Data Science *for the* Public Good

IOWA STATE UNIVERSITY

AgMRC Beginning Farmer Asset Mapping

Data Science *for the* Public Good

IOWA STATE UNIVERSITY

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Data Sources

Iowa Environmental MesoNet Reanalysis Tool

- The IEMRE is a tool available publicly to provide climate information that tries to bypass the many problems associated with single site observations. From this tool, we receive our precipitation and temperature data for selected periods of time.

Soil Survey Geographic Database (SSURGO)

- The SSURGO database was our choice of data for the soil information required by our project. This is a survey conducted by the National Cooperative Soil Survey covering soil maps for more than 95 percent of the nation's counties.

Specialty Crop Information

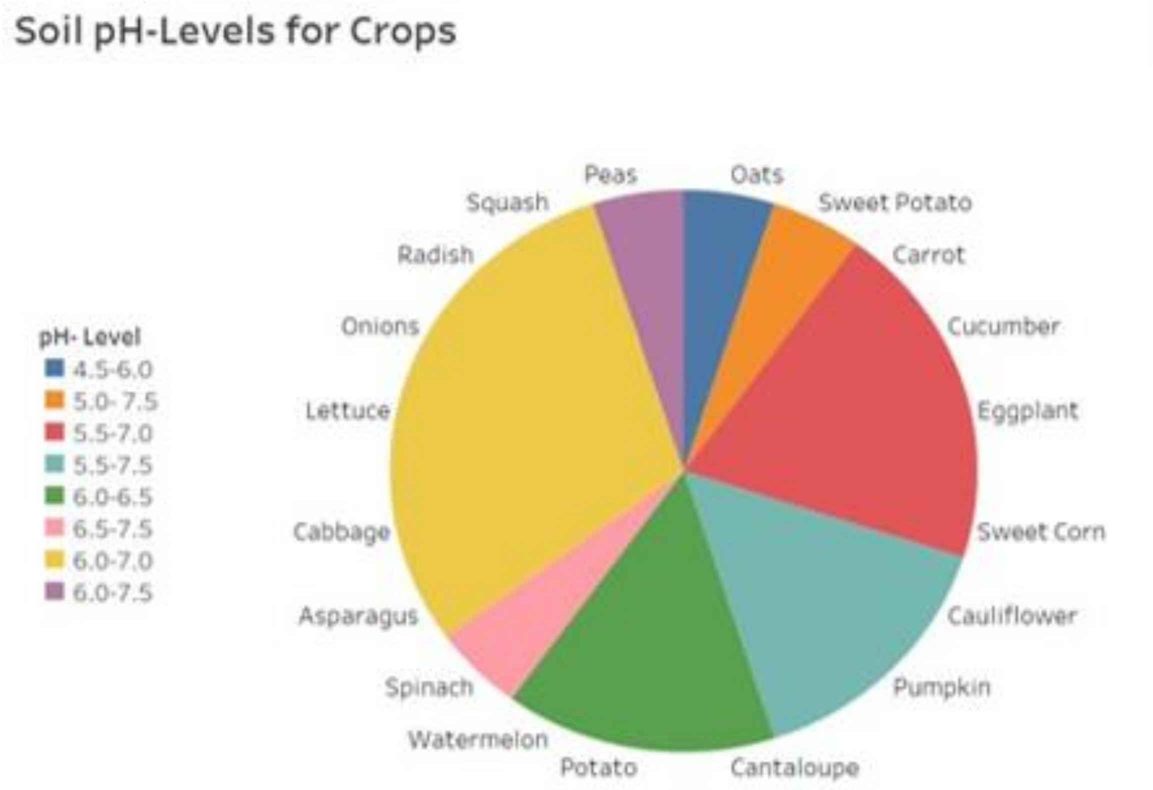
- "Midwest Vegetable Production Guide for Commercial Growers 2022" – Provided by the Iowa State Horticulture Extension
- "Knott's Handbook for Vegetable Growers" – Donald N. Maynard

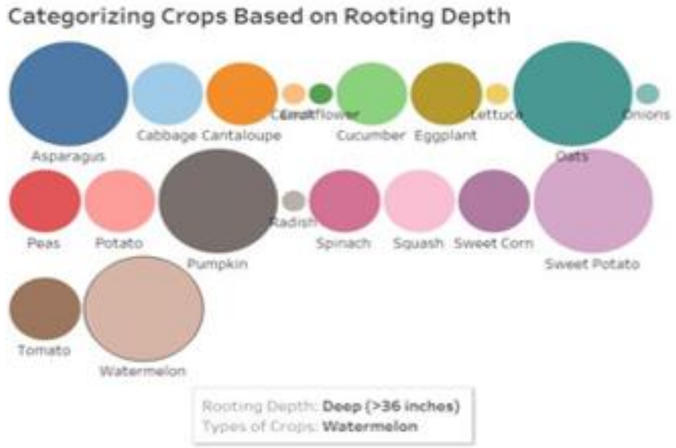
Specialty Crop Dataset

- Initial Findings
  - Sources
  - Challenges

- Growing Degree Day
  - How to calculate GDD
  - Merging Specialty Crop Dataset with Weather Data

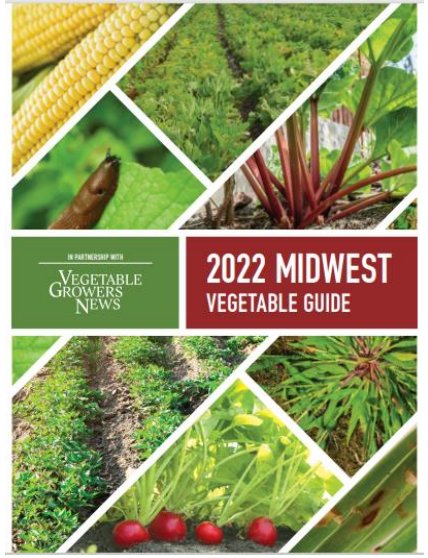
- Crop Rotation Examples
  - What is Crop Rotation?

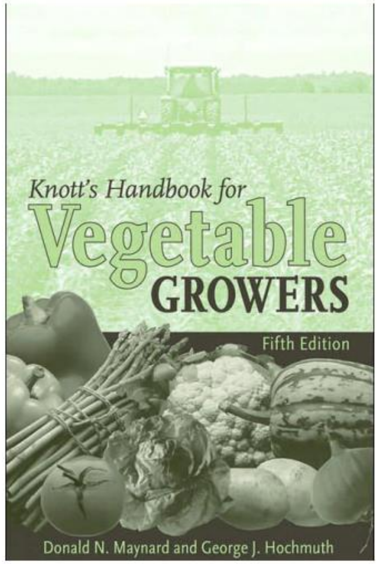




Initial Findings

- Started by choosing 19 specialty crops, and focused on various factors such as
    1. Soil Types
    2. pH Levels
    3. Rooting Depths
    4. Storage Conditions
    5. Crop Maturity
    6. Soil Nutrients etc.





- Sources- The research involved scraping data from various sources. Primary sources includes *2022-Midwest-Veg-Guide* and *Donald N. Maynard, George J. Hochmuth -Knott's Handbook for Vegetable Growers-Wiley*

- Challenges- Commonly faced hurdles included Data Insufficiency, misleading/incorrect data, and no area specific information

Snippet of Specialty Crop Dataset

Crops	Soil Types	Base Temp	Rooting Depth	Depth_low	Depth_higl	pH- Level	ph_L	ph_H	Temperature	Temp (˚F)	ımidity (%)	Storage Life	CropMaturity Early (
Onions	Sandy loam	40	Shallow (18-24	18	24	6.8-6.0	6.8	6	Cool-season (	32	65-70	8-16 weeks	90
Peas	Clay	39	Moderate (36-	18	48	6.8-5.5	6.8	5.5	Cool-season (	32	90-98	< 2 weeks	56
Asparagus	Sandy loam	50	Deep (>48 incl	48	100	6.8-6.0	6.8	6	Cool-season (	36	95-100	< 2 weeks	
Potato	Sandy loam	32	Shallow (18-24	18	24	6.8-5.0	6.8	5	Cool-season (	40-54	95-98	8-16 weeks	90
Cabbage	Loam	40	Shallow (18-24	18	24	6.8-6.0	6.8	6	Cool-season (	32	95-100	2-4 weeks	70
Sweet Pot	Sandy loam	65	Deep (>48 incl	48	100	6.8- 5.0	6.8	5	Cool-season (	55-59	85-95	8-16 weeks	120
Squash	Sandy , fertile	60	Moderate (36-	36	48	6.8-5.5	6.8	5.5	Warm-seasoı	45-50	95	< 2 weeks	40
Cucumber	loose sandy l	60	Moderate (36-	36	48	6.8-5.5	6.8	5.5	Warm-seasoı	50-54	85-90	< 2 weeks	55
Cauliflowe	well drained,	40	Shallow (18-24	18	24	6.8-6.0	6.8	6	Cool-season (	32	95-98	< 2 weeks	55
Pumpkin	well-drained,	60	Deep (>48 incl	48	100	6.8-5.5	6.8	5.5	Warm-seasoı	54-59	50-70	8-16 weeks	85
Tomato	Fertile loam	50	Deep (>48 incl	48	100	6.8-5.5	6.8	5.5	Warm-seasoı	50- 55	90-95	2-4 weeks	60
Watermel	Sandy Loam	50	Deep (>48 incl	48	100	6.8-5.0	6.8	5	Warm-seasoı	50-60	90	2-4 weeks	75
Carrot	Sandy Clay	40	Moderate (36-	36	48	6.8-5.5	6.8	5.5	Cool-season (	32	98-100	4-8 weeks	50
Sweet Cor	Clay	50	Shallow (18-24	18	24	6.8-5.5	6.8	5.5	Warm-seasoı	32	95-98	< 2 weeks	60
Lettuce	Loose	40	Shallow (18-24	18	24	6.8-6.0	6.8	6	Cool-season (	32	98-100	< 2 weeks	70
Eggplant	Sandy loam	50	Moderate (36-	36	48	6.8-5.5	6.8	5.5	Warm-seasoı	50	90-95	2-4 weeks	60
Radish	Sandy	40	Shallow (18-24	18	24	6.8-5.5	6.8	5.5	Cool-season (	32	95-100	4-8 weeks	22
Spinach	Clay	35	Shallow (18-24	18	24	6.8-6.0	6.8	6	Cool-season (	32	95-100	< 2 weeks	37
Cantaloup	Loam	65	Moderate (36-	36	48	6.8-6.0	6.8	6	Warm-seasoı	36-41	95	< 2 weeks	80

What is GDD?

Used to estimate the growth and development of plants and insects during the growing season.

$$GDD = T_{MEAN} - T_{BASE},\ \text{if } T_{MEAN} \text{ is greater than } T_{BASE}$$
$$GDD = 0,\ \text{if } T_{MEAN} \text{ is less than } T_{BASE}$$

Reported Base Temperatures for GDD Computations

BASE TEMP	CROP
40° F	wheat, barley, rye, oats, flaxseed, lettuce, asparagus
45° F	sunflower, potato
50° F	sweet corn, corn, sorghum, rice, soybeans, tomato

BASE TEMP	INSECT
44° F	Corn Rootworm
48° F	Alfalfa Weevil
50° F	Black Cutworm, European Corn Borer
52° F	Green Cloverworm

GDDs are used as a comparison tool that is used with the context of a Normal Growing Degree Day (NGDD), which is an average of the GDDs of the same day over the past 30 years.

GDDs can also be accumulated for a month and compared to past years as well.

