Project Title: *Examining the extent which differing algorithms used in spatially summarizing soil components vary the reporting of soil water holding capacity*
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Principal Investigator: Dr. Bryan Runck
Budget: ?
Account String: ?

Project Overview (3-5 bullets)

- Soil-water holding capacity is used as an input for estimating soil-water balance for irrigation scheduling
- Soil-water holding capacity can be calculated multiple different ways from individual gSSURGO polygons aggregated to the field-level. The existing literature is ambiguous about the sensitivity of the aggregation method (interpolation algorithm) to final results
- Project goal is to understand how the different ways of summarizing SSURGO map unit available water capacity (AWC) within field spatial variability results in different field-level soil-water holding capacity estimates
- Gridded SSURGO's soil water holding capacity is estimated at four depth ranges (0-25cm, 0-50cm, 0-100cm, 0-150cm), but needs to be reported in the Minnesota IMA tool as 0-12in, 12-24in, 24-36in, 36-48in.
- Project aims to produce a map for each soil-depth interval (4 maps total) which depict the difference between minimum estimate and maximum AWC estimates for each field.

Key References (3-5 citations and 2-3 sentences describe)

Easton, Z. M., Fuka, D. R., Walter, M. T., Cowan, D. M., Schneiderman, E. M., & Steenhuis, T. S. (2008). Re-conceptualizing the soil and water assessment tool (SWAT) model to predict runoff from variable source areas. *Journal of hydrology*, *348*(3-4), 279-291.

Easton et al. (2008) models the impacts and responses to excess rainfall with regards to 'variable source areas' (VSA's). This article was chosen as a key reference because it features an equation for calculating AWC along with a description of each variable involved in the equation.

Saxton, K. E., & Rawls, W. J. (2006). Soil water characteristic estimates by texture and organic matter for hydrologic solutions. *Soil science society of America Journal*, *70*(5), 1569-1578.

This article outlines in depth how a soil's ability to hold water (AWC) is the product of a variety of soil variables. This article contains a key table which lists the equations for a swath of soil-water relationships.

Toriyama, J., Ohta, S., Araki, M., Kanzaki, M., Khorn, S., Pith, P., ... & Pol, S. (2008). Comparison of soil physical properties in evergreen and deciduous forests in central Cambodia. *Journal of forest research*, *13*(1), 15-24.

Toriyama et al. (2008) identify a number of soil parameters within evergreen, deciduous, and mixed evergreen-deciduous forests in central Cambodia. This article was chosen because it outlines an alternate formula for "cumulative AWC."

Expected Outcomes:

- Determine the sensitivity of field-level soil-water holding capacity to the method of interpolation (variance between differing algorithms for summarizing total available water storage (AWS) for MN parcels via SSURGO polygons)
- Produce table of values documenting the variance of aggregated parcel AWS values between spatial interpolation methods.
- Determine the specific spatial (vertical) aggregation methods SSURGO used to arrive at the AWS values provided in the 'muggatt' table; use methods to calculate AWS at 0-12in, 12-24in, 24-36in, 36-48in soil-depth intervals & report variance in results between different algorithms
- Produce Python Jupyter Notebook allowing the replication of methods used and application to other research questions.

Data

Table 1. *Input data*

#	Title	Purpose in Analysis	Link to Source
1	Statewide soil composition (XY&Z dimensions) (via gSSURGO dataset)	Parsing out various soil component percentages across the extent of each gSSURGO "map unit" and at varying depths within units (0-25, 0-50cm, etc.) to address the question of how SSURGO arrives at their available water storage calculations aggregated by map units.	USDA-NRCS Soil Survey Geographic Database
2	Available Water Storage 0-25cm; 0-50cm; 0-100cm; 0-150cm (via gSSURGO dataset)	SSURGO provides Available Water Storage (AWS) values for each of their map units, aggregated at the depths of 0-25cm, 0-50cm, 0-100cm, and 0-150cm in their '*muggatt*' table. This table will be used to assess if the use of different algorithms in summarizing map unit AWS values to parcel boundaries results in substantial variance between results.	USDA-NRCS Soil Survey Geographic Database
3	MN County Parcel Data (Statewide)	Aggregating gSSURGO soil component data to agricultural fields	(Requested and received from UMN)

Proposed Methods

Research Objective 1.

- Soil components must be aggregated among Z-dimension before summarizing AWC at defined depth intervals at field-level
- Produce Jupyter Notebook which automates process of calculating soil water holding capacity for each '*mukey*' polygon at specific depth intervals of 0-12, 12-24, 24-36, and 36-48 inches
- Produce map visualizations of these findings within Esri ArcGIS Pro.

