SCALING OF AN ASSISTED PHYTOSTABILIZATION FROM GREENHOUSE TO FIELD-SCALE AT THE IRON KING MINE-HUMBOLDT SMELTER SUPERFUND SITE

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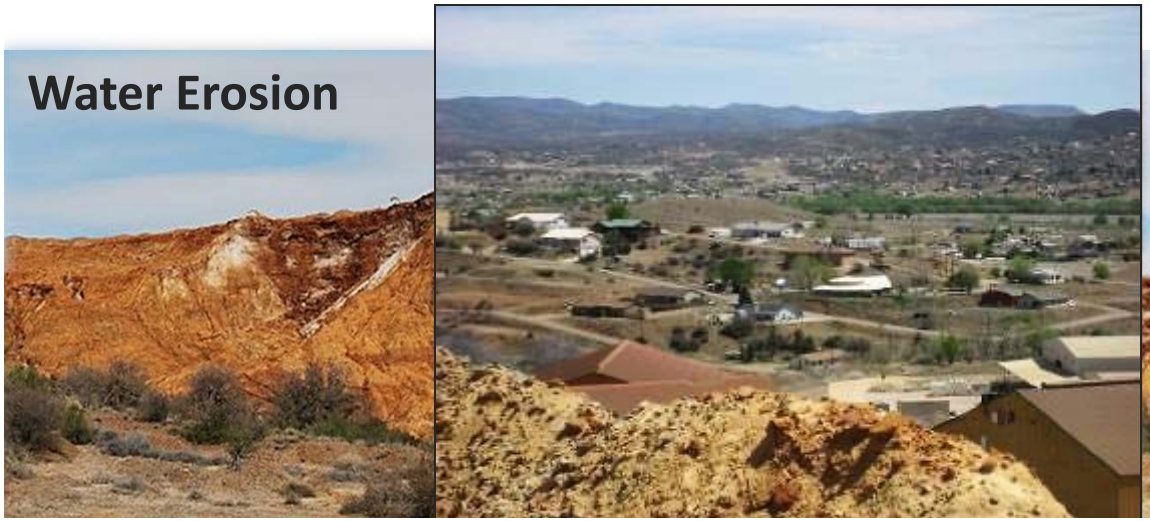
MINE TAILINGS

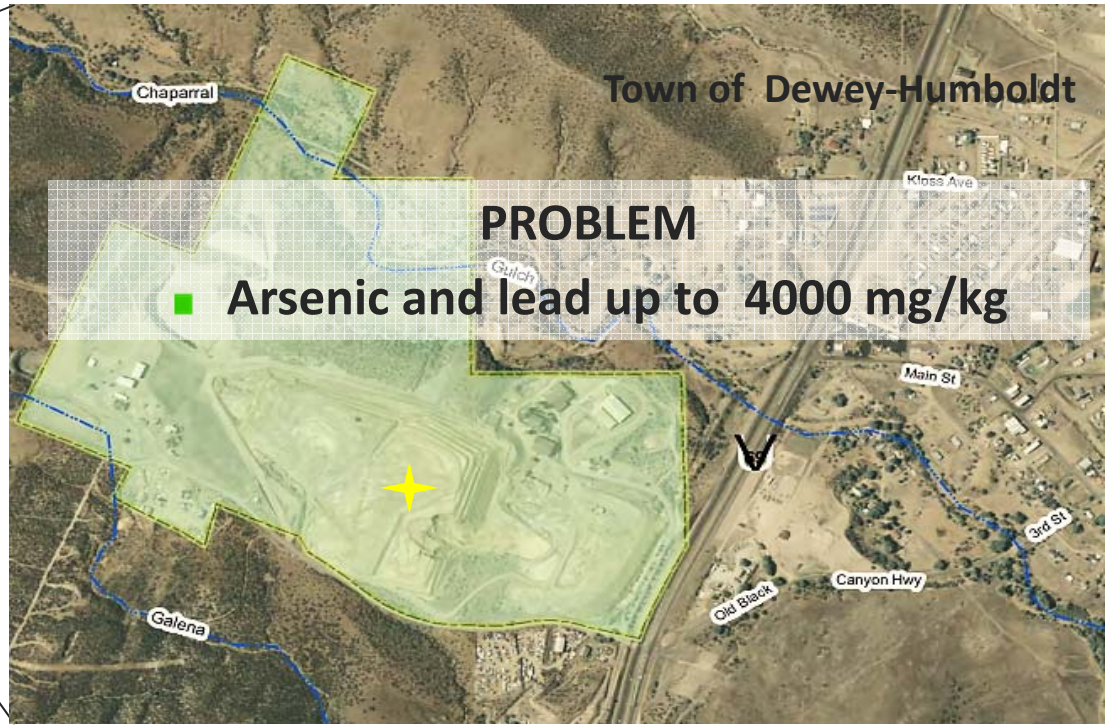
- High concentration of metals
- From acidic to neutral pH
- Poor soil structure
- Lack of nutrients
- Low microbial community
- Barren surface



