Mountain Studies Institute

The Center for Snow and Avalanche Studies

Proposal for San Juan Snowtography Network Expansion and Regional Analysis

Background and Project Need

Decreased water quantity and increased wildfire in the Southwest has led to conversations between land managers and collaborative groups to answer questions related to how forest canopy influences snow accumulation and ablation at low, middle, and high elevations; and how changes in snow dynamics influence soil moisture content and the implications for water yields and forest resilience. Current water availability is forecasted based off SNOTEL and remote sensing, which presents significant gaps in our understanding. SNOTEL sites are unrepresentative of complex forest structure and remote sensing has very low temporal resolution. To fill this knowledge gap and to address these questions, a partnership formed between the Mountain Studies Institute, United States Department of Agriculture, The Nature Conservancy, Dolores Watershed Resilient Forest Collaborative, and Dolores Water Conservancy District, and Fort Lewis College. To date, this group has installed three snowtography sites in the San Juan Mountains. Snowtography is a simple, yet effective way to quantify the impacts of forest structure on water resources and forest resilience. As this relationship is regionally variable, the goal is to create a strong network of sites across the San Juan's to better inform resource managers on the most effective way to create climate resilient forest and water supplies.

To better understand how forest structure impacts water yields in our backyard, the Mountain Studies Institute (MSI) and Center for Snow and Avalanche Studies (CSAS), in partnership with the above listed collaborators propose to install two snowtography sites. The first would be in the Pagosa Springs area, and will target burned forests, a disturbance type underrepresented in our current network. The second snowtography site will be close to Red Mountain Pass at CSAS's long term research site, Swamp Angel. Swamp Angel provides an excellent addition to the existing network for a number of reasons including filling in the data gap of high alpine ecosystems, long term meteorological data sets are available and no additional meteorological equipment is needed, remote sensing data of snow water equivalent (SWE) exists from the Airborne Snow Observatory, and the availability of local staff reduces travel times to the monitoring site.

MSI and CSAS have received funding commitments from Northern Arizona University and the Town of Silverton to partially support this project and is looking to the Southwest Basin Roundtable, Southwestern Water Conservation District, and The Nature Conservancy for the remainder of the funding needed for equipment and labor. In addition, we are applying to the USDA National Needs Graduate Fellowship to support a local master's student to manage the sites as well as work on regional analysis across established sites to better inform management of our local watersheds.

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Objectives

1. Establish a study site in Senator Beck Basin at the Swamp Angel Study Plot, a long-term study area monitored by the Center for Snow & Avalanche Studies.
2. Select and establish a site in the Pagosa Springs area to fill the data gap of burned systems.
3. Implement a monitoring program to collect snow density measurements and download instrumentation data twice monthly.
4. Provide mentorship to a Silverton local pursuing a master's degree with hopes of returning to continue to support the ecosystems of San Juan County.
5. Produce a published article on the regional interaction of climate and forest structure and their influence on water storage and availability.
6. Continue studies for longer-term data collection and continue partnerships to produce peer-reviewed literature and inform local management decisions.

Additional Scientific Background Information

There are two interconnected issues that western US resource managers are facing. The first is a significant decline in snowpack (Kirchner et al., 2020; Mote et al., 2018; Sun et al., 2018), while the precipitation regime is switching from snow to rain dominated (Gascoin et al., 2020; Kostadinov et al., 2019). As the snowpack represents upwards of 80% of in-stream flows (Li et al., 2017), this can have profound consequences for water resource managers in Southwest Colorado. Impacts of a declining snowpack can include decreased water availability, possible flooding due to rain on snow events, reduced storage capacity due to a decreased snowpack, issues of timing and availability, as well as an increased ecological demand for water and increased drought conditions.

