Water conservation benefits and environmental concerns of managed agricultural aquifer recharge

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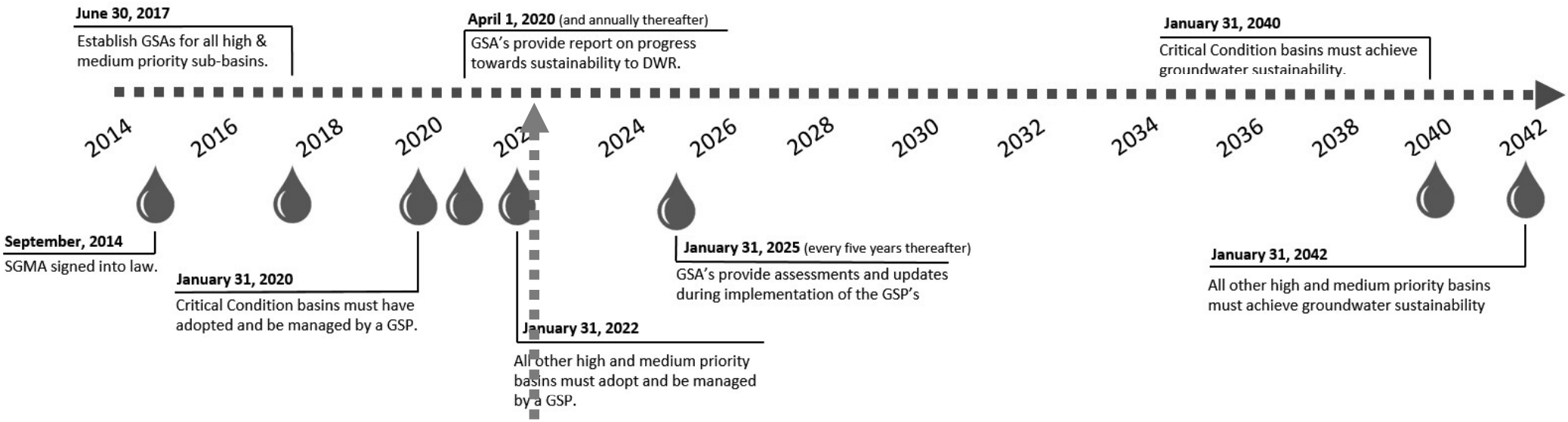
Golden State Dairy Management Conference, March 23, 2022

Sustainable Groundwater Management Act - Update

SGMA Implementation Timeline



GSAs are in the implementation process of SGMA

Source: MERCED SGMA

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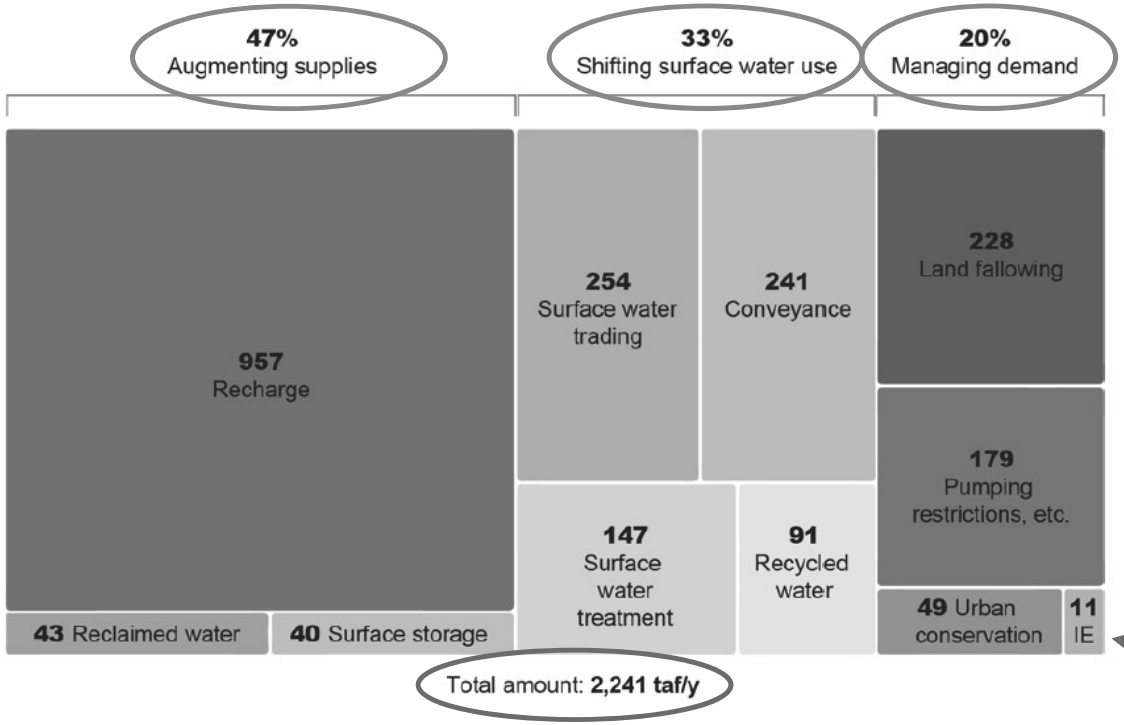
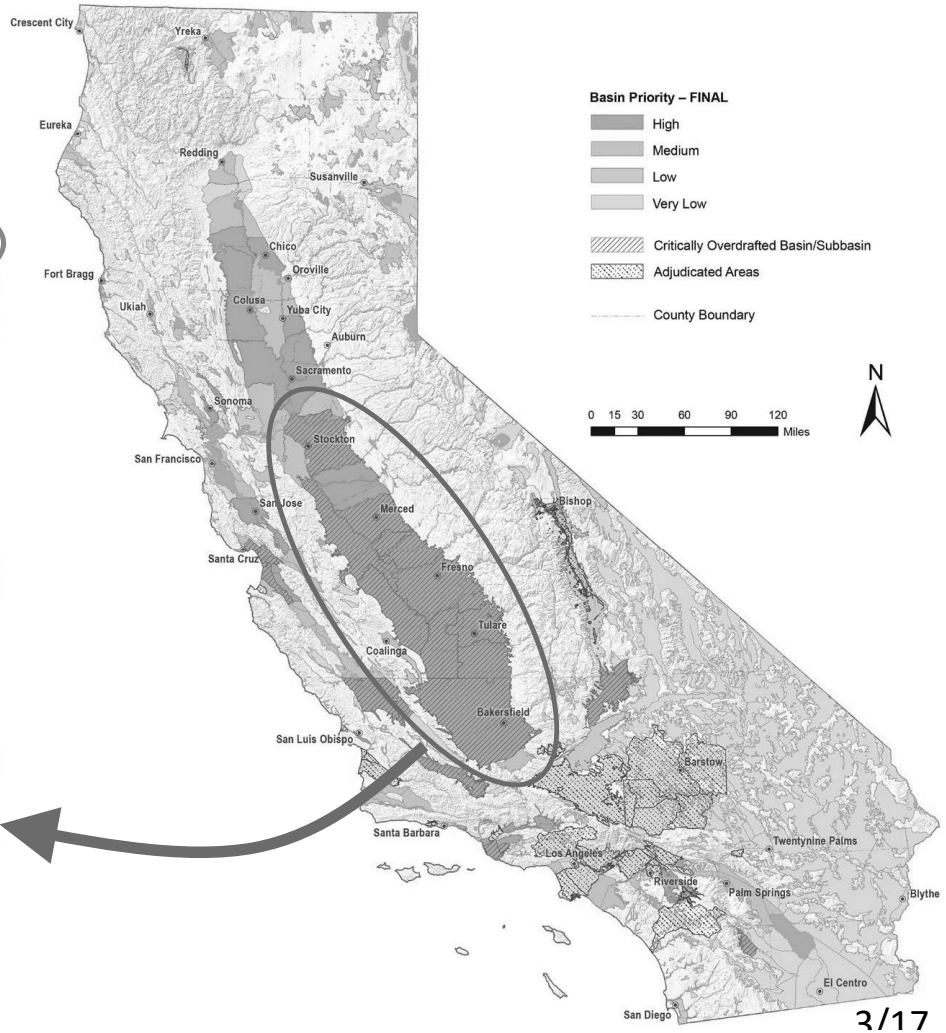
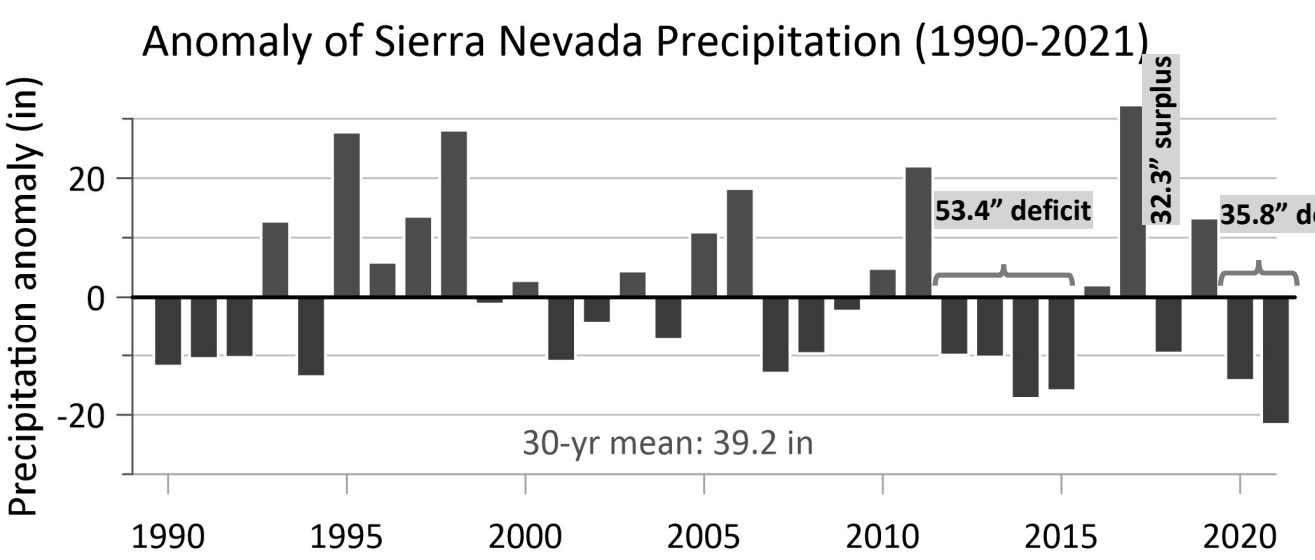
Addressing groundwater overdraft in California

