Linking Soil Health to Dust Prediction and Mitigation:

Project Updates from University of Arizona Research Team

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College of Agriculture & Life Sciences

ADEQ Arizona Department of Environmental Quality

USDA United States Department of Agriculture Natural Resources Conservation Service

The University of Arizona Research, Innovation & Impact Arizona Institutes for Resilience

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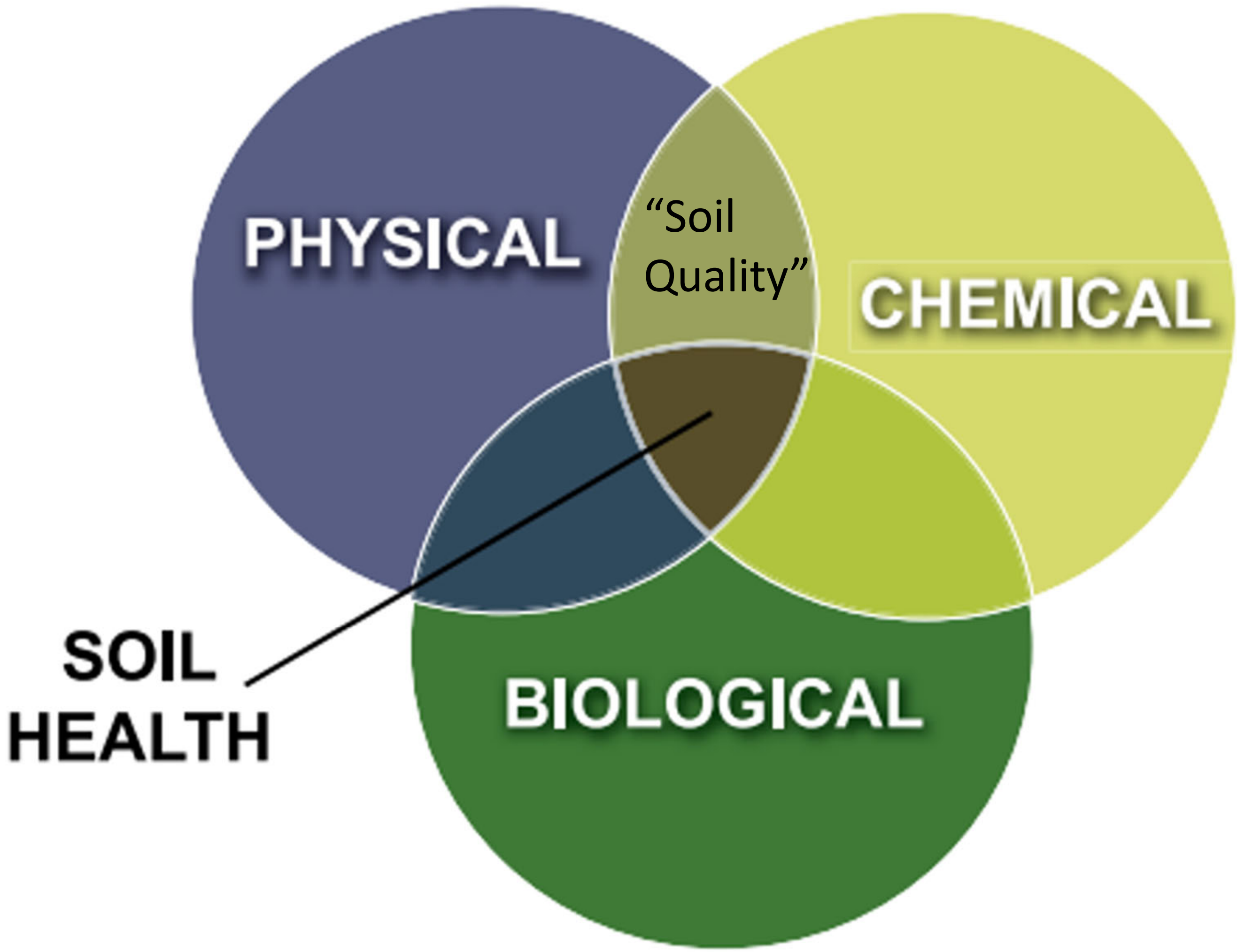
SOIL HEALTH

The continued capacity of a soil to **function** as a vital, **living** ecosystem that sustains plants, animals, and humans.


