DROUGHT CHALLENGES TO DRY FARMED VINEYARDS

OVERVIEW

- Drought…
  - Definition
  - Impacts to agriculture
  - Effects on grape vines
- Challenges for dry farming
- Case Study: Deep vs Shallow soils
- Free tools for accessing water use data

DROUGHT DEFINITION

Drought is generally defined as “a deficiency of precipitation over an extended period of time (usually a season or more), resulting in a water shortage.”

- Difficult to define: The absence of precipitation rather than the presence of something like hurricane or tornado
- “Creeping” phenomenon as it slowly impacts sectors of economy, especially agriculture
- Difficult to monitor and establish the beginning and end

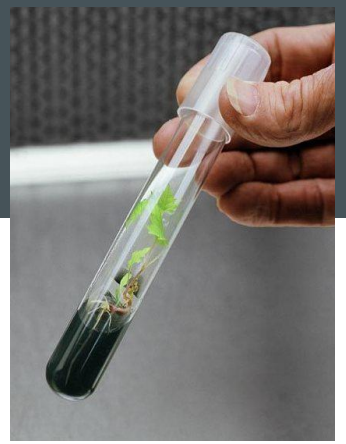
AGRICULTURAL IMPACTS

- Reduction in water availability and quality needed for production
- Contributes to insect outbreaks
  - Ex. Two-spotted spider mite
    - Dry conditions, low humidity, and temps >85F
- Increased wildfires which create poor air quality and taint
- Altered rates of carbon, nutrient, water cycling which can affect winter hardiness
- Long term plant water stress impacts

DROUGHT AND GRAPEVINES

- Biggest issue = Water stress!!!
  - Greater young vine mortality (personal observations)
    - Increased susceptibility to disease
      - Crown gall
      - Petri disease
  - Reduces nutrient uptake and partitioning
    - Low YAN and reduced carbohydrates
  - Exacerbates Botryosphaeria dieback symptoms (https://apsjournals.apsnet.org/doi/pdf/10.1094/PDIS-09-18-1549-RE)
    - Xylem containing embolisms from drought less impeding to fungus hyphae than intact vessels
  - Accelerates development of GLRaV3 symptoms (https://apsjournals.apsnet.org/doi/10.1094/PDIS-01-17-0104-RE)
    - Anthocyanin accumulation is upregulated by drought conditions
  - Reduces yields
  - Death of established vines ???

CAN GRAPEVINES DIE FROM WATER STRESS?



Ten-Year Study Shows How Far Vines Can Go…(https://www.science.org/doi/10.1126/sciadv.aao6969)

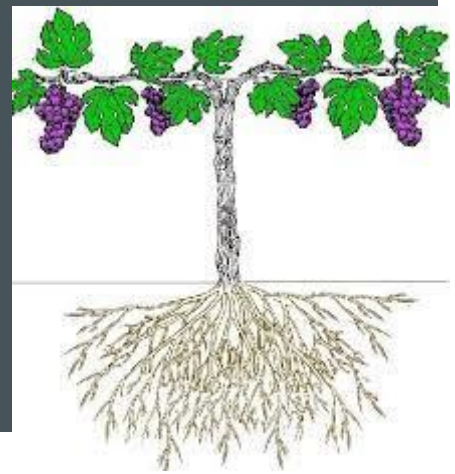
- Journal of Science Advances
  - 10-year study of grapevine hardiness during drought
  - French National Institute for Agricultural Research
  - Tipping point for grapes – air bubbles (embolisms) in xylem

Two tests…

- 1st Spun vines in a centrifuge to form air bubbles
  - Vines resisted forming air bubbles
  - As vines aged, the resistance increased
- 2nd Water starved plants in the lab
  - Periodically removed leaves and measured water
  - Vines unable to recover once sap reached ½ original content

Vines are naturally resistant to water stresses present during drought conditions!

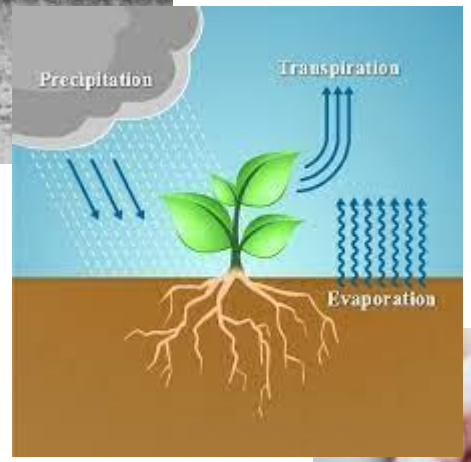
CHALLENGES FOR DRY FARMING



- Dry Farming Relies On…
  - Soil water holding capacity
  - Field capacity at budbreak
  - In season precipitation and temperatures
  - Timing of harvest (pre harvest water stress)
- Highly dependent on soil depth and textural makeup
  - Rooting depth
  - Plant available water
- Subject to lower yields due to nutrient and water deficits

HOW DOES DRY LAND FARMING WORK?

- The Great Matchup
  - Water Holding Capacity of Soil
  - Rainfall amounts and patterns (in season helpful)
  - Water use by grapevines (ETc)



TEXTURAL CLASS (PARTICLE SIZE) & HOLDING CAPACITY

Textural class	*Water holding capacity, inches/foot of soil*
Coarse sand	0.25 - 0.75
Fine sand	0.75 - 1.00
Loamy sand	1.10 - 1.20
Sandy loam	1.25 - 1.40
Fine sandy loam	1.50 - 2.00
Silt loam	2.00 - 2.50
Silty clay loam	1.80 - 2.00
Silty clay	1.50- 1.70
Clay	1.20 - 1.50

SOIL WATER DYNAMICS

Image source: The Daily Garden

- Soils saturated during rain season (Nov-Mar)
- Field capacity reached as gravitational water is lost and pores are saturated
- Wilting point reached once all available water is lost to plant use or evaporation
- Field Capacity - Wilting Point = Plant available water
- Know this amount for your soils!

