Introduction to GIS Model Predict --California's Pesticide Use Reporting Database and Applications

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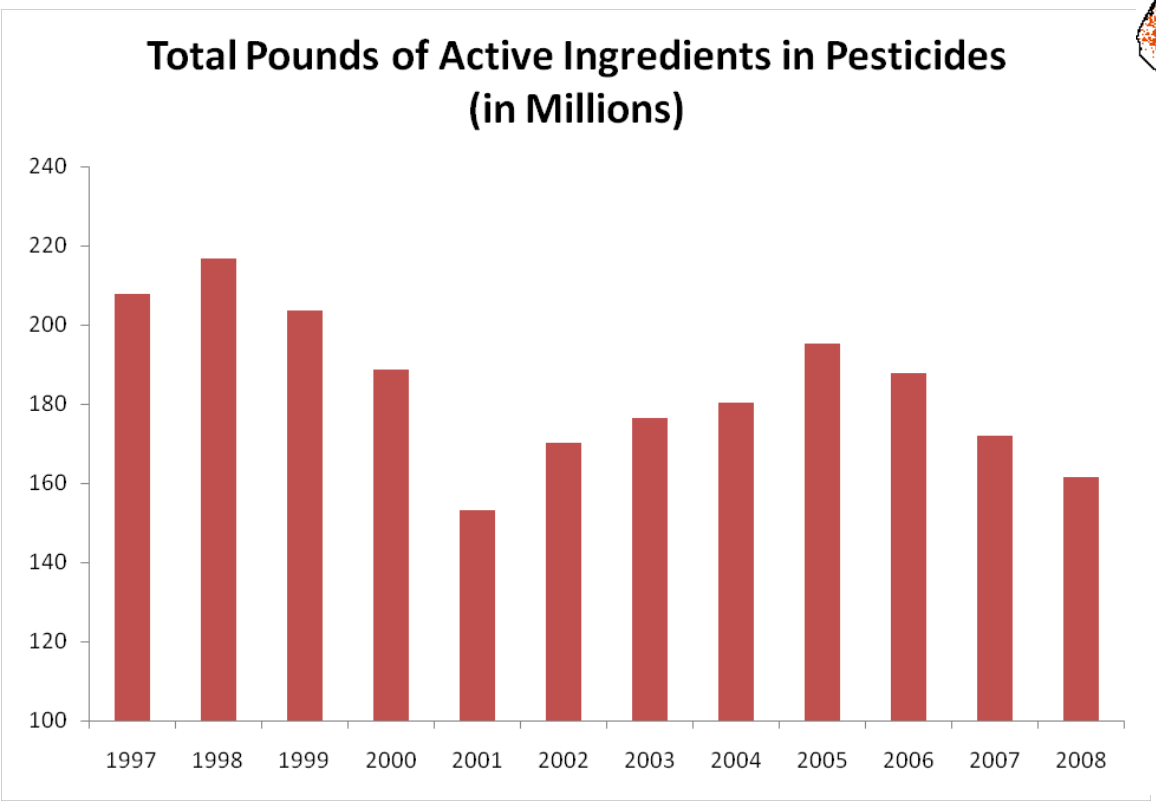
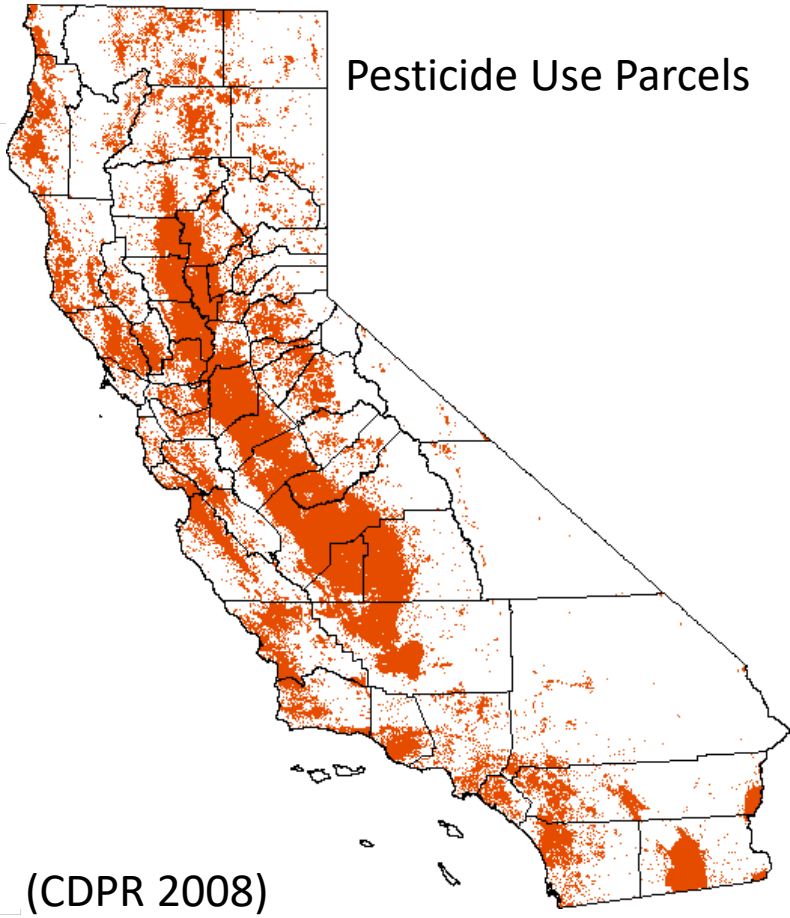
Intensive Pesticide Use in California

- California has 2-3% of the nation's croplands, yet accounts for 25% of the nation's pesticide use (Brady et al. 2006).





(CDPR 2008)

Outline

I. **Pesticide Use Reporting (PUR) Database**
   http://www.cdpr.ca.gov/docs/pur/purmain.htm

II. **PUR Query Tool - PURWebGIS**
   http://purwebgis.ucdavis.edu/PURwebGIS.html

III. **Pesticide Use Risk Evaluation (PURE) System**
   http://pure.ucdavis.edu

IV. **Surface Water Quality Modeling Using Soil and Water Assessment Tool (SWAT)**

I. Pesticide Use Reporting (PUR) Database

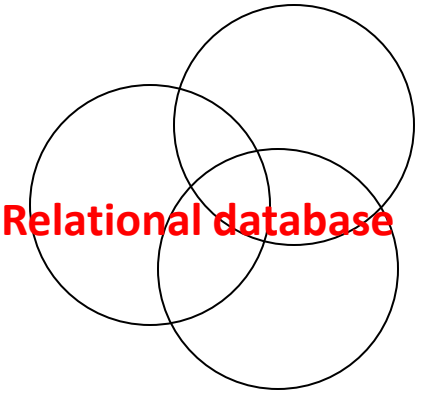
P U R

Pesticide Use Report

Identifications
County code
MTRS (section)
Operator ID
Permit number
Site Location ID
Site (crop) ID
Qualifier code
Commodity treated
Acres planted

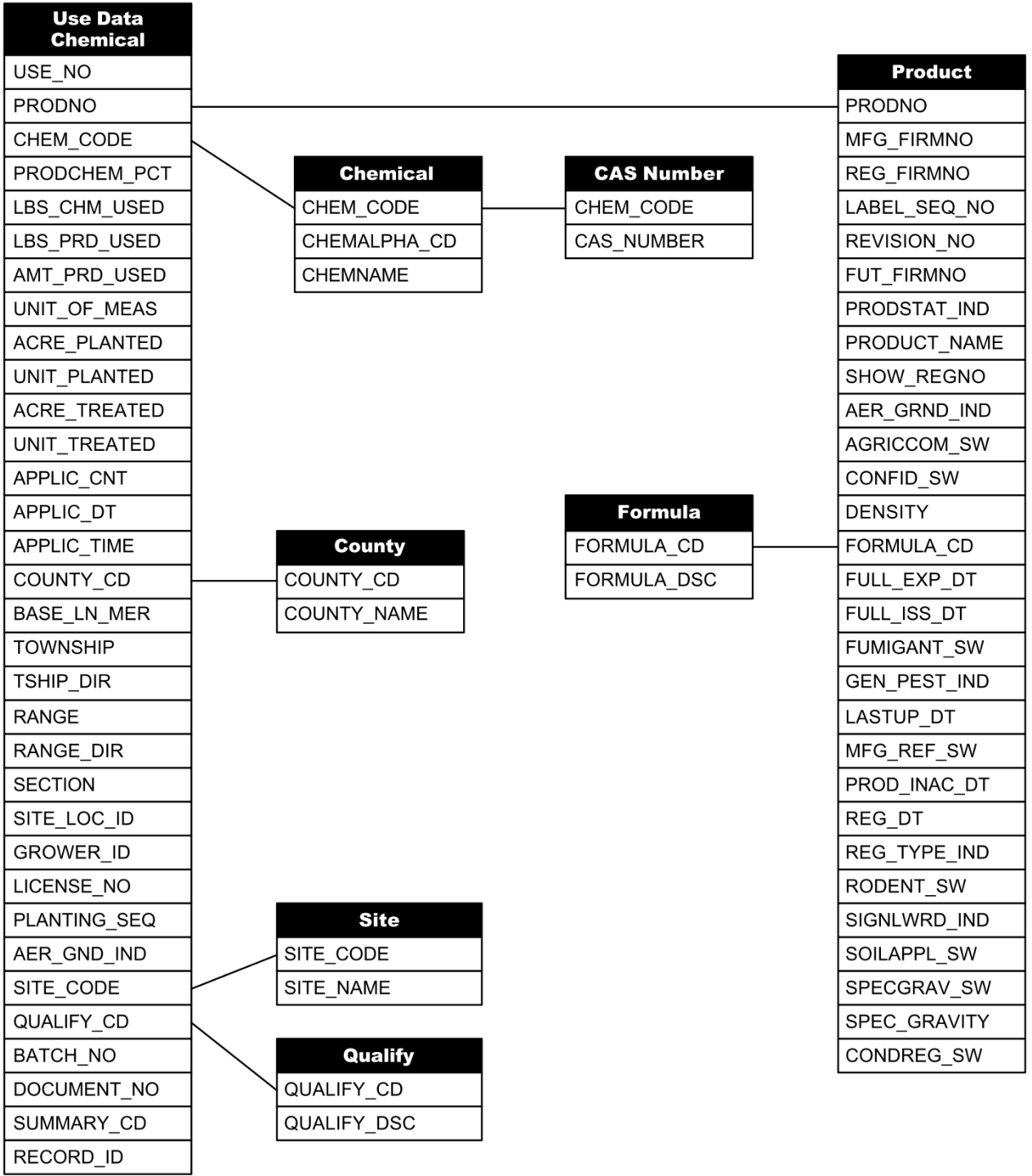
Chemical Use
Chemical code
Lbs of chemical used
Acres treated
Lbs of product used
# of applications
Date of application
Application method
……