SITE DESCRIPTION

Iron King Mine-Humboldt Smelter Site (IKMHSS)

Superfund Site by Environmental Protection Agency (EPA) in 2008.



PHYTOSTABILIZATION

Vegetative cap to stabilize metals in the root zone.

Reducing wind and water erosion.

PHYTOSTABILIZATION

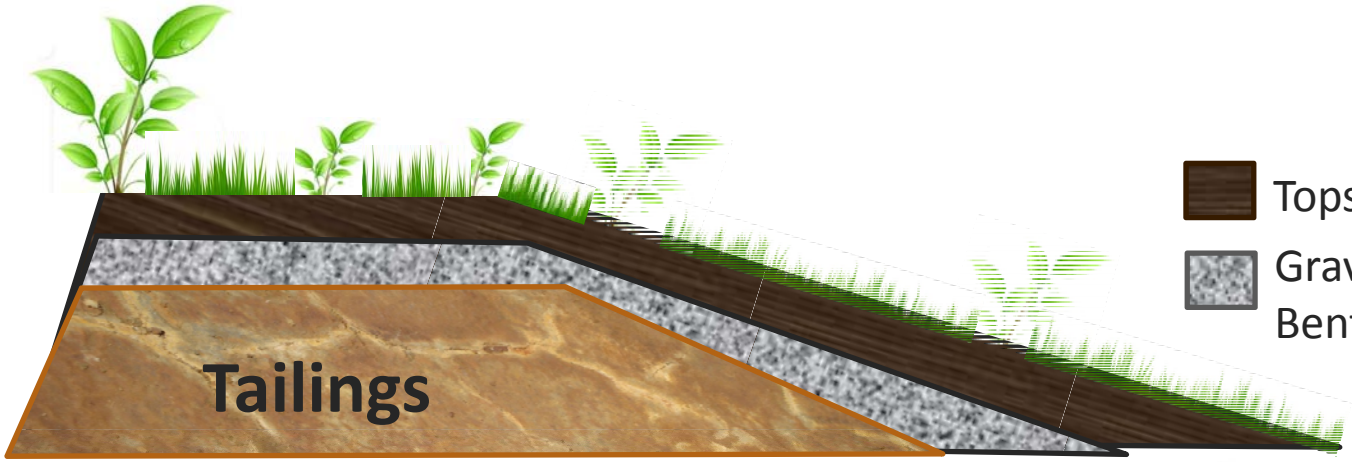
Capping → Liability

Disadvantage