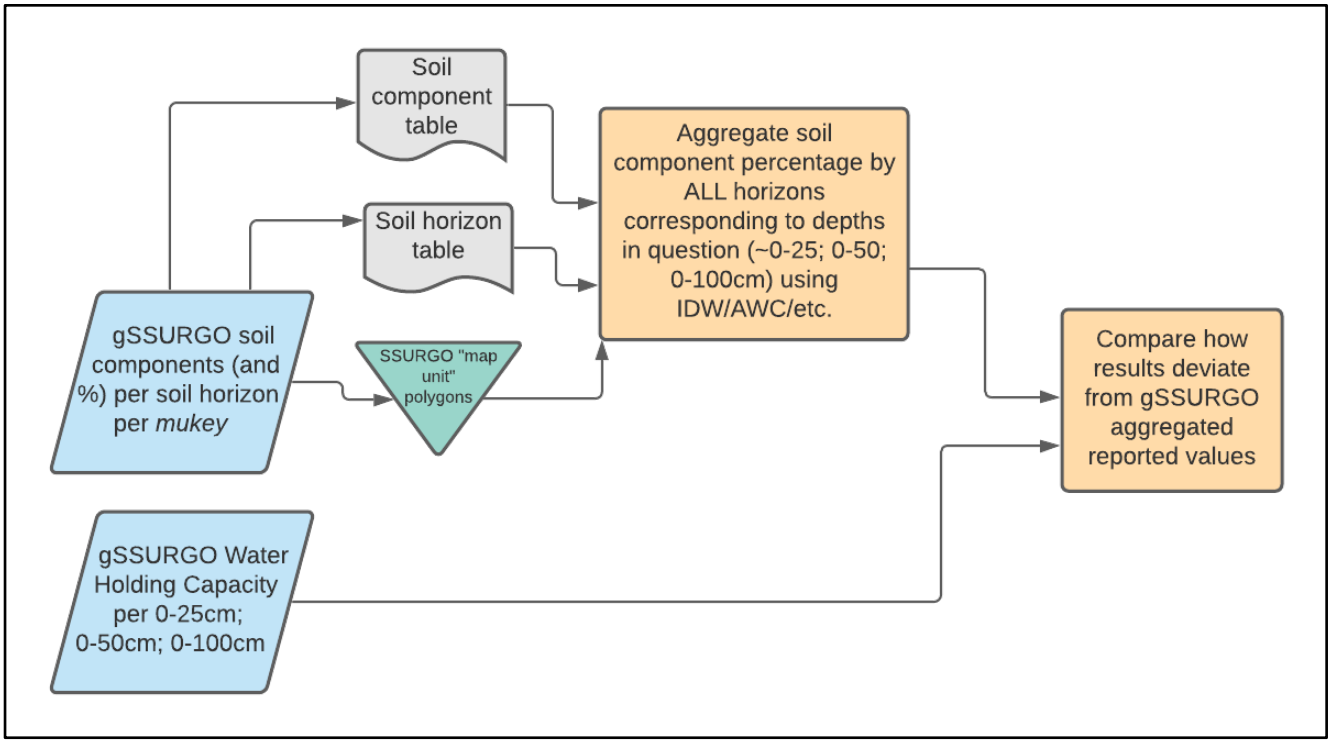

Fig. 1 Flow diagram depicting methodology for Research Objective 1.

Research Objective 2.

- Determine variance between differing algorithms that may be applied to summarize total available water storage (AWS) for MN parcels via SSURGO polygons.
- Create Jupyter Notebook for automating summarization of AWS per parcel polygon by each algorithm at each of the four depth intervals
- Join all of SSURGO's AWS values for each depth interval to all of the SSURGO map polygons
- Use "Identity" or "Union" tool from the ArcPy toolbox to determine which 'mukey' polygons underlay each parcel polygon; write this info to layer's attribute table
- Aggregate 'mukey' polygon AWS to the parcel divisions, documenting values achieved via each spatial interpolation algorithm for each of the four depth intervals, and the associated standard deviations among algorithm choices within each depth category
- Algorithms for IDW, Kriging, and Nearest Neighbor built into the ArcPy toolbox will be used to perform these calculations.