Record keeping
Record #
(Ag vs non-Ag)
Batch #
EPA registration #



1. Assist in addressing water and air quality issues
2. Assess pesticide use trends for pest management
3. Used to conduct worker health and exposure……

Database Scheme



History of PUR

- California first required limited reporting of pesticide use by 1950.
- The PUR database contains records starting in 1974.
- Current full use reporting system started in 1990.
- The PUR database contains about 2.5 million records for each year since 1990.

What is Reported?

- All pesticide applications in California production agriculture must be reported to the appropriate County Agricultural Commissioner's office.
- All pesticide applications made by commercial pest control businesses must be reported.
- The exceptions: pesticide applications made by home and garden use or most institutional use are not reported.

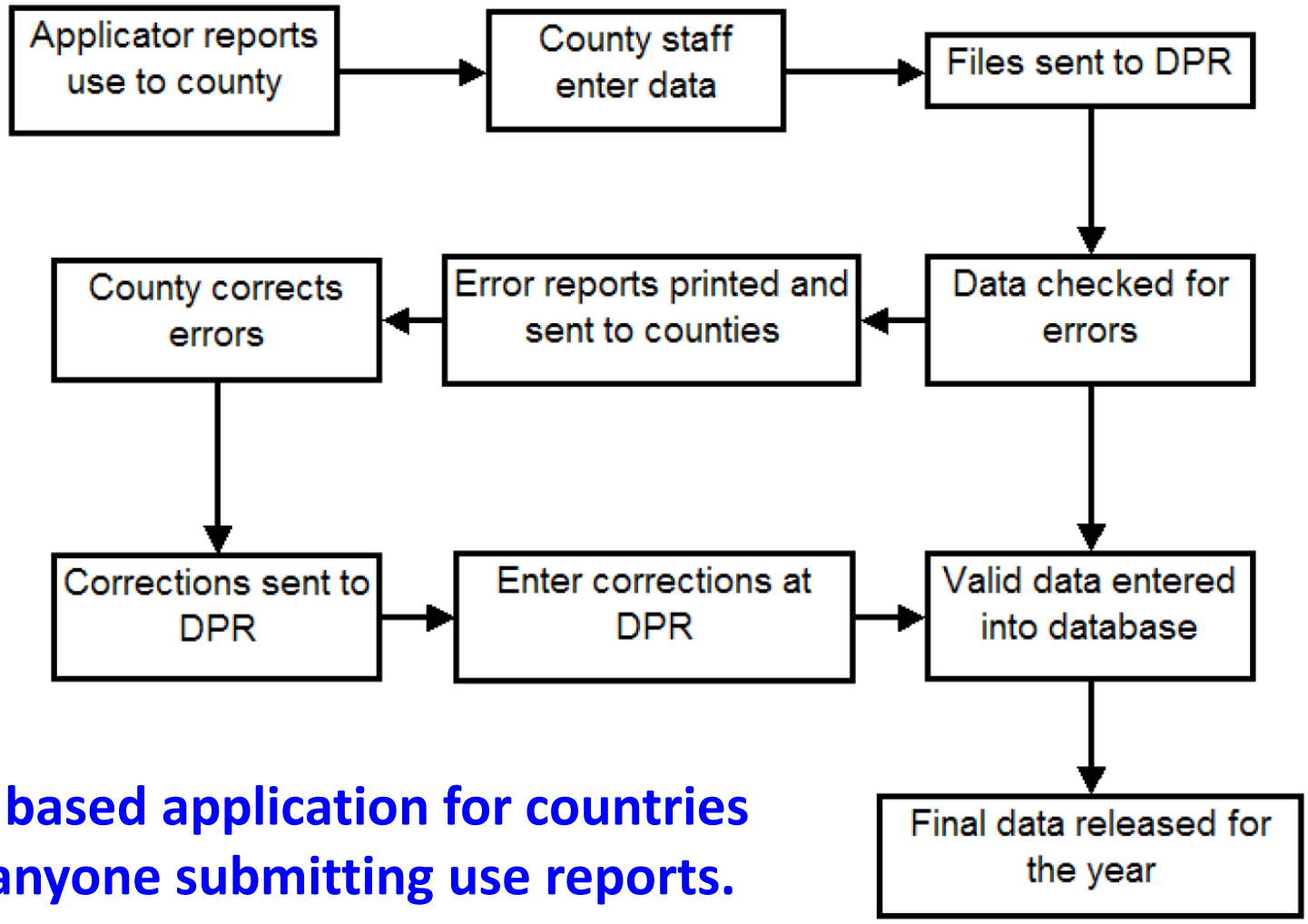
Two Types of PUR Records

- Production agricultural applications
  - Applications to agricultural fields
  - California defines agriculture broadly, including forests, parks, rangelands, turf
  - Each record in the PUR refers to one application of a pesticide product
- Monthly summary reports
  - All other uses by commercial applicators (post harvest, landscape, structural)
  - Each record refers to total use of a pesticide during each month on a site in a county by the applicator

Data Collected for Production Agricultural Records

- Pesticide product used (its name and EPA registration number)
- Amount of product used, in gallons, pounds, or other units
- Crop treated
- Area of the crop planted
- Area of the crop treated
- Date of treatment
- Geographic location of the treatment (to a square mile)
- Grower of operator identifier
- Field identifier
- Method of application (by air, ground, or other method)

Process from Grower to PUR



Web based application for countries and anyone submitting use reports.

PUR Data Quality

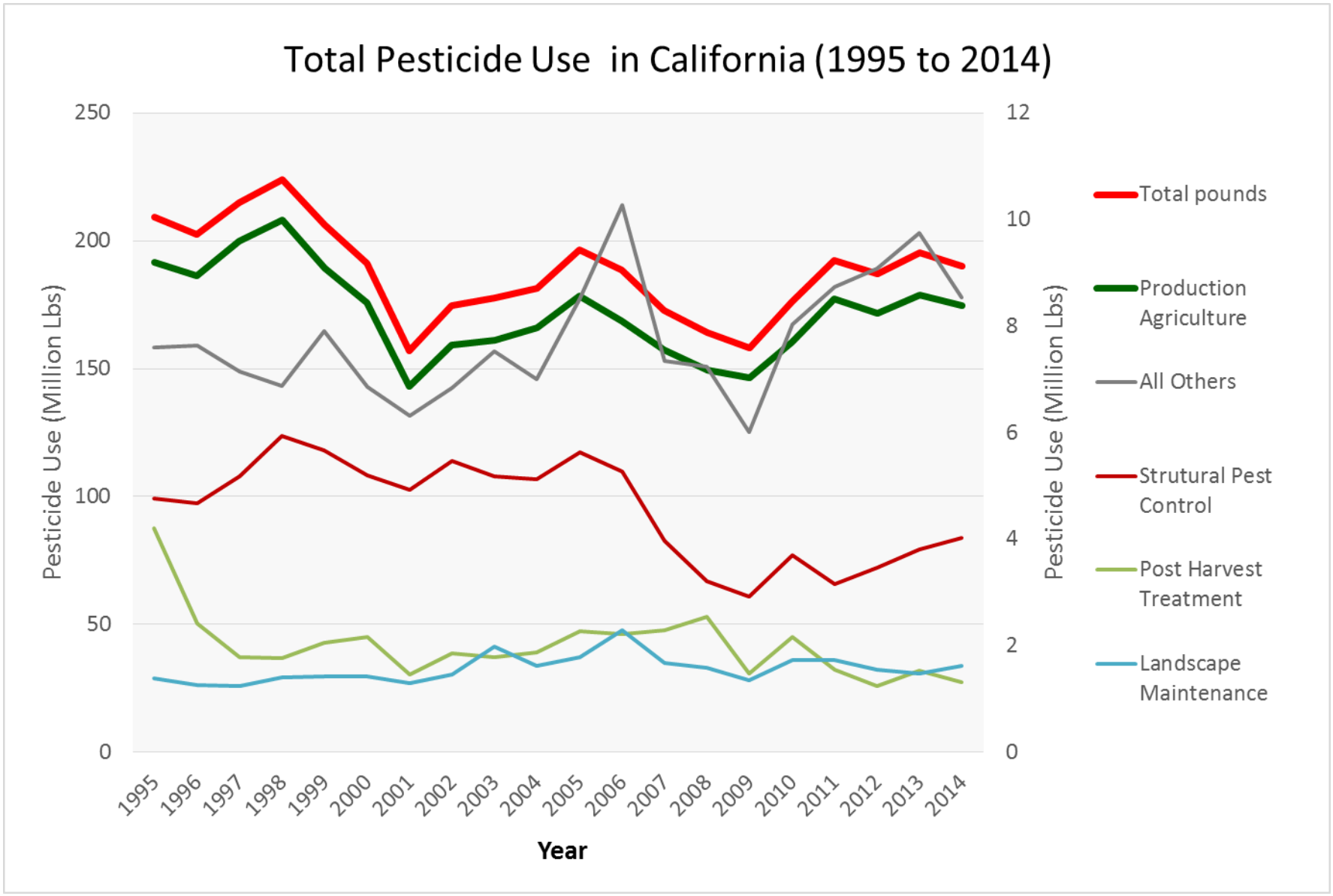
- All records are checked for 40 different possible errors
- Error rate less than 0.5%
- Probably 80 to 90% of actual use is reported

