Characterization of surface dust emission potential using a Portable In-Situ Wind Erosion Laboratory (PI-SWERL) for numerical modeling applications

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PI-SWERL

- **Portable In Situ Wind Erosion Lab**
- **Measures PM-10 dust emission potential from natural surfaces**
- **Turn-key device, easy to move, minimal setup, operated by one person**

Figure 1: Portable In Situ Wind Erosion Lab (PI-SWERL). Image by Desert Research Institute

Etyemezian et al.: The Portable In Situ Wind Erosion Laboratory (PI-SWERL): A new method to measure PM10 windblown dust properties and potential for emissions, Atmos. Environ., 41:3789-3796, 2007
Sweeney et al.: Comparison of PI-SWERL with dust emission measurements from a straight-line field wind tunnel, J. Geophys. Res., 113, F01012, 2008.

PI-SWERL

- **Open-bottomed chamber with a metal, annular ring that spins ~2.5 in above and parallel to the soil surface**
- **Generates wind shear**
- **Lofted soil and dust particles pass through particulate monitors**
- **Measures the number and size of entrained particles over test cycle.**

Figure 2: PI-SWERL fan. Image by Desert Research Institute

PI-SWERL at ERDC

Figure 3: Karen Foley collecting PI-SWERL (portable wind shear chamber) samples in the Sonoran Desert.

- **Mini Pi-SWERL (30 cm diameter)**
- **Can use either DustTrak II 8530 or DustTrak DRX 8533**
  - **Size-resolved dust concentrations**

General Use

- Dust emission potential of real world surfaces
  - Roads
  - Fields
  - Training grounds

- Assessment of dust mitigation techniques and palliatives

ERDC Dynamic Undisturbed Soils Testbed (DUST)

RELATING DUST AND SOIL STRENGTH to GEOMORPHIC TRAITS for DVE and MOBILITY via…

MODEL

Enhance dust transport modeling capabilities through development of a geomorphic-based, scale-aware dust erodibility parameterization.

RS/GIS

Generate observational database of spatial and temporal occurrence of dust emission in the southwest US and Mexico.

FIELD

Establish relationships of soil strength and dust emission potential, to geomorphic landform type and age.

LAB

Small- and large-scale facility lab research to better understand environmental factors that affect soil strength and dust emission.

Engineered Surfaces

- **Generate indoor, macroscale playa-like soil plots using climate control and brackish water delivery mechanisms**
- **PI-SWERL used to compare soil surface traits to real world analogs**

Figure 4: Indoor macroscale playa-like surface testbed.

Bigl, M. F., LeGrand, S. L., Beal, S. A., Sopher, A., and Ringelberg, D. B.: Macro-scale salt crust formation on indoor playa-like test plots for dust emission research applications: Methodology assessment, ERDC/CRREL TR-XX- DRAFT, U.S. Army Engineer Research and Development Center, Hanover, New Hampshire, USA, in review.

Erodible Material Composition

- **Influence of soil composition on dust emission by landform type**
- **PI-SWERL used to quantify dust emission potential of different landforms**
- **Measured soil composition variables do not explain the majority of observed variability**

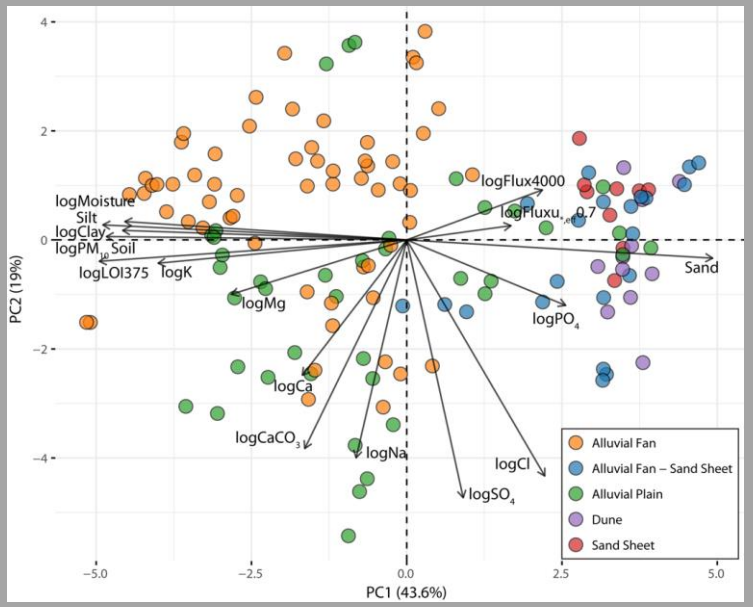

Figure 5: Biplot of the first two principal components of soil compositional variables and PM_{10} flux

Beal, S. A., Sweeney, M. R., McDonald, E. V., and LeGrand, S. L.: Soil compositional influences on dust emission across landform types in the Sonoran Desert, USA, Aeolian Res., in review.

