

Investigating the Effects of Land Cover Change on Water Use Within an Irrigation District Using the SWAT Model



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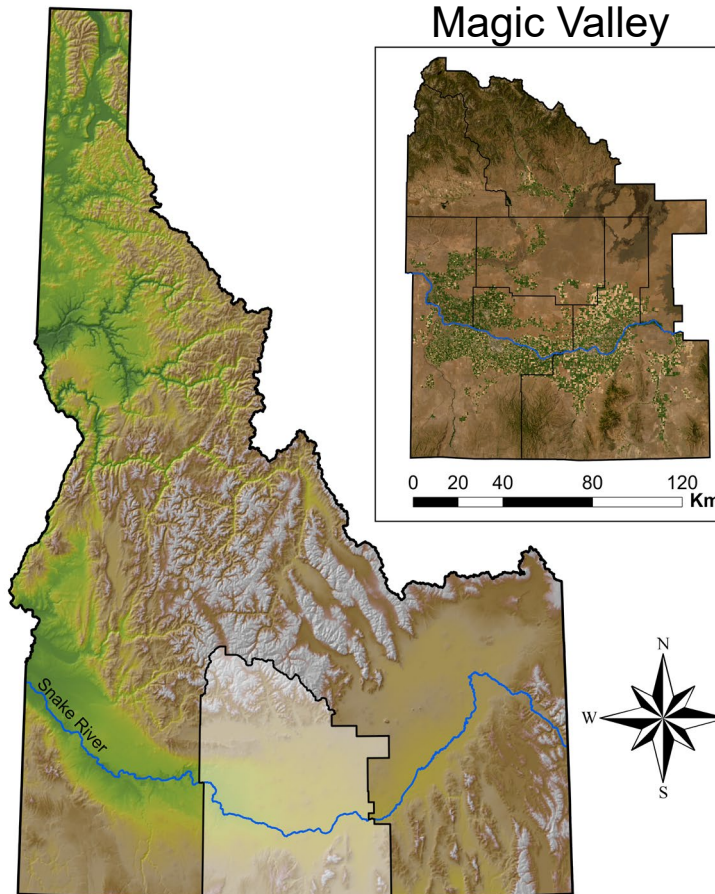
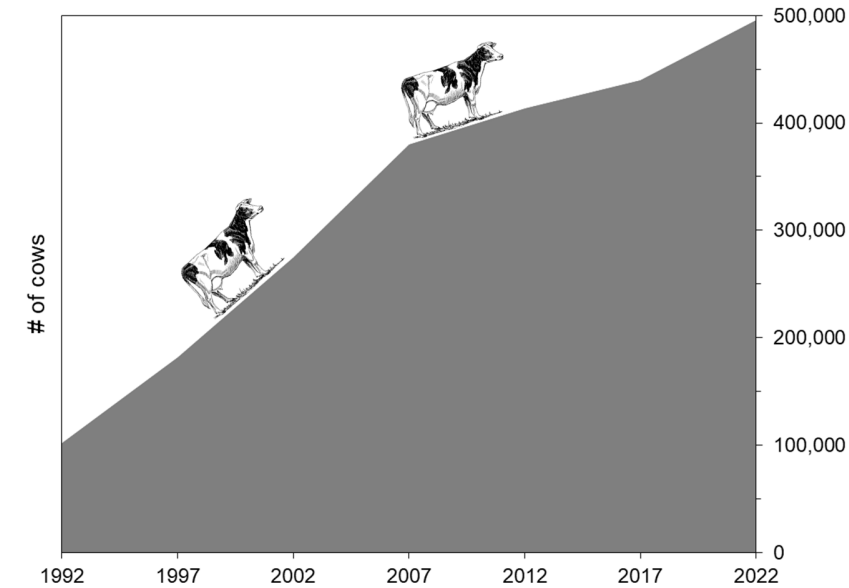
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and Water Systems

Project Purpose & Background

The **Magic Valley** is the heart of Idaho's irrigated agriculture

Dairy agriculture has increased dramatically in Idaho over the past 30 years

The majority of Idaho's \$10.7 billion dairy industry is in the Magic Valley



Background

Land cover in the Magic Valley changed for two main reasons:

- 1. Dairies grow silage corn and alfalfa for forage
- 2. Water rights and irrigation district boundaries limit agricultural land



Has this altered the water balance?

