

Central Valley Nonpoint Source Assessment Tool (CV-NPSAT) & CV-NPSAT_{web}

Thomas Harter

Giorgos Kourakos, Sreya Mathews, Zhendan Cao, Baibas Bhaduri
University of California Davis
ThHarter@ucdavis.edu

<https://gwt.ucdavis.edu>

All Pollution Problems Have **Three Important Elements** in Common!!

PATHWAYS

SOURCES



RECEPTORS

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All Pollution Problems Have **Three Important Elements** in Common!!

SOURCES



RECEPTORS

PATHWAYS

Notice: Sources, Pathways, and Receptors each all feature characteristic (water, air) **flows** and – within those – **concentration** of pollutants



Note:

concentration is the **mass** of pollutant per unit (air or water) **flow volume**

For any assessment, we need to know as much as possible about each of these elements: **Sources, Pathways, and Receptors**

– and that includes anything to understand their **flows** and their **concentrations !!**



CV-NPSAT combines our knowledge about:



SOURCES of nonpoint source pollution – specifically of **nitrate**



PATHWAYS (including travel times!) in the **unsaturated zone** and in the large alluvial **aquifer** of the Central Valley

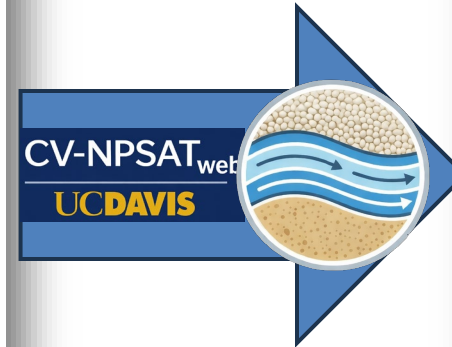
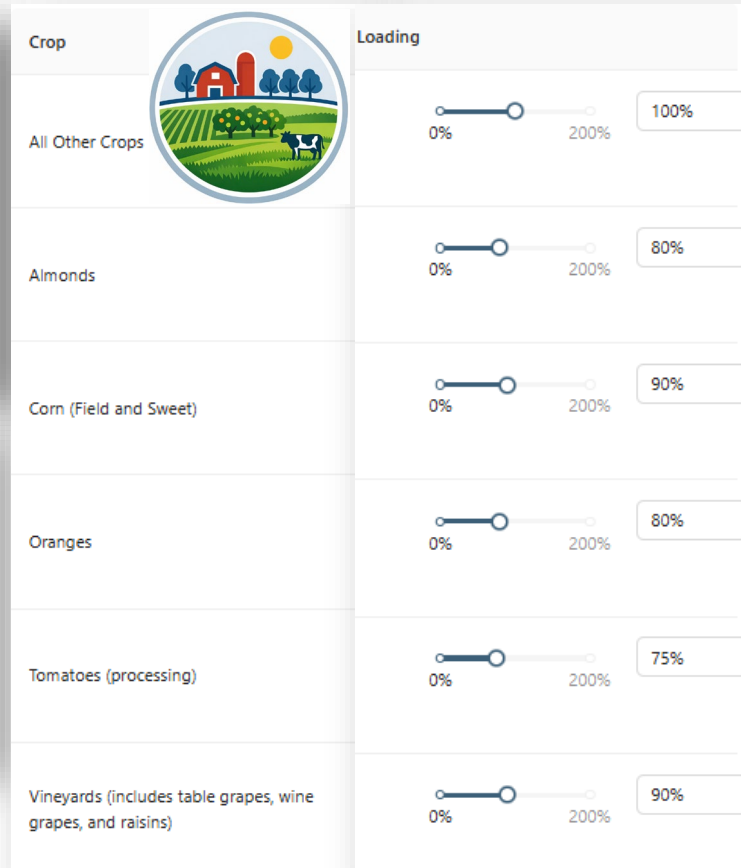
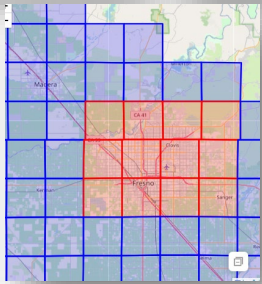
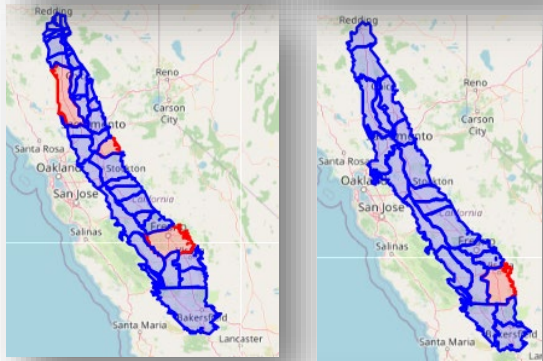


RECEPTORS: the location, depth, and screen length of **wells** and how much water they pump

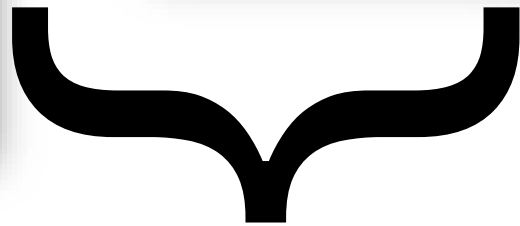
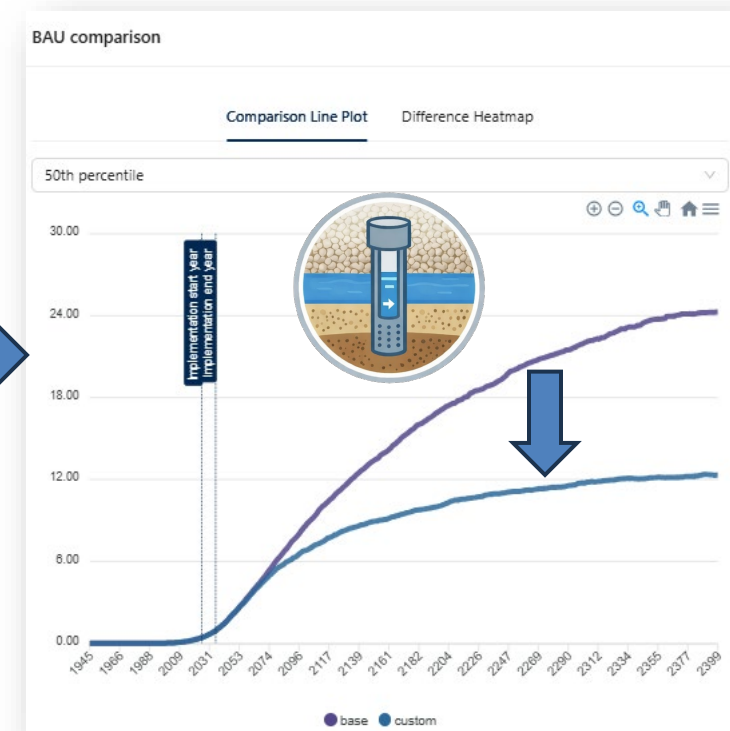
Note: this includes knowledge – at sources, pathways, and receptors - about

water **flow rates and volumes** and about
pollutant **mass and concentrations**

Recall: This is the kind of assessment that can be done with CV-NPSATweb!



Web
Back-end
Engine



User specified / User Choice

Prediction (Estimate)

Workshop Outline

- Conceptual Framework



- Nonpoint Sources of Nitrate: The Central Valley Groundwater Nitrate Loading Model, CV-GNLM



- Vadose Zone Transit Time
- Groundwater Flowpath Modeling
- Groundwater Nitrate Transport Modeling



- Some important simplifications in CV-NPSAT
- CV-NPSAT Validation
- Things that CV-NPSAT is not suited for
- Future CV-NPSAT developments

- The Online Tool

- Understanding user input choices
- Understanding results
- Some illustrative case studies
- Step-by-step tutorial

- Questions and Answers

A General Note about Data that CV-NPSAT is Using

Some data are rather definitive, but none are 100% accurate



Some data have to be estimated or rely on definitive physics/economics (models) but uncertain geology/hydrology/circumstances (model input, model concepts), which means assumptions have to be made and uncertainties can be quite high



Nitrate Losses to Groundwater from Central Valley's Landscape:

The Central Valley Groundwater Nitrogen Loading Model, CV-GNLM



Note:

CV-GNLM is about

SOURCE - nitrate-nitrogen MASS (not concentration!)

No worries – we talk about SOURCE – FLOW later...

But, but....what about concentrations of nitrate at the source?

Once we know MASS and FLOW, we know CONCENTRATION:
Remember that MASS per unit FLOW volume = CONCENTRATION !!

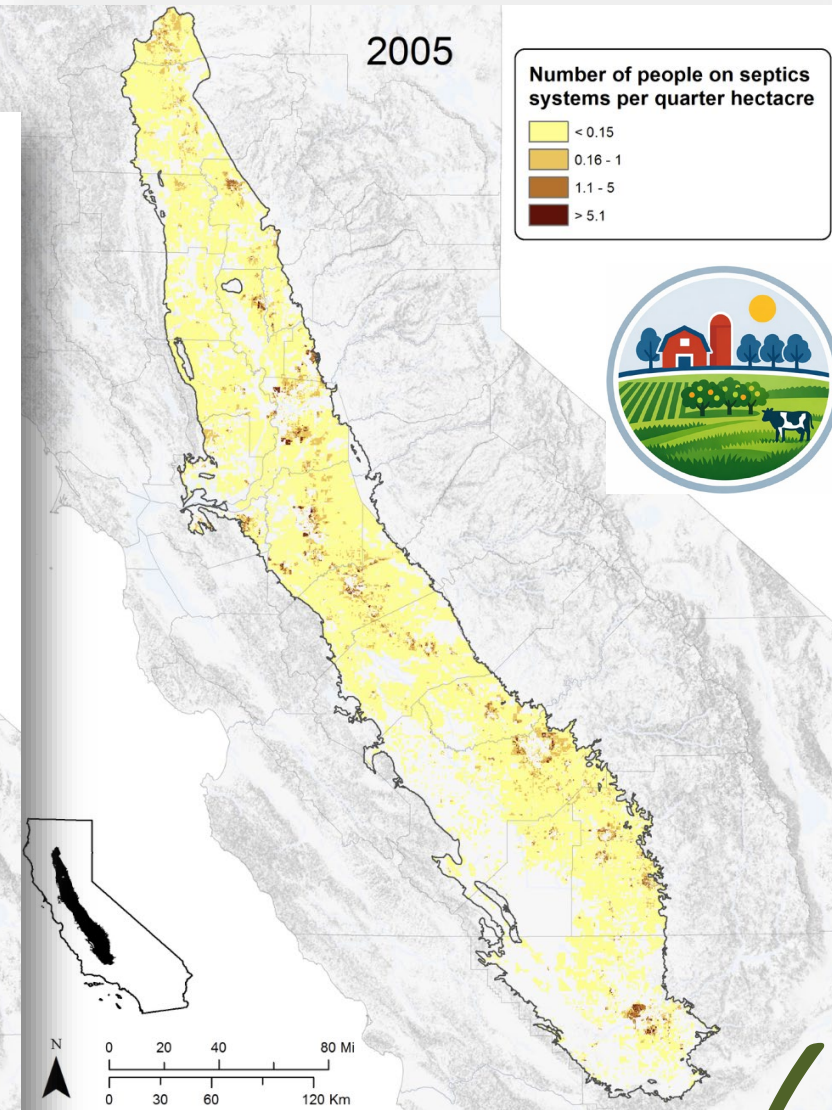
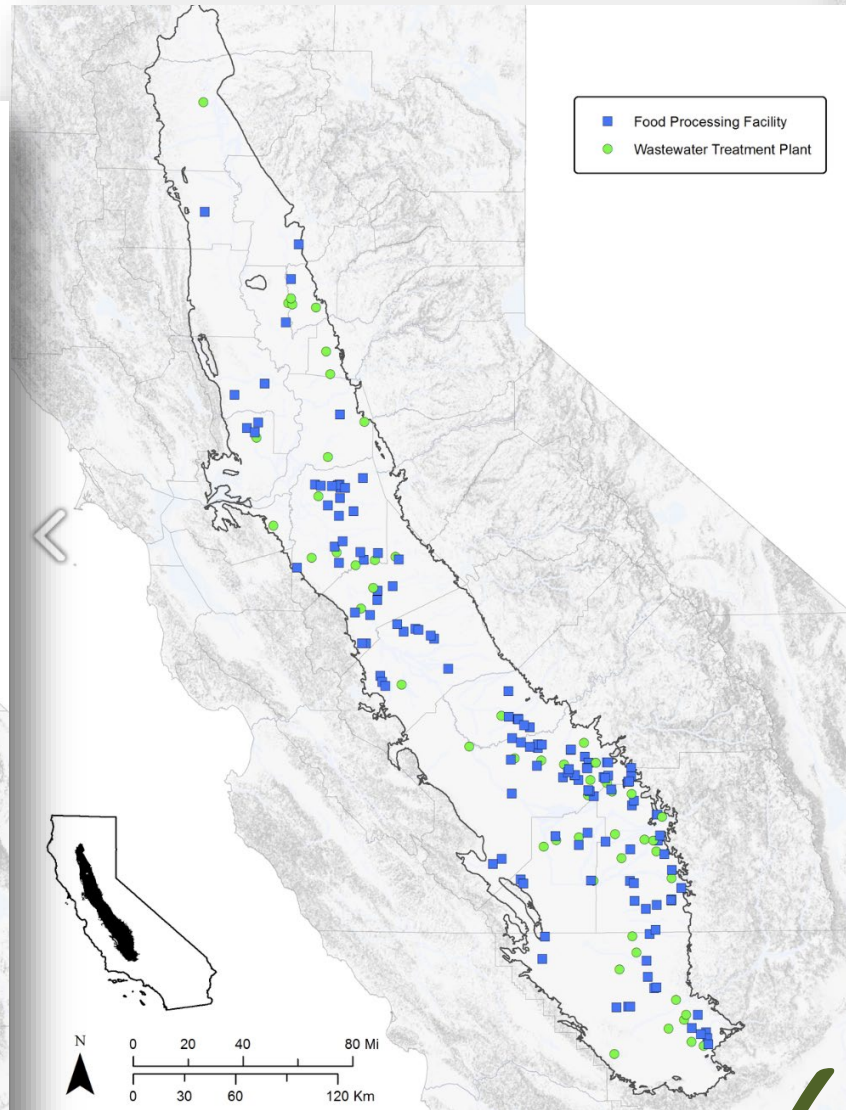
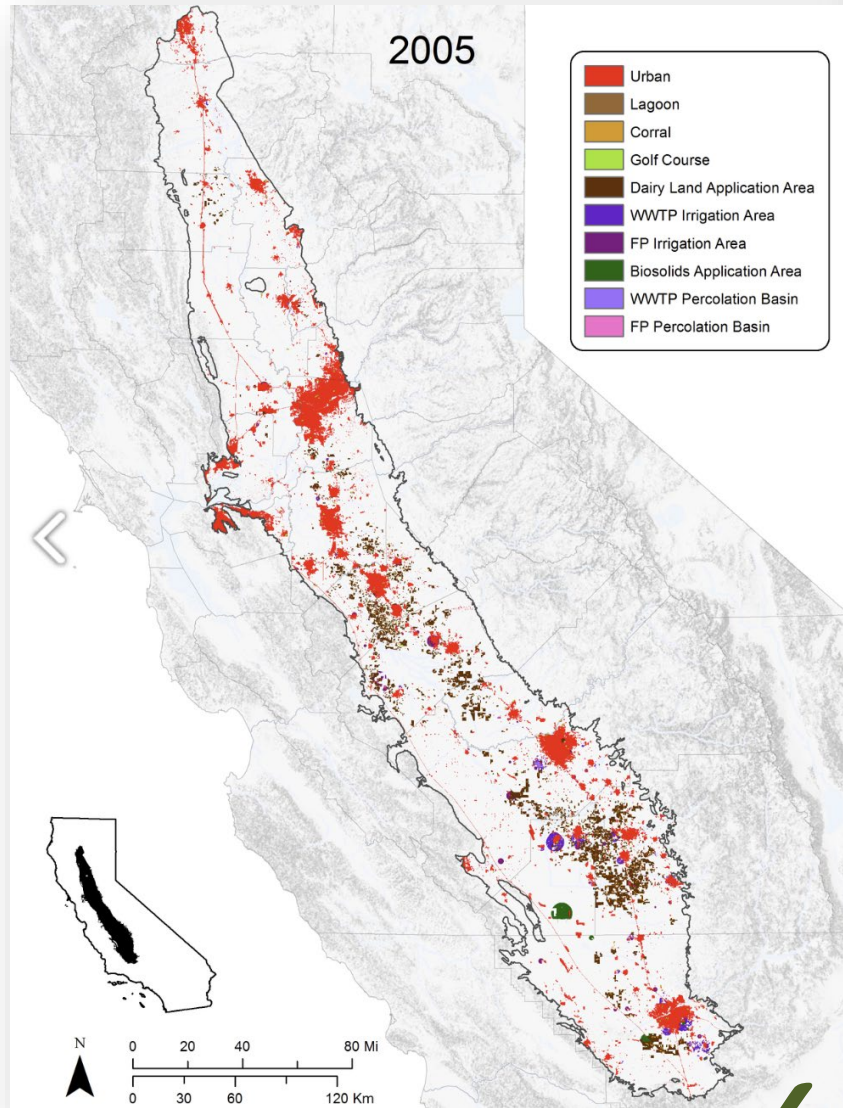
Step 1: Who are the sources of nitrate in groundwater?



Mg N/yr	1945	1960	1975	1990	2005	2020	2035	2050
Cropland (incl Alfalfa)	42,847	58,137	131,322	259,661	330,680	351,527	378,527	392,966
Urban	2,131	3,492	5,118	7,166	9,543	9,543	9,543	9,543
Golf Courses	66	66	66	66	66	66	66	66
Lagoons	0	0	2,787	2,787	2,787	2,787	2,787	2,787
Corrals	0	0	2,243	2,243	2,243	2,243	2,243	2,243
WWTP Percolation Basins	680	1,113	1,480	2,273	2,988	3,609	4,503	5,311
FP Percolation Basins	62	102	136	208	274	331	413	487
Septic Systems	1,312	2,148	2,851	4,333	5,565			
tons N/yr	1945	1960	1975	1990	2005	2020	2035	2050
Cropland (incl Alfalfa)	47,217	64,067	144,717	286,147	364,409	387,383	417,137	433,049
Urban	2,348	3,848	5,640	7,897	10,517	10,517	10,517	10,517
Golf Courses	73	73	73	73	73	73	73	73
Lagoons	0	0	3,071	3,071	3,071	3,071	3,071	3,071
Corrals	0	0	2,472	2,472	2,472	2,472	2,472	2,472
WWTP Percolation Basins	749	1,227	1,630	2,504	3,293	3,978	4,962	5,852
FP Percolation Basins	69	113	150	230	302	365	455	537
Septic Systems	1,446	2,367	3,142	4,775	6,132	7,220	8,668	9,885



2. Where are these sources of nitrate?



Harter et al., 2017; Bhaduri et al., *in prep*

That is information for TODAY, but what about all the legacy nitrate?

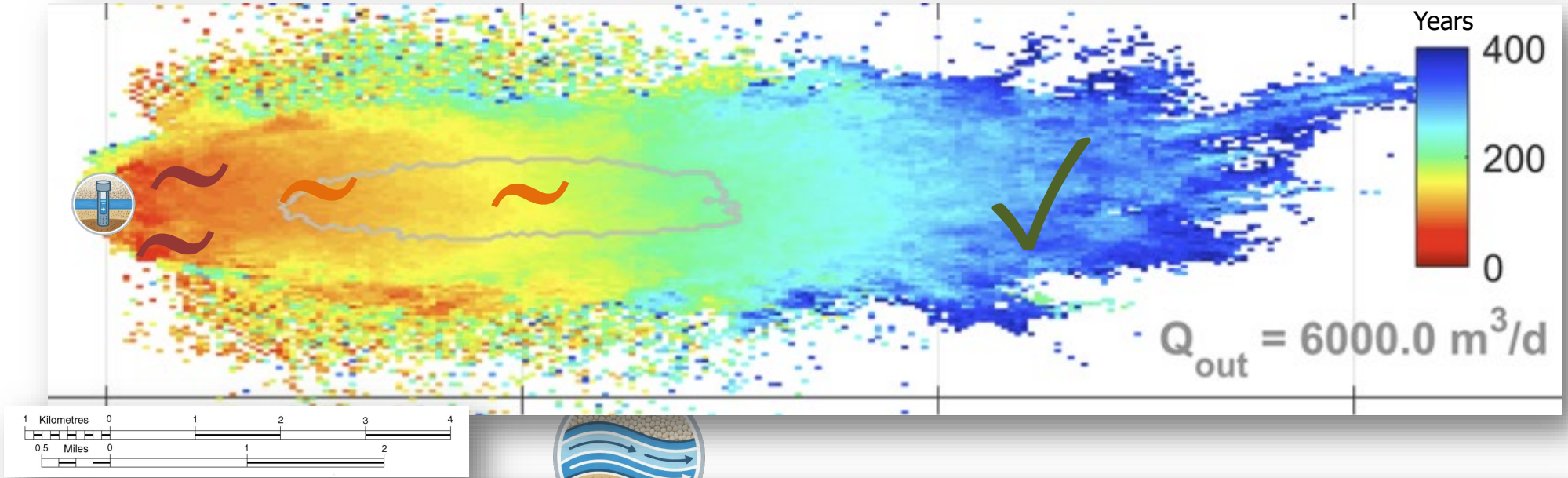




Insight:

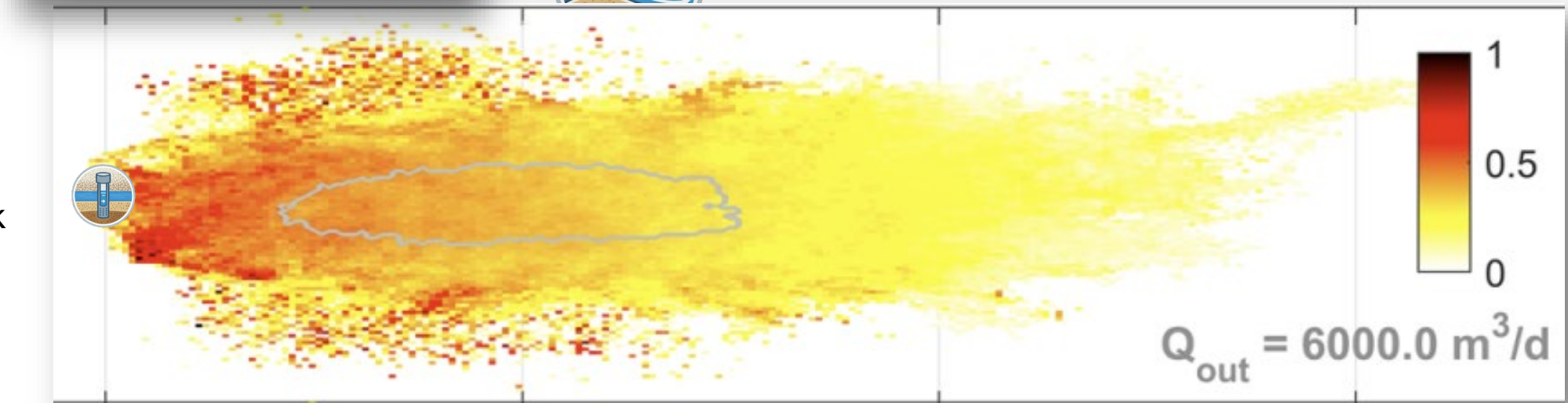
3 mile x 10 mile map of typical travel time from the source area to the well (1,100 gpm)

How long does it take for recharge to get from each location to the well?



How sure can we be about this travel time estimate?

0 – relatively ok
1 – relatively uncertain

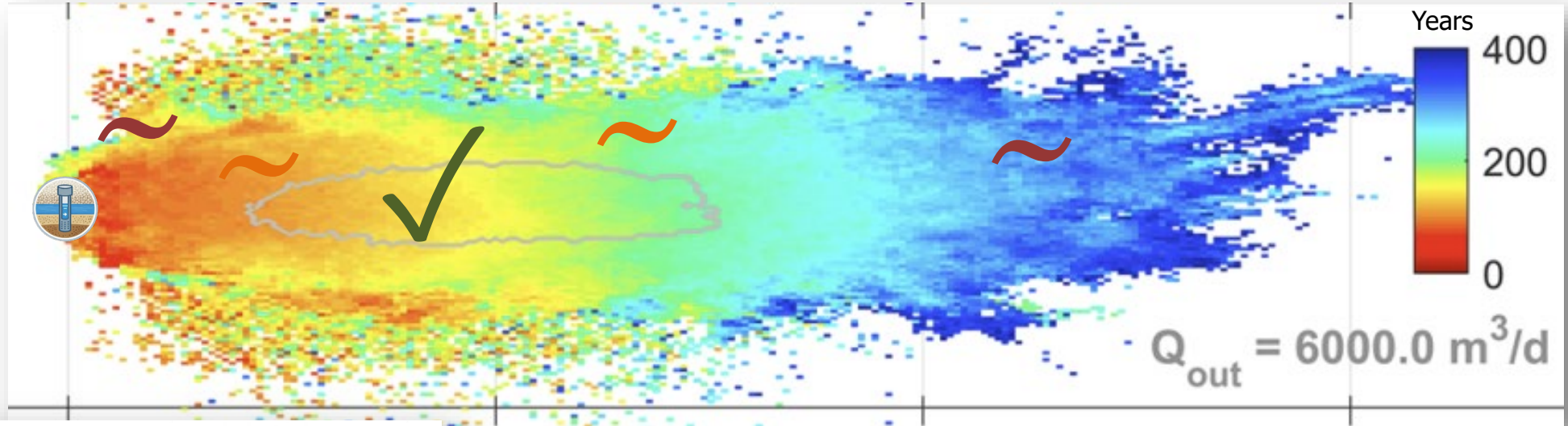


Insight:

3 mile x 10 mile map of typical travel time from the source area to the well (1,100 gpm)

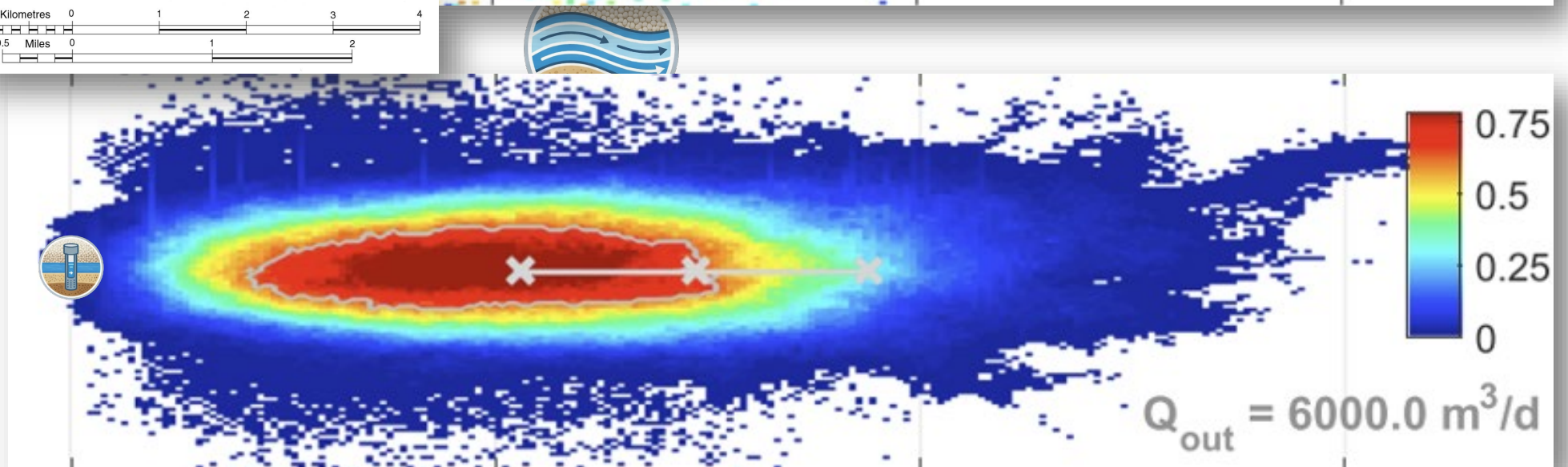


How long does it take for recharge to get from each location to the well?

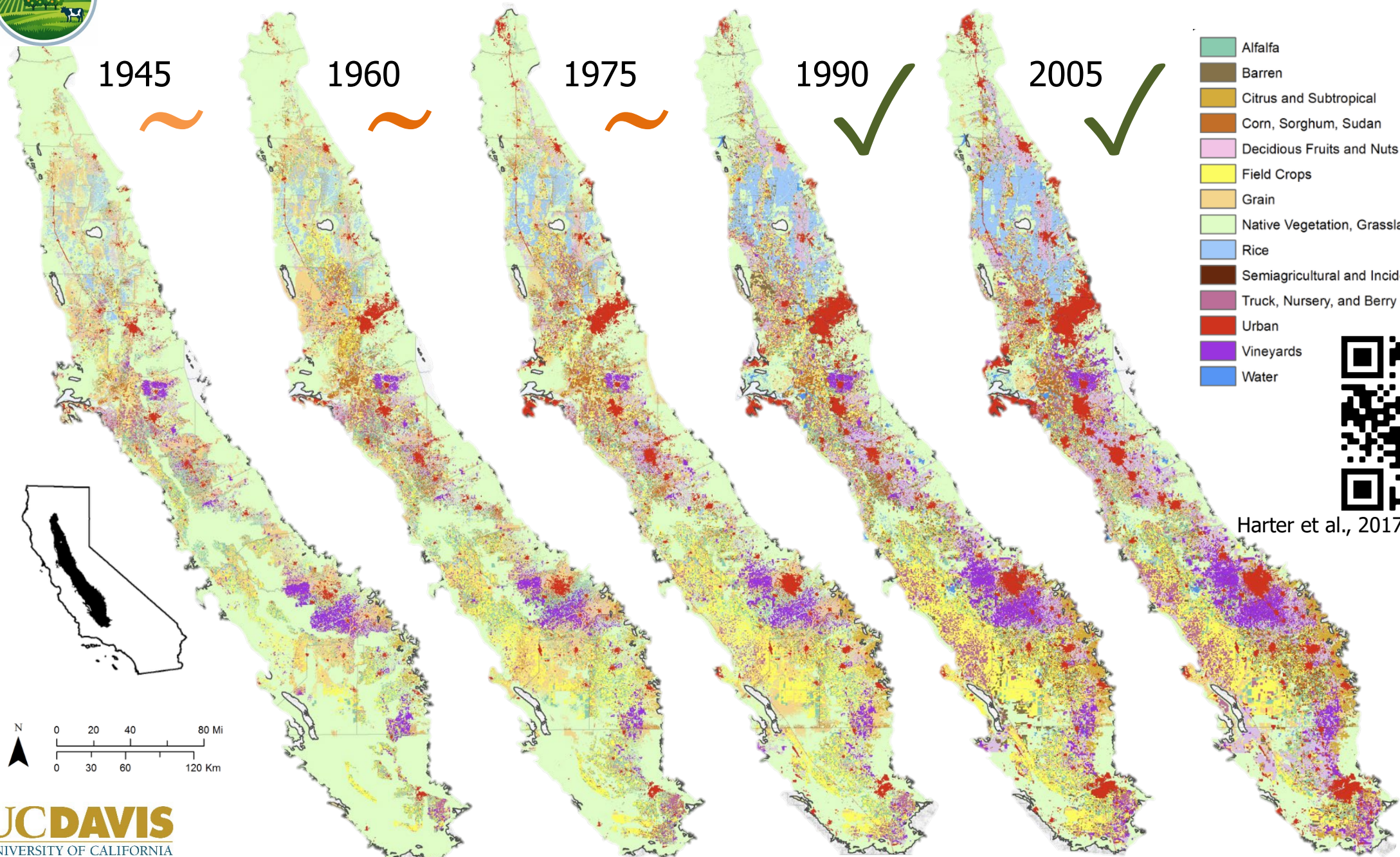


How sure can we be that any location is really contributing to that well?

0 – not likely
1 – very likely



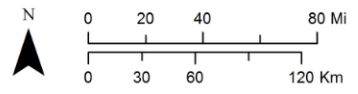
Legacy: Landuse reconstruction over the past century



- Alfalfa
- Barren
- Citrus and Subtropical
- Corn, Sorghum, Sudan
- Deciduous Fruits and Nuts
- Field Crops
- Grain
- Native Vegetation, Grassland, and Pasture
- Rice
- Semiagricultural and Incidental to Agriculture
- Truck, Nursery, and Berry Crops
- Urban
- Vineyards
- Water



Harter et al., 2017; Bhaduri et al., *in prep*



How much nitrate-nitrogen (mass) are these source leaching per year?



- **Urban areas:**
 - 10 kg N/ha/yr (8.9 lb n/ac/yr) from synthetic fertilizer applied lawns, gardens
 - 10 kg N/ha/yr (8.9 lb n/ac/yr) from wastewater pipeline leakage
- **Golf course:**
 - 10 kg N/ha/yr (8.9 lb n/ac/yr)
- **Dairy corrals**
 - 183 kg N/ha/yr (163 lb N/ac/yr)
- **Dairy lagoons**
 - 1171 kg N/ha/yr(1045 lb N/ac/yr)
- **Alfalfa cropland**
 - 30 kg N/ha/yr (26.8 lb N/ac/yr)
- **Clover cropland**
 - 15 kg N/ha/yr (26.8 lb N/ac/yr)
- **Septic systems:**
 - 4.125 kg (9.094 lb) N per person per year (85% of N in household wastewater)
 - fraction of households on septic system, 1990 census, by census block
 - Population density, 2010 census, by census block
 - Historically backward adjusted by total county population relative to 2005
- **Wastewater treatment plants and food processors (includes biosolids):**
 - Permitted discharges, converted to N, by individual facility
 - 72 WWTP facilities and 137 FP facilities reviewed
 - Not all facilities report data, smallest facilities not included
 - Historically backward adjusted by total county population relative to 2005



Harter et al. 2017

How much nitrate-nitrogen (mass) are these source leaching per year?



- **Dairy Manure:**

- Information available for over 1,000 individual facilities (2007-2012):
 - Number of animal units
 - Exported amount of manure
 - Assessor parcel numbers of all fields under dairy management (includes orchards and vineyards, vegetables and other crops that cannot receive manure for food safety reasons)
- Number of animals units => amount of N in manure
 - Historically adjusted by the number of animals units relative to 2005
- Atmospheric losses between time of manure generation and land application: 38% (per US EPA, literature 20% - 40%)

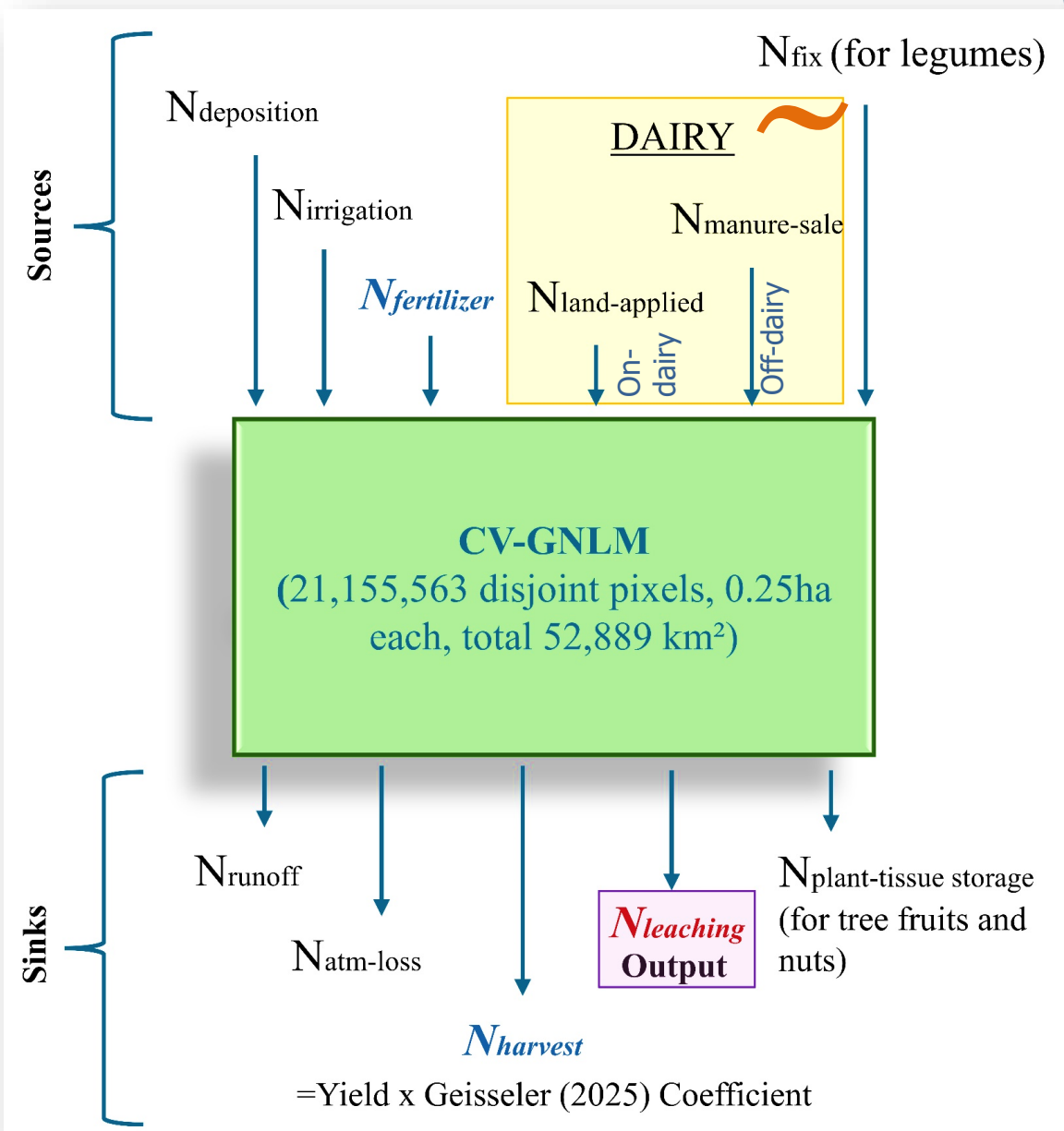
- Exported manure: added as soil amendment to all county crops that have no food safety restrictions
- Manure N generated minus atmospheric N losses minus exported manure N = dairy land applied manure N, replacing up to 50%/100% of synthetic fertilizer in 2005/2020
- Often far exceeds crop needs
- Full / Half / None Scenario Options:
 - Full: as above
 - Half: manure N x 50%
 - None: manure N x 0%



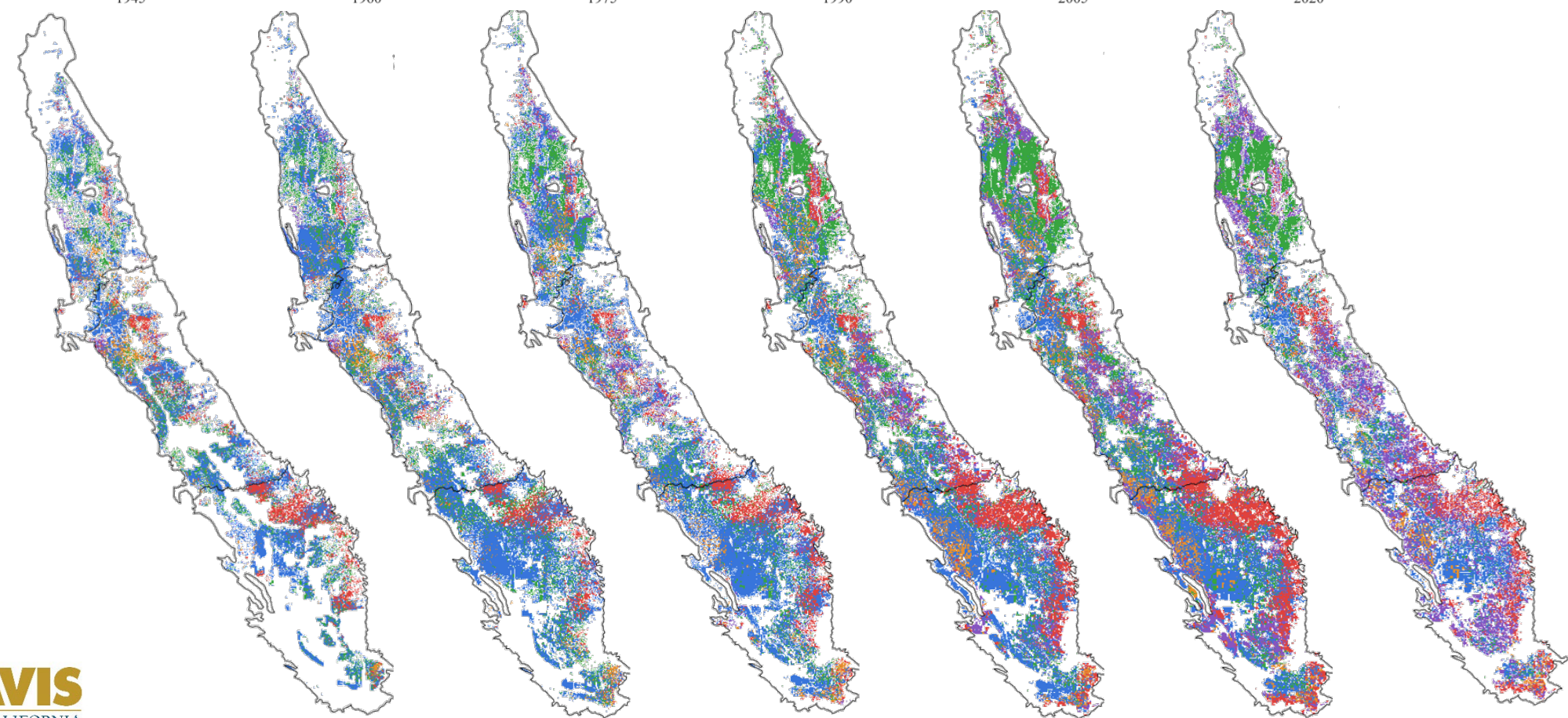
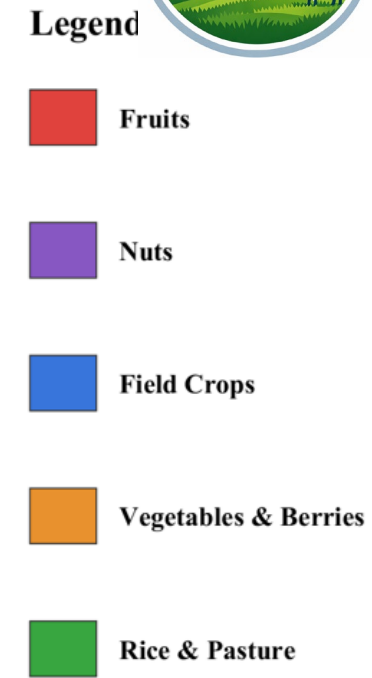
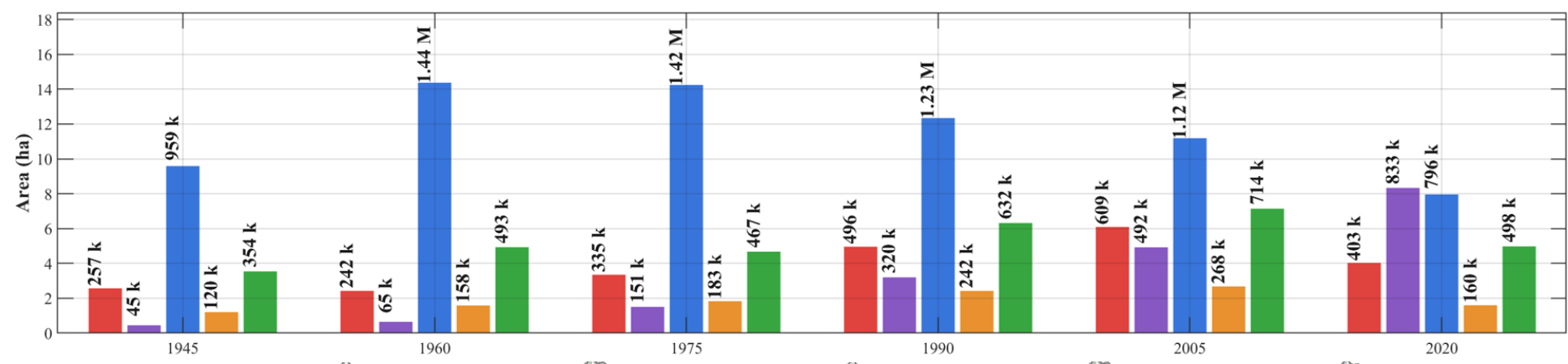


How much nitrate-nitrogen (mass) are fields/orchards leaching per year?

