MAGIP Higher Education Scholarship Awards 2020

Seth Mangini, PhD student
Department of Earth Sciences, Montana State University
"Southwestern Wetlands: Erosion, Geomorphology, and Implications for Restoration"

Wetlands are critically important to sustaining life and valuable ecosystem services worldwide, and especially in the semi-arid west. The integrated approach being proposed by Seth will us understanding the processes that drive the development and erosion of these vital ecosystem components and will be useful for guiding future management and conservation strategies.

To learn more about Seth's project his abstract is available here:

Abstract
The loss of wetlands is a critical problem globally. Between 1975 – 2015 over 35% of the world's wetlands were destroyed, and the rate of loss has increased since 2000 (Ramsar, 2018). Wetlands are disproportionately important in semi-arid climates where climate change threatens already scarce water supplies (Fretwell et al., 1996; Williams, 2011). New Mexico has lost at least 30% of its wetlands in the past 200 years. They constitute only 0.6% of the state's land area, but are critical to the survival of both human and natural communities (Dahl, 1990). We propose to study erosion in a model southwestern wetland, Bonito Creek, located in the Sangre de Christo Mountains of northeast New Mexico (Fig 1). Wetlands in the watershed are being lost due to arroyo formation (riparian erosion via channel incision) (Mangini and Sudmeir, 2010). Geologic evidence has shown that arroyo incision and infilling is a cyclic process in semiarid climates (Cooke and Reeves, 1976; Harvey et al., 2011; Leopold, 1976; Schumm, 1979; Summa-Nelson and Rittenour, 2012; Townsend et al., 2019), but the timescales and forces which control these cycles are not quantitatively understood. This study will determine the geomorphic processes, timing, and drivers of wetland formation and erosion. This project will produce three results: 1) a geomorphic analysis and history of erosion and sedimentation in the model system, Bonito Creek, 2) a comparison to arroyo erosion in other watersheds in the region, and 3) the establishment of restoration goals and monitoring metrics for Bonito Creek. This study will utilize a novel combination of research methods. These include geospatial analyses with high resolution LiDAR derived DEMs and multispectral imagery such as NAIP and Landsat. These will be tied to physical stream morphology measurements, stratigraphic and sedimentary descriptions, geochemical dating of sediments, ground penetrating radar (GPR), and electrical resistance tomography (ER). We will learn how long it took for wetland sediments to accumulate, how fast they are being lost, and what the consequences are for the hydrology and ecology of the watershed. This information will be used to develop a scientifically sound management and restoration plan.

Sasha Loewen, PhD student
Land Resources and Environmental Sciences, Montana State University
"Data driven adaptive management of organic dryland cropping systems"

Global demands on food production are powerful, and we will need sophisticated and accessible solutions to sustain the land and support society currently and in the future. The combination of contemporary data gathering and analysis techniques, and a strategy for empowering those that need the information the most, proposed by Sasha should have a powerful impact on the future of farming.

To learn more about Sasha's project his abstract is available here:

Abstract
The world population is growing and demands on global food production are rising (Garnett et al., 2013; Foley et al., 2011). All the while agricultural practices of high inputs and vast continuous monocultures are degrading land, waterways, and reducing ecological services worldwide. Organic agriculture proposes partial solutions to these problems by reducing inputs and emphasizing soil health, however it is unable to match conventional agriculture yields (Seufert et al., 2012). Conventional systems have increased yields with the adoption of precision agriculture (PA), and using data driven mapping techniques that allow variable rates of nitrogen to be applied to specific field points to maximize yield and reduce nitrogen loss (Peerlinck et al., 2019). Organic systems can emulate these results through variable seeding rate application of nitrogen-fixing green manure (GM) and subsequent cash crops. Preliminary results from one year of study show economic and environmental benefits from variable seeding rate application in organic systems. Further experiments of the proposed methods are currently being tested on five farms in the northern great plains. The proposed research will provide farmers with innovative on-farm precision experimentation (OFPE) methodologies and access to modern data sources. The objective of this research is to increase farmers' understanding of the causes of spatial variation in crop response and recommend management optimization strategies.

Zachary Miller, MS student
Department of Earth Sciences, Montana State University
"Mapping Snow Depth Variability in Complex Mountain Terrain Using UAS and SfM Photogrammetry"

Understanding the spatial and temporal dynamics of snow accumulation and melt in a mountainous environment is critical to effective management of land and water resources in Montana. The research proposed by Zachary into the use of UAS captured photogrammetry to asses those dynamics is timely, innovative, and is already demonstrating abundant potential.