The greater the GDD is than the NGDD, the more developed the crop is seen to be at that stage.

	sday	ogdd5086	oprecip	osdd86	cgdd5086	cgdd5086_acc
2014-05-01	0501	0	0.031102	0	9.145833333	9.145833333
2014-05-02	0502	8.271	0	0	9.743055556	18.88888889
2014-05-03	0503	10.431	0.031102	0	9.854166667	28.74305556
2014-05-04	0504	6.273001	0.020735	0	10.76388889	39.50694444
2014-05-05	0505	9.900002	0	0	11.29166667	50.79861111
2014-05-06	0506	11.943	0	0	11.00694444	61.80555556
2014-05-07	0507	20.475	0	1.133999	11.00694444	72.8125
2014-05-08	0508	17.163	0	0	11.71527778	84.52777778
2014-05-09	0509	8.973	0	0	11.49305556	96.02083333
2014-05-10	0510	14.796	0	0	12.06944444	108.0902778
2014-05-11	0511	13.446	0.746531	0	12.01388889	120.1041667
2014-05-12	0512	11.691	0.43551	0	11.125	131.2291667
2014-05-13	0513	3.582001	0	0	11.26388889	142.4930556
2014-05-14	0514	5.813999	0.031102	0	12.05555556	154.5486111
2014-05-15	0515	0	0.020735	0	12.81944444	167.3680556
2014-05-16	0516	2.034	0	0	13.57638889	180.9444444
2014-05-17	0517	8.405998	0	0	14.35416667	195.2986111
2014-05-18	0518	10.044	0	0	13.97222222	209.2708333
2014-05-19	0519	14.787	0.093306	0	14.15972222	223.4305556
2014-05-20	0520	21.762	0.850204	0.792	14.85416667	238.2847222
2014-05-21	0521	18.162	0	0	13.90972222	252.1944444
2014-05-22	0522	14.652	0	0	14.4375	266.6319444
2014-05-23	0523	16.047	0	0	14.76388889	281.3958333
2014-05-24	0524	17.505	0	0	14.5	295.8958333
2014-05-25	0525	18.081	0.010367	0	14.18055556	310.0763889
2014-05-26	0526	20.745	0.186612	0	14.11805556	324.1944444

GDD data from Iowa State Mesonet

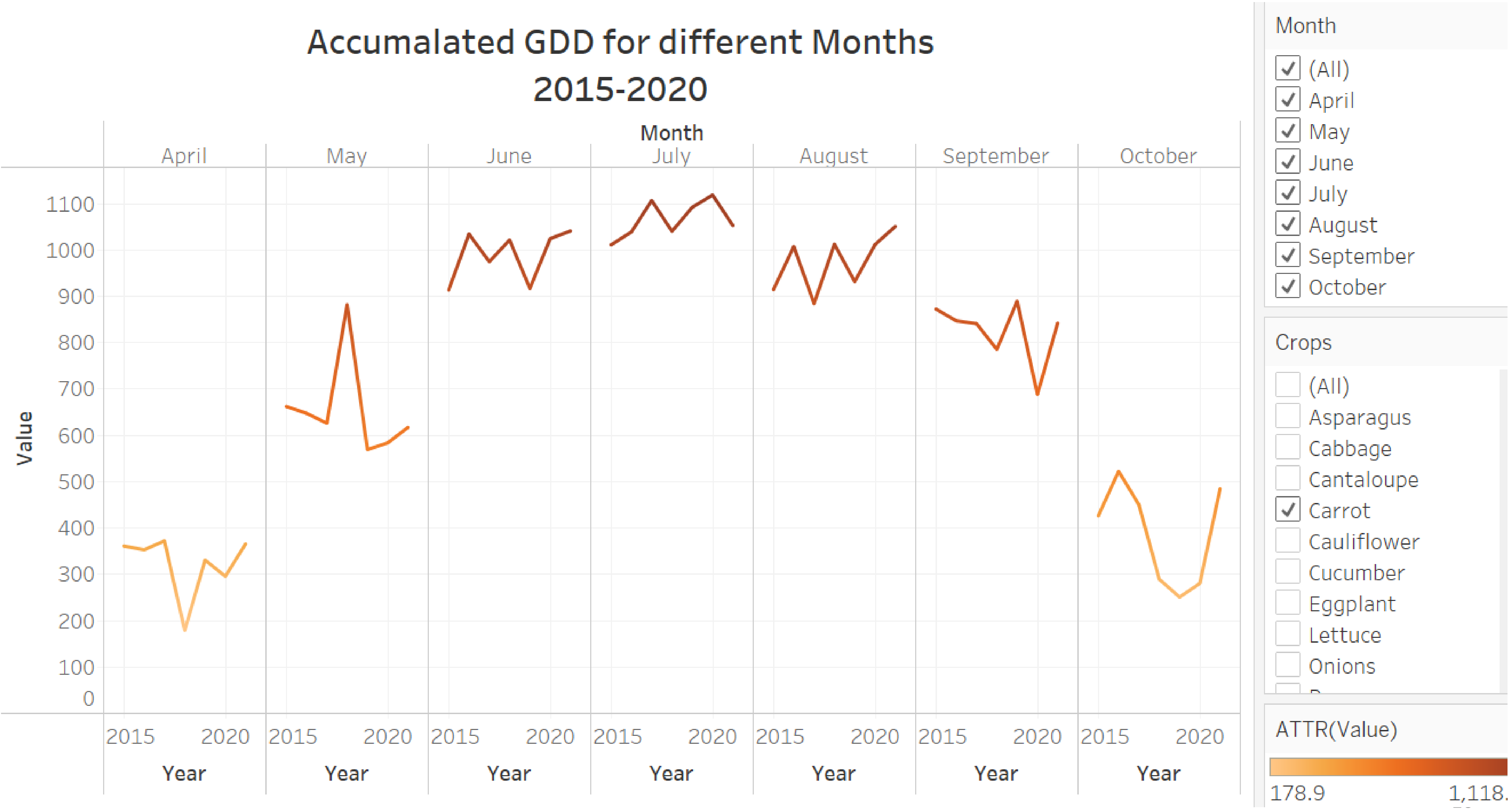
Calculating GDD

Combined the climate data from the Iowa State Mesonet, IEM with the Base Temperatures of Crops

Row Labels	Sum of OnionGDD	Sum of PeasGDD	Sum of AsparagusGDD
2015	**5161.731**	**5375.228**	**3129.867**
Apr	361.064	390.561	116.649
May	662.314	693.314	359.118
Jun	913.395	943.395	613.395
Jul	1011.28	1042.28	701.28
Aug	914.53	945.53	604.53
Sep	872.679	902.679	572.679
Oct	426.469	457.469	162.216
2016	**5451.5**	**5661.485**	**3438.9**
2017	**5255.047**	**5463.195**	**3253.077**
2018	**5210.896**	**5406.46**	**3345.273**
2019	**4981.047**	**5186.356**	**3072.888**
2020	**5003.897**	**5198.862**	**3146.292**
2021	**5454.38**	**5663.994**	**3461.832**
Grand Total	**36518.498**	**37955.58**	**22848.129**

	year	Month	acc_gdd_onion	acc_gdd_peas	acc_gdd_asparaguss	acc_gdd_potato	acc_gdd_cabbage	acc_gdd_sweet_p
1	2015	October	426.469	457.469	162.216	674.469	426.469	
2	2015	April	361.064	390.561	116.649	600.561	361.064	
3	2015	May	662.314	693.314	359.118	910.314	662.314	
4	2015	June	913.395	943.395	613.395	1153.395	913.395	
5	2015	July	1011.280	1042.280	701.280	1259.280	1011.280	
6	2015	August	914.530	945.530	604.530	1162.530	914.530	
7	2015	September	872.679	902.679	572.679	1112.679	872.679	
8	2016	October	522.364	553.364	237.042	770.364	522.364	
9	2016	April	352.942	378.927	148.896	580.752	352.942	
10	2016	May	647.581	678.581	344.349	895.581	647.581	
11	2016	June	1034.670	1064.670	734.670	1274.670	1034.670	
12	2016	July	1038.847	1069.847	728.847	1286.847	1038.847	
13	2016	August	1007.815	1038.815	697.815	1255.815	1007.815	
14	2016	September	847.281	877.281	547.281	1087.281	847.281	
15	2017	October	450.134	476.271	201.942	677.709	450.134	
16	2017	April	372.125	401.136	138.717	611.136	372.125	
17	2017	May	626.053	657.053	325.683	874.053	626.053	

Visualization of GDD, Crop- Carrot



Crop Rotation

- Crop Rotation is the process of growing crops on the same land in sequence. Practicing crop rotation has several benefits for soil systems, such as improvements in its chemical and nutritional properties and physical characteristics. Cover crop rotation also benefits the crop system by including fewer weeds, insects, and plant diseases.

Examples of Integrating Cover Crops

Cover crops help add organic matter, manage soilborne diseases, and avoid soil erosion. Below are examples of five, four-year cropping sequences that you can use with vegetable crops. Each cover crop rotation sequence is designed to take advantage of legumes for N-fixation, grass or buckwheat to suppress weeds, and brassica cover crops for bio-fumigation and reducing soil compaction. These rotations won't work on every farm. Growers should try likely rotations in manageable areas to develop the best strategy for their farms.

Cover Crop	**Pounds/ Bushel**	**Quantity of Seed per Acre (pounds)**	**Desirable Seeding Dates**
Nonlegumes			
Rye	60	90-120 (alone) 90 (mixture)	Sept. 1-Nov. 10
Perennial or common ryegrass	24	15-20 (alone) 5-8 (mixture)	Aug. 1-Sept. 15
Sudangrass	40	20-30	May 15-July 1
Field corn	56	50-60	May 15-July 1
Winter barley	48	80-100	2-3 weeks before fly-safe date
Wheat	60	90-120	Hessian fly-safe date
Legumes			
Sweet clover	60	16-20 (alone) 10-12 (mixture)	March 1-April 15 July 15-Aug. 20
Red clover	60	10-15 (alone)	Feb. 1-April 1
Soybean	60	90-100	May 15-July 1
Alfalfa	60	12-18	March-April
Hairy vetch	60	15-20 (mixture)	Sept. 1-Nov. 1
Mixtures			
Rye/ hairy vetch		90/15-20	Sept. 1-Oct. 1
Ryegrass/ sweet clover		5-8 12-15	July 15-Aug. 20
Sweet clover/ orchardgrass		6-8	March 1-April 15

Crop Rotation Example

Rotati... | Cro... | S... | Weath... | Risk Links | G...

Examples of Crop Rotation

Select A Crop: Sweet Corn

Exampl..	Year	Months	Crop	
2	0	Fall	Cereal Rye Hairy Vetch	
	1	March-June	Cerael Rye (terminate) Hairy Vetch (terminate)	
		June-October	Pumpkin	
	2	March-May	Cereal Rye (terminate)	
		May-September	Tomato	
		September-Novem..	Buckwheat	
		Novermber-May	Cereal Rye	
	3	March	Buckwheat (leave)	
		April-August	Carrot	
		August-November	Crimson Clover	
	4	March-May	Crimson Clover (termi..	
		May-September	Sweet Corn	Match
		September-Novem..	Cereal Rye Hairy Vetch	
4	0	Fall	Cowpea	
	1	March-May	Cowpea (leave)	
		May-August	Sweet Corn	Match
		August-October	Buckwheat	
	2	March-August	Garlic (leave)	
		August-November	Sorghum	
		October-August	Garlic	
	3	March-June	Sorghum (leave)	
		June-November	Pumpkin/Winter Squa..	
	4	March	Cereal Rye (terminate)	
		April-August	Potato	
		August-October	Cowpea	
		November-April	Cereal Rye	

Examples

- (•) 1
- ( ) 2
- ( ) 3
- ( ) 4
- ( ) 5

Example 1

Year 0
Fall before Year 1: Plant oats and peas as cover crops

Year 1
March: If field peas do not winter kill, terminate by mowing, tillage, or herbicide
April-August: Onion production
August-November: Crimson clover as a cover crop

Year 2
March: If crimson clover does not winter kill, terminate by tillage or herbicide
April-August: Potato production
August-November: Sorghum-sudangrass as a cover crop

Year 3
March-May: Leave winter-killed sorghum-sudangrass
May-October: Sweet potato production
October-June of Year 4: Cereal rye as a cover crop

Year 4
April-May: Terminate cereal rye by tillage, herbicide, or roller-crimping
June-September: Cucumber production
September-November: Oats and field peas as a cover crop

Year 5
Return to Year 1

Weather Data

- Data Discovery: Weather
  - Sources
  - Challenges

- Extracting Weather Information
  - How to leverage R to extract weather information from IEMRE
  - Extracting Weather Information with User Input

- Risk Management
  - What resources are available?