- All terms represent annual nitrogen source or sink components at the pixel scale
- Fluxes are expressed as $\text{kg N ha}^{-1} \text{ yr}^{-1}$
- Dairy-related inputs include land-applied manure and manure exported/sold off-site
- N leaching is the residual root-zone nitrogen surplus routed downward toward groundwater



Central Valley Agricultural Crops– Spatio-Temporal Distribution



EPSG:3310
Scale: 1.2x10⁶

Agricultural land use is mapped to 58 crops or crop types (covering 250 different products)



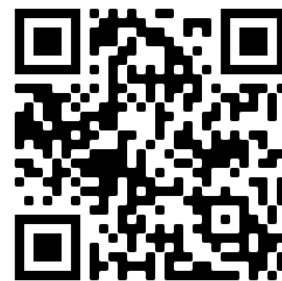
Crop Name	DWR/ CAML Crop Code
Citrus and Subtropical (Also Miscellaneous subtropical and jojoba)	300
Grapefruit	301
Lemons	302
Oranges	303
Avocados	305
Olives	306
Kiwis	308
Deciduous Fruits and Nuts	400
Mixed deciduous (Apples)	401
Apricots	402
Cherries	403
Peaches and Nectarines	405
Pears	406
Plums	407
Prunes	408
Figs	409
Almonds	412
Walnuts	413
Pistachios	414
Field Crops (includes Flax, Hops, Castor Beans, Miscellaneous Field, and Millet)	600
Cotton	601
Safflower	602

Crop Name	DWR/ CAML Crop Code
Sugar Beets	605
Corn (Field and Sweet)	606
Grain sorghum	607
Sudan	608
Beans (dry)	610
Sunflowers	612
Grain and Hay (includes miscellaneous)	700
Barley	701
Wheat	702
Oats	703
Pasture	1600
Alfalfa	1601
Clover	1602
Mixed pasture	1603
Rice (includes rice & wild rice subclasses)	1800
Truck, Nursery, Berry Crops (includes cole mix, mixed, and misc. truck crops)	2000
Asparagus	2002
Beans (green)	2003
Carrots	2006
Celery	2007
Lettuce	2008

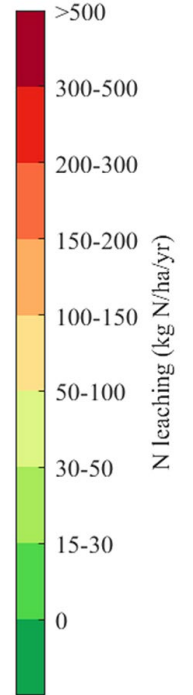
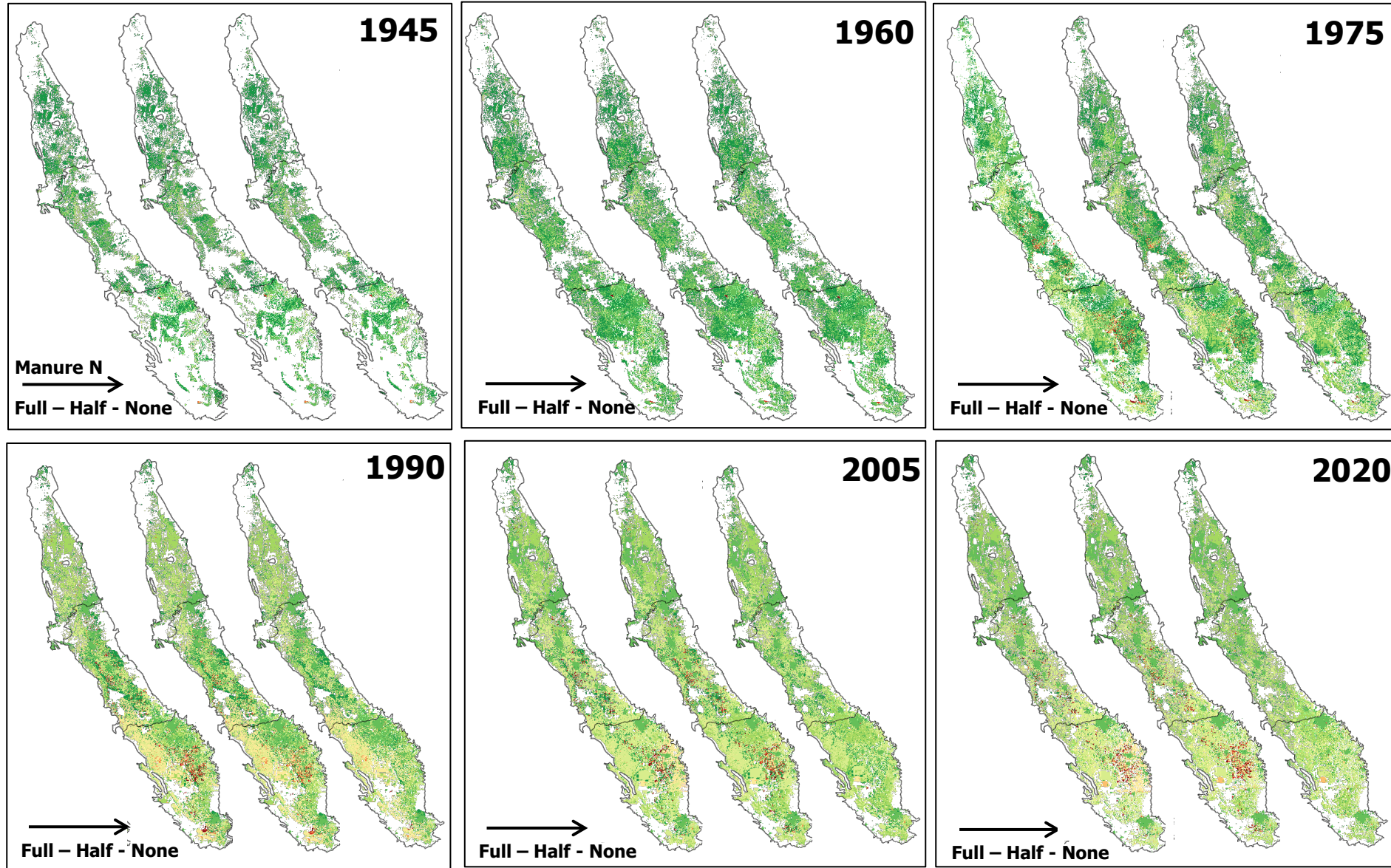
Crop Name	DWR/ CAML Crop Code
Melons, squash, cucumbers	2009
Onions and garlic	2010
Peas	2011
Potatoes	2012
Sweet Potatoes	2013
Spinach	2014
Tomatoes (processing)	2015
Bush berries	2019
Strawberries	2020
Peppers	2021
Broccoli	2022
Cabbage	2023
Cauliflower	2024
Brussels Sprouts	2025
(includes table grapes, wine grapes, and raisins)	2200

NOTE:
Does NOT account for rotations fo field crops (e.g., tomatoes/grain/b ell pepper) except, for 1990 and 2005 only:

All corn is assumed to be in a silage corn/grain summer/winter rotation, and some vegetables are assumed to be double cropped.



Estimated Central Valley Nitrates Leaching – Spatio-Temporal Distribution



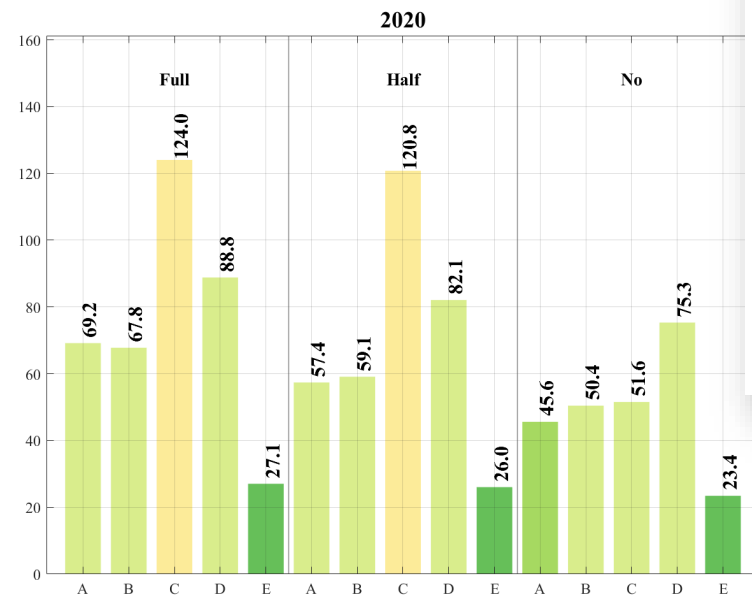
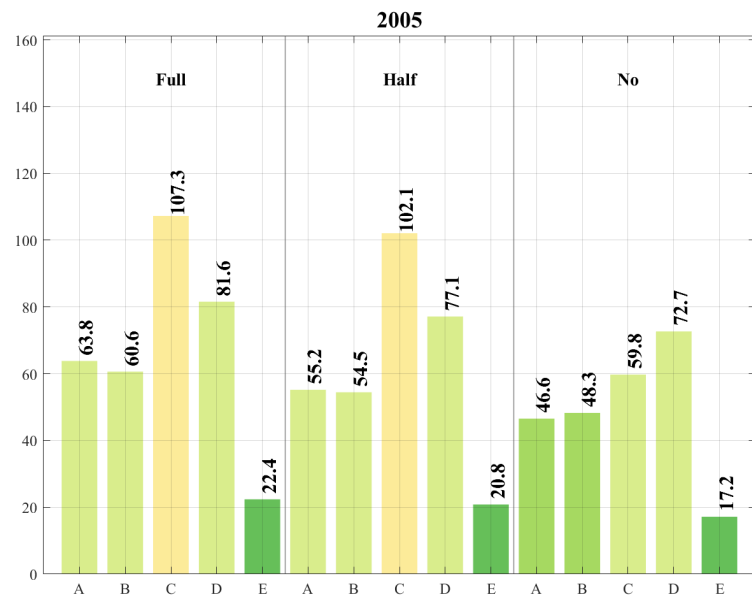
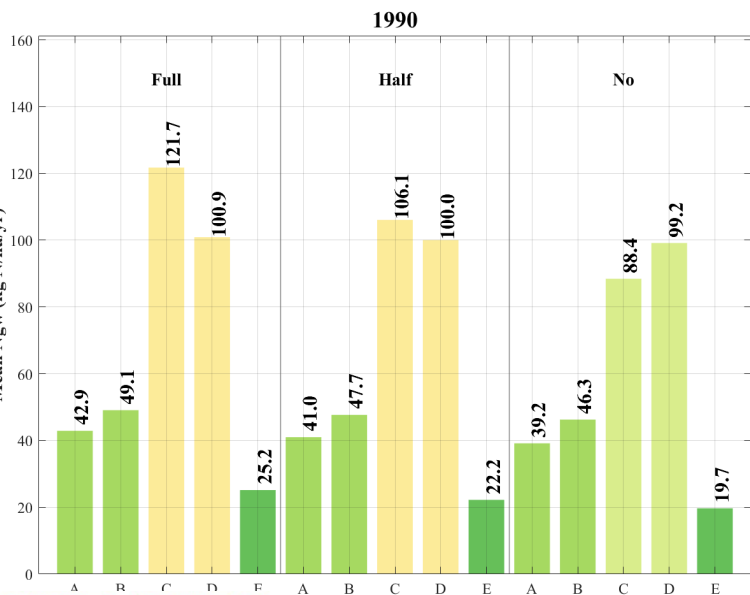
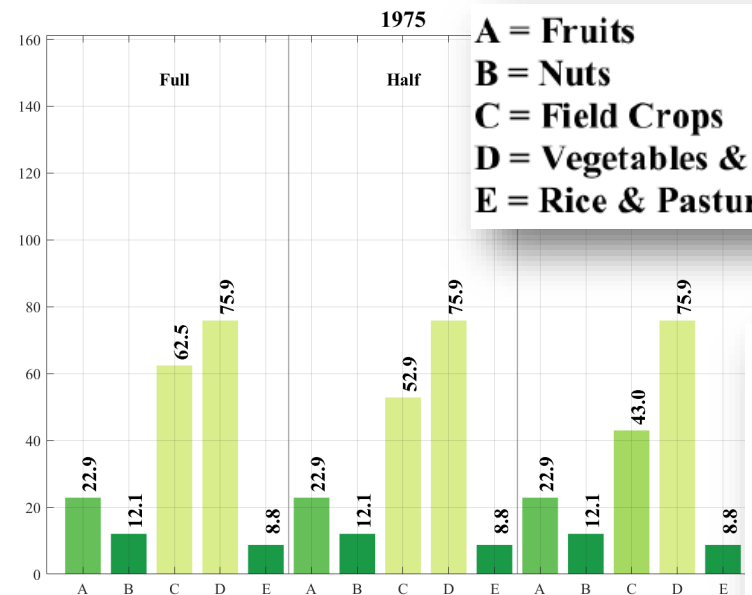
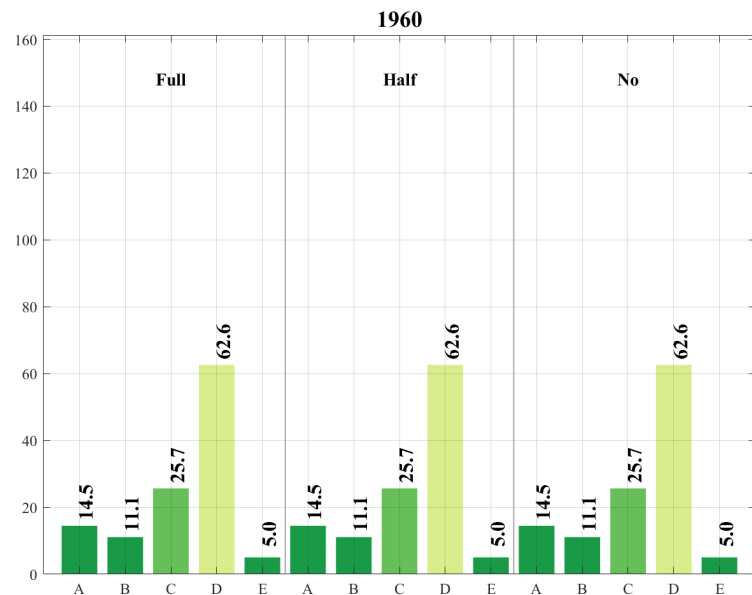
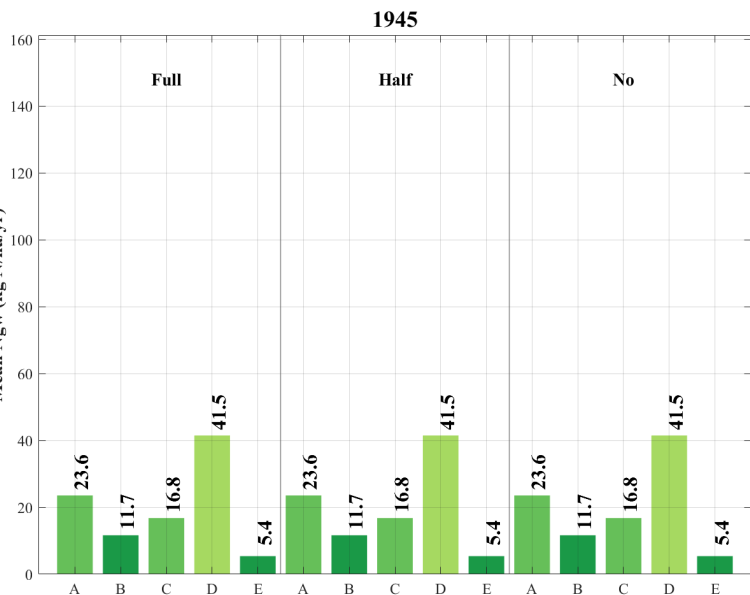
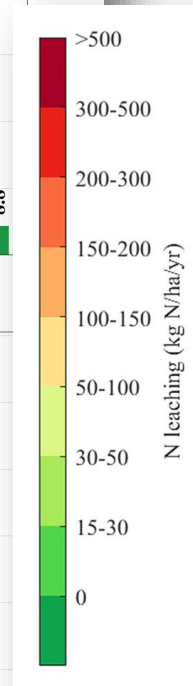
N

EPSG:3310
Scale: 1.2x10⁶

Mean Potential Groundwater N Leaching from Major Crop Groups



- A = Fruits**
- B = Nuts**
- C = Field Crops**
- D = Vegetables & Berries**
- E = Rice & Pasture**



Why these highly detailed nitrate-N leaching maps may **differ from reality**:



- Decadal (15-year) snap shots of land use – does **not** include crop rotations
- **Denitrification** potential of manure N in vadose zone may in some locations be significantly higher than estimated
- Errors due occasionally inaccurate dairy APN / WWTP / FP **reporting**
- For the same crop, **differences in N leaching due to**: farm-to-farm, field-to-field, soil-to-soil differences in N leaching due to water and nutrient management practices, soil conditions, day-to-day and seasonal climate conditions
- **Localized high atmospheric N deposition** near individual dairy/WWTP/FP facilities
- Local variability in N sources to which only an average leaching number was assigned as local data are unavailable:
 - Urban areas, golf courses, alfalfa and pasture, dairy corrals, dairy lagoons

The source “flow” associated with nitrate leaching: **RECHARGE**

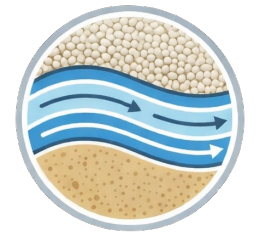
Recharge containing nitrate-N:



Landscape Recharge = [Precipitation PLUS Irrigation MINUS Evapotranspiration]



**Recharge that has negligible amounts of nitrate-N (< 1 mg/L)
may dilute nitrate along the pathway or at the well (receptor):**

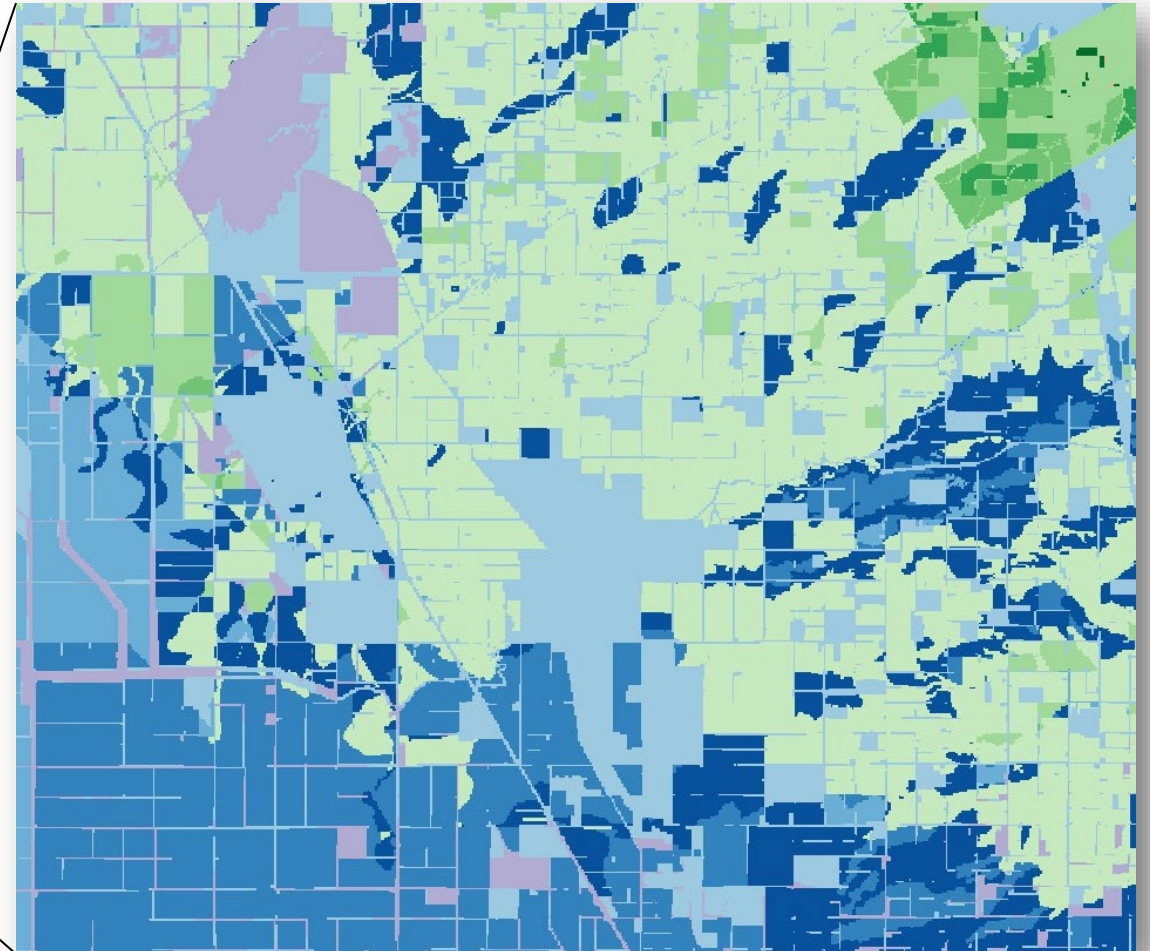
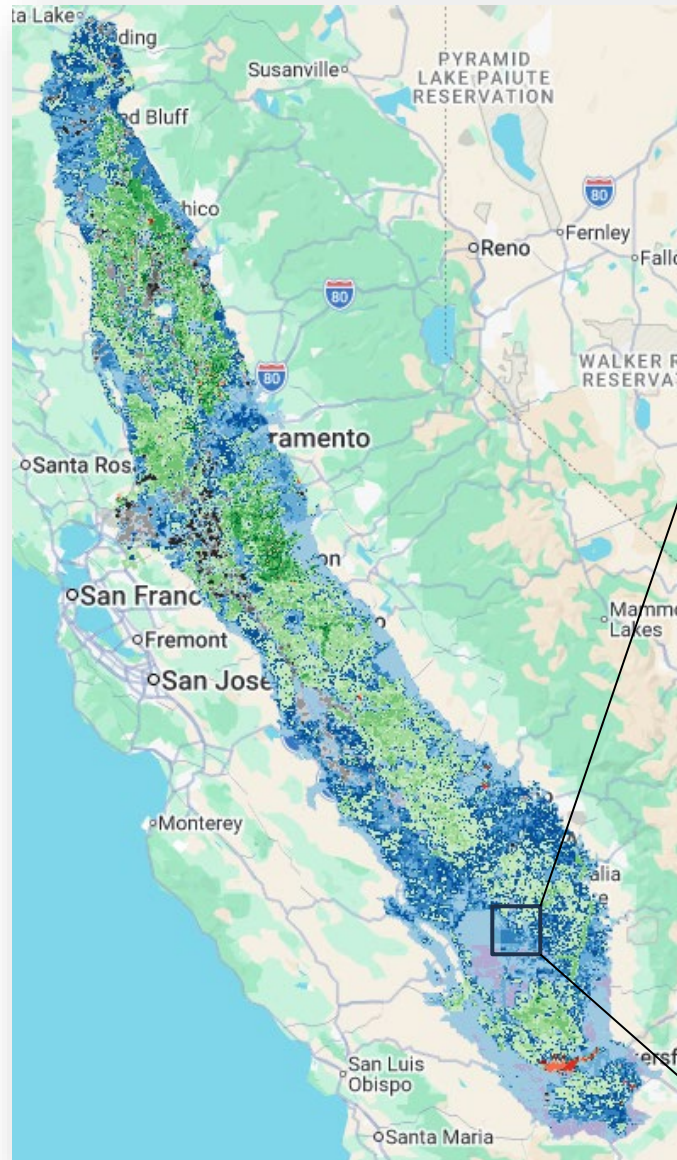


Recharge from Surface Waters = Managed Aquifer Recharge, Canal Seepage, River/Stream/Lake Recharge

Recharge Map



- <https://giorgk.users.earthengine.app/view/cvhm-recharge-redistribution>
- Recharge defined at 50 m (164 ft) cells

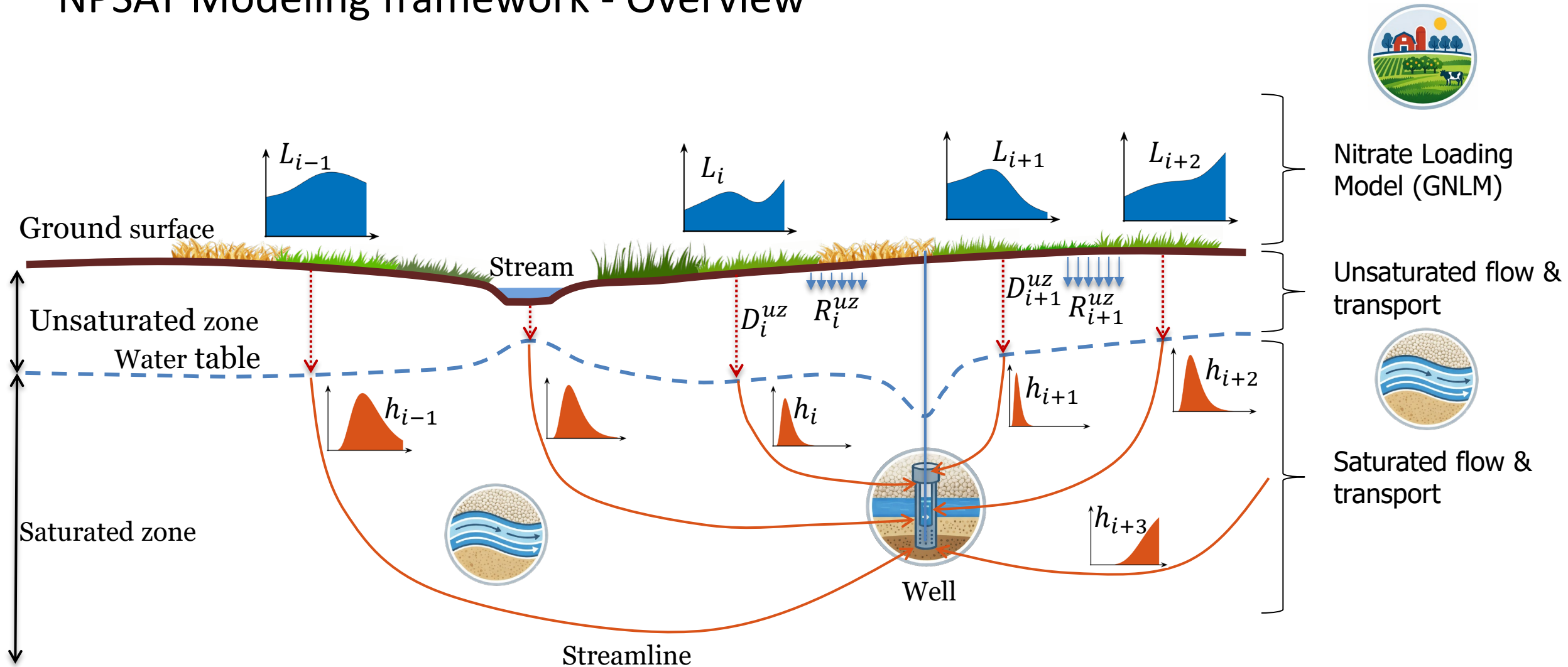


Nitrate **Pathways** from Central Valley's Landscape to Central Valley Wells (and Streams)



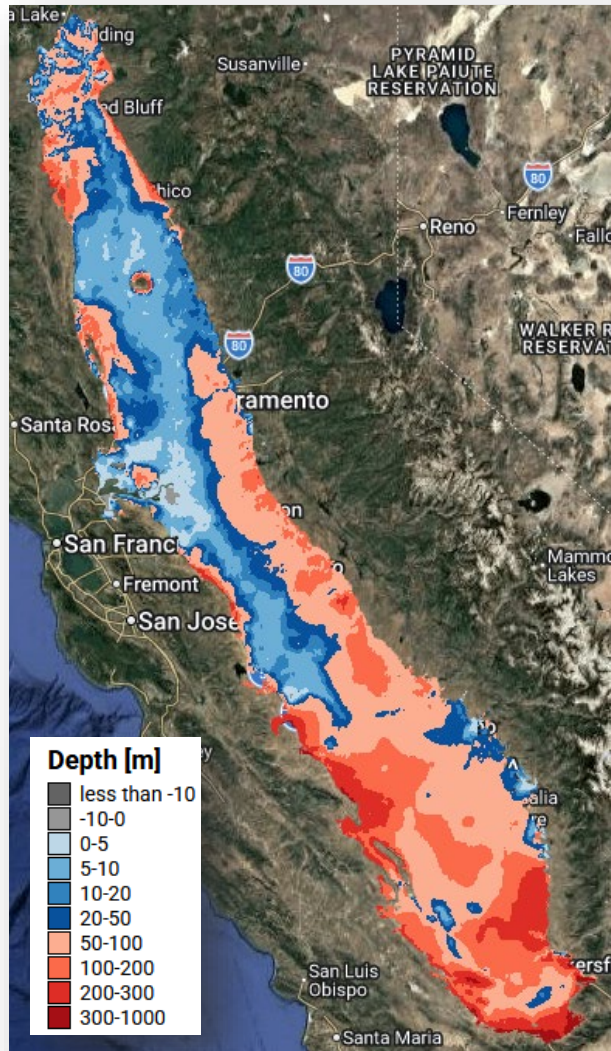
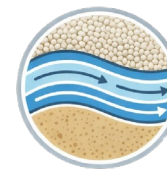
- Flow
- Concentration / Mass Transport

NPSAT Modeling framework - Overview

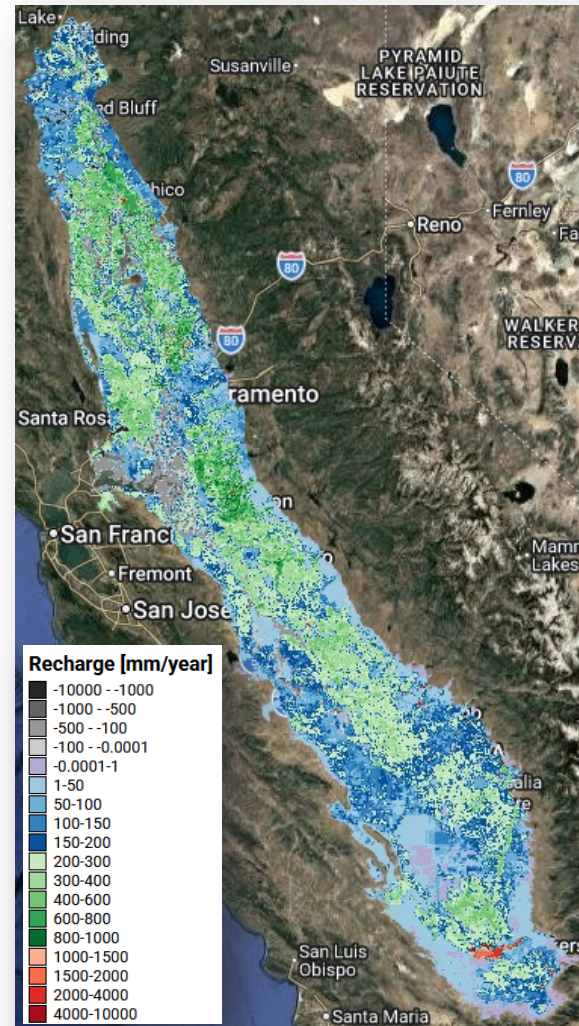


NPSAT Modeling framework – Unsaturated Transport

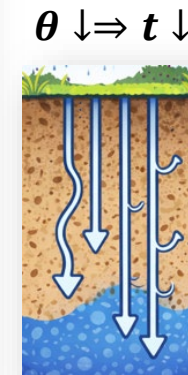
Piston flow + transport model



Depth

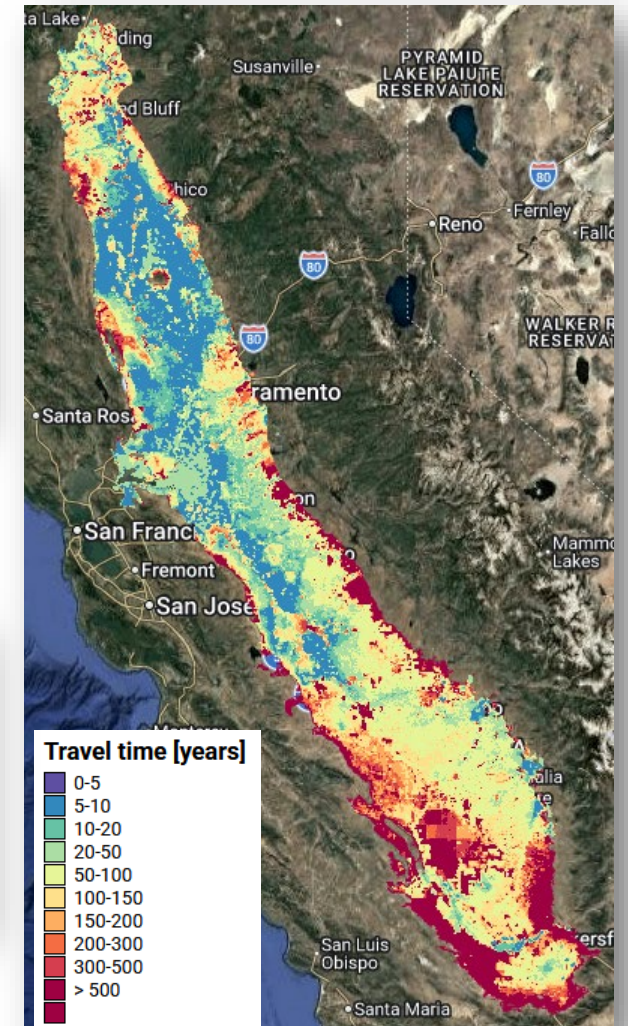


Groundwater Recharge



Water Content

×



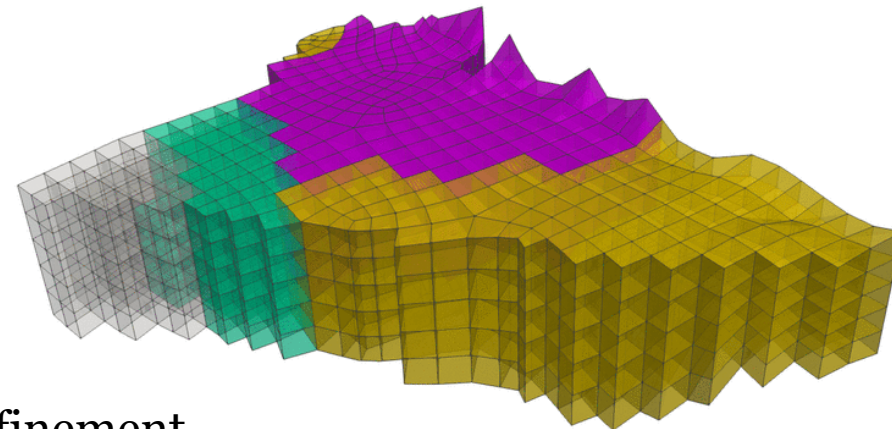
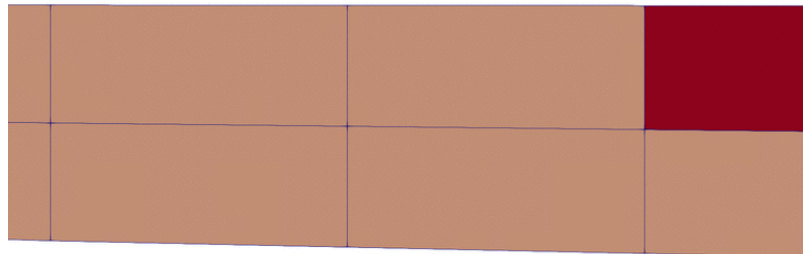
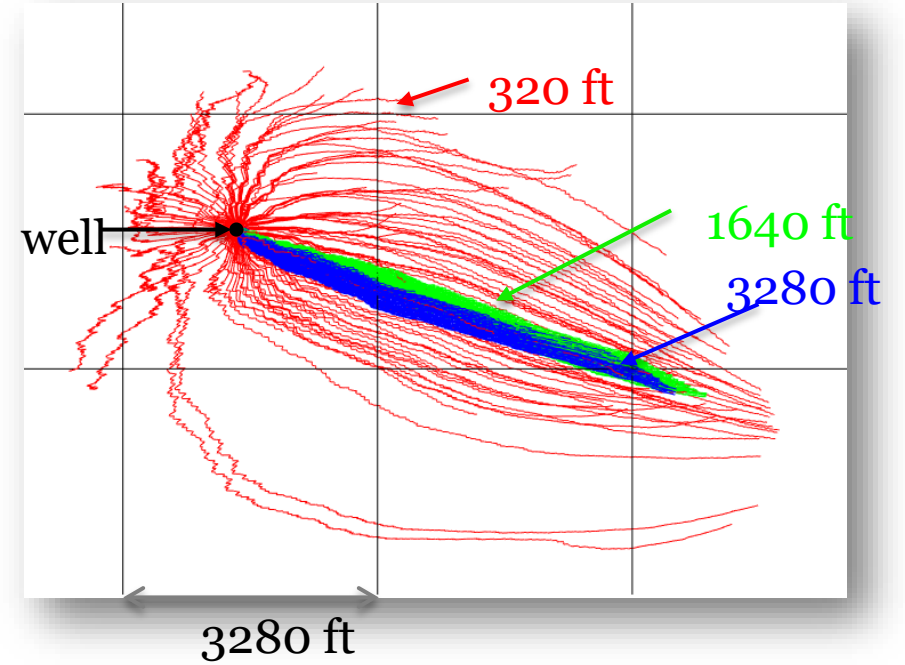
Unsaturated Zone travel time