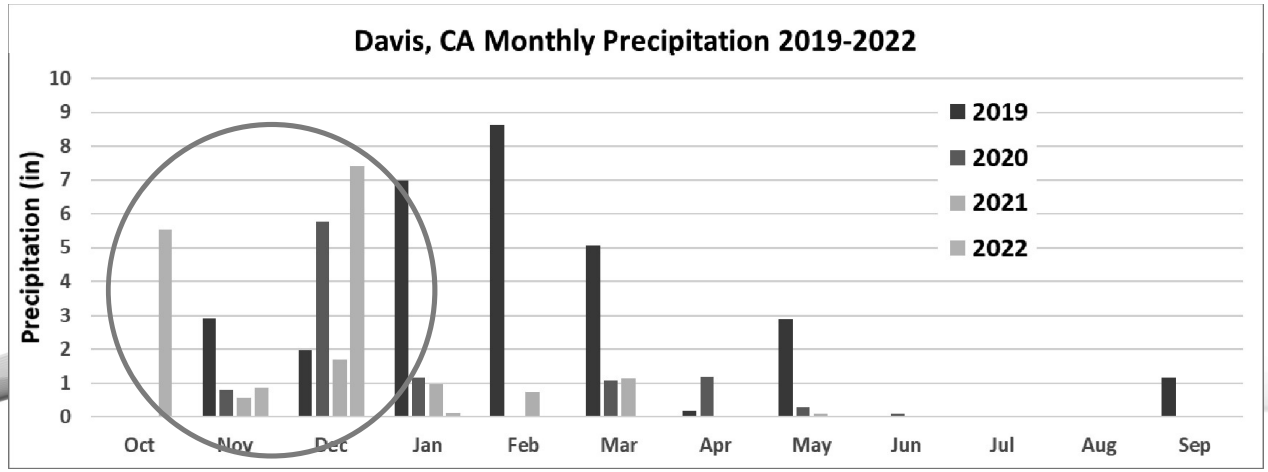




PPIC, 2020, A Review of San Joaquin Valley Groundwater Sustainability Plans

Addressing groundwater overdraft in California





Capture as much water as we can…

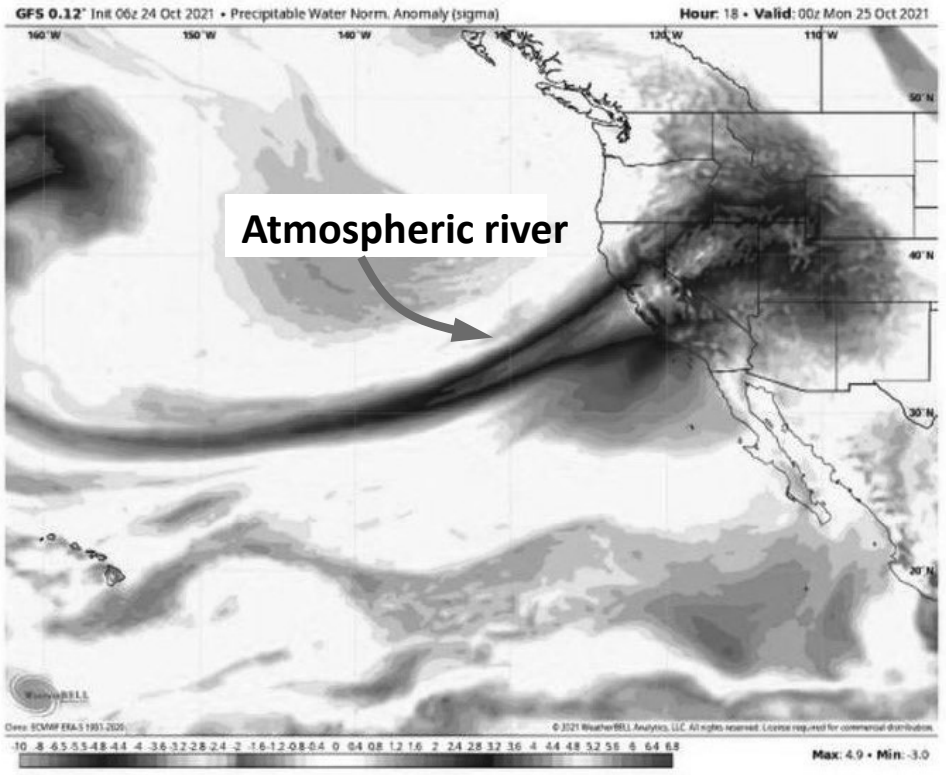
Recharge Basins

limited capacity, best with steady water supply