Data Discovery: Weather

Objective: Find data of locations by latitude and longitude

Data is available for stations but not always there for rural areas

Weather Stations usually interpolate based on data from surrounding stations to estimate temperatures across the US

Difficulties:

Websites such as NOAA have weather observations from stations and trying to locate data for areas in between the stations were difficult.

Climate Data Online: Dataset Discovery

Click on each dataset name to expand and view more details. Information generally includes a description of each dataset, links to related tools, FTP access, and downloadable samples.

Climate Data Online

The datasets listed in this section are accessible within the Climate Data Online search interface.

⊟ Daily Summaries

Global Historical Climate Network includes daily land surface observations from around the world. The GHCN-Daily was developed to meet the needs of climate analysis and monitoring studies that require data at a sub-monthly time resolution (e.g., assessments of the frequency of heavy rainfall, heat wave duration, etc.). The dataset includes observations from World Meteorological Organization, Cooperative, and CoCoRaHS networks. If observed, the station dataset includes max and minimum temperatures, total precipitation, snowfall, and depth of snow on ground. Some U.S. station data are typically delayed only 24 hours. More »

Search Tool | Mapping Tool | FTP | Documentation & Samples

- ⊞ Daily Summaries
- ⊞ Global Marine Data
- ⊞ Global Summary of the Month
- ⊞ Global Summary of the Year
- ⊞ Local Climatological Data
- ⊞ Normals Annual/Seasonal
- ⊞ Normals Daily
- ⊞ Normals Hourly
- ⊞ Normals Monthly
- ⊞ Precipitation 15 Minute
- ⊞ Precipitation Hourly
- ⊞ Weather Radar (Level II)
- ⊞ Weather Radar (Level III)

DATA TYPE	DESCRIPTION	START	END	COVERAGE[2]
DAPR	Number of days included in the multiday precipitation total (MDPR)	1893-01-02	2022-06-05	100%
DASF	Number of days included in the multiday snow fall total (MDSF)	1893-01-02	2010-02-11	100%
MDPR	Multiday precipitation total (use with DAPR and DWPR, if available)	1893-01-02	2022-06-05	100%
MDSF	Multiday snowfall total	1893-01-02	2010-12-31	100%
PRCP	Precipitation	1891-07-01	2022-06-05	100%
SNOW	Snowfall	1891-12-01	2022-06-05	100%
SNWD	Snow depth	1893-01-01	2022-06-05	100%

Example: Climate Data Online

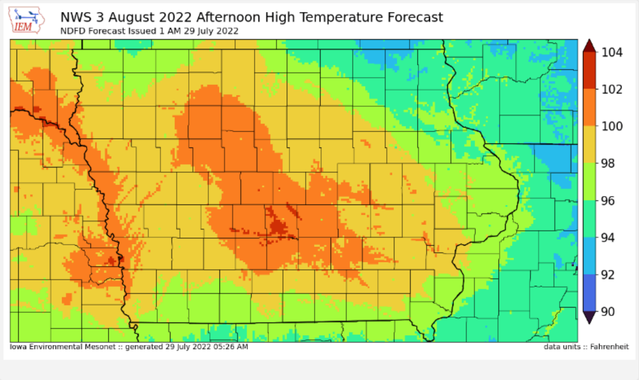
Iowa Environmental Mesonet Reanalysis (IEMRE)

- The Iowa Environmental Mesonet (IEM) collects environmental data from cooperating members with observing networks.
- Provides a regular dataset of Iowa Environmental Data. IEM Reanalysis provides access to hourly and daily interval data.

How Hot on Wednesday?

Posted: 29 Jul 2022 05:26 AM, Views: 273

The pessimistic Iowan has had a difficult time enjoying the near perfect July weather this week knowing that "payback" will soon come. Sure enough, this pessimism was warranted as much of next week looks to be scorching hot with Wednesday currently forecast to be the hottest of them all! The featured map presents the latest NWS grid forecast for afternoon high temperature on 3 August. Much of the state is shown in the upper 90s with a good chuck over 100 and even pushing 104 around the Des Moines metro.



Rate Feature | Good (8 votes) | Bad (2 votes) | Abstain (0 votes)

Previous Years' Features

2021: Daily Climate Report
2019: 2019 Severe T'Storm Warnings
2015: July maxes
2013: Cold above our heads
2010: Muggy Hours
2008: Sunday Night's event
2004: Humidity has returned
2002: Rain is moving out.
2020: July Highs vs Lows
2016: Hourly Dew Point Extremes
2014: Last week's RAGBRAI
2011: Dubuque's Record Rainfall
2009: Lack of GDDs
2005: Those that missed out
2003: Fog

IEM Homepage

IEM Reanalysis (IEMRE)

IEM Reanalysis is an effort to provide a regular dataset of Iowa Environmental Data without many of the problems associated with single site observations. The IEM will continue to provide single site observational data, but for some purposes, this dataset will be easier to work with. **No dataset is perfect and this dataset is provided without warranty.**

- **Why do this?**
  Previously, the IEM has only provided raw observations with limited quality control checks in place. Quality control is hard! Many times, users are simply looking for something "close" and perhaps not as perfect as high quality sensor observations can be. Producing a gridded analysis is one way to produce a dataset from point observations which can be sampled as a means of spatial interpolation.
- **Isn't this a duplication of effort?**
  While there are other "reanalysis" type projects out there with data freely available, many times their data does not update in near real-time and does not include many of the datasets the IEM uniquely collects. We may also produce an analysis on sub-hourly timescales.
  Having said that, here are some alternatives:
  DayMet
  GridMet
  PRISM

IEMRE Homepage

Extracting Weather Information

```r
base_url <- "https://mesonet.agron.iastate.edu/iemre/"

target_request <- "multiday/"
lat <- 42.038534290775225
lon <- -93.85498251613917
end_of_url <- "json"

#create a list of dates to concatenate to url
#dates <- c(2015-04-01,2015-10-31,2016-04-01,2016-10-31,2017-04-01,2017-10-31,2018-04-01,2018-10-31,2019-04-01,2019-10-31,2021-04-01,2021-1
0-31)

#create a list of dates to concatenate to url
start_dates = as.Date(c("2015-04-01", "2016-04-01", "2017-04-01", "2018-04-01", "2019-04-01","2020-04-01","2021-04-01"))

end_dates = as.Date(c("2015-10-31", "2016-10-31", "2017-10-31", "2018-10-31", "2019-10-31", "2020-10-31","2021-10-31"))

#Create empty list to store url's
url_list <-list()

#Loop through the start and end dates. First date is the start date, second date is the end date. Dates are paired.
#url format is: https://mesonet.agron.iastate.edu/iemre/multiday/start_dates/end_dates/lat/lon/json

#Create empty dataframe
df <- data.frame()

for (i in 1:length(start_dates)) {
  for (j in 1:length(end_dates)) {
    if (i == j) {
      url <- paste0(base_url, target_request, as.Date(start_dates[i]), "/", as.Date(end_dates[j]), "/", lat, "/", lon, "/", end_of_url)
      #Store the url in a list
      url_list <- c(url_list, url)
      print(url)
      data <- as.data.frame(jsonlite::fromJSON(url))
      df <- rbind(df,data)
    }
  }
}
```

Variable	Description
base_url	Url for IEMRE
target_request	Which data to access. Ex.”Multiday” – Multiday Request
End_of_url	Output is a JSON file

- Data retrieved from IEMRE
- The data used are the values of PRISM (Parameter elevation Regression on Independent Slopes Model) and Daily Values(high,low,precipitation)

Extracting Weather Information with User Input

```r
Year= 2015
startMonthName = "March"
EndMonthName = "February"


lat = 42
lon= -93

startMonth <- match(startMonthName, month.name)
EndMonth <- match(EndMonthName,month.name)


CurrentDate <- Sys.Date()-2
StartDates <- list()
EndDates <-list()
EndDay = lubridate::days_in_month(as.Date(paste("2000/",EndMonth,"/01",sep="")))
StartMonthCorrect <-format(as.Date(paste(startMonth,"/01/2000",sep=""), "%m/%d/%y"),"%m")
EndMonthCorrect <-format(as.Date(paste(EndMonth,"/01/2000",sep=""), "%m/%d/%y"),"%m")

YearRange = as.numeric(format(CurrentDate,"%Y"))-Year

for(yearVal in 0:YearRange){


  StartDate = paste(Year+yearVal,"-",StartMonthCorrect,'-',"01",sep="")
  EndDate = paste(Year+yearVal,"-",EndMonthCorrect,"-",EndDay,sep="")
  if(Year+yearVal==as.numeric(format(CurrentDate,"%Y"))){
    EndDate <- format(Sys.Date()-2,"%Y-%m-%d")
  }
  StartDates <-append(StartDates,StartDate)
  EndDates <-append(EndDates,EndDate)
}
```

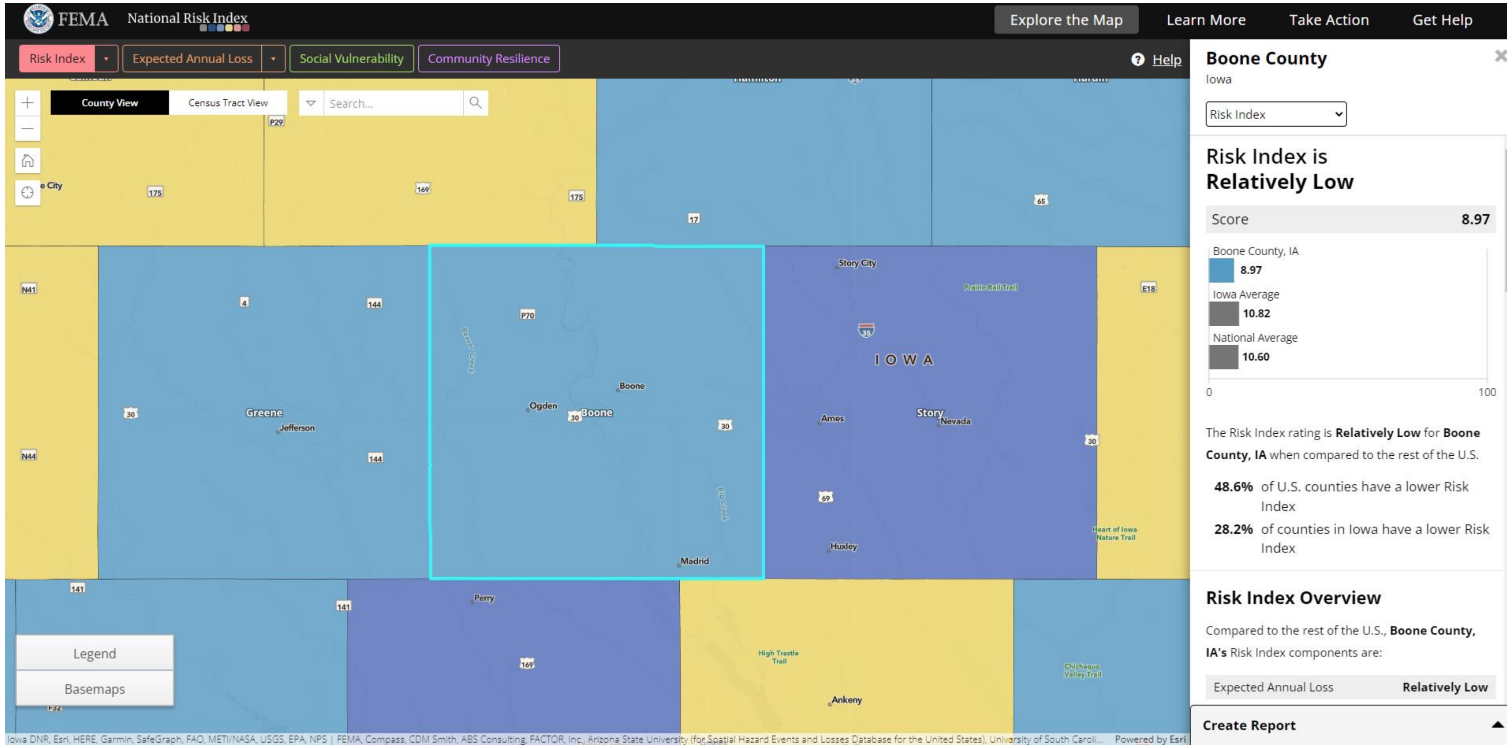
```r
base_url <- "https://mesonet.agron.iastate.edu/iemre/"
target_request <- "multiday/"
end_of_url <- "json"

#Create empty list to store url's
url_list <-list()

#Loop through the start and end dates. First date is the start date, second date is the end date. Dates are paired.
#url format is: https://mesonet.agron.iastate.edu/iemre/multiday/start_dates/end_dates/lat/lon/json

#Create empty dataframe
df <- data.frame()

for (i in 1:length(StartDates)) {

    url <- paste0(base_url, target_request, StartDates[i], "/", EndDates[i], "/", lat, "/", lon, "/", end_of_url)
    url_list <- c(url_list, url)
    print(url)
    data <- as.data.frame(jsonlite::fromJSON(url))
    df <- rbind(df,data)

}


write.csv(df,"Output\\WeatherData.csv")
```

- Updated script to take user input (location and dates)
- Data is saved to a csv file and passed on to a script that aggregates the weather data.

