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Re-Inventing the Nation's Urban Water Infrastructure (ReNUWIt)

Background

Protection of embankments of earth drainage canals and ponds from erosion in the arid regions has been a challenge. Soils of embankments are often sandy or sandy-loam and are vulnerable to erosion from wind and rainfall. While these earth embankments can be protected by gravel and rocks, the cost of material and labor is high and often are not aesthetically pleasing as practiced; and using grasses require irrigation. Despite some canals transport water, the embankments soils are often dry with little or no moisture. The method presented here uses succulent (*Delosperma cooperi*) plants to reduce soil erosion and sediment transport on drainage canal banks. *Delosperma cooperi* plants are drought tolerant, produce flowers to support insects and other wildlife and are aesthetically pleasing. In this study two treatments of soils were conducted, one with in-situ soil and the other with 3-inch layer of zeolite added on the soil surface for moisture retention. Preliminary results show that the succulents were able to grow without artificial irrigation and also were able to reduce soil erosion. The treatment with zeolite showed less soil erosion compared to in-situ soil.

Test-bed

- Sunland Park, NM

Industry Partner

- Elephant Butte Irrigation District



A view of Sunland Park, NM ReNUWIt test-bed

Barriers to Reinvention

- There are no "green" methods that use plants to protect earth embankments in arid warm environments from soil erosion and sediment transport along urban canals due to lack of irrigation water and cost of maintenance.
- Cost of lining canals with concrete or rocks is expensive and growing grass on the banks require irrigation.
- Exposed soils on embankments are prone to high erosion and therefore requires regular maintenance.

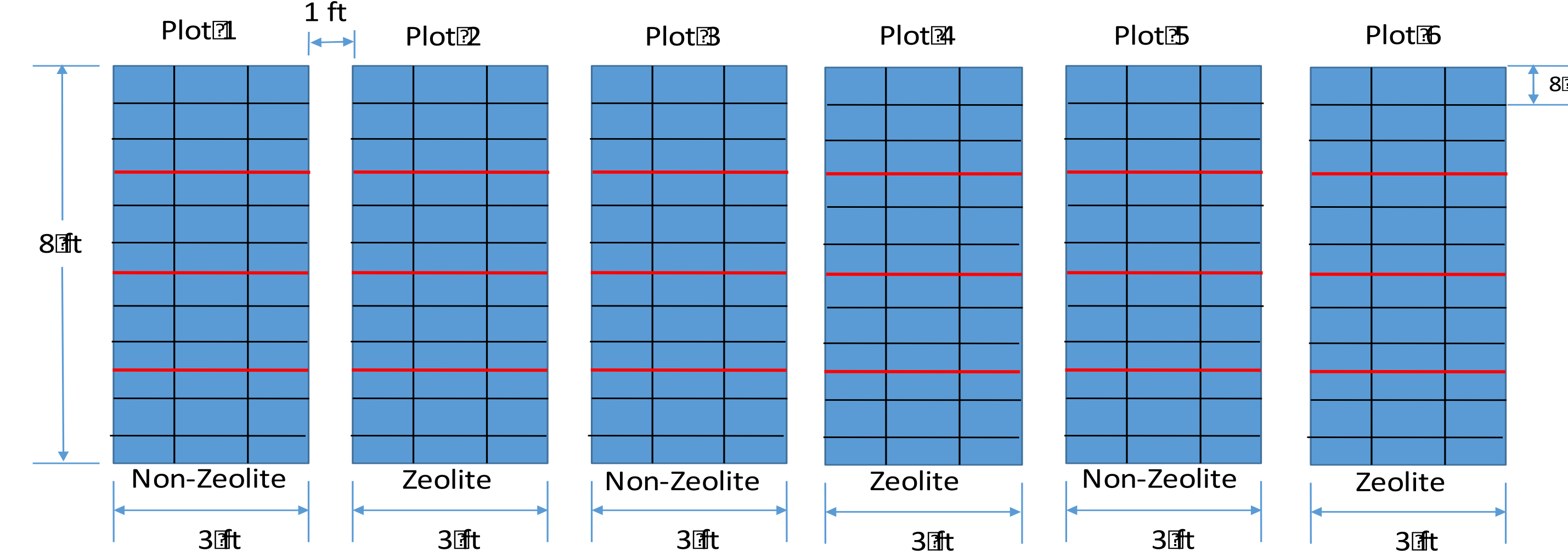
Research Hypotheses

- H1:** Drought tolerant *Delosperma cooperi* succulents will stabilize earth embankments and reduce soil erosion in semi-arid warm environments
- H2:** *Delosperma cooperi* succulents, when planted on the embankment of urban earthen canals, will reduce sediment flow into the canal and improve water quality, provide flowers (nectar) for insects and sap for birds.