PARTICLE MAKEUP EFFECT ON WATER

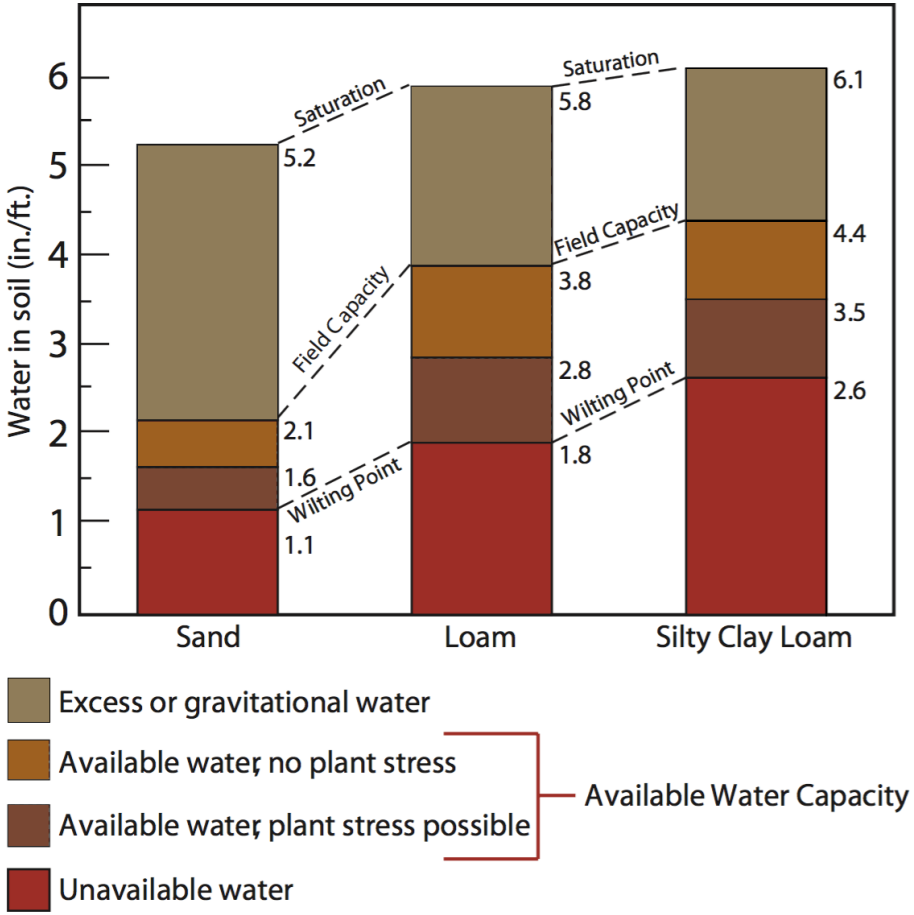
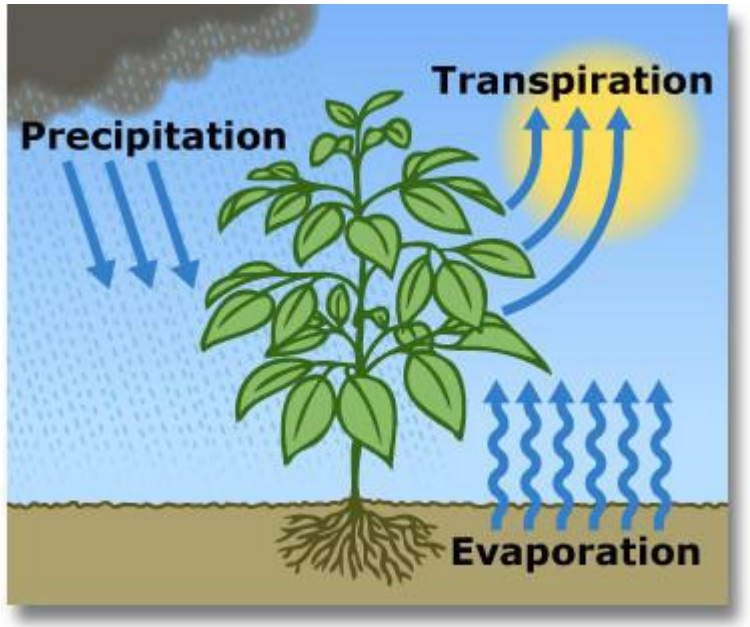


Image provided by Noble Research Institute

- Percent sand, silt, and clay affect the water capacity of soils
- Sandy soils hold less water due to large gravitational losses
- Loams hold adequate water, and much is available to plants
- Clayey soils hold the most water, but it becomes harder for plants to access as soil dries down

EVAPOTRANSPIRATION (ET)