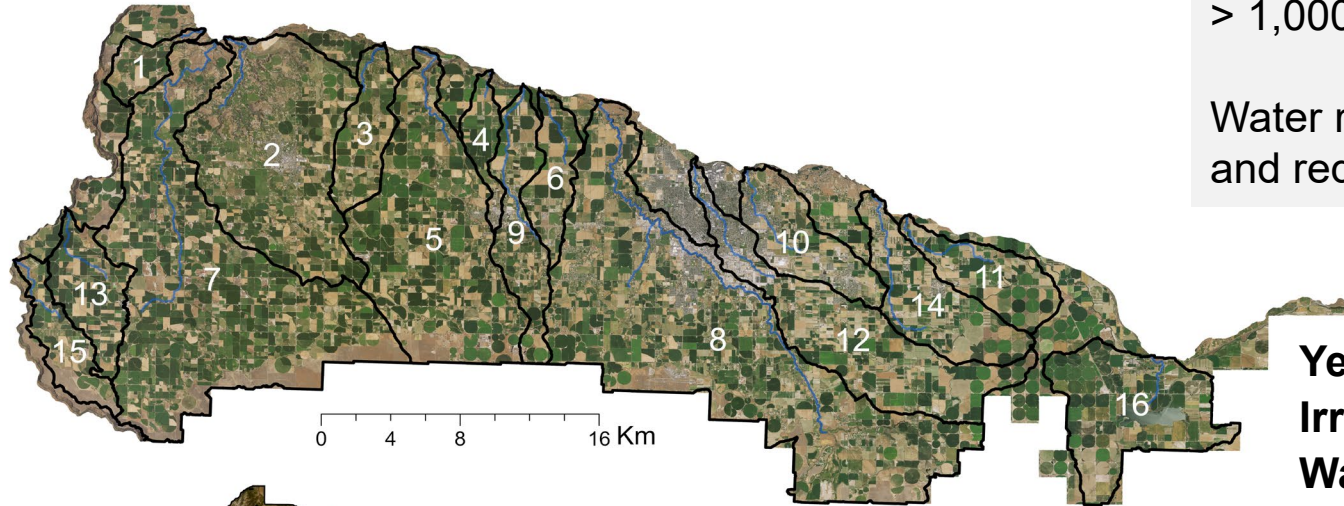
	1992 km ² (%)	2022 km ² (%)	Change (km ²)
Alfalfa	207 (25.7)	284 (34.6)	+ 77
Barley	97 (12.0)	143 (17.4)	+ 46
Beans	183 (22.7)	27 (3.3)	- 156
Corn Silage	55 (6.8)	230 (28.0)	+ 175
Potatoes	37 (4.6)	23 (2.9)	- 14
Sugar Beets	58 (7.1)	34 (4.1)	- 24
Wheat	170 (21.1)	79 (9.7)	- 91

Area of selected irrigated crops in 1992 and 2022 for Twin Falls County.
Source: USDA-NASS



Study Area & Model Setup

Twin Falls Canal Company (TFCC)



One of the largest Carey Act irrigation projects in Idaho

Delivers water to ~4,000 users via 110 miles of main canals and > 1,000 miles of laterals

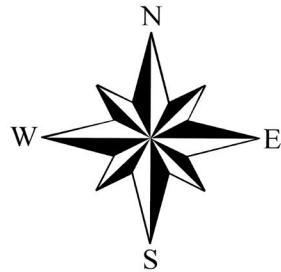
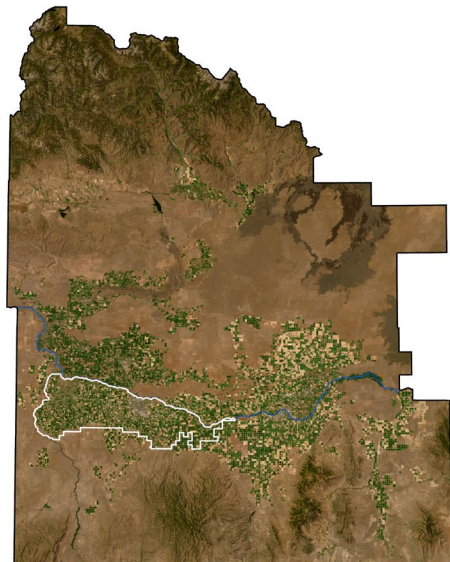
Water rights are per acre, starting at 3/4 miner's inch (~9.1 mm/day) and reducing to 1/2 miner's inch later in the season

Yearly Precipitation: 260 mm

Irrigation Season: April 15th – October 31st

Water Source: Snake River (snowmelt)

Cropland Area: 820 km²



SWAT Subbasin

Primary Crops:

Corn Silage (28%)

Alfalfa (25%)

Barley (11%)

Wheat (9%)

Beans (8%)

Potatoes (7%)

Sugar Beets (5%)

Study Area & Model Setup

SWAT model used: SWAT 2012 Version 692 (ArcSWAT)

Slope: 30m DEM, 2 slope classes (0 - 2, > 2)

Soils: gSSURGO

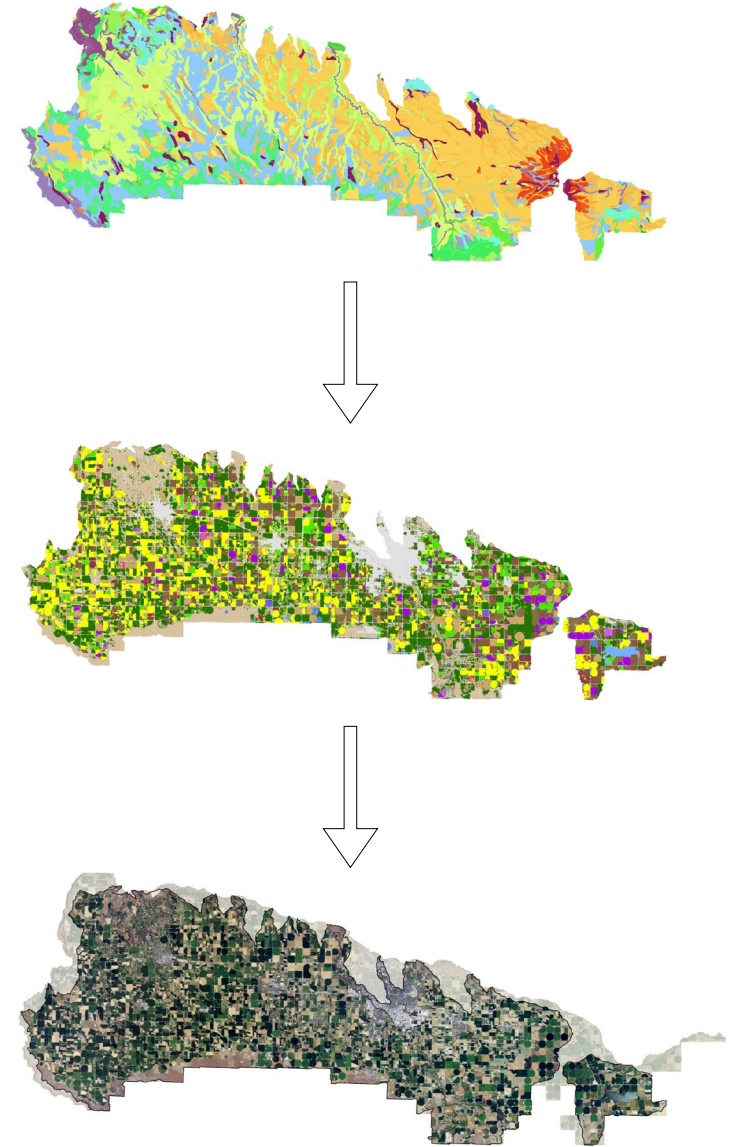
Land Cover: 2022 USDA NASS Cropland Data Layer