On-farm recharge

unlimited spreading area, best for biggest storms

October 24, 2021 – AR 5



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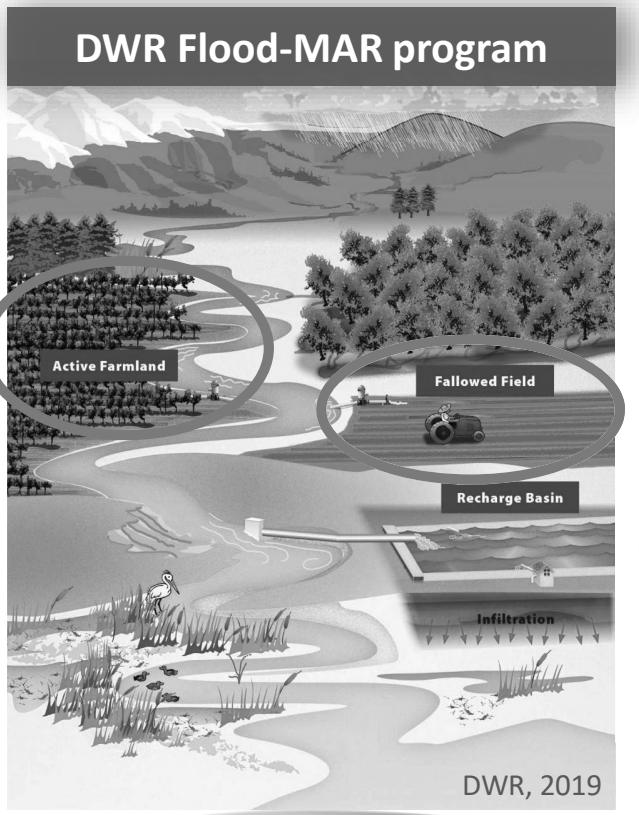
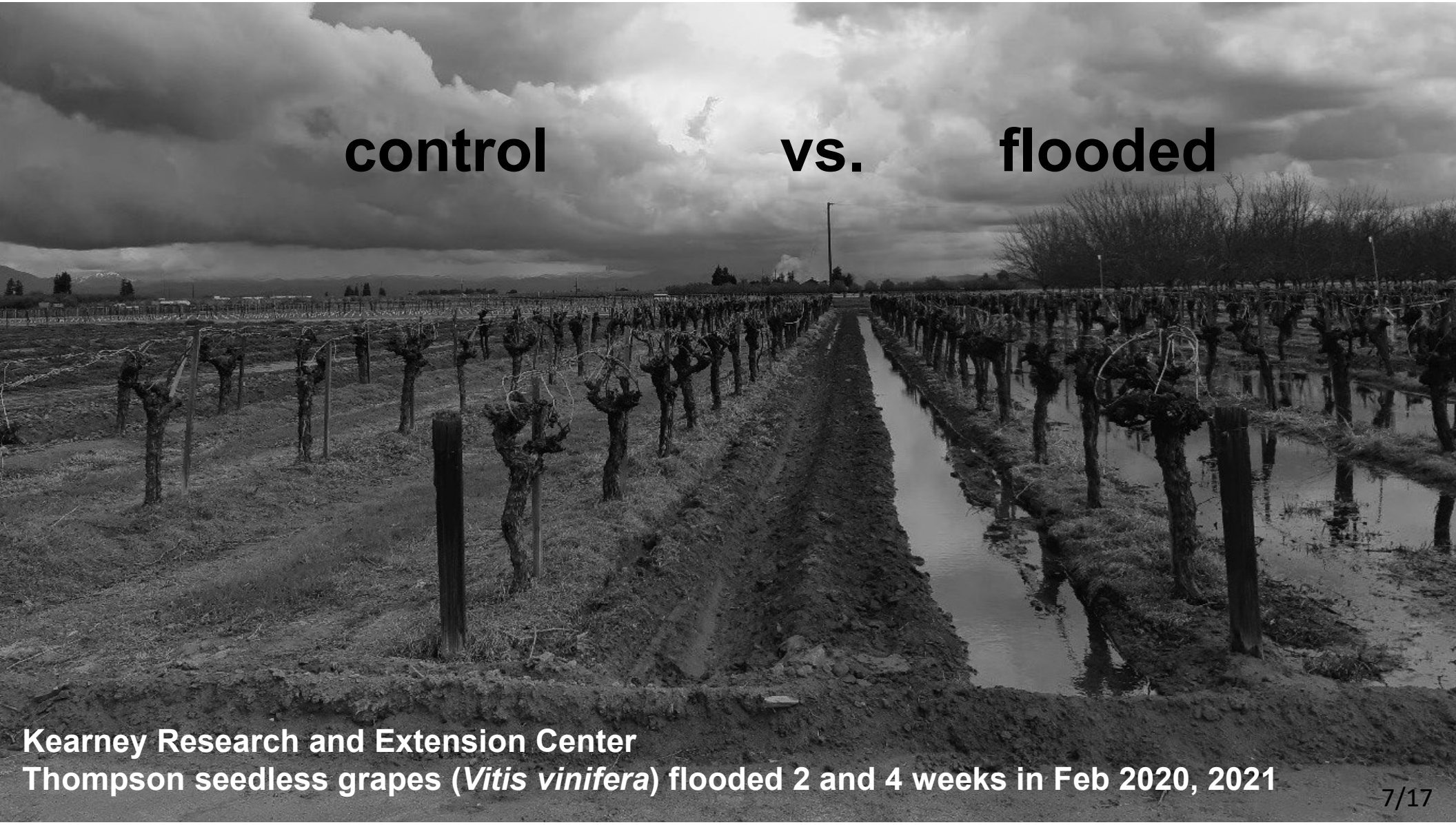
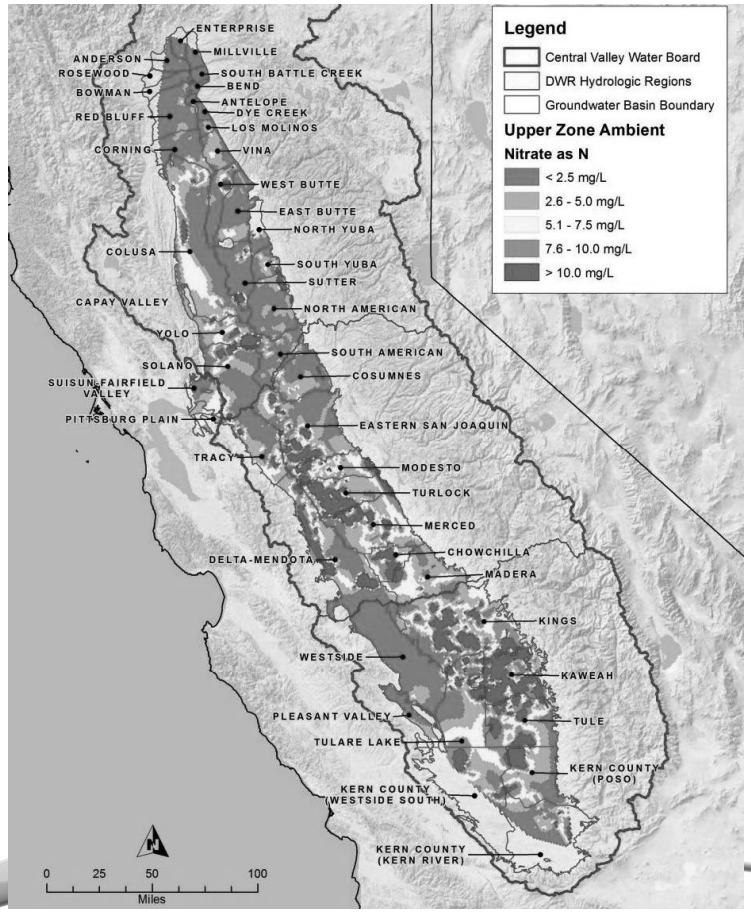
Groundwater recharge using agricultural land