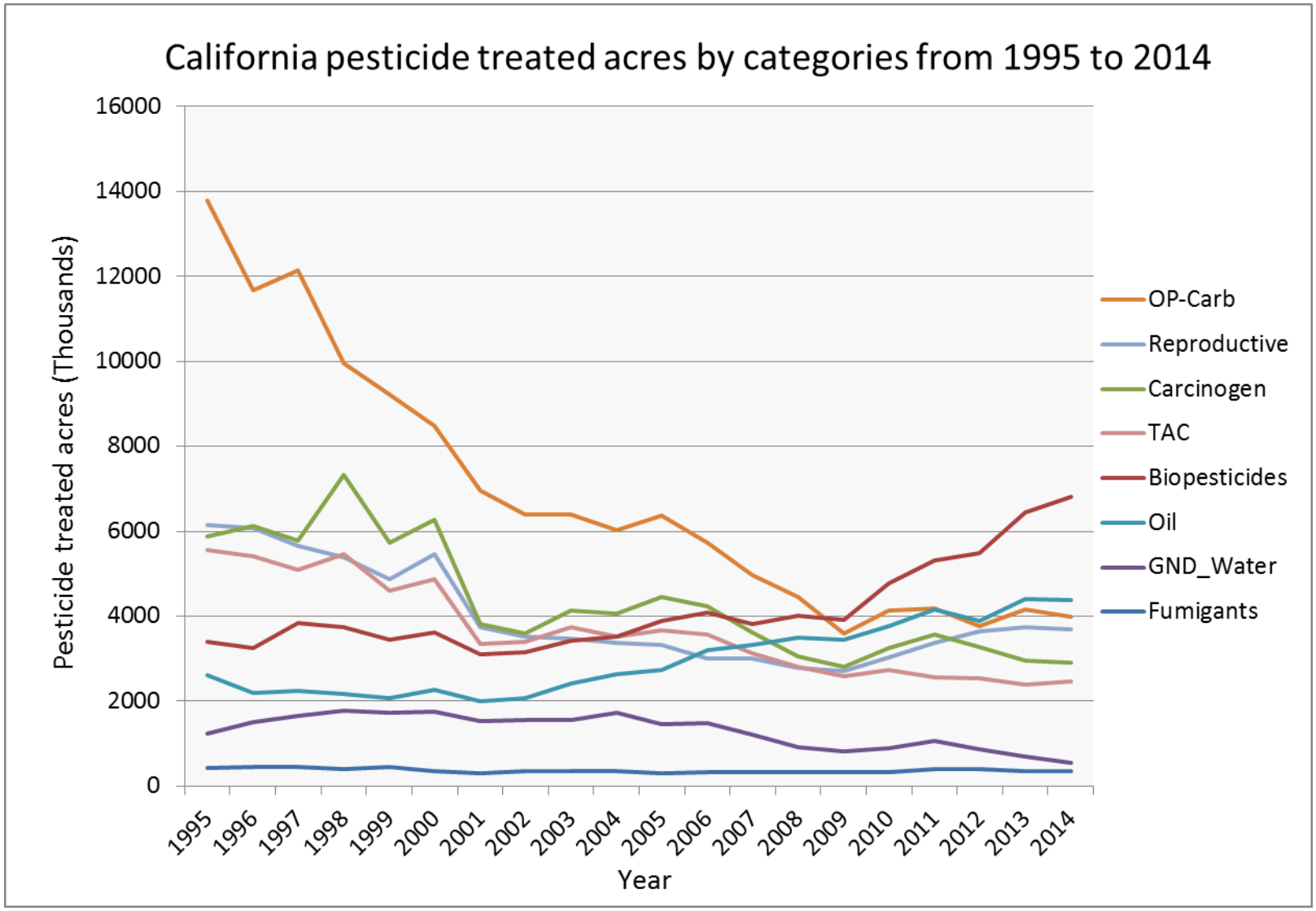
Strengths of PUR

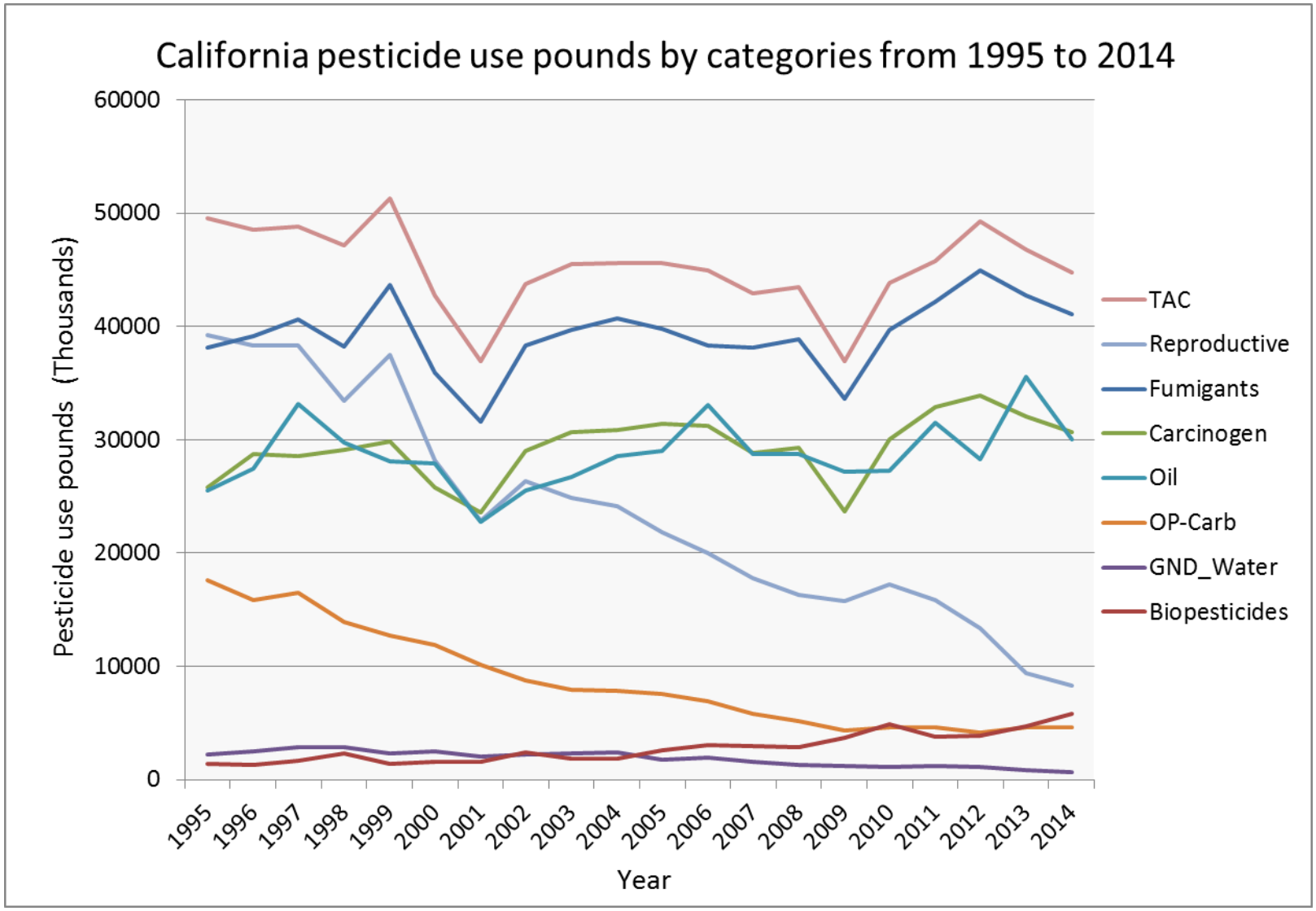
- PUR data includes detailed records of each agricultural application.
- Data are obtained from a census not just samples.
- Data are GIS friendly.
- Data can be linked with many other databases on the chemical, environmental, and health properties of pesticides.

