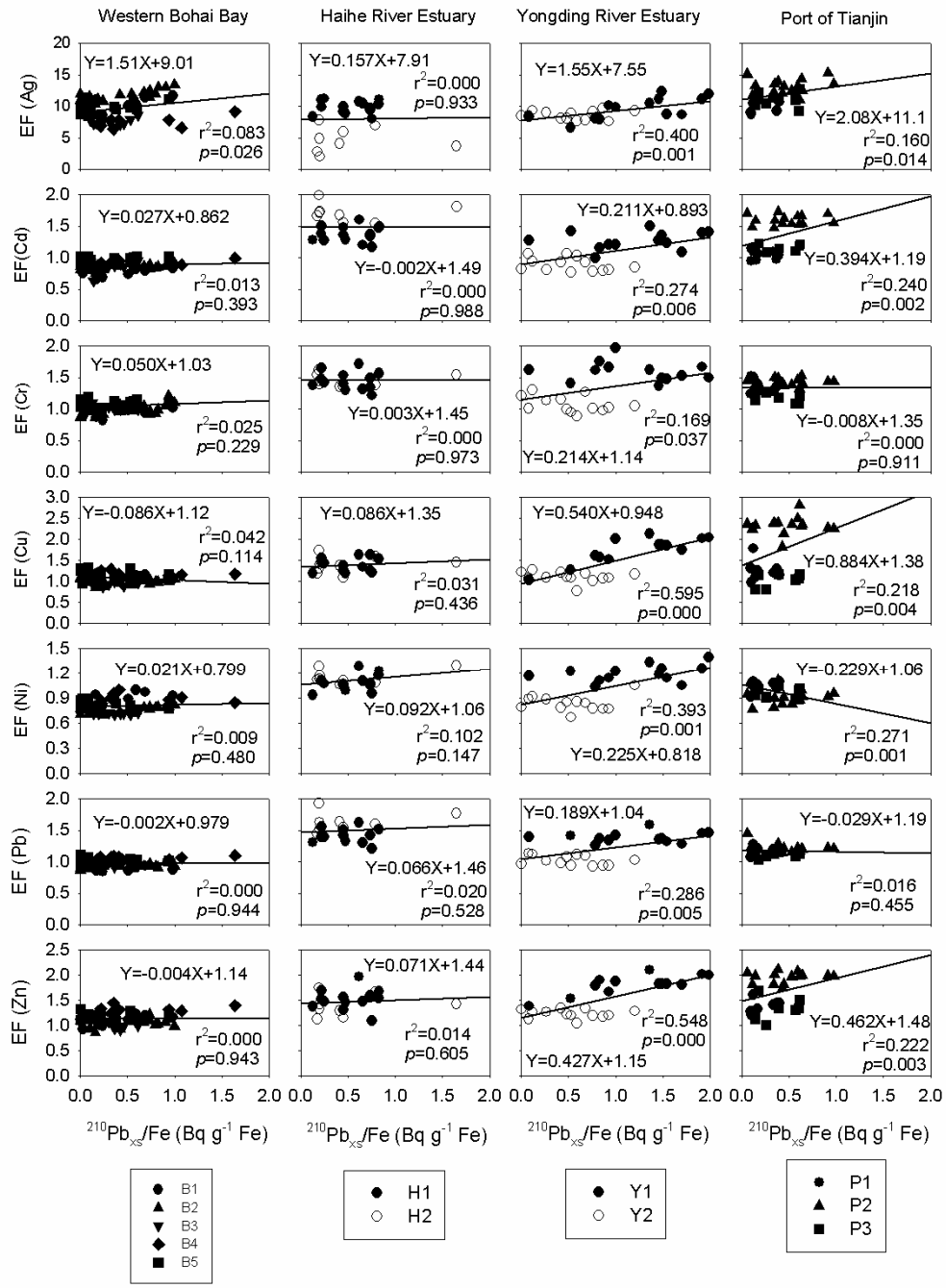
Shopping Street

Western Bohai Bay, China



$$EF = \frac{\left(\frac{Me}{Fe}\right)_{Sample}}{\left(\frac{Me}{Fe}\right)_{Background}}$$

- If 0.5≤ EF≤1.5, natural weathering processes
- If EF>1.5, non-natural weathering processes.