PHYSICAL
"Soil Quality"
CHEMICAL
BIOLOGICAL
SOIL HEALTH

Research Project Updates

1. Improving **dust prediction** along Arizona highways
   Why do some barren lands produce more dust than others?

2. Ongoing **dust mitigation** field-scale trial using wood chips

3. New project investigating plot-scale **dust mitigation** using soil microbial inoculants and native desert plants

Improving Dust Prediction

Funded by NRCS grant (2019-2022)

USDA
United States Department of Agriculture
Natural Resources
Conservation Service

Other team members:

Dr. Craig Rasmussen (soil geochemistry; UA)

Dr. Jason Field (plant/dust ecology; UA)

Dr. Eduardo Saez (chem & envi engineering; UA)

Sam Rathke (lab/field manager; UA)

The ecology of dust

Jason P Field[1*], Jayne Belnap[2], David D Breshears[1,3], Jason C Neff[4], Gregory S Okin[5], Jeffrey J Whicker[6], Thomas H Painter[7], Sujith Ravi[8], Marith C Reheis[9], and Richard L Reynolds[9]

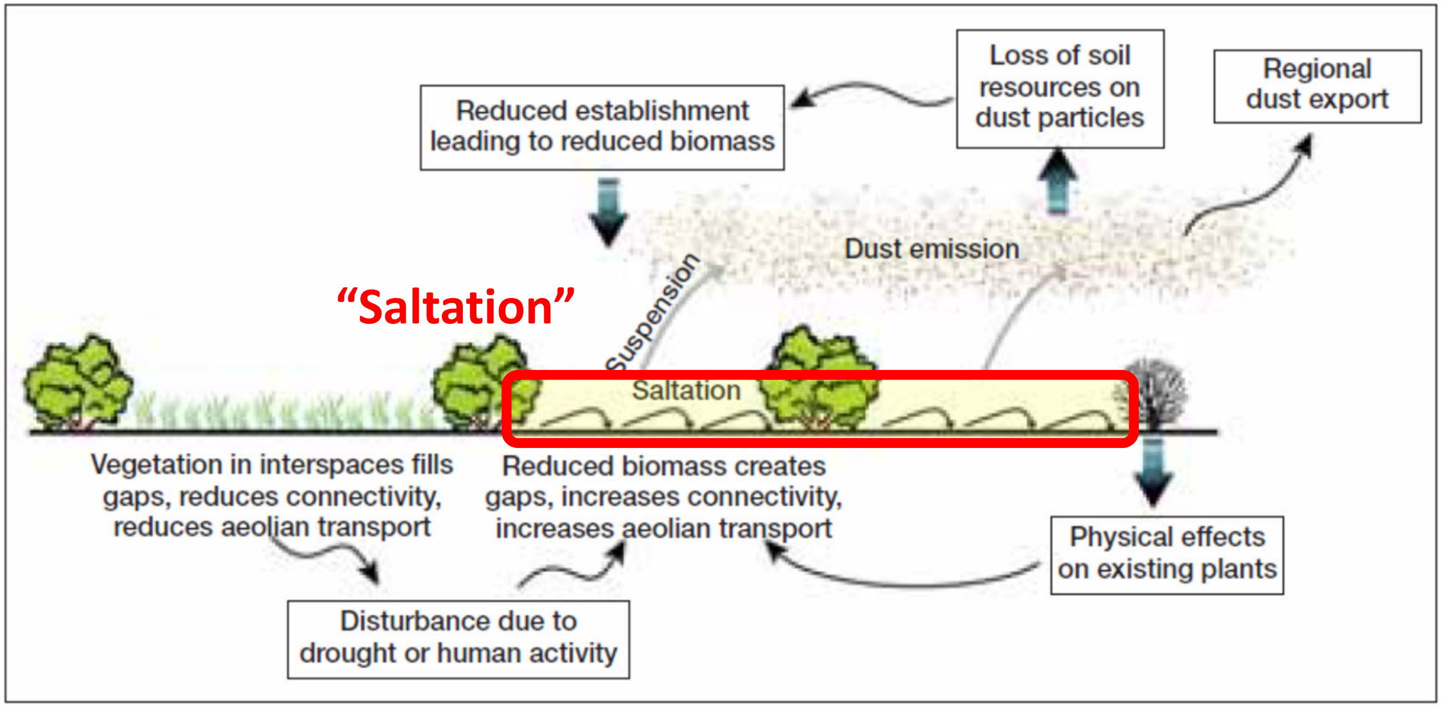


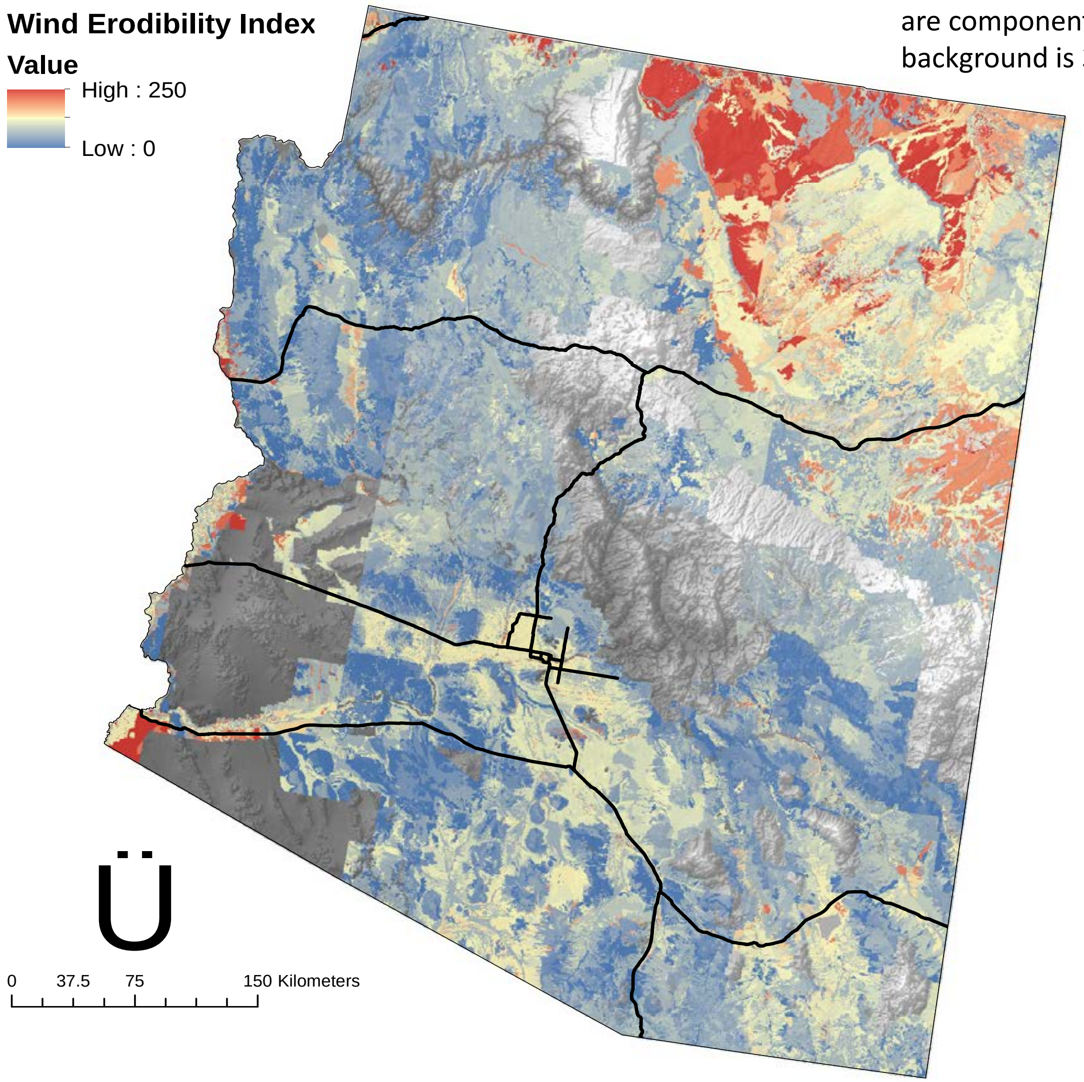
Figure 5. Primary feedbacks between ecosystem function, wind erosion, and ecosystem structure.