Kearney Research and Extension Center
Thompson seedless grapes (*Vitis vinifera*) flooded 2 and 4 weeks in Feb 2020, 2021

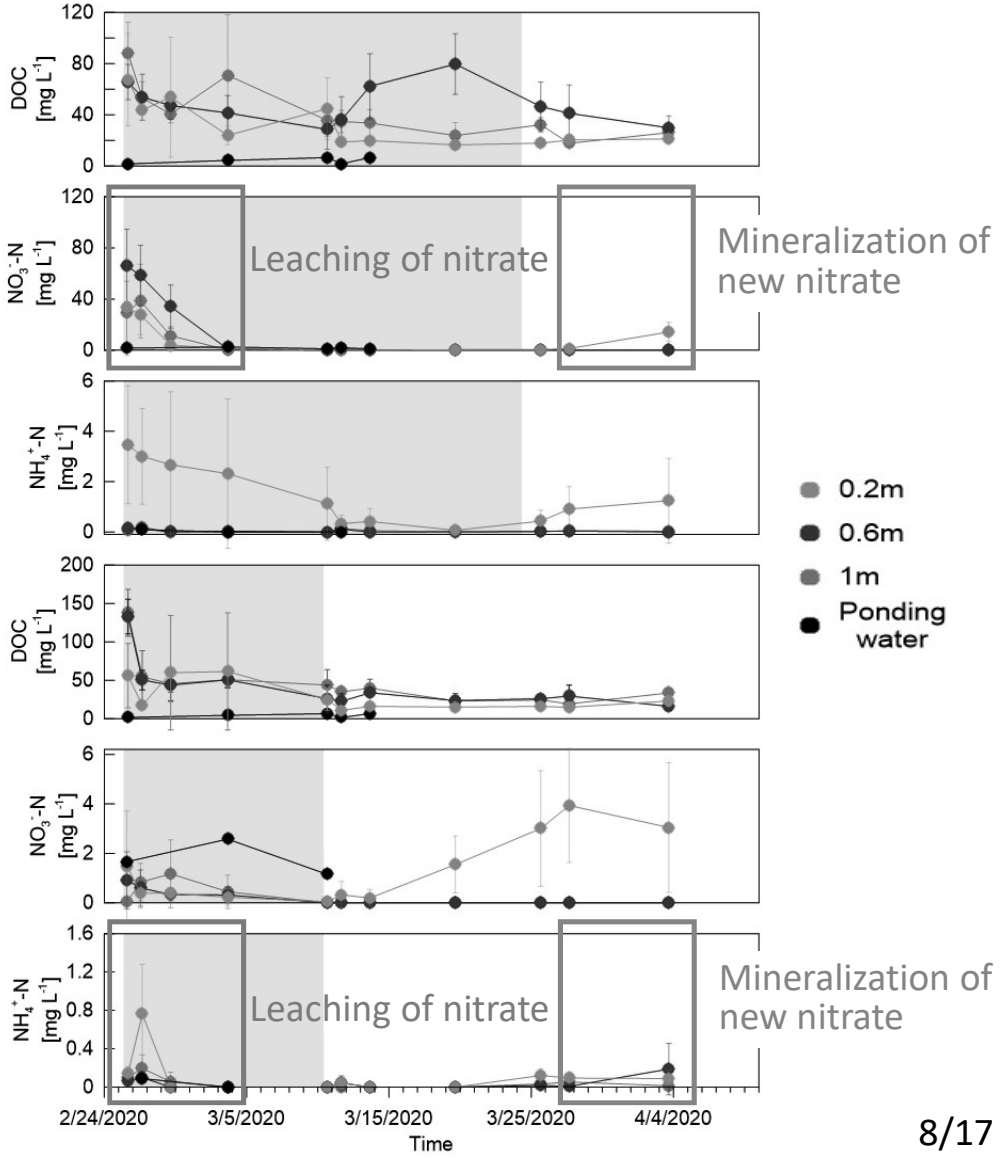
Risk of nitrate leaching



Source: CV-Salts Coalition

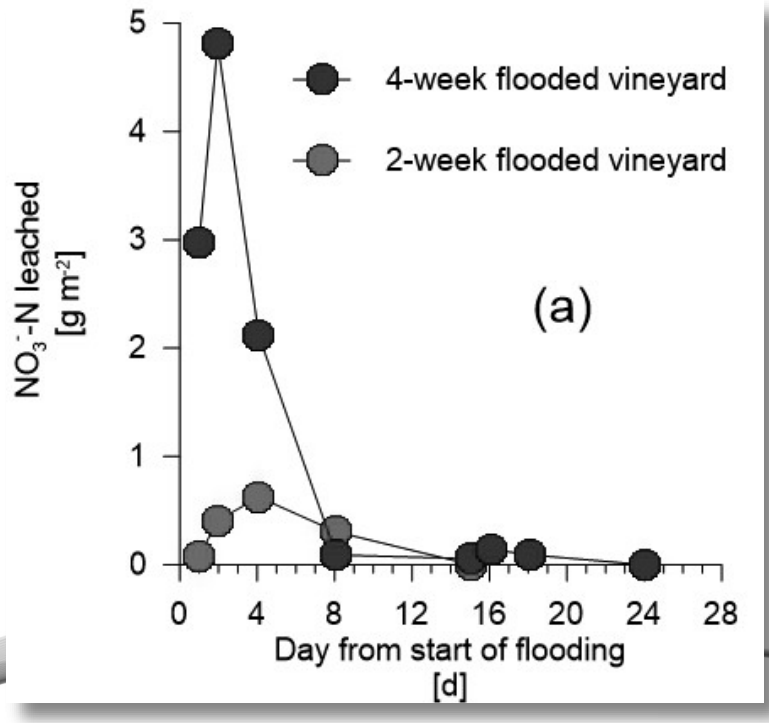
4-week flooded vineyard

2-week flooded vineyard



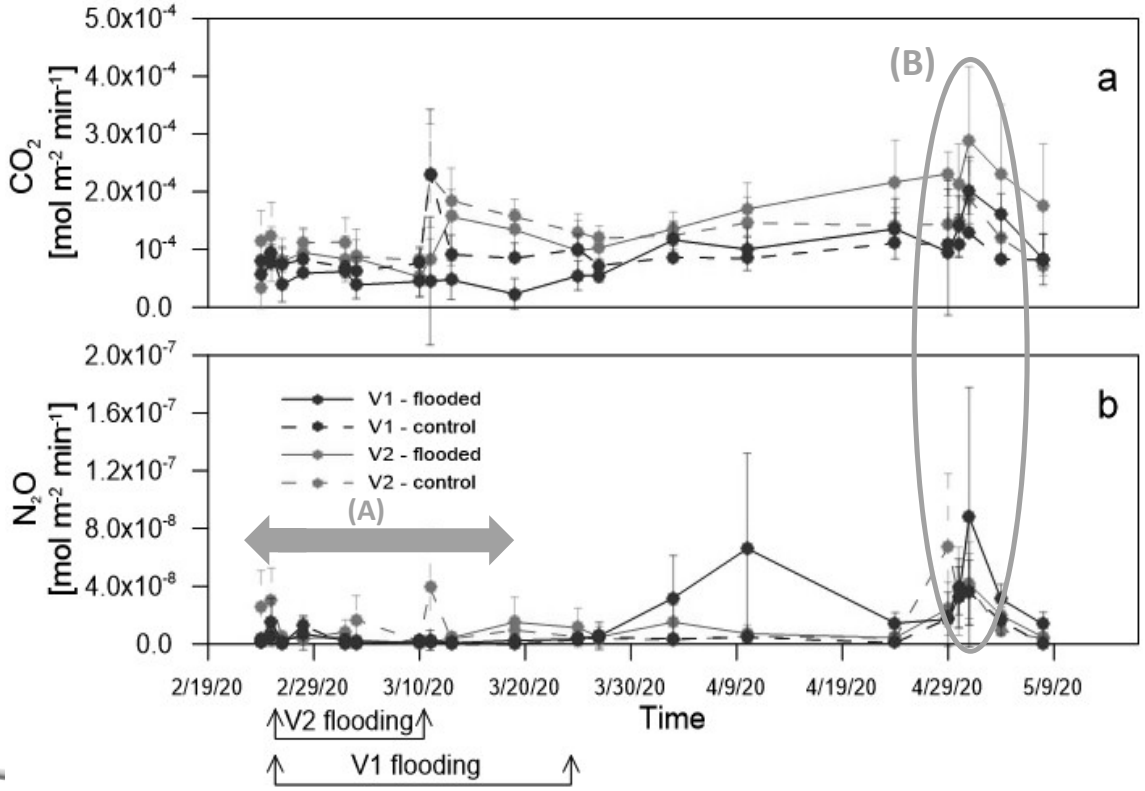
Risk of nitrate leaching