NPSAT Modeling framework – Saturated Flow simulation



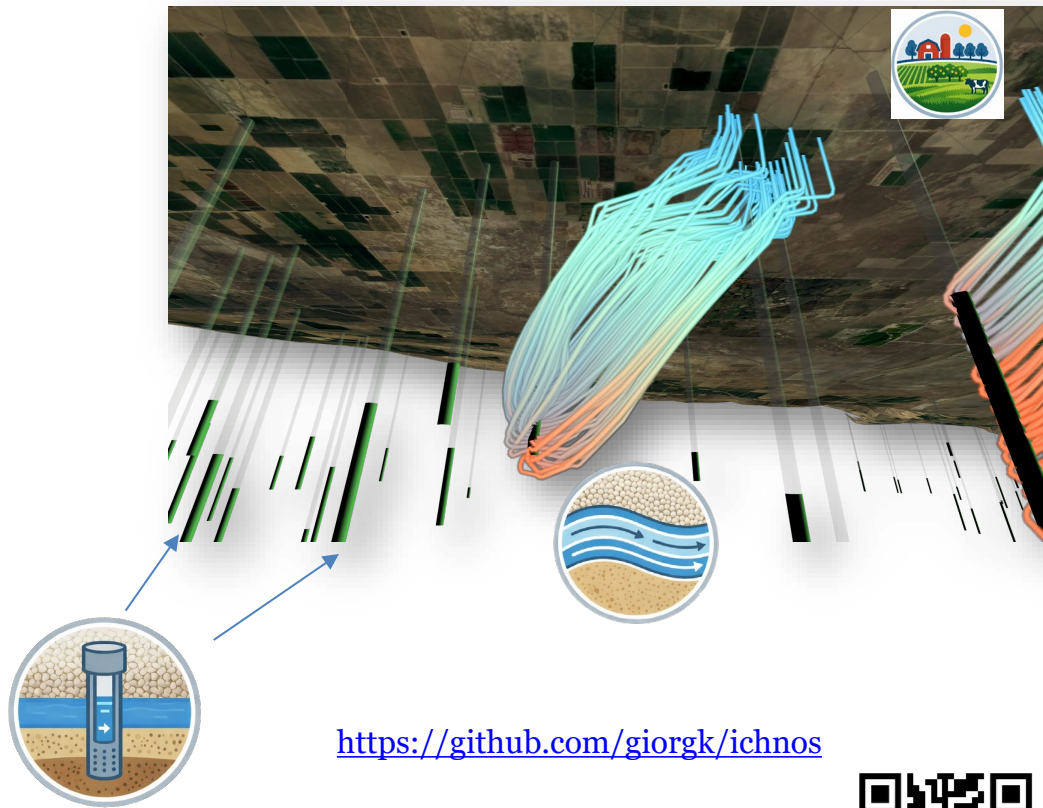
Effect of model resolution in pathway delineation



NPSAT Modeling framework – Saturated transport simulation

Transport Simulation

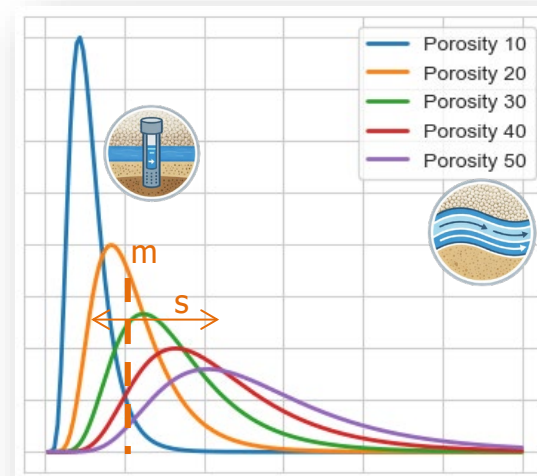
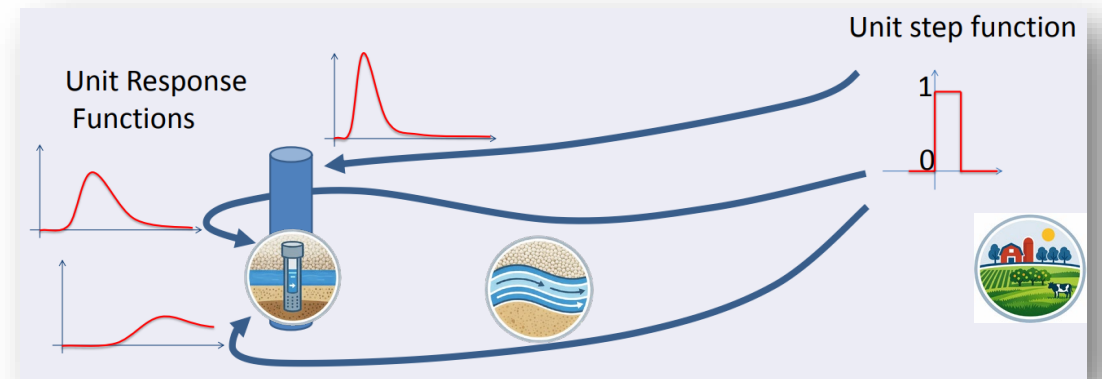
Particle Tracking



<https://github.com/giorgk/ichnos>



Advection dispersion

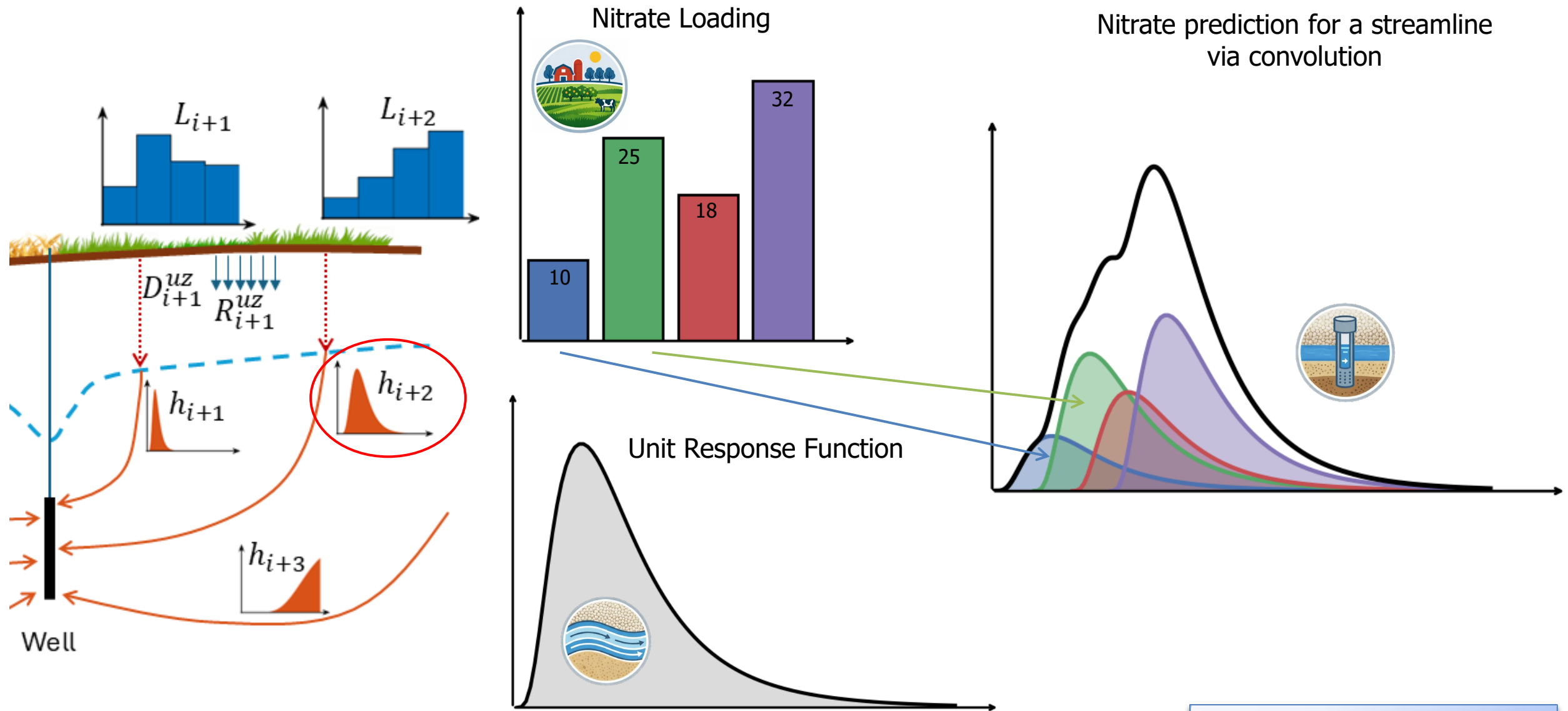


URF parameterization:

- Log normal distribution (m, s)
mean, std
- Analytical ADE (v, l)
velocity, streamline length

<https://github.com/giorgk/npsat-urf>

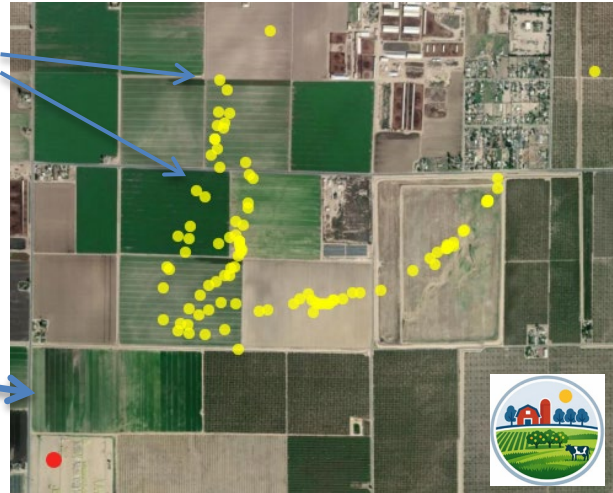
NPSAT Modeling framework – Prediction



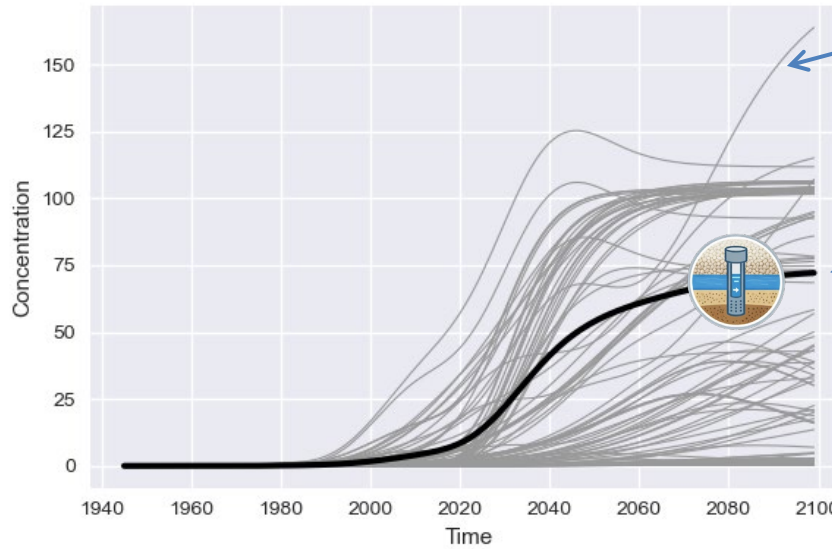
Mixing Nitrate sources over **time**

NPSAT Modeling framework – Scenario Predictions

Streamline starting points

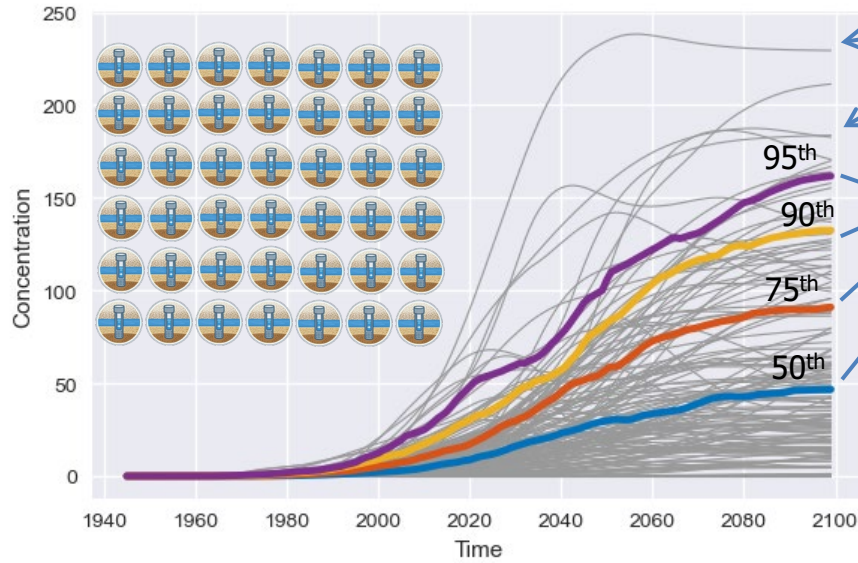
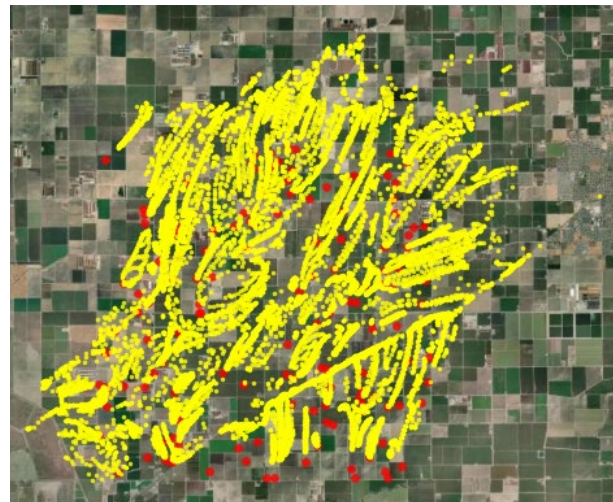


Streamline concentration



Well concentration

Regional Assessment:
e.g. Township



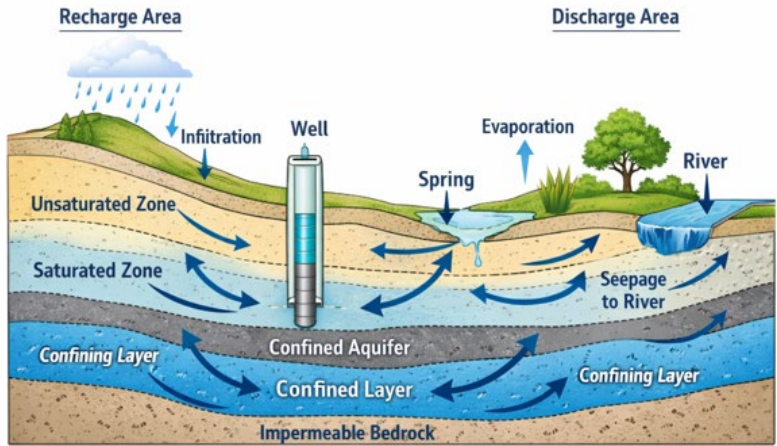
Well Concentrations

Regional impact of loading
(range of nitrate concentrations, and how that changes over time, across many wells)

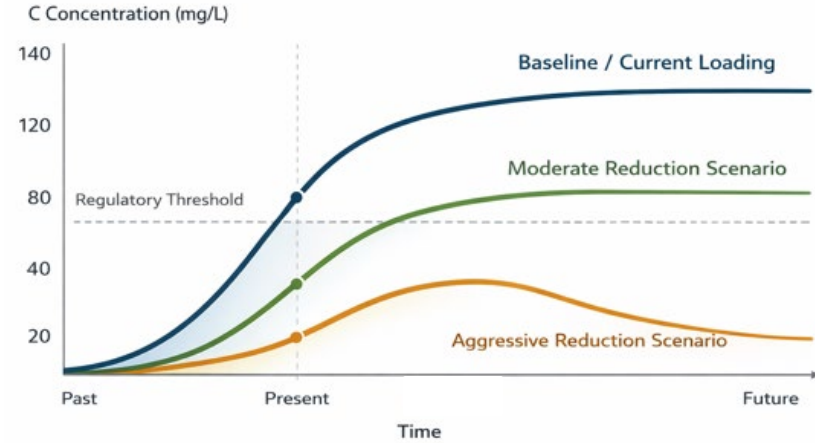
Mixing Nitrate sources over **space**

NPSAT Modeling Assumptions

- Flow system is stationary (long-term average & balanced)



- Long-term groundwater quality trends



- Sources are distributed

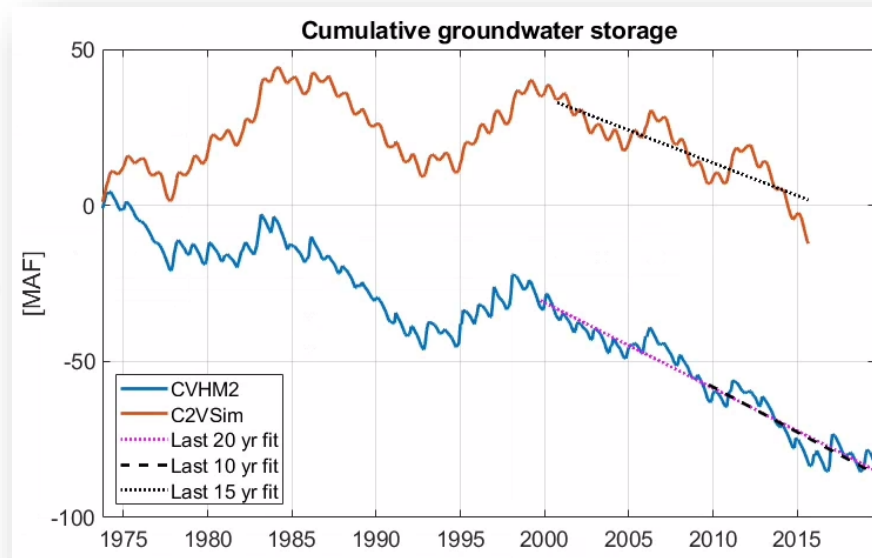
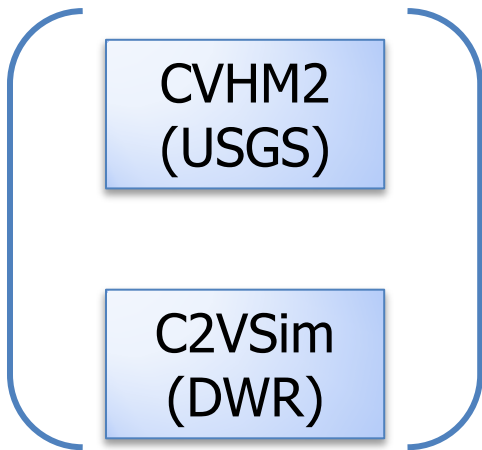


- Regional Assessment



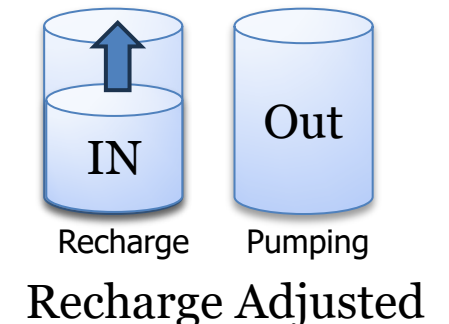
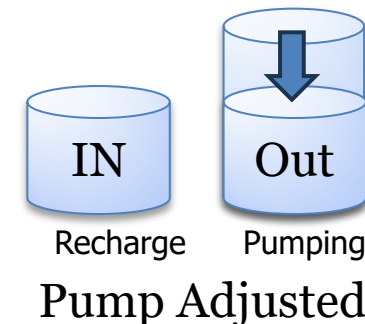
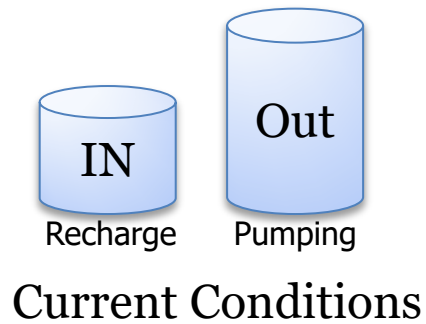
CV-NPSAT: Central Valley application of NPSAT

Regional Models



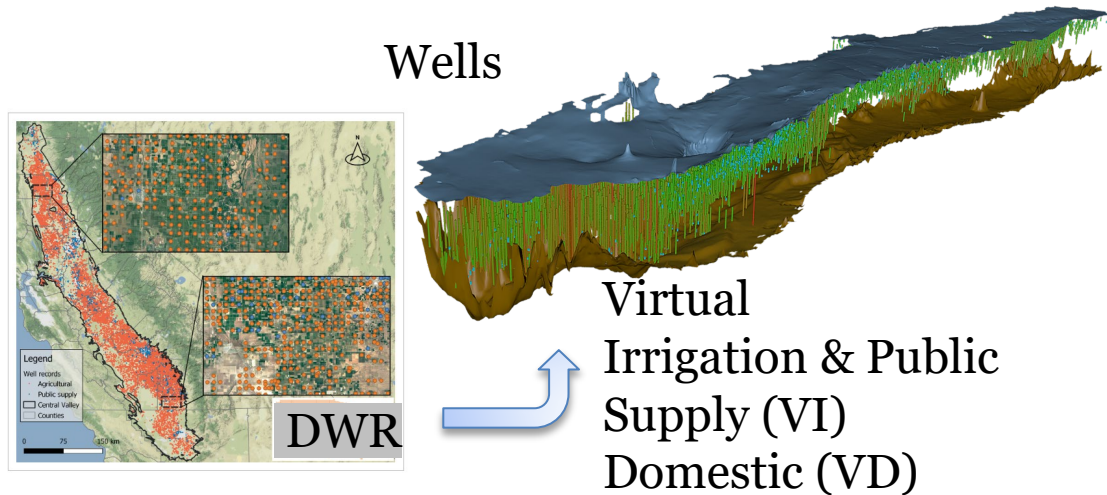
- With the current rate of groundwater depletion (2.3-2.9 MAF/year) 35% of aquifer water will be lost after 200 years
- NPSAT simulates multi-century diffuse transport in the Central Valley
- Addressing diffuse pollution is meaningful once sustainability has been achieved
- We consider the two extremes sustainable cases:

- CVHM2:
<https://www.usgs.gov/tools/central-valley-hydrologic-model-version-2>
- C2VSim:
<https://data.cnra.ca.gov/dataset/c2vsimfg>

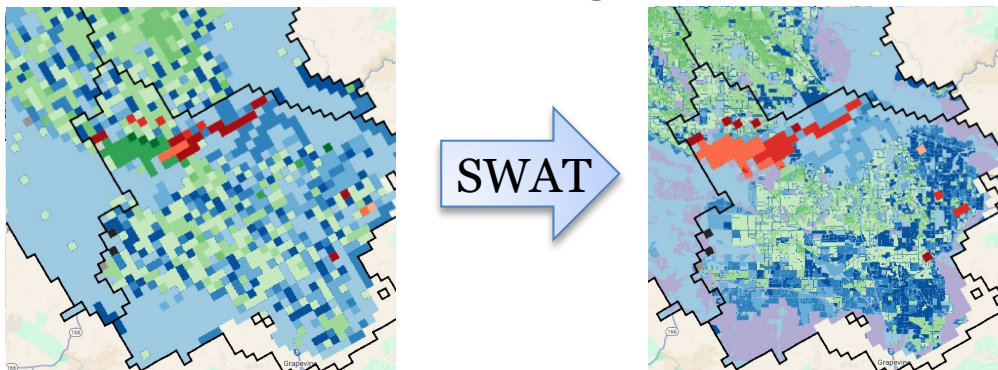


CV-NPSAT Simulation

Downscaling from the base models

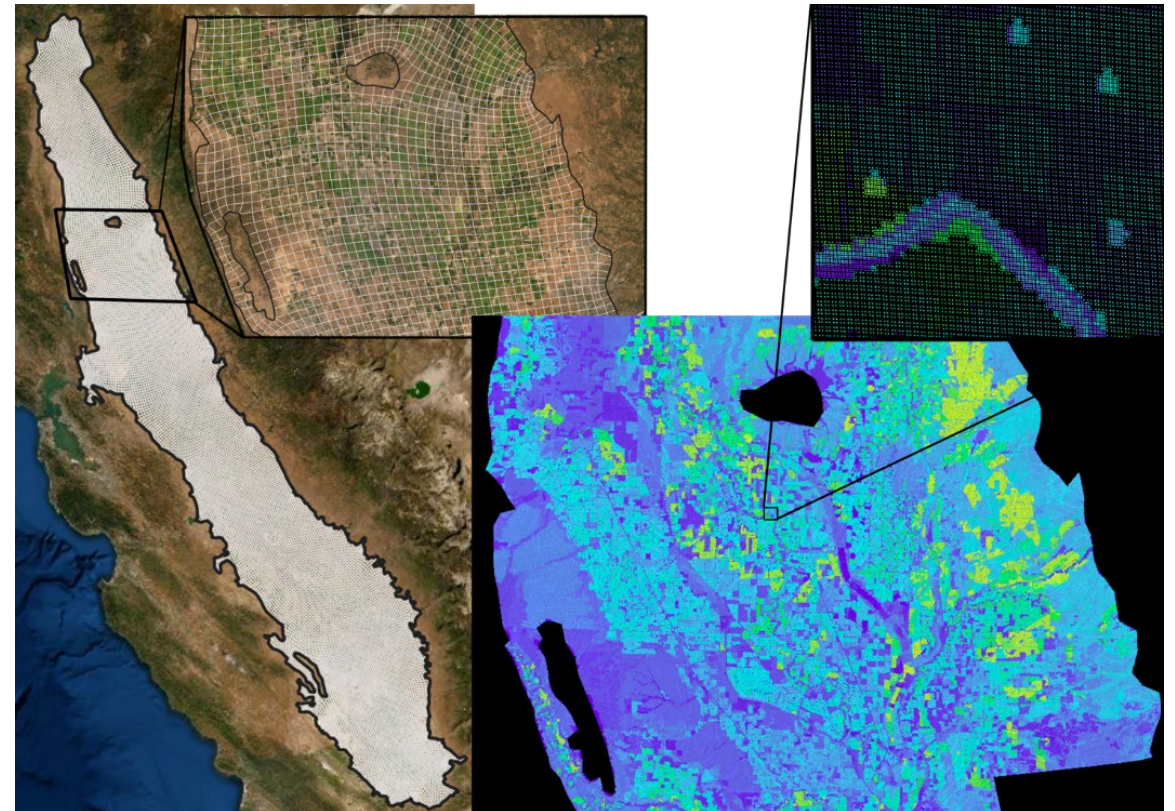


Groundwater Recharge downscale



Kourakos and Harter 2024

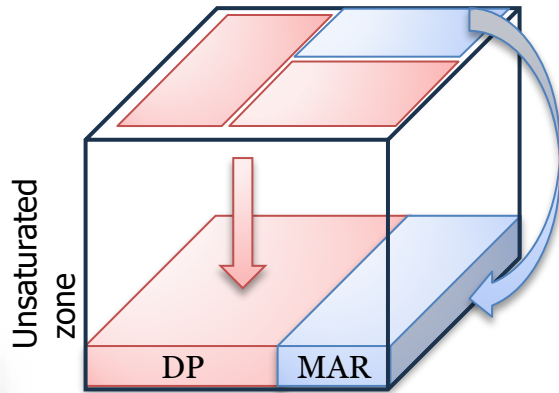
- Flow simulation to define groundwater pathways:
 - 150-200 ft horizontal resolution
 - 1 – 15 ft vertical resolution
 - ~120 - 130,000,000 elements
- Pathways:
 - ~4 million streamlines / per model run
- Receptors:
 - ~22,000 irrigation wells (100 streamlines to each)
 - ~2,500 public supply wells (100 streamlines to each)
 - ~55,000 domestic wells (30 streamlines to each)





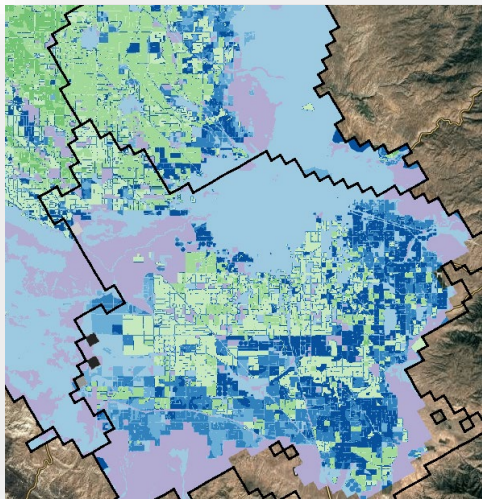
How does CV-NPSAT deal with:

- **MAR**
- Rivers
- Denitrification

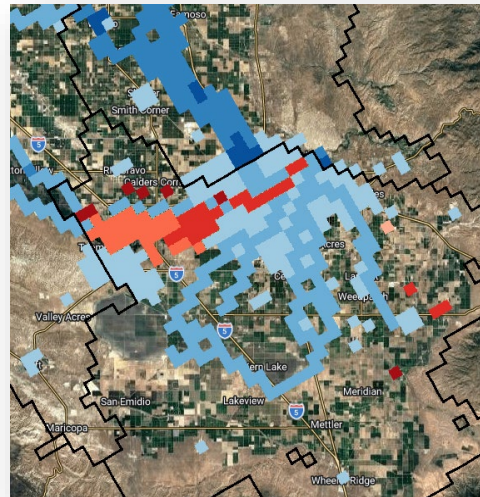


Existing MAR infrastructure is embedded in Parent models

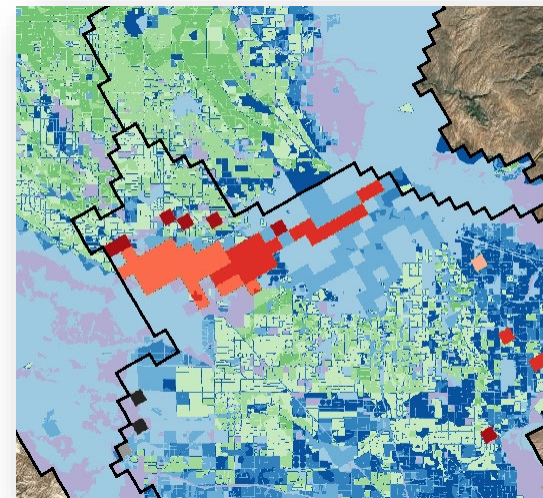
$$\text{Dilution Factor} = \frac{\text{Direct recharge (MAR)}}{\text{Total deep percolation}}$$



Deep percolation



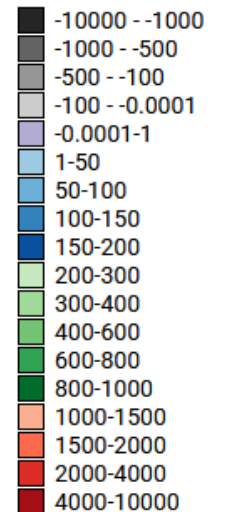
Direct recharge



Total deep percolation

Streamline concentrations are reduced based on the dilution factor

Recharge [mm/year]



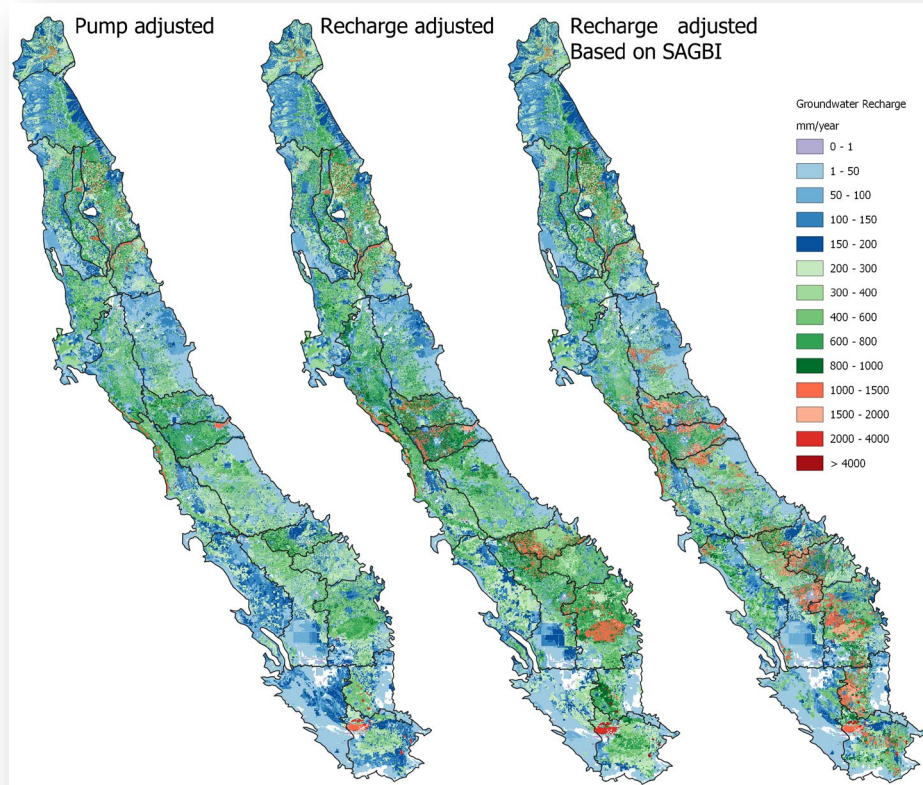


How does CV-NPSAT deal with:

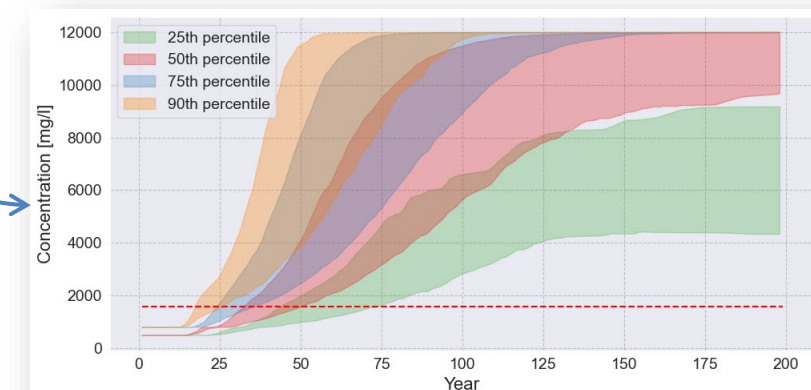
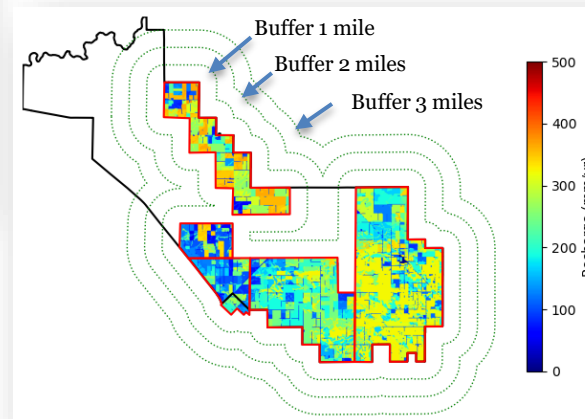
- **MAR**
- Rivers

New MAR infrastructure are not embedded in parent models

- A new MAR infrastructure affects
 - Flow field
 - Dilution factor
- Modifying the dilution factor is straightforward
- Modifying the flow field, however, is non-trivial
- Ideally the flow field requires simulation to account for the effects of new MAR facilities
- Central Valley-wide large scale MAR. The extra volume of water is applied on Excellent – Moderately good soils according to SAGBI index
- Adjust dilution in a buffer zone to estimate impacts on nearby wells and long-term nitrate benefits



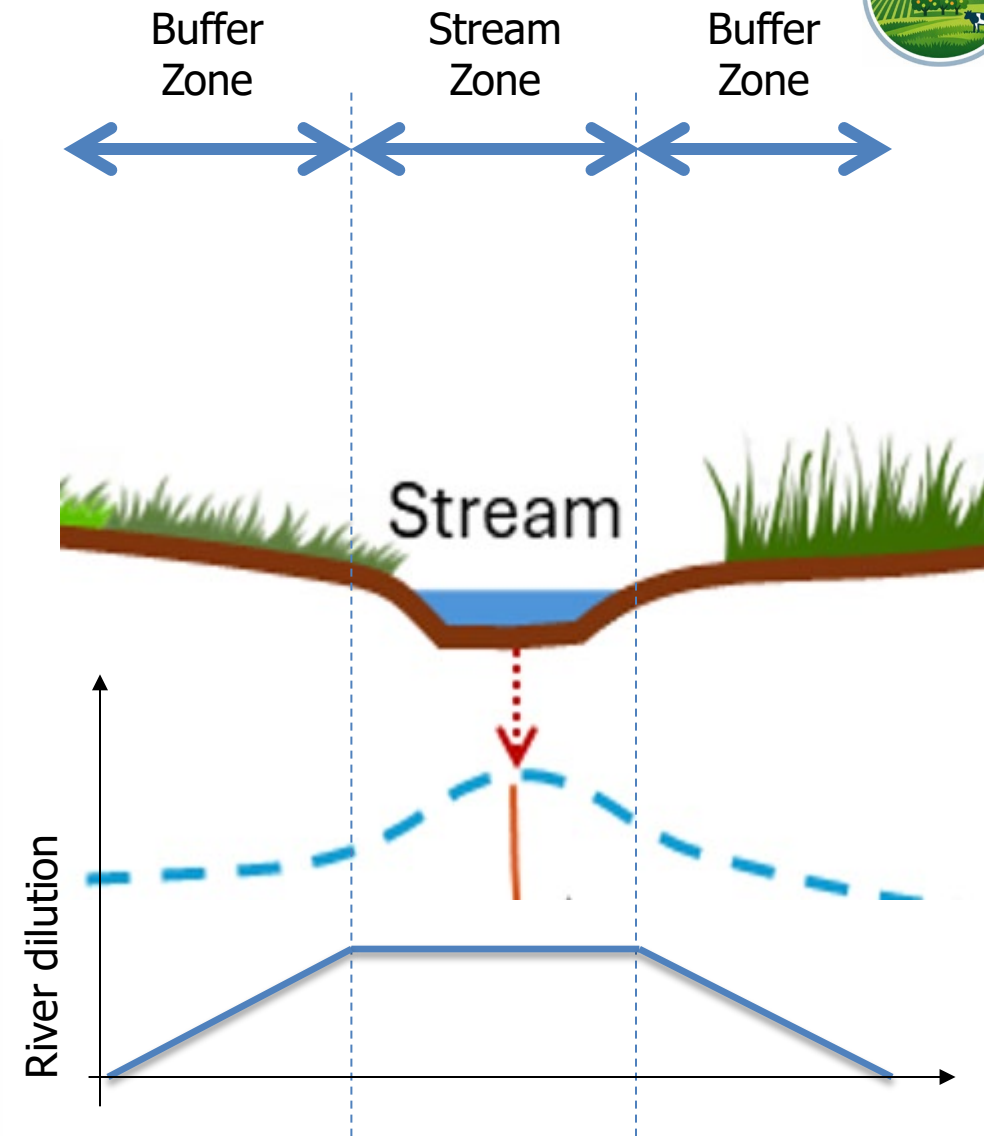
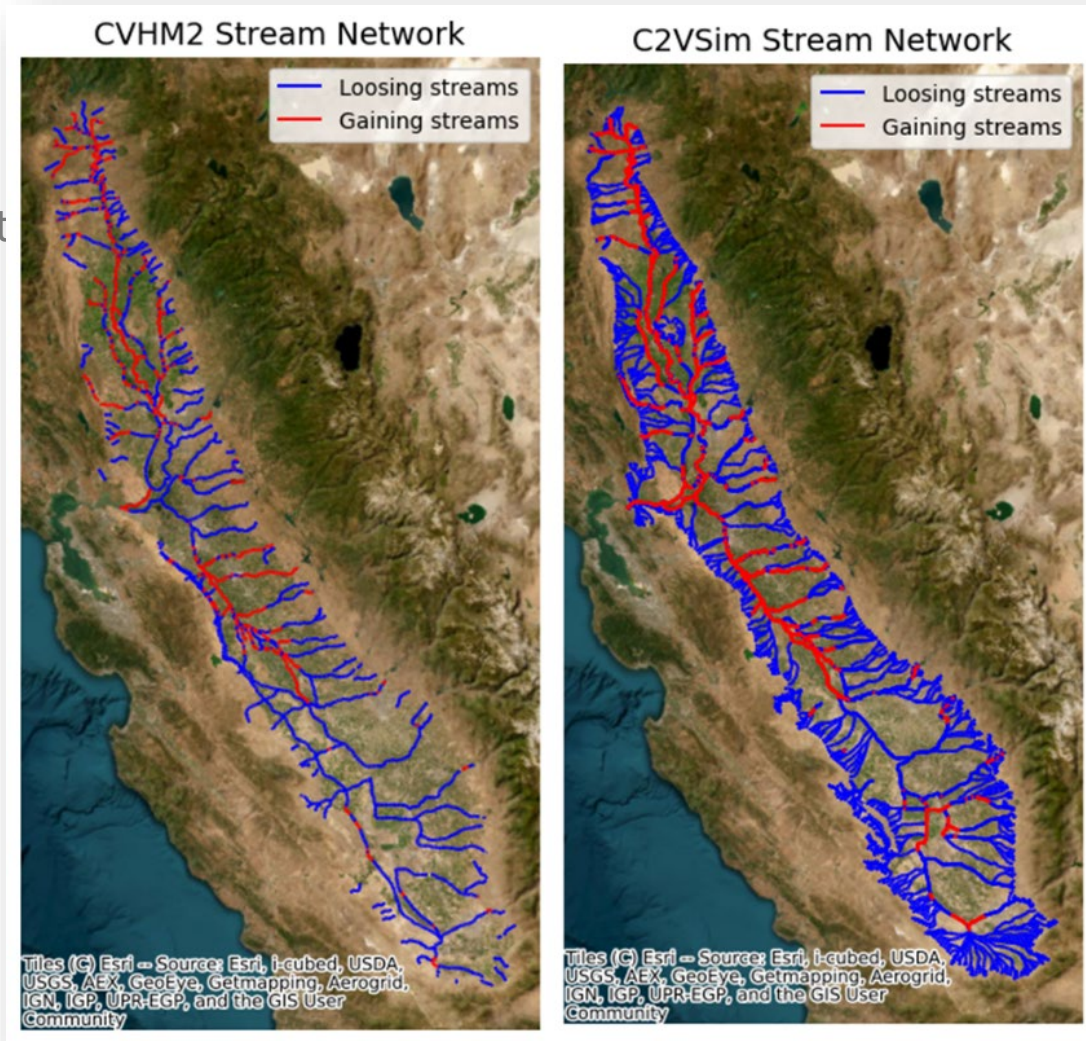
SAGBI: [Soil Agricultural Groundwater Banking Index](#)





