Corn Growers Climate Mapping Specification

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Overview

Objectives

The goal of this project is to develop a system that will:

- Provide a statewide map for
    - Growing degree days
    - Soil moisture
    - Evapotranspiration
- Provide field-level data interpolations
- Provide current and historical measurements
- Provide an API service for real time GeoJSON results

Problems

- Sparse data: point aggregation of data only in specific areas
- Complicated calculations: GDD and evapotranspiration
- Low spatial resolution: most current data is in point form, not field level interpolations
- Most farmers rely on other non-data driven approaches

Who it directly affects

- Minnesota Corn Growers Association (Farmers): Those who are growing actual corn crops.
- Stakeholders: Those who invest and profit from the corn grown by farmers.
- Soil Scientists: Those who are enlisted to support farmers and crop growth.
- Resellers: Those who make a living buying and reselling quality crops.
- Policy Makers: Those who need to understand the data to make informed economic and political decisions in regards to farming practices.

Why it's important

- The Minnesota Corn Growers Association represents corn farmers in the state and wishes to provide them with the tools needed to help maximize their yields. This application could provide a useful resource for informing farmers, scientists, and policy makers with data-driven planning. This application shows information about the soil quality across the state of Minnesota to support the maximization of crop yield.

Motivation

Agriculture is a major sector of huge importance, supporting not only those who grow crops but also countless others who rely on the produce for sustenance and economic prosperity. As crop yields fluctuate from year to year, the pressing reality of climate change brings a need for live, real-time data in order to maximize crop yields. Better data and predictive tools surrounding growing degree days, soil moisture, and evapotranspiration would allow agriculture specialists to be more informed and make better data-driven decisions.

The expected outcome is to build a practical user web service with the design partners being the Corn Growers Association. This service will allow users (the majority consumer group being farmers) to monitor soil qualities that allow them to maximize crop yields, despite the difficulties faced by the changing climate. Farmers, resellers, stakeholders, policy makers, and communities who enjoy corn can all benefit from corn being produced in the most efficient ways.

Definitions

- Growing Degree Days (GDD): measure of heat accumulation during the growing season.
- Evapotranspiration (ET): Water released into the atmosphere by evaporation and plant transpiration.
- Soil Moisture: Refers to the amount of water held within the soil particles and pore spaces in the ground.
- Interpolation: Estimating values for unknown locations within a set of known data points.

Scope

This section describes the scope of the project. It describes the functional and nonfunctional requirements as well as what items are out of scope for this iteration of the project.

Functional Requirements

GDD Data

- NOAA NCEI
- Historical Temperature and Precipitation Data
    - Back to 1951

    - NetCDF raster format
- 2 km grid
- Has API capabilities

ET Data
- National Weather Service
- NOAA
- Tomorrow IO Weather API
- Historical Temperature, Relative humidity, Wind Speed, Solar Radiation

Soil Moisture Data
- SSURGO:
  Soil Survey Geographic Database, this database provides detailed soil survey information, including soil type, across the United States
- Drought.gov:
  This platform gathers diverse datasets on soil moisture and drought from numerous origins, ensuring thorough coverage and in-depth analysis.
- Minnesota DNR:
- Grafana:
  These services can help determine soil moisture level for given coordinates.

Interpolated Surfaces
- Interpolation will be conducted using IDW, Kriging, or other methods
    - Necessary for any point data
- Essential: Interpolate for state of Minnesota at a low-resolution
- Nice to have: Higher resolution to a field-level scale
- Optional: Multiple interpolation methods

Web Interface
- Essential: Calendar through which users can analyze the historical data, and a raster map where a user can select each type of data
- Nice to have: Users can select cells and get all values together
- Optional: Field boundaries and field-level data

GeoJSON API
- User can input location of interest
- Has functionality with Google Cloud API Rest Services
- Returns data values at given location within Minnesota

Functional requirements are capabilities that the product must do to satisfy specific user needs. Functional requirements are sometimes referred to as business requirements. They describe capabilities that the intended product can perform to enable business users to do some part of their work and carry on with their business (operational) work. Each requirement should be prioritized with Essential, Nice to have, or optional priorities.

Non-Functional Requirements

- Easy to use
    - Essential: Usable by someone with basic web map reading skills (such as farmers)
- Reliable
    - Will be able to produce results across Minnesota for the data time range
- Live updates
    - Essential: Updates daily
    - Optional: Updates as often as possible for each weather type

Non-functional requirements include usability, performance, reliability and security requirements. These are qualities that the product must have. Technical requirements also fall under the non-functional category. Each requirement should be prioritized with Essential, Nice to have, or optional priorities.