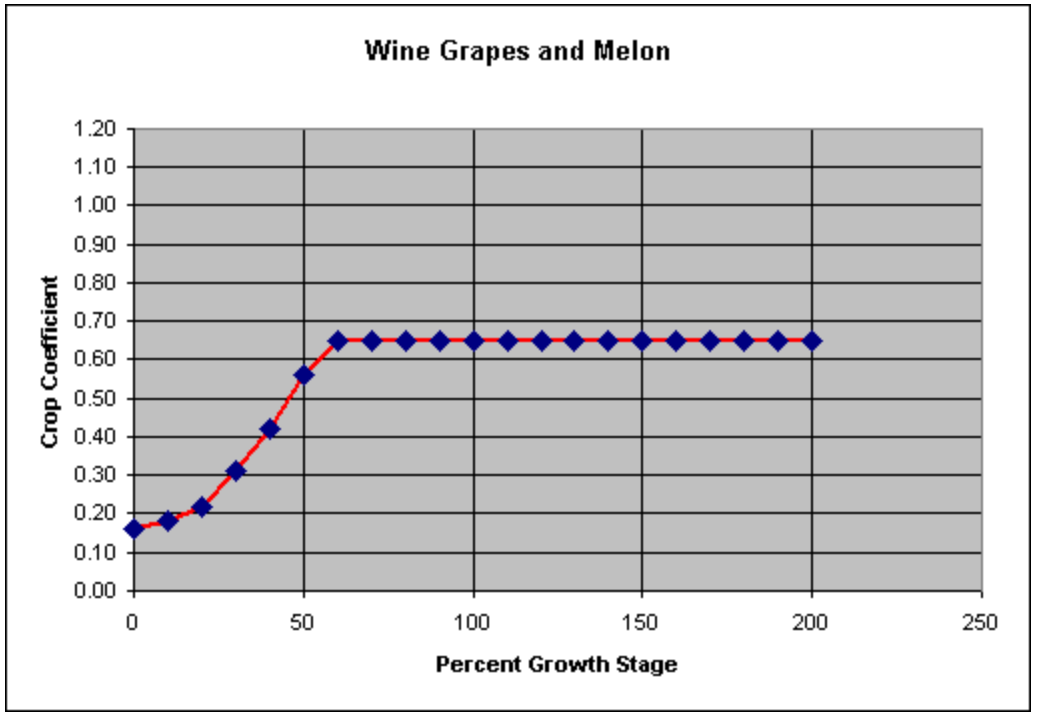
- Combination of two processes
  - Loss of water at soil surface (evaporation)
  - Loss of water from leaf surfaces as plants use for photosynthesis (transpiration)
- Usually measured in inches of water



Source: www.spruceirrigation.com

ET_C CROP WATER USE

- Percentage of ET using crop coefficient (Kc)
- Changes with growth stage
- Grape Kc = .15 @ 0 (budbreak)
- Grape Kc = .65 @ full canopy
- ET_C = ET * Kc