Weather: AgriMet station within TFCC for 2002 - 2022
(temperature, precipitation, solar radiation)

HRU Classification: 3% Land Use / 20% Soil / 20% Slope



329 HRUs within 16 subbasins



Scenarios & Study Design

2 Land Cover Scenarios

“Pre-Change” : use 1992 land cover

“Post-Change” : use 2022 land cover

Total cropland area: 746 km²

	Pre-Change km ² (%)	Post-Change km ² (%)
Alfalfa	189 (25.3)	244 (32.8)
Barley	104 (13.9)	132 (17.7)
Beans	169 (22.7)	60 (8.0)
Corn Silage	55 (7.4)	191 (25.7)
Potatoes	35 (4.6)	34.5 (4.6)
Sugar Beets	46 (6.2)	26 (3.5)
Wheat	148 (19.8)	57 (7.6)

Land cover within subbasins was adjusted to approximate county-level differences between the 1992 and 2022 census

4 Auto-Irrigation Schedules

→ Soil water deficit (SWD) approach

1. Irrigate 9.1 mm when soil water depletes 5 mm
2. Irrigate 9.1 mm when soil water depletes 7 mm
3. Irrigate 9.1 mm when soil water depletes 9.1 mm
4. Irrigate 25.4 mm when soil water depletes 25.4 mm

9.1 mm irrigations chosen because of TFCC water right and upper application limit of sprinkler systems

25.4 mm used as comparison and “default” option

Model run: 2002 - 2022

w/ 2 year warm up

Scenarios & Study Design

Crop Parameters

Generalized irrigation practices and planting/harvest dates based on local practices and AgriMet ET summaries

Crop	Emerge	Harvest	Irrigation Start	Irrigation Stop
Alfalfa*	March 1 st	---	April 15 th	October 9 th
Barley	April 15 th	August 10 th	April 15 th	July 25 th
Beans	July 1 st	September 25 th	June 26 th	September 10 th
Corn	June 1 st	September 25 th	May 25 th	September 18 th
Potatoes	May 20 th	September 10 th	May 15 th	September 1 st
Sugar Beets	May 1 st	October 5 th	April 20 th	September 25 th
Wheat	March 1 st	July 31 st	April 15 th	July 16 th

* Alfalfa harvested on June 15th, July 30th, August 30th, and October 15th. Irrigation paused 1 week before harvest date.

Adjusted crop parameters. If changed, default value is in parentheses.

	Alfalfa	Barley	Beans	Corn	Potato	Sugar Beets	Wheat
T_BASE	2 (4)	0	10	2 (8)	3 (7)	4	0
FRGRW1	0.15	0.05 (0.15)	0.1 (0.15)	0.1 (0.15)	0.15	0.05	0.01 (0.05)
FRGRW2	0.5	0.45	0.5	0.8 (0.5)	0.8 (0.5)	0.5	0.45
BLAI	5 (4)	4	1.5	4	4	6 (5)	5
LAIMX1	0.01	0.01	0.05	0.01 (0.05)	0.01	0.01 (0.05)	0.05
LAIMX2	0.95	0.95	0.95	0.95	0.95	0.95	0.95
DLAI	0.9	0.8 (0.6)	0.75 (0.9)	1 (0.7)	0.9 (0.6)	0.95 (0.6)	0.95 (0.5)
GSI	0.01	0.002 (0.008)	0.005 (0.0071)	0.003 (0.007)	0.004 (0.005)	0.01 (0.007)	0.01 (0.006)