Risk Management Resources

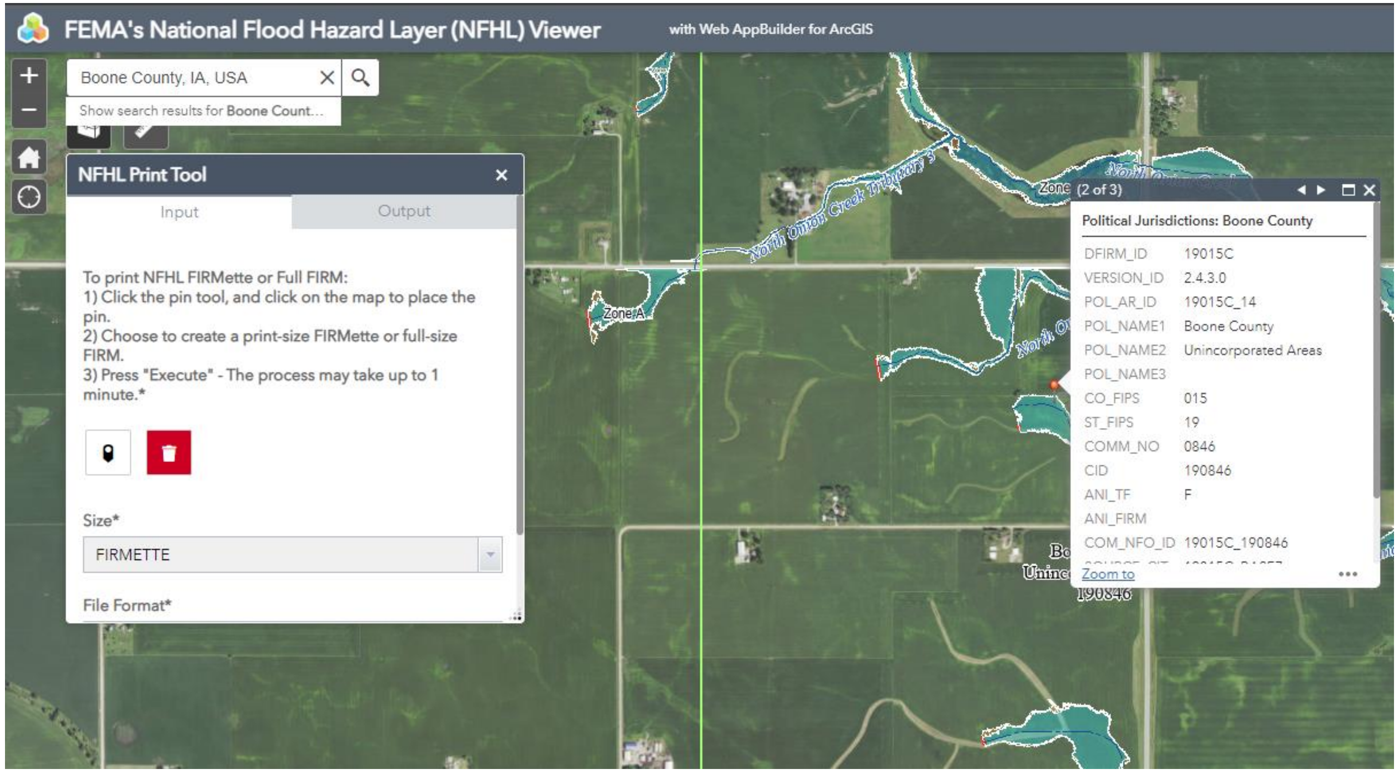
Farming entails a certain amount of risk. And managing agricultural risks is a crucial task that every farmer should take into account. We have provided some resources to help farmers.

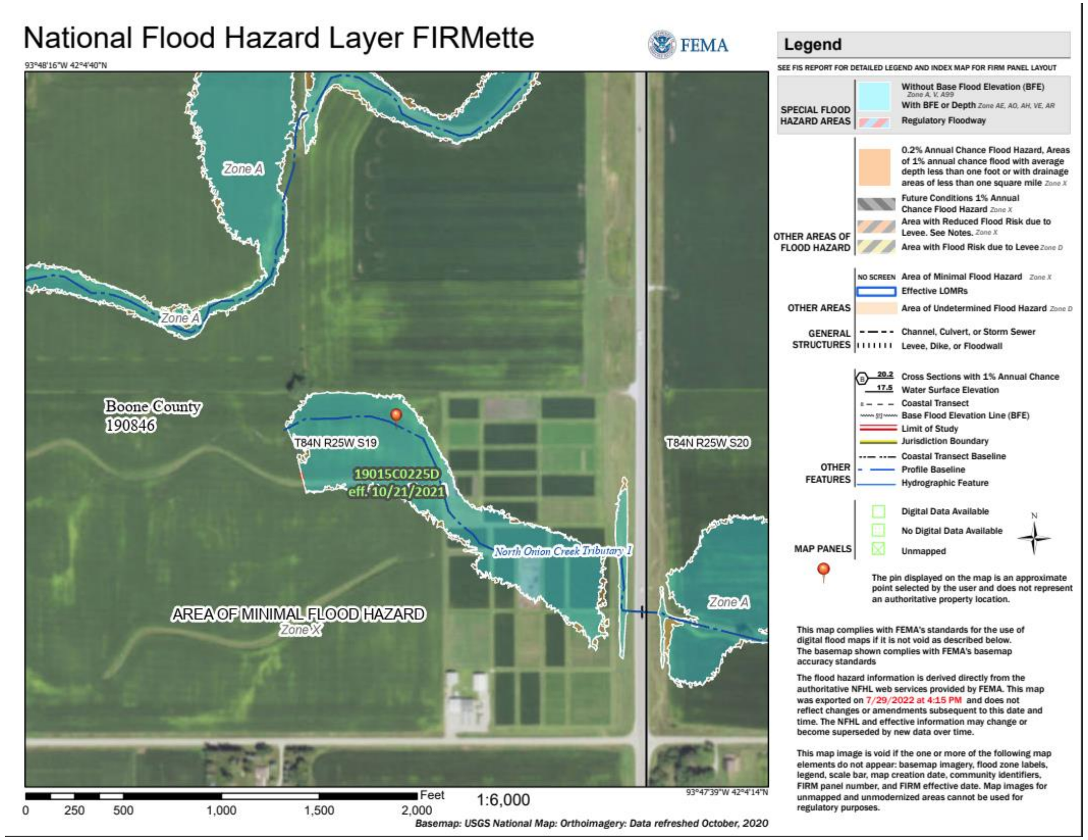
- [Hazard Index Map]()
  - The National Risk Index is an online tool that aims to illustrate the communities most at risk of natural hazards, including drought.



Risk Indicator	Description
Expected Annual Loss	Represents average economic loss in dollars resulting from natural hazards each year
Social Vulnerability	Susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood.
Community Resilience	The ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions.

- [FEMA's National Flood Hazard Layer (NFHL) Viewer (arcgis.com)]
    - The National Flood Hazard Layer (NFHL) is a geospatial database that contains current effective flood hazard data. FEMA provides the flood hazard data to support the National Flood Insurance Program. User can use the information to better understand the level of flood risk and type of flooding.



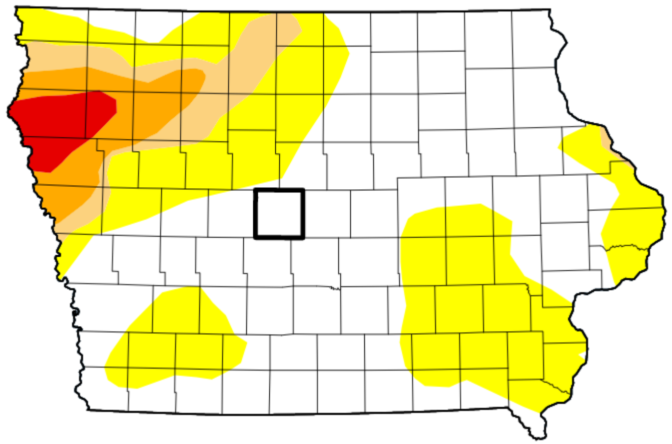


In the [NFHL Viewer], you can use the address search or map navigation to locate an area of interest and the NFHL Print Tool to download and print a full Flood Insurance Rate Map (FIRM) or FIRMette (a smaller, printable version of a FIRM) where modernized data exists.

- [US Drought Monitor]
    - The U.S. Drought Monitor is a map released every Thursday, showing parts of the U.S. that are in drought.
    - The map uses five classifications:
        - Abnormally dry (D0), showing areas that may be going into or are coming out of drought
        - Four levels of drought: moderate (D1), severe (D2), extreme (D3) and exceptional (D4).