CASE STUDY 2021 VS. 1999

SOIL WATER STATUS IN DROUGHT

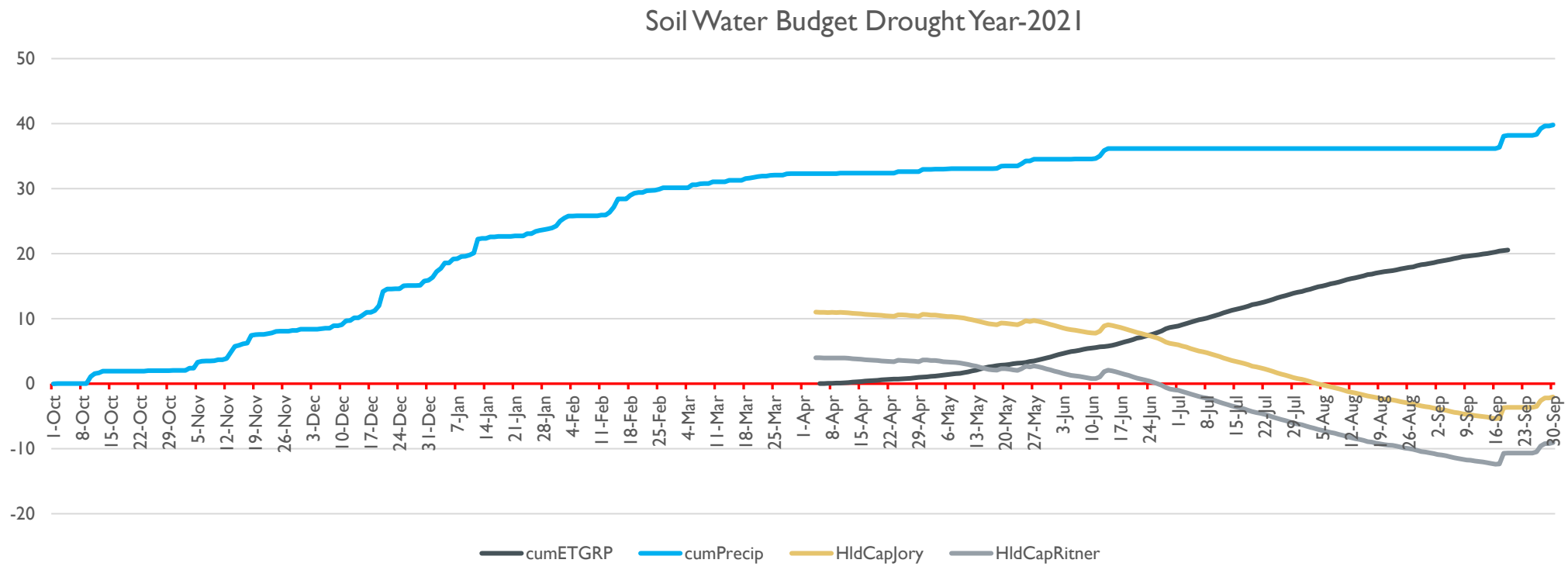
AVAILABLE WATER HOLDING CAPACITY

Red Hill Soils

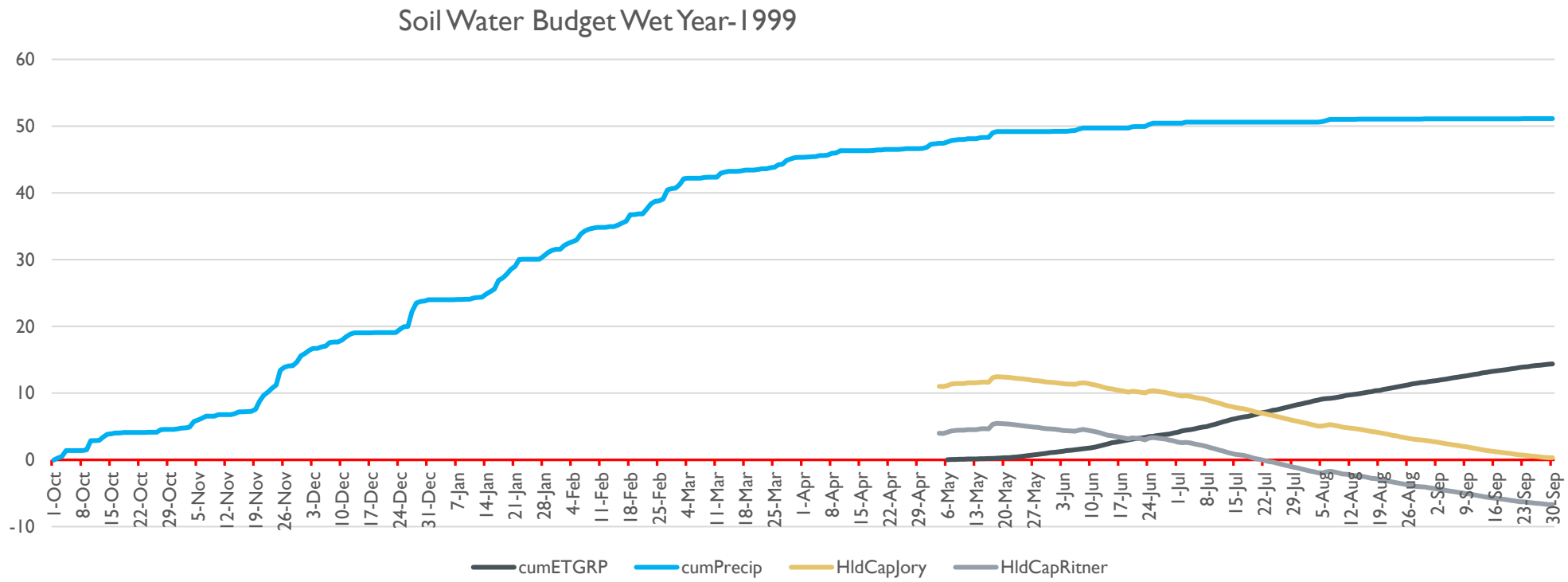
Table 1. Summary Soil Boring Data

Boring	Soil Series	Surface thickness (in)	Depth to basalt (in)	Depth to gravelly layer (in)	Available water holding capacity (in)
1	Gelderman	15	38	27	5 to 6
2	Jory	16	>60	>60	11
3	Jory	20	>60	>60	11
4	Saum	15	48	48	8
5	Cottrell	18	>60	>60	10
6	Saum	24	>60	>60	10
7	Jory	20	>96	76	12
8	Jory	16	>60	>60	11
9	Ritner	20	36	24	4
10	Jory	10	>60	>60	11
11	Saum	17	44	44	8