Uses of the PUR

- Dietary risk and exposure assessments
- Epidemiological studies
- Environmental monitoring
- Volatile Organic Compound (VOC) regulations
- Endangered species
- Pest management strategies
- Marketing
- Almost endless number of ways…


Total Pesticide Use in California (1995 to 2014)
Pesticide Use (Million Lbs)
250
200
150
100
50
0
12
10
8
6
4
2
0
Pesticide Use (Million Lbs)
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year
Total pounds
Production Agriculture
All Others
Strutural Pest Control
Post Harvest Treatment
Landscape Maintenance

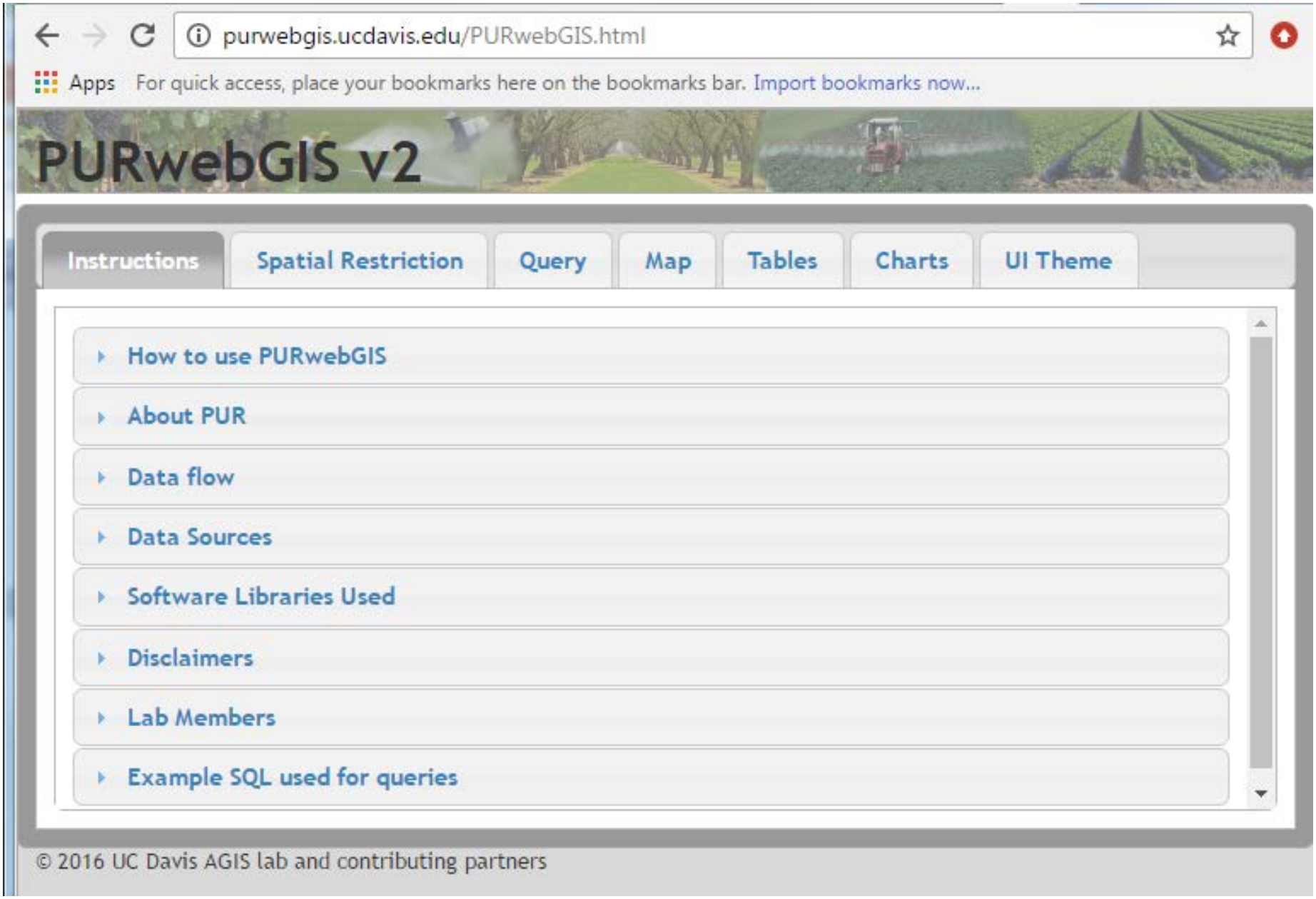

California pesticide treated acres by categories from 1995 to 2014
Pesticide treated acres (Thousands)
16000
14000
12000
10000
8000
6000
4000
2000
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year
OP-Carb
Reproductive
Carcinogen
TAC
Biopesticides
Oil
GND_Water
Fumigants

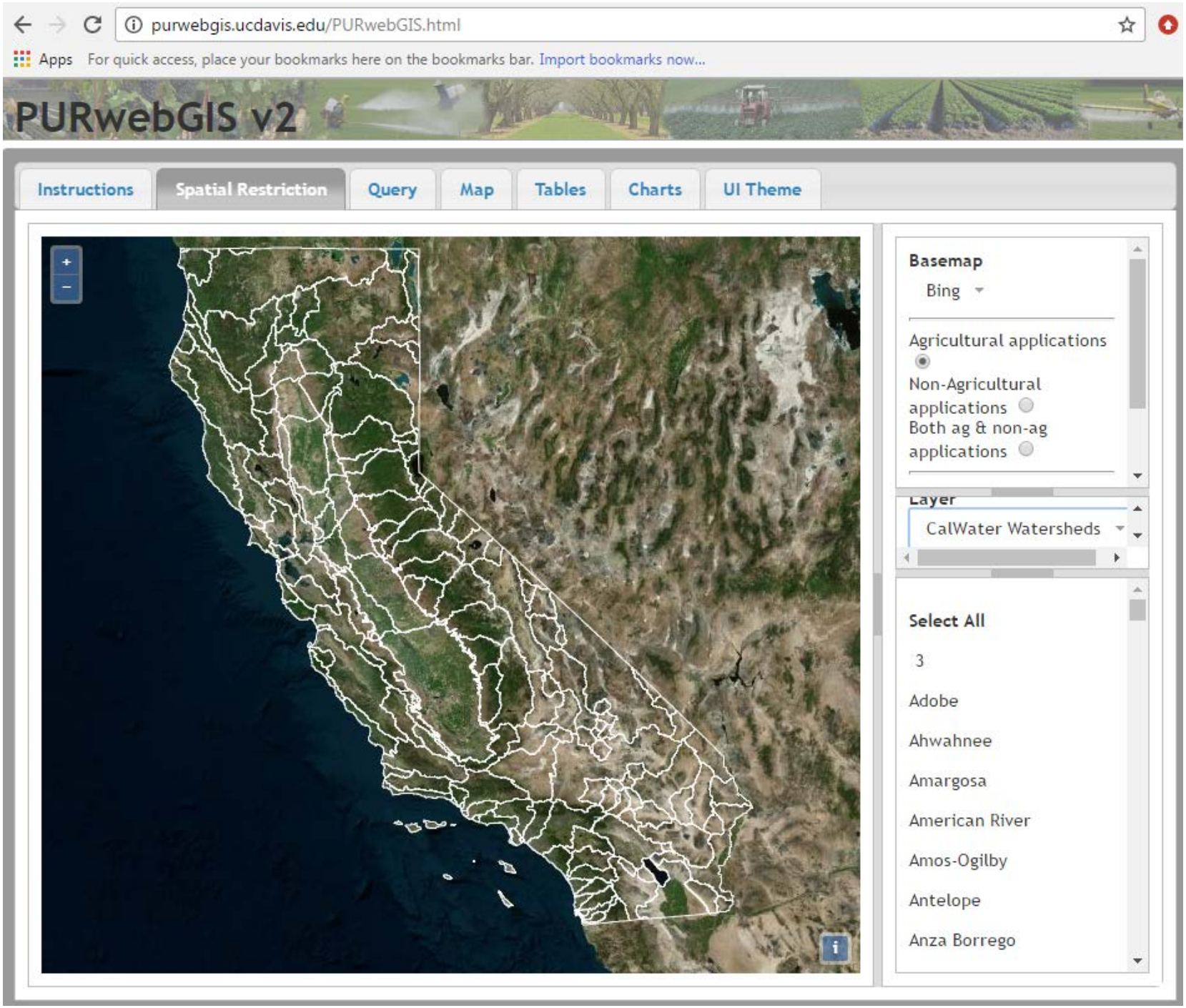

California pesticide use pounds by categories from 1995 to 2014
Pesticide use pounds (Thousands)
60000
50000
40000
30000
20000
10000
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year
TAC
Reproductive
Fumigants
Carcinogen
Oil
OP-Carb
GND_Water
Biopesticides