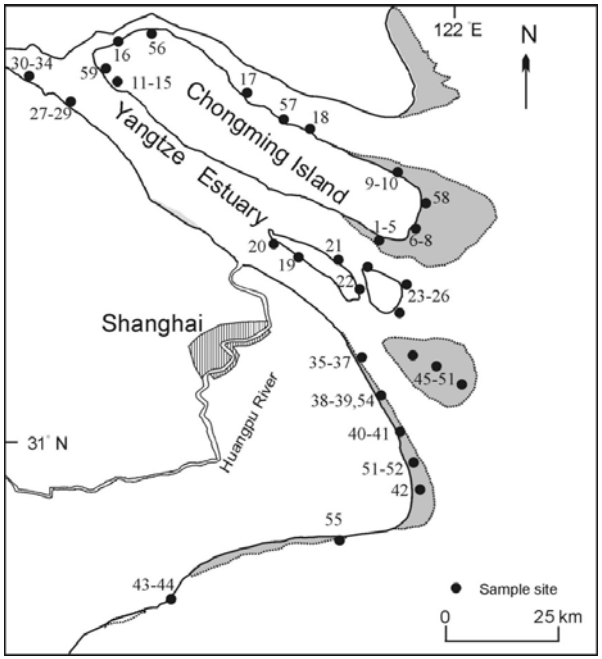


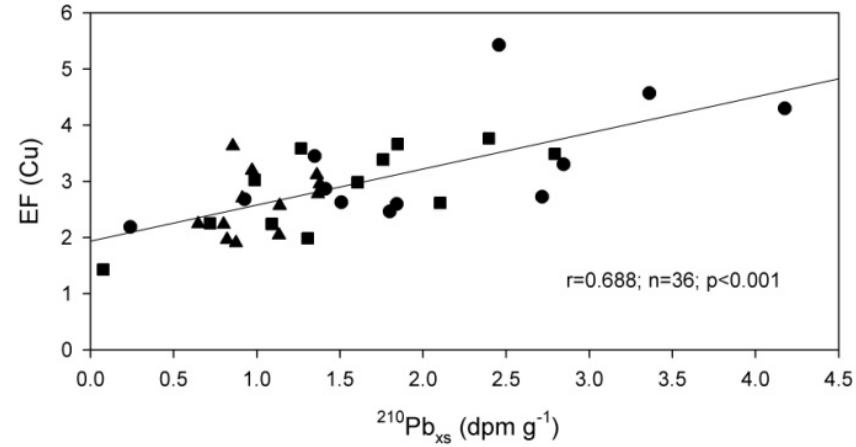
Urbanization and Economic Development in Shanghai, China

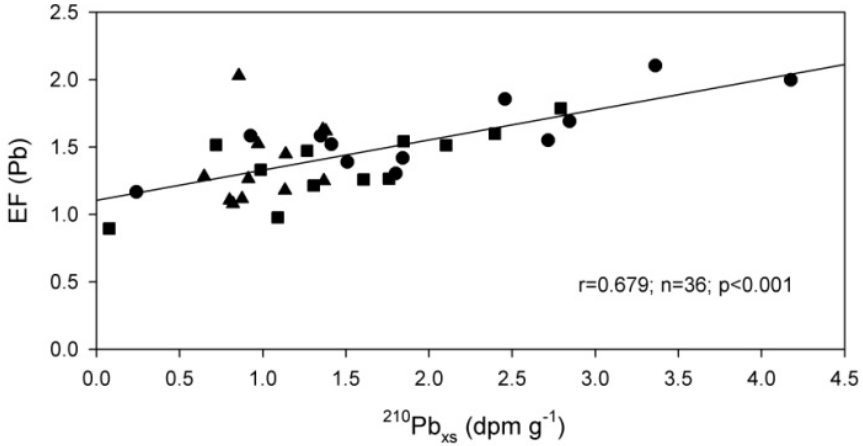
East China Normal University Campus and its vicinity in Shanghai