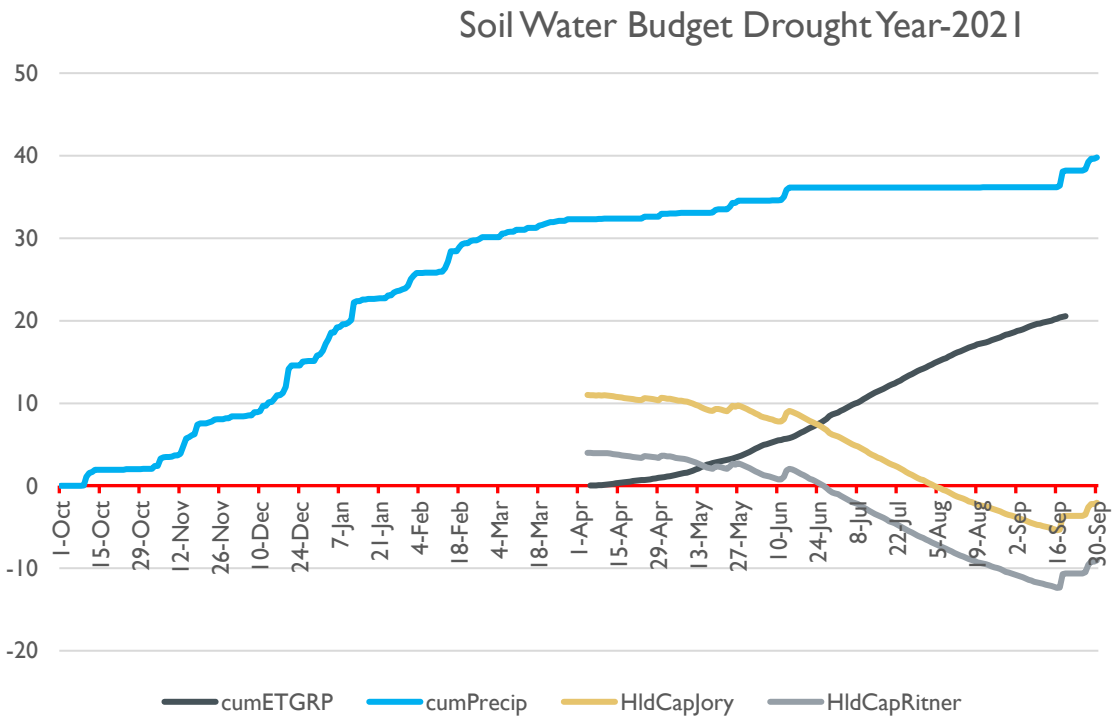
DROUGHT YEAR - 2021

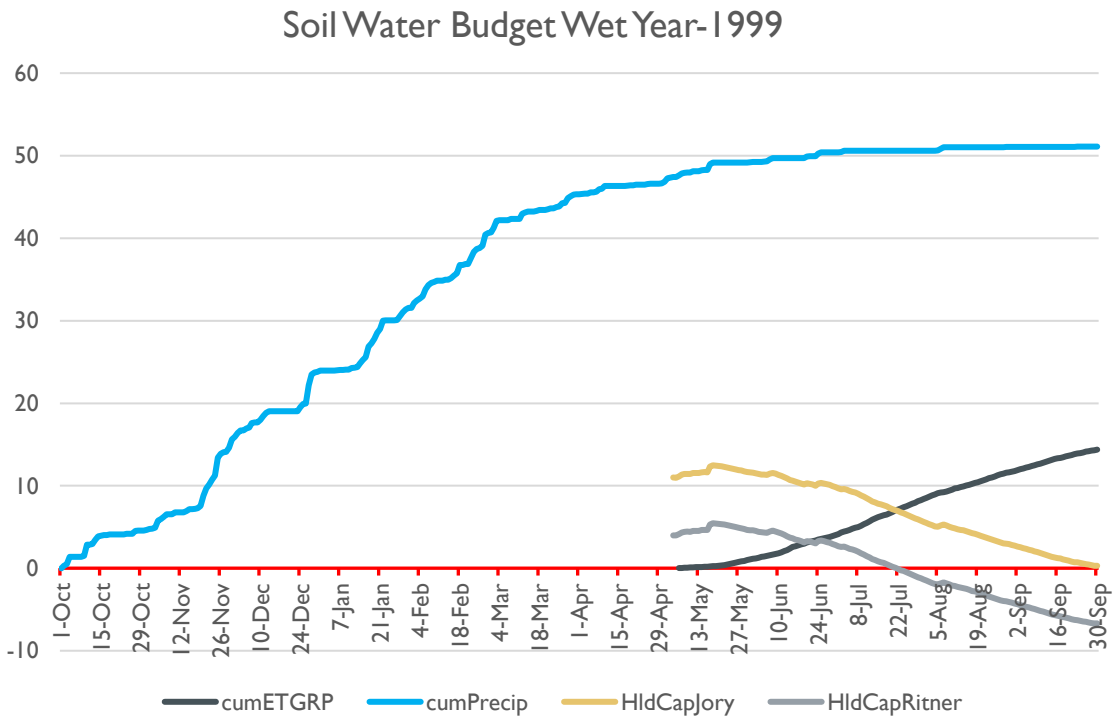


WET YEAR 1999



SIDE BY SIDE


Soil Water Budget Drought Year-2021
50
40
30
20
10
0
-10
-20
1-Oct
15-Oct
29-Oct
12-Nov
26-Nov
10-Dec
24-Dec
7-Jan
21-Jan
4-Feb
18-Feb
4-Mar
18-Mar
1-Apr
15-Apr
29-Apr
13-May
27-May
10-Jun
24-Jun
8-Jul
22-Jul
5-Aug
19-Aug
2-Sep
16-Sep
30-Sep
cumETGRP
cumPrecip
HldCapJory
HldCapRitner


Soil Water Budget Wet Year-1999
60
50
40
30
20
10
0
-10
1-Oct
15-Oct
29-Oct
12-Nov
26-Nov
10-Dec
24-Dec
7-Jan
21-Jan
4-Feb
18-Feb
4-Mar
18-Mar
1-Apr
15-Apr
29-Apr
13-May
27-May
10-Jun
24-Jun
8-Jul
22-Jul
5-Aug
19-Aug
2-Sep
16-Sep
30-Sep
cumETGRP
cumPrecip
HldCapJory
HldCapRitner

AS A MATTER OF SOIL – SURVIVING DROUGHT

- Deep soils holding 10” or more of water
  - Maintain a healthy level of water stress in dry seasons
  - Allow for deeper rooting and hold more water
  - Provide adequate nutrition through season
- Shallower soils holding 5” or less
  - Can become very stressed too early in the season
  - Need to be amended with biomass to increase water holding capacity
  - May need supplemental irrigation to maintain yields
  - May not get adequate nutrition/nitrogen leading to low YAN

FREE TOOLS FOR BETTER UNDERSTANDING

- Instant Weather Data
- Daily Weather Data
- Crop Water Use
- ET Summary
- Graphs
- Weather Forecast (NWS)
- Station Parameters
- AgriMet Network Map