Out of Scope Requirements

- Extremely high resolution (less than 30 meter)
- Scale larger than Minnesota
- Ranking quality of soil
- Crop evapotranspiration
- Field specific analysis

These are requirements that we are deeming out of scope for this iteration of the project. We list them here in order to be unambiguous and entirely clear with respect to project scope.

Persona Acceptance Criteria

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

As a developer, I …

- Require access to datasets and APIs so that I can download the data and perform analysis.
- Require Flask so that I can have a flexible web framework.

As an Operator, I…

- Require reliable data streams so that I can maintain databases with a small margin of error.
- Require robust QA/QC methods so that I can ensure quality data is being provided.

As an end user, I

- Require a web interface so that I can interact with the data in a user-friendly way.
- Require live, real time data, so that data-driven decisions are made from accurate data.

Open Questions

What assumptions we are making and known risks with respect to the feasibility of a project? This can be with respect to licensing, staffing, or how a particular requirement will be achieved. All open questions must be addressed by the design stage.

- How much will this cost to build and maintain?
- How much should we simplify the data for the standard layperson?
- How far back should the historic data go?
- How should the map be divided once a web application is built?
- What is the aerial extent of this project?
- Would covering the entire State of Minnesota be possible?
- What resolution of raster/interpolation is enough?

Dependencies

What dependencies does this specification have on other projects, components, or software? All dependencies must be highlighted here as every dependency is a potential risk.

Closed Source Dependencies:

- ESRI Infrastructure
    - ArcGIS Pro
    - ArcGIS Online
        - Experience Builder
- Google Cloud
- GitHub
- NDAWN
- Grafana

Open Source Dependencies:

- SSURGO
- Minnesota DNR
- Drought.Gov
- NOAA NCEI
- Flask
- PostGIS

References

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- https://www.nrcs.usda.gov/resources/data-and-reports/soil-survey-geographic-database-ssurgo
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- https://grafana.com/

Appendix

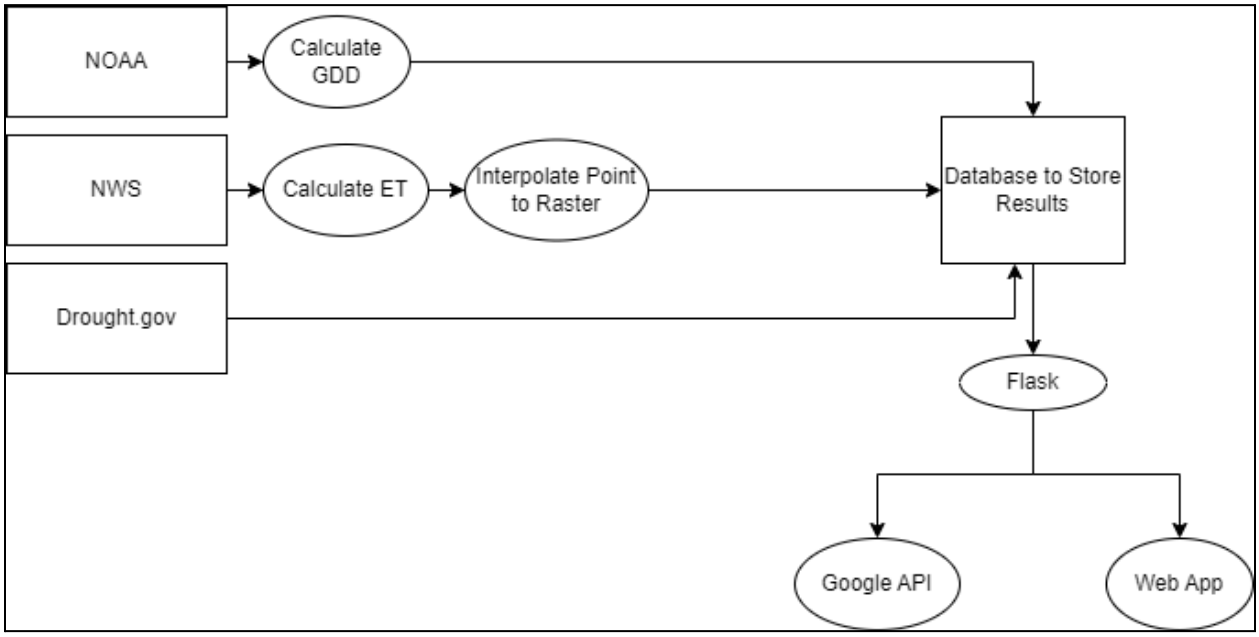

Figure 1: Data Flow Diagram