Our snowpack is largely declining due to increased atmospheric temperature, changes in jet streams, as well as increased dust on snow events. These climatological impacts are not only impacting our snowpack, but also our forested ecosystems that typically serve as our winter storage for water while demand is low, releasing snowmelt in the spring and summer when water demands are higher. With increased temperatures, and shifts in wind intensity, we are seeing larger and larger wildfires (Abatzoglou & Williams, 2016; Steel et al., 2015). This forms a positive feedback loop, where a decreased snowpack reduces soil and fuel moisture, increasing the likelihood of a wildfire. Once a wildfire has occurred, there is limited vegetation to provide cover from incoming solar radiation and wind, decreasing the snowpack even further. Historically, the San Juan Mountains has seen logging, grazing, tree regeneration, and over a century of fire exclusion, leading to a homogenized forest structure with dense canopy cover in dry forests (Brown et al., 2005; Romme et al., 2009). These conditions create an opportunity for management-based interventions to drought resistance, including prescribed fire and mechanical treatments, but these types of treatment may influence near-surface soil water content or temperature, having a greater impact on seedlings and re-growth potential (Korb & Stoddard, 2020) (Belmonte et al., 2022; Botero et al., 2017; Flathers et al., 2016; Kolb et al., 2020; Kolb & Dixit, 2016; Simonin et al., 2007).

Budget and Funding Sources

Table 1. Cost by task and site

	Task 1 - Install	Task 2 - Monitoring	Task 3 - Analysis Support	Grad Student
Swamp Angel	$31,870	$15,760	$7,800	
Pagosa Springs	$31,420	$15,760	$7,600	$64,000
Total	$63,290	$31,520	$15,400	
Project Total	**$174,210**			

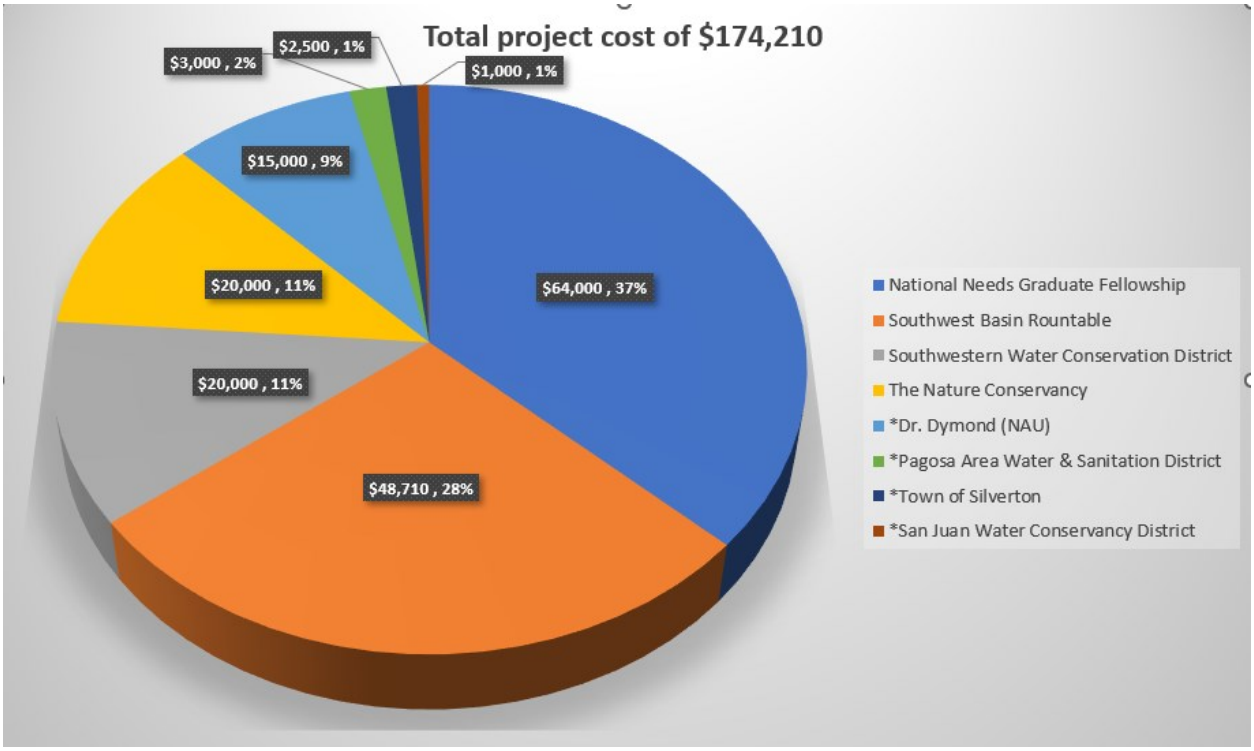

*Figure 1. Funding Sources and anticipated asks. *Notes committed funds.*

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