- Majority of nitrate is leached during the first week of flooding
- Initial nitrate concentrations determine amount leached



(A) No observed GHG emissions during the flooding period

(B) Main Increase in N_2O emissions is observed after fertilization

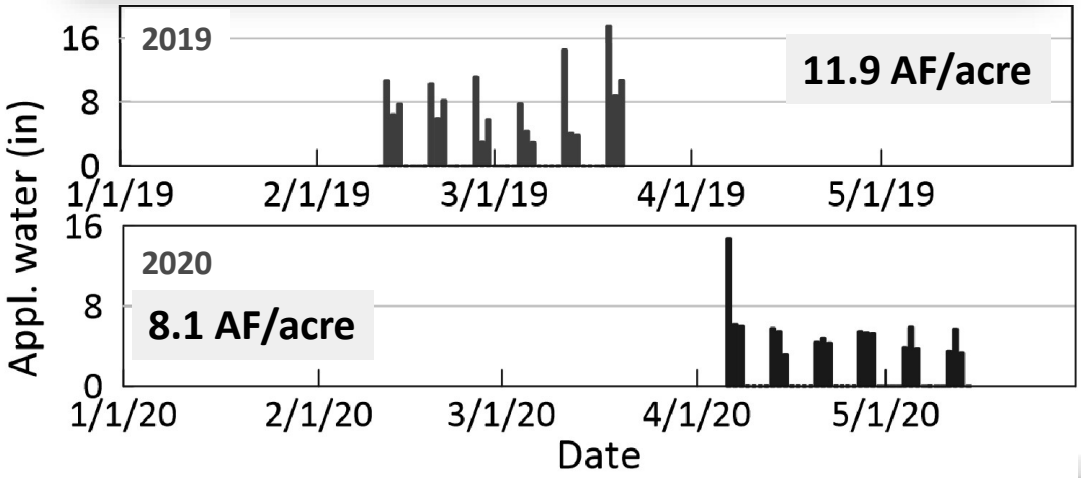


Kearney Research and Extension Center
Alfalfa (*Medicago sativa*) variety Ameristand 835NT RR, flooded in March 2019

