MN Corn Growers Specification List

Product Owner	Alexander Danielson	Carl Sones
Engineering Lead	Alexander Danielson	Carl Sones
Required Approvers	MN Corn Growers Association (Bryan Runck)	(Lucas Rosen)

Overview

My name is Jude and I represent the Minnesota Corn Growers Association. We are an association that covers the entire State of Minnesota. We'd like to provide our growers a map on a website that updates every day for the entire state and shows them 1) current and past growing degree days, 2) current and past soil moisture, and 3) current and past reference evapotranspiration. Can you help us make the system?

Also, we have some other developers that want to get the results in real-time too. They can receive geojson. Can you do that?

The main problem we are trying to solve/create is developing a live website that contains daily growing degree days, past and current soil moisture and past and current reference evapotranspiration for the MN Corn Growers Association. With this website, the growers would be able to better speculate and deduce when to grow certain crops and harvest them during seasons with ease and for more yields. Likewise for other intermediaries who would like this information in a GeoJSON format.

Further components that need to be considered for undertaking project in retrospect and for future considerations are:

- Estimation of and comprehension of Growing Degree Day by changes in temperature
- Statistics of past soil moisture and how it relates to current soil moisture
- How weather and climate trends affect evapotranspiration cycles
- Establishing connections with stakeholders, shareholders and farmers on how said above variables affect them in harvesting crops.

Motivation

Assisting the MN Corn Growers Association for ALL growers in the State of Minnesota in finding better solutions for growing degrees for farmer's crops. Predicting the right harvesting periods for when farmers and when they should plant based on past/current harvest trends. Likewise the evapotranspiration cycles and the impact it has on agriculture cycles throughout the state,

outcomes are potentially having a system that covers these and all-inclusive website. The potential for them to be design partners is probable, but not necessary.

Definitions

Growing Degree Day (GDD): Estimate the growth and development of plants and insects during the growing season, development will only occur if the temperature exceeds some minimum threshold or base temperature.

Growing Degree day calculation:

Growing Degree Day (GDD) are calculated by taking the integral of warmth above a base temperature. Or simply, approximately equivalent to take the average temperature and minus base temperature in the following equation:

GDD = (Tmax + Tmin) /2 – Tbase

Tmax, Tmin, and Tbase are the daily maximum, daily minimum and base temperatures, respectively. Normally the maximum and minimum daily temperatures are pre-calculated before the above equation. If the maximum or minimum daily temperature is lower than the base temperature, then we set the maximum or minimum daily temperature equal to the base temperature.

For example, if the maximum daily temperature is 20, the minimum daily temperature is 5 and the base temperature is 10, we will have the GDD in the following equation: GDD = (20 + 10)/2 − 10 = 5

Credit: *Samikshya Subedi* *via* *Final Project Report for ArcGIS I*

Past/Present Soil Moisture: The total amount of moisture or water vapor in an unsaturated soil. (In regards to past moisture and current)
Evapotranspiration: Process by which water is transferred from land to the atmosphere by evaporation from soil and other surfaces and by transpiration from plants.
GeoJSON: Open standard format designed for representing simple geographical features, along with their non-spatial attributes.

Scope

Functional Requirements

INFRASTRUCTURE AS A SERVICE (IaaS) (Essential) (basis for project) :

Architecture:

- User Expectations of Functionality:
    - Problem Definition: Assistance for MN growers to find suitable harvesting and crop productions with interactive and dynamic web app of GDD, soil moisture and evapotranspiration.
    - Functional Requirements: GeoJSON format and accessibility of web app that can be user friendly with shareholders/stakeholders including having longevity and maintenance for said application (via ArcGIS Online and Flask) See more for Software as a Service below.

SOIL MOISTURE SENSORS (Nice to have):

- ***Volumetric sensors***
    - *Volumetric soil moisture sensors directly measure the amount of water in the soil. (Indirectly linked to scale of how corn is grown at different areas/regions within the State of Minnesota)*
- ***Tensiometers***
    - *Soil particles hold water through either tension or adhesion. Tensiometers are soil moisture sensors that measure this tension between soil particles and water molecules. (Factors with soil moisture content and how evapotranspiration cycle can implicate changes in soil moisture content)*
- ***Solid state sensors***
    - *The most inexpensive option for measuring soil moisture content.*

WEATHER INSTRUMENTS (optional):

- *Anemometers*
- *Wind Vanes - Scale which North Dakota monitors affect Minnesota monitors*
- *Barometers - Scale which North Dakota monitors affect Minnesota monitors*
- *Hygrometers*
- *Rain Gauges*
- *Thermometers*

SOFTWARE AS A SERVICE (SaaS) (Essential):

- ***ArcGIS Online Server and Flask***
    - An interactive web map ***app*** that is seamlessly integrated with GDD data, past/current soil moisture and past/current evaporation data that is easily discernible and easy to navigate is imperative.