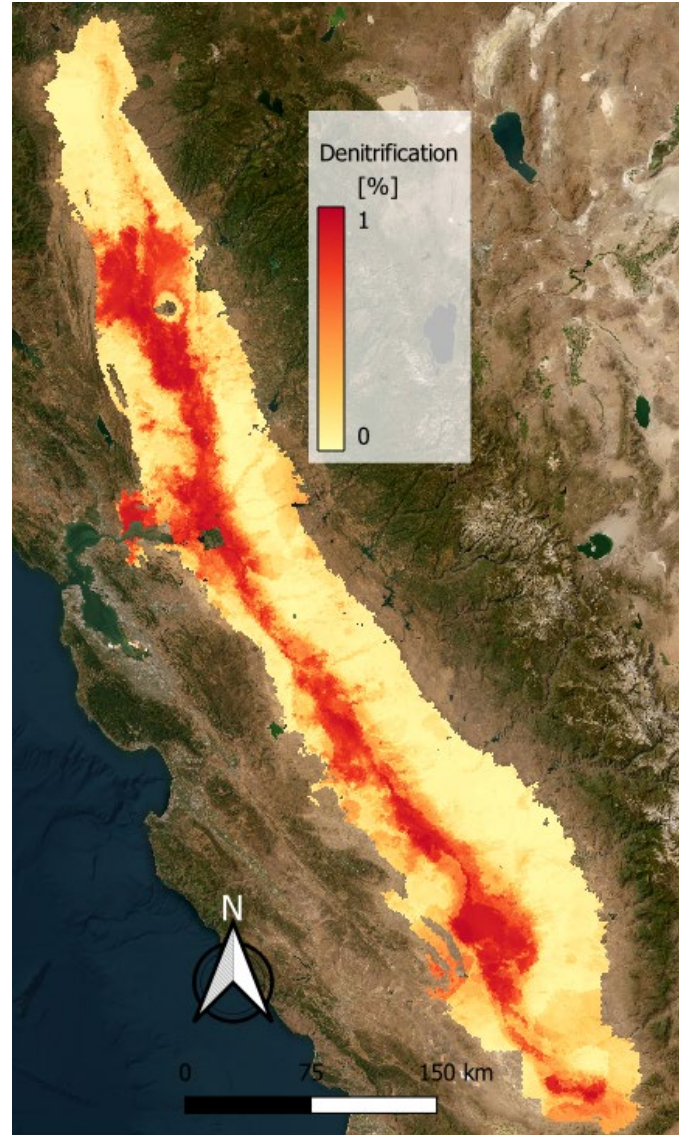
How does CV-NPSAT deal with:

- MAR
- **Rivers**
- Denitrification

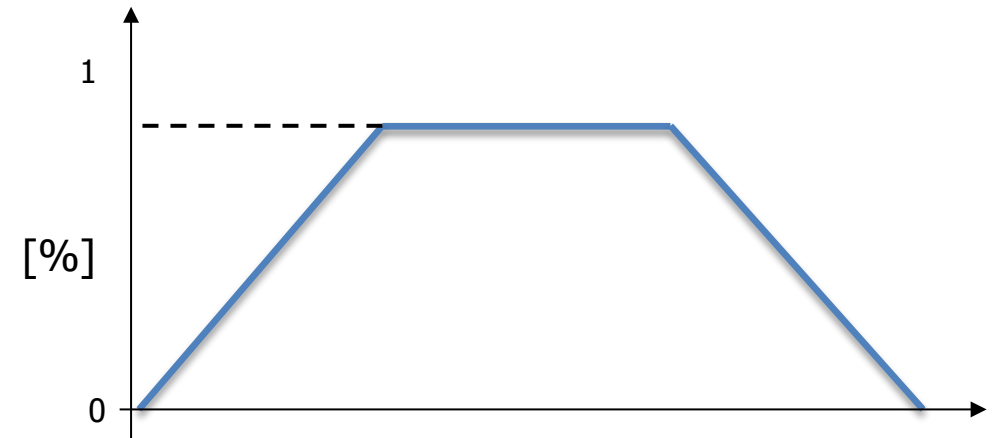


How does CV-NPSAT deal with:

- MAR
- Rivers
- **Denitrification**



Reduction due to denitrification



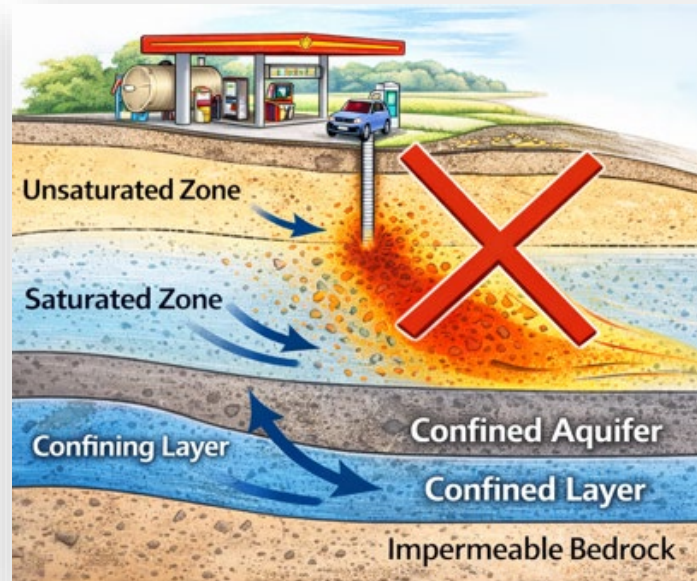
This is not in the model yet, but it's coming very soon.

CV-NPSAT: What it can't and should not be used for

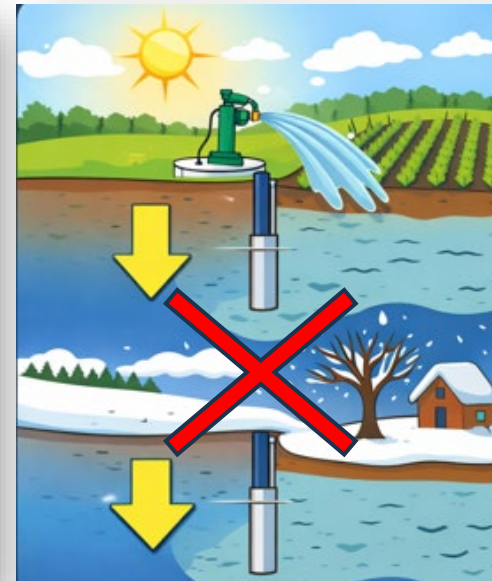
- Small scale site investigations



- Small plumes with sharp concentration fronts



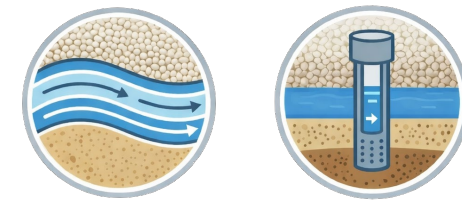
- Seasonal Pumping



- Individual grower management

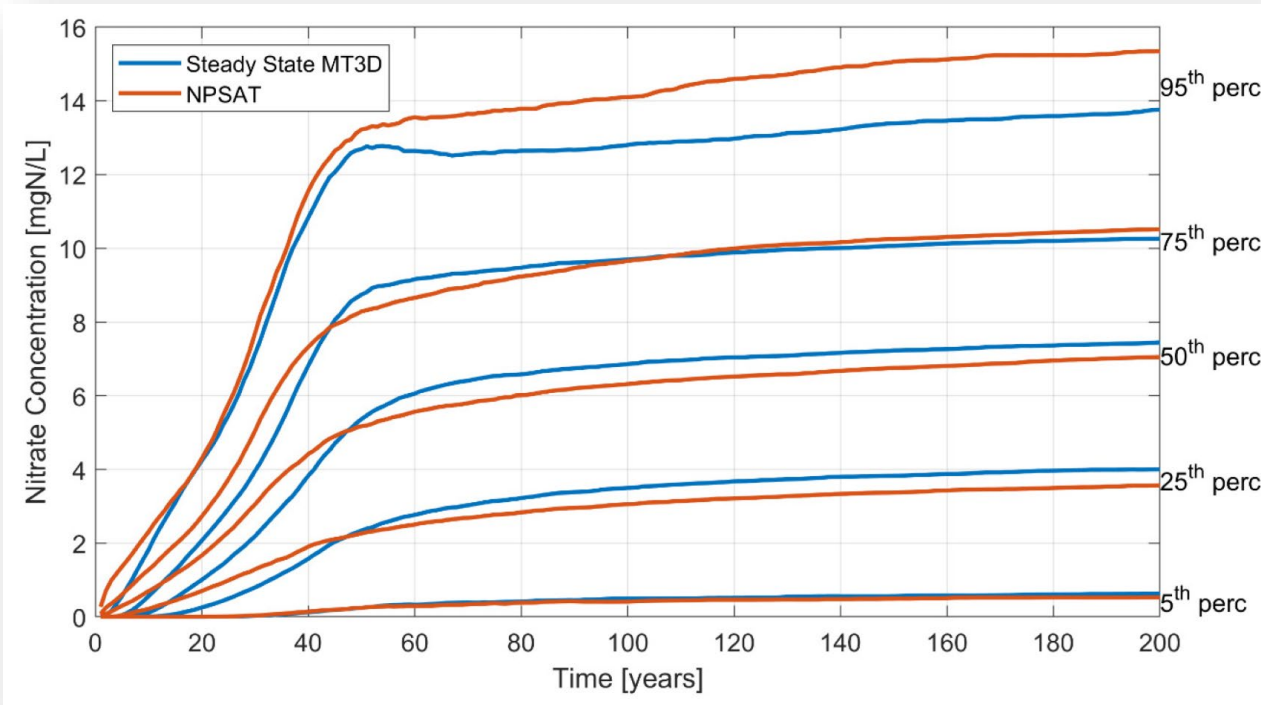


NPSAT Validation

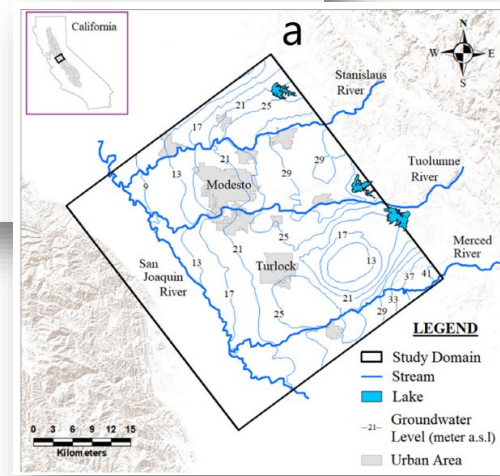
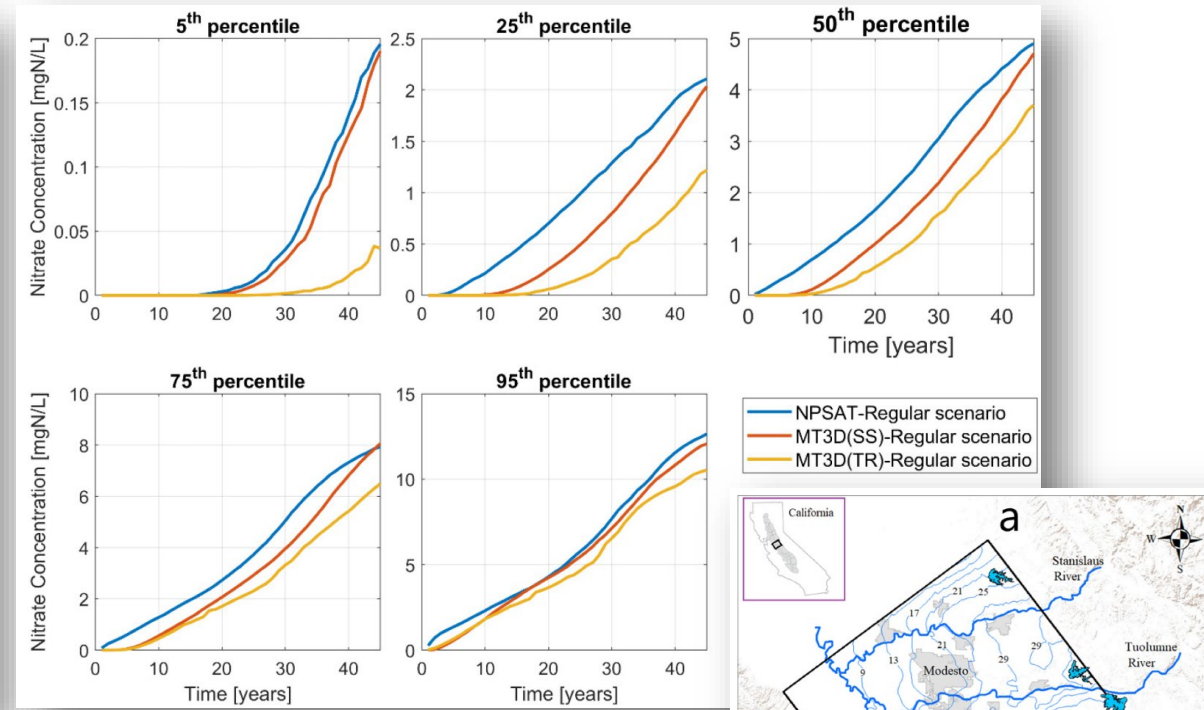


Streamline transport (NPSAT) against Advection Dispersion (MODFLOW-MT3D) with Modesto area model

Steady state flow conditions

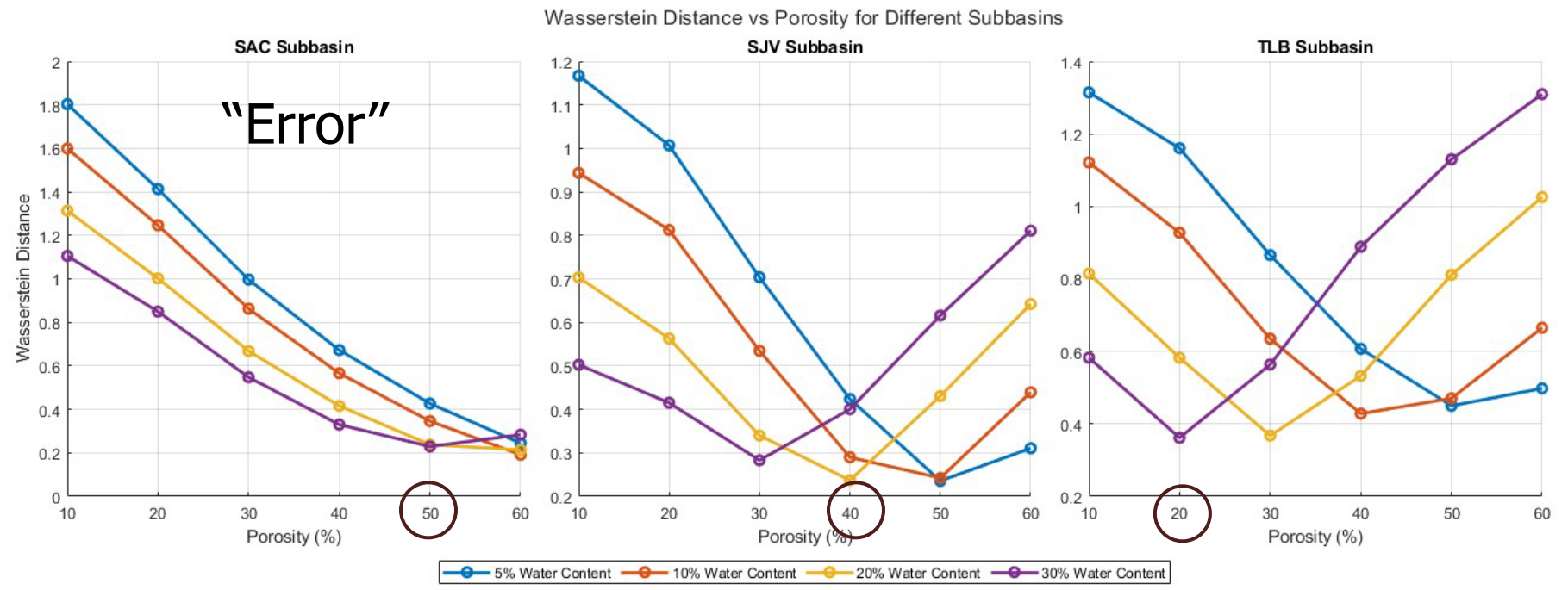
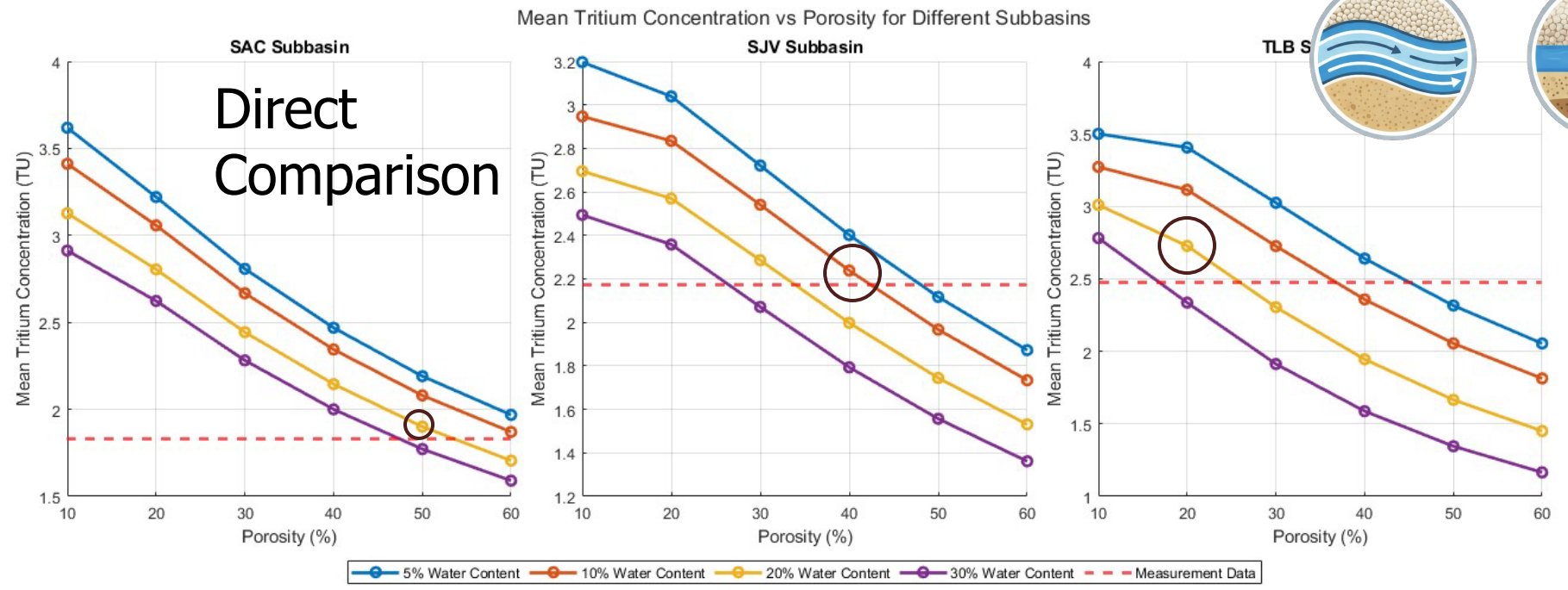
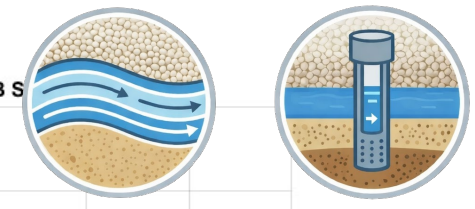


Transient state flow conditions



Fine-tuning
(calibrating)
nitrate-N
transport speed
along the
pathway:

Sensitivity of
age tracer
(tritium)
concentration to
aquifer porosity
and vadose
zone water
content

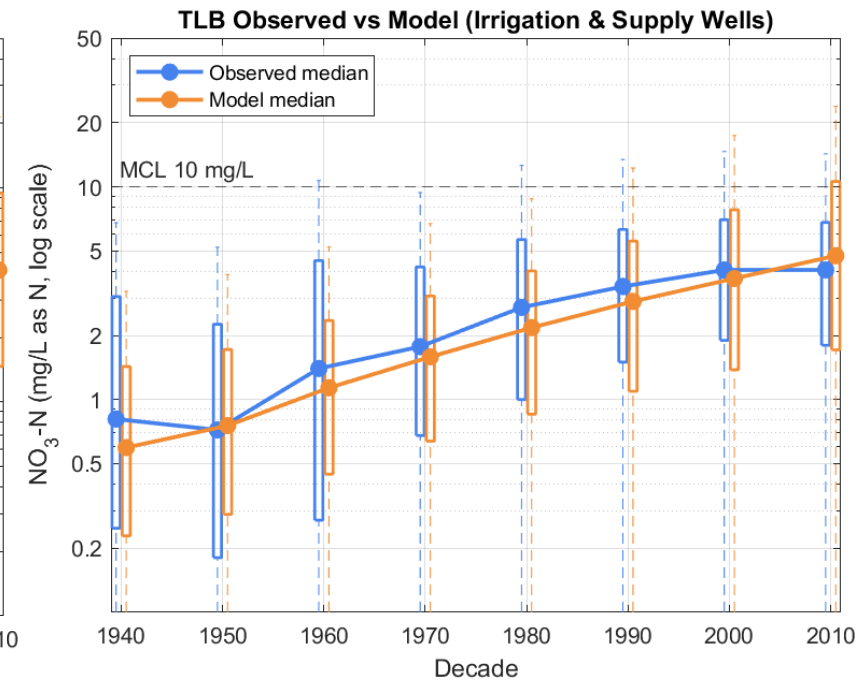
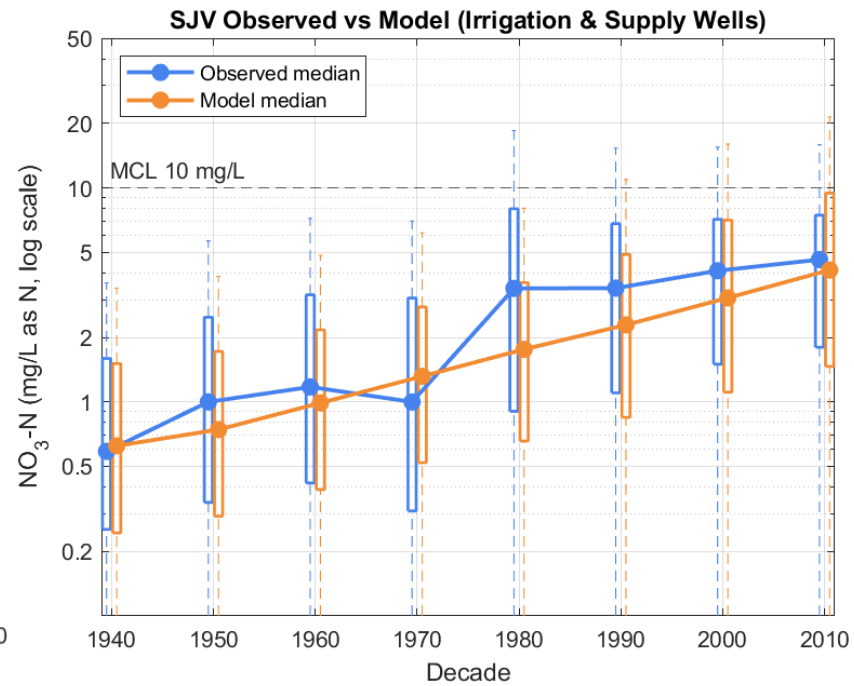
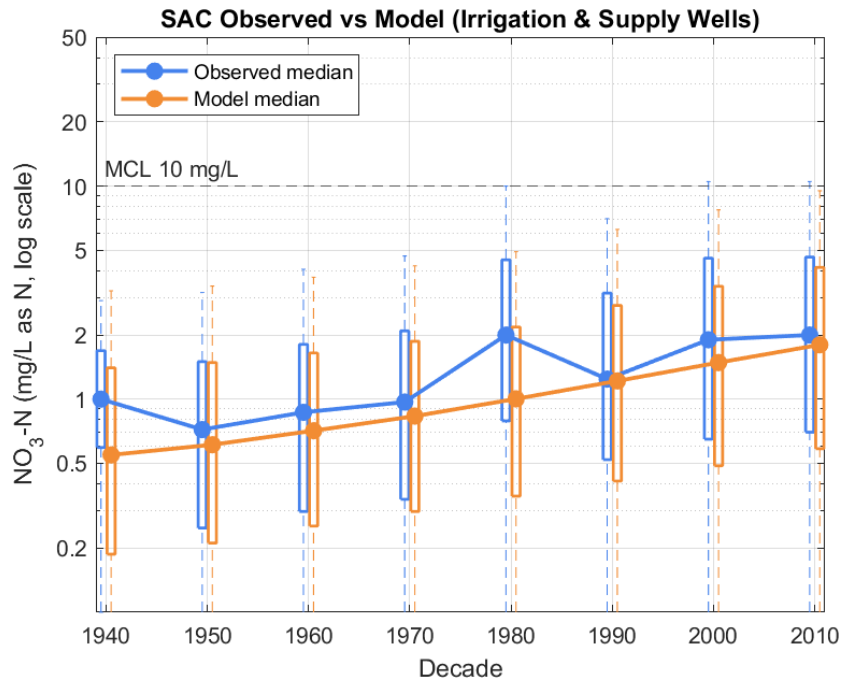




Nitrate-N Validation

Measured vs Simulated

(Irrigation & Public Supply Wells)



Additional Capabilities of CV-NPSAT

- Stand alone server (Mantis)
 - Python
 - Matlab
 - R
- Modify loading at a 50 m cell raster level rather than crop based
- More configuration options:
 - River concentration
 - Modify dilution factor
 - Well source areas
- Scripting multiple runs
 - Sensitivity analysis
 - Optimization
- Use with other areas/models
 - Eastern San Joaquin Valley
 - Tule basin, Tulare County
 - Salinas Valley
- Alternative nitrate loading in lieu of CV-GNLM, e.g. CV-SWAT

```
Windows PowerShell
Reading TLRData/RCH/TLR_RCH_main.dat
Reading TLRData/RCH/TuleRiver_RCH.h5
Read data from TLRData/RCH/TuleRiver_RCH.h5 in 0.0237866
Reading TLRData/RCH/TuleRiver_SWAT_II_RCH.mnts
Read TLRData/RCH/TuleRiver_SWAT_II_RCH.mnts data in 1.24944 sec
Read Recharge data in 1.28607
----- Wells -----
Reading TLRData/WELLS/TLR_Wells.mnts
Read Wells in 0.0147367
----- URFs -----
Reading TLRData/URFS/TLR_Urfs.h5
Read URFS in 0.43715
----- Well sources -----
-----1000-----
0 | 0
----- NO3 Loading -----
Read Nload from TLRData/NO3LOAD/TLR_Load_A.h5 in 0.0726749
Reading TLRData/NO3LOAD/TLR_Load_B.idxLu
Reading TLRData/NO3LOAD/TLR_Load_B.nload
Read Nload from TLRData/NO3LOAD/TLR_Load_B in 1.00255
Reading TLRData/NO3LOAD/TLR_Load_C.h5
Read data from TLRData/NO3LOAD/TLR_Load_C.h5 in 0.0756386
Read Loading maps in 1.15477

=====
Mantis Server is Ready...
Version: 2.2.08
IP: 127.0.0.1
PORT: 1234
```



Mantis
(Greek: oracle, seer, prophet)

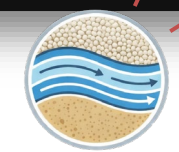


```
In [15]: btc_load_A, tf = mnts.run_mantis(scenario)
```

Python

```
In [11]: [btc_historic, tf] = runMantis(scenario);
```

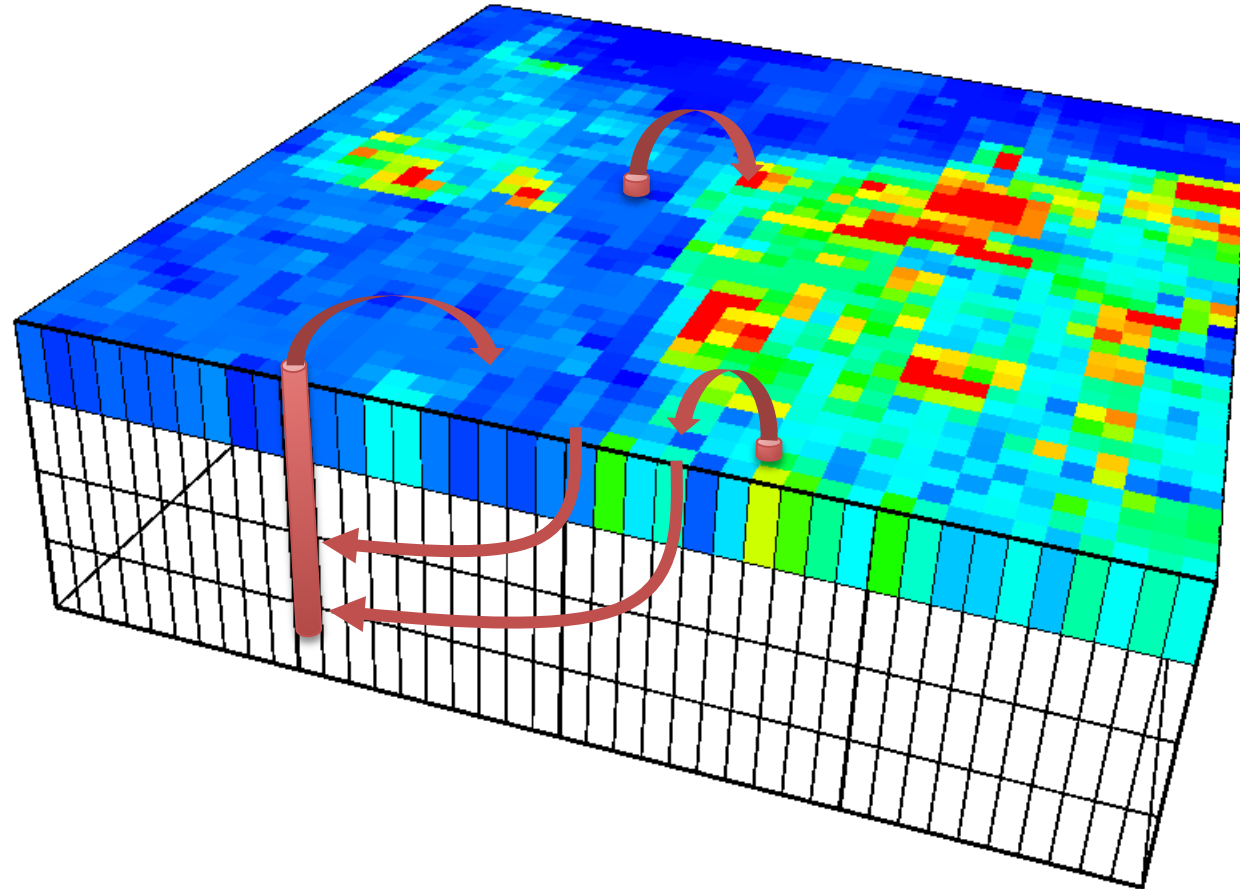
Matlab



CV-NPSAT data available upon request

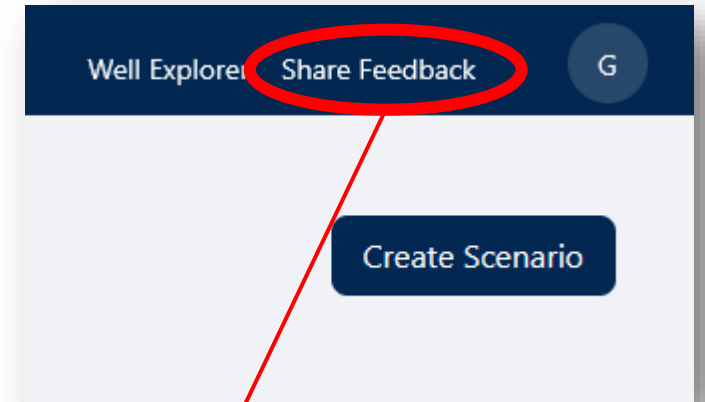
Future Developments for NPSAT and CV-NPSAT

- Simulation of Salt Transport (ongoing)
 - Development of **MantisSA**, a standalone application for simulating salinity transport.
 - The model explicitly accounts for feedback mechanisms between salinity and groundwater system dynamics.



Future Developments for NPSAT and CV-NPSAT

- Update of NPSAT Flow and Transport code
 - Finite Elements => Hybridized Mixed Finite Elements
 - Simulation of wellbore flow
 - Streamline transport through well boreholes
- Investigate possibility to simulate transient state conditions (cyclical)
- Wellbore flow in abandoned wells
- Update Recharge and Pumping redistribution
- Update CVHM2 based NPSAT
- Develop C2VSim v1.5 based NPSAT
- Consider the latest Groundwater Sustainability Plans to update flow simulation (natural recharge, MAR, pumping, aquifer properties)

A screenshot of a feedback form. The form has a blue header with the text 'Share your feedback - We'd love to hear your thoughts, questions, or suggestions.' Below the header, there is a dropdown menu for 'Feedback Type' with the placeholder text 'Select a feedback category'. Below that is a text area for '* Message' with the placeholder text 'Add your message here...' and a character count '0 / 1000'. At the bottom, there is a 'Contact Info' section with the text '(If you would like to be contacted regarding this feedback, please leave your contact info. Our team will get back to you as soon as possible.)' and two input fields for 'Name:' and 'Email:'. A dark blue 'Submit Feedback' button is located at the bottom right of the form.

CV-NPSAT_{web}

UCDAVIS

1. A quick look at how this tool works –
we will do a more detailed step-by-step later

Recap: CV-NPSAT combines our knowledge about:



SOURCES of nonpoint source pollution – specifically of **nitrate**



PATHWAYS (including travel times!) in the **unsaturated zone** and in the large alluvial **aquifer** of the Central Valley

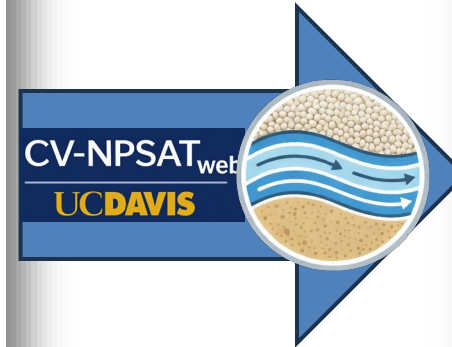
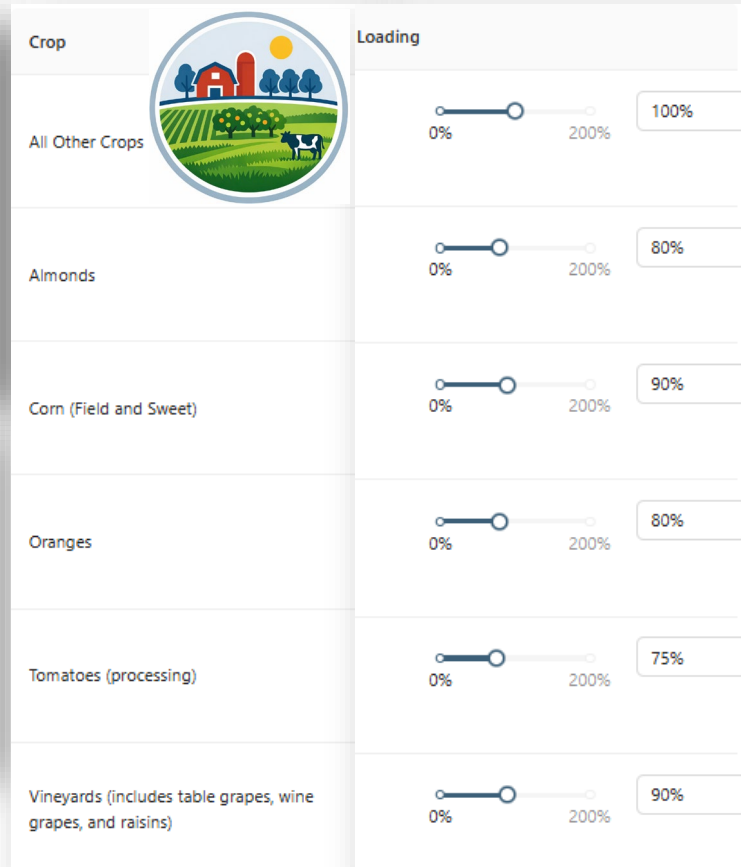
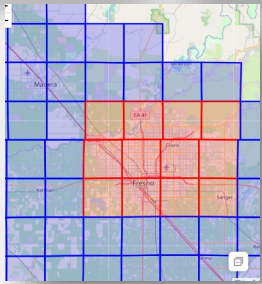
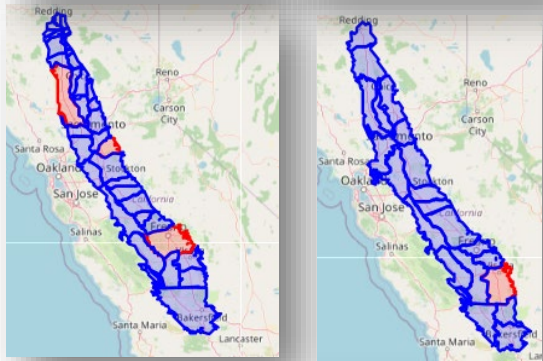
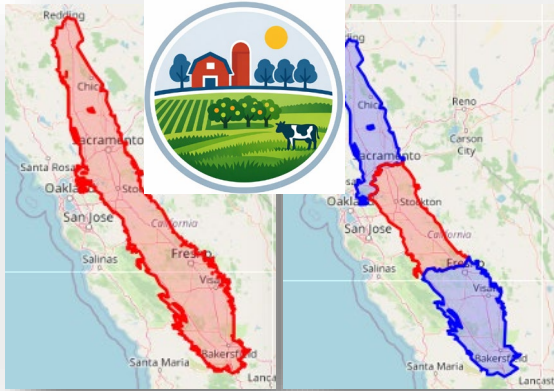


RECEPTORS: the location, depth, and screen length of **wells** and how much water they pump

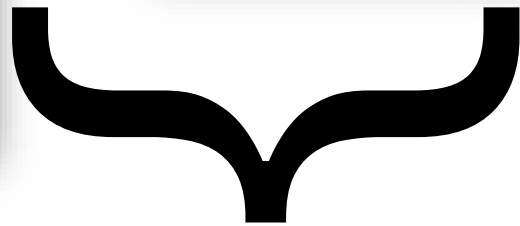
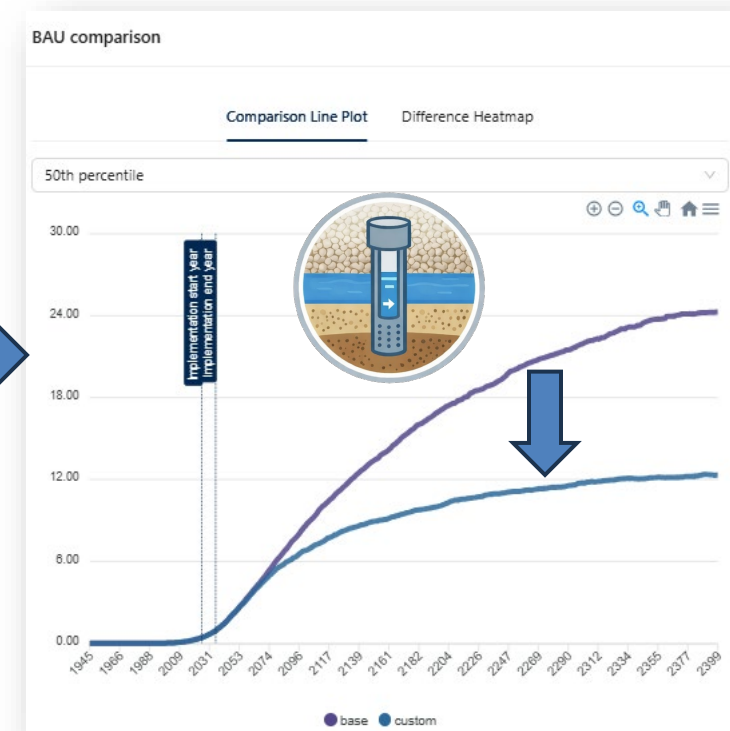
Note: this includes knowledge – at sources, pathways, and receptors - about

water **flow rates and volumes** and about
pollutant **mass and concentrations**

Recall: This is the kind of assessment that can be done with CV-NPSATweb!



