Hazards of Soluble Mineral Dust Components

R. Scott Van Pelt – USDA Agricultural Research Service, Big Spring, TX - scott.vanpelt@usda.gov
Guoming Zhang – Beijing Normal University, Beijing, P.R. China

Introduction

- Salt flats and dry lake beds are common features of dryland regions globally
- Accumulation of soluble salts results from interior drainage and evaporation of runoff containing weathering products from geological exposures
- Post development in affected watersheds for agricultural production runoff also contained pesticides, fertilizer contaminants, and other agricultural wastes
- The soluble salts may and often do contain toxic elements
- Surface salts near sandy beach areas during dust events are abraded by beach sand to produce clouds of mineral dust with soluble potentially toxic salts
- In addition to toxic elements, the dust clouds my obscure visibility and create hazards to transportation and commerce
- Finally, some drying and ephemeral lake beds contain appreciable amounts of lithium, ensuring near-future disturbance

Methods

- Stainless steel soil pans 14 X 77 X 1.3 cm were filled with 2 kg of sieved Harkey clay loam soil and rolled to a bulk density of 1.40 to 1.45 g cm^{-3}
- Soil-filled trays were wetted from the bottom to settle the soil and begin formation of structural elements
- Pans were subsequently wetted from bottom with brine solutions to allow surface evaporation and creation of an efflorescence
- Pans were dried in a ventilating oven at 60^{o}C and tested in a wind tunnel with a sediment sorting and capture system at a centerline velocity of 12 m s^{-1} for 20 minutes
- Loss of sediments smaller than the #40 abrader sand were weighed to determine erodibility of the soil surface and very fine sediments collected on glass fiber filters were leached to determine the soluble portions
- Data from four replicates of each salt were analyzed using PROC GLM in SAS and means were separated using Ryan's Q

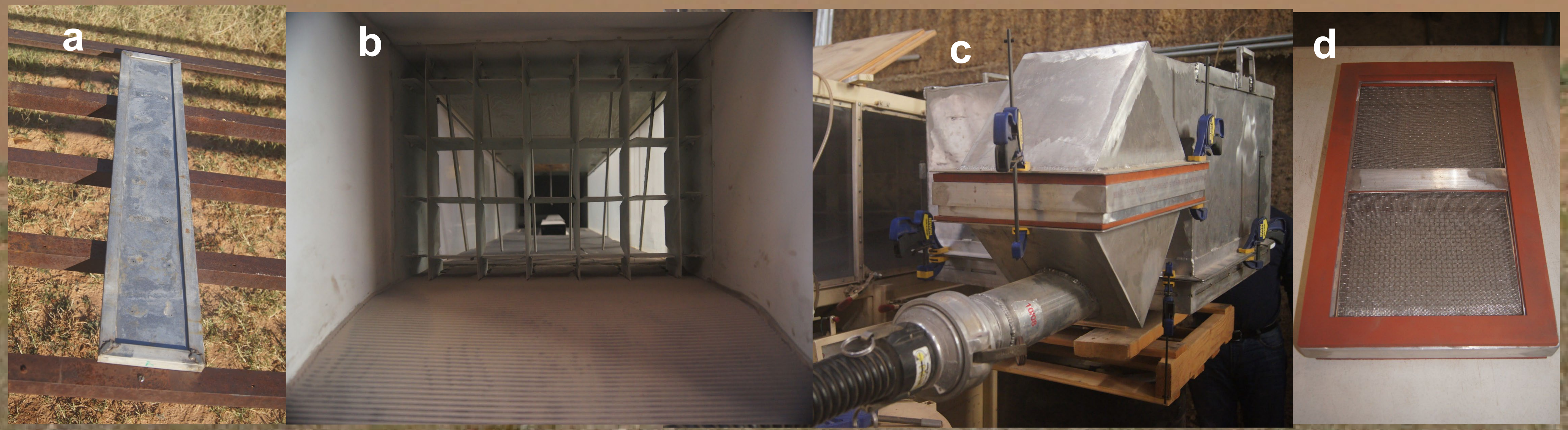

Fig. 1. Stainless steel soil pan (a), wind tunnel showing abrader drop tubes (b), dust settling chamber and filter aspirator shell (c), and filter cassette (d).

Results

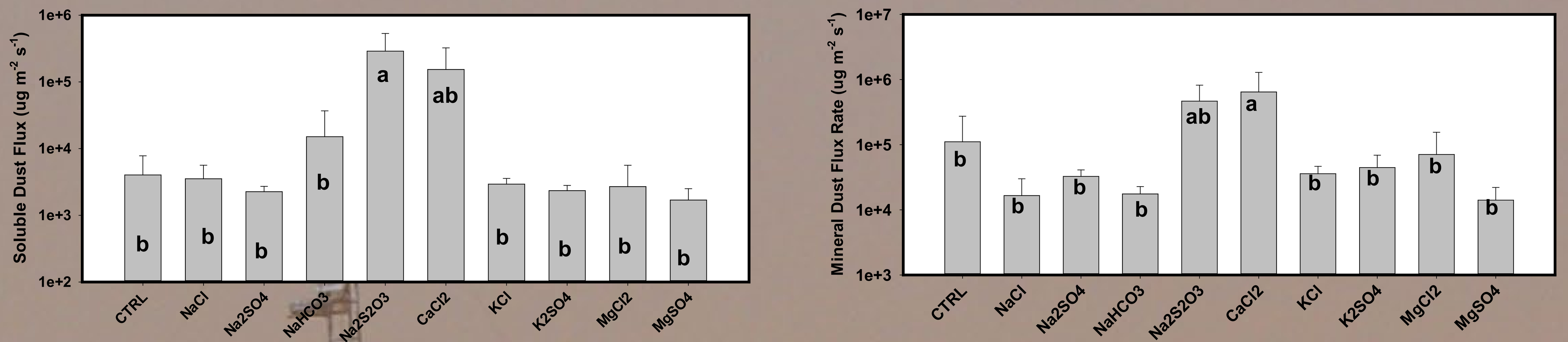

Fig. 2. Mean total (left) and soluble (right) dust flux rates and standard deviations

- Seven of the nine salts tested resulted in reduction of dust emissions, both soluble and insoluble, when compared to the untreated control
- The untreated control emitted mineral dust and soluble salt dust (110935 and 4026 μg m^{-2} s^{-1}, respectively)
- Soil treated with$MgSO_4$ had the lowest dust and soluble salt flux rates (14083 and 1694 μg m^{-2} s^{-1}, respectively)
- $CaCl_2$ emitted the greatest flux of mineral dust (646331 μg m^{-2} s^{-1}) of which nearly ¼ was soluble salt (153776 μg m^{-2} s^{-1})
- $Na_2S_2O_3$ Emitted the second greatest flux of mineral dust (467117 μg m^{-2} s^{-1}) of which nearly 5/8 was soluble salt (289110 μg m^{-2} s^{-1})

Future Work

- Repeat experiment with complexes of sodium, Calcium, and Magnesium salts consistent with irrigation with water from depleted Ogallala aquifer water with different target salinities and also sodium salts to create soils with different sodicities
- Field testing of naturally salinized soils and sodic soils if available with a Portable In-Situ Wind Erosion Laboratory (PI-SWERL) along with sediment capture appliance (Fig. 3.)

Fig. 3. PI-SWERL with sediment capture appliance: PI-SWERL and cart in field mode (a), downward look at PI-SWERL footprint (b), and detail of port overlap (c).