Erodible Material Biome

- **Microbial dust hitchhikers by landform type**
- **PI-SWERL used to quantify erosion potential of sampling sites**
- **Found patterns in dominant bacteria taxa in select landform types**

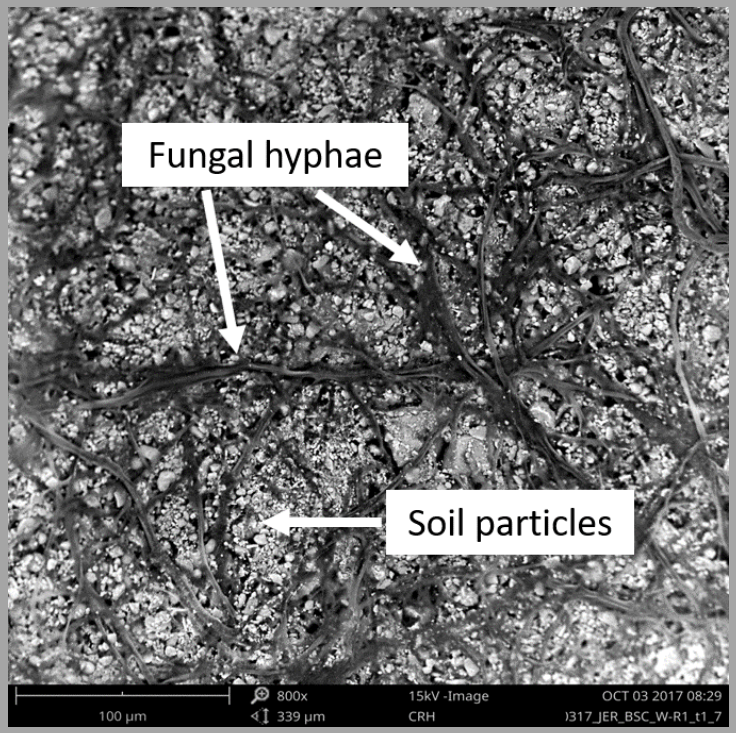

Figure 6: SEM image of fungal hyphae stabilizing soil particles.

Barbato, R. A., Jones., R. M., Doherty, S. L., Fisher, A. R., Foley, K. L., McDonald, E. V., and LeGrand, S. L.: Patterns in microbial community structure are influenced by geomorphic landform type in the Southwest USA, in prep.

Numerical Modeling

- **ERDC-Geo Scheme**
- **Scale-aware, geomorphic soil erodibility parameterization**
- **Spatially-varying dust emission flux multiplier designed to work with most physics-based dust emission schemes.**

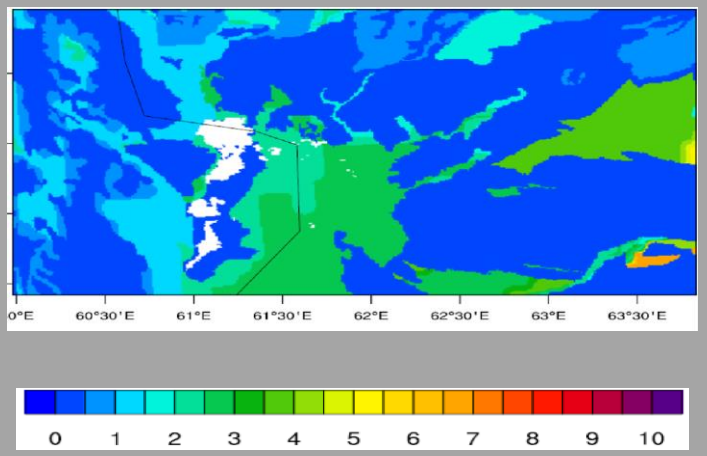

Figure 7: Erodibility multiplier for a WRF-Chem AFWA-GOCART domain along the AFG/Iran boarder.

Numerical Modeling

- **PI-SWERL used to create landform-based dust emission potential look-up tables.**
- **Ratio of physically modeled to analog-based dust emission potential used to generate spatially varying multiplier.**

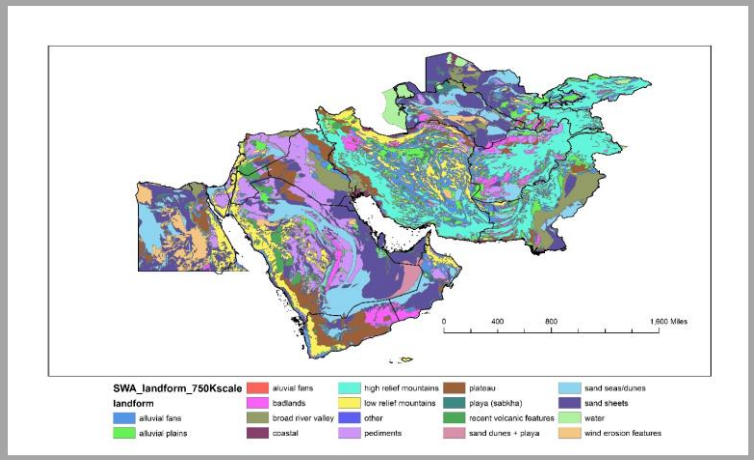

Figure 8: 1:750K scale geomorphic landform map for Southwest Asia

LeGrand, S. L.: A geomorphic, scale-aware approach to erodible material parameterization in dust transport models, in prep.

Summary

- **PI-SWERL is a turn-key device, easy to set up and use**
- **Measures PM-10 dust emission potential from natural surfaces**
- **PI-SWERL can be used to**
  - **Measure dust emission potential, and**
  - **Assess dust mitigation techniques**
- **Currently used in many applications at ERDC including large-scale testbed work, landform characterization, and numerical modeling**

Applications for the NRCS

- **PI-SWERL used to estimate in situ erodibility of soils under different disturbance conditions**
- **Produce maps of soil erodibility that can be used in management, and wind erosion and dust emission modeling**
- **PI-SWERL can provide robust sampling to support assessments of erodibility over large areas**


Questions?