Raw Data Format of PUR

use_no	prodno	chem_code	prodchem_pct	lbs_chm_used	lbs_prd_used	amt_prd_used	unit_of_meas	acre_planted	unit_planted	acre_treated	unit_treated
3952658	26368				14.3224	240	OZ				
3952169	58635	5820	48.7	35.5138906	72.9238	824	OZ				
3952133	56369	2308	24	12.9948	54.145	416	OZ				
3950259	58635	5820	48.7	87.2331445	179.1235	2024	OZ				
4061990	23072	161	99	82.17	83	83	LB	29	A	8.3	A
4061991	50073	151	76.77	30.708	40	40	LB	29	A	10	A
4061997	49295	677	54	7.790256	14.4264	1.3	GA	29	A	8	A
4061999	50073	151	76.77	24.5664	32	32	LB	29	A	8	A
4062000	50073	151	76.77	19.65312	25.6	25.6	LB	29	A	6.4	A
4062002	49295	677	54	6.591726	12.2069	1.1	GA	29	A	6.4	A
4060787	50014	1685	97	3.97215	4.095	4.095	LB	25	A	8.19	A
4062044	35055	4037	50	0.00925	0.0185	8.4	GR	7	A	15000	S
4062047	56792	3849	21.4	0.0617818	0.2887	4	OZ	7	A	6000	S
4062048	5947	161	99	4.95	5	5	LB	50	A	0.5	A
4062054	50073	151	76.77	46.8297	61	61	LB	13	A	12.2	A
4062055	61767	3850	38.7	2.7437139	7.0897	97.6	OZ	13	A	12.2	A
4062059	55399	4011	22.5	0.0469125	0.2085	3	OZ	10	A	12000	S
4062065	49295	677	54	2.808972	5.2018	60	OZ	10	A	37500	S
4062076	3833	2254	1.9	0.0034067	0.1793	90	ML	7	A	12500	S
4062079	58825	7	85	0.207995	0.2447	111	GR	7	A	2000	S
4061164	56792	3849	21.4	0.210041	0.9815	13.6	OZ	29	A	8	A
4061053	50073	151	76.77	10.7478	14	14	LB	73	A	3.5	A
4061062	64365	3898	40	3.356	8.39	3.2	QT	29	A	6.4	A
4061065	49295	677	54	6.591726	12.2069	1.1	GA	29	A	6.4	A
4061072	64365	3898	40	5.24372	13.1093	1.25	GA	29	A	10	A
4061075	49295	677	54	3.745332	6.9358	5	PT	9	A	5	A
4061078	14682	6103	27.15	3.28495995	12.0993	5	QT	9	A	5	A
4061085	49295	677	54	9.73782	18.033	13	PT	13	A	13	A
4061086	14682	6103	27.15	3.28495995	12.0993	5	QT	9	A	5	A
4061093	49295	677	54	6.741576	12.4844	9	PT	26	A	9	A
4062015	56792	3849	21.4	0.2625566	1.2269	17	OZ	29	A	10	A
4062026	63038	404	69.6	14.7870072	21.2457	2.5	GA	29	A	5	A
4061101	49295	677	54	6.741576	12.4844	9	PT	26	A	9	A
4060758	50073	151	76.77	27.6372	36	36	LB	73	A	12	A

II. PURWebGIS

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Non-Agricultural applications
Both ag & non-ag applications
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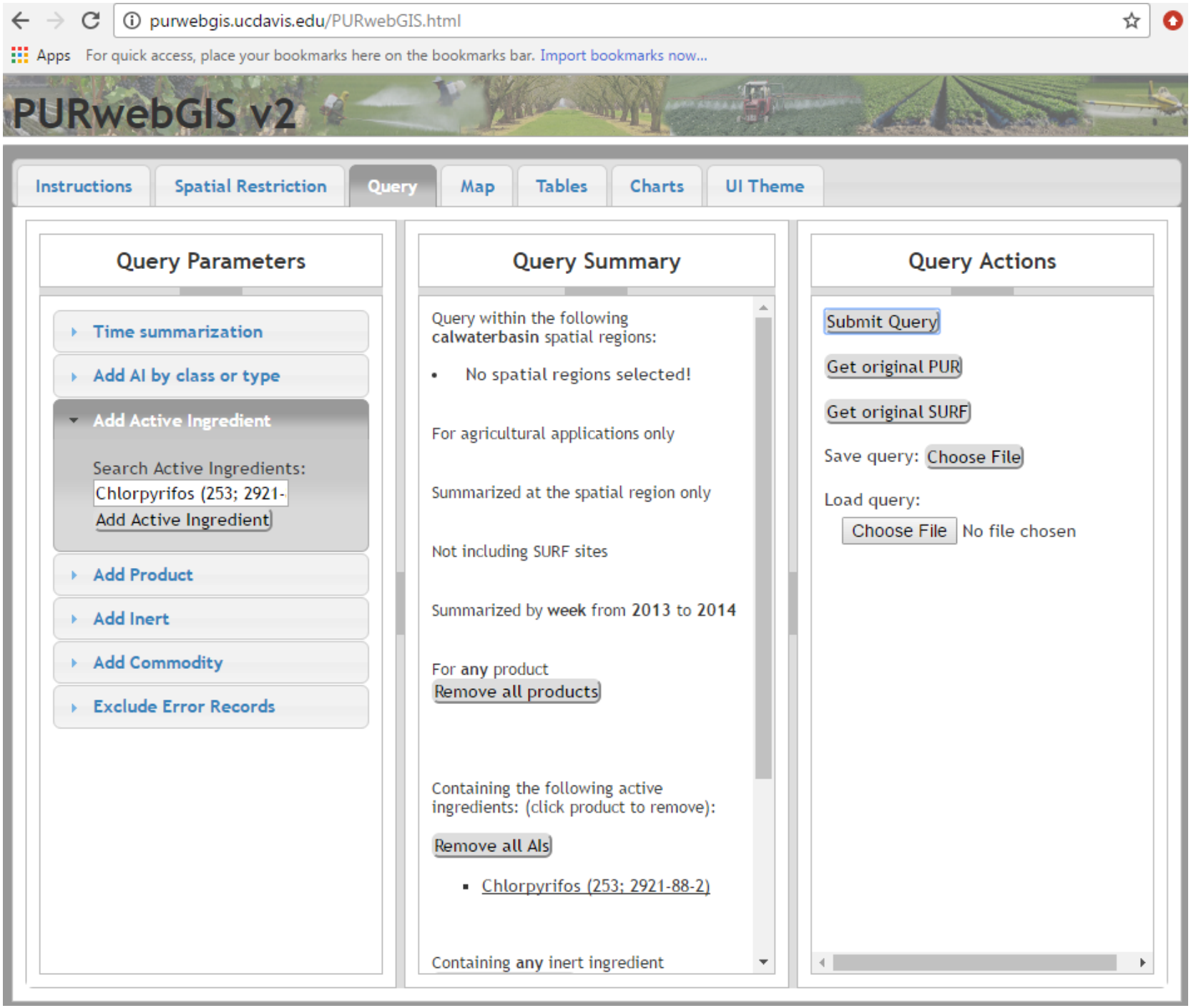
Ahwahnee
Amargosa
American River
Amos-Ogilby
Antelope
Anza Borrego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Time summarization
Add AI by class or type
Add Active Ingredient
Search Active Ingredients:
Chlorpyrifos (253; 2921-
Add Active Ingredient
Add Product
Add Inert
Add Commodity
Exclude Error Records
Query Summary
Query within the following calwaterbasin spatial regions:
No spatial regions selected!
For agricultural applications only
Summarized at the spatial region only
Not including SURF sites
Summarized by week from 2013 to 2014
For any product
Remove all products
Containing the following active ingredients: (click product to remove):
Remove all AIs
Chlorpyrifos (253; 2921-88-2)
Containing any inert ingredient
Query Actions
Submit Query
Get original PUR
Get original SURF
Save query: Choose File
Load query:
Choose File
No file chosen

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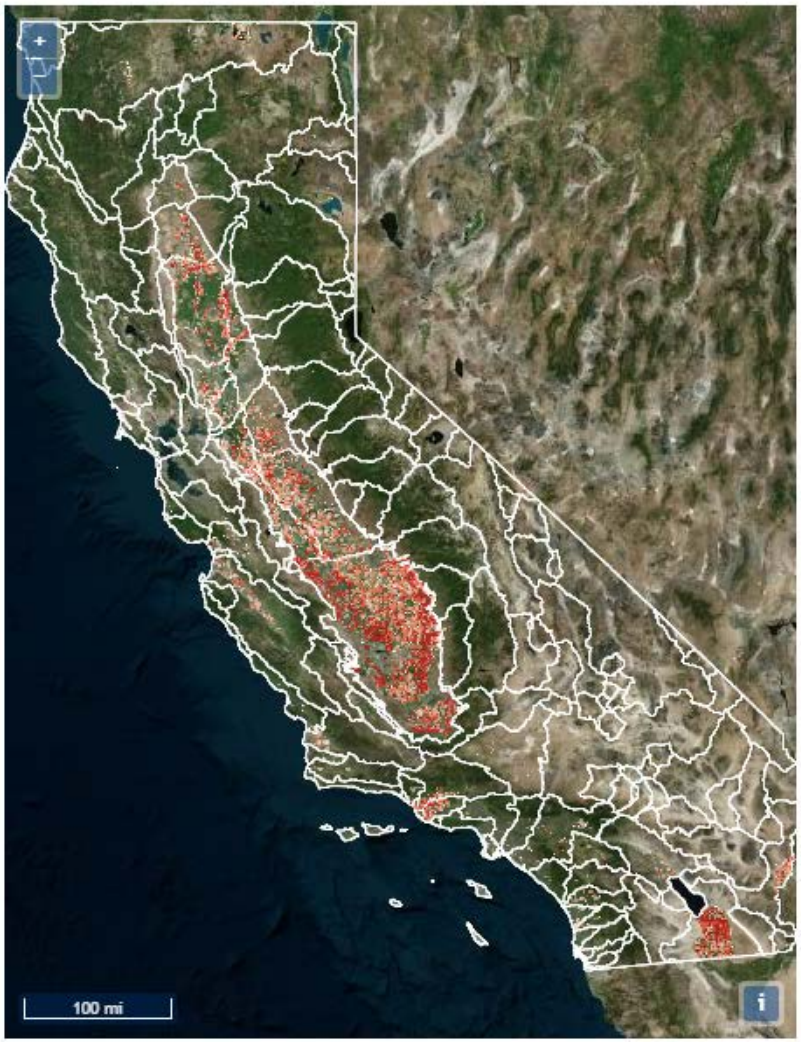