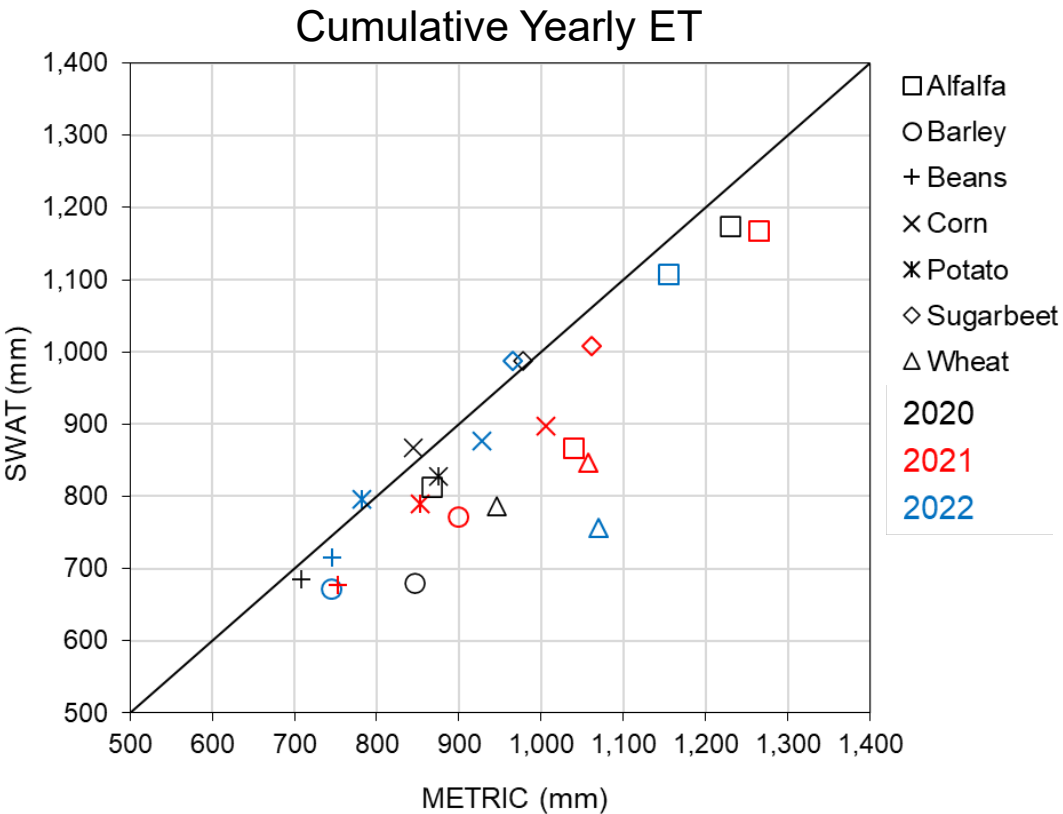
Calibration & Validation

Evapotranspiration (ET)