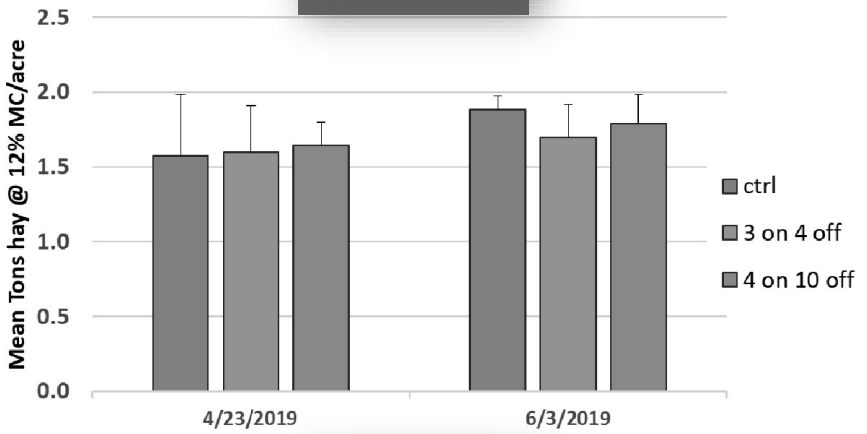
Crop tolerance to winter/spring recharge

- 2-year alfalfa stand (2019) with fall dormancy rating of 8 (Ameristand 835NT RR)
- Hanford fine sandy loam (K_{sat} is high 1.98 to 5.95 in/hr)

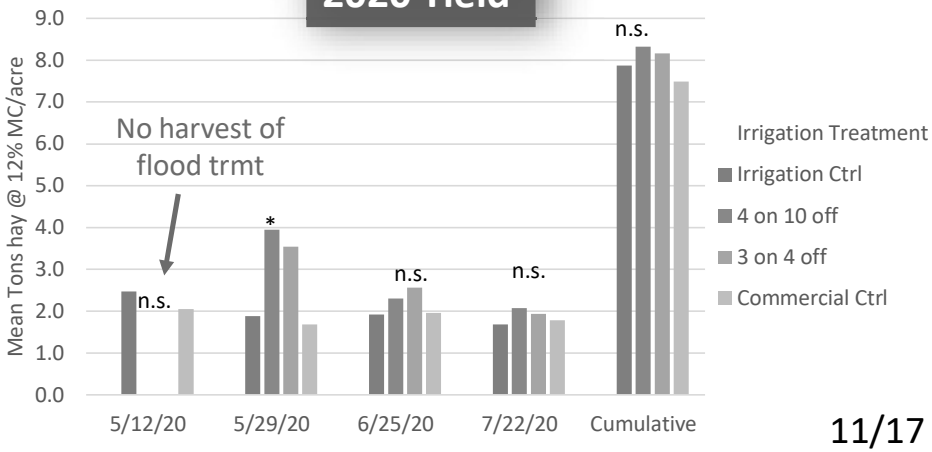
Treatment: 3 days of flooding, 4 days off (3 on 4)



2019 Yield



2020 Yield



Flooding impacts digestible fiber content

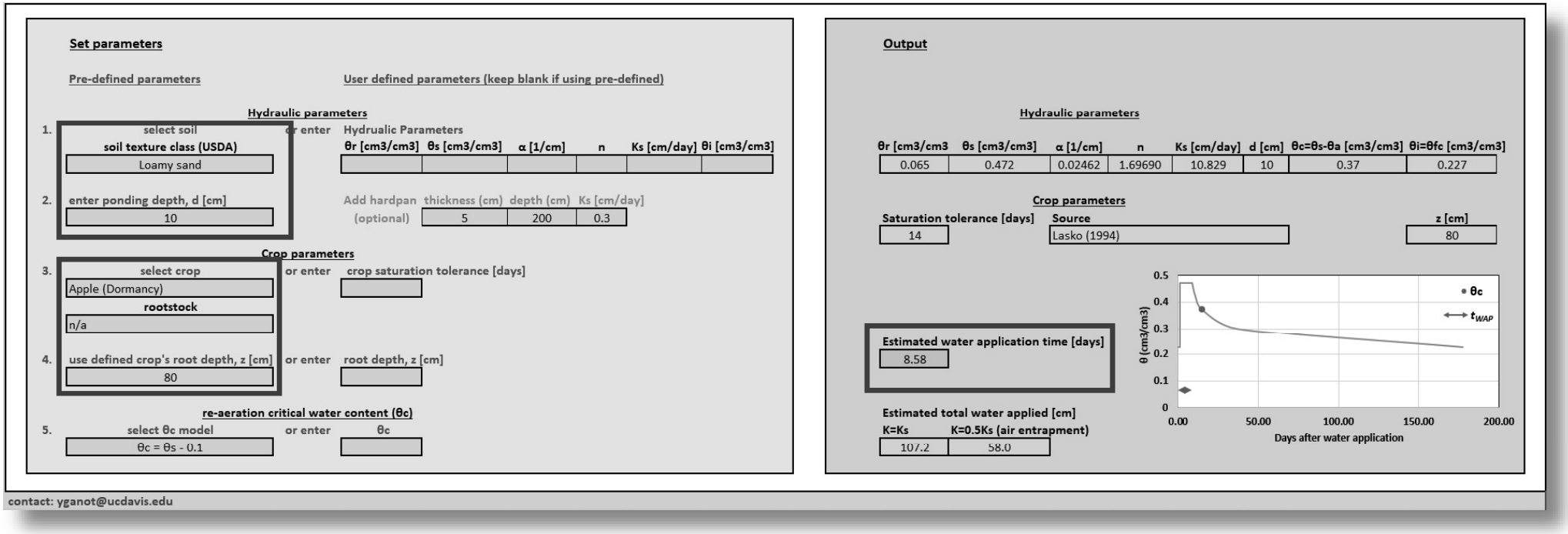
2019	Treatment	Amylase-treated neutral detergent fiber (aNDF)		Acid Detergent Fiber (ADF)		Ash		Crude Protein (CP)	
Control	1	39.75 Good	b	31.54 Good	a	12.07	a	21.56 Premium	a
4 on 10 off	2	42.23 Fair	a	33.31 Fair	a	11.79 High	a	20.17 Premium	b
3 on 4 off	3	40.72 Fair	ab	32.02 Fair	a	11.96	a	20.76 Premium	ab
p-value		*p=0.047*		*p=0.078*		*p=0.69*		*p=0.036*	