Improving Dust Prediction

1. *Phase 1*: Intensive sampling near Picacho Peak to identify and "calibrate" the best soil and plant predictors of dust saltation during different seasons and years

2. *Phase 2*: Extensive sampling across Arizona to test broad applicability of newly identified index of dust saltation

Wind erodibility index (WEI) from the Arizona gSSURGO database. WEI values reported are component weighted averages by map unit; note incomplete gSSURGO coverage, background is 30 m DEM, and national highway system overlay.



WEI is based on:

- Soil texture
- Dry soil aggregates
- Total soil organic carbon
- Calcium carbonate

WEI is not based on:

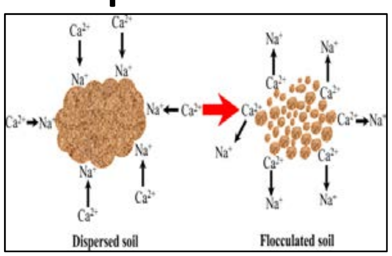
- Soil or plant biology
- Actual measurements of dust emission

Developing new mechanistic predictors of soil stability and susceptibility to wind erosion

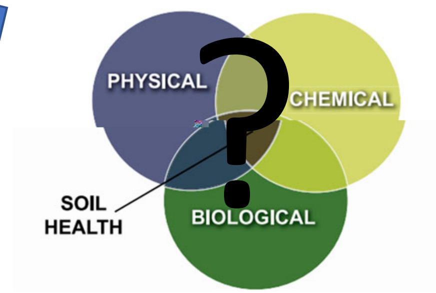
1. Soil surface roughness

2. Water-stable soil aggregates

3. Dispersible soil cations



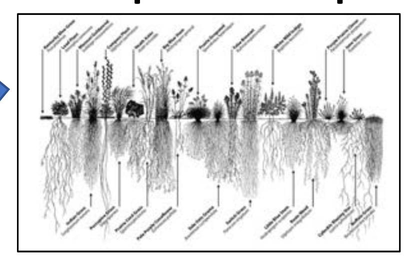
Measured dust production and threshold friction velocity