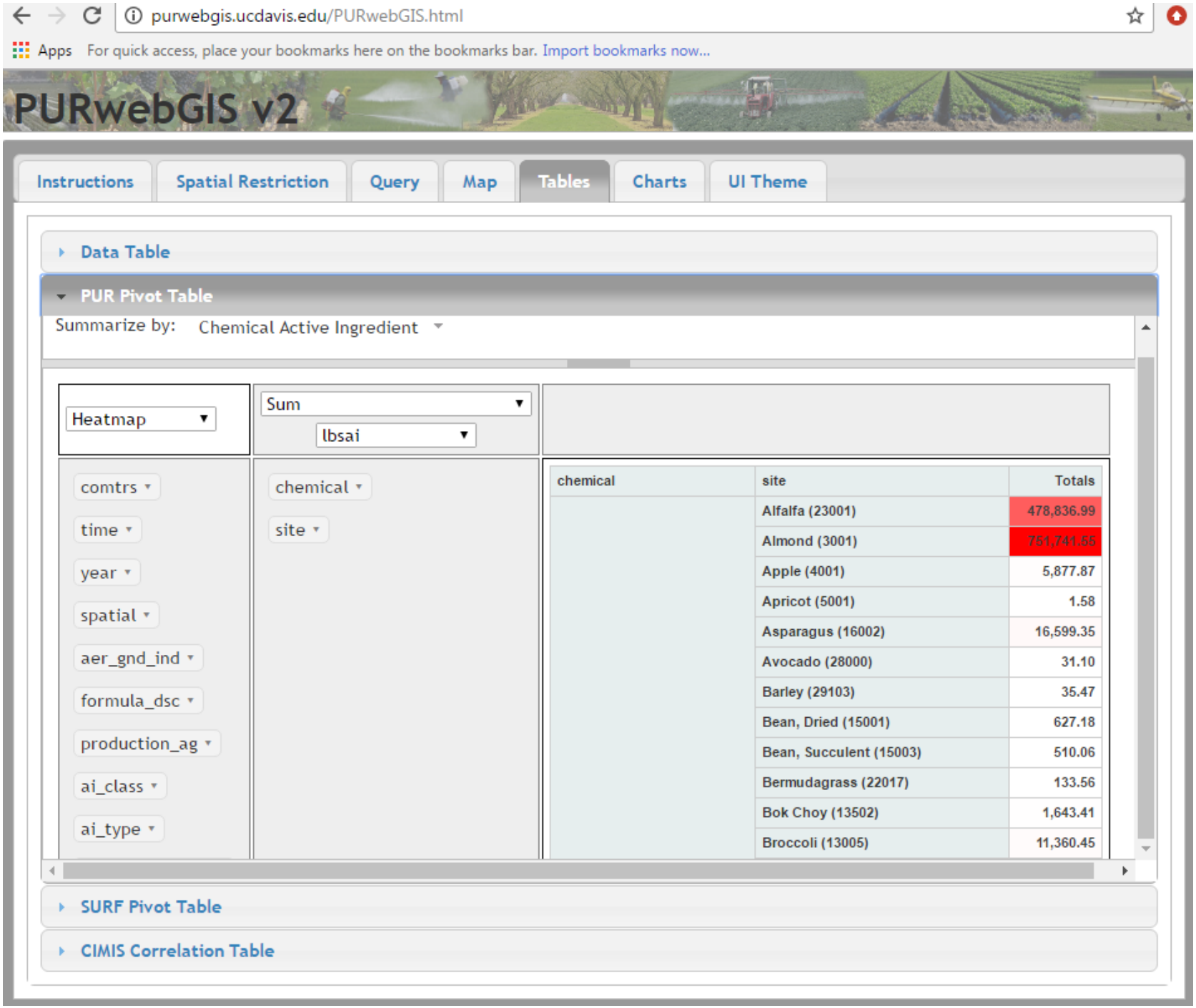
Download Map

Basemap

Bing

Click on layer nodes below to change their properties

- **Basemap**
  - Visible
  - Opacity
- **Query: spatial restriction level choropleth**
  - Visible
  - Opacity
  - Summary Units: Pounds Active Ingredient
  - Load Summary Data Values:
    - Choose File: No file chosen
  - Color scale: Outline Only
  - Number of Colors: 4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Summarize by: Chemical Active Ingredient
Heatmap
Sum
lbsai
comtrs
time
year
spatial
aer_gnd_ind
formula_dsc
production_ag
ai_class
ai_type
chemical
site
chemical
site
Totals
Alfalfa (23001) 478,836.99
Almond (3001) 751,741.55
Apple (4001) 5,877.87
Apricot (5001) 1.58
Asparagus (16002) 16,599.35
Avocado (28000) 31.10
Barley (29103) 35.47
Bean, Dried (15001) 627.18
Bean, Succulent (15003) 510.06
Bermudagrass (22017) 133.56
Bok Choy (13502) 1,643.41
Broccoli (13005) 11,360.45
SURF Pivot Table
CIMIS Correlation Table

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Timeseries Line Chart

PUR Chart Visible

PUR chart parameters

Dependent Variable:

Pounds Active Ingredien

Summarize by:

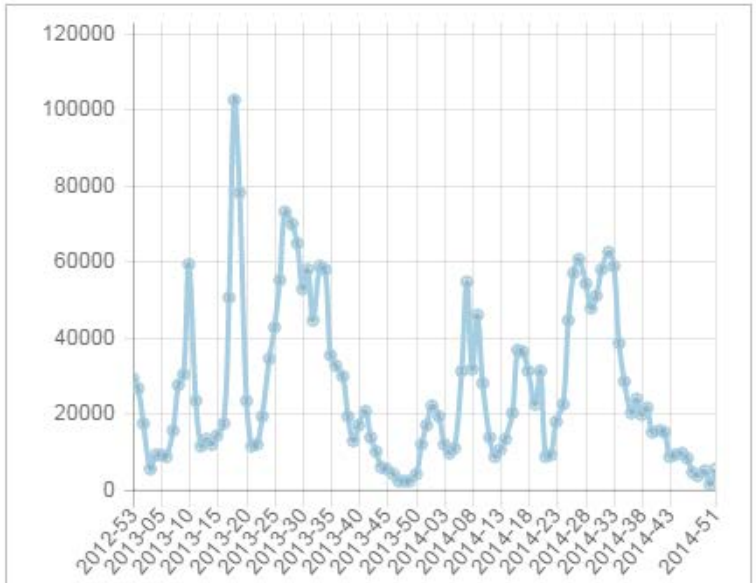
Active Ingredient

Limit to top: All

Download Chart

PUR Legend

Chlorpyrifos (253; 2921-88-2)