- High cost for large tailing areas
- Low durability in arid and semi-arid areas

→ **Cost-effective**

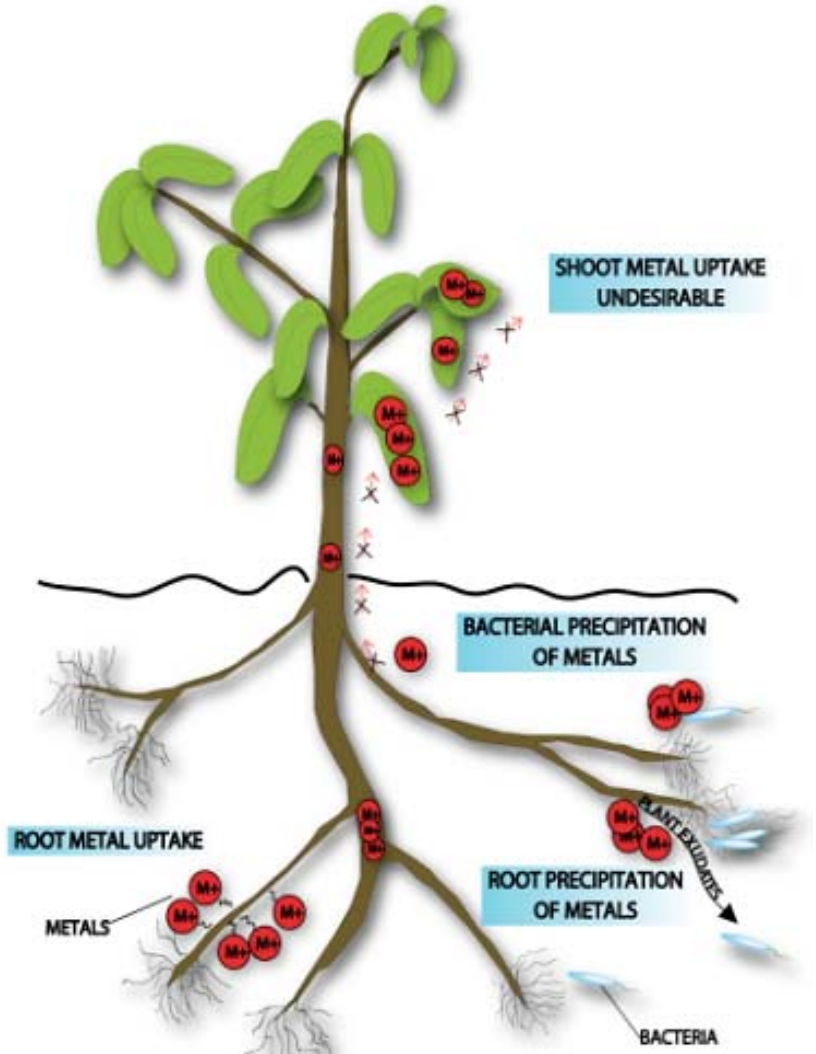
Planting directly into the tailings



Topsoil cap

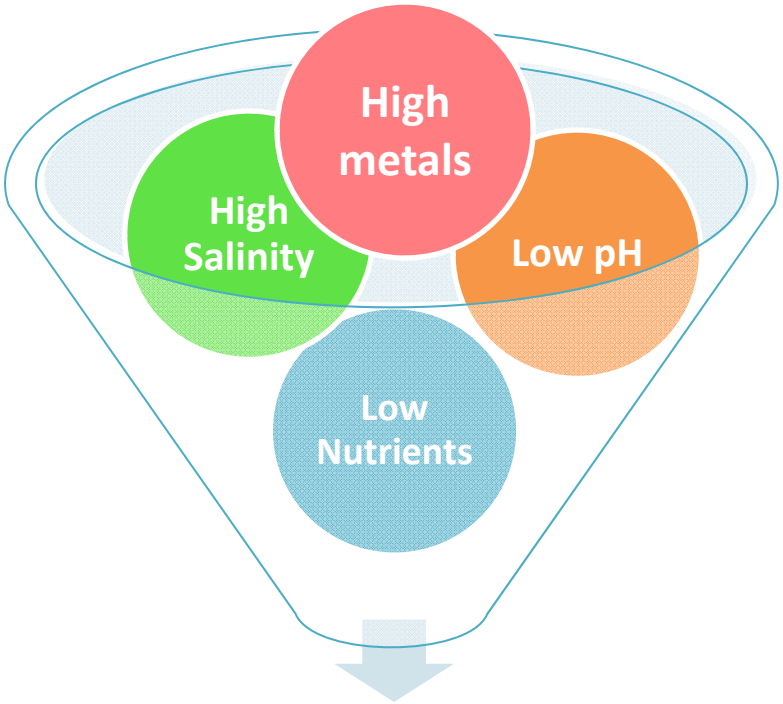
Gravel layer or Bentonite-cement seal

PHYTOSTABILIZATION



Mendez and Maier, 2008. Environ. Health Perspec.