Approach

Experiment Plots Setup

An area on an earth embankment of drainage canal with 30% slope and made of in-situ riparian sandy soil was divided into two triplicated treatments of 8 ft. x 3 ft. sections. A 3-in layer of zeolite to enhance soil moisture-holding-capacity was added to one of the triplicate. Each treatment was further divided into 24 sub-sections of 1 ft. x 1 ft. grid. Two additional 8 ft. x 3 ft. sections were added to the experiment as a control; a 3-in layer of zeolite was added to one of the control sections. Sprigs from the succulents were then planted in the two treatments at the center of 1 ft. x 1 ft. and thoroughly irrigated until the soil was wet. Irrigation continued once a week for a month and then once a month for 3 months. No irrigation was applied thereafter. The soils of control sections were left bare.



Plant growth was determined as percentage of plant cover per unit area of each plot. Erosion of soil was monitored visually for any gullies. Sediment transport will be determined using a rainfall simulator later this summer.



Experimental setup on the embankment of Diez Lagos earth drainage canal at the Sunland Park ReNUWIt Test-Bed



Planting sprigs of Succulents [*Delosperma cooperi*]

Progress to Date

Monitoring of soil erosion during early stage of plant growth showed that zeolite plots had less erosion as compared to in-situ soil of sandy loam soil. **Figure below shows the effect of erosion on zeolite and non-zeolite plots; erosion is more pronounced in non-zeolite plot. Plants continue to grow and cover the ground.**



Before: October 5, 2017 After: April 19, 2019

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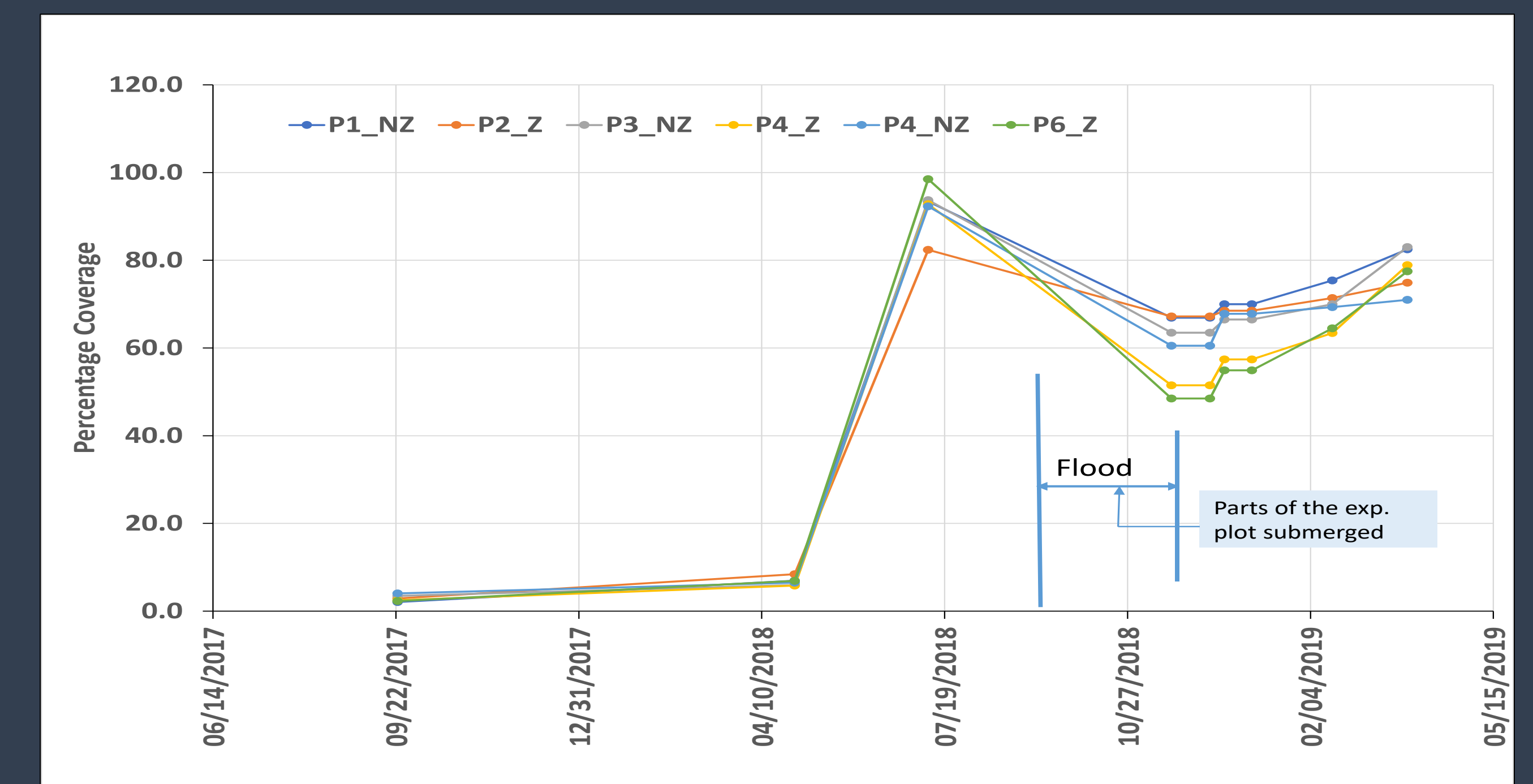
Before: October 5, 2017 After: April 19, 2019