Web
Back-end
Engine



User specified / User Choice

Prediction (Estimate)

2. A quick review of what you may want to do with this.

- **What is the contribution of crop X to nitrate in wells of my area-of-interest?**
 - Consider turning N loading from “all other crops” to zero, but keep crop X at 100%
 - This will show the incremental nitrate concentration increase from crop X only
 - Consider turning N loading from crop X to 0%, but keep “all other crops” at 100%:
 - This will show how much different nitrate would be in wells if places where crop X is currently grown had no nitrate in recharge (but the recharge itself were to continue to occur)

2. A quick review of what you may want to do with this.

- **What will it take to get nitrate-N in 50% (75%, 90%, ...) to below the drinking water limit of 10 mg N/L?**
 - Adjusting the N loading from various crops until the desired target concentration is achieved in 50%, 75%, 90%, ... of wells in the area-of-interest
 - **Note 1:** this tool will assume that recharge – including return-flows from irrigation – will not change under any of these future scenarios, which may not be realistic to achieve certain larger levels of leaching reductions
 - **Note 2:** Achieving nitrate leaching reductions, even to 90% or 80% of current loading in agricultural landscapes requires extensive training, outreach, education of growers and farm staff, technical innovations, and potentially costly capital and capacity building investments by landowners/growers. We have only very, very limited economic guidelines on that.

2. A quick review of what you may want to do with this.

- **What water quality improvements can be achieved** if crop X in my area-of-interest achieves a load reduction to a realistic fraction of current loading (typically in the range from 75% to 95%)?
- (A similar question, perhaps posed by a grower): Based on INMP data, my own N surplus (“A – R”) is X% of the average. **If all my colleagues were able to operate similar to how I grow crop X, what would that mean with respect to long-term changes in groundwater nitrate?**

3. Finally – the detailed instructions!

IMPORTANT NOTE:

You will not be able to do this on your own screen until early next week!!

<https://NPSAT.ucdavis.edu> is locked to avoid overload.

Why? When you run a scenario, your job is put into a queue on our UC Davis server. If several tens of you – or all of you – will all launch a job, each lasting 1 minute, then we'll all be waiting here for a long time! 😊

- Thank you for understanding.

Login

- Registering yourself as a new user with your email
 - Depending on usage, we may need to manage access in the future
- Login
- Forgot Password

CV-NPSAT_{web}
UCDAVIS
Non Point Source Assessment Tool

Email

Password

Log in

[Register now](#) or [forgot password](#)

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thharter@ucdavis.edu

.....

Log in

[Register now](#) or [forgot password](#)

Login

- Registering yourself as a new user with your email
 - Depending on usage, we may need to manage access in the future
- Login
- Forgot Password

CV-NPSAT_{web}
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User Agreement & Disclaimer

Welcome to CV-NPSAT Web

Before continuing, please review the following information:

- The Nonpoint Source Assessment Toolbox (NPSAT) is a groundwater modeling framework designed to evaluate the fate and transport of nonpoint source (NPS) contaminants such as nitrate and salts leaching to groundwater from agricultural, urban, and natural land uses. Its primary application is to assess groundwater quality in irrigation, public, and domestic supply wells.
- The NPSAT framework – in contrast to other groundwater flow and transport models - is designed specifically (a) for high-resolution nonpoint source contaminant transport across entire groundwater (sub)basins and (b) to facilitate “on-the-fly” evaluation of dozens, hundreds, or thousands of different user-designed nonpoint source contaminant leaching future scenarios. These scenarios represent user-selected application of alternative source management practices associated with user-selected specific land uses and/or crops.

By clicking “I Agree”, you confirm that you have read and understood this information:

I Agree

Home screen

CV-NPSAT_{web}
UC DAVIS
T

Home

Create Scenario

Scenario Type:

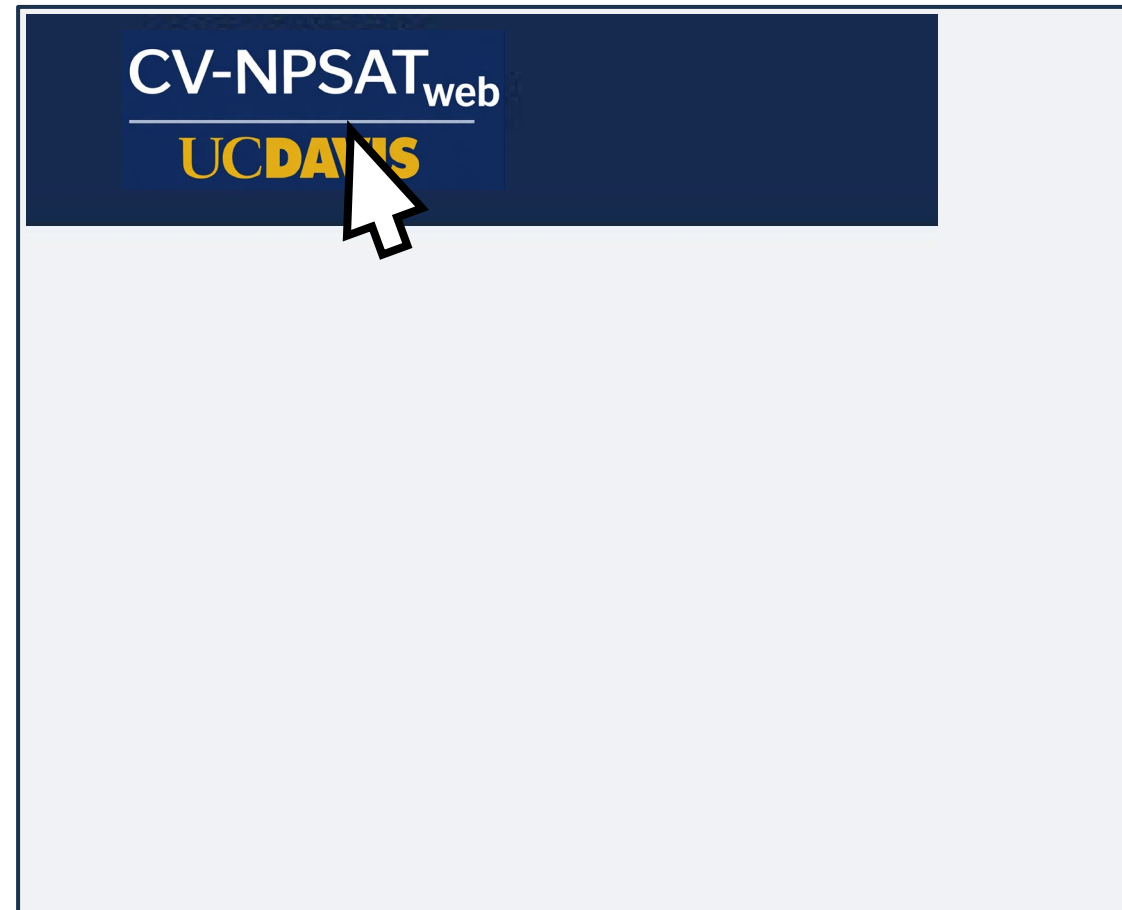
🔍 You may select two or more models to compare. Maximum of 32.
Compare Scenario

<input type="checkbox"/>	Scenario Name	Description	Flow Scenario	Load Scenario	Unsat Scenario	Well Type Scenario	Year Range	Implementation Start Year	Implementation Complete Year	Water Content	Porosity	Date Created	Simulator Version	Actions
<input type="checkbox"/>	Test		C2VSIM with Pumping adjusted to match the Recharge	GNLM Full	C2VSIM Typical vadose zone thickness	Domestic Wells	1945 - 2100	2026	2036	10%	10%	2026-03-16	2.2.11	Edit Delete
<input type="checkbox"/>	TLB-CVpN-VD-default BAU		CVHM2 with Pumping adjusted to match the Recharge	GNLM No	CVHM2 Typical vadose zone thickness	Domestic Wells	1945 - 2400	2026	2036	20%	20%	2026-03-16	2.2.11	Edit Delete
<input type="checkbox"/>	TLB-CVpH-VD-Default BAU		CVHM2 with Pumping adjusted to match the Recharge	GNLM Half	CVHM2 Typical vadose zone thickness	Domestic Wells	1945 - 2400	2026	2036	20%	20%	2026-03-16	2.2.11	Edit Delete
<input type="checkbox"/>	TLB-CVpF-VD-default BAU		CVHM2 with Pumping adjusted to match the Recharge	GNLM Full	CVHM2 Typical vadose zone thickness	Domestic Wells	1945 - 2400	2026	2036	20%	20%	2026-03-16	2.2.11	Edit Delete
<input type="checkbox"/>	TLB-C2pN-VD-default BAU		C2VSIM with Pumping adjusted to match the Recharge	GNLM No	C2VSIM Typical vadose zone thickness	Domestic Wells	1945 - 2400	2026	2036	20%	20%	2026-03-16	2.2.11	Edit Delete
<input type="checkbox"/>	TLB-C2pH-VD-default BAU		C2VSIM with Pumping adjusted to match the Recharge	GNLM Half	C2VSIM Typical vadose zone thickness	Domestic Wells	1945 - 2400	2026	2036	20%	20%	2026-03-16	2.2.11	Edit Delete
<input type="checkbox"/>	TLB-C2pF-VD-default BAU		C2VSIM with Pumping adjusted to match the Recharge	GNLM Full	C2VSIM Typical vadose zone thickness	Domestic Wells	1945 - 2400	2026	2036	20%	20%	2026-03-16	2.2.11	Edit Delete
<input type="checkbox"/>	Kaweah-CVpG-VI-MiscReductions V2.2.11B	check against old version "100-400m", dairy crop reduced to 30% and others to 50%	CVHM2 with Pumping adjusted to match the Recharge	GNLM Full	CVHM2 Typical vadose zone thickness	Public Supply Wells and Irrigation Wells	1945 - 2400	2026	2036	20%	40%	2026-03-10	2.2.11	Edit Delete
<input type="checkbox"/>	Hilmar-CVpG-VD-10%CornGrainSudan V2.2.11B	An evaluation of large reductions in manure loading.	CVHM2 with Pumping adjusted to match the Recharge	GNLM Full	CVHM2 Typical vadose zone thickness	Domestic Wells	1945 - 2400	2026	2036	20%	40%	2026-03-10	2.2.11	Edit Delete
<input type="checkbox"/>	SAC-CVpG-VD V2.2.11B	BAU for reference/comparison, CVHM2pump-adjusted, GNLMfull, 40p/20wc	CVHM2 with Pumping adjusted to match the Recharge	GNLM Full	CVHM2 Typical vadose zone thickness	Domestic Wells	1945 - 2400	2025	2035	20%	40%	2026-03-10	2.2.11	Edit Delete

< 1 2 3 4 5 6 >
10 / page

Home screen: how to get here any time

- You can always go back to the home screen by clicking the CV-NPSAT icon in the upper left corner of the screen
- You can open the tool in more than one browser tab, e.g., to look at your home-screen while you are working on creating a scenario on the first tab



Home screen: how to create a new scenario

CV-NPSAT_{web}
UC DAVIS

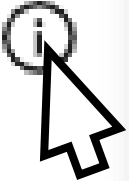
Home

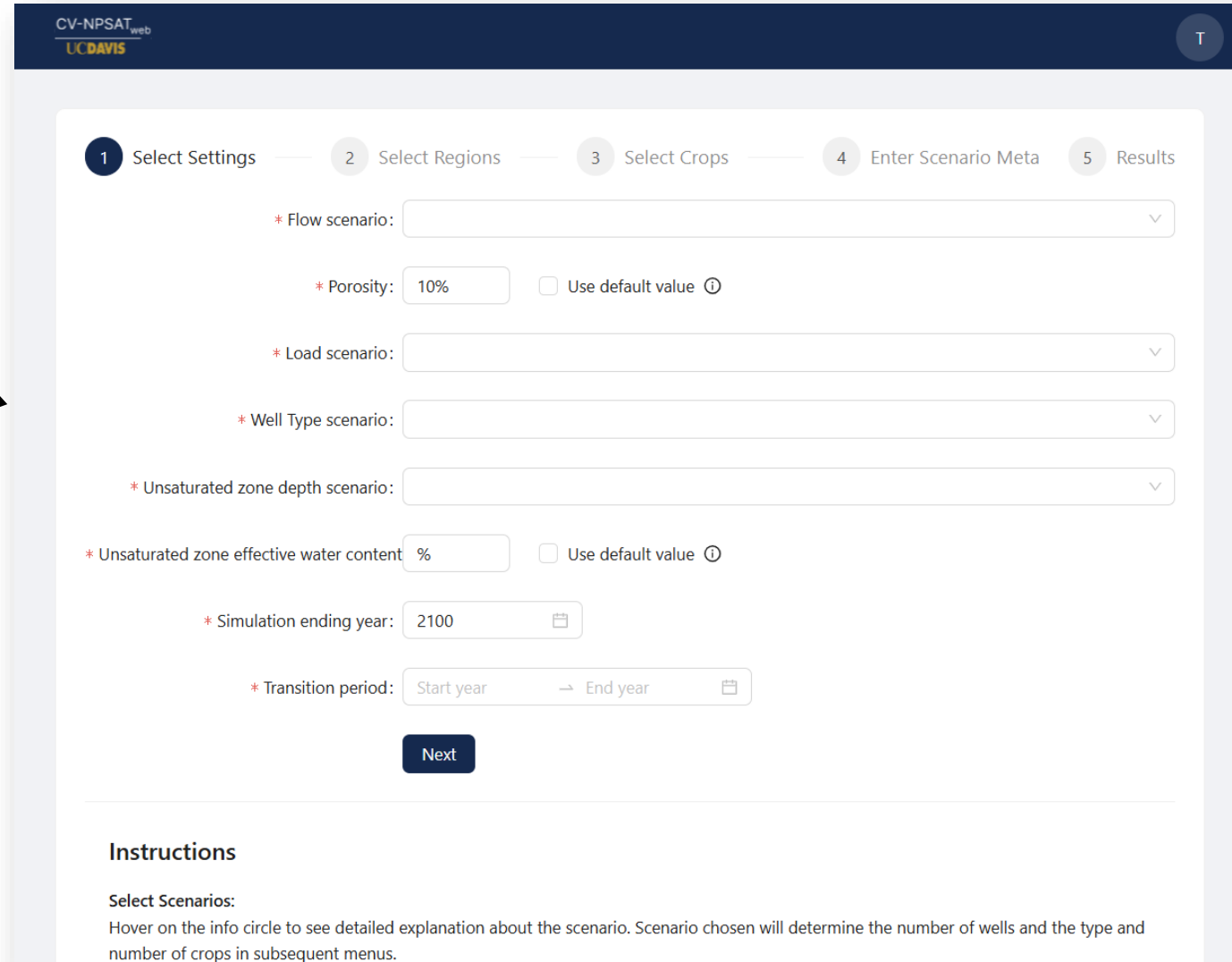
Scenario Type: Filter Scenarios

ⓘ You may select two or more models to compare. Maximum of 32. Compare Scenario

<input type="checkbox"/>	Scenario Name	Description	Flow Scenario	Load Scenario	Actions
<input type="checkbox"/>	Test		C2VSIM with Pumping adjusted to match the Recharge	GNLM Full	Edit Delete

1 Select Settings (for the scenario)

- On-screen instructions can be found in two places:
 - Bottom of the page in the “Instructions” section
 - Clicking on the information icon 
- This input screen allows users to select from various discrete options that affect:
 - Groundwater pumping and recharge
 - Groundwater flow direction
 - Groundwater velocity
 - Which type of wells to look at
 - How far into the future to simulate
 - How soon and over what period changes in loading occur



CV-NPSAT_{web}
UCDAVIS

1 Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

* Flow scenario:

* Porosity: Use default value ⓘ

* Load scenario:

* Well Type scenario:

* Unsaturated zone depth scenario:

* Unsaturated zone effective water content Use default value ⓘ

* Simulation ending year: ⓘ


* Transition period: → ⓘ

Next

Instructions

Select Scenarios:
Hover on the info circle to see detailed explanation about the scenario. Scenario chosen will determine the number of wells and the type and number of crops in subsequent menus.

1 Select Settings (for the scenario)

- Flow scenario choices:
 - Additional on-screen information is here 
 - CV-NPSAT includes four different **FLOW** models from which the user chooses one. Two of these are based on CVHM2 and two are based on C2VSIM (see earlier slides)
 - Using information from each of these two existing Central Valley flow models, CV-NPSAT has one with lower pumping (“pumping adjusted to match recharge”) and one with higher recharge (“recharge adjusted to match pumping”)

CV-NPSAT_{web}
UCDAVIS

1 Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

* Flow scenario:

* Porosity:

* Load scenario:

* Well Type scenario:

* Unsaturated zone depth scenario:

* Unsaturated zone effective water content: % Use default value

* Simulation ending year:

* Transition period: →

Next

1 Select Settings (for the scenario)

- Flow scenario choices:
 - What CV-NPSAT uses from either C2VSIM or CVHM:
 - Shape and form of the Central Valley aquifer system
 - Hydrogeologic properties (hydraulic conductivity, storage coefficient)
 - Total average pumping within each “Subregion” (= CVHM “Farm”)
 - Total average recharge within each “Subregion”
 - Long-term average stream-aquifer interaction
 - Long-term average mountain-front recharge and small watershed input

CV-NPSAT_{web}
UCDAVIS

1 Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

* Flow scenario:

* Porosity:

* Load scenario:

* Well Type scenario:

* Unsaturated zone depth scenario:

* Unsaturated zone effective water content: % Use default value ⓘ

* Simulation ending year: ⓘ

* Transition period: → ⓘ

Next

1 Select Settings (for the scenario)

- Flow scenario choices:
 - Remember that CV-NPSAT requires steady-state flow conditions (to allow for these very fast online simulations)!
 - Hence: total recharge to the aquifer must equal total discharge from the aquifer
 - The balance is achieved separately for the three “Basins” Sacramento Valley, San Joaquin Valley, Tulare Lake Basin

CV-NPSAT_{web}
UCDAVIS

1 Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

* Flow scenario:

* Porosity:

* Load scenario:

* Well Type scenario:

* Unsaturated zone depth scenario:

* Unsaturated zone effective water content: % Use default value

* Simulation ending year:

* Transition period: →

Next

1 Select Settings (for the scenario)

- Flow scenario choices:
 - Past flow conditions often have been driven by high pumping relative to recharge and relatively faster flow rates. This is perhaps best captured by the “recharge adjusted to match pumping” scenario, but may not be a good scenario to look 100 or more years into the future where overdraft has been very large, e.g., in the Tulare Lake Basin
 - For areas with future pumping significantly less to match recharge (including recharge from managed aquifer recharge, MAR), the “pumping adjusted to match recharge” may be a better tool for long-term predictions.

CV-NPSAT_{web}
UCDAVIS

1 Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

* Flow scenario:

* Porosity:

* Load scenario:

* Well Type scenario:

* Unsaturated zone depth scenario:

* Unsaturated zone effective water content: % Use default value ⓘ

* Simulation ending year: ⓘ

* Transition period: → ⓘ

Next

1 Select Settings (for the scenario)

- Porosity:
 - Refers to the effective porosity of the aquifer for nitrate transport in groundwater
 - The smaller the porosity, the faster average groundwater pore velocity. For example, at 10% porosity, transport will be twice as fast as at 20% porosity, and three times as fast as at 30% porosity.
 - Selecting the default values reflects the calibrated values of porosity, found by matching age tracer data to simulation results

CV-NPSAT_{web}
UC DAVIS

1 Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

* Flow scenario:

* Porosity: 20% Use default value ⓘ

* Load scenario:

* Well Type scenario:

* Unsaturated zone depth scenario:

* Unsaturated zone effective water content: % Use default value ⓘ

* Simulation ending year: 2100

* Transition period: Start year → End year

Next

1 Select Settings (for the scenario)

- Load Scenario
 - This affects the amount of manure-related nitrogen that is assumed to reach the aquifer.
 - “GNLM Full” refers to the original GNLM estimates for manure-related N cycling ([Harter et al., 2017](#))
 - “GNLM Half” cuts the original amount of manure N that is exported or land-applied in half; it is approximately reflective of grower-reported land-application; and leads to an overall better (but not perfect) match to historic and recent groundwater nitrate, compared to “Full”
 - “GNLM No” is a hypothetical loading scenario assuming no animal manure N is used

CV-NPSAT_{web}
UCDAVIS

1 Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

* Flow scenario:

* Porosity: Use default value ⓘ

* Load scenario:

* Well Type scenario:

* Unsaturated zone depth scenario:

* Unsaturated zone effective water content: Use default value ⓘ

* Simulation ending year: ⓘ

* Transition period: → ⓘ

Next

1 Select Settings (for the scenario)

- Well Type Scenario
 - CV-NPSAT allows users to only simulate one or the other group of wells:
 - Domestic wells (from the DWR well database, limited to those younger than 40 years)
 - Large production wells (from DWR well database, limited to those younger than 35 years). These are known irrigation wells and public supply wells
 - Domestic wells have very small pumping rates compared to irrigation and public supply wells are mostly screened in the shallower parts of the aquifer (younger groundwater)

CV-NPSAT_{web}
UCDAVIS

1 Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

* Flow scenario:

* Porosity: Use default value ⓘ

* Load scenario:

* Well Type scenario:
 Domestic Wells ⓘ
 Public Supply Wells and Irrigation Wells ⓘ
 Virtual Shallow Monitoring Well Network Grid ⓘ

* Unsaturated zone depth scenario:

* Unsaturated zone effective water content:

* Simulation ending year: ⓘ

* Transition period: → ⓘ

Next

1 Select Settings (for the scenario)

- Unsaturated Zone Depth Scenario
 - Best to choose the one matching the “Flow scenario”:
 - CVHM2 for CVHM2
 - C2VSIM for C2VSIM
 - Affects the unsaturated zone travel time
 - Maps with detailed information on unsaturated zone thickness, travel time, and recharge for these two cases can be found here:
 - <https://giorgk.users.earthengine.app/view/cv-unsat>

CV-NPSAT_{web}
UC DAVIS

1 Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

* Flow scenario:

* Porosity: Use default value ⓘ

* Load scenario:

* Well Type scenario:

* Unsaturated zone depth scenario:

* Unsaturated zone effective water content:

* Simulation ending year: ⓘ

* Transition period: → ⓘ

Next

1 Select Settings (for the scenario)

- Unsaturated Zone Effective Water Content
 - Refers to the effective water content of the unsaturated zone for nitrate transport in groundwater
 - The smaller the water content, the faster the vadose zone travel time. For example, at 5% water content, transport will be twice as fast as at 10% water content, and four times as fast as at 20% water content.
 - Selecting the default values reflects the calibrated values of porosity, found by matching age tracer data to simulation results

CV-NPSAT_{web}
UCDAVIS

1 Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

* Flow scenario:

* Porosity: Use default value ⓘ

* Load scenario:

* Well Type scenario:

* Unsaturated zone depth scenario:

* Unsaturated zone effective water content: Use default value ⓘ

* Simulation ending year: ⓘ

* Transition period: → ⓘ

Next

1 Select Settings (for the scenario)

- Simulation Ending Year:
 - Type the year manually or select from the list.
 - The transport simulation always begins in the year 1945 AD and assumes that nitrate concentration in groundwater at that time were negligible.
 - The maximum period through which the scenario can be simulated is the year 2444 AD (over 400 years from now).
 - The online execution time is nearly proportional to the how long the simulated period is.
 - The scenario always assumes that future conditions stay constant at the user-defined loading rate, after the end of the transition period (next input box)

The screenshot shows the 'Select Settings' step of the CV-NPSAT web interface. The 'Simulation ending year' field is set to 2400, and a dropdown menu is open showing a grid of years from 2399 to 2410. A mouse cursor is pointing at the year 2400 in the dropdown.

Instructions

Select Scenarios:
Hover on the info circle to see detailed e... n will determine the number of wells and the type and number of crops in subsequent menus.

Simulation ending year:
Enter the last year of the scenario simulation run. By default, this will be the year 2100. It can be no later than the year 2500.

1 Select Settings (for the scenario)

- Transition Period:
 - Type the start and end year of the transition period manually or select from the list or swipe over the period with the mouse while holding down the left mouse button.
 - Over the transition period, the user-defined N loading (later screen) will gradually take effect over the 2020 business-as-usual (BAU) conditions.
 - A linear decrease/increase from the BAU to the user-defined conditions occurs during the transition period

CV-NPSAT_{web}
UC DAVIS

1 Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

* Flow scenario:

* Porosity: Use default value ⓘ

* Load scenario:

* Well Type scenario:

* Unsaturated zone depth scenario:

* Unsaturated zone effective water content: % Use default value ⓘ

* Simulation ending year: ⓘ

* Transition period: → ⓘ

2020-2029			2030-2039			>>
2019	2020	2021	2029	2030	2031	
2022	2023	2024	2032	2033	2034	
2025	2026	2027	2035	2036	2037	
2028	2029	2030	2038	2039	2040	

Instructions

Select Scenarios:
Hover on the info circle to see detailed e...
number of crops in subsequent menus.

Simulation ending year:
Enter the last year of the scenario simula...

Transition period:
This is the beginning year and final year of the transition from the current Business As Usual (BAU) to the new nitrate loading scenario.

1 Select Settings (for the scenario)

- Click “Next” to advance to the next screen

CV-NPSAT_{web}
UCDAVIS

1 Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

* Flow scenario: C2VSIM with Pumping adjusted to match the Recharge ⓘ

* Porosity: % Use default value ⓘ

* Load scenario: GNLM Full ⓘ

* Well Type scenario: Domestic Wells ⓘ

* Unsaturated zone depth scenario: C2VSIM Typical vadose zone thickness ⓘ

* Unsaturated zone effective water content: % Use default value ⓘ

* Simulation ending year: 2400 ⓘ

* Transition period: 2026 → 2036 ⓘ

Next

2 Select the area of interest

- This is the screen as it appears when default values have been selected for porosity and/or water content
- Everything in blue is *not* selected (on the initial screen nothing in the Central Valley is selected)
- Zoom in/out tools and background map layer selection can be used
- The number of wells in the selected area-of-interest will be displayed below the map
- On-screen instructions are located below the map

CV-NPSAT_{web}
UC DAVIS

✓ Select Settings — 2 Select Regions — 3 Select Crops — 4 Enter Scenario Meta — 5 Results

i Using Default Values from Mantis
Porosity value selected: -
Unsaturated zone effective water content value selected: -

Central Valley Basin County B118 Basin Subregions Township

* Region:

Number of Wells Selected: 0

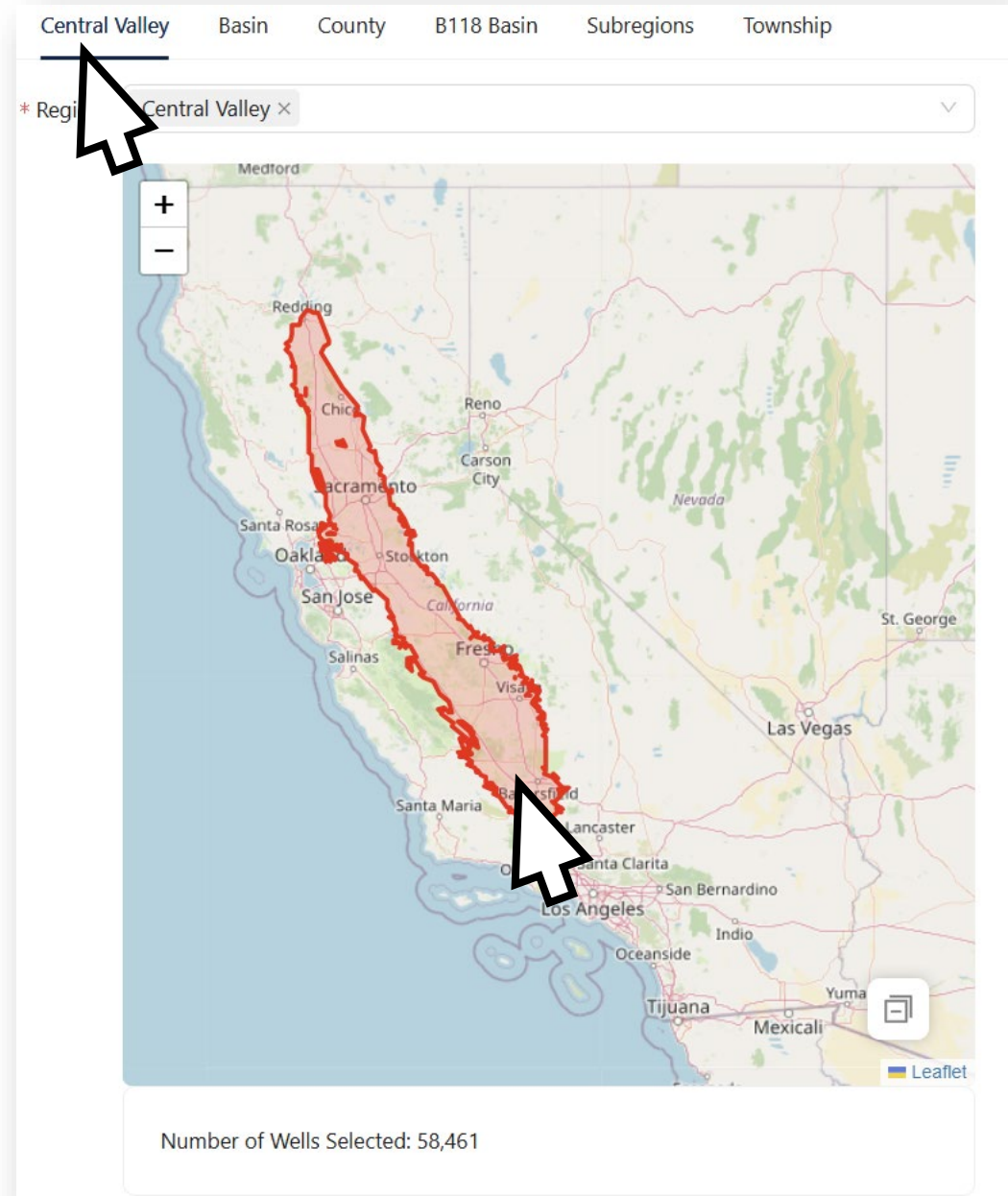
Advanced filter: off

Prev Next

Instructions

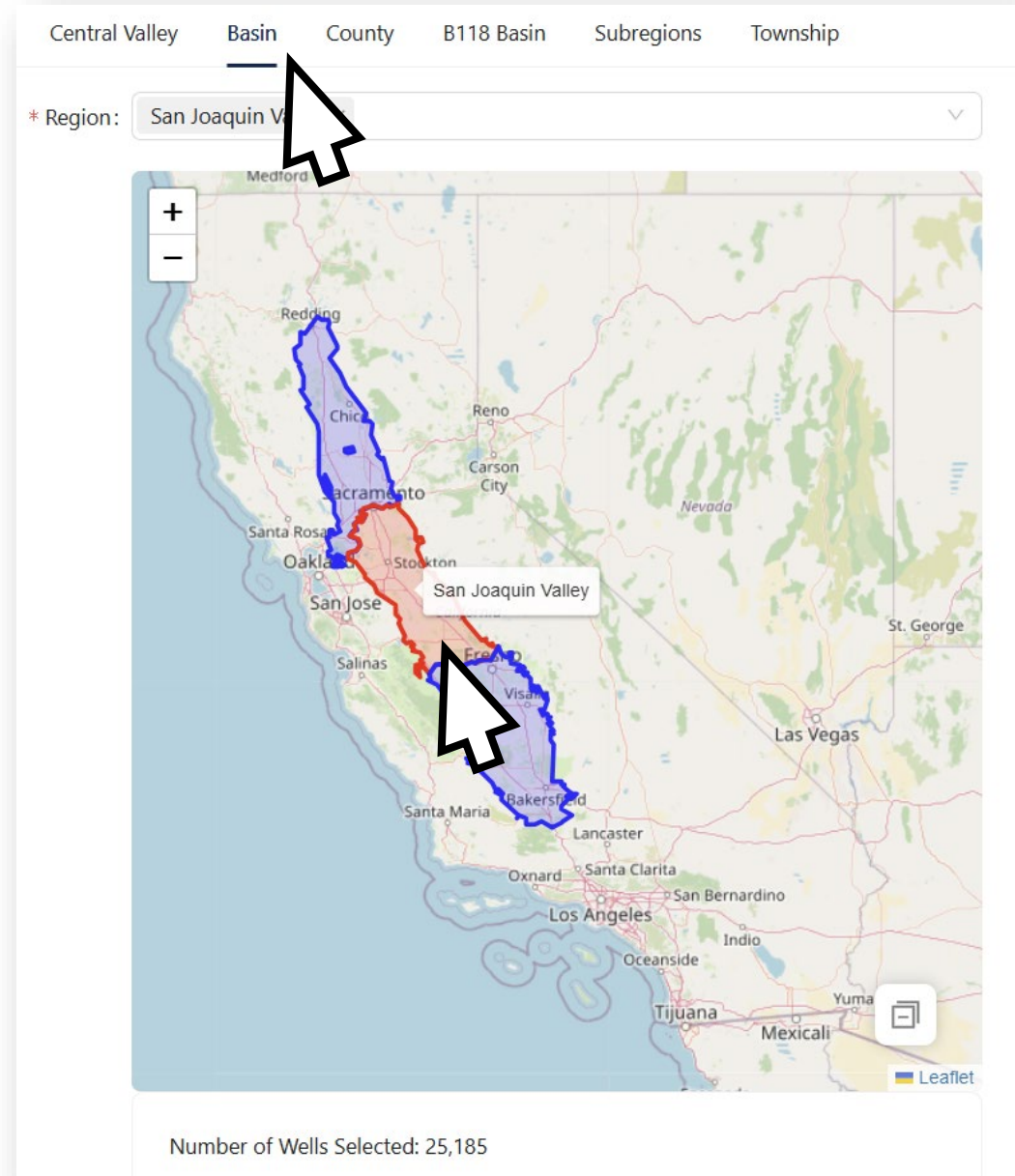
2 Select the area of interest

- First, from the six tabs above the map, select the type of area-of-interest you want to choose.
- An area-of-interest can be one of six types:
 - Central Valley-wide
- Second, click on the Central Valley on the map to select the entire Central Valley



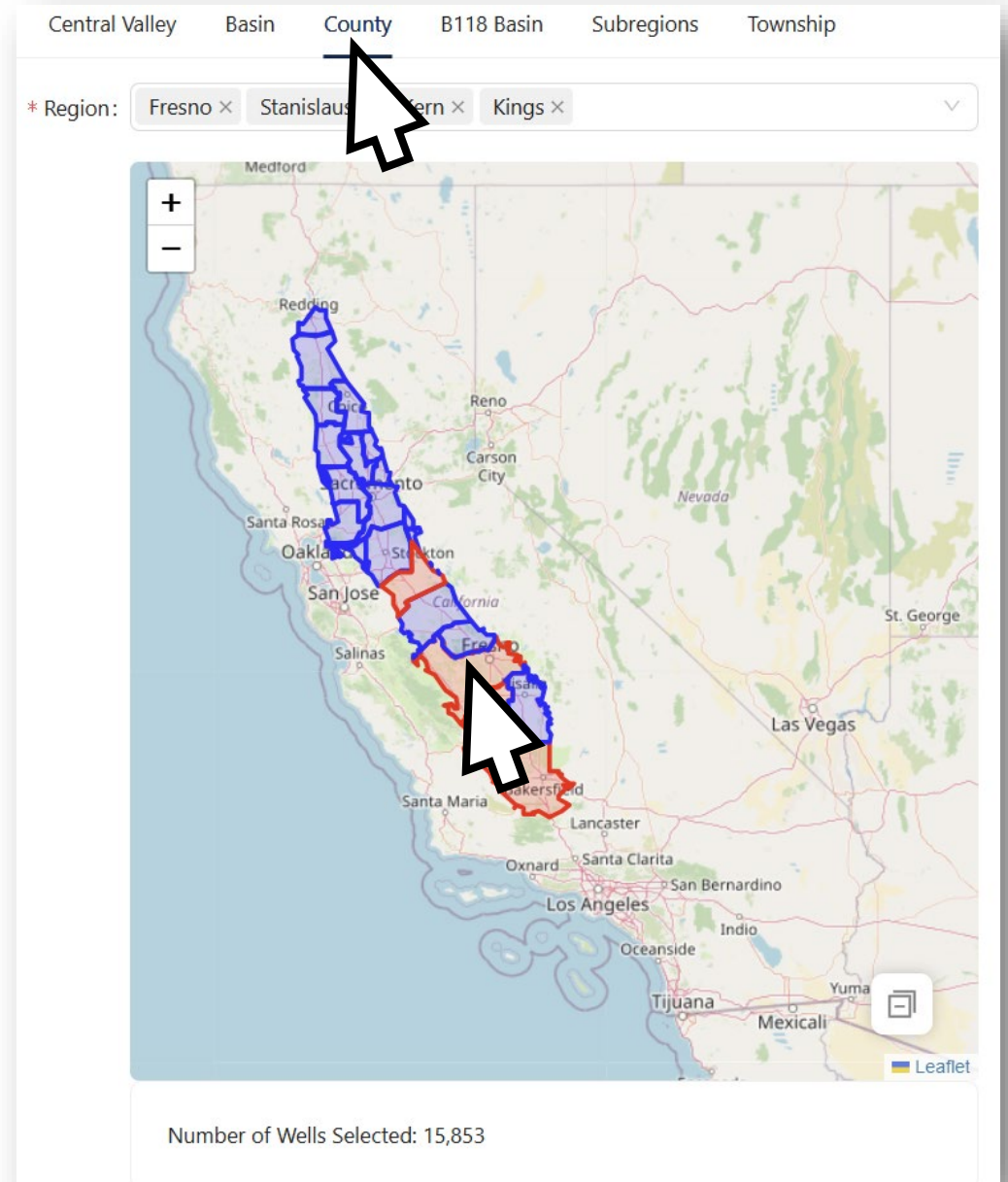
2 Select the area of interest

- First, from the six tabs above the map, select the type of area-of-interest you want to choose.
- An area-of-interest can be one of six types:
 - Central Valley-wide
 - Basin (Sacramento Valley, San Joaquin Valley, Tulare Lake Basin)
- Second, click on the map to select the basin that is the area-of-interest (one or two or three of these basins)



2 Select the area of interest

- First, from the six tabs above the map, select the type of area-of-interest you want to choose.
- An area-of-interest can be one of six types:
 - Central Valley-wide
 - Basin (Sacramento Valley, San Joaquin Valley, Tulare Lake Basin)
 - County
- Second, click on the map to select the basin that is the area-of-interest (one or several)



2 Select the area of interest

- First, from the six tabs above the map, select the type of area-of-interest you want to choose.
- An area-of-interest can be one of six types:
 - Central Valley-wide
 - Basin (Sacramento Valley, San Joaquin Valley, Tulare Lake Basin)
 - County
 - B118 Basin (SGMA groundwater basins as defined by California Dept. of Water Resources)

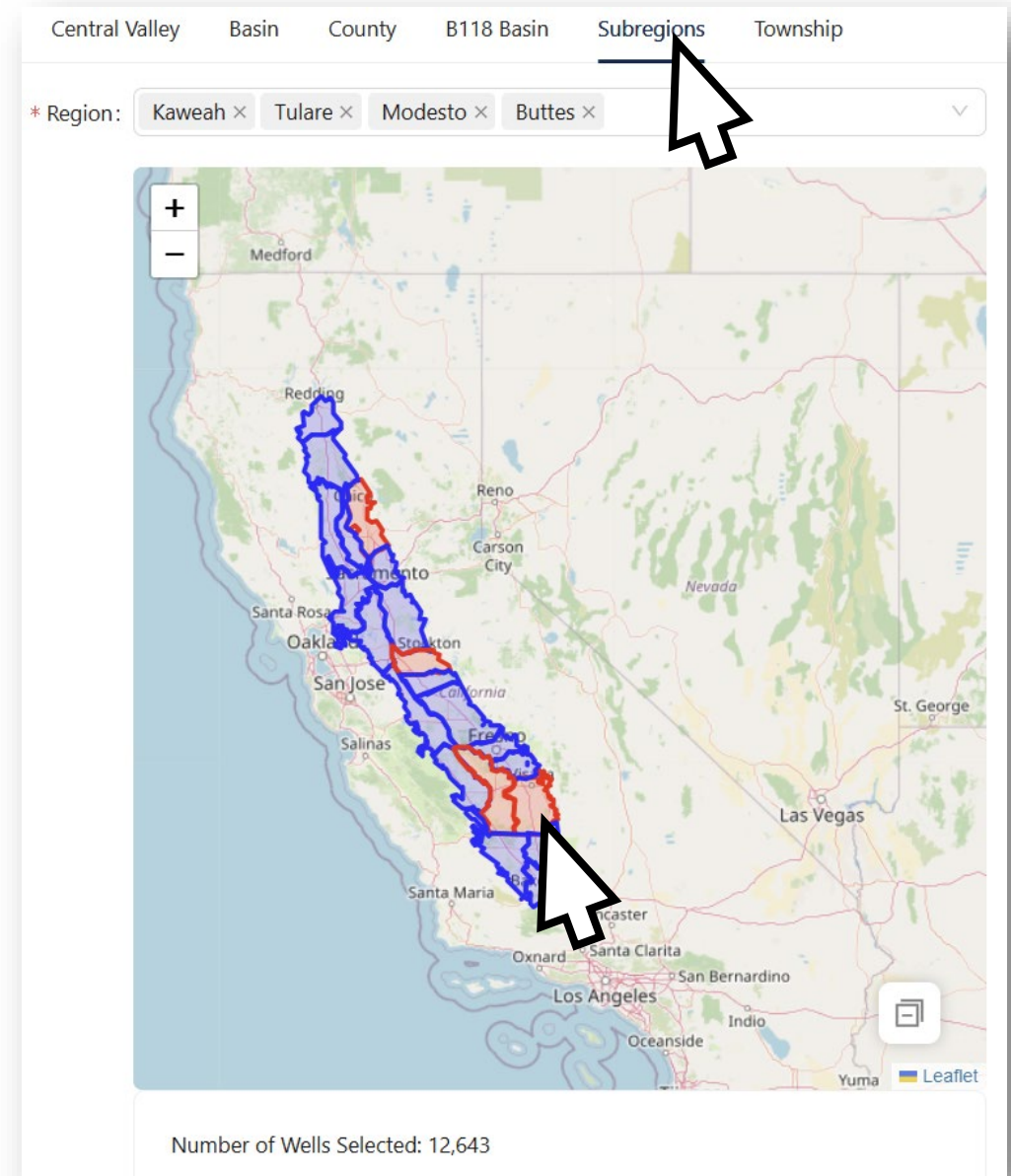
Central Valley Basin County **B118 Basin** Subregions Township

Region: TULE x TULARE LAKE x CHOWCHILLA x MODESTO x WEST BUTTE x EAST BUTTE x

Number of Wells Selected: 5,837

2 Select the area of interest

- First, from the six tabs above the map, select the type of area-of-interest you want to choose.
- An area-of-interest can be one of six types:
 - Central Valley-wide
 - Basin (Sacramento Valley, San Joaquin Valley, Tulare Lake Basin)
 - County
 - B118 Basin (SGMA groundwater basins as defined by California Dept. of Water Resources)
 - Subregions, as defined by C2VSIM and CVHM2 (formerly known in CVHM as “farms”), which are used for water accounting purposes by these models



2 Select the area of interest

- First, from the six tabs above the map, select the type of area-of-interest you want to choose.
- An area-of-interest can be one of six types:
 - Central Valley-wide
 - Basin (Sacramento Valley, San Joaquin Valley, Tulare Lake Basin)
 - County
 - B118 Basin (SGMA groundwater basins as defined by California Dept. of Water Resources)
 - Subregions, as defined by C2VSIM and CVHM2 (formerly known in CVHM as “farms”), which are used for water accounting purposes by these models
 - Townships, which are surveying units that have an area of approximately 36 square miles each. A township consists of 36 (6 by 6) “sections” each of which is about one square mile. For example, many of California’s cities have major city roadways following the boundaries of these sections.