Iron King Mine tailings



Plants don't grow

GREENHOUSE

Amendments

Native plants selection

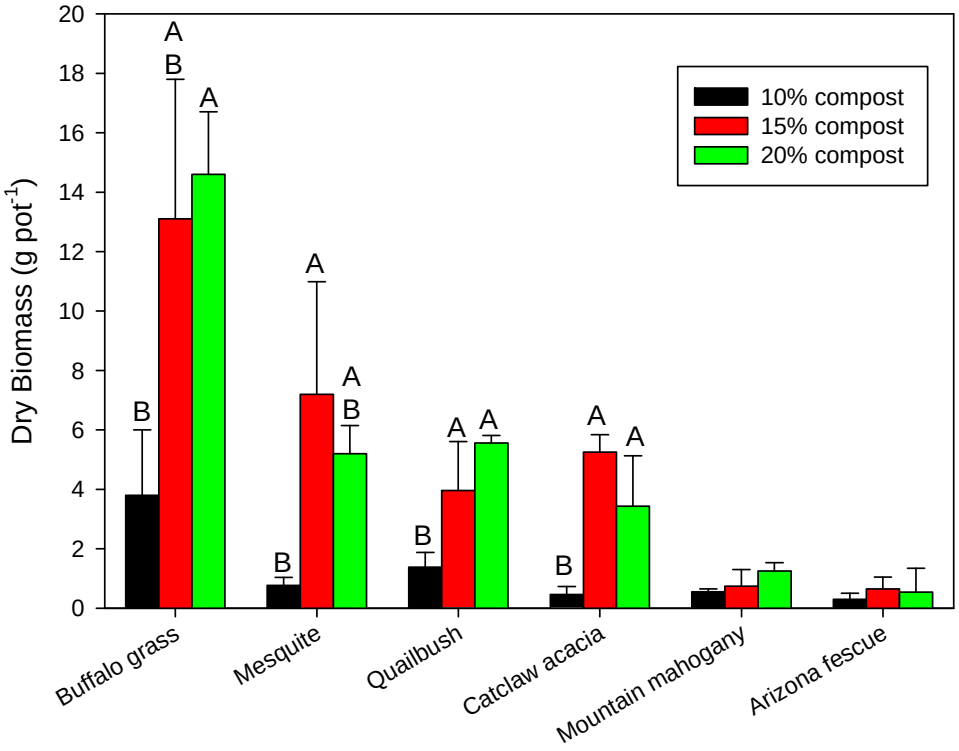
15 species

- Compost
- Lime
- Irrigation

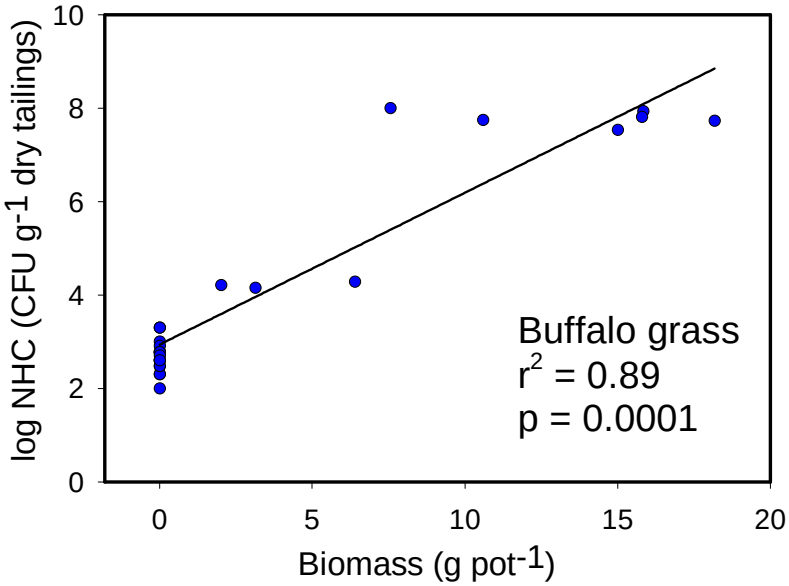
- Buffalo grass (BG) –*Buchloe dactyloides*
- Arizona fescue (AF) –*Festuca arizonica*
- Quailbush (QB) – *Atriplex lentiformis*
- Mountain mahogany (MM) –*Cercocarpus montanus*
- Mesquite (MQ) –*Prosopis juliflora*
- Catclaw acacia (AC) – *Acacia greggi*