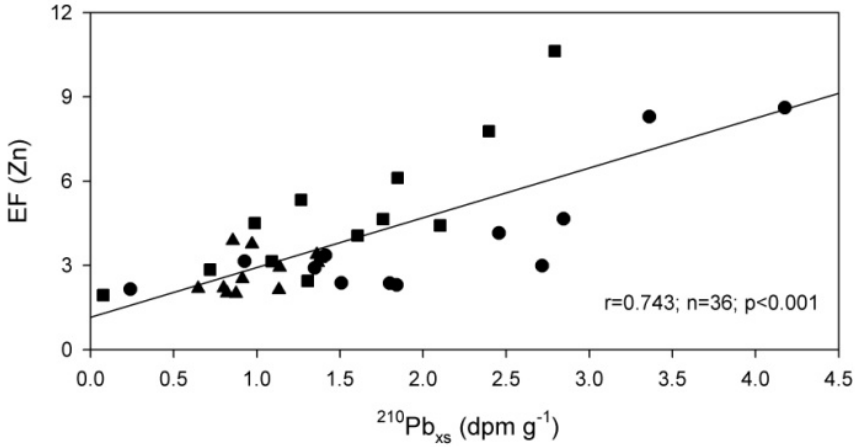
Coastal Pollution

Yangtze River intertidal zone



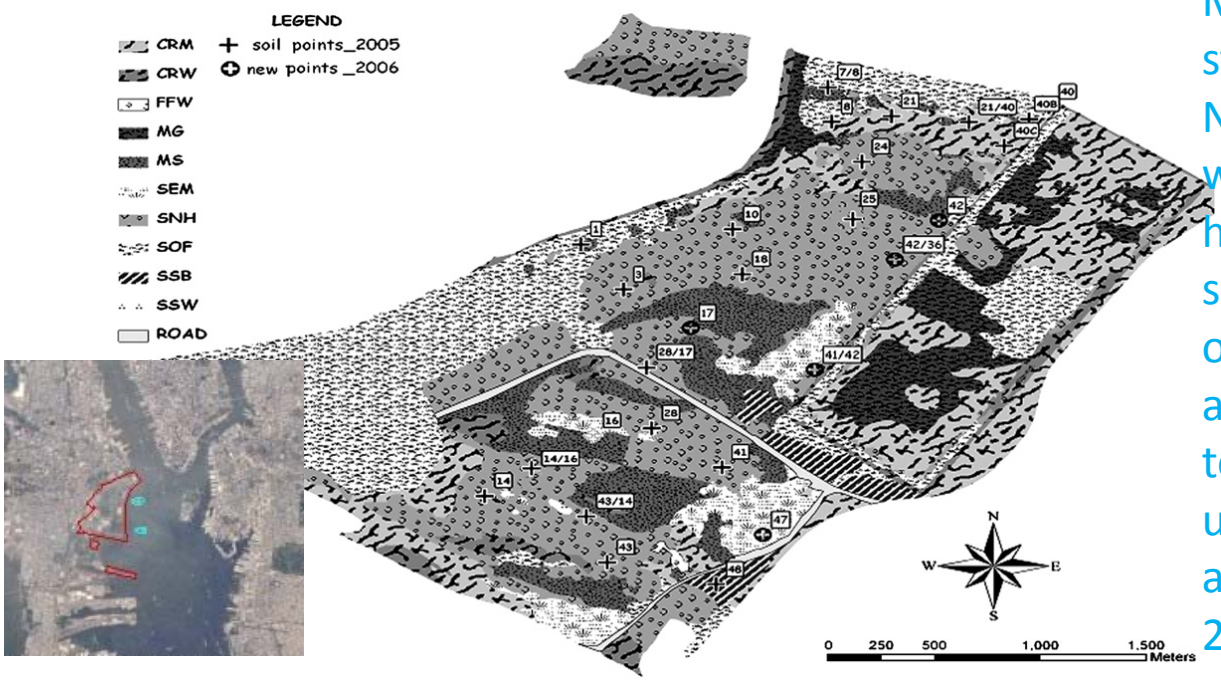






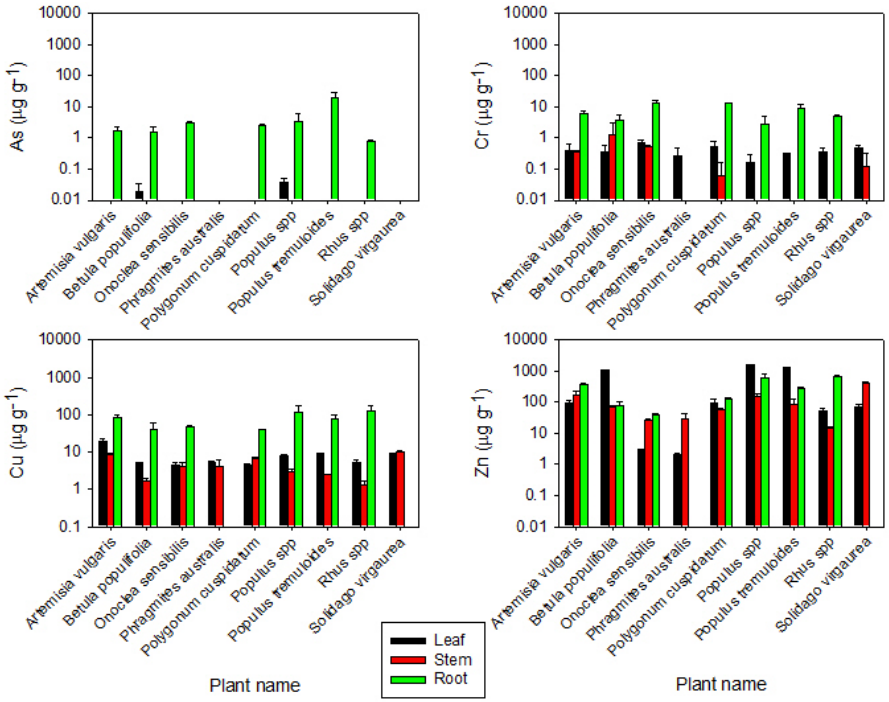
Objective: Remediation of Contaminated Sediments

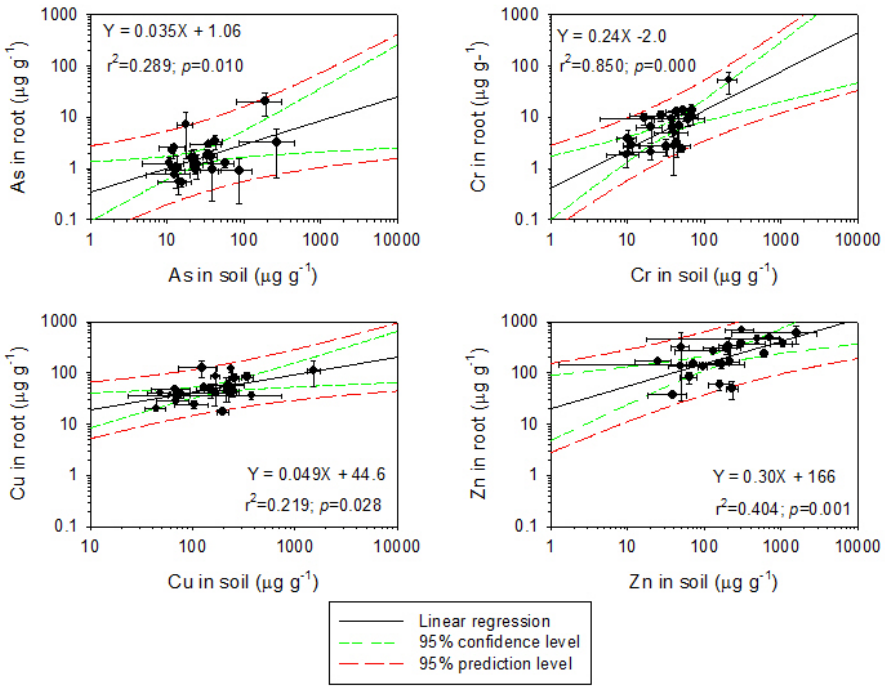
- Coastal urban sediment metal contamination is both environmental and social concerned.
- Wetland plant metal assimilation is a major flux of transporting metals from sediments to biota.
- A good knowledge of plant uptake and translocation of metals in the rhizosphere is essential to understand wetland plant ecological function of metal removal.