Crop parameters adjusted using eeMETRIC (OpenET) from 2020 to 2022

ESCO decreased from 0.95 to 0.85

EPCO decreased from 1 to 0.5

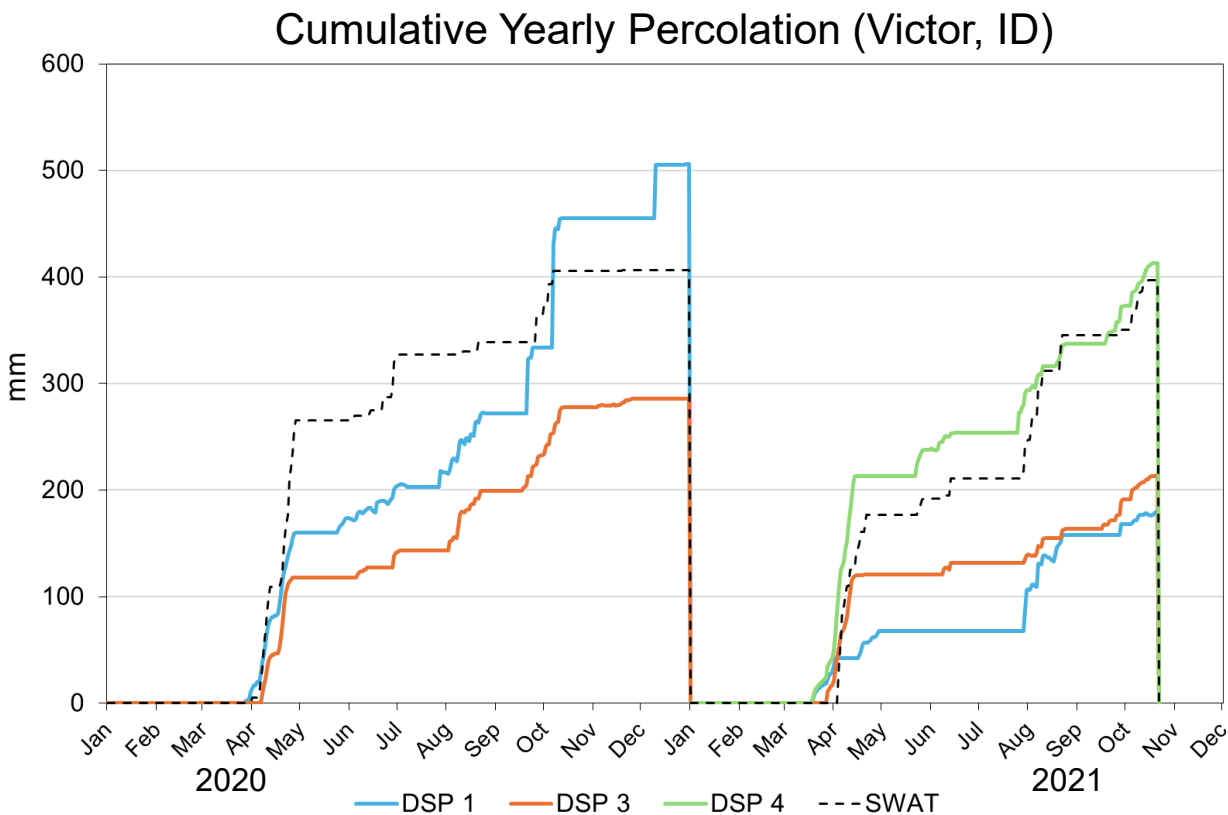


Percolation

Muti-year percolation study in irrigated alfalfa field

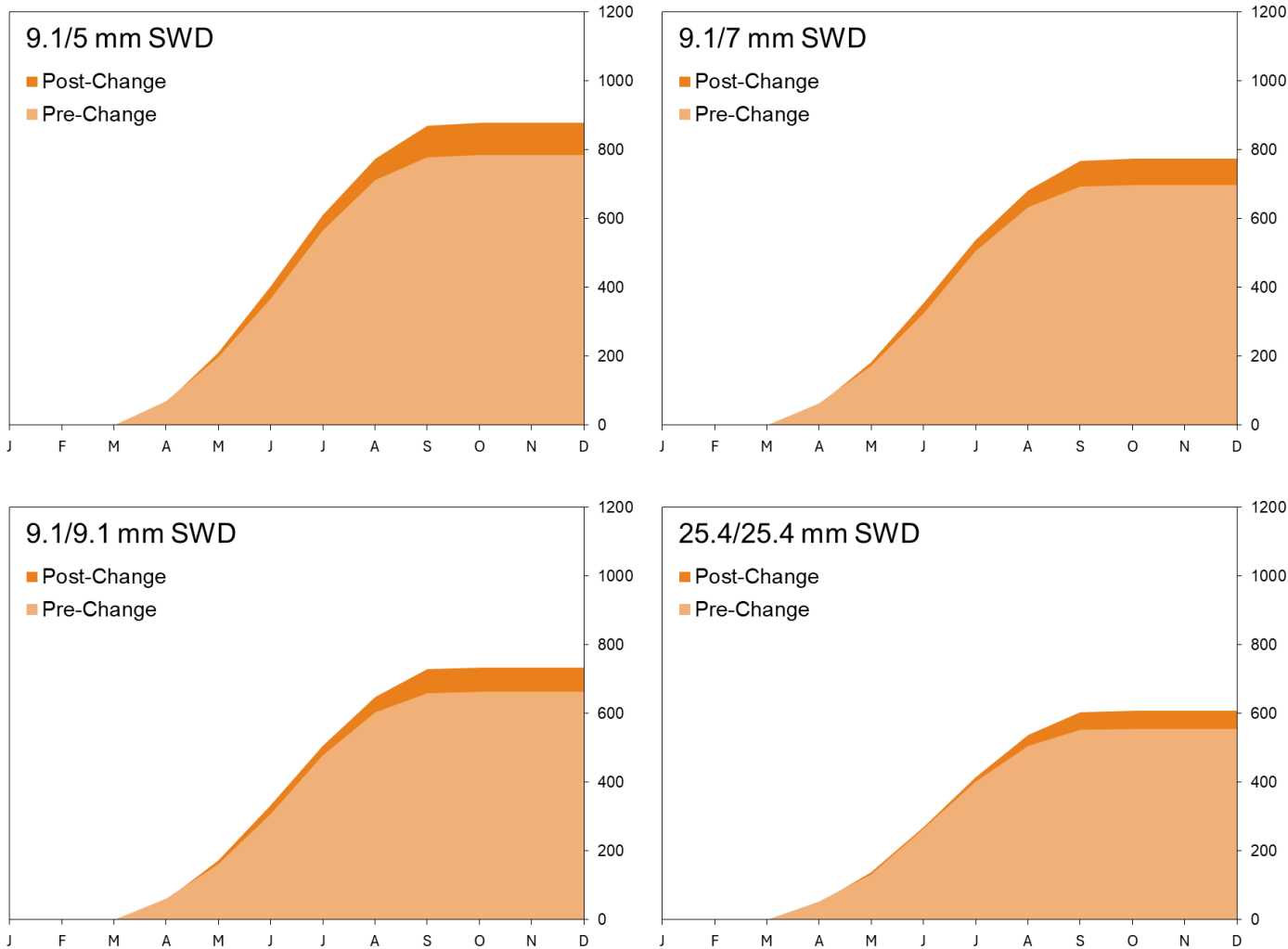
Soil parameters altered based on field sampling results

SWAT adequately captured timing and amount of snowmelt + irrigation percolation



Results

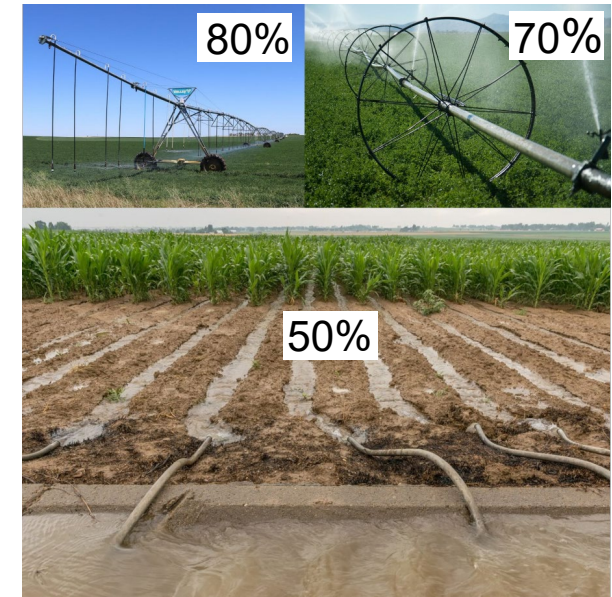
Irrigation



- Average depths ranged from 556 - 878 mm
- Irrigation amounts were 9-12% higher under the Post-Change scenarios
- Smallest monthly difference in April, greatest difference in September (44-48%)
- 25.4 mm schedule had the lowest irrigation amounts