2020	Treatment	Amylase-treated neutral detergent fiber (aNDF)		Acid Detergent Fiber (ADF)		Ash		Crude Protein (CP)	
Commercial control	4	41 Fair	b	33.76 Fair	b	11.02 High	b	21.07 Premium	a
Irrigation control	1	42.2 Fair	b	35.02 Fair	b	13.22 High	a	22.22 Supreme	a
4 on 10 off	2	47.11 Utility	a	39.35 Utility	a	13.61 High	a	19.01 Good	b
3 on 4 off	3	48.28 Utility	a	40.03 Utility	a	13.29 High	a	18.11 Good	b
		p< 0.001		*p< 0.001*		*p< 0.001*		*p< 0.001*	

aNDF = total insoluble fiber in feeds
ADF = least digestible fiber, subset of aNDF
Ash = total mineral content
CP = nitrogen content of alfalfa amino acids

	ADF	NDF	RFV	TDN-100%	TDN-90%	CP-100%
Supreme	<27	<34	>185	>62	>55.9	>22
Premium	27-29	34-36	170-185	60.5-62	54.5-55.9	20-22
Good	29-32	36-40	150-170	58-60	52.5-54.5	18-20
Fair	32-35	40-44	130-150	56-58	50.5-52.5	16-18
Utility	>35	>44	<130	<56	<50.5	<16

Safe water application duration decision support tool



Spreadsheet:
https://ars.els-cdn.com/content/image/1-s2.0-S0378377421002961-mmc1.xlsx

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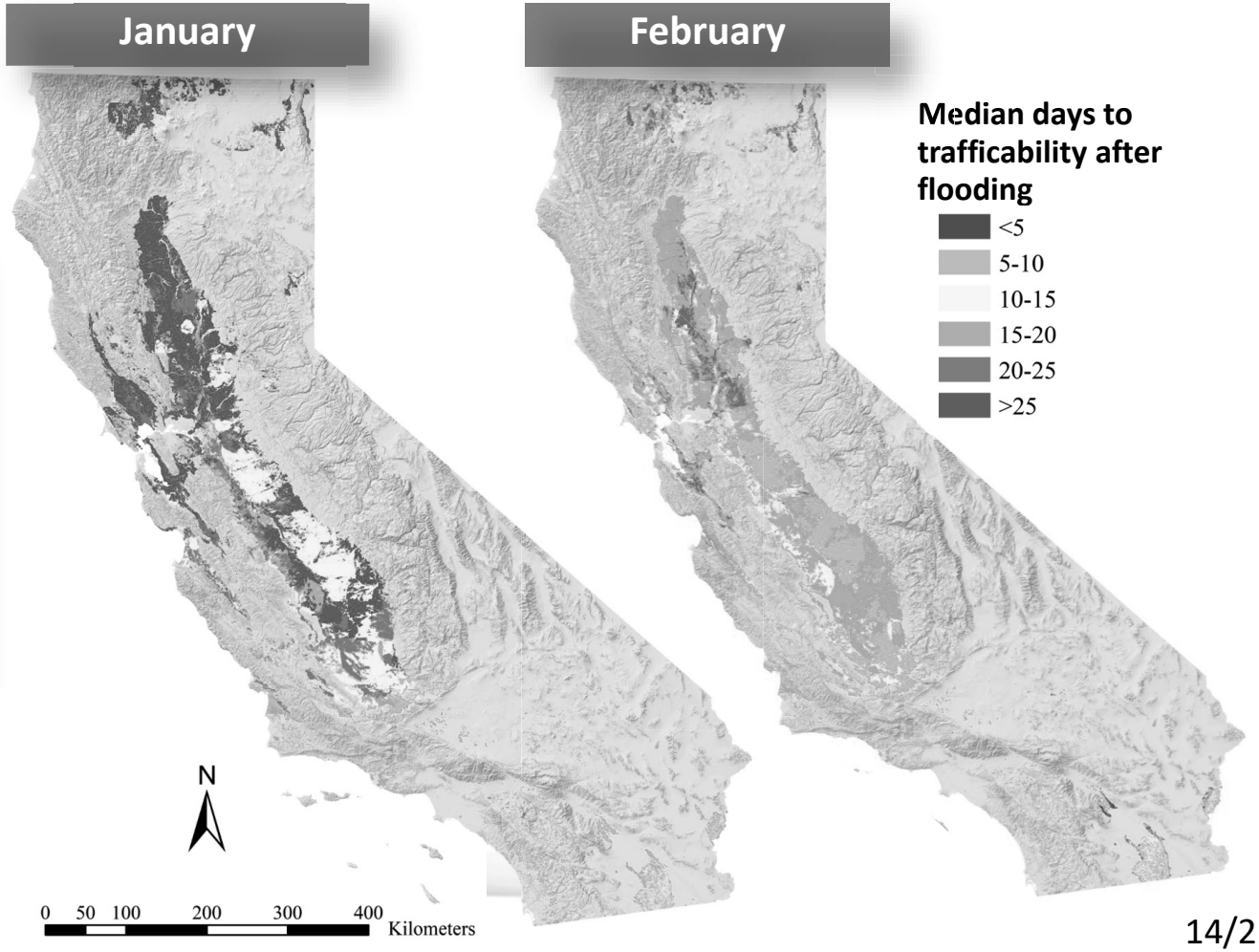
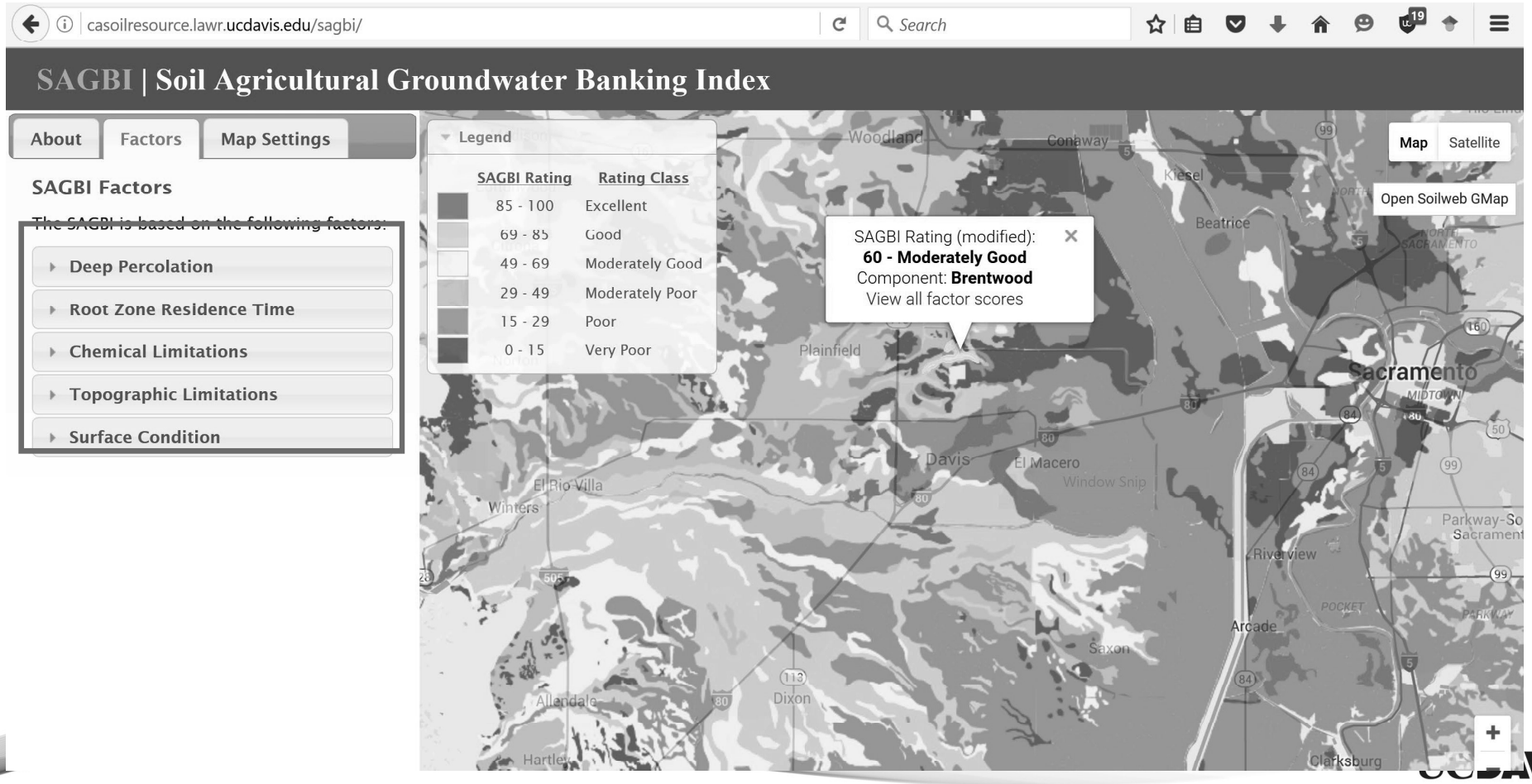
Trafficability after dormant season deep wetting