Map showing Liberty State Park study site. Liberty State Park, New Jersey is a brownfield site, where is historically polluted by human activity. The dominant species that grow in the wetland of Liberty State Park showed ability to tolerate high level of toxic metal of the site, and to uptake heavy metal into root and shoot (Gallagher et al., 2008).

Results





Comparisons of metal (As, Cr, Cu and Zn) uptake by plant leaves, stems and roots of selected predominant plant species in the study site. The results indicate the metals are mainly accumulated in the plant roots. (Qian et al. 2012)

Significant correlations of metal (As, Cr, Cu and Zn) concentrations between the soils and the plant roots. The results indicate the ability of plant uptake of metals from the metal contaminated soils.

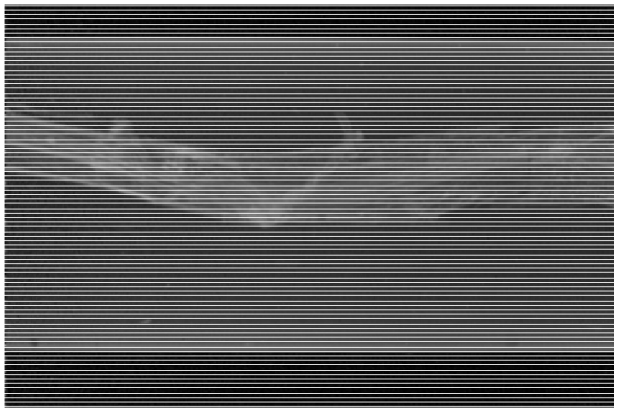
Brookhaven National Laboratory

National Synchrotron Light Source