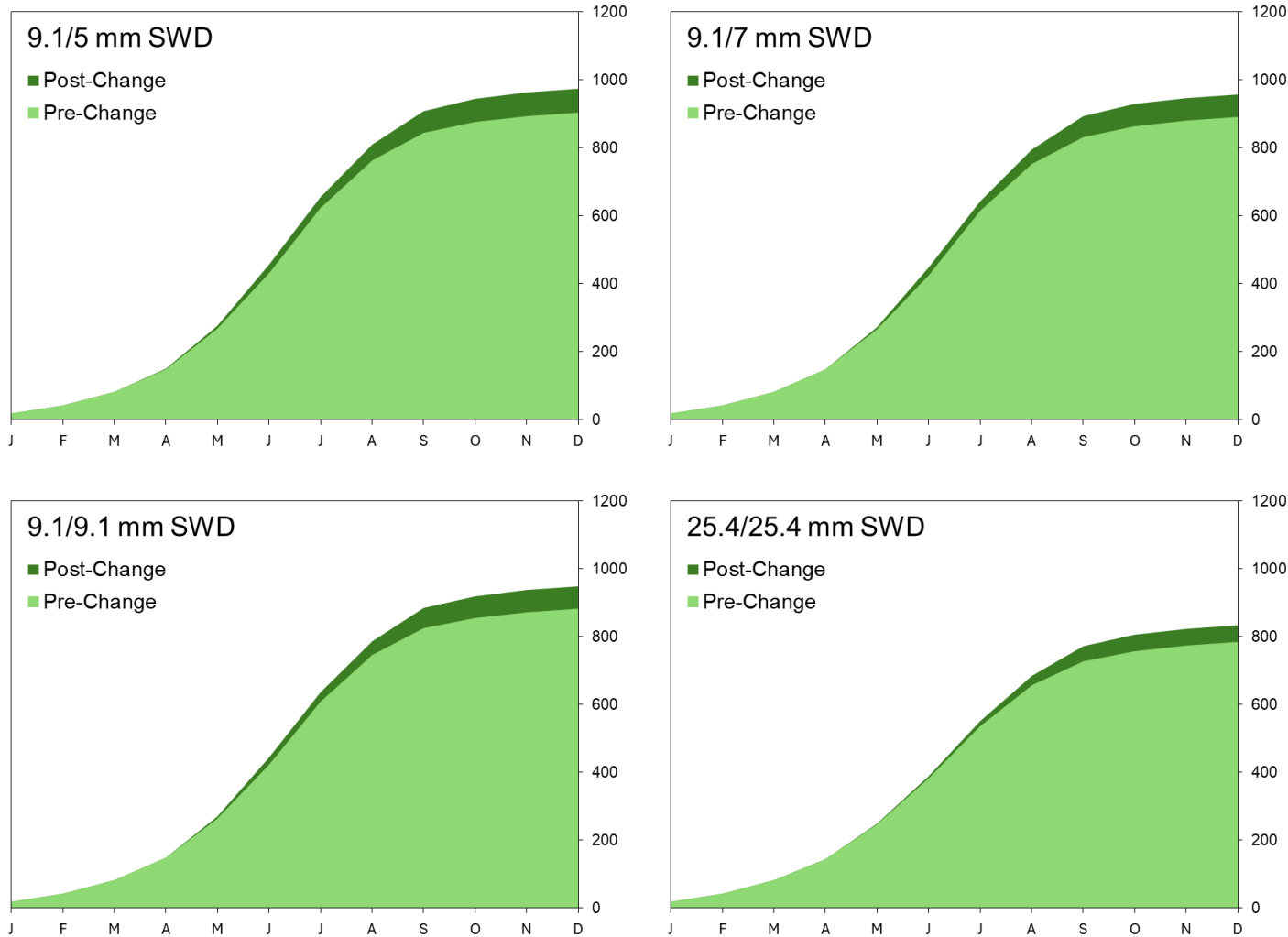
Note:

Irrigation amounts are water put into the soil and *not* applied water

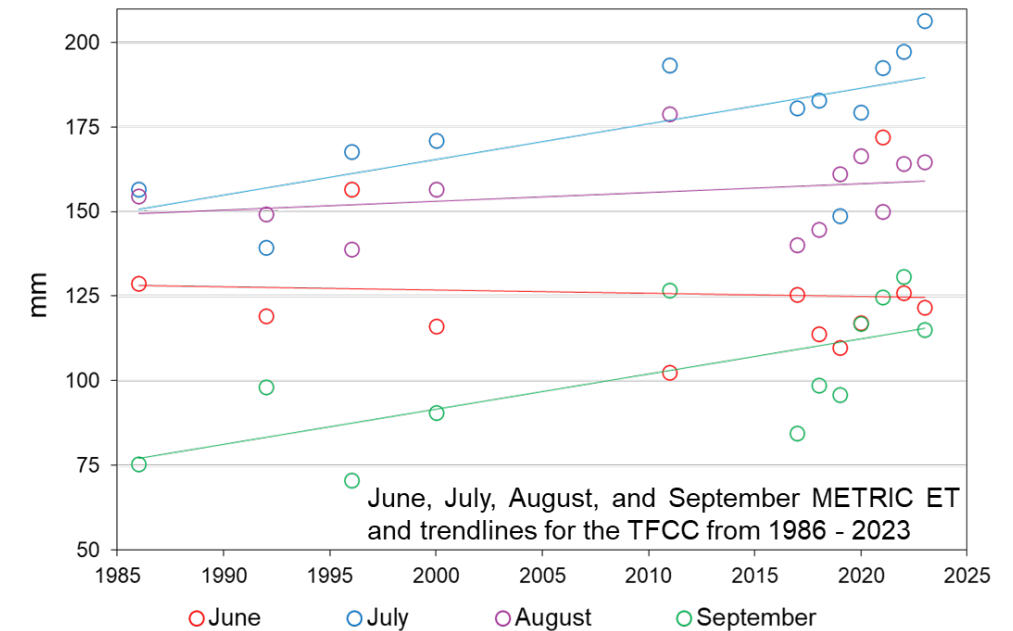


Results

Evapotranspiration

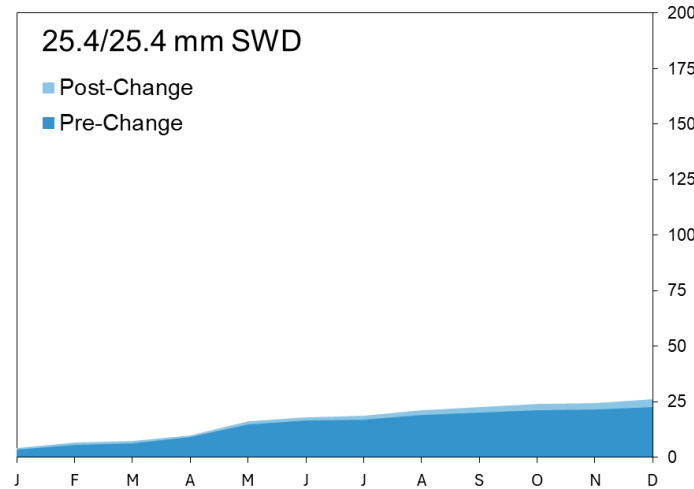
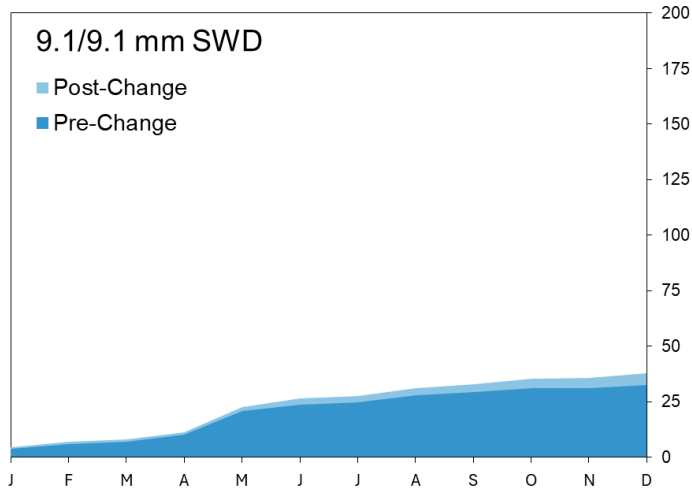
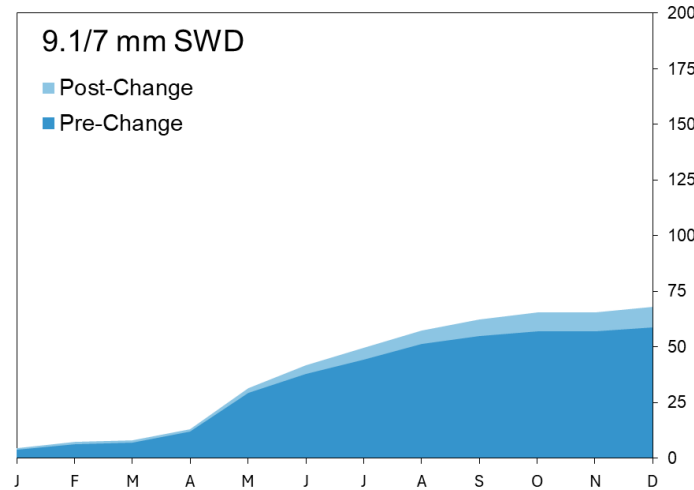
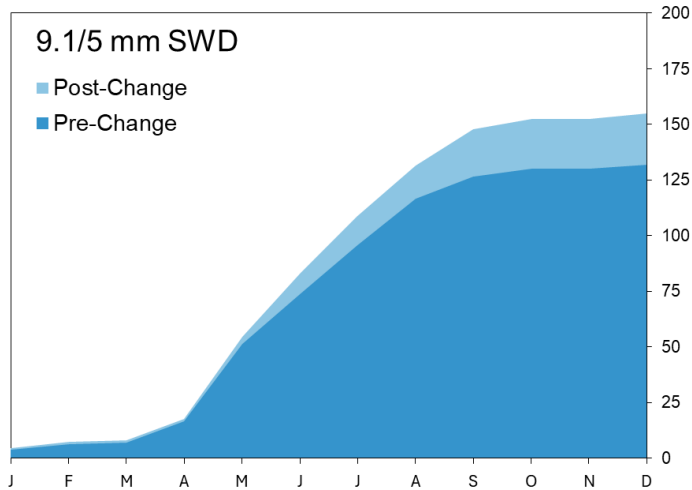


- Post-Change ET is 6-8% greater
- Largest difference between scenarios in July and September (~19 mm)
- 25.4/25.4 mm ET is 12% lower than 9.1/9.1 mm
- ET differences due to cropping and irrigation