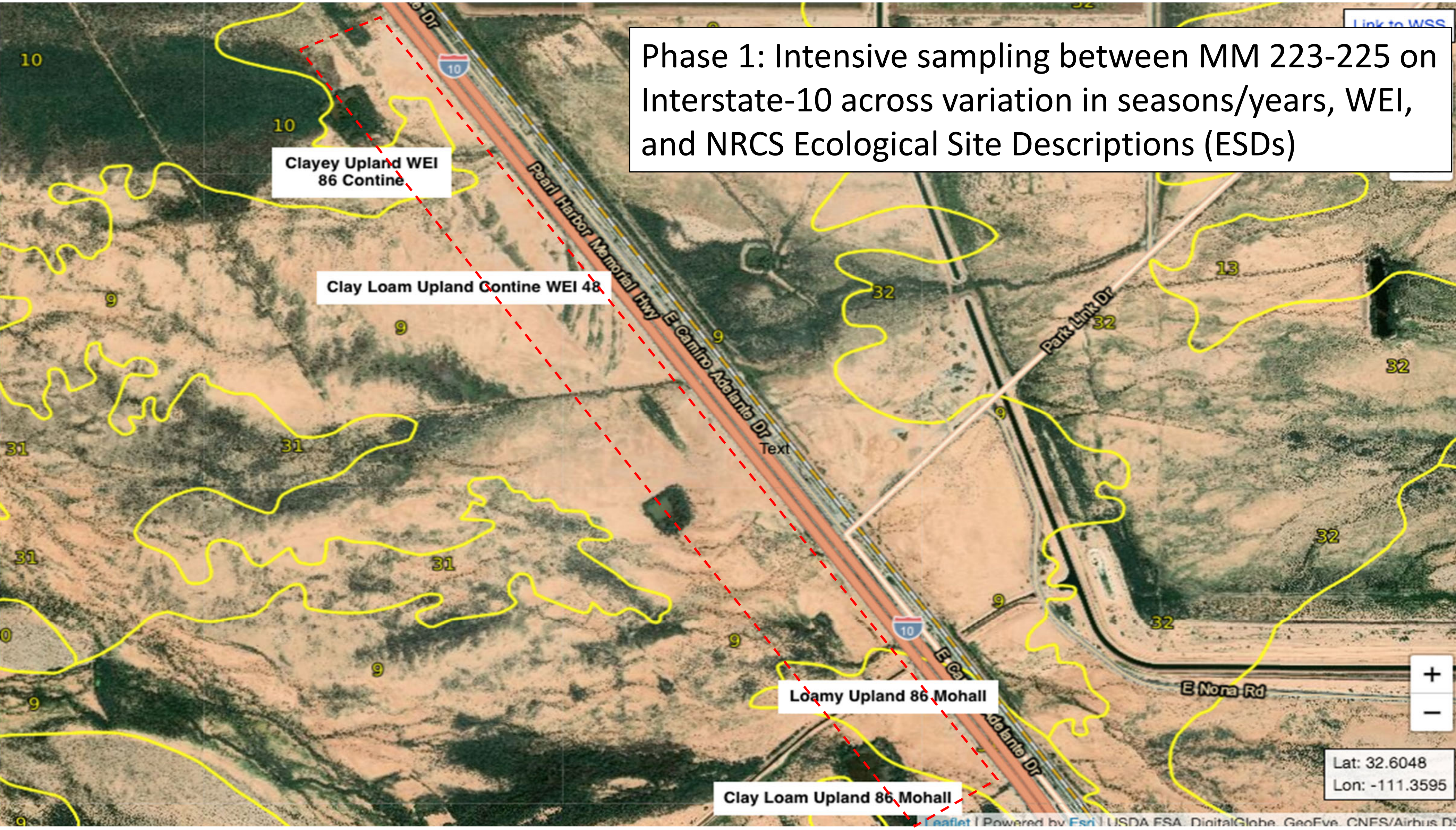
4. Soil microbial “glues”

