Soil Mapping Using Near Remote Sensing in SW United States

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Current soil mapping methods are time consuming and expensive, especially at small scales and in remote areas. Traditional methods require both aerial photographs and field measurements such as textural and color classifications to be collected and studied by a professional soil scientist (Soil Survey Staff, 2017). After data is collected the scientist will then create a conceptual model of soil formation to predict the soil taxonomy of the surrounding area. Traditional soil mapping methods have high propensity for error (Wilding, 1965; Drohan, 2003). Modern soil surveys produce maps at 1:24,000 or 1:12,000; at these scales one inch on th map is equal to 2,000 feet and 1,000 feet respectively (Soil Survey Staff, 2017), meaning acres of soils can be missidentified. To create a soil map that is more detailed with current methods is logistically cost prohibitive to undertake, especially in range-land areas.

With the advancement of technology several new approaches have been proposed to create a soil map using differentiation of soil properties (Dobos, 1998; Engle, 2009; Lagacherie, 2006; Lunt, 2003; Mcbratney, 2003; Moran and Bui, 2003; Scull, 2003; Ulaby, 1996). Generally these approaches fall into two categories: digital soil mapping and remote sensing. Physical soil properties such as grain size, organic matter content, and slope influence the residence time of water in the soil (Anderson et al. 2013). Soil moisture can be obtained using electromagnetic induction or moisture probes (Birchak, 1974; Sudduth, 2003), however, these methods are limited to 50 acres and are immobile. Estimates of soil moisture can be made from satellite imagery through radar or energy balance algorithms. This is done either through radar (Ulaby, 1996; Dobos, 1998) or through multispectral bands using energy balance algorithms (Bastiaanssen et al. 1998). Radar is only accurate 0-5cm in depth (Reich, 2014;Dobos, 1998; Suarez, 2010; Scull et al. 2003), while energy balance algorithms predict moisture to root depth (Allen et al. 2009; Bastiaanssen, et al. 1998; Hendrickx 2005, 2009). A limitation of this method is that it relies heavily on satellite data which has coarse spatial and temporal resolutions and is inhibited by cloud cover.

We hypothesize that an accurate and detailed soil map can be produced using data collected by way of Unmanned Aerial Vehicles (UAVs). We have collected remote imagery data using UAVs before using energy balance algorithms to estimate soil moisture. We then observed the changes in soil moisture estimation over several days and compared these changes to established drying curves, which are correlated to physical properties. Theoretical drying curves are indicative of texture and horizontality (Cosby, 1984; Miller, 1973). We trained the computer to recognize differences in soil types based on soil moisture changes. The result is a soil map with increased temporal and spatial resolution with a reduced misclassification.

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