HTTPS://WWW.USBR.GOV/PN/AGRIMET/WXDATA.HTML

ARAO - ET SUMMARY - 2021

DATE	ETr	ALFP	ALFM	PAST	LAWN	GRSD	WGRN	SGRN	POTA	FCRN	SCRN	PEAS	ONYN	APPL	WGRP	SBRY	TBER	BLUB	PPMT
02/26	0.05	--	--	--	--	--	0.01	--	--	--	--	--	--	--	--	--	--	--	--
02/27	0.06	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	--	--
02/28	0.07	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	--	--
03/01	0.05	--	--	0.01	0.01	0.02	0.02	--	--	--	--	--	--	--	--	--	--	--	--
03/02	0.05	--	--	0.01	0.01	0.02	0.02	--	--	--	--	--	--	--	--	--	--	--	--
03/03	0.05	--	--	0.01	0.01	0.02	0.02	--	--	--	--	--	--	--	--	--	--	--	--
03/04	0.06	--	--	0.02	0.01	0.02	0.02	--	--	--	--	--	--	--	--	--	--	--	--
03/05	0.02	0.00	0.00	0.01	0.00	0.01	0.01	--	--	--	--	--	--	--	--	0.00	--	--	--
03/06	0.07	0.01	0.01	0.02	0.02	0.02	0.03	--	--	--	--	--	--	--	--	0.01	--	--	--
03/07	0.06	0.01	0.01	0.02	0.02	0.02	0.03	--	--	--	--	--	--	--	--	0.01	--	--	--
03/08	0.05	0.01	0.01	0.02	0.02	0.02	0.02	--	--	--	--	--	--	--	--	0.01	--	--	--
03/09	0.06	0.01	0.01	0.02	0.02	0.02	0.03	--	--	--	--	--	--	--	--	0.01	--	--	--
03/10	0.06	0.01	0.01	0.02	0.03	0.02	0.03	0.01	--	--	--	--	--	--	--	0.01	--	--	--
03/11	0.08	0.02	0.02	0.03	0.04	0.03	0.05	0.02	--	--	--	--	--	--	--	0.01	--	--	--
03/12	0.08	0.02	0.02	0.03	0.04	0.04	0.05	0.02	--	--	--	--	--	--	--	0.02	--	--	--
03/13	0.08	0.02	0.02	0.03	0.04	0.04	0.05	0.02	--	--	--	--	--	--	--	0.02	--	--	--
03/14	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	--	--	--	--	--	--	--	0.00	--	--	--
03/15	0.05	0.02	0.02	0.02	0.03	0.03	0.03	0.01	--	--	--	--	0.02	--	--	0.01	--	--	--
03/16	0.07	0.03	0.03	0.03	0.04	0.04	0.05	0.01	--	--	--	--	0.02	--	--	0.02	--	--	--
03/17	0.08	0.03	0.03	0.03	0.05	0.05	0.05	0.02	--	--	--	--	0.03	--	--	0.02	--	--	--
03/18	0.04	0.02	0.02	0.02	0.03	0.02	0.03	0.01	--	--	--	--	0.01	--	--	0.01	--	--	--
03/19	0.08	0.04	0.04	0.04	0.06	0.05	0.06	0.02	--	--	--	--	0.03	--	--	0.03	--	--	--
03/20	0.09	0.04	0.04	0.04	0.06	0.06	0.07	0.02	--	--	--	--	0.04	0.02	--	0.03	0.01	0.02	0.01
03/21	0.05	0.03	0.03	0.02	0.04	0.03	0.04	0.01	--	--	--	--	0.02	0.01	--	0.02	0.01	0.01	0.01
03/22	0.08	0.04	0.04	0.04	0.06	0.06	0.06	0.02	--	--	--	--	0.03	0.02	--	0.03	0.01	0.02	0.01
03/23	0.08	0.05	0.05	0.04	0.06	0.06	0.06	0.02	--	--	--	--	0.04	0.02	--	0.03	0.01	0.02	0.01
03/24	0.02	0.01	0.01	0.01	0.02	0.01	0.02	0.01	--	--	--	--	0.01	0.00	--	0.01	0.00	0.00	0.00
03/25	0.05	0.03	0.03	0.03	0.04	0.04	0.04	0.01	--	--	--	--	0.02	0.01	--	0.02	0.01	0.01	0.01
03/26	0.08	0.05	0.05	0.04	0.06	0.06	0.07	0.02	--	--	--	--	0.04	0.02	--	0.04	0.01	0.02	0.01
03/27	0.10	0.06	0.06	0.06	0.08	0.08	0.09	0.03	--	--	--	--	0.05	0.02	--	0.05	0.02	0.03	0.02
03/28	0.04	0.03	0.03	0.02	0.03	0.03	0.04	0.01	--	--	--	--	0.02	0.01	--	0.02	0.01	0.01	0.01
03/29	0.09	0.06	0.06	0.05	0.07	0.08	0.08	0.03	--	--	--	--	0.05	0.02	--	0.05	0.02	0.03	0.02
03/30	0.09	0.06	0.06	0.05	0.07	0.08	0.08	0.04	--	--	--	--	0.05	0.02	--	0.05	0.02	0.03	0.02
03/31	0.14	0.10	0.10	0.09	0.11	0.12	0.13	0.06	--	--	--	--	0.07	0.03	--	0.09	0.03	0.05	0.03
04/01	0.13	0.10	0.10	0.08	0.10	0.11	0.12	0.06	--	--	--	--	0.07	0.03	--	0.09	0.03	0.05	0.03
04/02	0.11	0.08	0.08	0.07	0.09	0.10	0.10	0.06	--	--	--	--	0.06	0.03	--	0.08	0.03	0.04	0.02
04/03	0.10	0.08	0.08	0.06	0.08	0.09	0.10	0.06	--	--	--	--	0.05	0.03	--	0.07	0.02	0.04	0.02
04/04	0.12	0.09	0.09	0.08	0.10	0.11	0.12	0.07	--	--	--	--	0.06	0.03	--	0.09	0.03	0.05	0.03
04/05	0.12	0.10	0.10	0.08	0.10	0.11	0.12	0.08	0.04	--	--	--	0.06	0.04	0.02	0.09	0.03	0.06	0.03