Home > Boone County, IA

Boone County, IA



Map released: Thurs. July 14, 2022

Data valid: July 12, 2022 at 8 a.m. EDT

Intensity

- None
- D0 (Abnormally Dry)
- D1 (Moderate Drought)
- D2 (Severe Drought)
- D3 (Extreme Drought)
- D4 (Exceptional Drought)
- No Data

Authors

United States and Puerto Rico Author(s):
Brian Fuchs, National Drought Mitigation Center

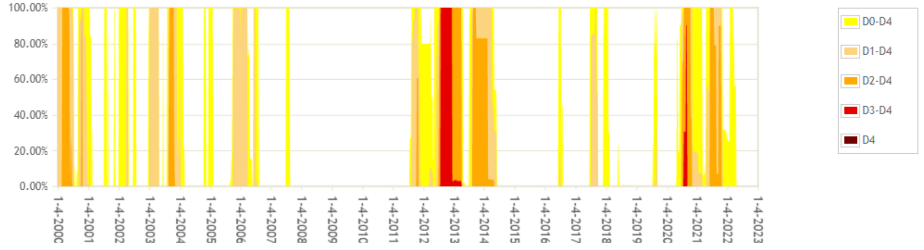
Pacific Islands and Virgin Islands Author(s):
Brad Rippey, U.S. Department of Agriculture

Statistics type: Cumulative Percent Area   Export table: CSV XLS

Week	Date	None	D0-D4	D1-D4	D2-D4	D3-D4	D4	DSCI
Current	2022-07-12	100.00	0.00	0.00	0.00	0.00	0.00	0
Last Week	2022-07-05	100.00	0.00	0.00	0.00	0.00	0.00	0
3 Months Ago	2022-04-12	43.42	56.58	0.00	0.00	0.00	0.00	57
Start of Calendar Year	2021-12-28	70.10	29.90	0.00	0.00	0.00	0.00	30
Start of Water Year	2021-09-28	0.00	100.00	100.00	89.88	0.00	0.00	290
One Year Ago	2021-07-13	0.00	100.00	100.00	99.88	0.00	0.00	300

Estimated Population in Drought Areas: 0   View More Statistics

Percent Area in U.S. Drought Monitor Categories

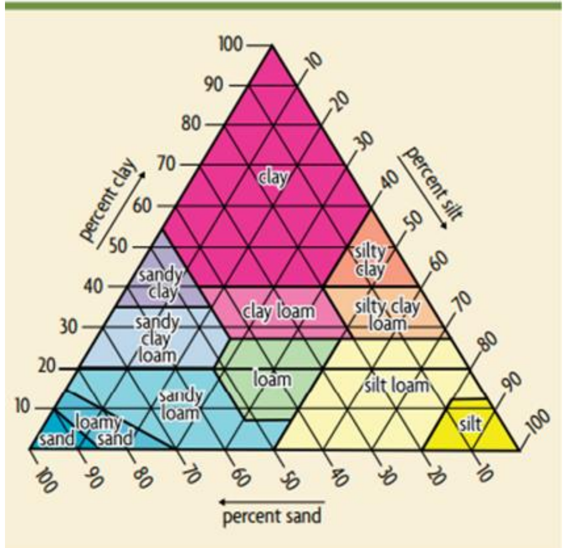


Soil Data

- Initial Findings
- The SSURGO Data Set
  - Uses
  - Challenges
- Using R to gather and combine information
  - Process
  - Changes Made

Initial Findings

- What soil datasets are out there
  - SSURGO vs STATSGO
    - Choosing to go with SSURGO
      - Data available for smaller areas
      - SSURGO is data underling in STATSGO anyways
- Soil Factors Affecting Crop Growth
  - pH
  - Soil Texture
  - Organic Matter
  - Nutrient Level
  - And More



Soil Texture Triangle

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054167

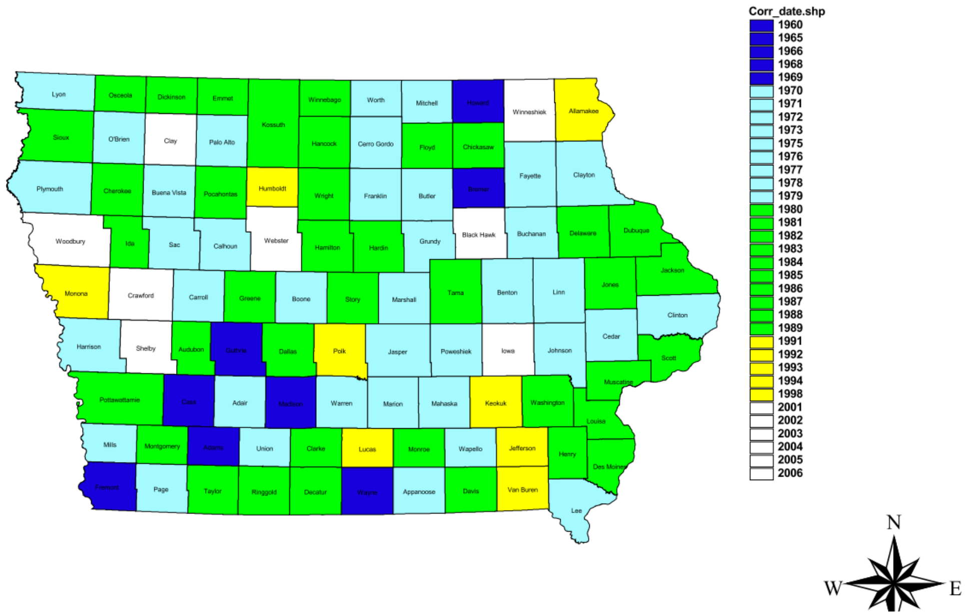
Nutrients Important to Crop Growth:

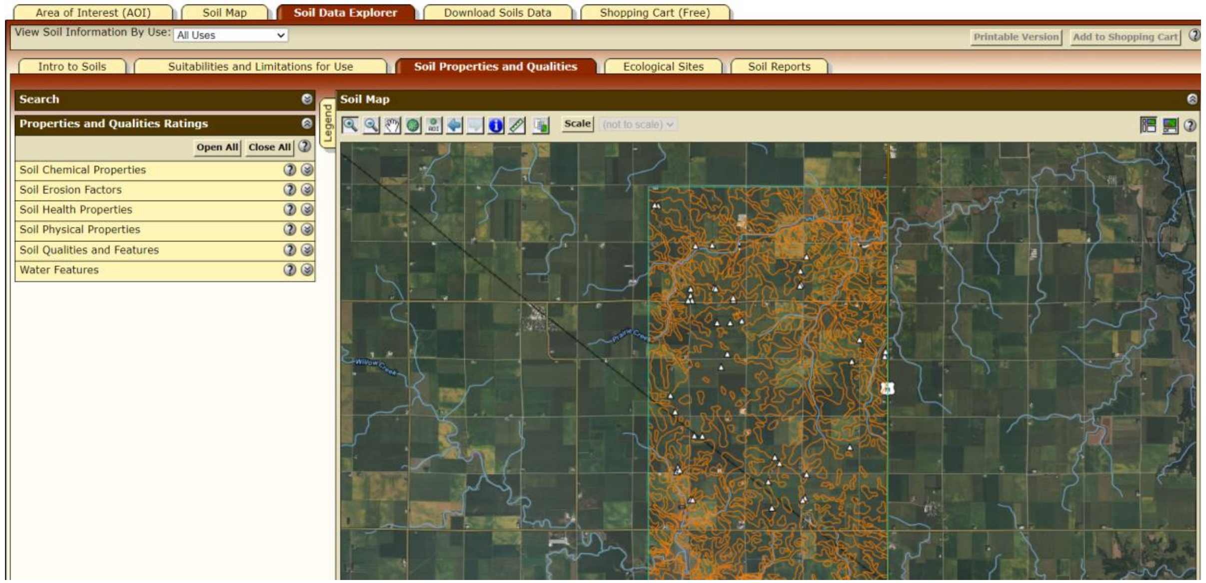
- Phosphorus
- Potassium
- Calcium
- Iron
- Magnesium
- Nitrogen
- Boron
- Manganese
- Molybdenum
- Chlorine

USDA Web Soil Survey (SSURGO)

- A website that allows users to select a preexisting area (county) or user defined area and get soil (SSURGO) data
- The plan was to use this to download Soil Information
  - Decide whether to download it for whole county or just the selected Area

Soil Survey Correlation Date



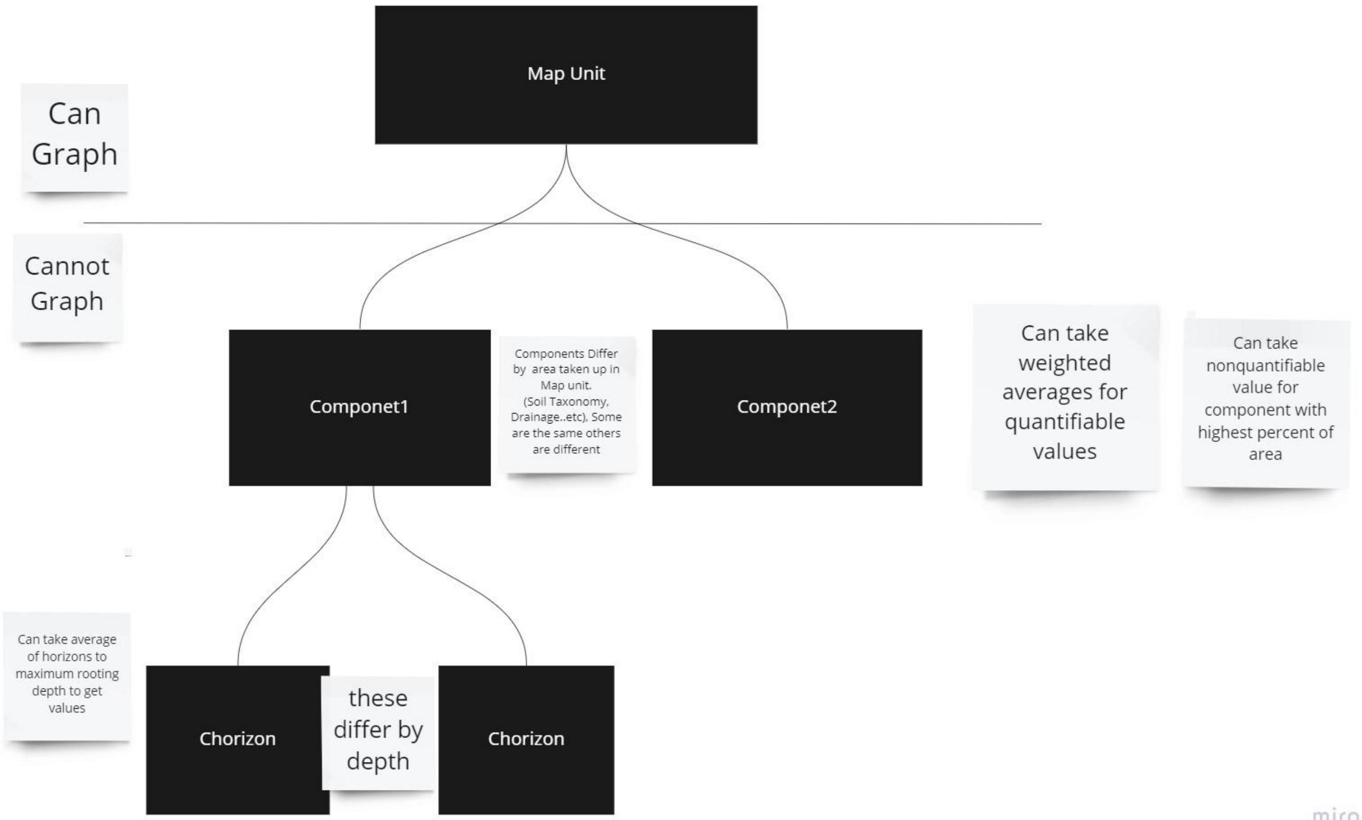


https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

SSURGO Data

- The information included in SSURGO data is divided into three parts for the soil
  - Mapunits, Componets, and Chorizon

- Can use provided mukey, cokey, chkey to merge different parts together



Using R to obtain data

```
Area<- get_ssurgo(template = s,label = "CropSelection_V3", force.redo =TRUE)
```

*s is a raster that has coordinates of the area selected

- Don't want to be stuck downloading large files (county wide) or have manual downloading
- Use FedData package to download SSURGO data for a given area in R
    - Downloads both Spatial and Tabular Data

```
Data <- Area$tabular

##Tables of data we are using
componet <- Data$component
muaggart <-Data$muaggatt
mapunit <-Data$mapunit
comonth <- Data$comonth %>% filter(month=="May") ##only want month of may to follow CSR2
coerosionacc <- Data$coerosionacc %>% filter(rvindicator=="Yes") ##only care about dominant areas
chorizon <- Data$chorizon
chtexturegrp <-Data$chtexturegrp %>%filter(rvindicator == "Yes") ##only care about dominant areas
```

- SSURGO data cleaning
    - Cm to Inches
    - Averaging values with differing depths
    - Selecting surface level qualitative values
- Can merge Tabular Data Together