To read more about Zachary's work his abstract is available here:

Abstract
Mountain snowfall acts as essential water storage and a potential natural hazard to communities worldwide. The seasonal evolution of the spatial distribution of snow depth reflects water data that is valuable to resource managers and downstream communities concerned about water availability and flooding. These data also provide information that aids avalanche risk assessment regarding the safety of infrastructure and winter mountain recreationalists. Snow depth can be difficult to assess due to its inherently complex variability across different spatial and temporal scales, especially

in mountainous regions. Unmanned Aerial Systems (UASs) combined with Structure-from-Motion (SfM) photogrammetry provide new methods that show promise for quantifying snowpack variability at the slope scale. However, the majority of current studies have been constrained to relatively simple terrain. Recently, there has been considerable research done utilizing UASs and photogrammetry for snow depth sensing in a variety of environments. Comparatively low-cost UASs equipped with high-resolution digital cameras and high accuracy GNSS hardware are capable of creating digital surface models (DSMs), 3D models and orthophotos of snow-covered physical landscapes with greater than 10cm accuracy (Bühler et al., 2016). Additional studies established that UASs and photogrammetry can successfully model measurable snow depth change over a variety of time scales. Although proving the feasibility of UAS at sensing snow depth change, these projects have largely been conducted over relatively planar flat slopes in alpine environments. While these studies prove the methodology, they have failed to capture valuable information about water storage in complex mountainous terrain, invaluable for Montana water resource managers.

Lochlin Ermatinger, Bachelor degree student
Land Resources and Environmental Sciences, Montana State University
"Developing Spatial Tools and Methods for Integrated Pest Management of the Wheat Stem Sawfly (Cephus cinctus) in Montana's Golden Triangle"

Agriculture is a major component of Montana's economy and culture. Our land and people are going to need innovative and practical solutions in order to meet the demands of a hungry world, and Lochlin's work involves addressing issues related to integrated pest management in Montana wheat fields.

For more information about this project, his abstract is available here:

Abstract
The wheat stem sawfly, Cephus cinctus Norton (Hymenoptera: Cephidae), is currently the most detrimental pest to the production of wheat, Trtiticum aestivum L., among other cereal crops, in the United States and Canada (Beres et al. 2011; Reis et al. 2019). The main strategies used to mitigate yield losses induced by wheat stem sawfly (WSS) infestation are infrequent insecticide application, planting solid stem cultivars, and varying seeding densities (Keren et al. 2015). Unfortunately, insecticides are relatively ineffective and expensive (Knodel et al. 2009). Furthermore, a survey conducted in 2015 showed that only 12% of wheat producers in the Northern Great Plains (NGP) use modified plant densities to offset the effects of WSS, while 33% used solid stem cultivars (Keren et al. 2015). This is alarming considering that producers of cereal crops in the NGP are estimated to incur economic losses of $350 million per year as a result of damage caused by WSS (Beres et al. 2011). Given the economic setbacks of WSS paired with the lack of uniform pest-management strategies among producers, there is a need for new methods and techniques to suppress WSS.
Current efforts in developing techniques to mitigate WSS induced losses focus on bolstering the populations of parasitoids endemic to the NGP. The natural enemies Bracon lissogaster Muesebeck and Bracon cephi (Gahan) (Hymenoptera: Braconidae) are seen to have considerable efficacy as biological control agents (Davis et al. 1955; Somsen & Luginbill 1956; Morrill et al 1994; Eilenberg et al. 2001) as they are the only insects known to attack WSS larva inside wheat stems (Weaver et al. 2004; Beres et al. 2011; Reis et al. 2019). Lab studies have shown that these parasitoids can experience increased egg load, size, and extended life spans when they have access to carbohydrate rich diets (Reis et al. 2019). Such carbohydrates can be found in the floral and extrafloral nectar of flowering plants (Wratten et al. 2003). Past studies looking at other species have demonstrated that increasing these resources on the

landscape can improve the abilities of natural enemies to suppress their target pests (Patt et al. 1997; Westphal et al. 2015). However the aforementioned studies employed this tactic in potato and rice producing systems, respectively. In order to implement a successful flower stripping system for the natural enemies of WSS in the NGP we must first: identify species that provide accessible resources to the natural enemies of WSS and understand their habitat requirements. This endeavor represents a pioneering effort for the integrated pest management (IPM) of cereal crop systems in North America and will take time to develop but has the potential to not only suppress WSS but enhance broader ecosystem services (Adhikari et al. 2019). To support development of this technique we will create a geospatial infrastructure that leverages existing knowledge while incorporating field truthed data will aid this effort greatly while better informing future integrated pest management tactics.