Central Valley Basin County B118 Basin Subregions Township

Region: M13S23E × M14S22E × M15S21E × M14S21E × M15S22E ×
M14S23E × M16S19E ×

Number of Wells Selected: 1,541

2 Select the area of interest

- Note how the “Number of Wells Selected”, below the map, changes as the area-of-interest changes. This reflects the number of wells in the area-of-interest (in this case: domestic wells, selected as an option on the previous screen)

Central Valley Basin County B118 Basin Subregions Township

* Region: TULE × TULARE LAKE × CHOWCHILLA × MODESTO × WEST BUTTE × EAST BUTTE ×

Central Valley

* Region: k

Number of Wells Selected: 5,837

Number of Wells Selected: 12,643

Number of Wells Selected: 1,541

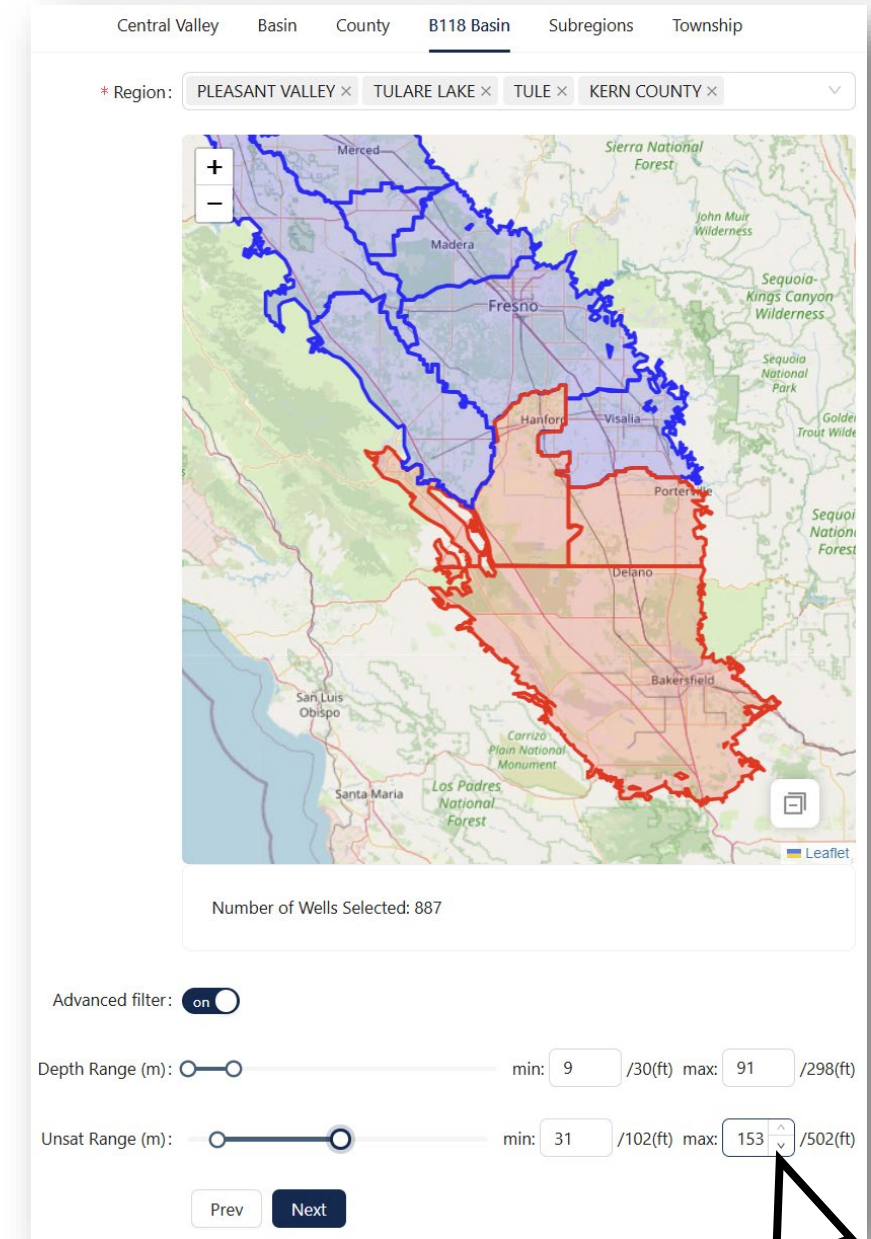
2 Select the area of interest

- Once the area-of-interest is selected, the user can also select wells with specific characteristics:
 - Wells with a total depth (m) ranging from a user-specified minimum to a user-specified maximum
 - Wells with an unsaturated zone thickness (m) ranging from a user-specified minimum to a user-specified maximum

The screenshot shows a web application interface for selecting wells. At the top, there are navigation tabs: Central Valley, Basin, County, B118 Basin, Subregions, and Township. Below these, a dropdown menu shows the selected region: PLEASANT VALLEY, TULARE LAKE, TULE, and KERN COUNTY. The main part of the interface is a map of the Central Valley region, with a red outline indicating the selected area of interest. The map includes labels for various locations such as Merced, Madera, Fresno, Hanford, Visalia, Porterville, Delano, Bakersfield, San Luis Obispo, Santa Maria, Los Padres National Forest, Carrizo Plain National Monument, Sierra National Forest, John Muir Wilderness, Sequoia-Kings Canyon Wilderness, Sequoia National Park, and Golden Trout Wildlife Area. A zoom control is visible on the left side of the map. Below the map, a box displays "Number of Wells Selected: 3,356". At the bottom, there is an "Advanced filter" section with a toggle switch that is currently turned on. Below the toggle, there are two range sliders: "Depth Range (m)" with a minimum of 9 /30(ft) and a maximum of 564 /1850(ft), and "Unsat Range (m)" with a minimum of 1 /3(ft) and a maximum of 299 /981(ft). A mouse cursor is pointing at the "Advanced filter" toggle. At the very bottom, there are "Prev" and "Next" buttons.

2 Select the area of interest

- Once the area-of-interest is selected, the user can also select wells with specific characteristics:
 - Wells with a total depth (m) ranging from a user-specified minimum to a user-specified maximum
 - Wells with an unsaturated zone thickness (m) ranging from a user-specified minimum to a user-specified maximum
- You can use the slider or manually enter the numbers on the right.
- Note that you enter these numbers in meters (“m”). The corresponding numbers in “ft” are given next to the selected “m”.



3 Select the crops for which to adjust N loading

CV-NPSAT_{web}
UCDAVIS

Select Settings
 Select Regions
 3 Select Crops
 4 Enter Scenario Meta
 5 Results

* Crop(s): All Other Crops ×

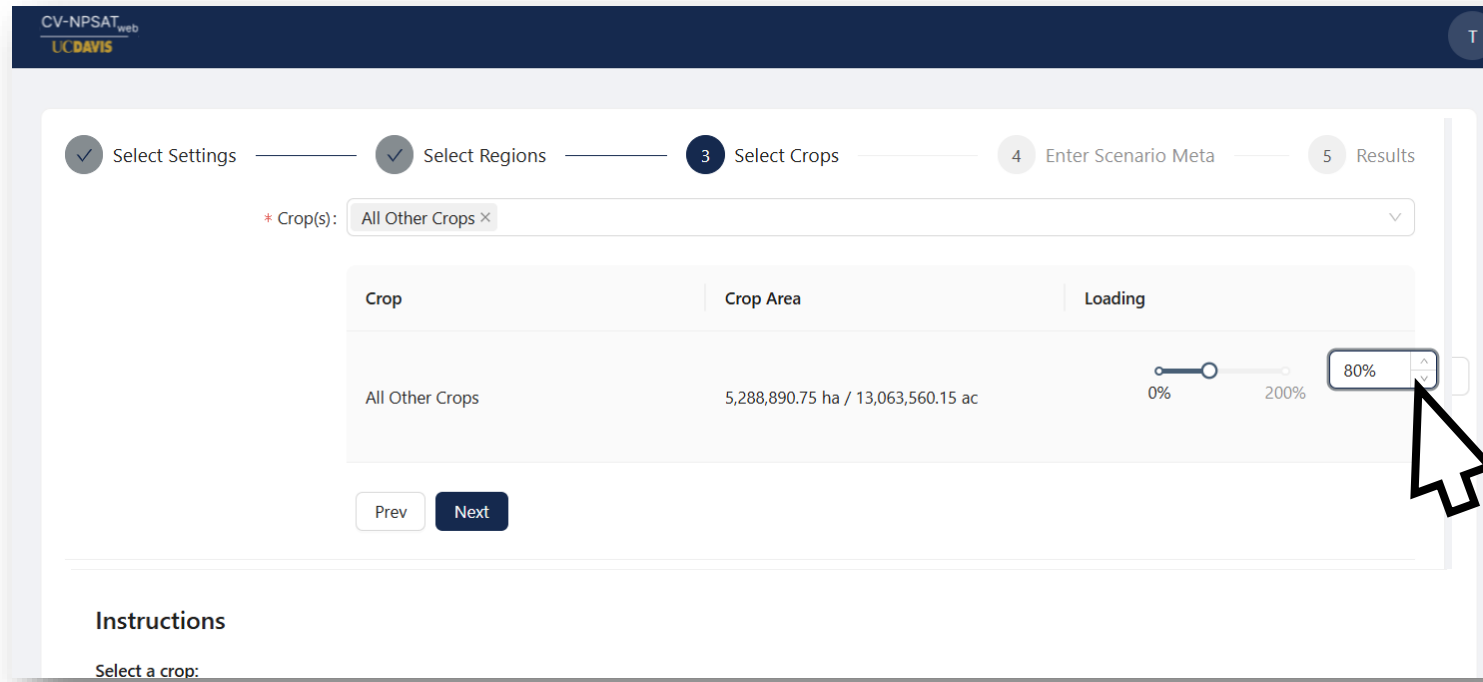
Crop	Crop Area	Loading
All Other Crops	5,288,890.75 ha / 13,063,560.15 ac	0% — 100% — 200%

Prev Next

Instructions
Select a crop:

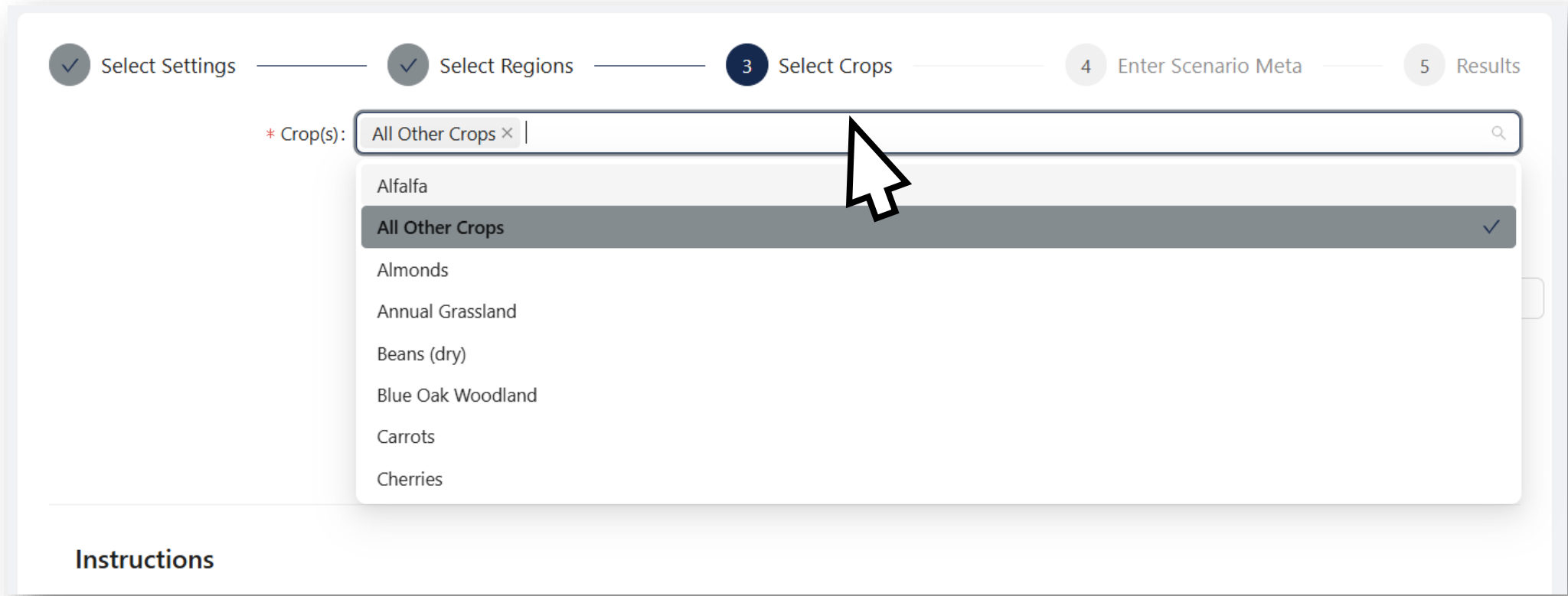
- On this screen, the user selects the specific crops for which future N loading will be adjusted, relative to 2020 business-as-usual (BAU) loading.
- “All Other Crops” refers to all crops that are NOT specifically selected. These also can be adjusted

3 Select the crops for which to adjust N loading



- You can use the slider or the percent box to adjust the N loading. The percent loading selected is relative to the 2020 BAU N loading.
- For example “80%” reflects a 20% reduction from the 2020 BAU N loading (which is “100%).
- Any value between 0% and 200% can be selected.
- Note: for each crop, it’s total area in the selected area-of-interest is displayed.

3 Select the crops for which to adjust N loading



- Crops are selected from the drop-down list at the top, by clicking on the crop or crops for which the user wants to adjust the N loading.
- One or multiple crops can be selected

3 Select the crops for which to adjust N loading

Crop	Crop Area	Loading
All Other Crops	5,288,890.75 ha / 13,063,560.15 ac	95%
Almonds	NaN ha / NaN ac	85%
Pistachios	NaN ha / NaN ac	85%
Walnuts	NaN ha / NaN ac	85%

- The drop-down box disappears once clicking on the white space outside the drop-down menu
- The N loading is adjusted separately for each crop selected
- Crops can be deselected from the list by clicking “x” in the Crop list at the top.

3 Select the crops for which to adjust N loading

Crop	Crop Area	Loading
All Other Crops	5,288,890.75 ha / 13,063,560.15 ac	95%
Almonds	NaN ha / NaN ac	85%
Pistachios	NaN ha / NaN ac	85%
Walnuts	NaN ha / NaN ac	85%

- Click “Next” to advance to the final input screen.

Enter scenario name and meta-data

- Scenario names appear in figure labels when comparing multiple scenarios, so best to make them informative
- Description should be useful for house-keeping and documentation

CV-NPSAT_{web}
UCDAVIS

✓ Select Settings ——— ✓ Select Regions ——— ✓ Select Crops ——— 4 Enter Scenario Meta ——— 5 Results

* Scenario name: C2p-F-D-default-p default-wc

Description: Everything reduced to 95%. Nuts (almonds, pistachios, walnuts) reduced to 85%

Prev Next

Instructions

Scenario name
Enter a scenario name, limited 255 characters.

Scenario description
Enter scenario optional description, no characters limit.
Once submitted, your customized scenario will be created and run. Scenario will be running for a few seconds to up to a minute (based on number of wells selected) to generate results.

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Enter scenario name and meta-data

- Click “Next” to run the scenario

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UCDAVIS

✓ Select Settings ——— ✓ Select Regions ——— ✓ Select Crops ——— 4 Enter Scenario Meta ——— 5 Results

* Scenario name: C2p-F-D-default-p default-wc

Description: Everything reduced to 95%. Nuts (almonds, pistachios, walnuts) reduced to 85%

Prev Next

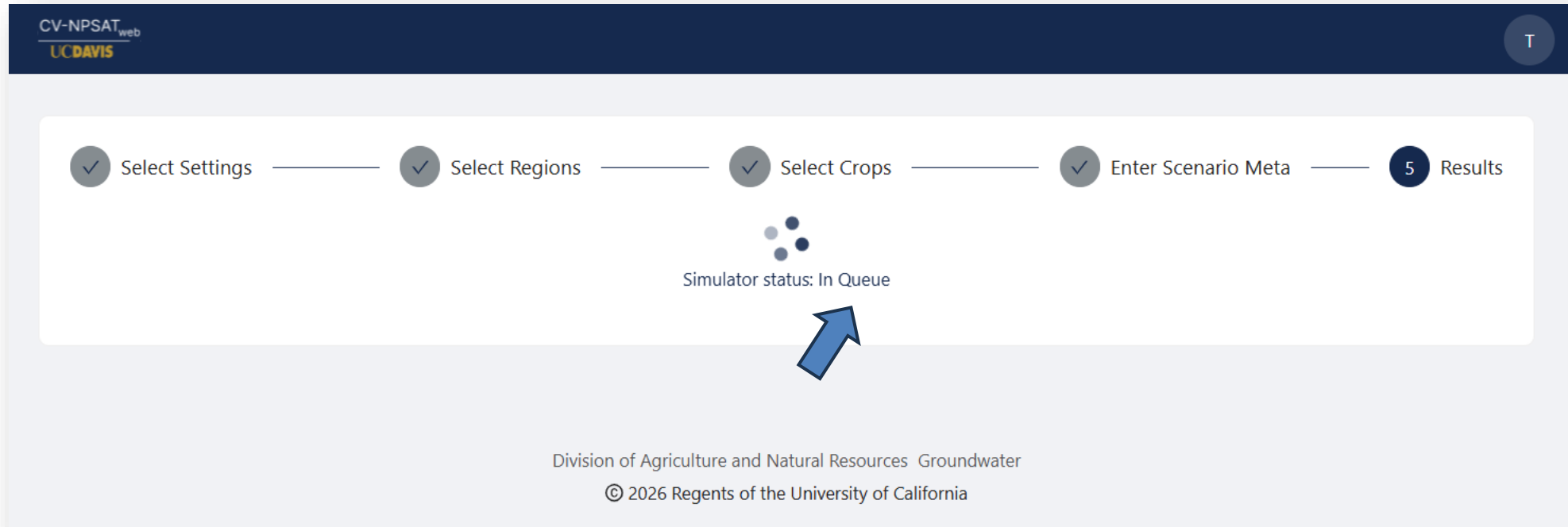
Instructions

Scenario name
Enter a scenario name, limited 255 characters.

Scenario description
Enter scenario optional description, no characters limit.
Once submitted, your customized scenario will be created and run. Scenario will be running for a few seconds to up to a minute (based on number of wells selected) to generate results.

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Running the scenario



- Congratulations! You just built an enormous model, you maybe simulating hundreds of years across thousands of square miles of a deep aquifer system with perhaps tens of thousands of wells.
- Be patient, our computers are busy. Importantly, your scenario is in the queue!
- You can close your laptop or turn off your computer if you want, nothing will be lost. You can come back later to see whether your scenario has completed (it will show up at the top of your home screen list)

Running the scenario

CV-NPSAT_{web}
UCDAVIS

✓ Select Settings ——— ✓ Select Regions ——— ✓ Select Crops ——— ✓ Enter Scenario Meta ——— 5 Results

Simulator status: Running

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- If you waited: good news is showing here – your scenario is now out of the waiting queue and running, should be done shortly (minutes)

Running the scenario

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UCDAVIS

✓ Select Settings ——— ✓ Select Regions ——— ✓ Select Crops ——— ✓ Enter Scenario Meta ——— 5 Results

✓

Simulation Complete

View scenario run Create another scenario

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- Your results are back! Click “View scenario run” to see them.

View results from the scenario

The screenshot shows the CV-NPSATweb interface. At the top left is the logo. The main heading is 'Home'. On the right is a 'Create Scenario' button. Below the heading is a 'Scenario Type' dropdown menu with 'Filter Scenarios' selected. A light blue banner contains an information icon and the text 'You may select two or more models to compare. Maximum of 32.' with a 'Compare Scenario' button on the right. Below this is a table with the following columns: Scenario Name, Description, Flow Scenario, Load Scenario, Unsat Scenario, Well Type Scenario, and Actions. The first row of the table is highlighted, and a mouse cursor points to the 'Scenario Name' cell.

Scenario Name	Description	Flow Scenario	Load Scenario	Unsat Scenario	Well Type Scenario	Actions
<input type="checkbox"/> C2p-F-D-default-p default-wc	Everything reduced to 95%. Nuts (almonds, pistachios, walnuts) reduced to 85%.	C2VSIM with Pumping adjusted to match the Recharge	GNLM Full	C2VSIM Typical vadose zone thickness	Domestic Wells	Edit Delete

- If you closed your browser tab and/or your computer, log back into CV-NPSATweb and find the scenario at the top of the list.
- Click on it anywhere in the scenario row to see the results

View results from the scenario

- The first part of this screen shows reflects the scenario input information



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Delete Scenario
Copy and Modify Scenario

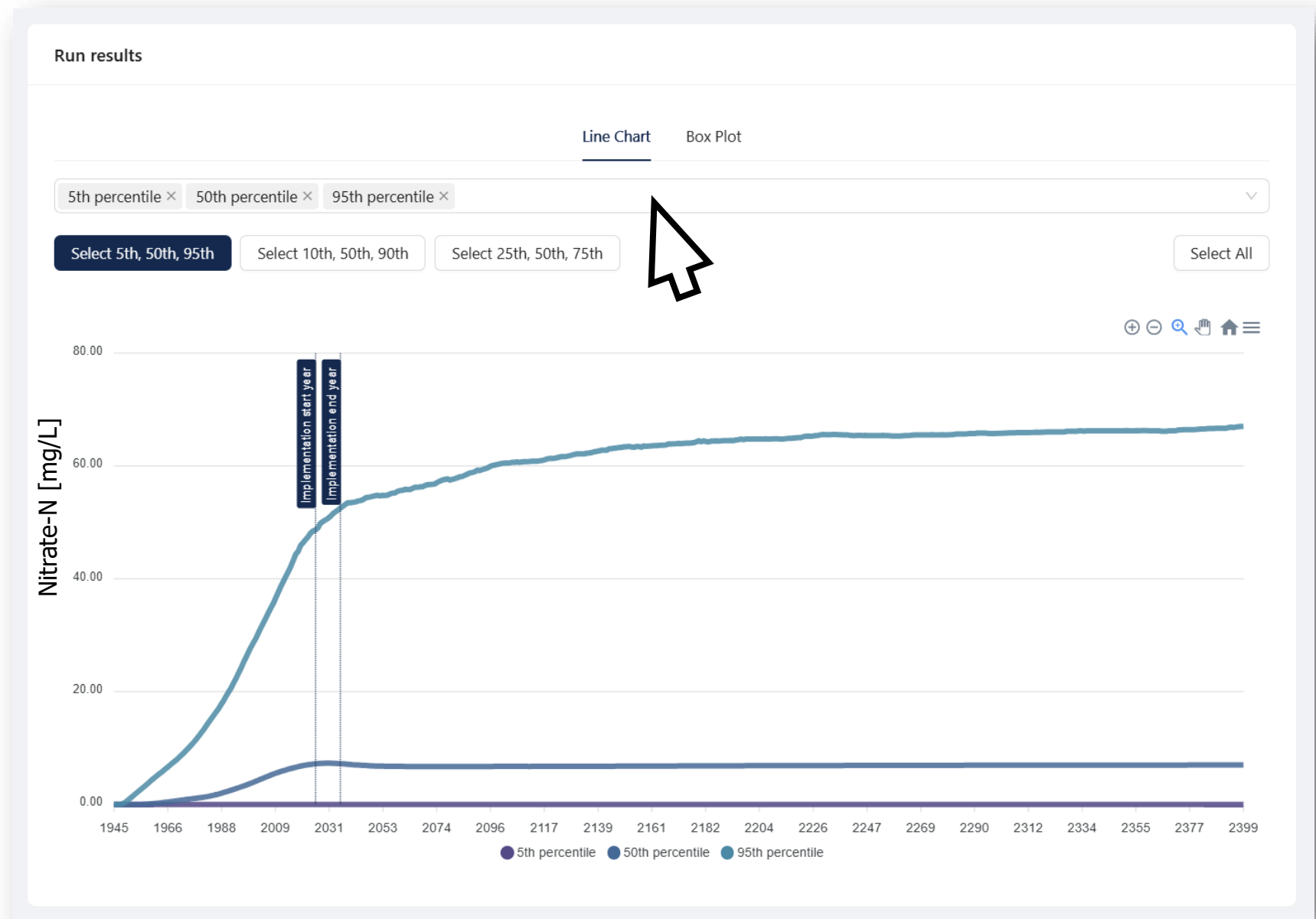
Details and Results

Scenario info

Scenario name	C2p-F-D-default-p default-wc	Date created	3/16/2026, 3:27:12 AM	Date completed	3/16/2026, 3:34:15 AM
Stimulation end year	2400	Implementation start year	2026	Implementation complete year	2036
Flow Scenario	C2VSIM with Pumping adjusted to match the Recharge	Load Scenario	GNLM Full	Well Type Scenario	Domestic Wells
Unsat Scenario	C2VSIM Typical vadose zone thickness	Water content	10%	Number of wells detected in selected region(s)	57340
Porosity	10%	Region(s)	Central Valley	Simulator Version	2.2.11
Depth range	6.00 - 669.00 meters		Screen length range	1.00 - 323.00 meters	
Scenario description	Everything reduced to 95%. Nuts (almonds, pistachios, walnuts) reduced to 85%.				

View results from the scenario

- Scrolling down, the first chart shows the scenario results: the long-term concentration across wells in the area-of-interest
- The user can select any number of percentiles to be shown



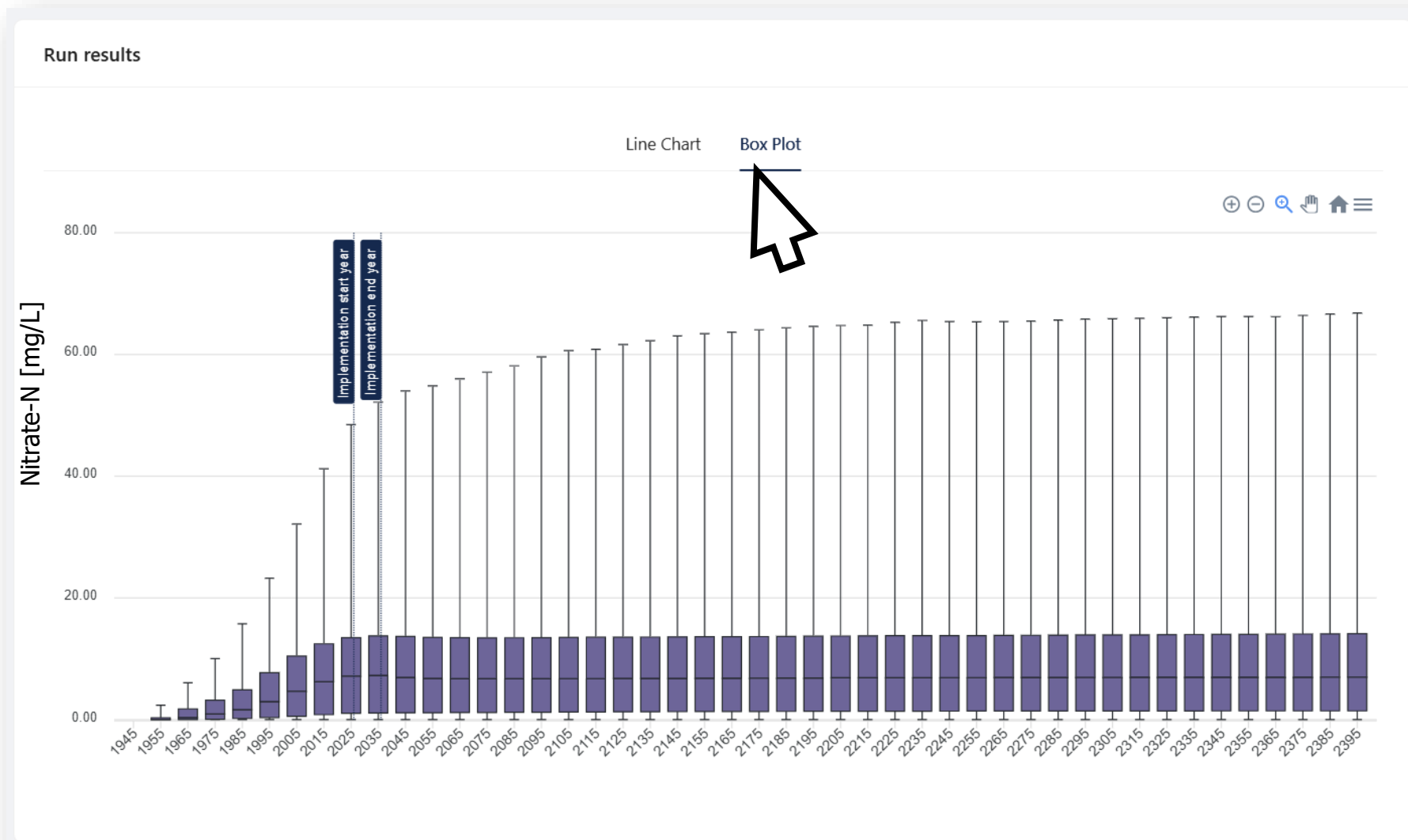
View results from the scenario

- Scrolling down, the first chart shows the scenario results: the long-term concentration across wells in the area-of-interest
- The user can select any number of percentiles to be shown



View results from the scenario

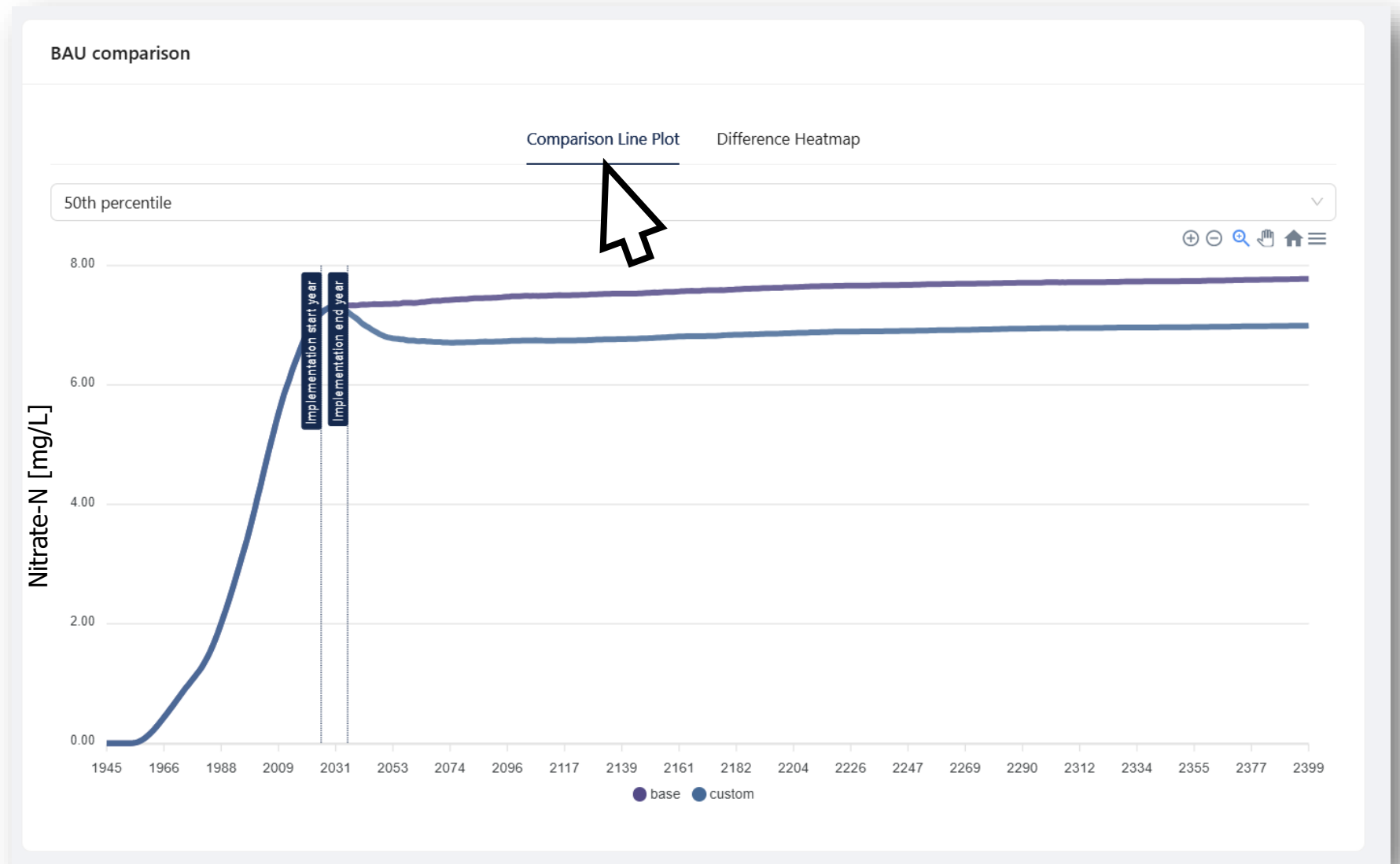
- Alternatively, a boxplot can be viewed to see how nitrate-N distribution in wells of the area-of-interest evolve with time



Whiskers: 5th and 95th percentile; Box: 25th to the 75th percentile; horizontal line: median (50th percentile)

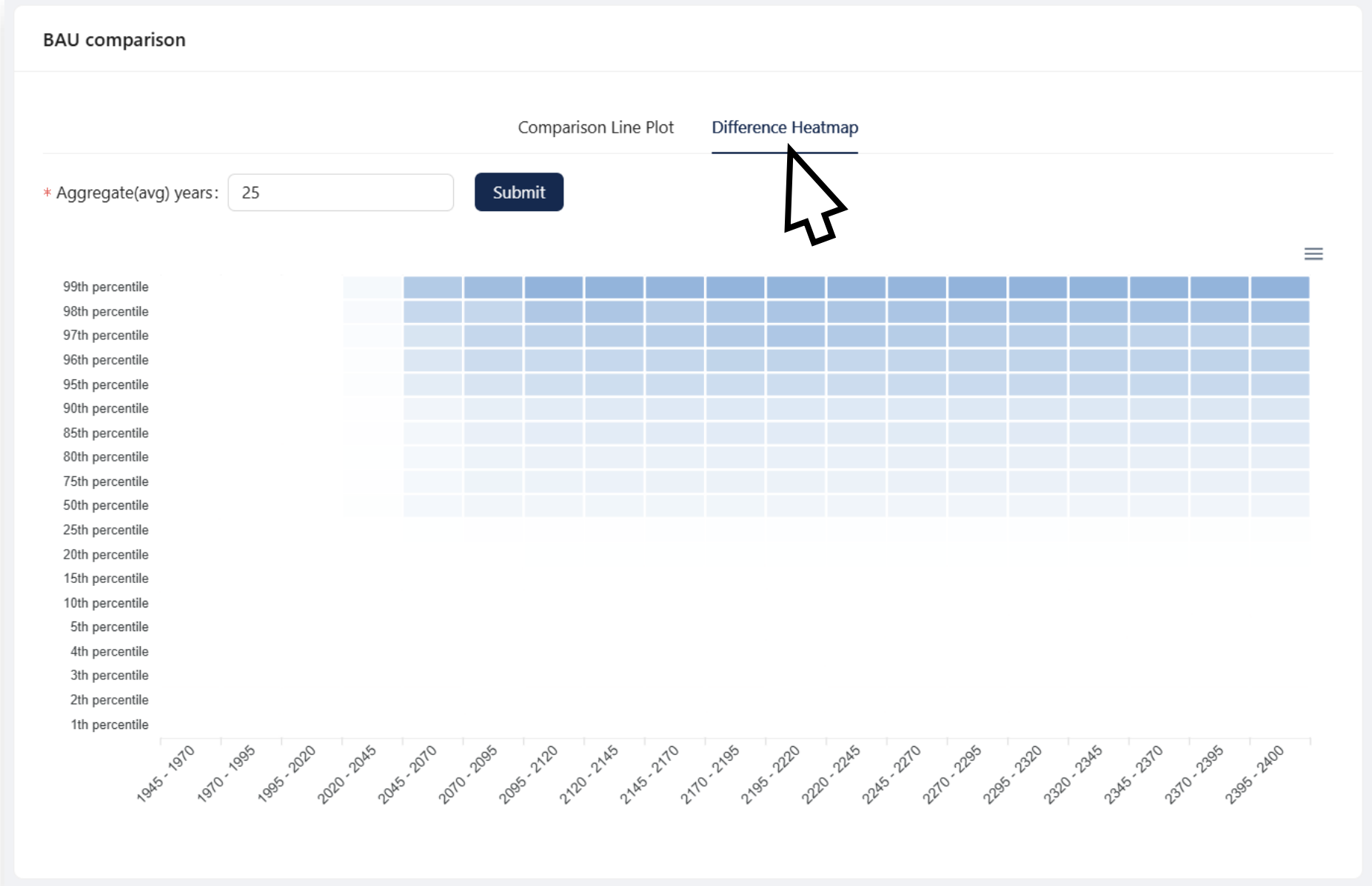
View results from the scenario

- **Scrolling further down**, the second chart shows a comparison of the “base” BAU scenario with the selected “custom” scenario
- The comparison can only be done for a specific percentile (shown: median)



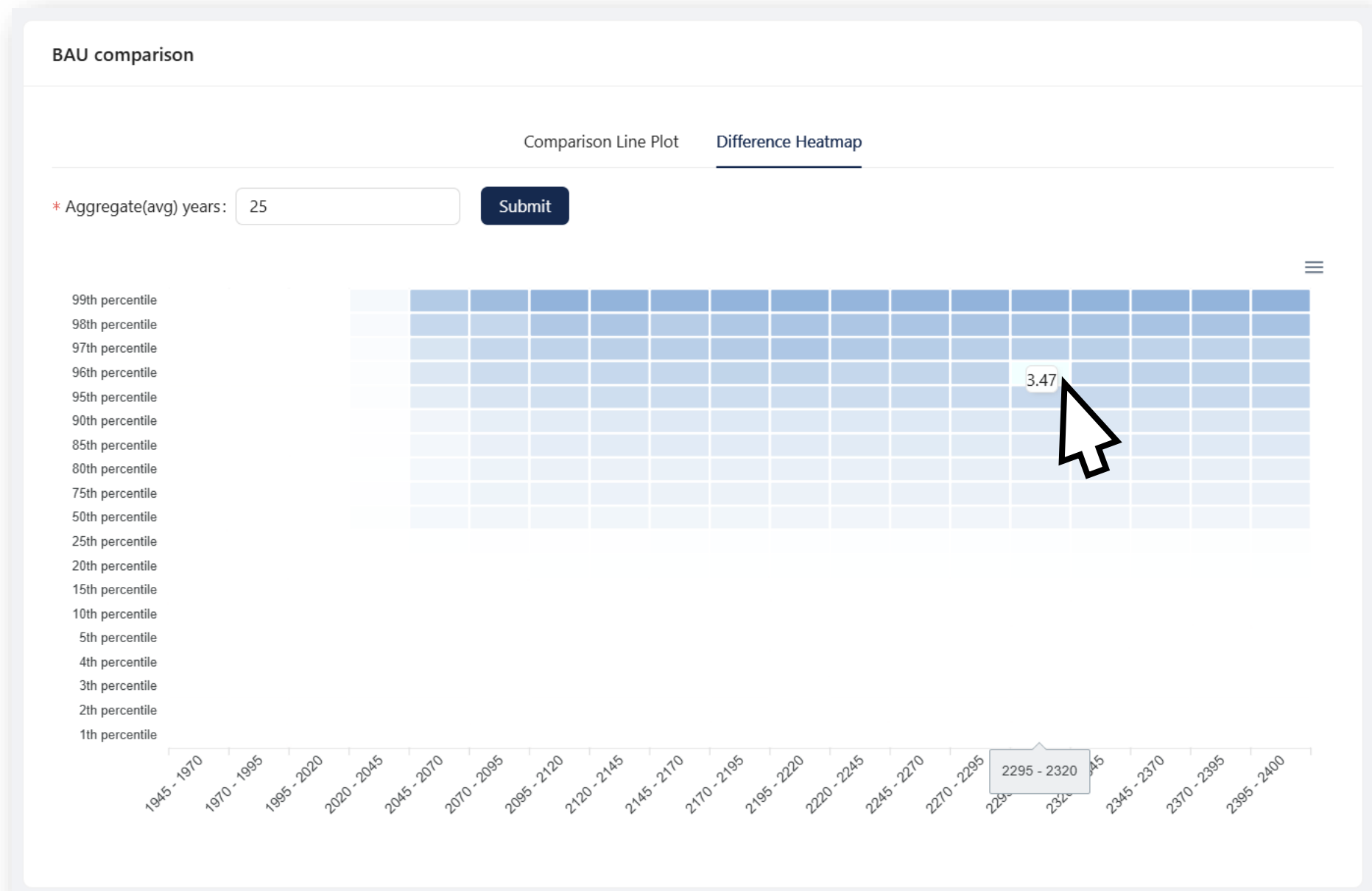
View results from the scenario

- Alternatively, the difference between the “custom” scenario and the BAU (“base”), can be viewed as a heatmap.