5. Soil biocrust cover and type

6. Plant species composition



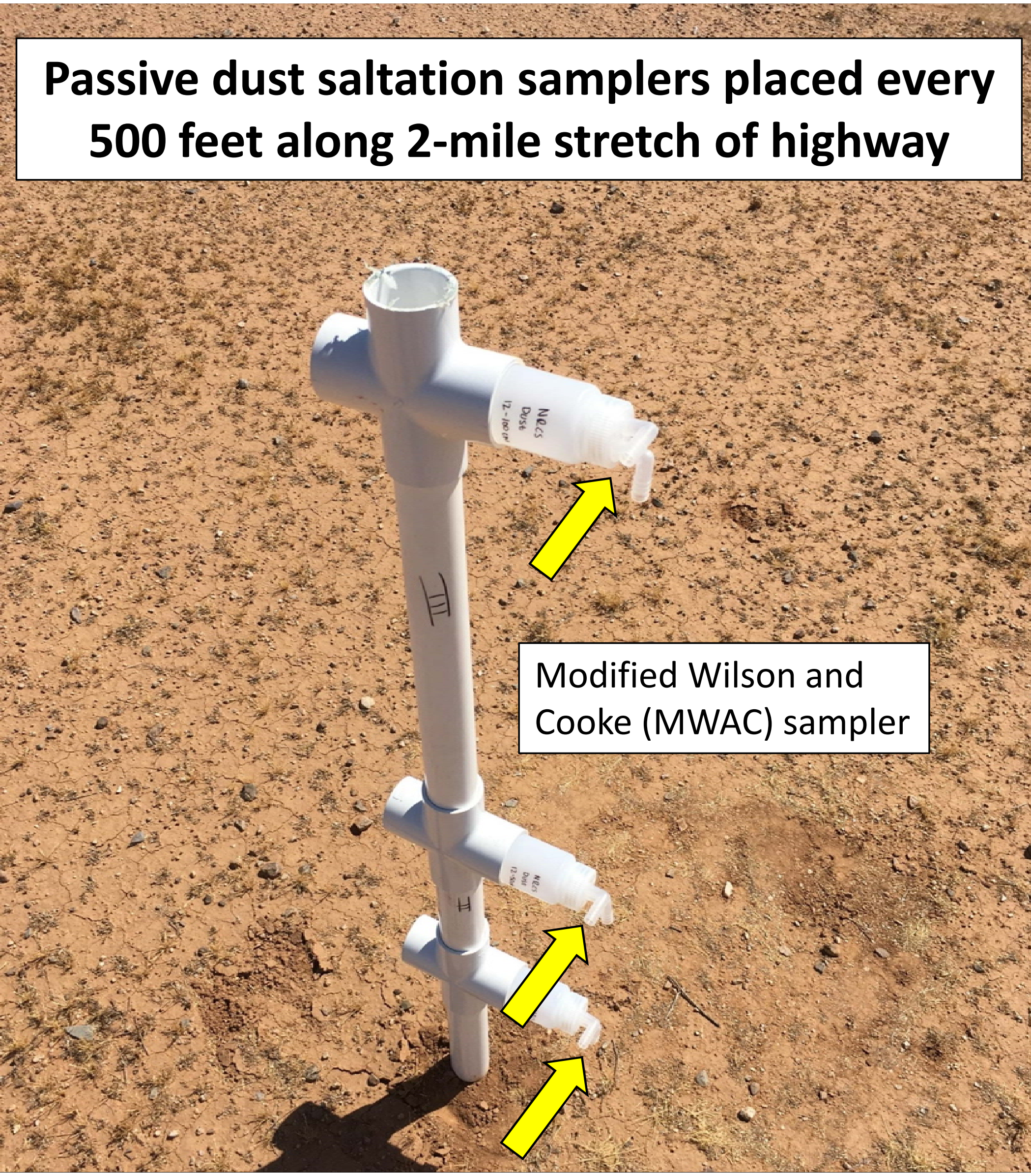
Phase 1: Intensive sampling between MM 223-225 on Interstate-10 across variation in seasons/years, WEI, and NRCS Ecological Site Descriptions (ESDs)



Ground truthing soil dust emission using portable wind tunnel

- Measures dust production at various “wind” speeds
- Determines mass of dust produced and threshold friction velocity

**** But can’t sample over plants**


Passive dust saltation samplers placed every 500 feet along 2-mile stretch of highway
Modified Wilson and Cooke (MWAC) sampler