Solis-Dominguez F. A., et.al.. 2012, *Environ. Sci. Technol.*

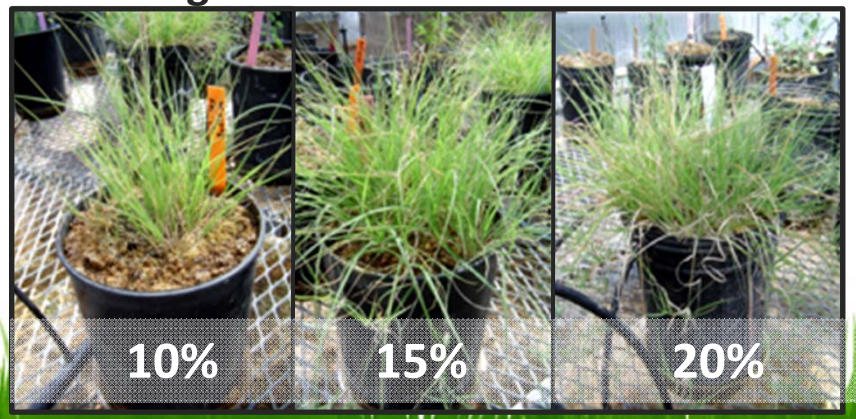
Plant Biomass



Neutrophilic heterotrophic and Plant biomass



Buffalo grass



Not shoot metal uptake, except for Zn in quailbush

Solis-Dominguez F. A., et.al.. 2012, *Environ. Sci. Technol.*

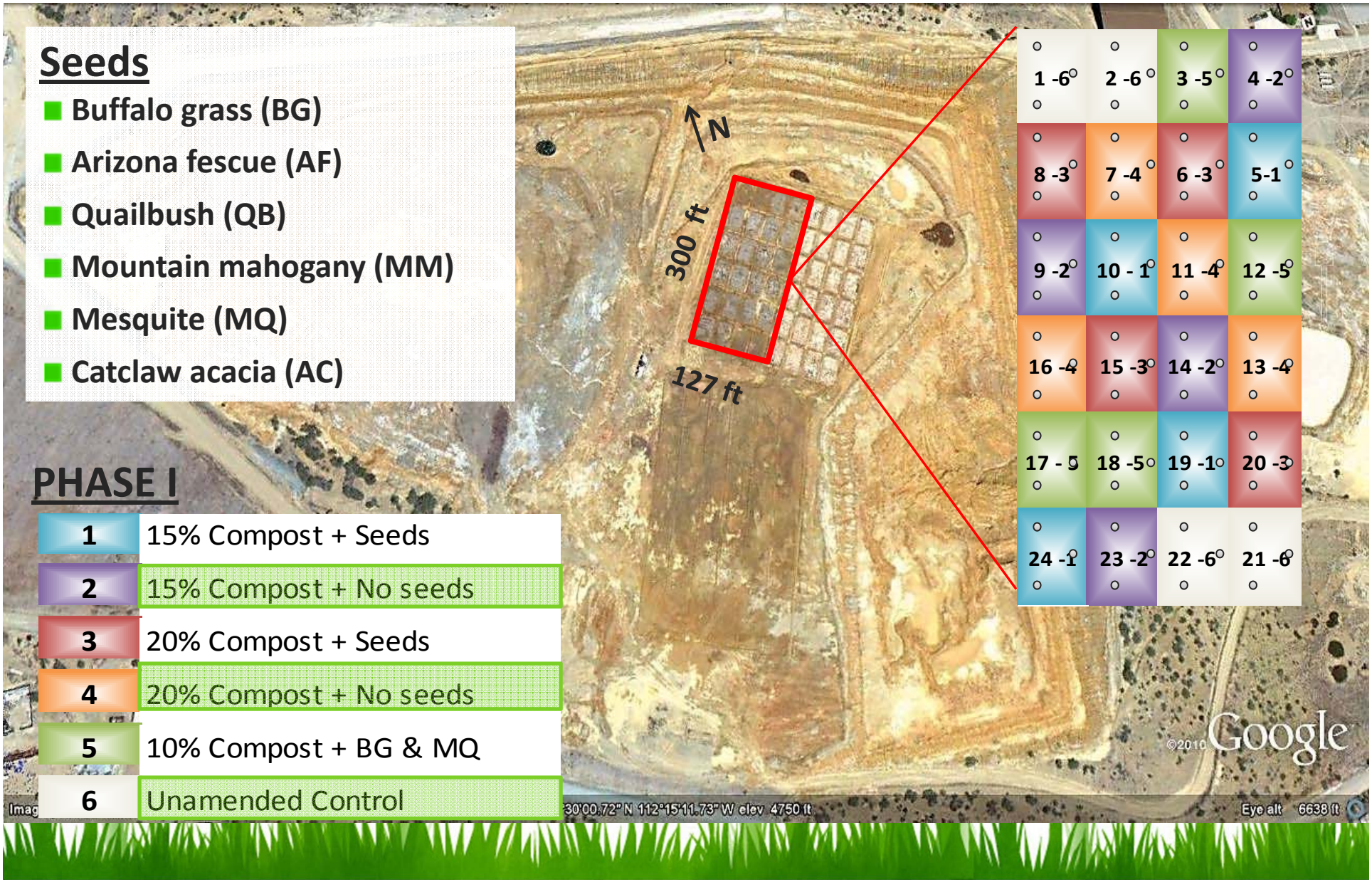
OBJECTIVE

To determine whether successful results from greenhouse studies can be translated to the field, and also, to identify the parameters that indicate successful phytostabilization at IKMHSS.

METHODOLOGY -Field plot and treatments-

Seeds

- Buffalo grass (BG)
- Arizona fescue (AF)
- Quailbush (QB)
- Mountain mahogany (MM)
- Mesquite (MQ)
- Catclaw acacia (AC)



PHASE I

1	15% Compost + Seeds
2	15% Compost + No seeds
3	20% Compost + Seeds
4	20% Compost + No seeds
5	10% Compost + BG & MQ
6	Unamended Control