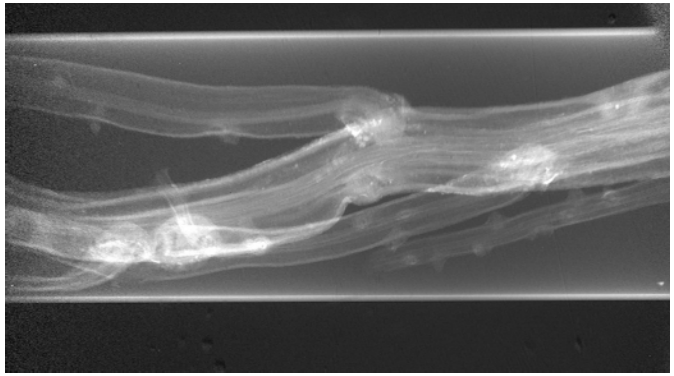
Micro-scale high resolution study

Synchrotron X-ray Computed Tomography

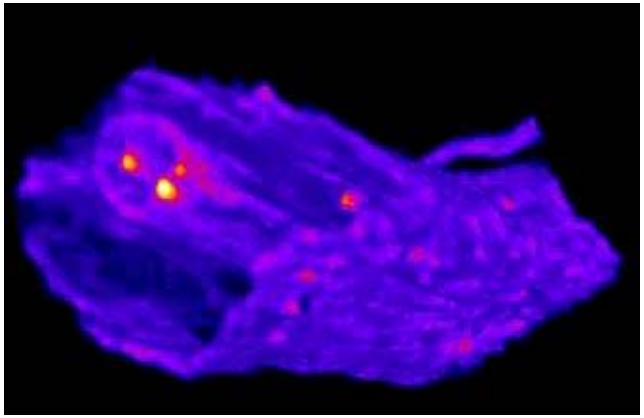
Typha latifolia

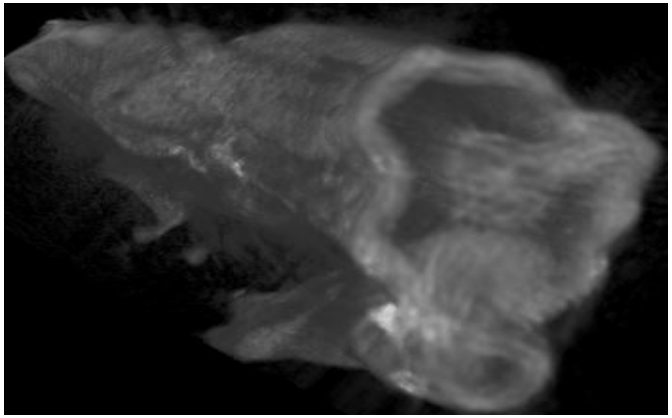


Phragmites australis



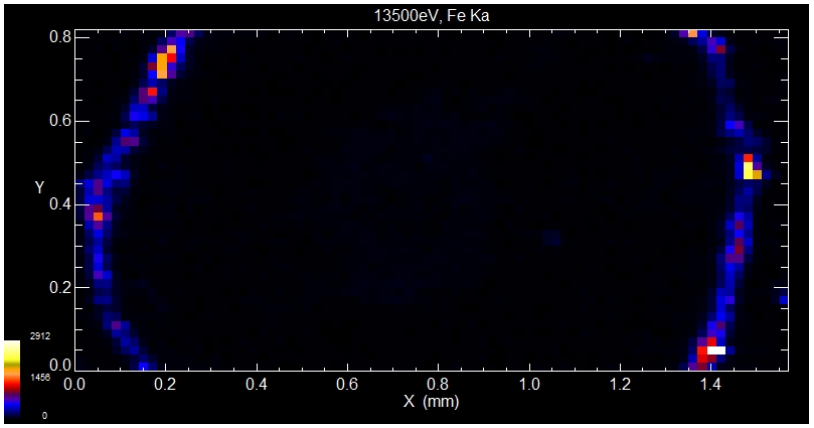
Synchrotron X-ray image



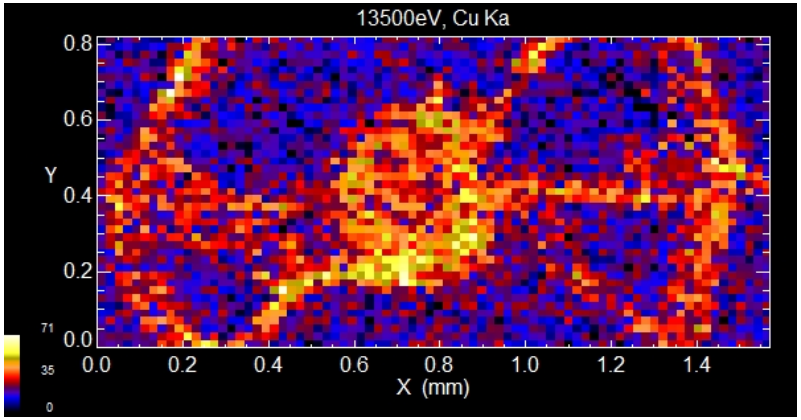


Reconstructed image

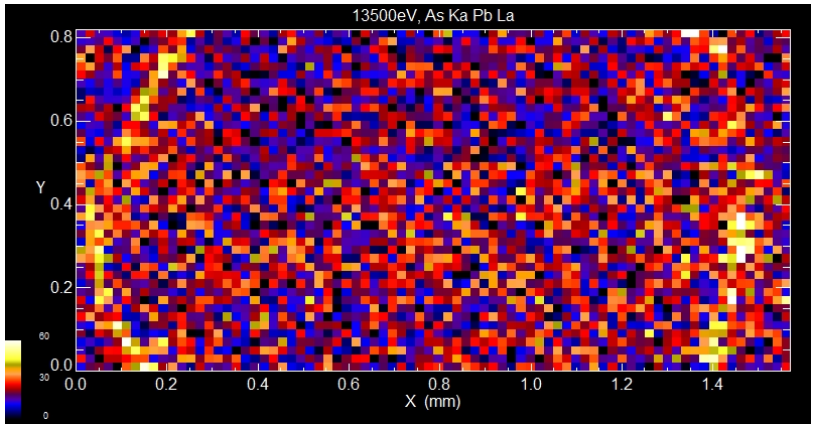
Fe



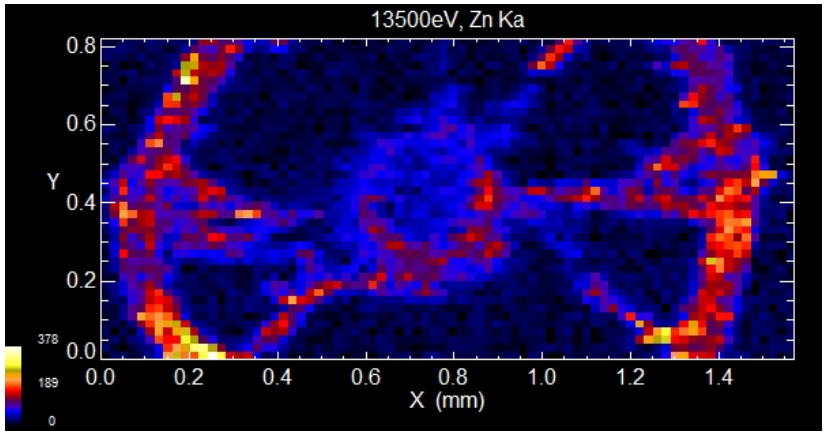
Cu



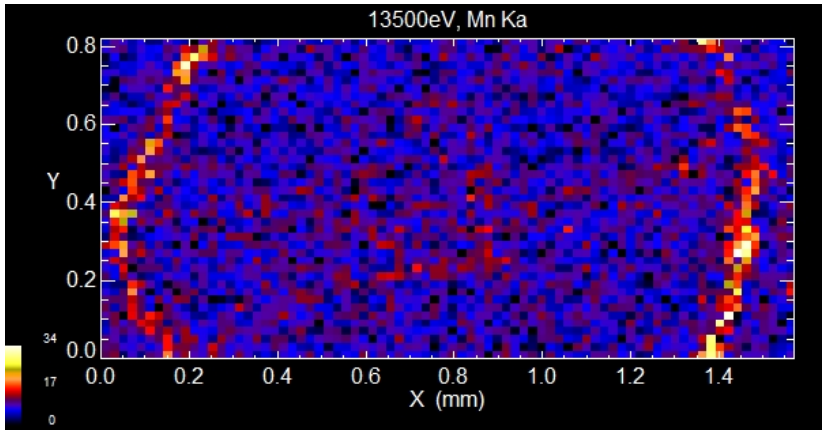
Pb



Zn

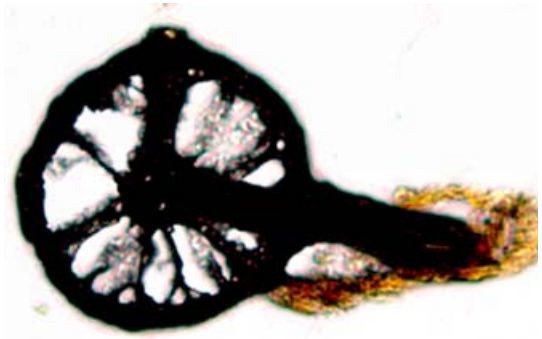


Optical image of a root cross section of *Phragmites australis*, and metal (Fe, Pb, Mn, Zn and Cu) distributions in the root cross section. Resolution = 10 µm. (Sample #: 43P_A_M, LSP)

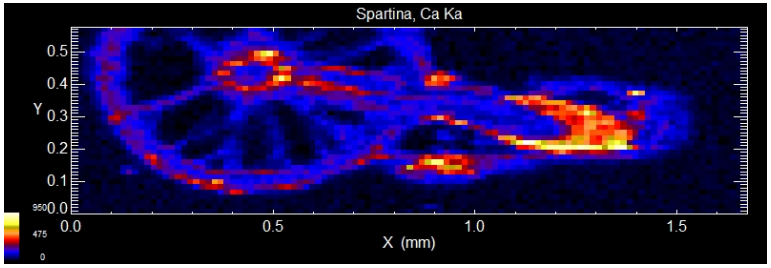


Mn

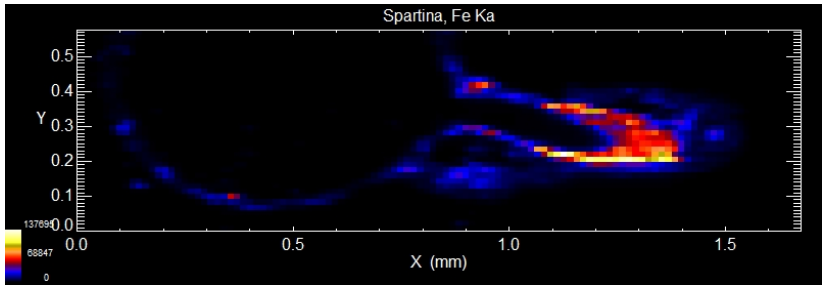
Spartina alterniflora from Yangtze River Intertidal Zone