View results from the scenario

- Moving the cursor over the heatmap will display the difference in nitrate-N [mg/L]



View results from the scenario

- **Scrolling further down**, additional information on the scenario can be found.

Crop loading details

Crop	C2p-F-D-default-p default-wc - Loading Percentage	BAU model - Loading Percentage	Crop Area (Acre)	Crop Area (Hectare)
All Other Crops	95%	100%	11,846,995	4,796,354
Almonds	85%	Not specified	812,224	328,836
Pistachios	85%	Not specified	127,314	51,544
Walnuts	85%	Not specified	277,027	112,157

View results from the scenario

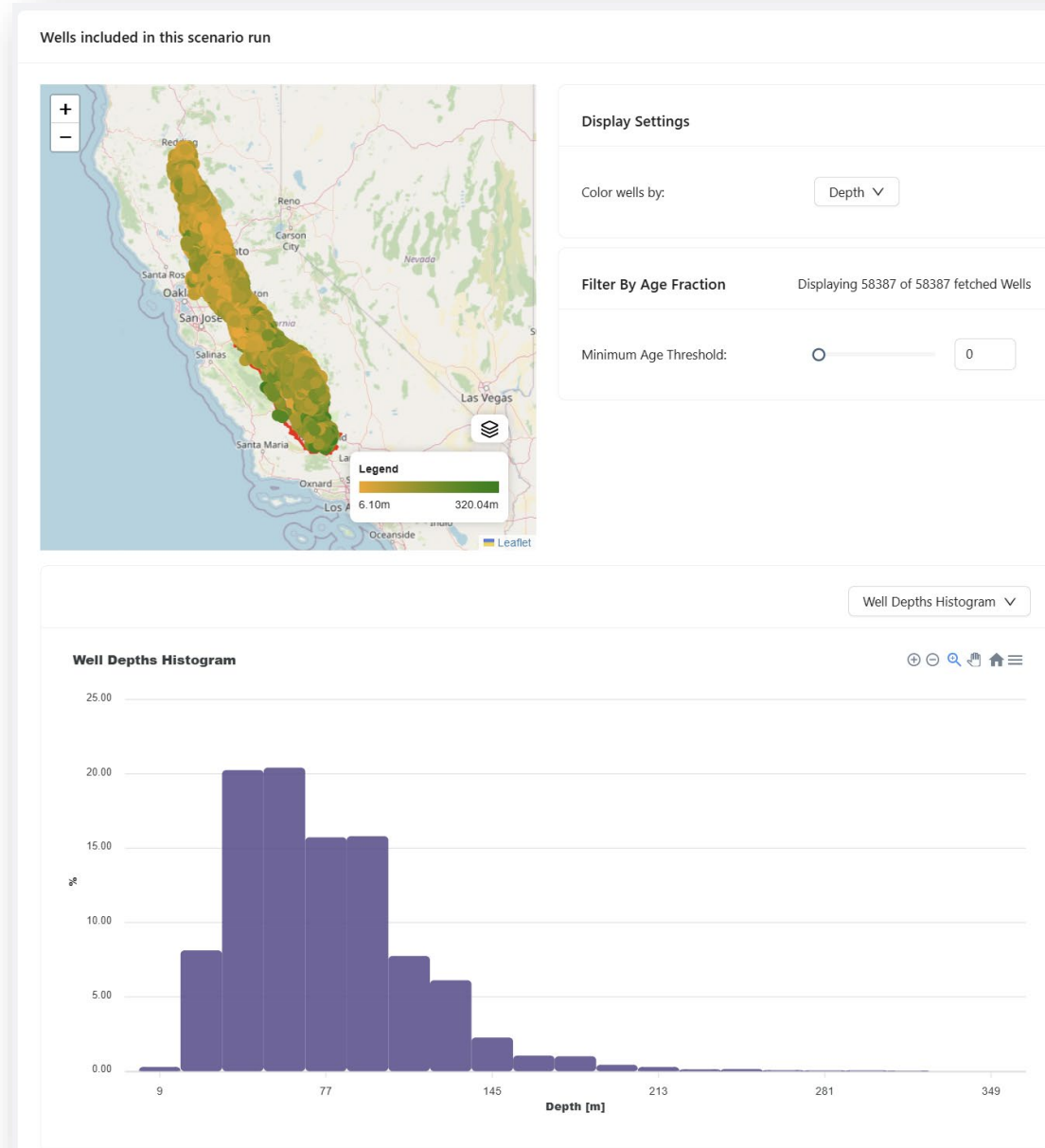
- **Scrolling further down**, this shows the N Loading percentage selected by the user for the scenario and the area associated with each selected crop

Crop loading details

Crop	C2p-F-D-default-p default-wc - Loading Percentage	BAU model - Loading Percentage	Crop Area (Acre)	Crop Area (Hectare)
All Other Crops	95%	100%	11,846,995	4,796,354
Almonds	85%	Not specified	812,224	328,836
Pistachios	85%	Not specified	127,314	51,544
Walnuts	85%	Not specified	277,027	112,157

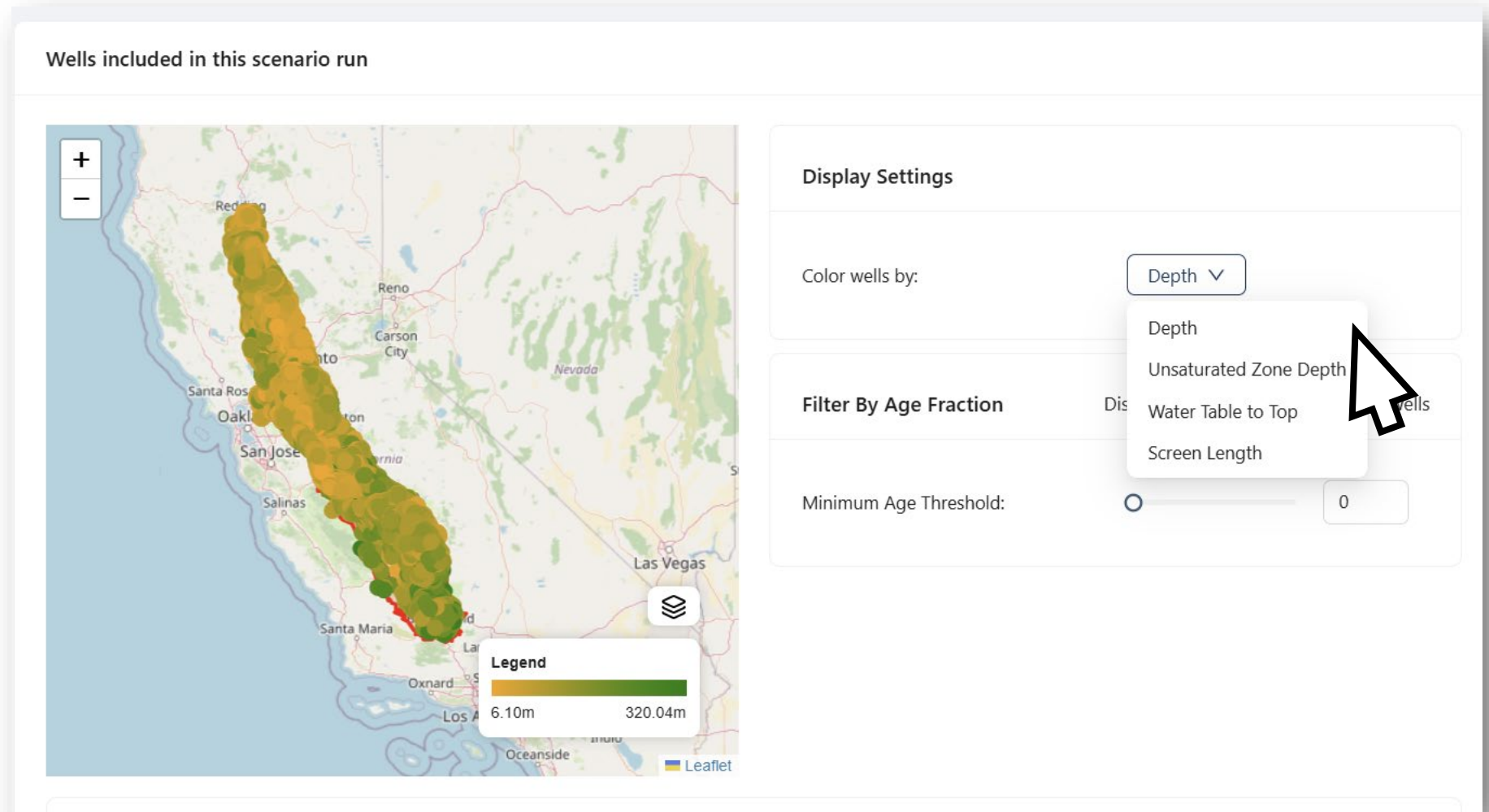
View results from the scenario

- **Scrolling further down**, a map with all (here: domestic) wells in the area-of-interest and a histogram of the properties of those mapped wells are shown



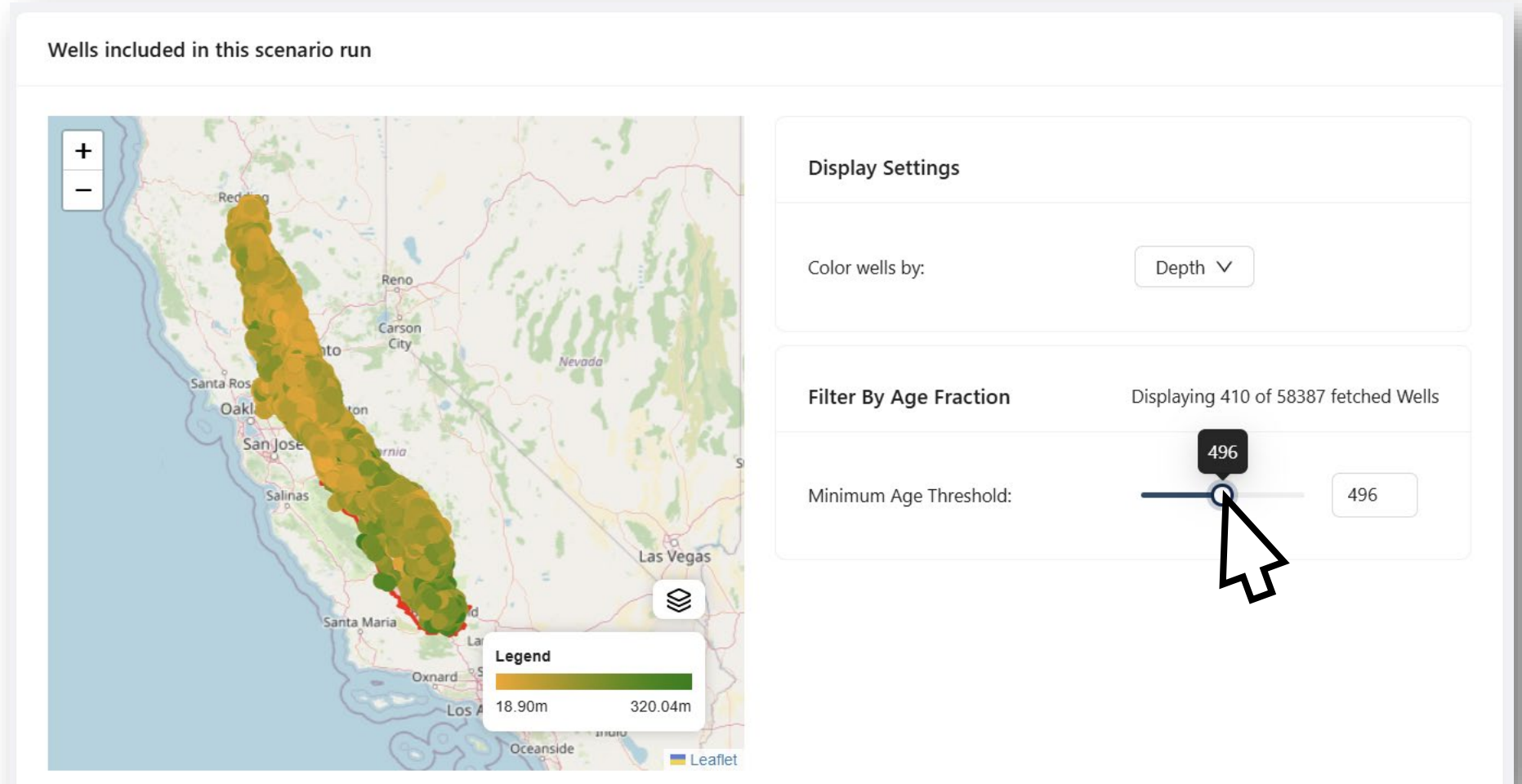
View results from the scenario

- Coloring of wells can be selected to be by:
 - Depth (i.e., total depth) of the well
 - Unsaturated Zone Depth
 - Distance from the Water Table to the top of the well screen
 - Total screen length



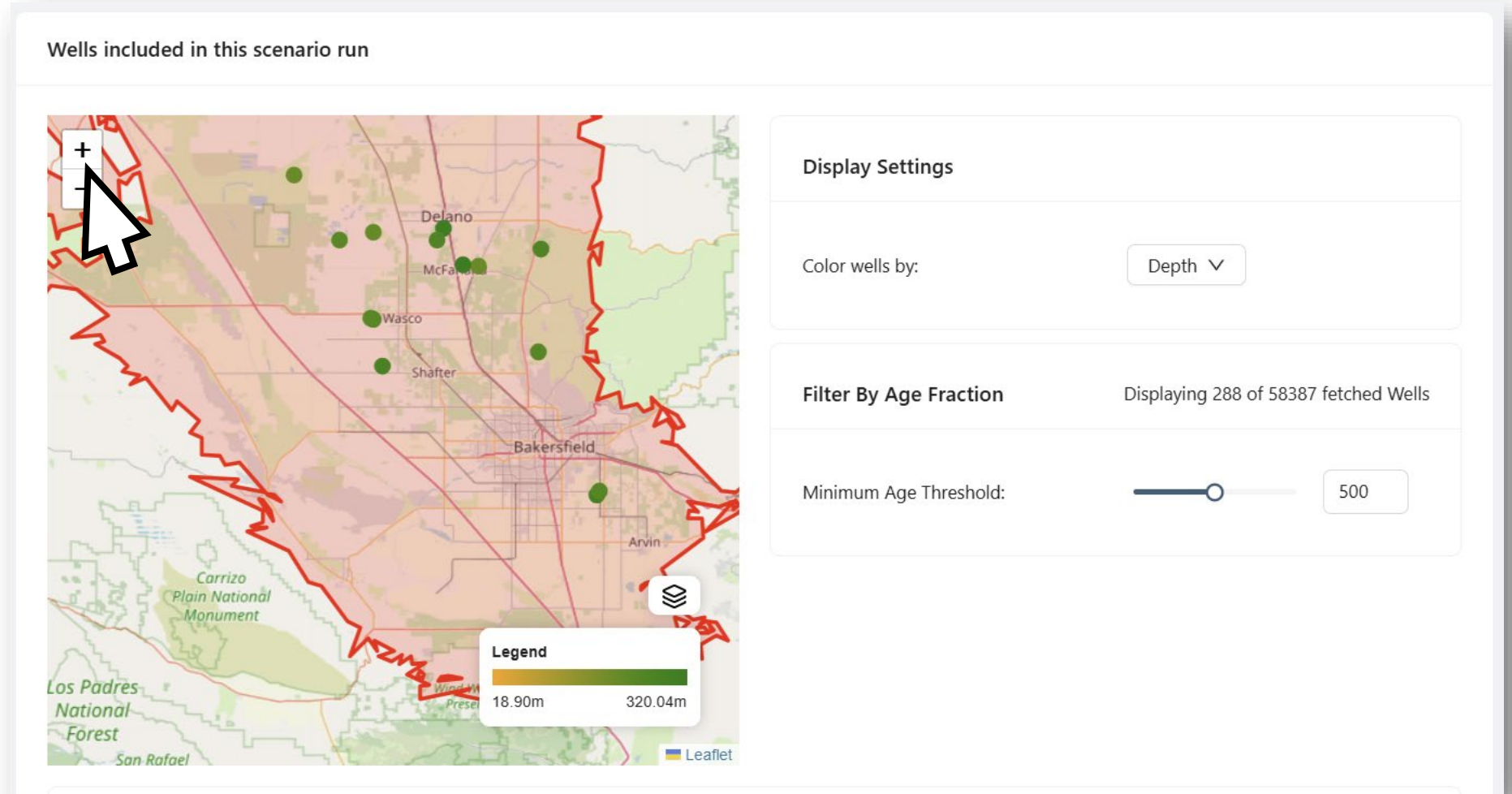
View results from the scenario

- Wells shown can be selected to be only those where the water age is older than a user-selected threshold [years]



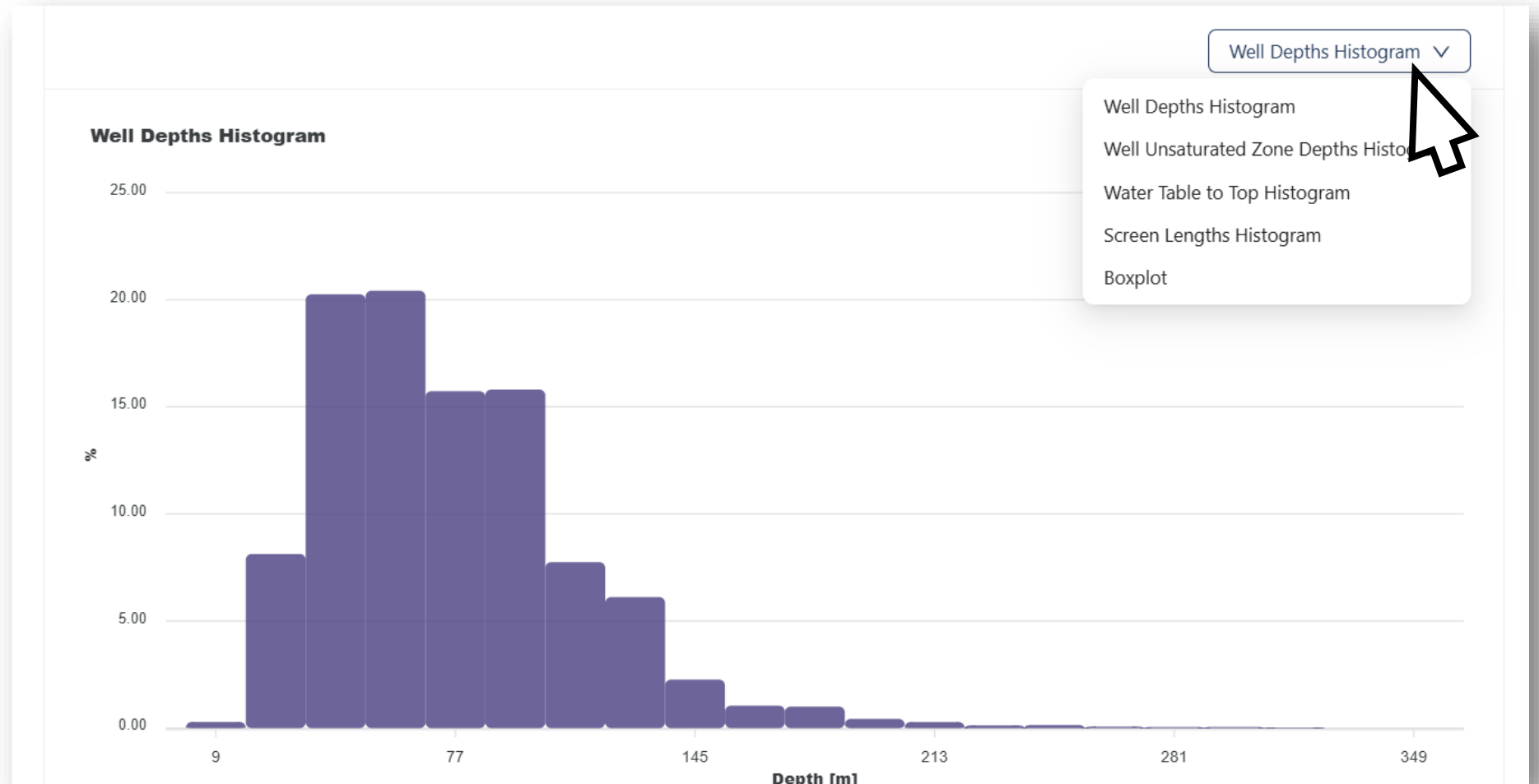
View results from the scenario

- The well symbols do not change in size and are better visible when zooming in.
- Note that there are few domestic wells (in this case) that have old water. And those that have are rather deep.



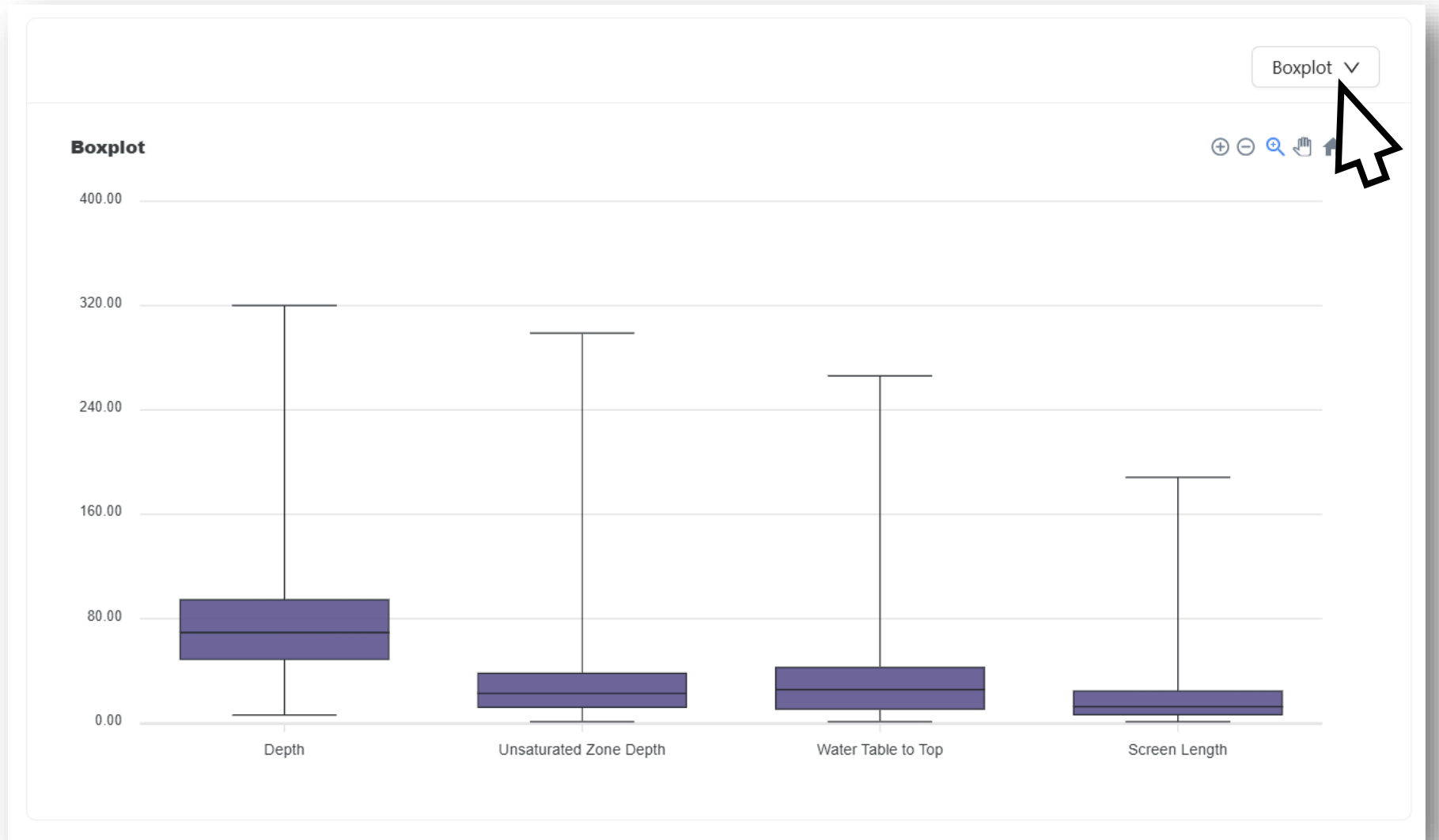
View results from the scenario

- The histogram can also be done by:
 - Well depth
 - Unsaturated zone depth at the wells
 - Depth from the water table to the top of the well screen
 - Well screen length



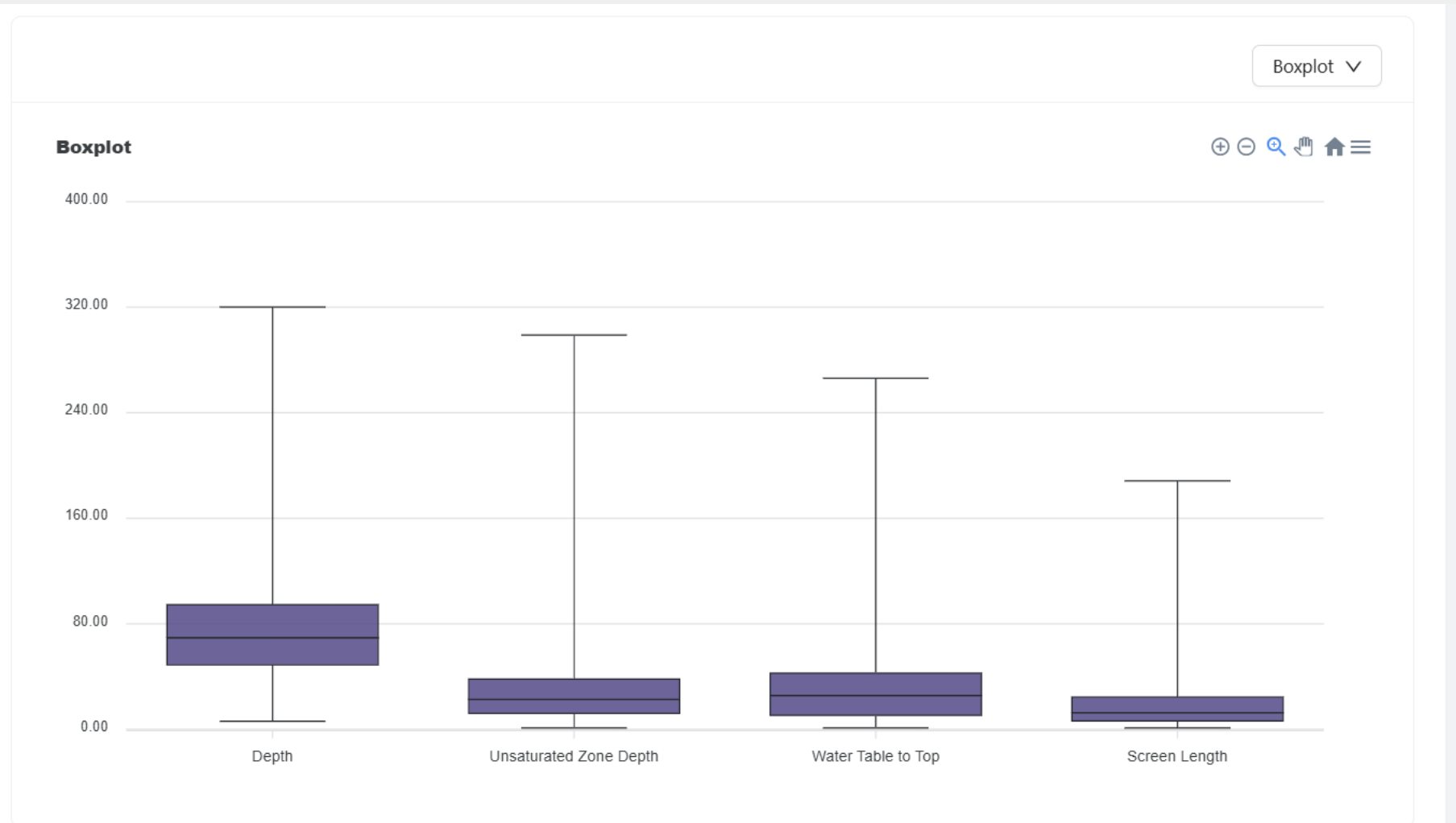
View results from the scenario

- A boxplot is displayed, when the “boxplot” option is selected from the drop-down menu, for the same four well construction variables.



View results from the scenario

- At the very bottom of the scenario results page are links to additional useful CV-NPSAT results tools.
 - Well Explorer
 - Unsaturated Zone Explorer



[Looking for other wells? Water age? Well source area? Explore the full dataset.](#)

[Explore Central Valley Unsaturated Travel Time \(Google Earth\)](#)

- The well explorer runs independent from any CV-NPSAT scenario. It has some familiar options to select a specific group of wells for inspection of groundwater age and well source area:

- Base model
 - C2VSIM
 - CVHM
- Scenario
 - Pump adjusted
 - Recharge adjusted
- Well type
 - Domestic
 - Irrigation & Public Supply
- Area-of-interest

The screenshot shows the 'Explore Wells' interface with the following components:

- Step 1: Select Region(s) From Map**
 - Buttons: Central Valley, Basin, County, B118 Basin, Subregions, Township
 - Map: Shows the Central Valley region with a blue outline of the area of interest.
 - Map Controls: Zoom in (+), zoom out (-), and a legend for 'Streampoints Display Mode'.
- Step 2: Configure Model**
 - Base Model: [Dropdown]
 - Scenario: [Dropdown]
 - Well Type: [Dropdown]
- Step 3: Fetch Wells**
 - Fetch Wells: [Button]
- Results Section**
 - Display Settings: Color wells by: [Depth]
 - Filter By Age Fraction: Displaying 0 of 0 fetched Wells
 - Minimum Age Threshold: [Slider] 0
 - Porosity: [Slider] 0.2

- The well explorer runs independent from any CV-NPSAT scenario. It has some familiar options to select a specific group of wells for inspection of groundwater age and well source area:

- Base model
 - C2VSIM
 - CVHM
- Scenario
 - Pump adjusted
 - Recharge adjusted
- Well type
 - Domestic
 - Irrigation & Public Supply
- Area-of-interest

- Select your configuration, then
- “Fetch Wells”

- Next, select one of the available variable by which to color wells and a minimum age threshold as needed
- Specify the aquifer porosity for the area-of-interest (it will be uniform). The porosity acts like an inverse scaling factor on velocity and affects the age of every flow path in CV-NPSAT

The screenshot displays the 'Well Explorer' web application interface. At the top, the CV-NPSAT logo and 'UC DAVIS' are visible. The main heading is 'Explore Wells'. Below this, a progress bar indicates three steps: 1. Select Region(s) from Map (with an 'Edit Selection' link), 2. Configure Model (with dropdowns for 'C2VSim', 'Pump adjusted', and 'Domestic'), and 3. Fetch Wells (with a 'Fetch Wells' button). The 'Select Region(s) From Map' section shows a dropdown menu with 'Central Valley' selected. Below this is a map of the Central Valley region, with a color-coded area of interest. A legend for the map shows a color gradient from 6.10m to 668.46m. To the right of the map, there are controls for 'Results' (displaying 58461 of 58461 fetched wells), 'Display Settings' (Color wells by: Depth), and 'Filter By Age Fraction' (Minimum Age Threshold: 0, Porosity: 0.2). A mouse cursor is pointing at the Porosity input field.

- If your area-of-interest is very large, zoom closer on the map to explore the age and source area of specific wells

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Explore Wells

- 1 Select Region(s) from Map [Edit Selection](#)
- 2 Configure Model
C2VSim Pump adjusted Domestic
- 3 Fetch Wells
Fetch Wells

Select Region(s) From Map

Central Valley Basin County B118 Basin Subregions Township

Central Valley

+

-

Modesto

Streampoints Display Mode

Legend

6.10m 668.46m

Leaflet

Results

Display Settings

Color wells by: Depth

Filter By Age Fraction

Displaying 58461 of 58461 fetched Wells

Minimum Age Threshold: 0

Porosity: 0.4

- If your area-of-interest is very large, zoom closer on the map to explore the age and source area of specific wells
- If the tool is slow in responding, select fewer wells: select “Edit Selection”, adjust your area-of-interest (and any other model configuration) and, again, “Fetch Wells”

- Click on a well to display it's well-water's age properties and the source area of that water

The screenshot shows the 'Explore Wells' interface. At the top, there are three steps: 1. Select Region(s) from Map (with an 'Edit Selection' link), 2. Configure Model (with dropdowns for 'C2VSim', 'Pump adjusted', and 'Domestic'), and 3. Fetch Wells (with a 'Fetch Wells' button). Below this is the 'Select Region(s) From Map' section, which includes tabs for 'Central Valley', 'Basin', 'County', 'B118 Basin', 'Subregions', and 'Township'. A dropdown menu shows 'M04S08E' and 'M03S08E'. The main map area displays a grid of wells colored by depth, with a legend at the bottom right showing a color scale from 24.38m (orange) to 169.16m (green). A mouse cursor is hovering over a well labeled '169.16 m'. To the right of the map is a 'Results' panel with 'Display Settings' (Color wells by: Depth), 'Filter By Age Fraction' (Minimum Age Threshold: 0, Porosity: 0.4), and a status indicator 'Displaying 511 of 511 fetched Wells'. The bottom right corner of the map area includes a 'Streampoints Display Mode' button and a 'Legend' box.

- The source area is depicted by the yellow dots on the map
- Use the zoom tools on the map.
- Especially for domestic wells, which pump relatively small amounts of water, the source area is very small.

The screenshot shows the 'Explore Wells' interface. At the top, there are three numbered steps: 1. Select Region(s) from Map (with an 'Edit Selection' link), 2. Configure Model (with dropdowns for 'C2VSim', 'Pump adjusted', and 'Domestic'), and 3. Fetch Wells (with a 'Fetch Wells' button). Below this is a 'Select Region(s) From Map' section with tabs for 'Central Valley', 'Basin', 'County', 'B118 Basin', 'Subregions', and 'Township'. A dropdown menu shows 'M04S08E' and 'M03S08E'. The main map area displays a map with a yellow highlighted region and several yellow dots representing source areas. A red square on the map is labeled '30.48 m'. A mouse cursor is pointing at this red square. A legend at the bottom right shows a color scale from 24.38m (yellow) to 169.16m (green). On the right side, there are 'Results' and 'Display Settings' sections. The 'Display Settings' section includes 'Color wells by:' set to 'Depth'. The 'Filter By Age Fraction' section shows 'Minimum Age Threshold' at 0 and 'Porosity' at 0.4. A status bar indicates 'Displaying 511 of 511 fetched Wells'. The Leaflet logo is visible in the bottom right corner of the map area.

- Each yellow dot marks the beginning of a streamline that goes to the selected well. Hence, this map shows the **source** area, and the **receptor** (well) location (but not the actual travel pathway of each streamline).

The screenshot displays the 'Well Explorer' web application interface. At the top, there are three main steps: 1. Select Region(s) from Map, 2. Configure Model (with dropdowns for C2VSim, Pump adjusted, and Domestic), and 3. Fetch Wells (with a 'Fetch Wells' button). Below this, the 'Select Region(s) From Map' section shows navigation tabs for Central Valley, Basin, County, B118 Basin, Subregions, and Township. A search bar contains 'M04S08E' and 'M03S08E'. The main map area shows a selected well (red square) and several yellow dots representing source areas. A streamline is shown as a dashed blue line connecting a source area to the well. A tooltip indicates a distance of 30.48 m from the selected well to the source area. The 'Results' panel on the right shows 'Display Settings' (Color wells by: Depth), 'Filter By Age Fraction' (Minimum Age Threshold: 0, Porosity: 0.4), and 'Streampoints Display Mode'. A legend indicates a distance range from 24.38m to 169.16m.

- The source area is depicted by the yellow dots on the map
- Use the zoom tools on the map.
- Especially for domestic wells, which pump relatively small amounts of water, the source area is very small.

