Remediating Salt-Contaminated Sites in Canada Using Phytotechnologies

Barbara Zeeb (zeeb-b@rmc.ca), Logan Morris, Amelie Litalien and Kassandra Yun (Royal Military College of Canada, Kingston, ON, Canada)
Allison Rutter (ruttera@queensu.ca) (Analytical Services Unit, Queen's University, Kingston, ON, Canada)

Background/Objectives. Cement kiln dust (CKD) is a high salinity byproduct (waste material) from the cement production process generated during the heating of raw materials in cement kilns. The dominant salt ions are potassium (K^+) and chloride (Cl^-). CKD is not considered a hazardous waste in Canada, and as salt is not a regulated contaminant, landfills and their saline leachate are free to impact surrounding environments. Halophytes make up only ~1% of the world's terrestrial flora and utilize a variety of mechanisms to tolerate high salinity environments. The mechanism employed by 'recretohalophytes' involves the use of specialized salt glands to excrete salts onto plant stem and leaf surfaces in processes that are not yet fully understood. It has been theorized that wind could continuously mobilize excreted salts from recretohalophytes into the air and move them away from a site of contamination to areas of lower salt concentration. This proposed theory of 'haloconduction' has yet to be demonstrated in the scientific literature. The objectives of this study were to characterize excreted salts and evaluate the efficacy of using haloconduction as a remediation technique at an industrial cement plant in Bath, ON where CKD was landfilled over a period of 30 years.

Approach/Activities. Two native, recretohalophytic grasses, *Distichlis spicata* and *Spartina pectinata* were identified, and experiments to quantify the amount of salt they excreted were carried out in greenhouse trials as well as in experimental plots in the field. X-ray dispersive scanning electron microscopy was undertaken to characterize the size and density of salt particles on plant surfaces. In addition, three salt collection methods were developed and installed in the field to test their efficacy for capturing and measuring windborne salt mobilized from plant surfaces.

Results/Lessons Learned. Under ideal conditions in the laboratory, measurements of salt excreted by large (>15 shoots and >50 cm height) plants of each plant species were 280 ± 164 g/m^2 and 164 ± 75 g/m^2, respectively, resulting in potential remediation timeframes of 1.4 ± 0.9 and 2.4 ± 1.1 years for the site in Bath, ON. It was determined that the salt crystals excreted by *S. pectinata* were significantly smaller than those excreted by *D. spicata*, and *S. pectinata* also excreted significantly more salt crystals per unit area of plant surface than *D. spicata*. All three salt collection methods (two ground-level and one at 260 cm height) employed were successful in capturing and quantifying airborne salts at distance from the experimental plots. This study is the first to collect and quantify dispersed salt from recretohalophytes and hence confirm the theory of haloconduction. The data collected can now be used in particulate dispersal modelling systems to help determine the fate of the excreted salts once they become airborne by wind.