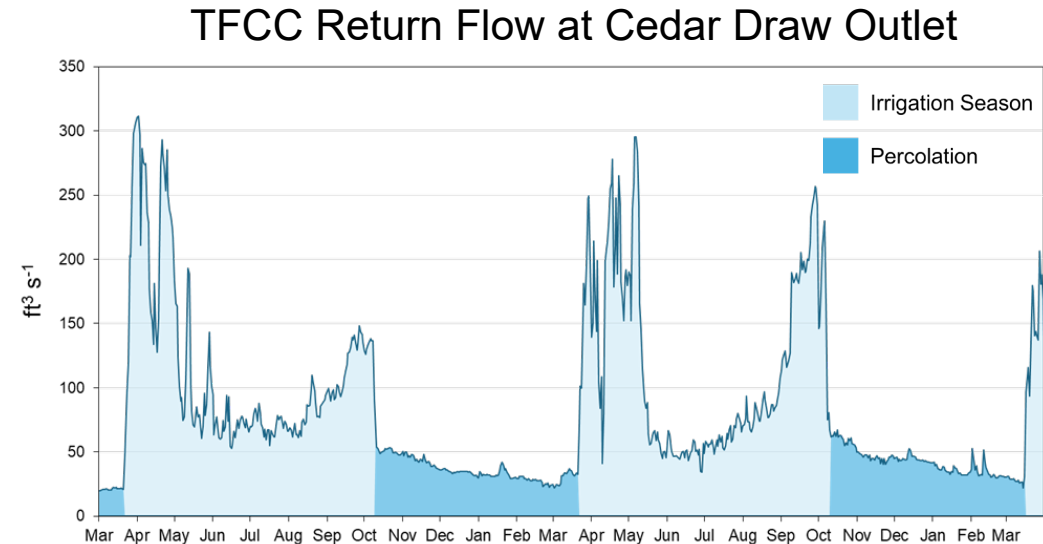
Results

Percolation



- 23 mm difference for the 9.1/5 mm, 3 mm for the 25.4/25.4 mm
- High percolation from the 9.1/5 mm irrigation schedule
- Very low percolation from the 25.4/25.4 mm irrigation schedule

How much of the percolation is from irrigation?

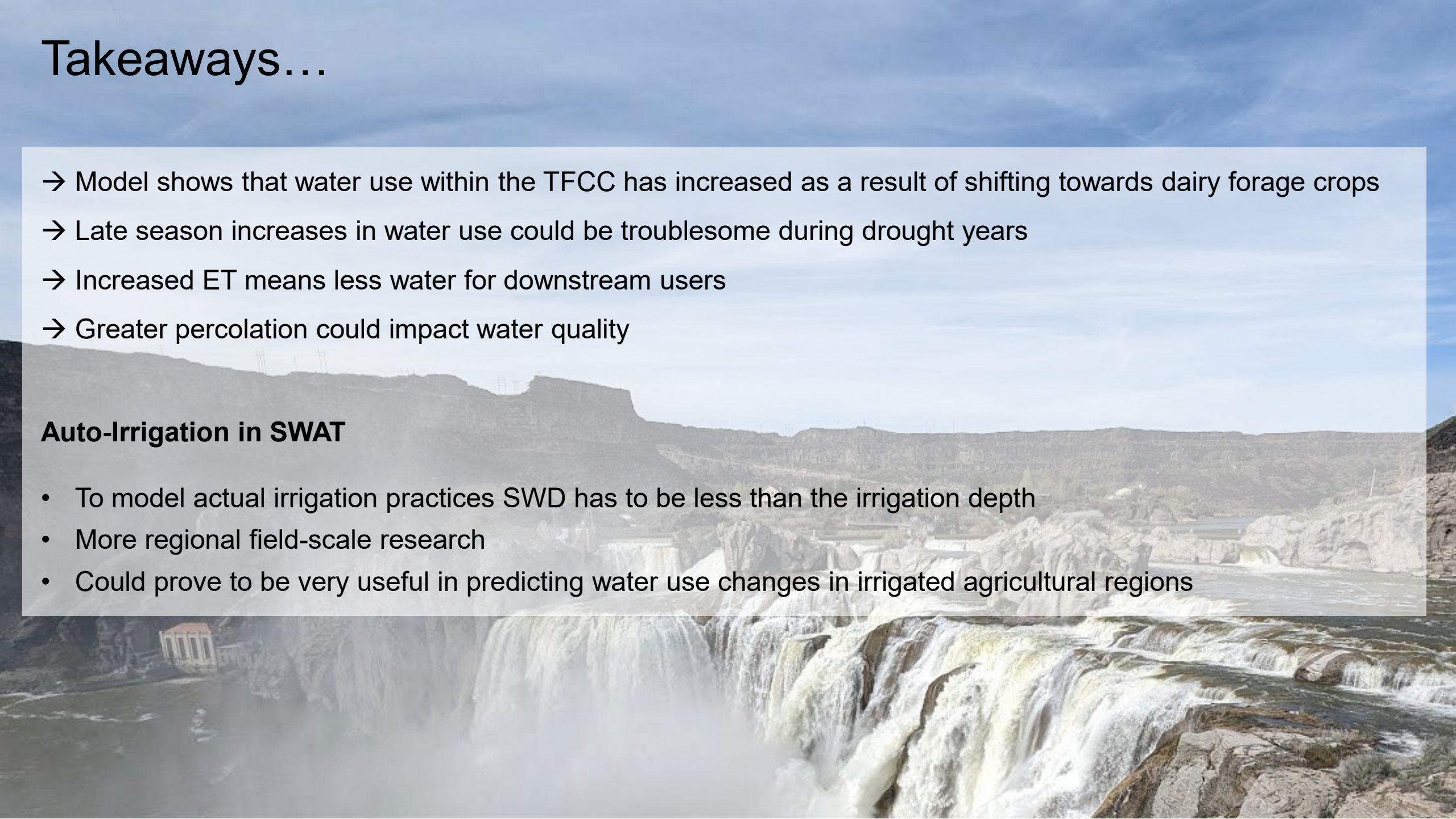


Takeaways...

- Model shows that water use within the TFCC has increased as a result of shifting towards dairy forage crops
- Late season increases in water use could be troublesome during drought years
- Increased ET means less water for downstream users
- Greater percolation could impact water quality

Auto-Irrigation in SWAT

- To model actual irrigation practices SWD has to be less than the irrigation depth
- More regional field-scale research
- Could prove to be very useful in predicting water use changes in irrigated agricultural regions



Thank You

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