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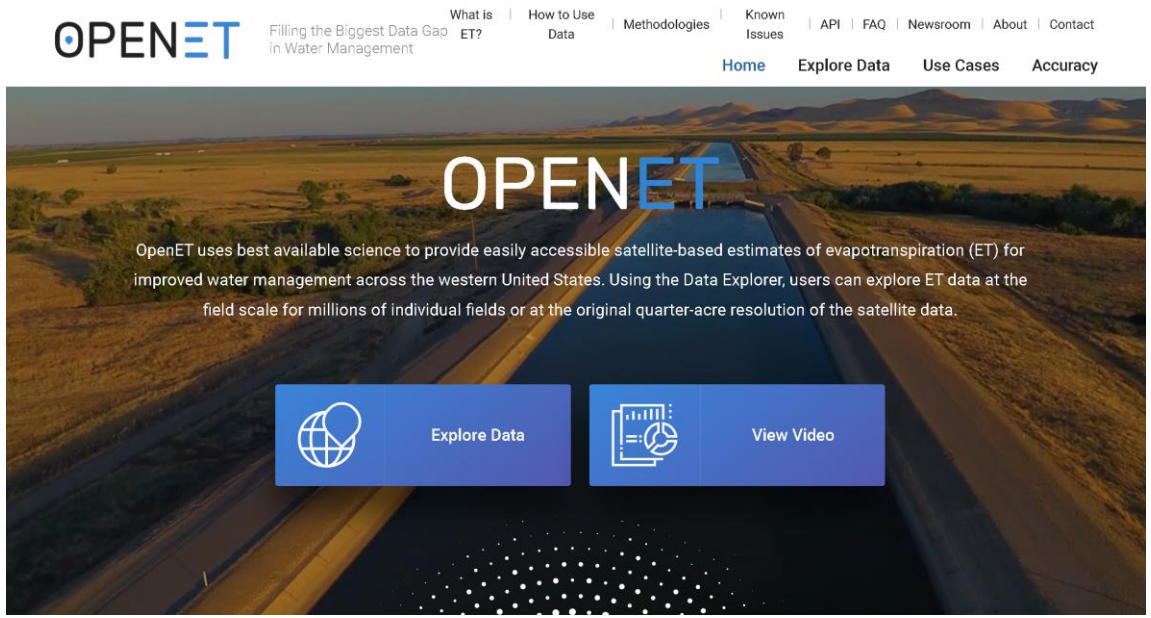
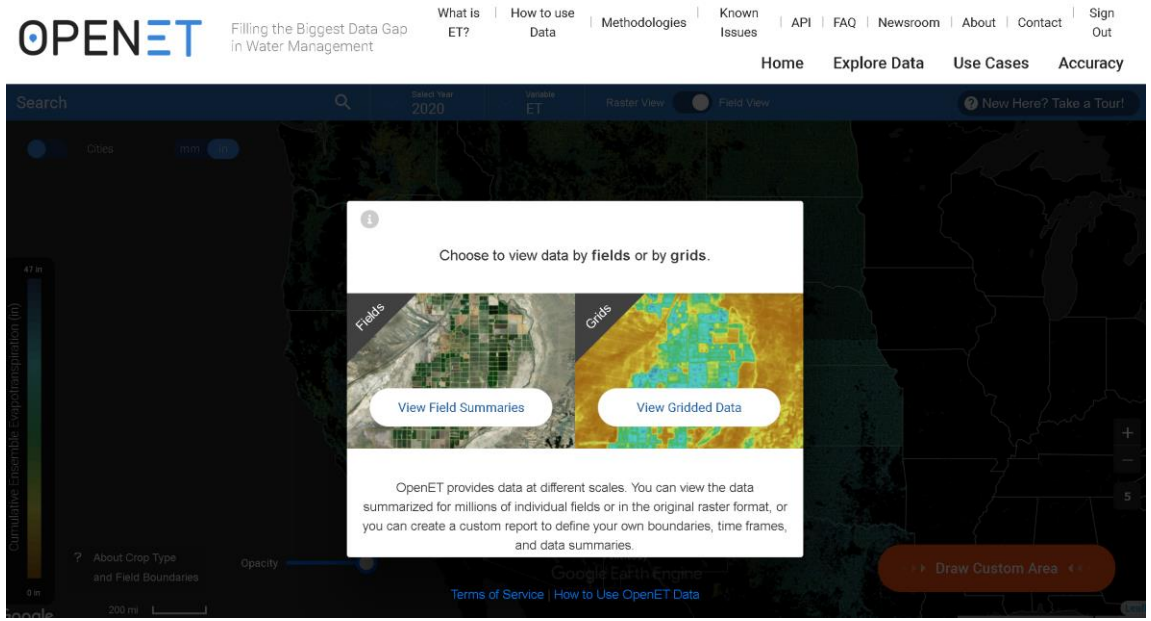
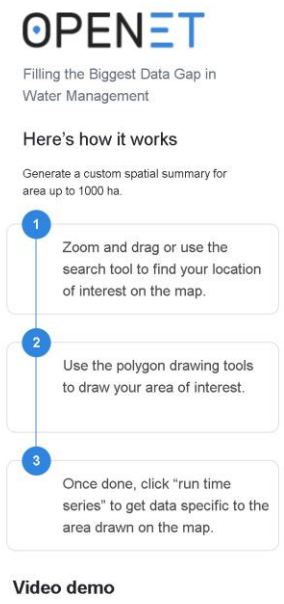
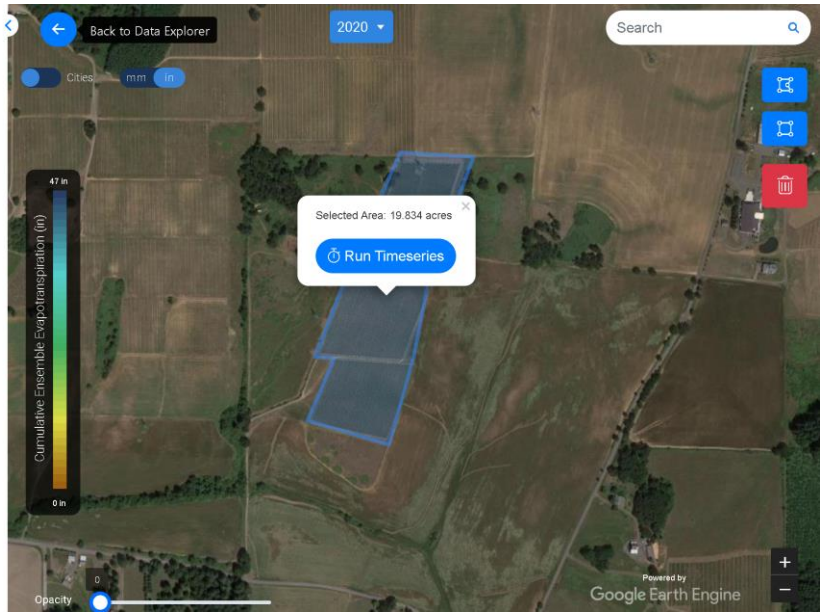