Beginning to put Soil and Crop Data Together

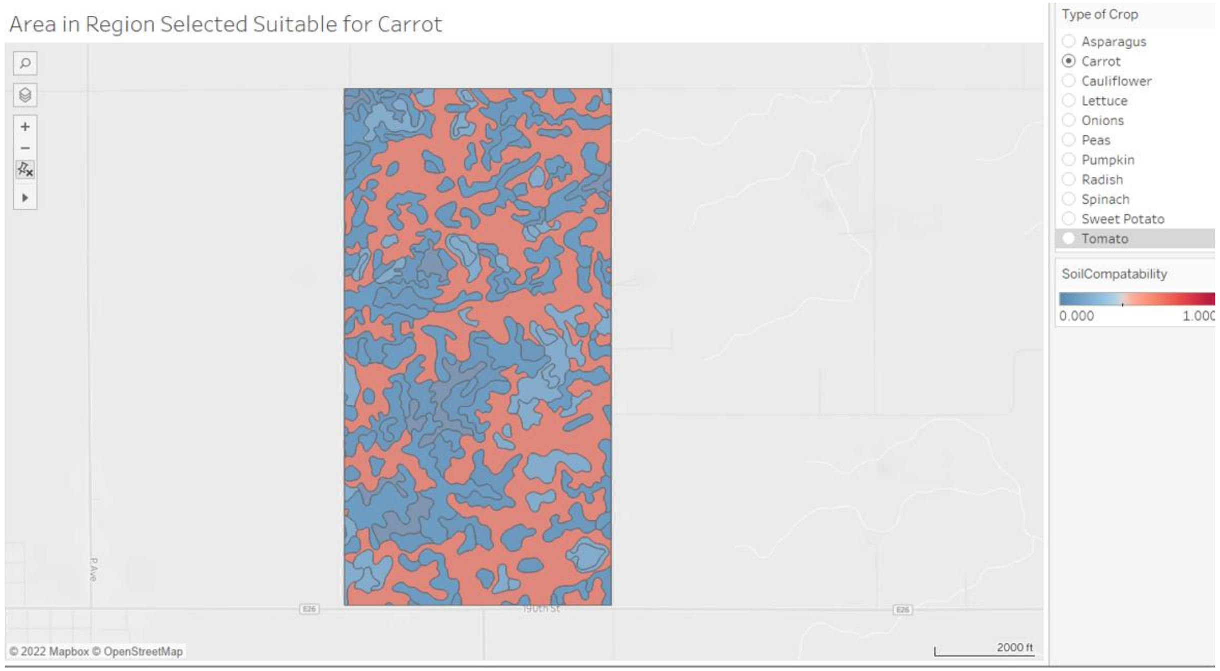
- Linked Soil Data to Crop Data by finding if Soil pH is in Crop Suitable pH

```
test2 <- sqldf("select * from Overall left join CropData
          on (Overall.pH_average >= CropData.ph_L and Overall.pH_average <= CropData.ph_H
           and Overall.depth <= CropData.Depth_h and Overall.depth >= CropData.Depth_l)")
```

Initial Code Used to merge soil and crop data

- Used pH, and Soil Texture to determine suitability
  - Colored by word share of soil Texture

- However, there are more than just those factors to consider, and removing areas because they don't meet one criteria



Initial design on how to show suitability.
Color was % of words shared for soil texture
Area would only be highlighted if Soil pH was in range of Crops

New Factors To Consider

Looked Into What Factors Affect Corn Suitability Rating (CSR2)

Found more Information relating to soil on:

- Erosion (Tolerance and Type)
- Flooding Frequency
- Drainage
- Water Storage
- Nutrient Levels

erokind	erocl	tfact	Kfact	wei	niccdcd	hydgrp	soilslippot	drainagecl	drclassdcd	awc	aws025wta	aws0150wta	flodfreqcl
Sheet erosion	Class 1	5	0.3025000	48	2	B	NA	Well drained	Well drained	0.1875	5.12	27.64	None
NA	None - deposition	5	0.2933333	48	2	C/D	NA	Poorly drained	Poorly drained	0.1800	4.57	27.17	None
Sheet erosion	Class 1	5	0.3100000	86	1	B/D	NA	Somewhat poorly drained	Somewhat poorly drained	0.2000	5.17	28.30	None
NA	None - deposition	5	0.3366667	86	3	C/D	NA	Very poorly drained	Very poorly drained	0.2100	5.35	30.38	None
Sheet erosion	Class 2	5	0.3233333	56	3	B	NA	Well drained	Well drained	0.1800	4.57	27.07	None
Sheet erosion	Class 1	5	0.2800000	48	2	C	NA	Moderately well drained	Moderately well drained	0.1950	5.20	27.74	
Sheet erosion	Class 1	5	0.3125000	48	1	B/D	NA	Somewhat poorly drained	Somewhat poorly drained	0.1950	5.21	28.04	None
NA	None - deposition	5	0.3100000	86	2	C/D	NA	Poorly drained	Poorly drained	0.1900	4.68	27.95	None
Sheet erosion	Class 1	5	0.3025000	48	3	B	NA	Well drained	Well drained	0.1875	5.04	27.54	None
NA	None - deposition	5	0.3060000	86	2	C/D	NA	Poorly drained	Poorly drained	0.1780	4.58	27.00	None
NA	None - deposition	5	0.3200000	86	3	C/D	NA	Very poorly drained	Very poorly drained	0.2200	5.35	30.38	None
Sheet erosion	Class 1	5	0.2800000	86	1	B/D	NA	Somewhat poorly drained	Somewhat poorly drained	0.2100	5.17	28.30	None
Sheet erosion	Class 1	5	0.2800000	48	2	B	NA	Well drained	Well drained	0.1900	5.12	27.64	None
Sheet erosion	Class 2	5	0.3000000	56	3	B	NA	Well drained	Well drained	0.1800	4.57	27.07	None
Sheet erosion	Class 1	5	0.2933333	48	1	B/D	NA	Somewhat poorly drained	Somewhat poorly drained	0.2000	5.21	28.04	None
Sheet erosion	Class 1	5	0.2800000	48	2	C	NA	Moderately well drained	Moderately well drained	0.1950	5.20	27.74	
NA	None - deposition	5	0.2800000	86	2	C/D	NA	Poorly drained	Poorly drained	0.1800	4.58	27.00	None

Nitrogen:

- Have not found sources on Nitrogen levels in soil because of variability
- Have found source that gives recommendations on how much nitrogen to add while growing certain crops

Recommendations

The following information provides guidelines for additional amounts and timing of N needed by vegetables during the growing season, to ensure they produce the best crop possible.

Asparagus

Apply 1.6 to 2.4 ounces of N per 100 square foot area in early spring as the asparagus emerges and again after the last harvest in June.

Beans

Use an inoculum of nitrogen-fixing bacteria–do not side-dress[2] with N.

Broccoli

Side-dress with 4 ounces of N per 250 foot of row when plants are half grown.

Brussels sprouts

Apply one side-dress application of 4 ounces of N per 250 foot of row when plants are 12 inches tall. Water appropriately to keep the crop growing vigorously during the heat of summer.

Cabbage

Side-dress with 8 ounces of N per 250 foot row when plants are half grown.

Carrots and beets

Side-dress with 4 ounces of N per 250 foot of row, 4 to 6 weeks after planting. Do not apply fresh manure; misshapen roots may result.

https://extension.colostate.edu/topic-areas/yard-garden/vegetable-gardening-nitrogen-recommendations-7-247/

Redesigning of Merging Data Together

- Updated How Suitability is Determined
- Updated how we merged data

Color Process:

•Based on amount of Issues with Crop and Soil

•For example: if the average pH of the soil is not in range with crop, will increase the # of flags

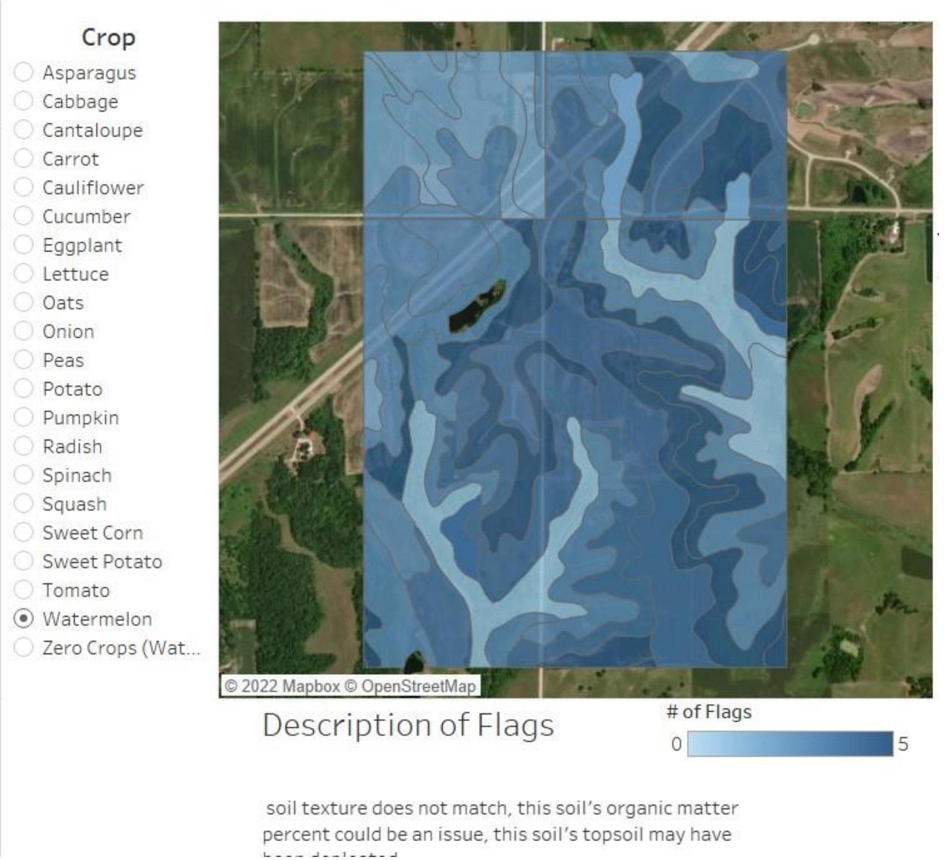
•Based on both crop and soil information

•The more flags, the more issues that would have to be changed in order to grow that crop in that area.

•Weights every issue the same as of now

```
MergedData <- sqldf("select * from chorizon2 left join CropData
          on (chorizon2.depth <= CropData.Depth_1)")
```

Updated Code for Merging Soil and Crop Data

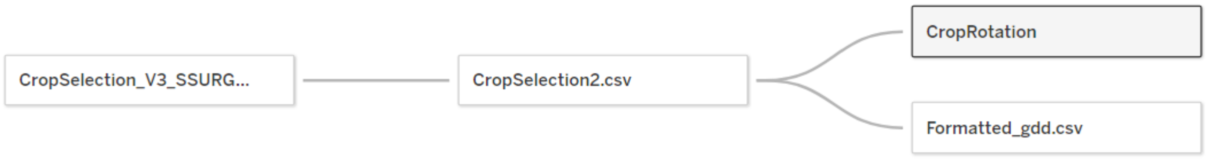


Making of Tableau

- Setup
  - Used tabs to separate information by type
  - Easier to digest and not overcrowding one dashboard