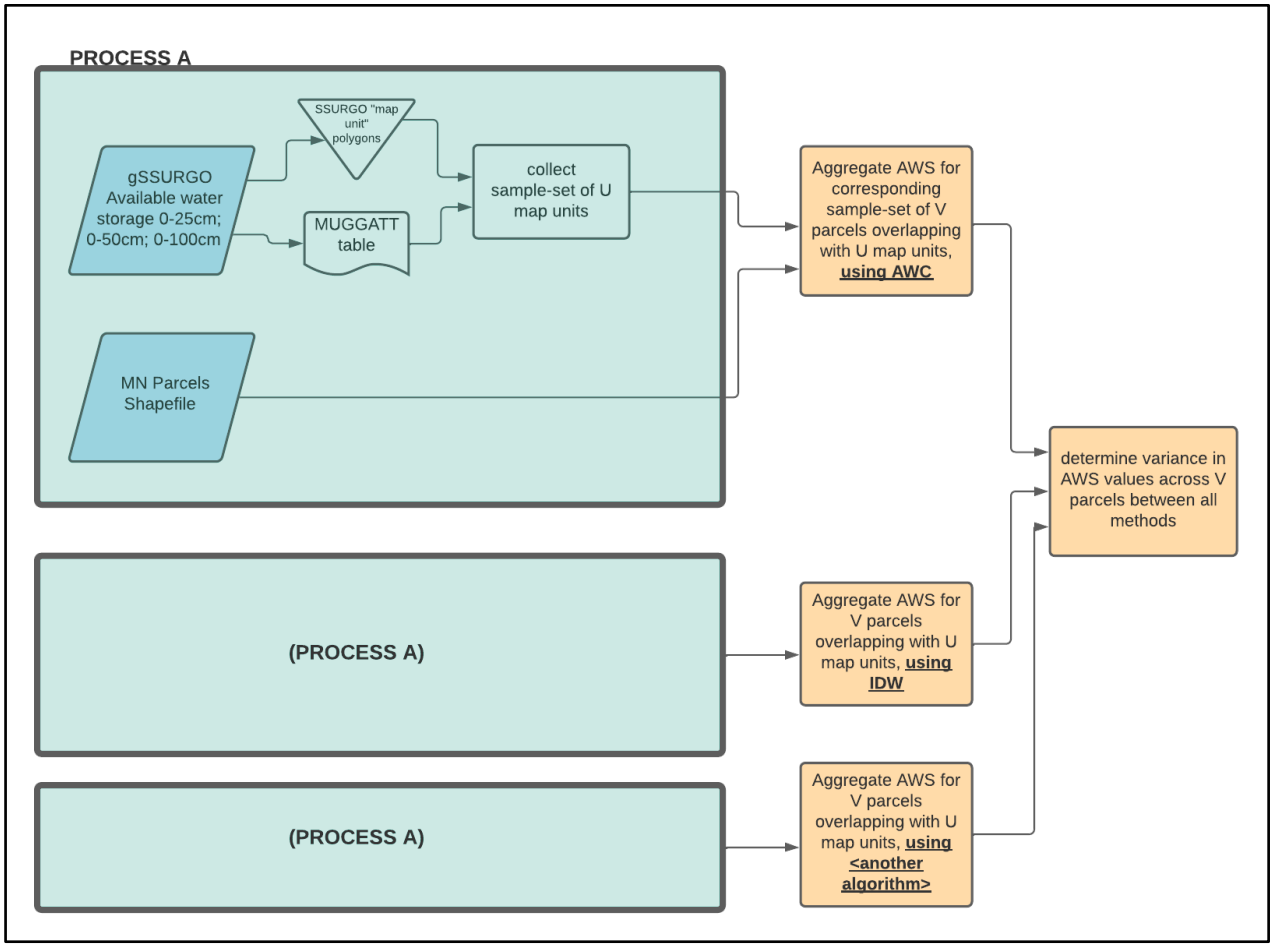

Fig. 2 Flow diagram depicting methodology for Research Objective 2.

Timeline

Task #	Task Name	Task Description	Time Estimate (hr) [min+max+4*realistic=/3 = ESTIMATED TIME	Statement of Work Category
1.0	Data Preparation	Load SSURGO//Parcels data into ArcGIS Pro, PostgreSQL	5hr (10)	**Setup**: Loading data; Understanding general methods to complete tasks
1.1	Analysis Preparation	Understand how to query parts of features that fall within the bounds of another shapefile feature; understand how to query soil components, horizons at specific depth intervals from SSURGO map units via table relates	15hr (30)	
1.2	Analysis Preparation	Understand how to create custom Python functions which aggregate data based on specific algorithms (IDW, Area Weighted, misc. heuristics)	15hr (30)	
1.3	Analysis	Aggregate all map-unit soil horizon AWC at depths of 0-12in, 12-24in, 24-36in, and 36-48in, using various algorithms(?).	15hr (30)	**Analysis**
1.4	Analysis	Aggregate the vertically summarized AWC values of map units at each of the four depth intervals to parcel/field boundaries, using various interpolation algorithms.	15hr (30)	
1.5	Writeup	Describe results of the work. Include scripts documenting all steps taken in analysis. Present data in tables which show results for each summarization step at each depth interval for each algorithm used.	20hr (40)	**Final Product**
1.6	Final Submission	Final submission package will be a Github.com repository containing: - ReadMe (containing script requirements) - Necessary Data (SSURGO; Parcels) - Clean commented Notebooks - Final Writeup	10hr (20)	