- No subscription necessary
- Based on LandSat
- Lots of instructions and use cases presented

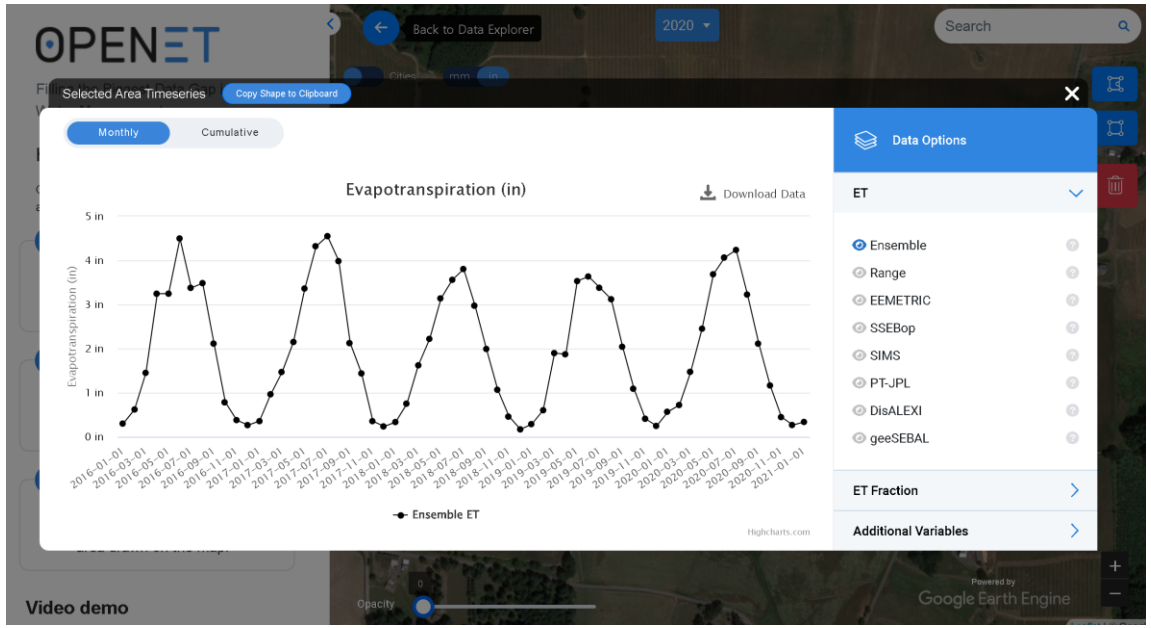
HTTPS://OPENETDATA.ORG/







ET GRAPHS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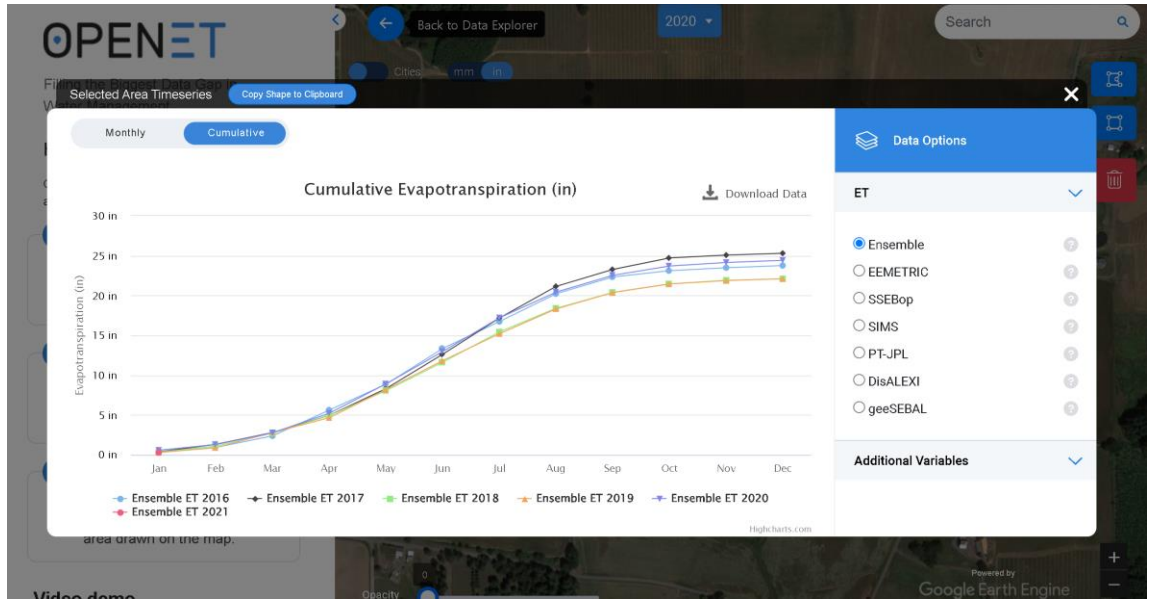
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SUMMARY

- Drought conditions can cause challenges for dry farmed viticulture
- Grapes are naturally resistant to drought conditions… too a point
- Understanding soil water holding capacity and water stresses involved
- Consider irrigation for shallower soils or work on building biomass (increase water capacity)
- Long term drought will challenge vines grown in shallower soils
- Free tools available to track water conditions