METHODOLOGY -Field implementation-


1. Study Area


2. Site Preparation


3. Sampling


4. Seeding


5. Irrigation


Setup Complete

PARAMETERS -Measured-

CANOPY COVER

Daubenmire frame method

NEUTROPHILIC HETEROTROPHIC BACTERIA

Plate counts on R2A agar

SHOOT METAL UPTAKE

Microwave digestion and ICP-MS analysis

RESULTS

After 5 and 17 months
of phytostabilization for PHASE I

RESULTS -PHASE I -

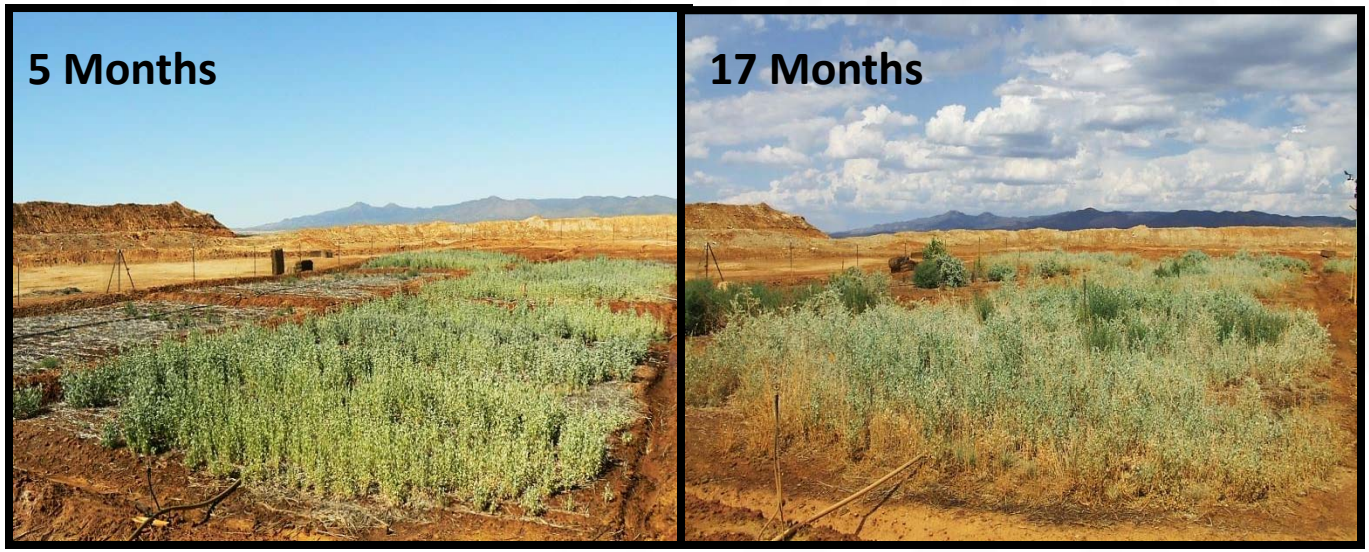
Canopy Cover

- There is no cover vegetation for the unamended control compared with those treated with compost.
- Canopy cover is higher than 30% after 5 months for those treated with compost and seeds. Then, after 17 months they have decrease to 20%.
- Canopy cover after 17 months looks healthy. And it is more similar to the surroundings.
- On those unseeded treatments canopy cover ranges from 7 to 16% due to volunteer plants (plants that grew without having been planted) have established after 17 months.

2010

2011

20% compost + Seeds



20% compost + No Seeds

Unamended irrigated control

Off-site

Buffalo grass

Blooming and seeding after 17 months

Quailbush

RESULTS -PHASE I-

Neutrophilic Heterotrophic Bacterial Counts

- Unamended control results showed bacterial counts of 10^2 to second and how they increase 2 or 3 orders of magnitude at time 0 with the rate of compost.
- NHBC increase 1 or 2 orders of magnitude with time on those plots treated with compost, after 14 months.
- Taking into account that for 0 months we only have tailings, compost and seeds, and after 14 months we have a vegetation cover established, we can see that there is likely an interaction between microorganisms and plants.

RESULTS -PHASE I-

uptake

- The National Research Council has defined the domestic animal toxicity limits for cattle being 30, 100, and 500 mg/kg for As, Pb, and Zn, respectively.

- Metal accumulation in shoot tissue for buffalo grass and quail bush do not exceed the domestic animal toxicity limits at any rate of compost with an exception for zinc in buffalo grass, which is slightly higher.

[a] DATL= domestic animal toxicity limit.


April, 2010


September, 2011


September, 2011

SUMMARY

- Phytostabilization was successfully scaled from the greenhouse to the field.
- Direct planting achieved a canopy cover equivalent to the surrounding area. We will follow tailings characteristics over time to see if they improve as a medium for plant growth.
- Percent canopy cover, neutrophilic heterotrophic bacteria, and shoot uptake of metal(oids) are promising criteria to use in evaluating phytostabilization success.

Phase I –March, 2011-

Phase I –October, 2011-

REFERENCES

Mendez M.O., Maier R.M., 2008. Rev Environ Sci Biotechnol 7:47–59

Epelde L., et al., 2010, Environ Pollut 158:1576–1583

Solis-Dominguez, F. A., et.al.. 2012, *Environ. Sci. Technol.,46* (2), pp 1019–1027.

What is next ?

- Effect of lime and use of transplants
- Stopping irrigation
- Self-sustainability of vegetative cap
- Metal mobility and bioavailability (Soil-Water-plant)
- Relationship between vegetative cover and dust emissions

10-meter dust flux tower (1 of 3) designed to measure meteorological parameters and vertical dust fluxes from the contaminated tailings.

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THE UNIVERSITY OF ARIZONA

**You can follow the field study at :

http://cals.arizona.edu/crops/irrigation/azdrip/BostonMill/IK/photolog.htm

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http://superfund.pharmacy.arizona.edu/

THANKS

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Questions ?