    - Integration of Flask to coincide with ArcGIS Online will require tweaking the interaction of web applications with wrangling of data and display of web apps.
    - Stakeholders and business users must be able to use this in the field seamlessly and make edits if they so choose and for farmers to understand/comprehend these changes.

Non-Functional Requirements

- ***Google Cloud Server via performance, reliability, and security of project***
    - Utilizing the Google Cloud Server and Structured Query Language properties the performance/specifications of our server with vCPUS at 4, memory at 8 RAM and SSD 100 GB should be optimal and reliable enough for stakeholders and end-users needs
    - Security parameters include HTTPS that allow security and confidentiality between end-users, so that if necessary it will be strictly available for stakeholders/farmers. Likewise, authorized and authenticated through reliable connections and maintain integrity from phishing if presented for public use and malware.

Out of Scope Requirements

What is the standard soil depth for planting crops? How does this range from other areas within the State of Minnesota? Other crop types to consider?

Persona Acceptance Criteria

Who are the stakeholders impacted by the project's success? What are they trying to achieve?

As developers Carl and Alex

- *Require accessible software and hardware to use for this project and an acceptable amount of funds to meet the end goal.*
- *Require possible discussion with stakeholders and end users/farmers to see areas of site if needed.*

As Operators MN Corn Growers Association

- *Require consistency and resilience with developers to ensure that milestones are met on time and the project is a success for the end users in the State of Minnesota.*
- *Require that additional stakeholders have access to required functionality and formats if needed so data integrity is achieved in multiple formats.*

As an end user of the application

- *Require easy navigation, flexibility in the management of GDD, past/present soil statistics and how evapotranspiration interacts with crops*
- *Require simplistic information and negotiation with intermediaries so that resources (i.e repellents, water, seeds) can be utilized better in factors for growing.*

Open Questions

- Are there any other intangible products that are needed/formats (besides GeoJSON) that must be considered? Similar to Out Scope question presented, how do other physiographic regions vary in data alterations for the whole state? Besides interactive web maps, will presentation/Powerpoint or user documentation be applicable for this forum/project?

Dependencies

- *NDAWN*
- *MN Department of Agriculture*
- *Iowa State University*
- *ArcGIS Pro*
- *Arcpy, fiona/shapely, requests, zipp,*
- *Psycopg2/sqlalchemy*
- *ArcGIS Online*
- *Google Cloud Server*
- *Architecture/Pipeline (pg Admin, Flask, Python, SQL, PostGIS)*

References

6 inch soil temperature network map. (n.d.). State.Mn.Us. Retrieved February 7, 2023, from https://gis.mda.state.mn.us/mda-soiltemp/

7 important types of weather instruments you should know about. (2021, December 20). Acurite.com. https://www.acurite.com/blog/weather-instruments.html

Buchen, L. (2017, December 11). 3 types of soil moisture sensors - which is best for you? Trellis. https://mytrellis.com/blog/smstypes

Ghiat, I., Mackey, H. R., & Al-Ansari, T. (2021). A review of evapotranspiration measurement models, techniques and methods for open and closed agricultural field applications. Water, 13(18), 2523. https://doi.org/10.3390/w13182523