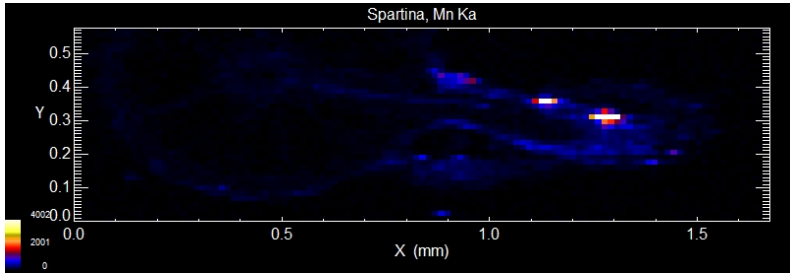
Ca



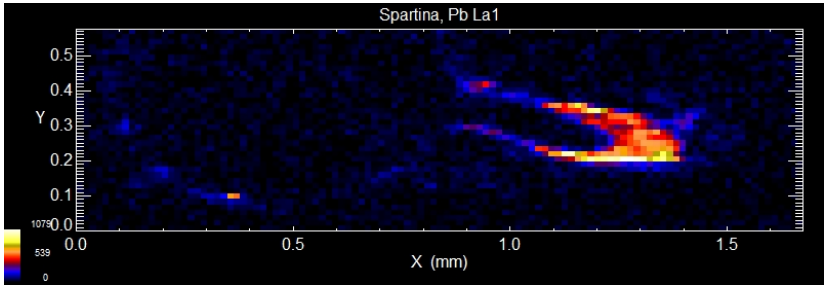
Fe



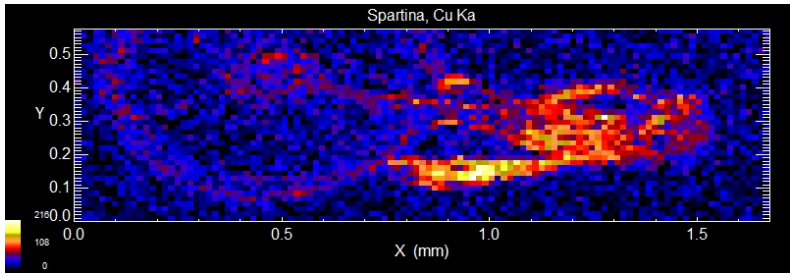
Mn



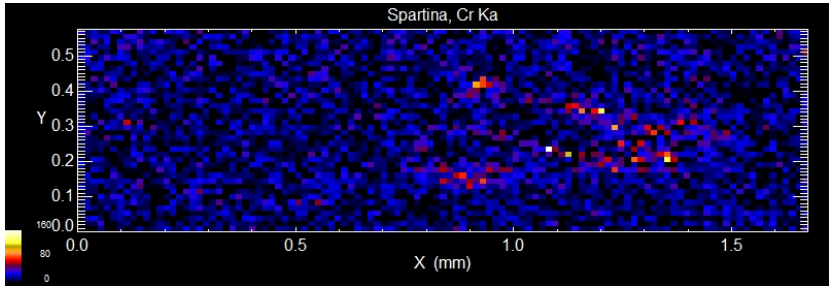
Pb



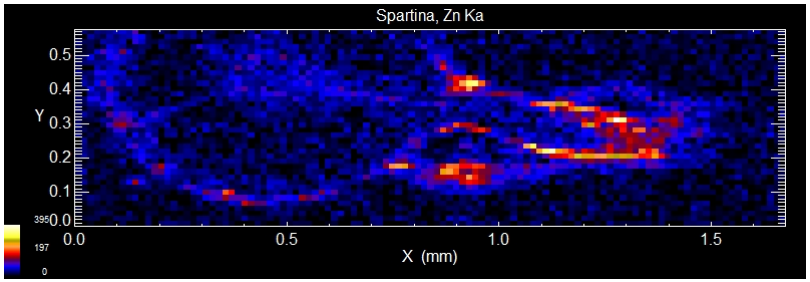
Cu



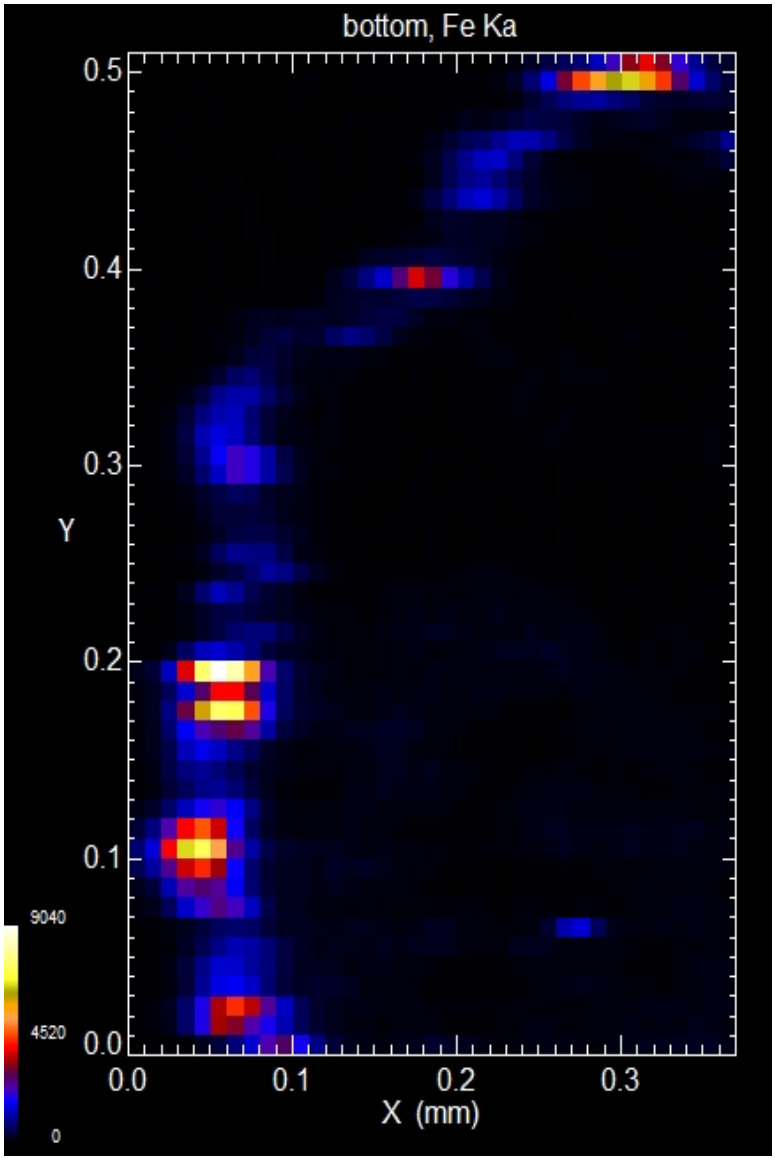
Cr

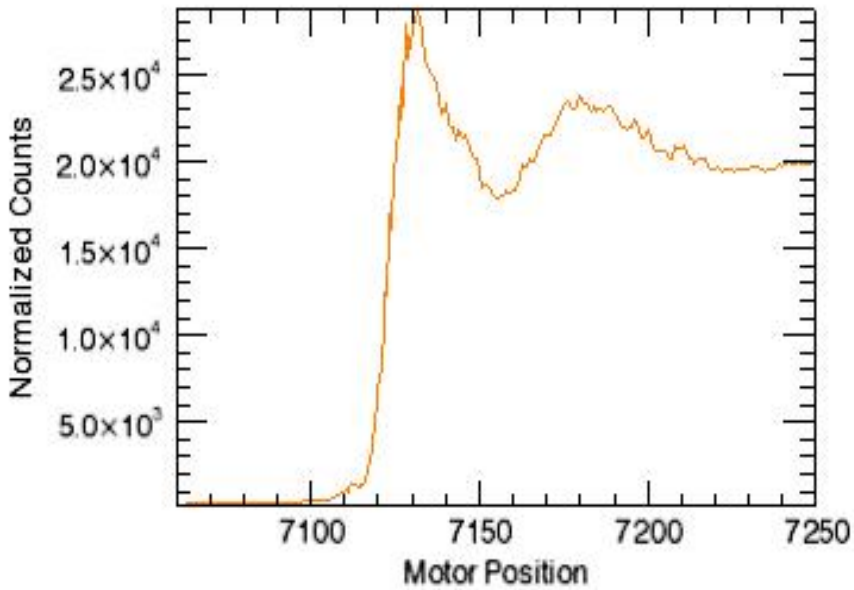


Zn



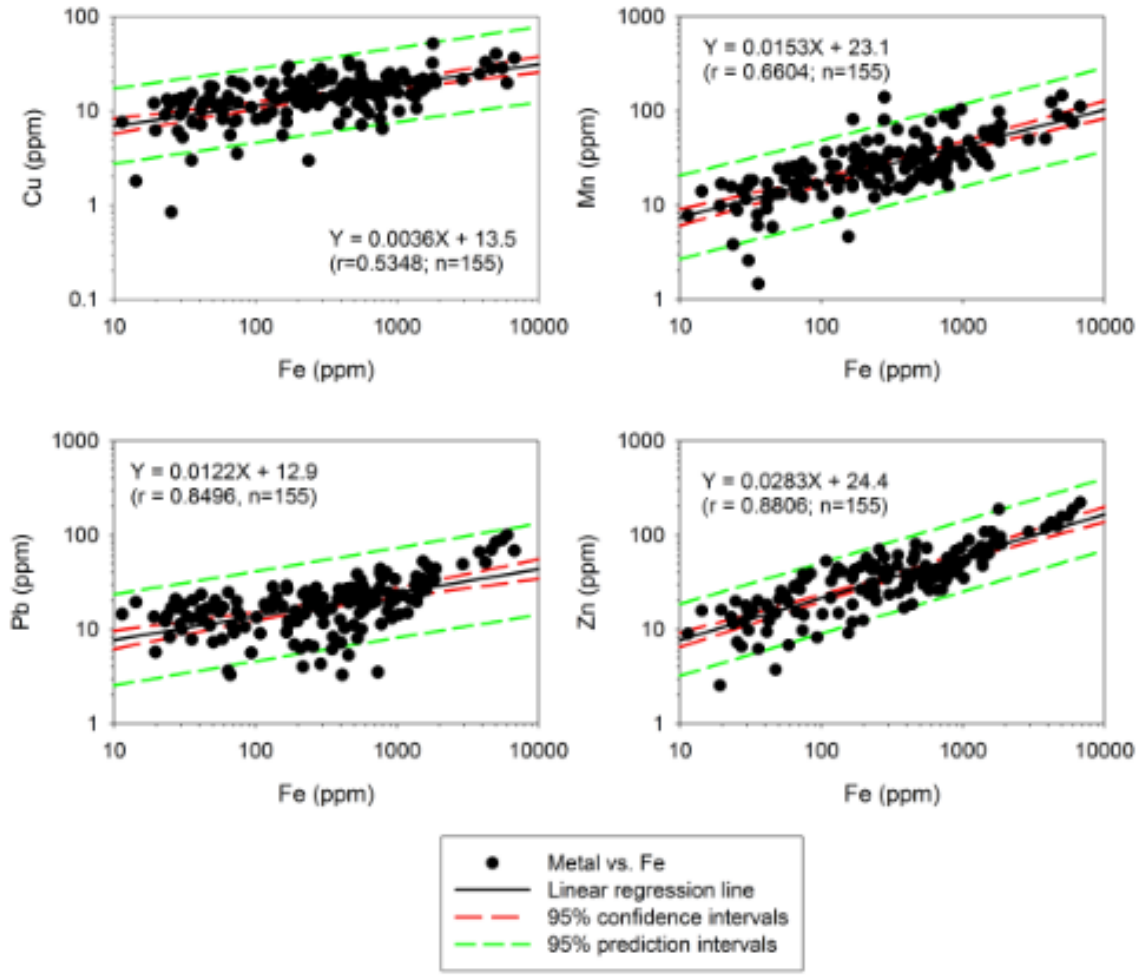
Synchrotron XANES Measurement





- (**Left**) Accumulation of Fe in *Typha latifolia* root thin section (30 µm) was measured by synchrotron XRF technique. Pixel size is 10 µm; and (**Above**) Graph showing Fe XANES diagram on a single spot (10 µm x 10 µm) in epidermis of *Typha latifolia* root thin section. Refer to NIST Reference Standard Materials (SRM), the oxidation state of Fe is ferric iron (Fe^{3+}) based on the pre-edge (7124 eV) showing in this Fe XANE diagram.

Function of Fe plaque in metal scavenge in the root epidermis



Relationship of Cu, Mn, Pb and Zn with Fe in the epidermis of *Typha latifolia* root collected at Site TP-1 in LSP. Significant correlation between metals (Cu, Mn, Pb and Zn) and Fe indicates metal scavenge by Fe plaque and formation of Fe-Mn oxides.

Conclusion

- Plants can be used to remediate metal contaminated surficial sediments through phytoextraction;
- Uptake and translocation of metals by plants are both metal and plant species dependent;
- Iron plaque can form on surface of the plant root in rhizosphere, scavenge other metals and affect metal transport inside the root tissue;
- Synchrotron radiation measurement is an effective technique for micro-scale study.

Acknowledgement

Support

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Mentors / Collaborators

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Thank You!