Trafficability and risk of soil compaction



Devine et al. 2021, submitted

Soil Agricultural Groundwater Banking Index (SAGBI)

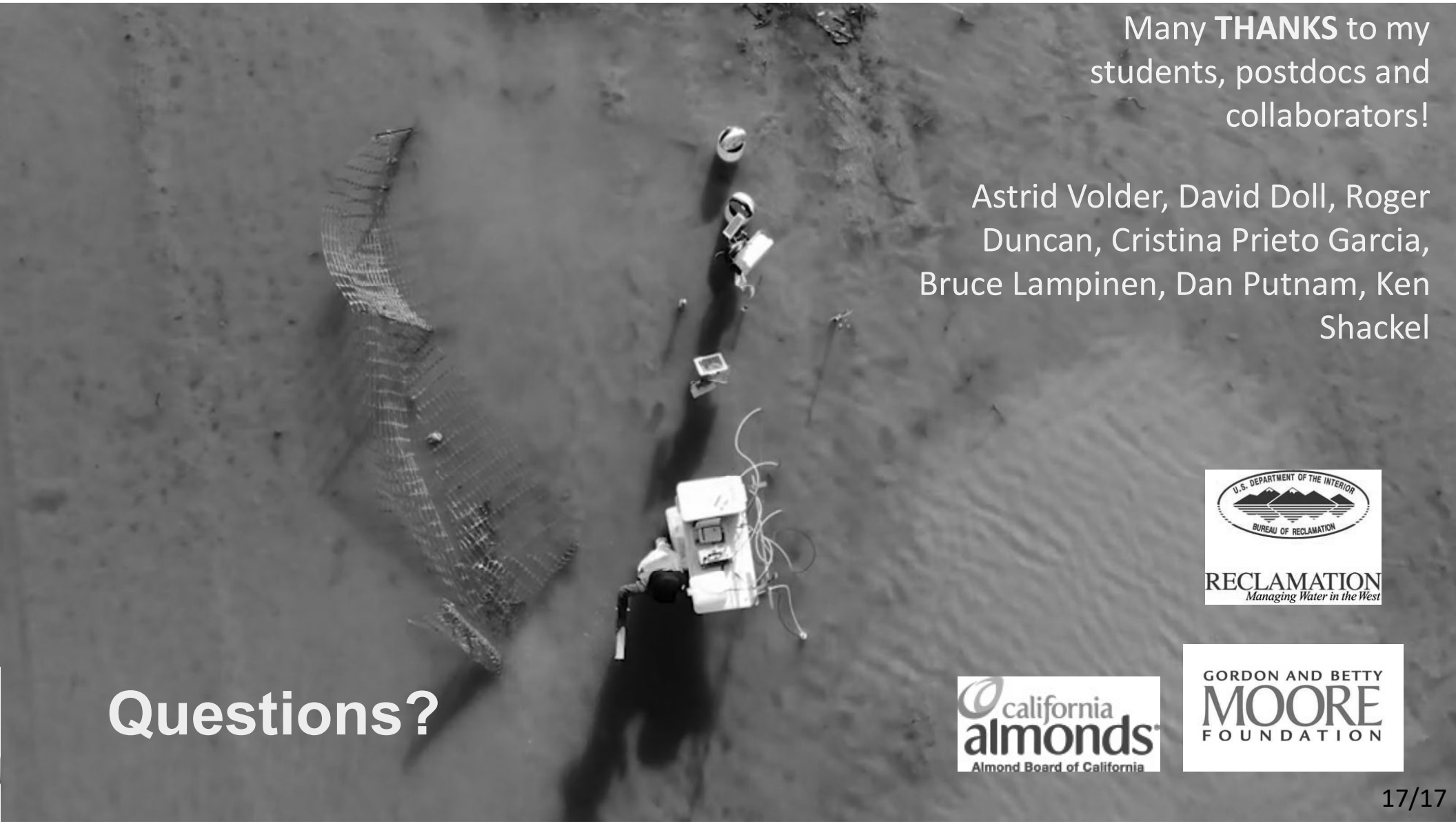


http://casoilresource.ucdavis.edu/sagbi/

O'Geen et al. 2015, CalAg

Conclusions

- Pulsed flooding can recharge 1x and 2x of growing season water demand with little impact on yield
- Soil texture affects the amount of nitrate leached under Ag-MAR
- Most nitrate is leached within hours – days (depending on initial load)
- Mineralization of organic nitrogen might produce substantial amounts of nitrate under favorable conditions (high water content but aerated soil)
- In fine textured soils reducing time between flooding events reduces nitrate produced by mineralization and increases denitrification
- Development of several decision support tools under way
  - Time to trafficability
  - Safe water application duration estimation tool



Many **THANKS** to my students, postdocs and collaborators!

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Questions?