SURF chemical concentration (ppb) vs time by site

CIMIS chart Visible

CIMIS chart parameters

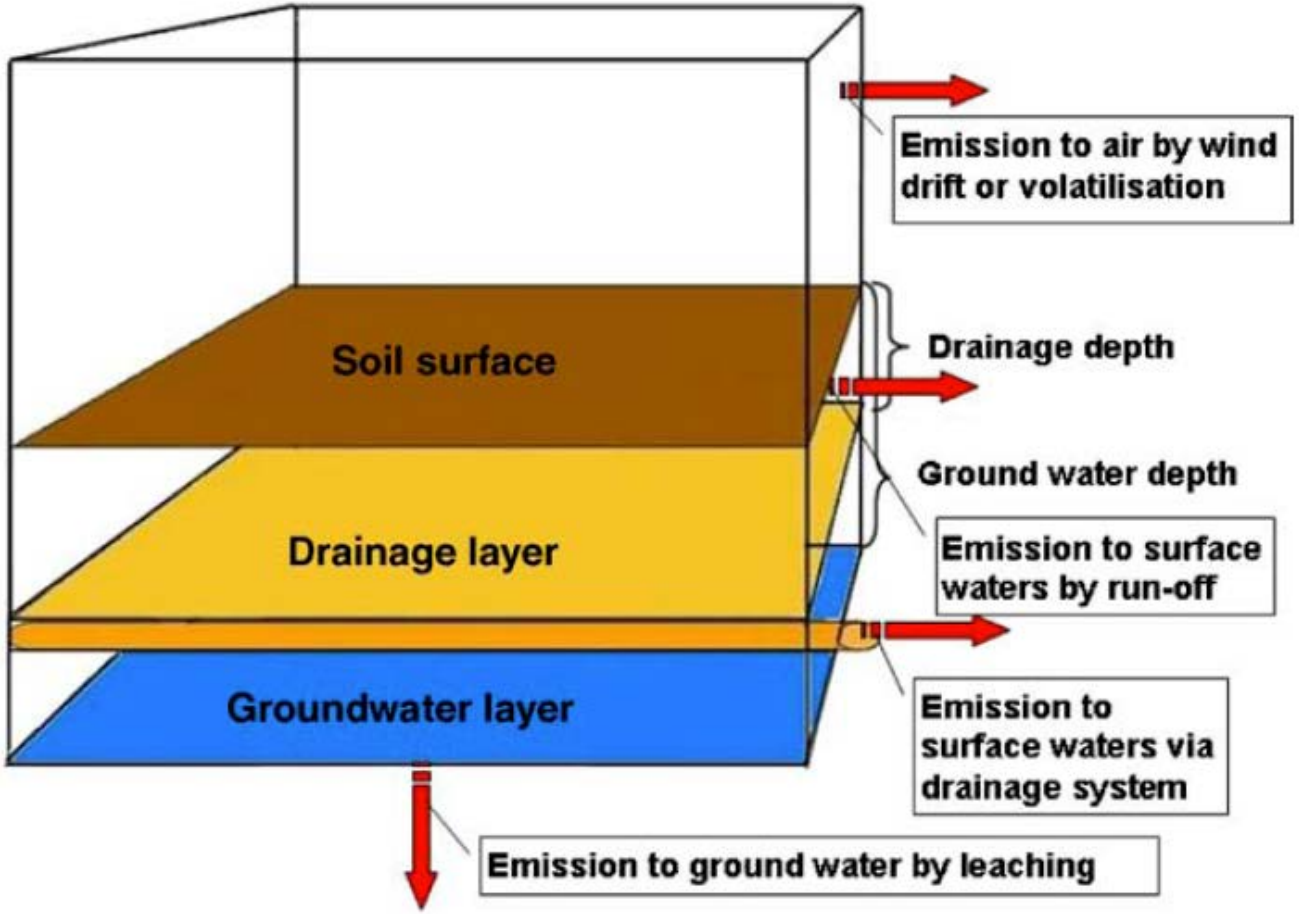
Summarize by:

Download CIMIS data

CIMIS Legend

Pie Chart

Pesticide Transport



(Birkved and Hauschild 2006)

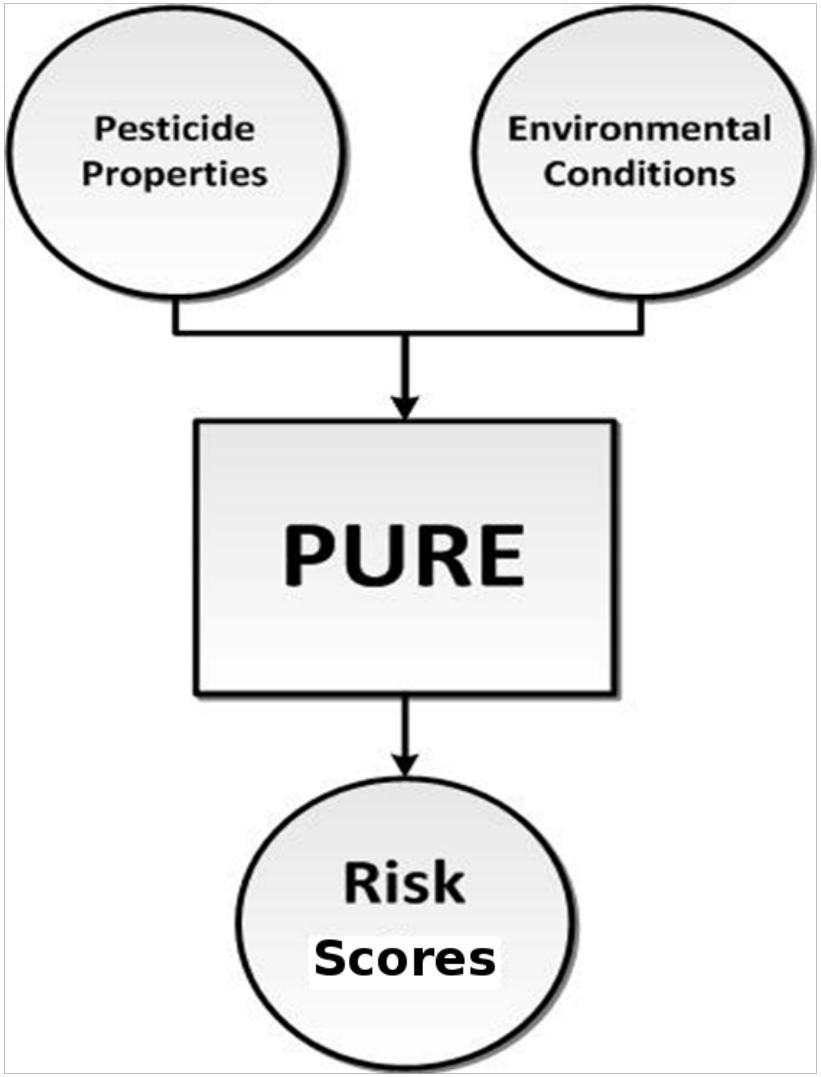
Table 1 Pesticide risk evaluation models

Acronym	Model	Methodology*	Country	Year	Reference
EIQ	Environmental Impact Quotient	S	USA	1992	(Kovach et al. 1992)
SSRP	Site Specific Pesticide Recommendations	S	USA	1992	(Hornsby 1992)
PI	Pesticide Index	S	Australia	1994	(Penrose et al. 1994)
CHEMS 1	Chemical Hazard Evaluation for Management Strategies	S	USA	1997	(Swanson et al. 1997)
EEP	Environment Exposure to Pesticides	S	Netherlands	1997	(Wijnands 1997)
SYNOPS 1.1	Synoptic Evaluation Model for Plant Protection Agents 1.1	R	Germany	1997	(Gutsche and Rossberg 1997)
Ipest	Pesticide Environmental Impact Indicator	F	France	1998	(van der Werf and Zimmer 1998)
PERI	Pesticide Environmental Risk Indicator	S	Sweden	1999	(Reus et al. 1999)
EYP	Environmental Yardstick for Pesticides	R	Netherlands	2000	(Reus and Leendertse 2000)
Ipest-B	Pesticide Environmental Risk Indicator for Brittany	F	France	2000	(Roussel et al. 2000)
ERIP	Environmental Risk Index for Pesticides	R	Italy	2001	(Finizio et al. 2001)
EcoRR	Ecological Relative Risk	R	Australia	2002	(Sanchez-Bayo et al. 2002)
MATF	Multi-Attribute Toxicity Factor	S	USA	2002	(Benbrook et al. 2002)
POCER	Pesticide Occupational and Environmental Risk Indicator	R	Belgium	2002	(Vercruysse and Steurbaut 2002)
p-EMA	Pesticide-Environmental Management for Agriculture	R	UK	2003	(Brown et al. 2003, Hart et al. 2003, Lewis et al. 2003)
EPRIP 1	Environmental Potential Risk Indicator for Pesticides 1	R	Italy	2004	(Padovani et al. 2004)
ERI	Environmental Risk Index	R	Chile	2005	(Alister and Kogan 2006)
PIRI	Pesticide Impact Rating Index	R	Australia	2005	(Kookana et al. 2005)
WIN-PST	Windows Pesticide Screening Tool	S	USA	2005	(NRCS 2005)
Ag-PIE	Agricultural Pressures and Impacts on European waters	R	Italy	2006	(Giupponi and Vladimirova 2006)
Rpest	Assessing Risk of Pesticide Pollution	F	France	2007	(Tixier et al. 2007)
PestScreen	A Screening Approach for Scoring and Ranking Pesticides	R	Spain	2007	(Juraske et al. 2007)
PRoMPT	Pesticide Risk Management and Profiling Tool	R	UK	2007	(Whelan et al. 2007)
SPIDER	Simulating Pesticides in Ditches to Assess Ecological Risk	R	UK	2008	(Renaud et al. 2008)
EPRIP 2	Environmental Potential Risk Indicator for Pesticides 2	R	Italy	2009	(Trevisan et al. 2009)

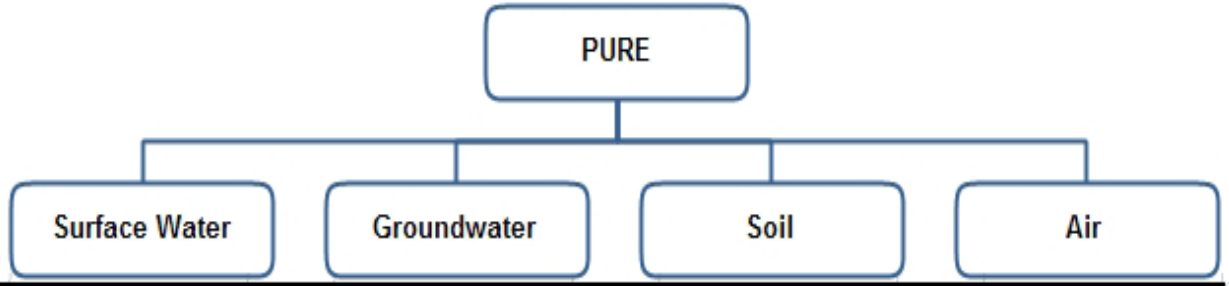
* S: relative scoring method; R: risk ratio method; F: fuzzy logic method.