Dominant wind direction

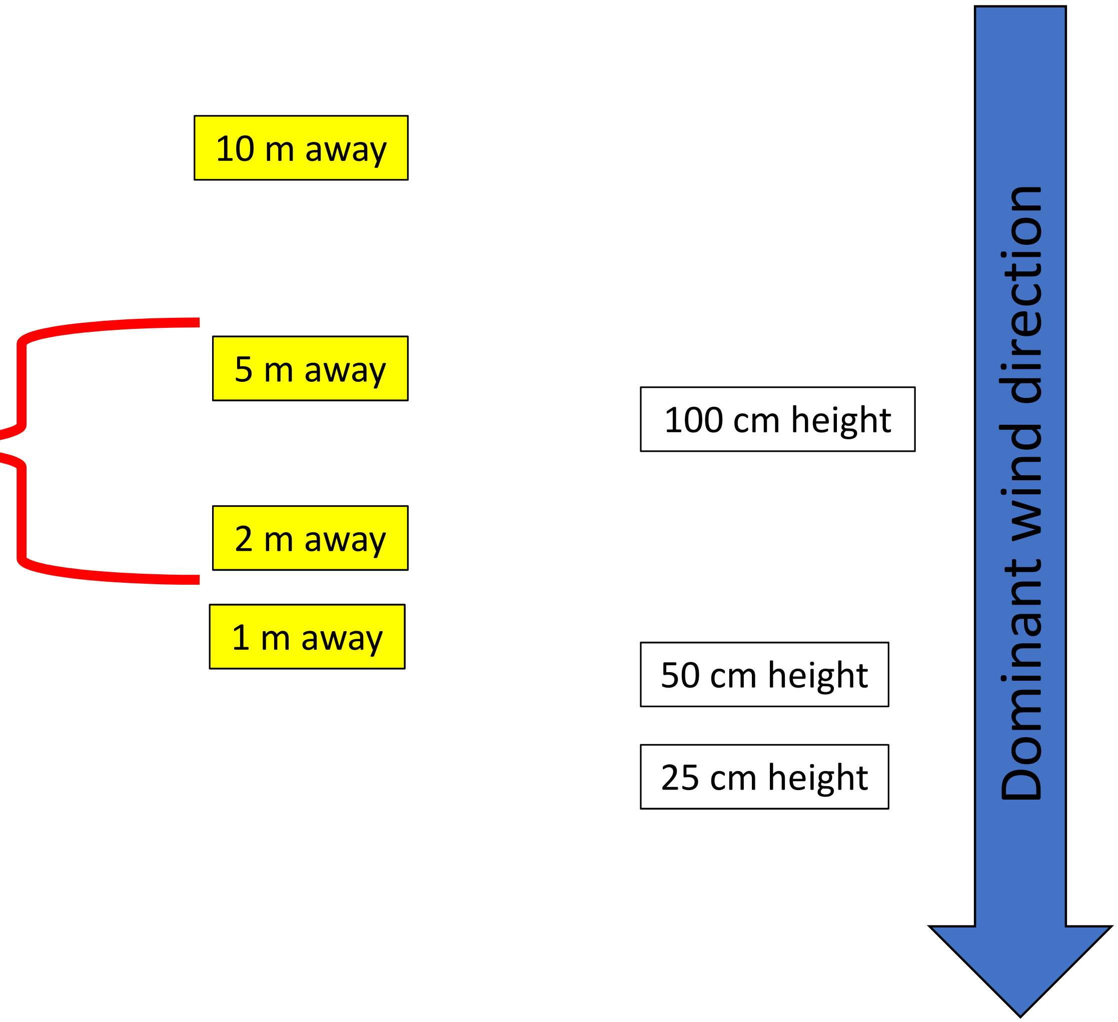
Results so far…

Based on top 1 cm of soil

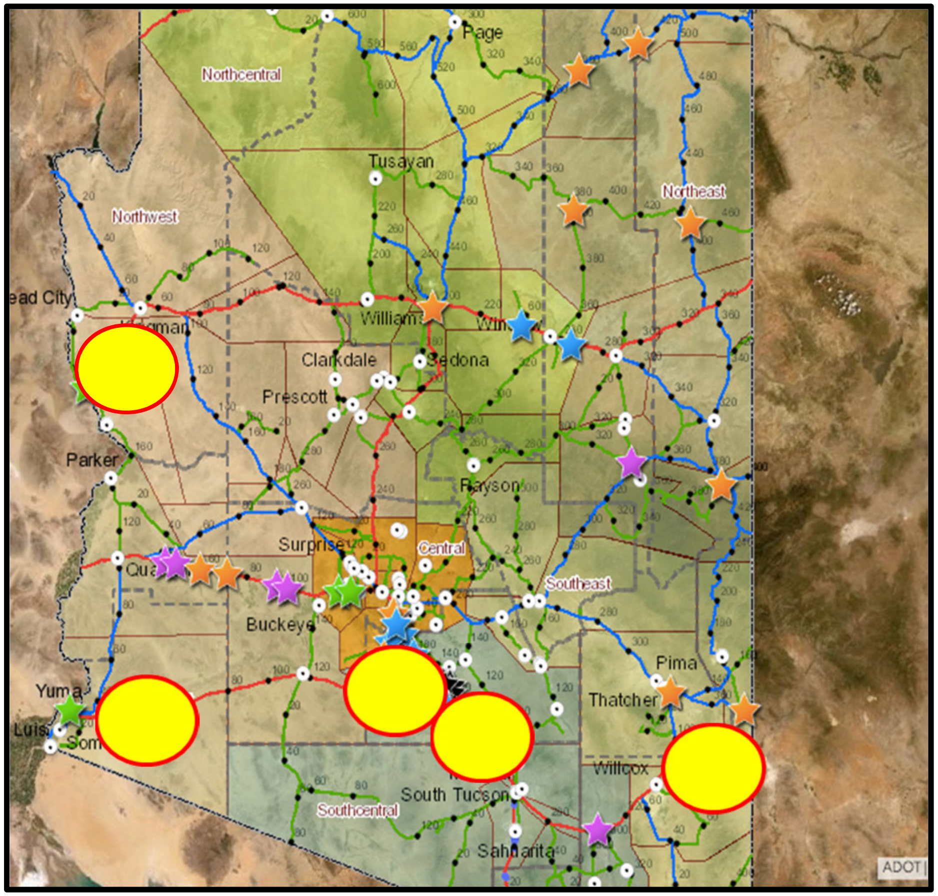
1. Increasing surface roughness decreases dust at 25 & 50 cm heights but increases dust at 100 cm height (?)