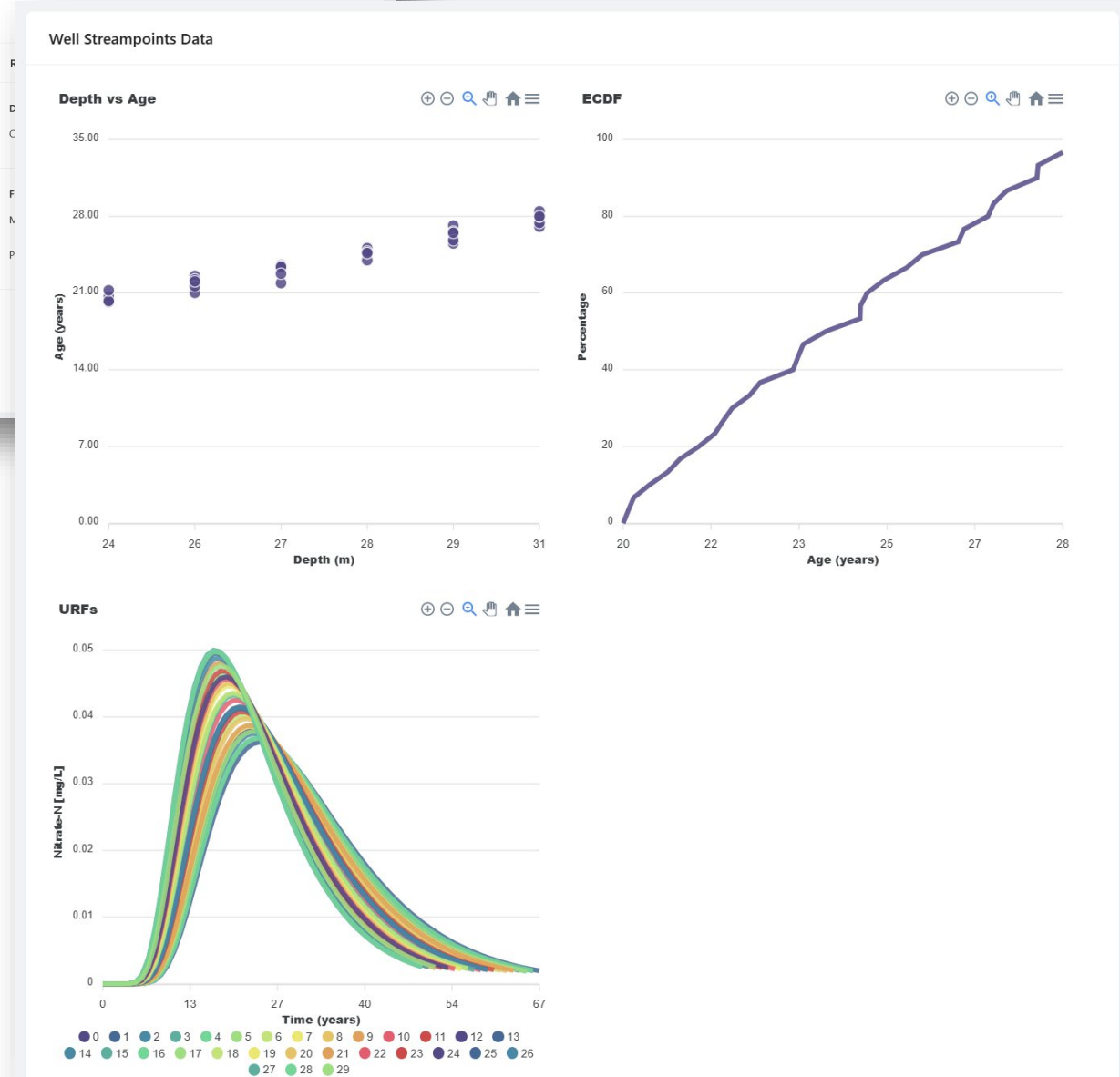
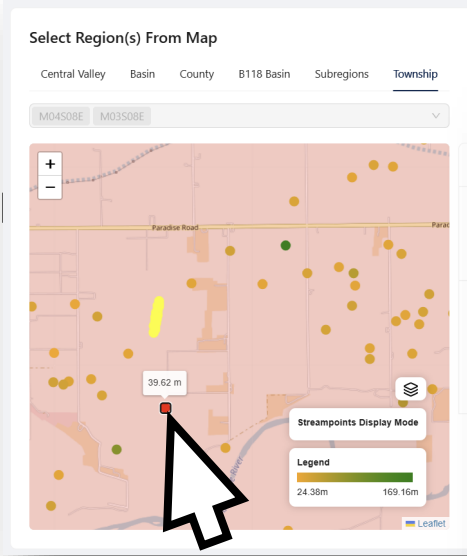
The screenshot shows the 'Explore Wells' interface. At the top, there are three numbered steps: 1. Select Region(s) from Map (with an 'Edit Selection' link), 2. Configure Model (with dropdowns for 'C2VSim', 'Pump adjusted', and 'Domestic'), and 3. Fetch Wells (with a 'Fetch Wells' button). Below this is a 'Select Region(s) From Map' section with tabs for 'Central Valley', 'Basin', 'County', 'B118 Basin', 'Subregions', and 'Township'. A dropdown menu shows 'M04S08E' and 'M03S08E'. The main map area displays a map with a yellow highlighted region and several yellow dots representing source areas. A red square on the map is labeled '30.48 m'. A mouse cursor is pointing at this red square. The map includes a legend for 'Streampoints Display Mode' with a color scale from 24.38m to 169.16m. On the right side, there are 'Results' and 'Display Settings' sections. The 'Display Settings' section includes 'Color wells by:' set to 'Depth', 'Filter By Age Fraction' set to 'Displaying 511 of 511 fetched Wells', 'Minimum Age Threshold' set to 0, and 'Porosity' set to 0.4.

- You can use the “Streampoints Display Mode” to make the display of source area points “sticky” or not, or to clear the sticky source areas.

The screenshot shows the 'Explore Wells' interface. At the top, there are three steps: 1. Select Region(s) from Map (with an 'Edit Selection' link), 2. Configure Model (with dropdowns for 'C2VSim', 'Pump adjusted', and 'Domestic'), and 3. Fetch Wells (with a 'Fetch Wells' button). Below this is the 'Select Region(s) From Map' section, which includes tabs for 'Central Valley', 'Basin', 'County', 'B118 Basin', 'Subregions', and 'Township'. A dropdown menu shows 'M04S08E' and 'M03S08E'. The main map area displays a grid of wells, with a cluster of wells highlighted in yellow. A 'Streampoints Display Mode' popup is visible over the map, with options for 'Only for selected well' and 'Sticky' (which is selected). A 'Clear Data' button is also present. A 'Legend' at the bottom of the popup shows a color gradient from orange to green, with values '24.38m' and '169.16m'. On the right side, the 'Results' section shows 'Display Settings' (Color wells by: Depth), 'Filter By Age Fraction' (displaying 511 of 511 fetched Wells), 'Minimum Age Threshold' (set to 0), and 'Porosity' (set to 0.4).

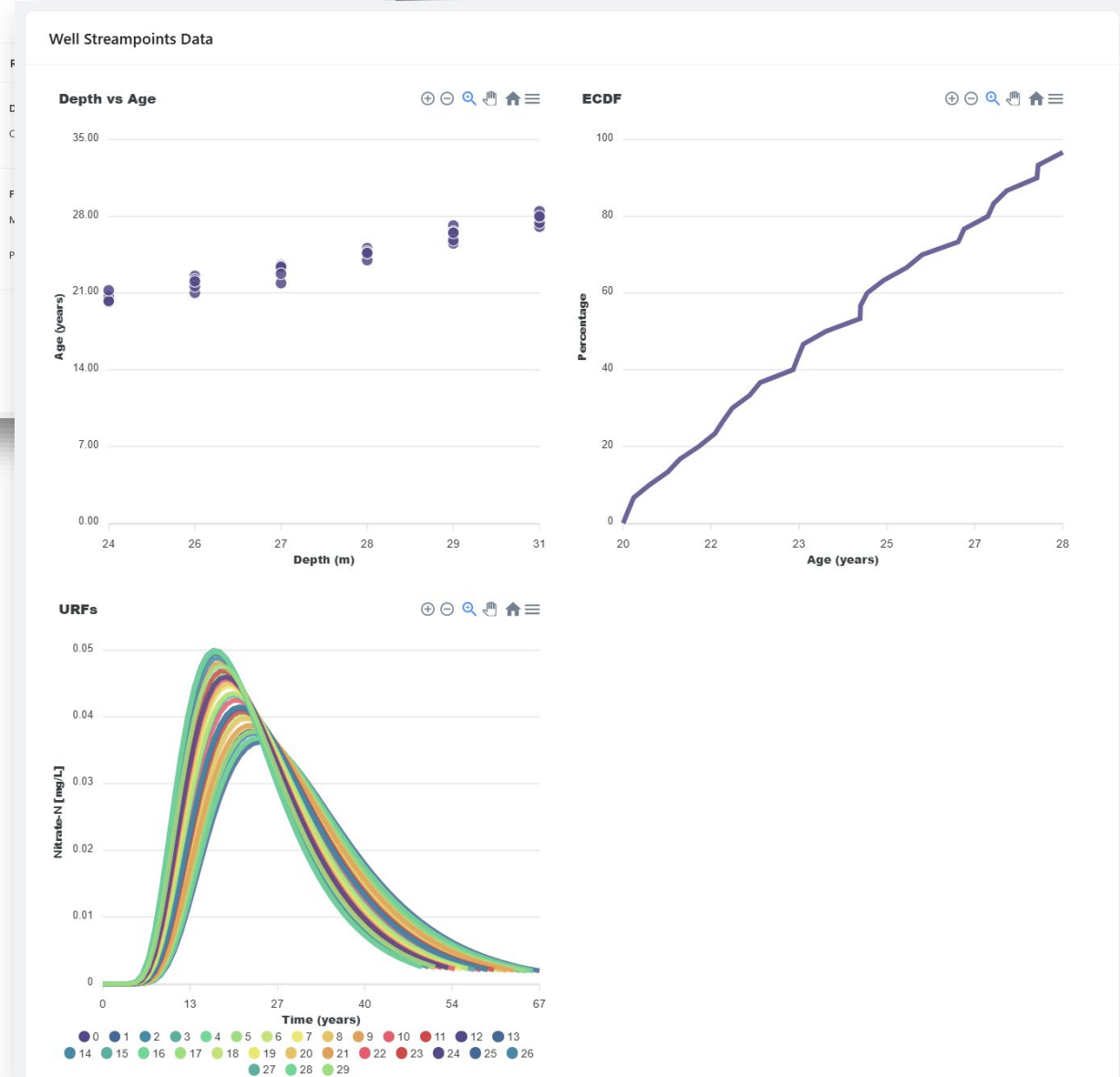
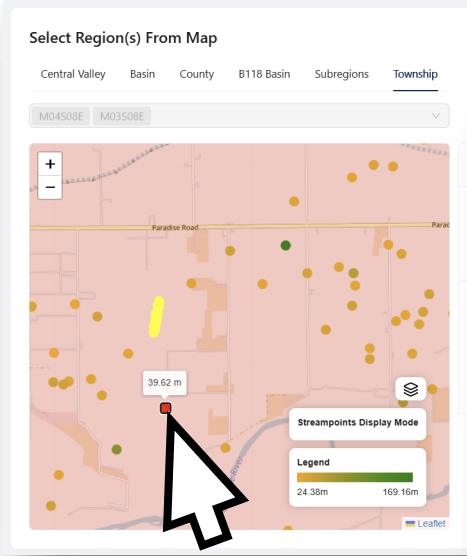
Well Explorer: Understanding groundwater age & source area

- Below the selection map is a panel of figures displaying:
 - Age (years) vs Depth of the well screen position where (simulated) streamlines enter the well (m)
 - Percentage of streamlines entering the well that are younger than the Age (years) on the x-axis
 - The Unit Response Function (URF) associated with each streamline. The URF is the breakthrough curve at the well (end of the streamline) for a one-year-long source input pulse of concentration 1 mg N/L (zero before and after) at the beginning (source) of the streamline. The streamlines are sequentially numbered from top to bottom of the screen.



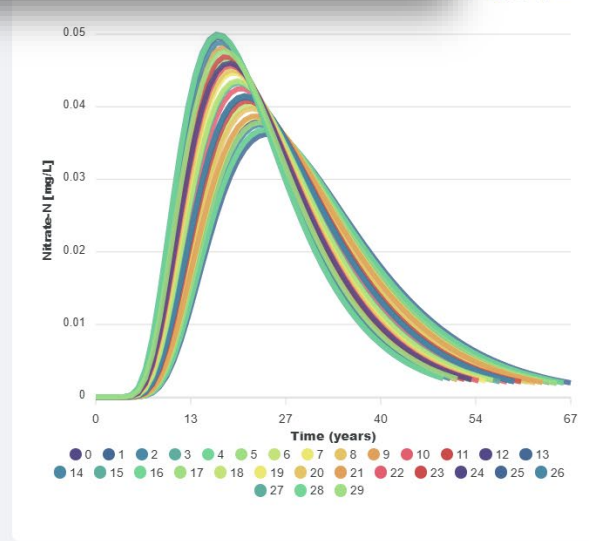
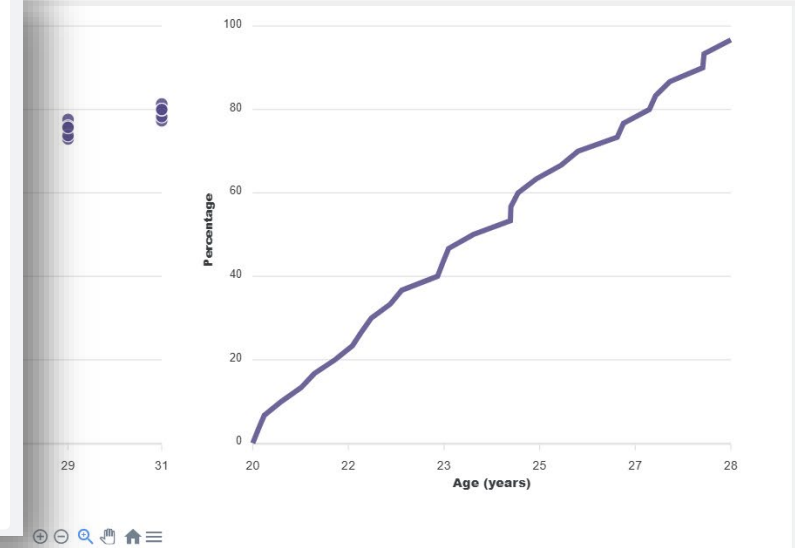
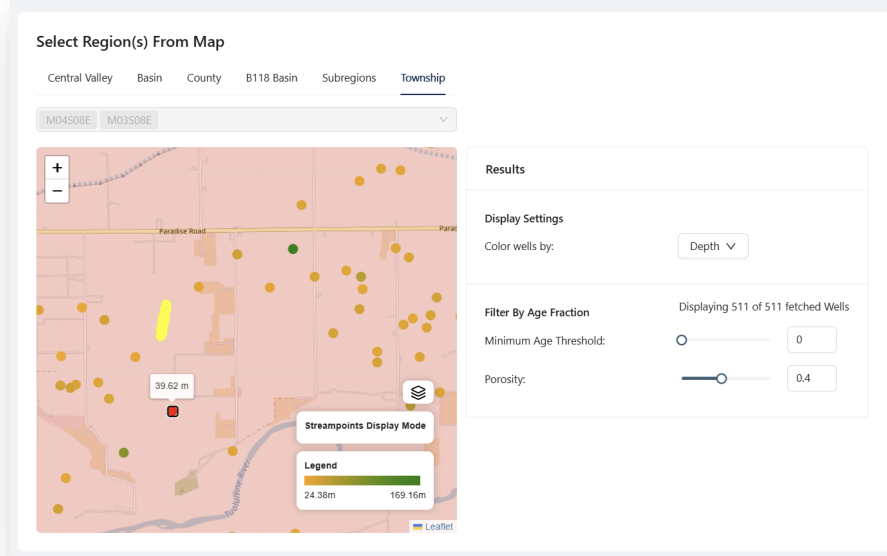
Well Explorer: Understanding groundwater age & source area

- The information displayed is derived from the CV-NPSAT groundwater flow model.
- The information is the exact same information used in the CV-NPSAT groundwater transport simulation tool to predict nitrate-N in wells



Well Explorer: Understanding groundwater age & source area

- Note that the groundwater age associated with each streamline entering a well does not include the travel time in the unsaturated zone.
- Use the Unsaturated Zone Explorer to learn more about unsaturated zone travel time

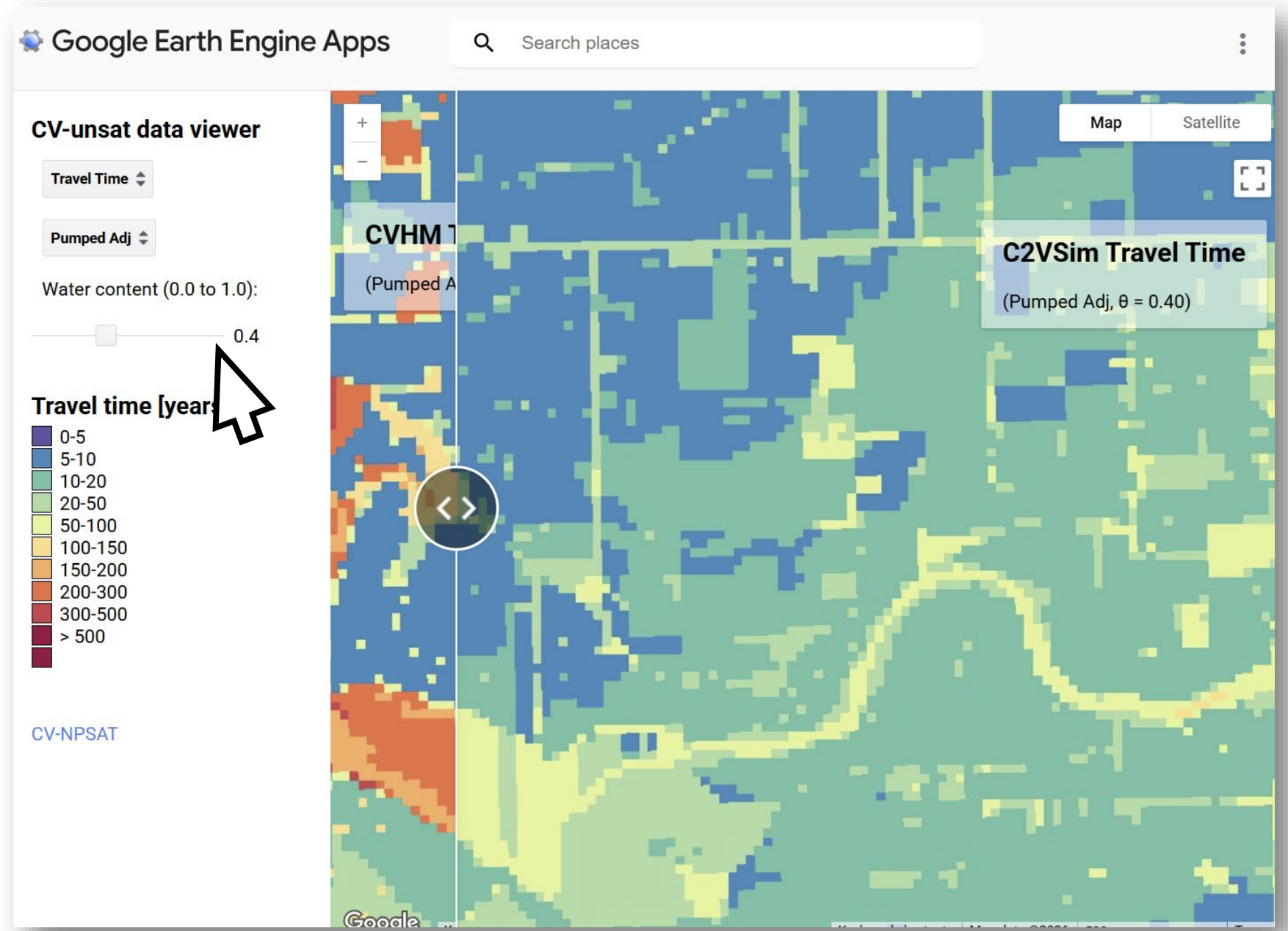


[Explore Central Valley Unsaturated Travel Time \(Google Earth\)](#)



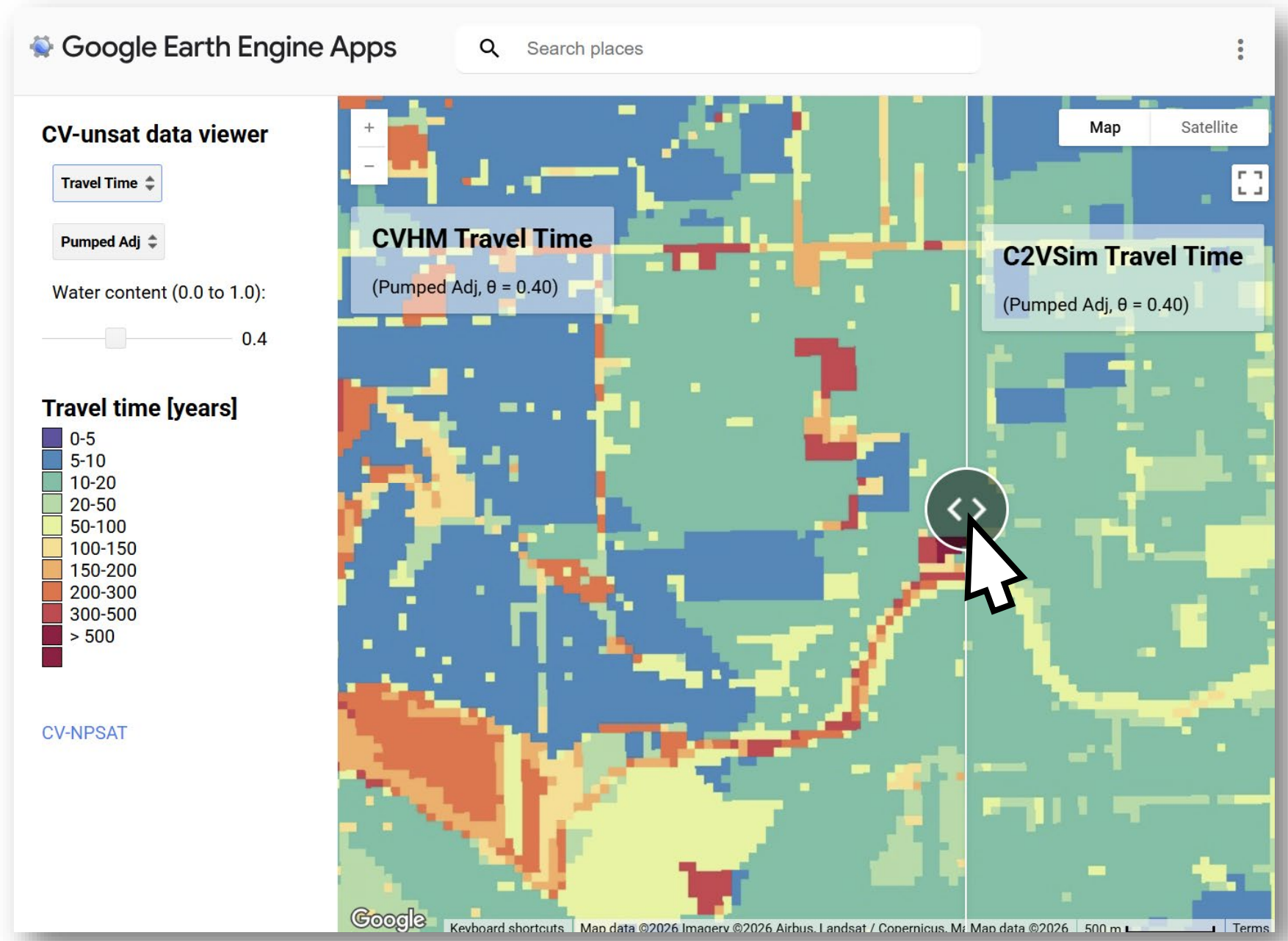
Unsaturated Zone Explorer: Depth, travel time, recharge

- Maps of:
 - Travel Time
 - Vadose Zone (Unsaturated Zone) Depth
 - Recharge
- User selects:
 - CV2VIM or CVHM2
 - Pump or Recharge adjusted
 - water content
- travel time is proportional to the ratio of
(vadose zone depth) to
(water content)



Unsaturated Zone Explorer: Depth, travel time, recharge

- Side-by-side comparison of CVHM- and C2VSIM-based estimates of these three variables
 - Travel time
 - Vadose zone depth
 - Recharge
- This is exactly the same information used in CV-NPSAT scenario simulations



Compare different scenarios

- By selecting multiple scenarios on the CV-NPSATweb home page, their results can be compared directly
- Select scenarios by checking the box to the left of the scenarios to be included (maximum: 32)
- Click “Compare Scenarios”

The screenshot shows the CV-NPSATweb interface. At the top, there is a 'Home' header and a 'Create Scenario' button. Below the header, there is a 'Scenario Type' dropdown menu. A notification bar states: 'You may select two or more models to compare. Maximum of 32.' To the right of this bar is a 'Compare Scenario' button, which is highlighted by a mouse cursor. Below the notification is a table with the following columns: Scenario Name, Description, Flow Scenario, Load Scenario, Unsat Scenario, Well Type Scenario, and Actions. The table contains several rows of scenarios, each with a checkbox in the 'Scenario Name' column. A mouse cursor is also pointing to the checkbox for the scenario 'TLB-C2pN-VD-default BAU'.

Scenario Name	Description	Flow Scenario	Load Scenario	Unsat Scenario	Well Type Scenario	Actions
<input type="checkbox"/> C2p-F-D-default-p default-wc	Everything reduced to 95%. Nuts (almonds, pistachios, walnuts) reduced to 85%.	C2VSIM with pumping adjusted to match recharge	GNLM Full Dairy	C2VSIM Typical vadose zone thickness	Domestic V	Edit Delete
<input checked="" type="checkbox"/> TLB-CVpN-VD-default BAU		CVHM2 with pumping adjusted to match recharge	GNLM No Dairy	CVHM2 Typical vadose zone thickness	Domestic V	Edit Delete
<input checked="" type="checkbox"/> TLB-CVpH-VD-Default BAU		CVHM2 with pumping adjusted to match recharge	GNLM Half Dairy	CVHM2 Typical vadose zone thickness	Domestic V	Edit Delete
<input checked="" type="checkbox"/> TLB-CVpF-VD-default BAU		CVHM2 with pumping adjusted to match recharge	GNLM Full Dairy	CVHM2 Typical vadose zone thickness	Domestic V	Edit Delete
<input checked="" type="checkbox"/> TLB-C2pN-VD-default BAU		C2VSIM with pumping adjusted to match recharge	GNLM No Dairy	C2VSIM Typical vadose zone thickness	Domestic V	Edit Delete
<input checked="" type="checkbox"/> TLB-C2pH-VD-default BAU		C2VSIM with pumping adjusted to match recharge	GNLM Half Dairy	C2VSIM Typical vadose zone thickness	Domestic V	Edit Delete
<input checked="" type="checkbox"/> TLB-C2pF-VD-default BAU		C2VSIM with pumping adjusted to match recharge	GNLM Full Dairy	C2VSIM Typical vadose zone thickness	Domestic V	Edit Delete

Compare different scenarios

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Compare Models

Scenarios Selected

Name	Description	Flow Scenario	Load Scenario	Unsat Scenario	Well Type Scenario	Regions
TLB-C2pH-VD-default BAU		C2VSIM with pumping adjusted to match recharge	GNLM Half Dairy	C2VSIM Typical vadose zone thickness	Domestic Wells	Tulare Lake Basin
TLB-CVpF-VD-default BAU		CVHM2 with pumping adjusted to match recharge	GNLM Full Dairy	CVHM2 Typical vadose zone thickness	Domestic Wells	Tulare Lake Basin
TLB-CVpH-VD-Default BAU		CVHM2 with pumping adjusted to match recharge	GNLM Half Dairy	CVHM2 Typical vadose zone thickness	Domestic Wells	Tulare Lake Basin
TLB-C2pF-VD-default BAU		C2VSIM with pumping adjusted to match recharge	GNLM Full Dairy	C2VSIM Typical vadose zone thickness	Domestic Wells	Tulare Lake Basin
TLB-CVpN-VD-default BAU		CVHM2 with pumping adjusted to match recharge	GNLM No Dairy	CVHM2 Typical vadose zone thickness	Domestic Wells	Tulare Lake Basin
TLB-C2pN-VD-default BAU		C2VSIM with pumping adjusted to match recharge	GNLM No Dairy	C2VSIM Typical vadose zone thickness	Domestic Wells	Tulare Lake Basin

Crop Selection

Crop	TLB-C2pH-VD-default BAU - Loading Percentage	TLB-C2pH-VD-default BAU - Crop Area (Acre)	TLB-CVpF-VD-default BAU - Loading Percentage	TLB-CVpF-VD-default BAU - Crop Area (Acre)	TLB-CVpH-VD-Default BAU - Loading Percentage	TLB-CVpH-VD-Default BAU - Crop Area (Acre)	TLB-C2pF-VD-default BAU - Loading Percentage	TLB-C2pF-VD-default BAU - Crop Area (Acre)	TLB-CVpN-VD-default BAU - Loading Percentage	TLB-CVpN-VD-default BAU - Crop Area (Acre)	TLB-C2pN-VD-default BAU - Loading Percentage	TLB-C2pN-VD-default BAU - Crop Area (Acre)
All Other Crops	100%	5,228,079	100%	5,228,079	100%	5,228,079	100%	5,228,079	100%	5,228,079	100%	5,228,079

At the top of the comparison screen, the first two information fields show (A) details of each scenario selected and (B) details about the Loading Percentage and acreage of each crop in the scenario

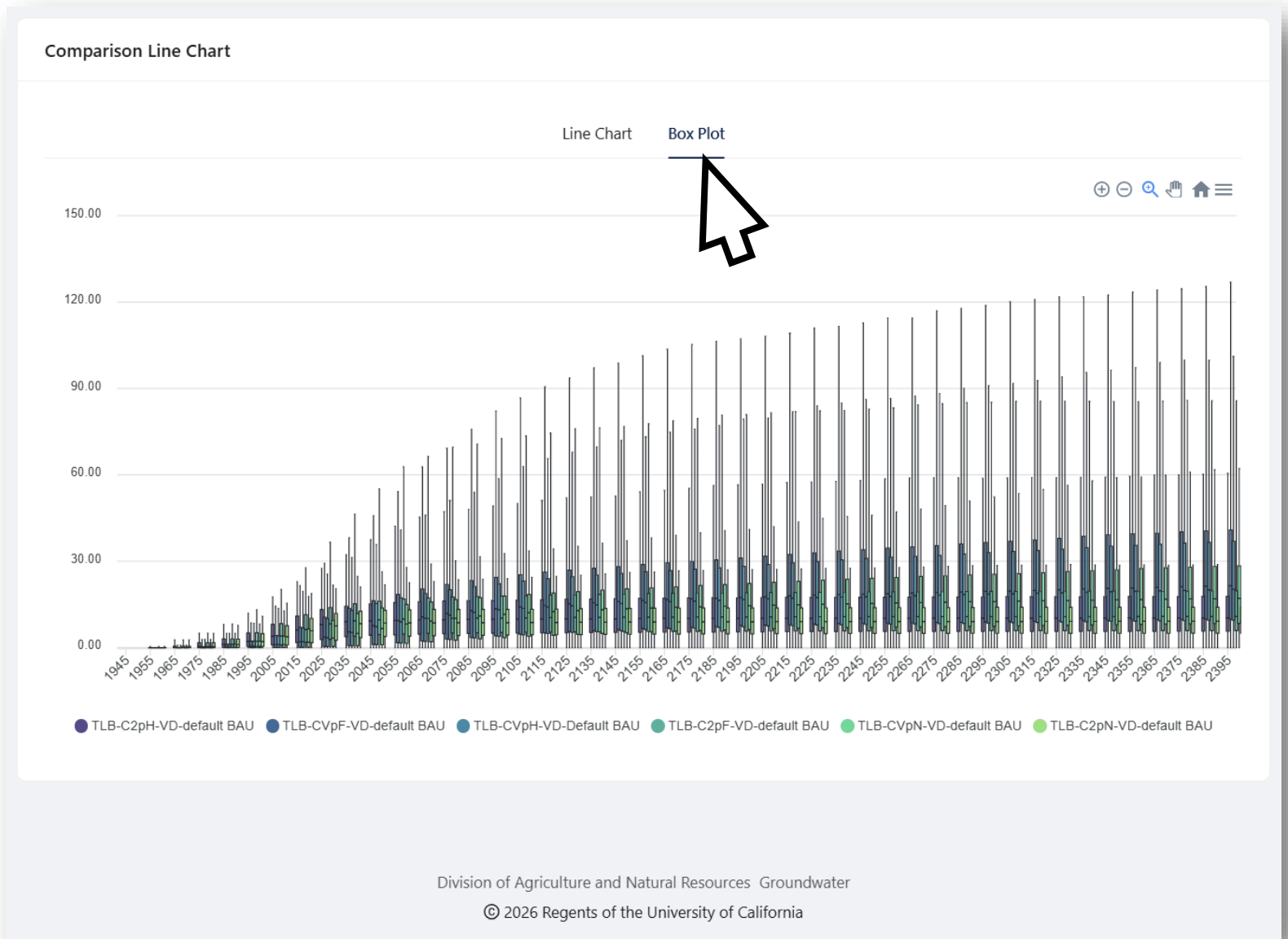
Compare different scenarios

- The Line Chart option compares
 - the nitrate-N evolution over time
 - for the user-selected percentile among the wells
 - in the area-of-interest of each scenario



Compare different scenarios

- The Box Plot shows
 - the nitrate-N evolution over time
 - Using boxplots for automatically grouped numbers of years
 - Whiskers: 5th and 95th percentile
 - Box: 25th and 75th percentile, median (horizontal line)



How to see your entire long list of scenarios

CV-NPSAT_{web}
UC DAVIS

Home Create Scenario

Scenario Type:

0 You may select two or more models to compare. Maximum of 32. Compare Scenario

<input type="checkbox"/>	Scenario Name	Description	Flow Scenario	Load Scenario	Unsat Scenario	Well Type Scenario	Year Range	Implementation Start Year	Implementation Complete Year	Water Content	Porosity	Date Created	Simulator Version	Actions
<input type="checkbox"/>	Test		C2VSIM with Pumping adjusted to match the Recharge	GNLM Full	C2VSIM Typical vadose	Domestic Wells	1945 - 2100	2026	2036	10%	10%	2026-03-16	2.2.11	Edit Delete
<input type="checkbox"/>	TLB-CVpN-VD-default BAU		CVHM2 with Pumping adjusted to match the Recharge	GNLM Ni										Edit Delete
<input type="checkbox"/>	TLB-CVpH-VD-default BAU		CVHM2 with Pumping adjusted to match the Recharge	GNLM Hi										Edit Delete
<input type="checkbox"/>	TLB-CVpF-VD-default BAU		CVHM2 with Pumping adjusted to match the Recharge	GNLM Fu										Edit Delete
<input type="checkbox"/>	TLB-C2pN-VD-default BAU		C2VSIM with Pumping adjusted to match the Recharge	GNLM Ni										Edit Delete
<input type="checkbox"/>	TLB-C2pH-VD-default BAU		C2VSIM with Pumping adjusted to match the Recharge	GNLM Hi										Edit Delete
<input type="checkbox"/>	TLB-C2pF-VD-default BAU		C2VSIM with Pumping adjusted to match the Recharge	GNLM Fu										Edit Delete
<input type="checkbox"/>	Kaweah-CVpG-VI-MiscReductions V2.2.11B	check against old version "100-400m", dairy crop reduced to 30% and others to 50%	CVHM2 with Pumping adjusted to match the Recharge	GNLM Fu										Edit Delete
<input type="checkbox"/>	Hilmar-CVpG-VD-10%CornGrainSudan V2.2.11B	An evaluation of large reductions in manure loading.	CVHM2 with Pumping adjusted to match the Recharge	GNLM Full	CVHM2 Typical vadose zone thickness	Domestic Wells	1945 - 2400	2026	2036	20%	40%	2026-03-10	2.2.11	Edit Delete
<input type="checkbox"/>	SAC-CVpG-VD V2.2.11B	BAU for reference/comparison, CVHM2pump-adjusted, GNLMfull, 40p/20wc	CVHM2 with Pumping adjusted to match the Recharge	GNLM Full	CVHM2 Typical vadose zone thickness	Domestic Wells	1945 - 2400	2025	2035	20%	40%	2026-03-10	2.2.11	Edit Delete

< 1 2 3 4 5 6 >

10 / page

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20 / page

50 / page

< 1 2 3 4 5 6 > 10 / page

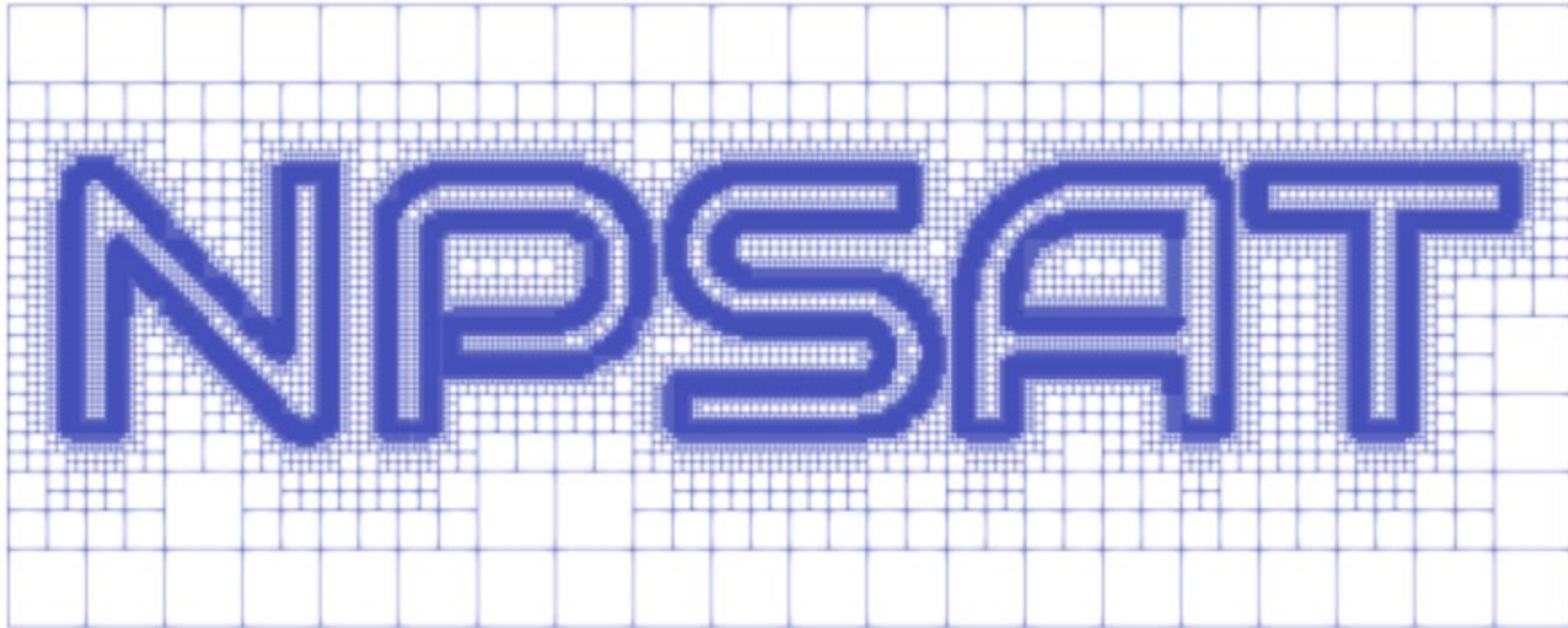
Home screen: how to find specific types of scenarios

- Scenarios can be found by type:
 - Flow scenario
 - Load scenario
 - Unsaturated Zone scenario
 - Well Type scenario

The screenshot shows the 'Home' page of the CV-NPSAT web application. At the top, there is a search bar labeled 'Filter Scenarios' with a magnifying glass icon. Below the search bar, a dropdown menu is open, displaying a list of scenario types: GNLM No, Unsat Scenario, C2VSIM Typical vadose zone thickness, CVHM2 Typical vadose zone thickness, Well Type Scenario, Domestic Wells, Public Supply Wells and Irrigation Wells, and Virtual Shallow Monitoring Well Network Grid. A mouse cursor is pointing at the 'Unsat Scenario' option. To the left of the search bar, there is a label 'Scenario Type:' and a blue information icon with the text 'You may s'. Below the search bar, there are several checkboxes and labels: 'Scenar', 'Test', and 'TLB-CVpN-VD-default'. At the bottom right, there is a label 'CVHM2 with Pumpin'.

Important Final Disclaimers

- The CV-NPSAT Framework encompasses information about sources, pathways, and receptors (wells) of nitrate pollution in the Central Valley
- It assembles the best available information on all of these aspects of the nonpoint source pollution process
- Necessarily, the complexity of the process across the Central Valley is such that even with the best information and the best tools, there remain many uncertainties, which in turn affect the accuracy of the results.
- CV-NPSAT_{web} nitrate breakthrough curves, source areas, vadose zone information, or groundwater travel time distributions obtained from CV-NPSAT for a specific well are highly uncertain and must not be taken as a close-to-realistic prediction.
- Making accurate predictions for a specific well would take a large amount of field investigation and years of observation, no matter how “fancy” or physically representative of all processes a model may be
- CV-NPSAT_{web} focuses on predicting the median and various percentiles of the nitrate distribution across wells in an area-of-interest
- The larger the area-of-interest (minimum: township / 20 wells), the more reliable is the estimate of the median and percentile distribution.
- The concentrations associated with the percentiles outside the interquartile range (25th to 75th percentile) are much less certain than those within the interquartile range. Predicting the likelihood of very high (or very low) nitrate is no less difficult (or reliable) than, e.g., making a forecast for a 100-year flood or a 1000-year flood from a 20-year streamflow record



<https://npsat.ucdavis.edu>