Appendix

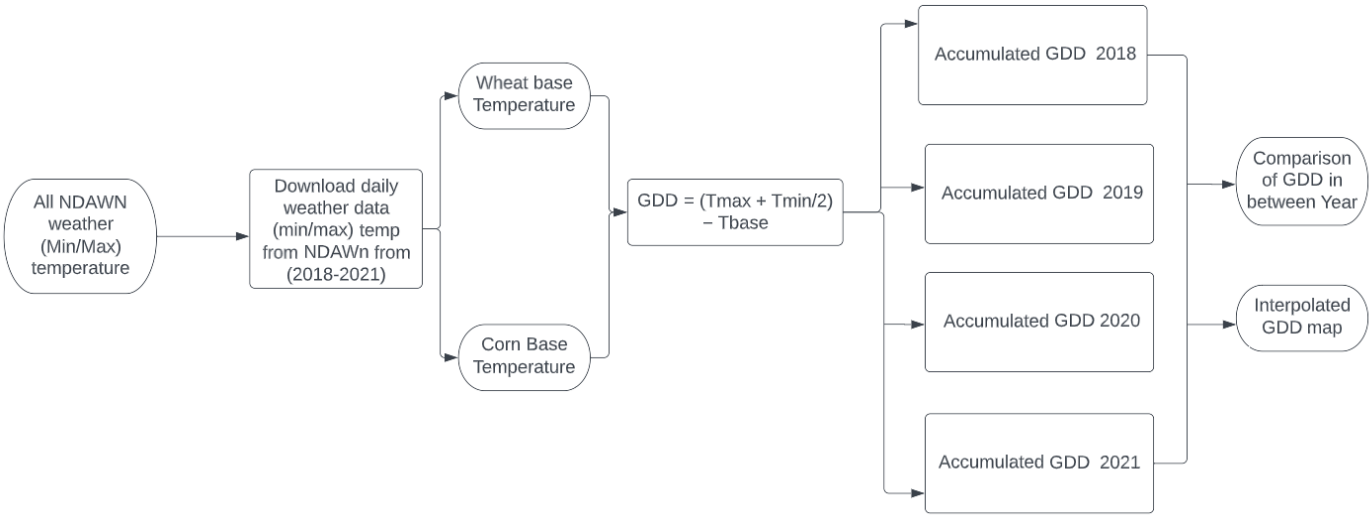

Figure 1.
Data flow diagram of process for GDD in above description
Credit: *Samikshya Subedi* *via* *Final Project Report for ArcGIS I*

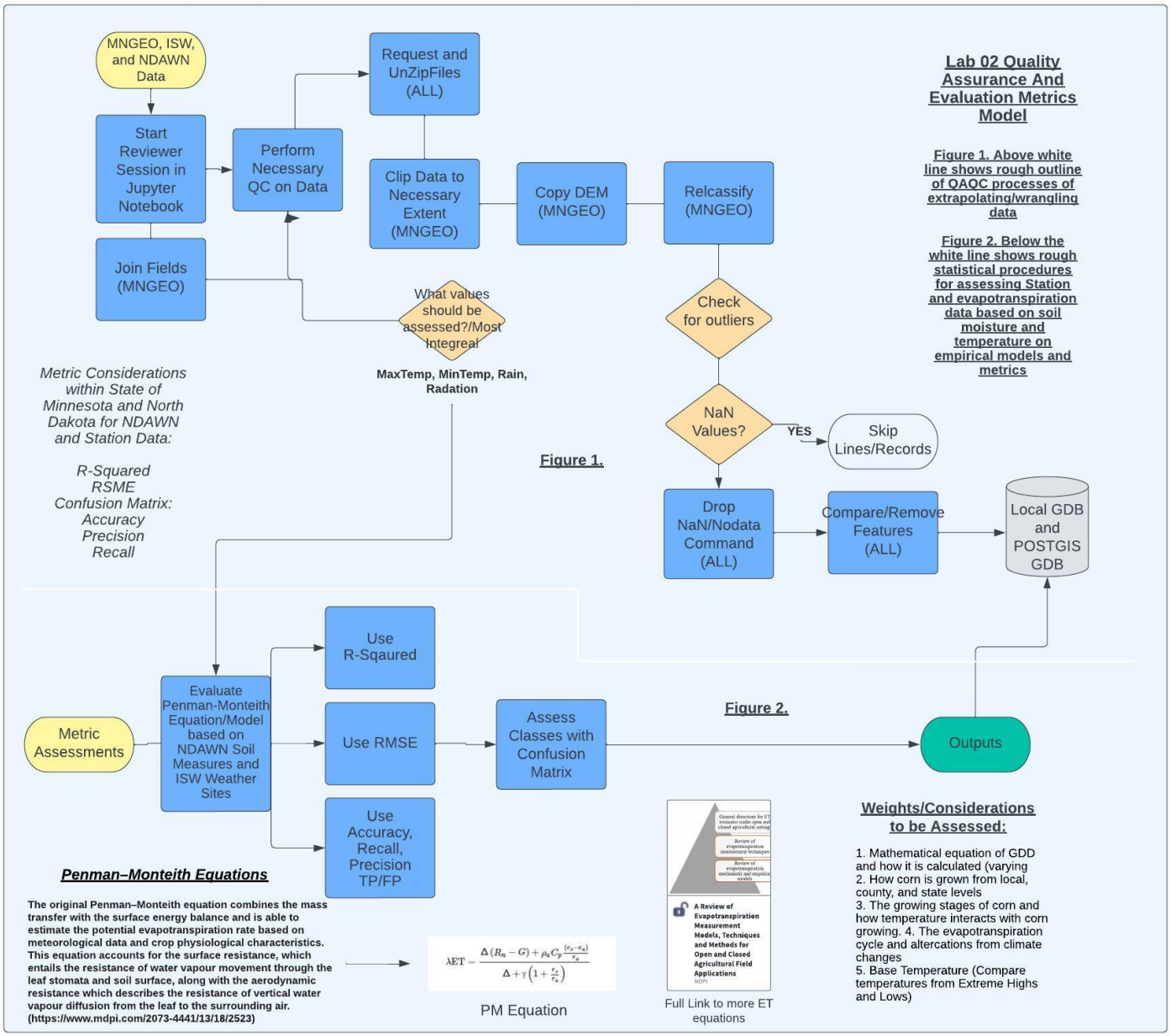

Figure 2.
QAQC Data flow diagram of Raster, Weather Station, and Soil Evaluation with Evapotranspiration Model and Metric Consideration