Developing an Effective Monitoring Strategy Using Photogrammetry and 3D Mapping to Measure the Impact of a Plug and Spread Composite Treatment in a Degraded Alluvial Fan in the Semi-Arid Grasslands of the Southwest

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INTRODUCTION

The degradation of alluvial fans in semi-arid grasslands of the Southwest is often the result of channel incision and has been shown to contribute to a loss of hydrologic connectivity between montane areas and lowland grassland areas. In this study we examine the impact of the Plug and Spread (Figure 1) composite restoration treatment (Zeedyk, 2015) by measuring sediment aggradation as an indicator of restored sheet flow to the fan surface using photogrammetry and 3D mapping. Understanding the impact of restoration in degraded alluvial fan systems can be applied to land management strategies to increase water availability, forage production and groundwater recharge potential in increasingly warmer, less predictable climatic conditions.

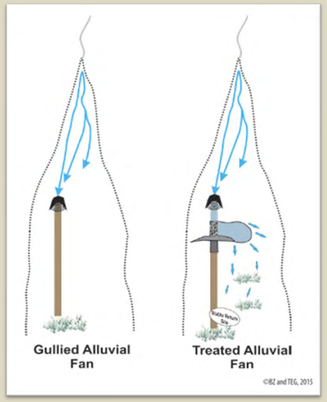

Figure 1. Illustration of Plug & Spread treatment in alluvial fan system (Zeedyk, 2015)

METHODS & OBJECTIVES

- **March – June 2020** Plug and Spread composite treatment to reroute runoff back to alluvial fan floodplain, ancillary structures to stabilize sheet flow and prevent future channelization (Figure 2)
- **June 2020** Post-restoration, pre-monsoon season unmanned aerial vehicle (UAV) flight with New Mexico Forest & Watershed Restoration Institute (NMFWRI) to capture pre-monsoon season imagery for baseline analysis (Figure 4)
- **August – December 2020** Develop methodology using Pix4D, ArcMap, and ArcGIS Pro software for image synthesis and to determine accuracy of digital elevation model (DEM) products and 3D model generation, develop analytical analysis to quantitatively determine effectiveness of treatment
- **November 2020** Post-restoration, post-monsoon season UAV flight with NMFWRI to capture post-monsoon imagery used to calculate differences in elevation height and sediment volume before/after the monsoon season as an indicator of restored sheet flow to the fan floodplain

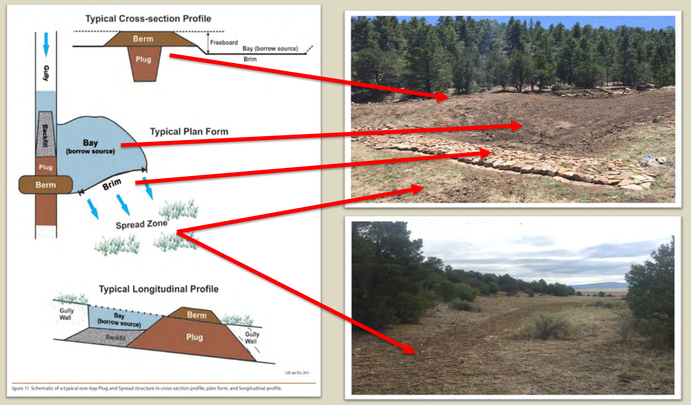

Figure 2. Profile illustration of Plug & Spread treatment (Zeedyk, 2015) and associated restoration structures within study site

ANTICIPATED OUTCOMES

This study aims at developing a methodology using UAV imagery, photogrammetry, and 3D mapping as an effective monitoring tool to determine the impact of a Plug and Spread composite restoration treatment. If the research objectives are met, we expect to see the following:

- Pix4D Mapper synthesis of UAV collected imagery (Figure 5) will generate accurate DEMs (Figure 7) of pre- and post-monsoon season flyovers in which elevation height differences will be detected as a result of sediment aggradation
- Lidar generated point clouds (Figure 8) in conjunction with 2D orthophotos (Figure 6) will construct accurate 3D models pre- and post-monsoon season in which changes in sediment volume will be detected a result of sediment aggradation
- Multiple Pairwise Comparison statistical analysis will provide quantifiable, measurable evidence into the effectiveness of a Plug and Spread composite treatment as a viable technique for restoring hydrologic connectivity in this particular alluvial fan in a semi-arid grassland ecosystem
- Photo monitoring will provide qualitative evidence into the effectiveness of a Plug and Spread composite treatment by tracking increases in vegetative cover and decreases in % bare ground

Figure 3. Study site area of interest

Figure 4. NMFWRI UAV flight path, pre-monsoon flight

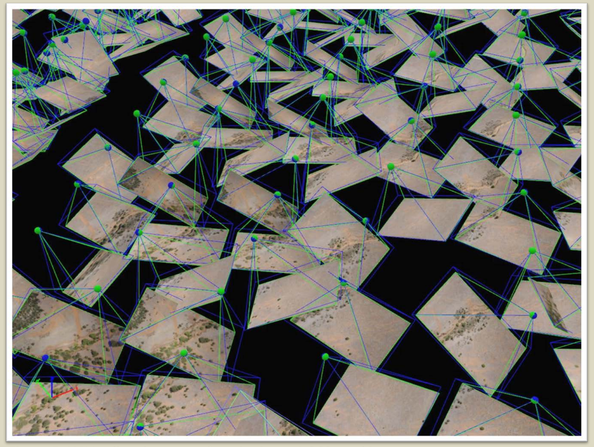

Figure 5. UAV collect imagery of study site - ~1,360 total images

Figure 6. Pix4D generated 2D orthophoto

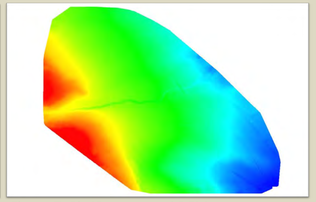

Figure 7. Pix4D generated DEM

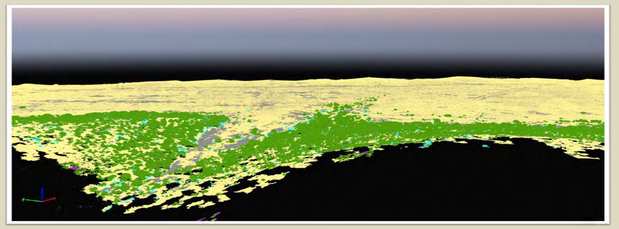

Figure 8. Lidar generated point cloud

SUMMARY

This research project combines traditional ecological knowledge, site-specific restoration treatments, and GIS technology to develop an effective monitoring strategy to measure the impact of a Plug and Spread composite treatment. Changes in sediment height and volume will be measured as indicators of restored sheet flow through 2D and 3D digital modeling between two UAV flights, before and after the 2020 monsoon season. In precipitation driven systems, the amount, frequency, and duration of precipitation events will determine the impact of the Plug and Spread composite treatment and the anticipated outcomes of this study. Despite the lack the predictability, by plugging the incised channel, we are effectively capturing and rerouting any amount of water back on to the fan floodplain that would otherwise be accelerated out of the alluvial fan system.

REFERENCES & ACKNOWLEDGMENTS

Thank you to Dr. Blanca Cespedes, Dr. Julie Tsatsaros, Dr. Craig Conley, Sara Amina Sena, Bill Zeedyk, Patti Dappen, Katie Withnall, Joe Zebrowski, Josh Miner, Cameron Snyder, & Sol Ranch

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