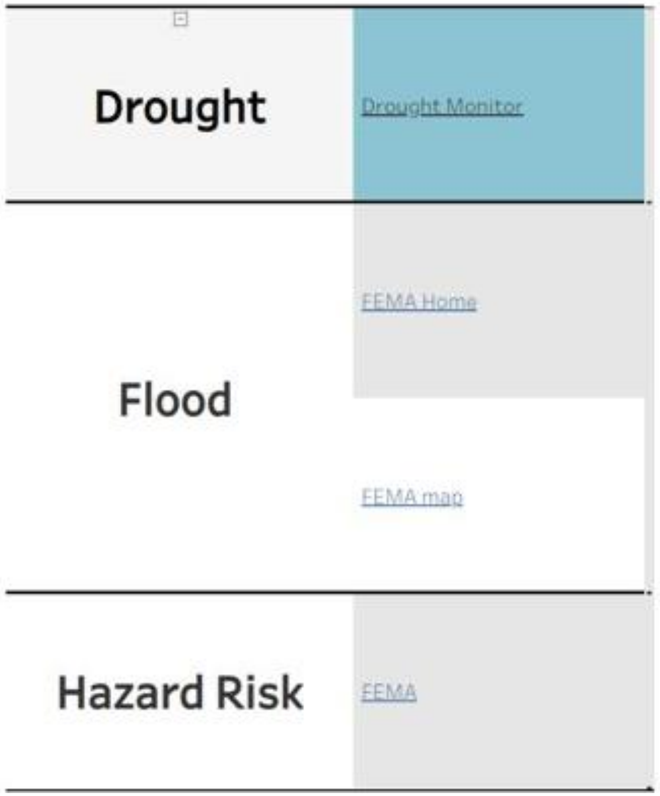
Tabs used to separate Data

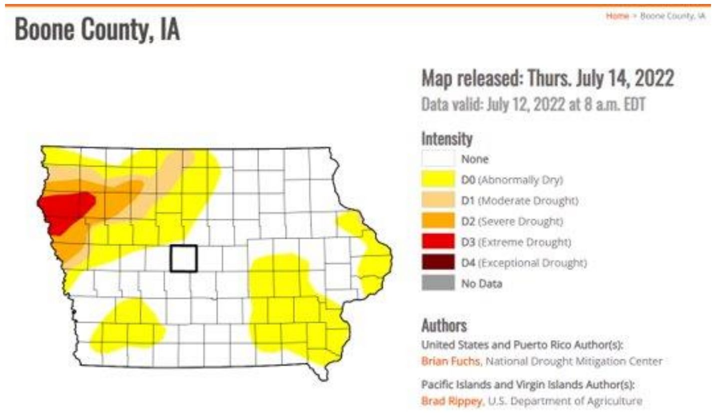
- Linking data together
  - In Tableau
    - Map is joined with crop and soil info
    - Crop and soil info joined to GDD and Crop Rotation
    - Weather and Risk information are separate



Making Visualizations Dynamic

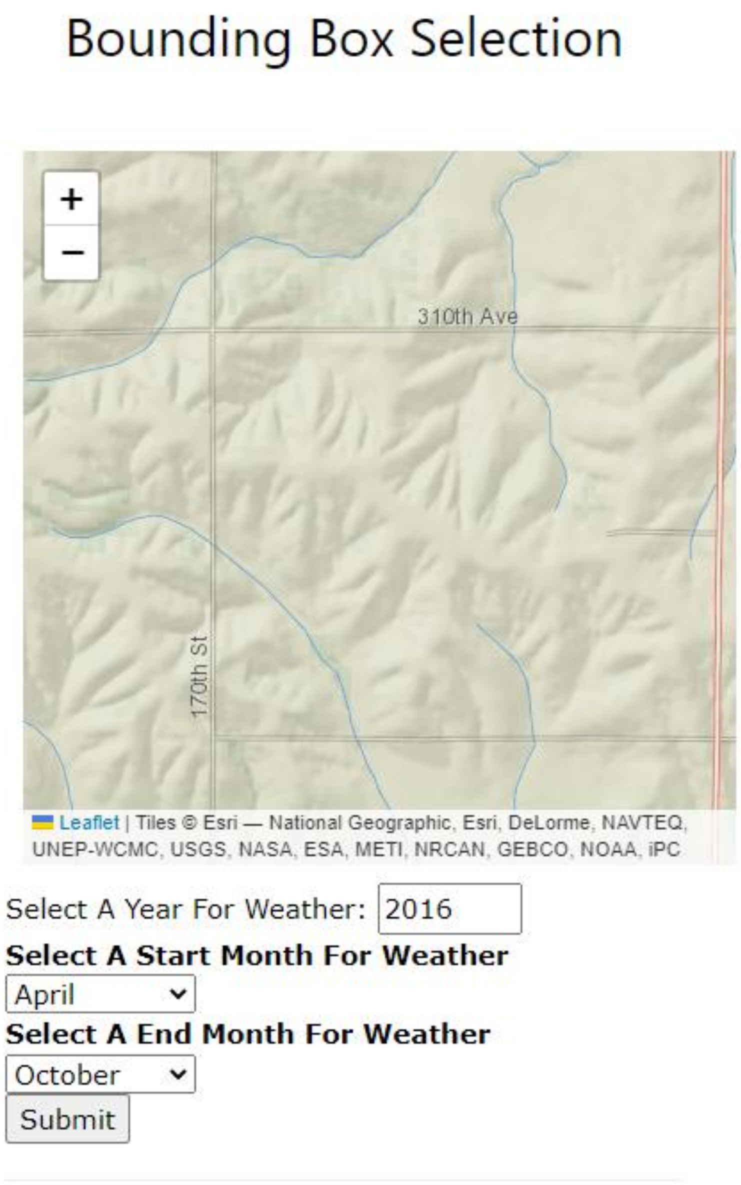
- Risk management links are general, and want to show based on users' inputs
  - Use R script to add user inputs as query tools
- Want to have tabs working together, if crop is selected on one, want to have it be changed in the other
- Dynamic images for Crop Rotation





Making Website

- Want a way for users to select their area and be able to determine for what months do they want weather data for
  - For weather, uses year selected to the current date for month ranges specified



Using User Inputs

- Use PHP to allow for inputs to be selected and run the code we've created to gather the data

```
##Takes in user inputs from OutlineUI.html
#coords should be an array of 4 numbers, xmin,xmax,ymin,ymax of a bounding box
$coords = $_POST['coords'];

##startmonth is for range of months to look at for weather data
$startmonth = $_POST['smonth'];

##endmonth is for range of months to look at for weather data
$endmonth = $_POST['emonth'];


##year is for weather data
$year = $_POST['year'];

    ##Bounding Box of user input, use for soil data
    $xmin = $coords[0];
    $xmax = $coords[1];
    $ymin = $coords[3];
    $ymax = $coords[2];
```

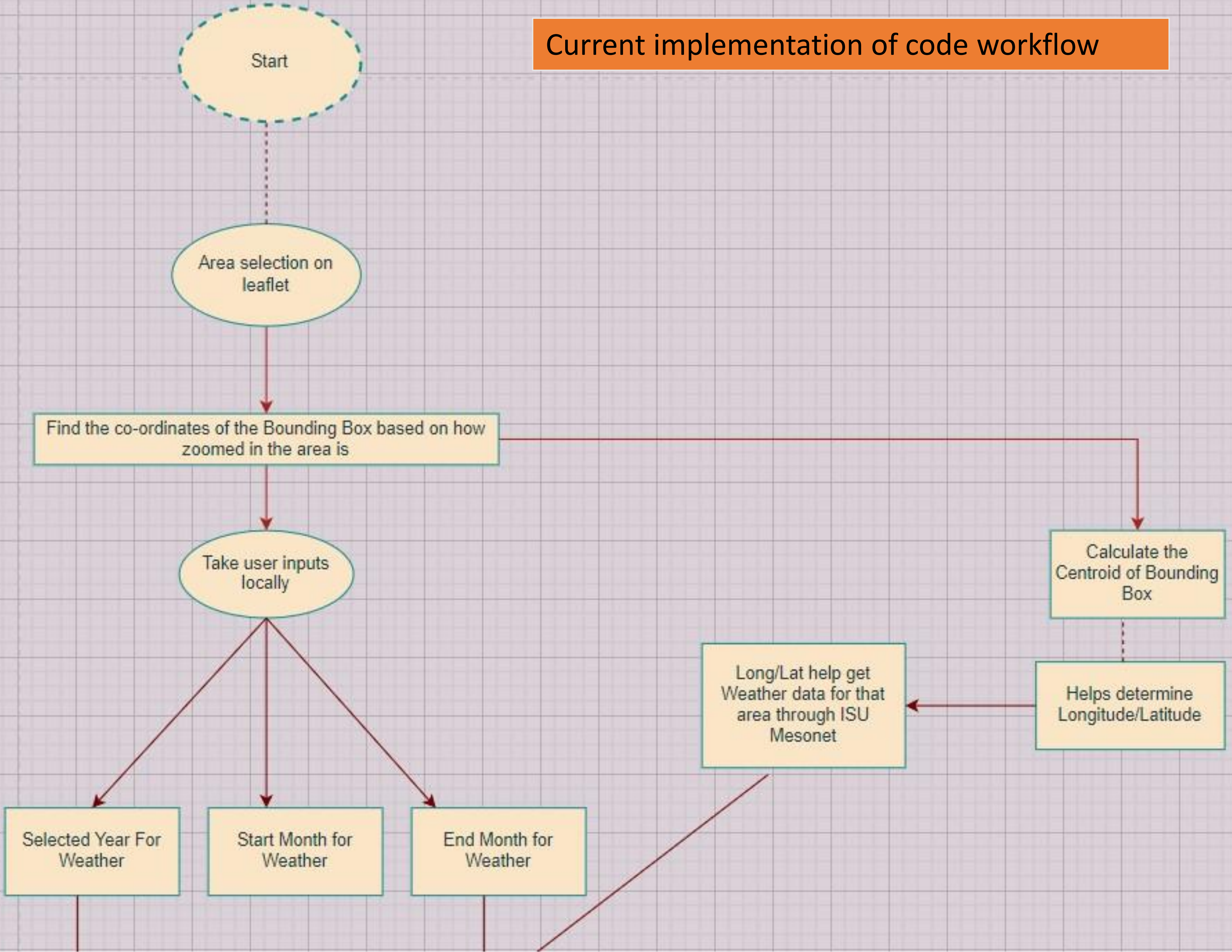
Obtaining user inputs from HTML

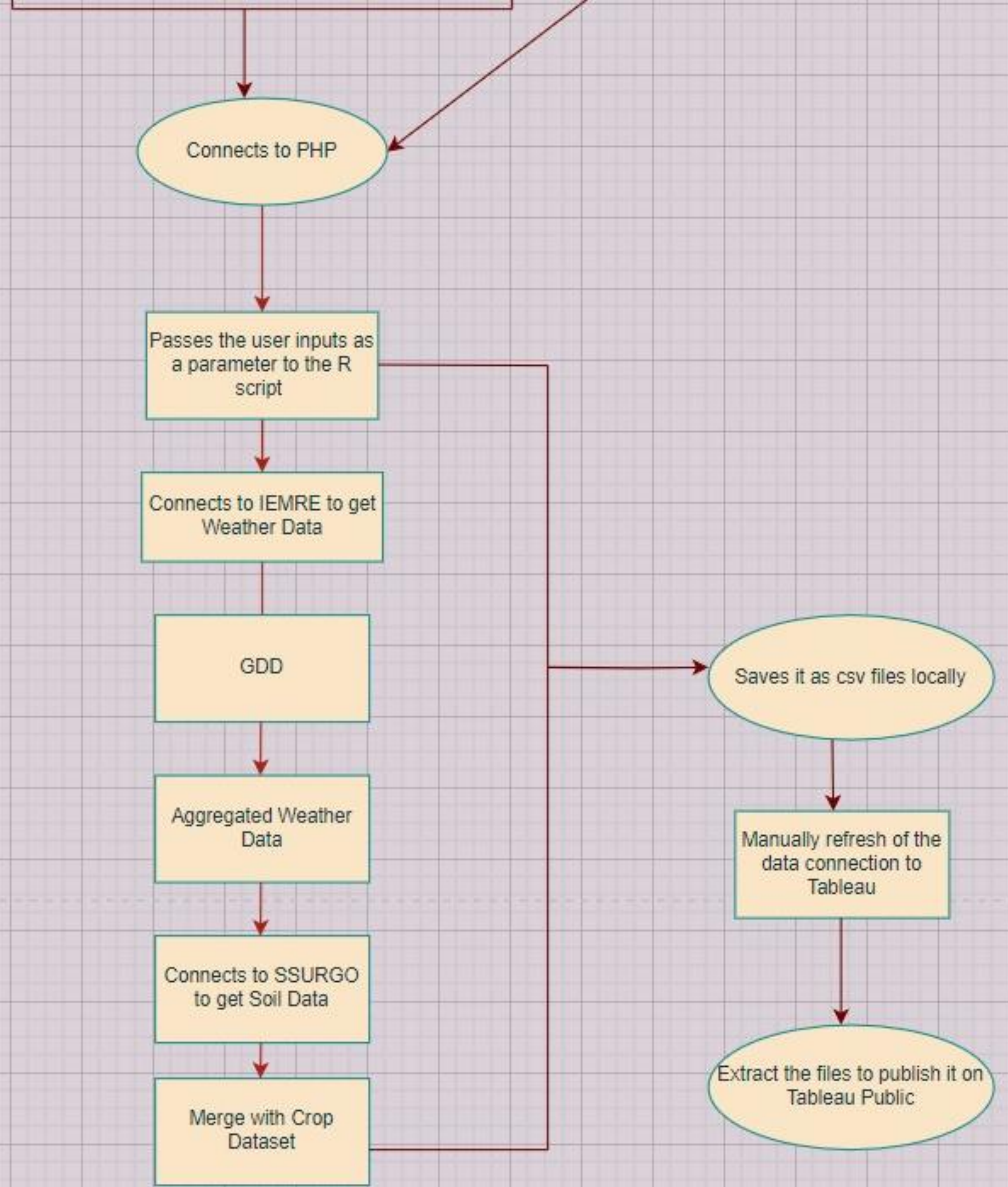
Running Our R scripts to gather and clean data with user inputs