Plots with zeolite

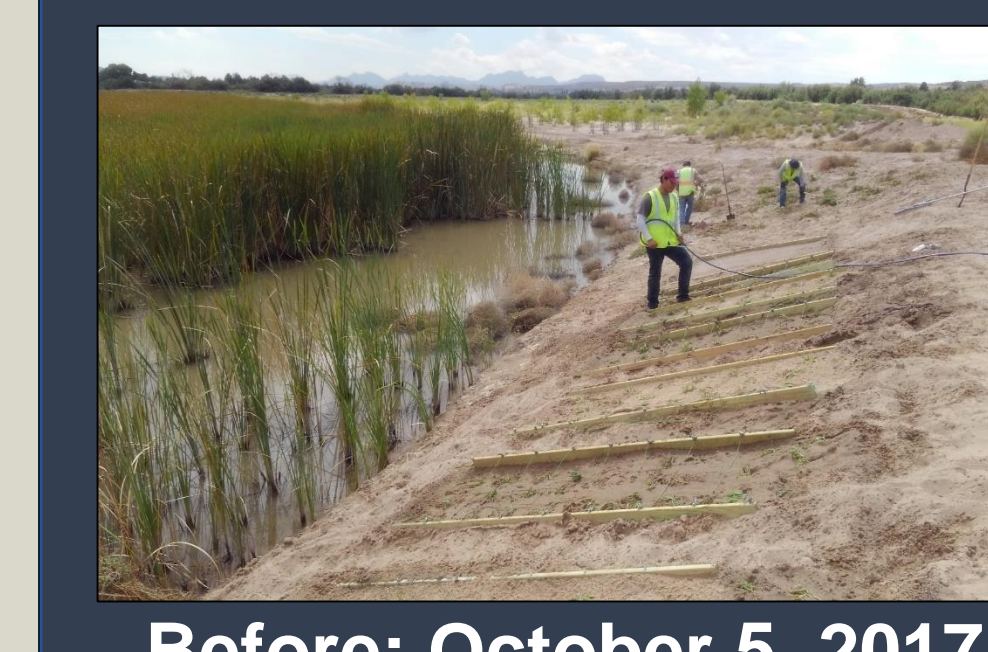
Plots without zeolite

Results: Plant percent coverage over time

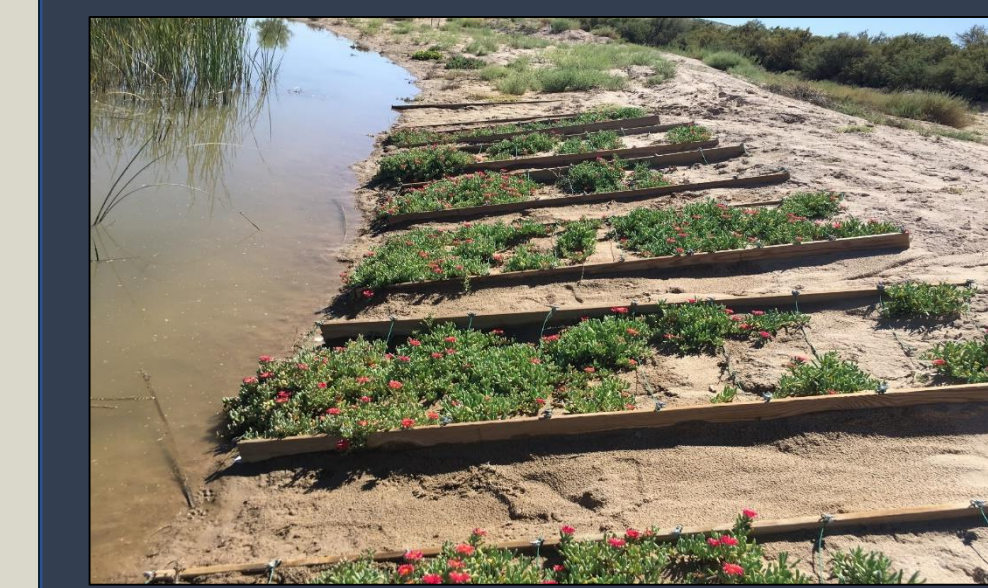
DATE	Plot 1 (%) Non-Zeolite	Plot 2 (%) Zeolite	Plot 3 (%) Non-Zeolite	Plot 4 (%) Zeolite	Plot 5 (%) Non-Zeolite	Plot 6 (%) Zeolite
4/28/2018	6.9	8.4	5.9	5.8	6.5	6.9
7/10/2018	93.4	82.4	93.7	92.8	92.3	98.5
11/20/2018	66.9	67.2	63.5	51.5	60.5	48.5
12/11/2018	66.9	67.2	63.5	51.5	60.5	48.5
12/19/2018	70.0	68.5	66.5	57.4	67.8	54.9
1/3/2019	70.0	68.5	66.5	57.4	67.8	54.9
2/16/2019	75.4	71.4	70.0	63.4	69.3	64.5
3/29/2019	82.5	74.9	83.0	78.9	71.0	77.5



Plant Percent Coverage of succulent (*Delosperma cooperi*)



Before: October 5, 2017

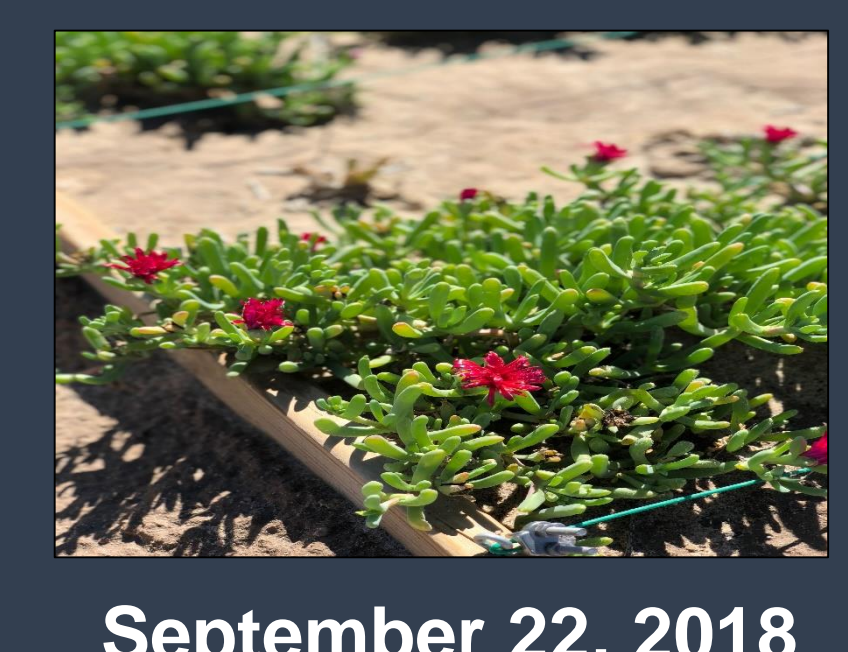


After: September 22, 2018



Plants trap soil

April 13, 2019



September 22, 2018



April 13, 2019

Future work

Analysis of plant growth and sediment transport is in progress. Succulents are expanding and the percentage of plant coverage have increased. Numerical values of plant density in each plot and treatment is being assessed. Sediment transport will be measured using a rainfall simulator.

Relevance and Implications

Protection of earth embankments of urban drainage canals from erosion in the arid warm environments has been a challenge. The current methods used involve lining the canal with concrete, gravel, or rocks. These methods are expensive and not beneficial to the environment. The alternative is to leave the banks exposed and vulnerable to erosion which also requires regular maintenance. This study investigates the use of succulent plants which produce flowers to support insects, can withstand drought and are aesthetically pleasing to control soil erosion and reduce sediment flow into urban canals.

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