2. Transects with more smaller soil aggregates (<250 μm) and free sand, silt, and clay produce more dust at 50-cm height

* Biocrusts and plants are not important factors yet



Phase 2: Extensive sampling across AZ to assess broad applicability of new predictors of soil stability and dust production



Site #	Site Name	Ecological Site Description (ESD)	Soil Series	Wind Erodibility Index (WEI)
1	Picacho Peak (I-10)	Clay Loam Upland 7-10 p.z.	Contine	48
2	Picacho Peak (I-10)	Loamy Upland 7-10 p.z.	Mohall	86
3	Casa Grande (I-10)	Clayey Swale 7-10 p.z.	Gadsden	86
4	San Simon (I-10)	Saline Upland 8-12 p.z.	Hondale	86
5	Topock (I-40 @ Rt 95 South)	Sandy Wash 3-7 p.z.	Carrizo	86
6	Topock (I-40 @ Rt 95 South)	Limy Upland 3-7 p.z.	Gunsight	48
7	Tacna (I-8 near Yuma)	Limy Fan 3-7 p.z. Sandy	Wellton	134

Example field site near Casa Grande, AZ

Improving Dust Prediction

Anticipated products:

a) New **Dust Risk Index** based on actual dust emission and new mechanistic predictors that can be integrated with geospatial data and dust models

b) Set of **guidelines** for NRCS to incorporate "ground truthed" dust risk into Ecological Site Description (ESD) framework for scaling up

c) New **map** identifying current and future high-risk landscapes to target dust monitoring, warning, and mitigation

d) Scientific **publications**

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Arizona Department
of Environmental Quality
TANK'S GREEN STUFF
100% ORGANIC
COMPOST • GARDEN SOIL • FERTILIZER
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June 2019


Each row of mulch is
roughly 10-feet wide

Nine 1-acre plots:

- 3 **control** plots
- 3 plots with **mulch** (7 rows)
- 3 plots with **chemical stabilizer** (Site-Lok)

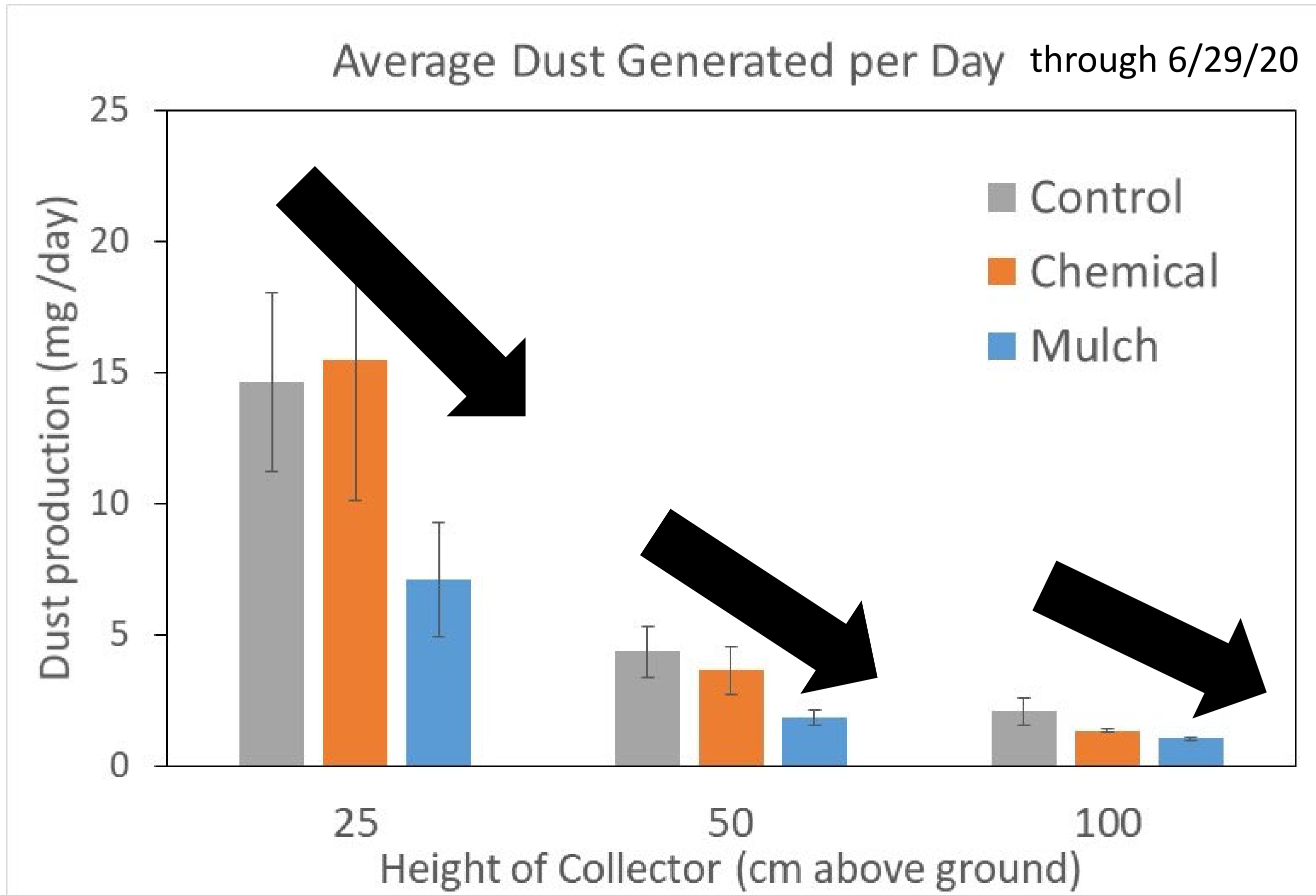
There is a BSNE dust sampler in the center of each plot, with dust collectors 25, 50, and 100 cm above soil surface

Dust results

After 1 year…

Chemical stabilizer had no effect at 25 cm height and reduced dust by 17% and 35% at 50 cm and 100 cm heights.