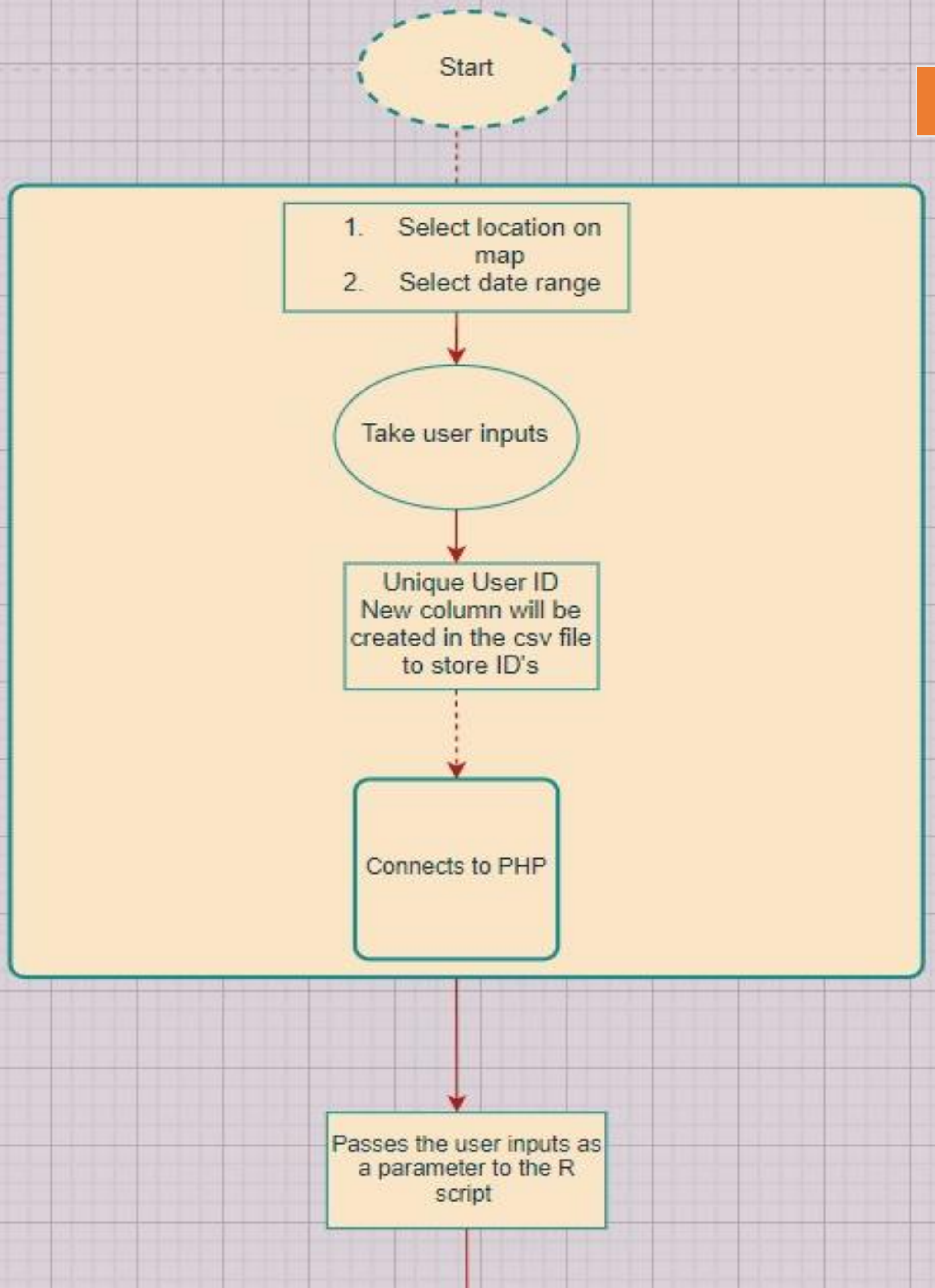
```
#exec("Weather") "5inputs"
##Runs r script with 5 inputs: year, startmonth, endmonth, and centerpoints
##Scrapes weather data from IEM based on given year and month range for a given area(centerpoint)
##Stores Data to a CSV
exec("\"C:\\Program Files\\R\\R-4.2.0\\bin\\Rscript.exe\" \"C:\\Users\\cornd\\OneDrive\\Documents\\GitHub\\Farmer-Asset-Mapping\\Data Exploration\\TestPHP\\WeatherScript.R\"
$year $startmonth $endmonth $centpoints[0] $centpoints[1]");

##R script with no input
##Reads the Weather data from CSV and calculates AGDD by month,year for each crop in dataset
##Stores Data to a CSV
exec("\"C:\\Program Files\\R\\R-4.2.0\\bin\\Rscript.exe\" \"C:\\Users\\cornd\\OneDrive\\Documents\\GitHub\\Farmer-Asset-Mapping\\Data Exploration\\TestPHP\\GDD.R\"");
#exec("GDD") "no inputs"

##R script with no input
##Takes Raw Weather Data and aggreates by month,year
##Stores Data to a CSV
exec("\"C:\\Program Files\\R\\R-4.2.0\\bin\\Rscript.exe\" \"C:\\Users\\cornd\\OneDrive\\Documents\\GitHub\\Farmer-Asset-Mapping\\Data Exploration\\TestPHP\\TempDataSummary.R\"");
#exec("SUMWeather") "no inputs"

##
exec("\"C:\\Program Files\\R\\R-4.2.0\\bin\\Rscript.exe\" \"C:\\Users\\cornd\\OneDrive\\Documents\\GitHub\\Farmer-Asset-Mapping\\Data Exploration\\TestPHP\\Cory_CropInfoV3.R\"
$xmin $xmax $ymin $ymax $centpoints[0] $centpoints[1]");
#exec("Soil") "4inputs" "Return State Name, FIPS CODE"
```

User Input Demo

Current implementation of code workflow

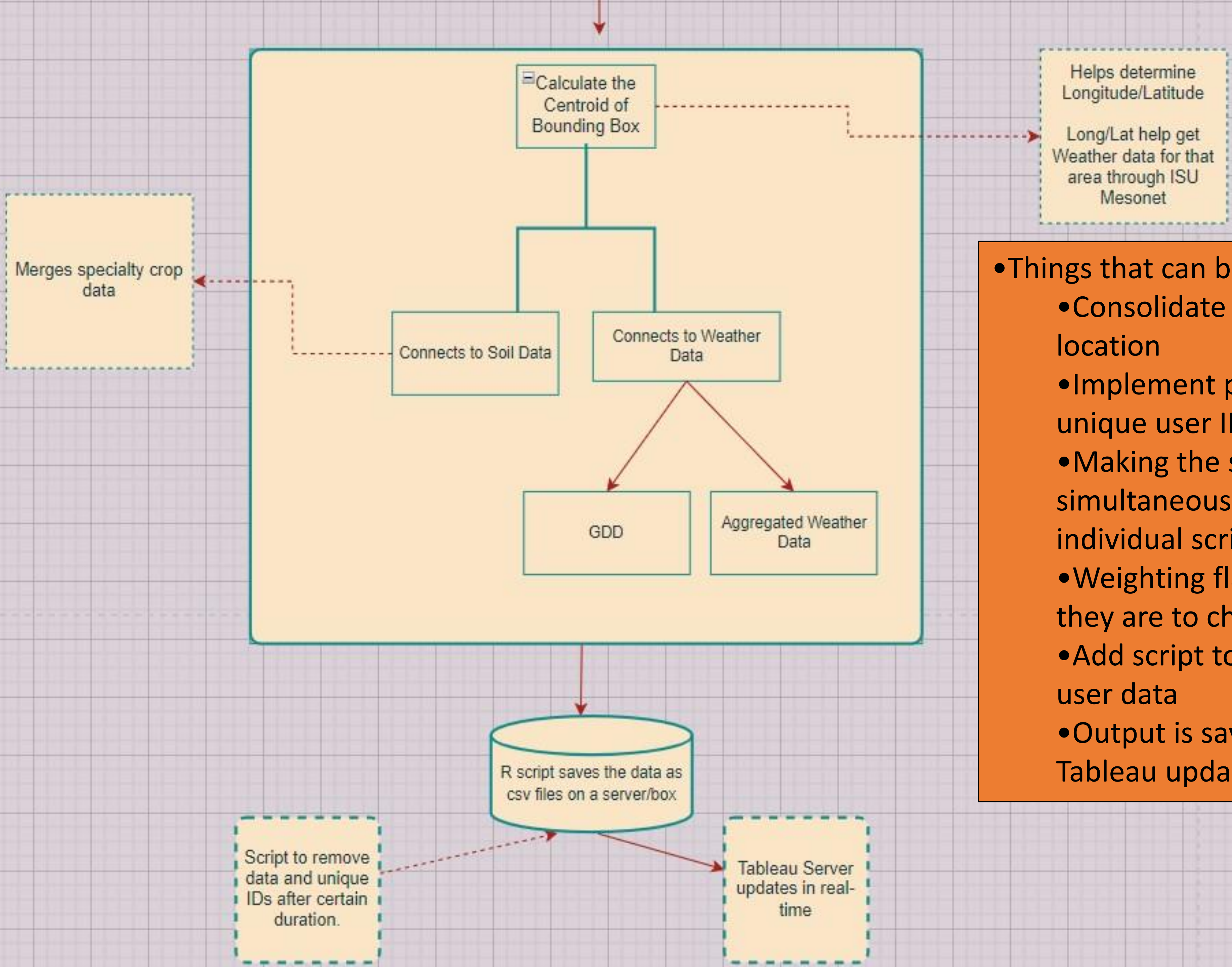



Connects to PHP
Passes the user inputs as a parameter to the R script
Connects to IEMRE to get Weather Data
GDD
Aggregated Weather Data
Connects to SSURGO to get Soil Data
Merge with Crop Dataset
Saves it as csv files locally
Manually refresh of the data connection to Tableau
Extract the files to publish it on Tableau Public



Future implementation of code workflow

- Things that can be improved upon
  - Consolidate files into one location
  - Implement process to create unique user ID
  - Making the scripts run simultaneously vs running individual scripts
  - Weighting flags by how hard they are to change
  - Add script to clean up/remove user data
  - Output is saved to a server and Tableau updates in real-time.



- Things that can be improved upon
    - Consolidate files into one location
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    - Add script to clean up/remove user data
    - Output is saved to a server and Tableau updates in real-time.

Data Science *for the* Public Good

IOWA STATE UNIVERSITY

Dashboard Demo

https://dspg-2022.github.io/Farmer-Asset-Mapping/index.html

Thank you!