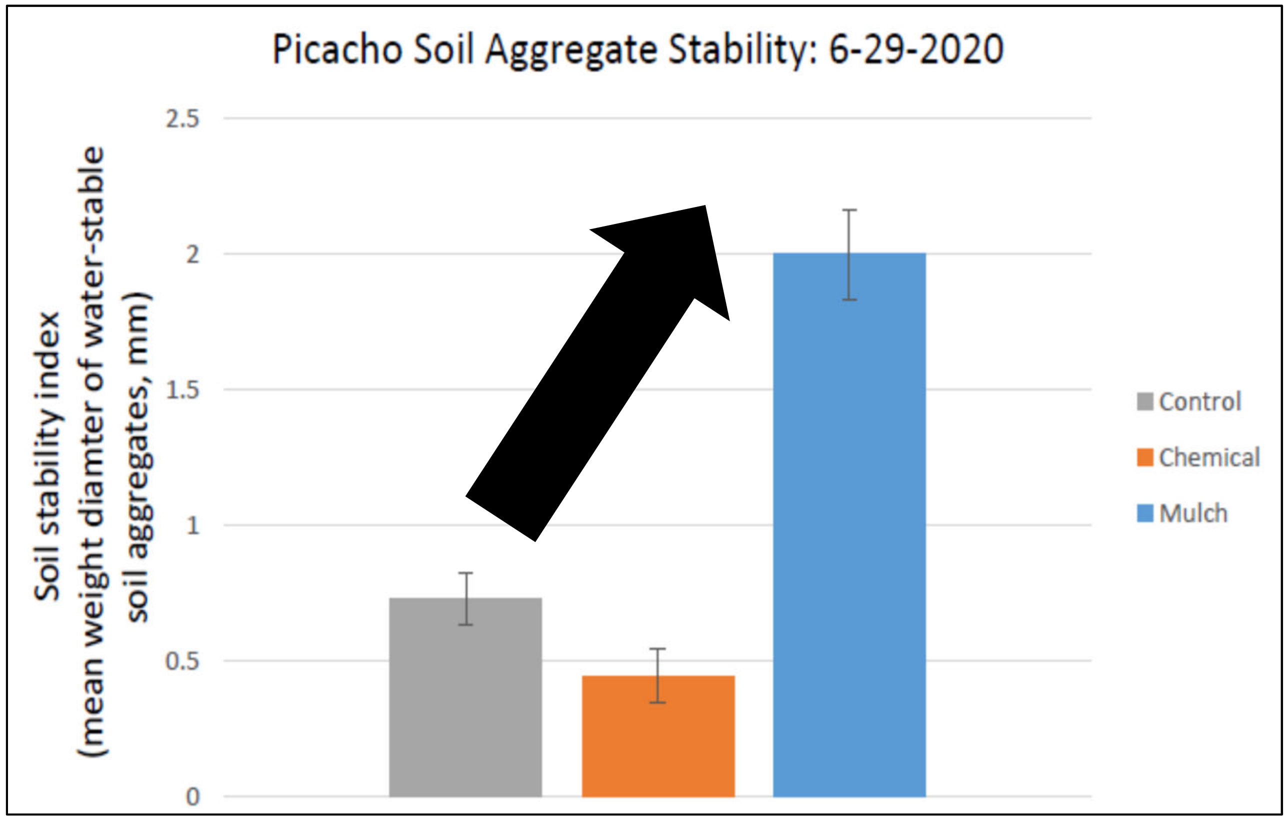
Mulch has reduced dust by 50-57% at all heights!



Soil stability results

After 1 year, our index of soil stability is definitely heading in the right direction with mulch…

Separation of soil into water-stable aggregates using wet-sieving method




Control plots
2/4/20


Example of plot with mulch
2/4/20

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Developing Biological Solutions for Arizona Dust Hazards

PIs: Blankinship, Babst-Kostecka, Barberán, Field, Gornish, Rasmussen, Saez, & Tfaily

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RESEARCH, INNOVATION & IMPACT
Arizona Institutes for Resilience

Plant

3 Native Plant Species:
Bush muhly
Low woollygrass
Fourwing saltbush

Microbe

Soil

3 Microbial Inoculants:
Cyanobacteria
Mycorrhizal fungi
(Possible) EPS-producing bacteria

- Soil aggregates
- Microbial EPS "glues"
- Other organic metabolites
- Nutrients
- Metagenome
- Plant root biomass
- Dust production