Pesticide Environmental Risk

- Risk = Exposure + Effect
- PURE (Pesticide Use Risk Evaluation) Indicator
  - California based
  - Modularized
  - Transparent
  - Freely accessible

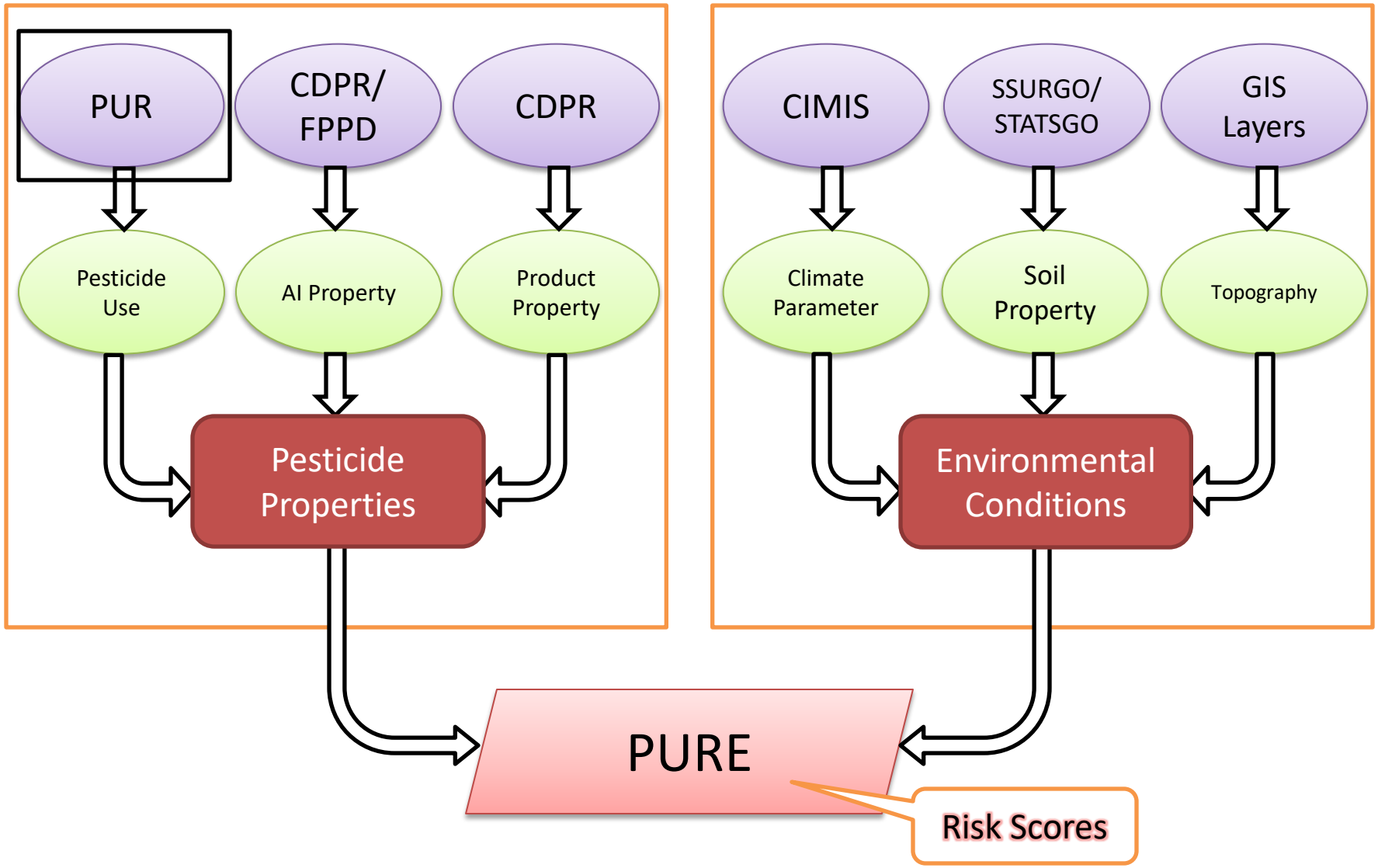


Parameters for each compartment

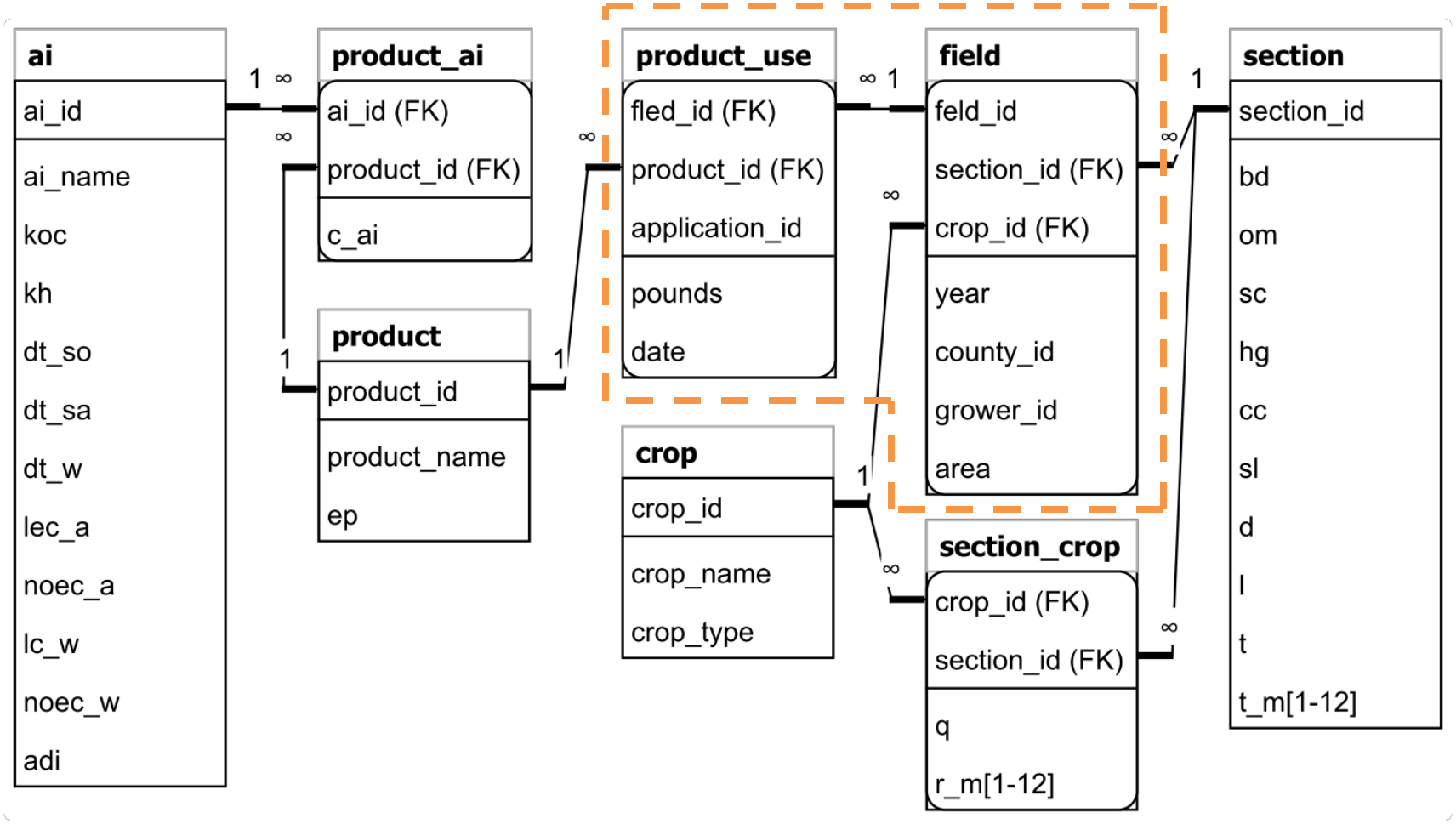


Physical-chemical	Sorption Coefficient	*		*				
	Henry's Law Constant			*				
	Half Life in Soil	*		*		*		
	Half Life in Water	*						
	Emission Potential							*
Toxicity	Toxicity to Aquatic Organisms	*						
	Toxicity to Earthworm					*		
	Acceptable Daily Intake			*				
Soil Property	Bulk Density	*		*		*		
	Organic Carbon Content	*		*				
	Sand Content	*						
	Hydrology Group	*						
	Field Capacity			*				
Topography	Ground Slope	*						
	Distance to Surface Water	*						
	Groundwater Table			*				
Meteorology	Annual Rainfall	*		*				
	Maximum Daily Rainfall	*						
	Temperature	*		*		*		
Miscellaneous	Crop Type	*		*		*		
	Application Time	*		*		*		
	Application Intensity	*		*		*		*

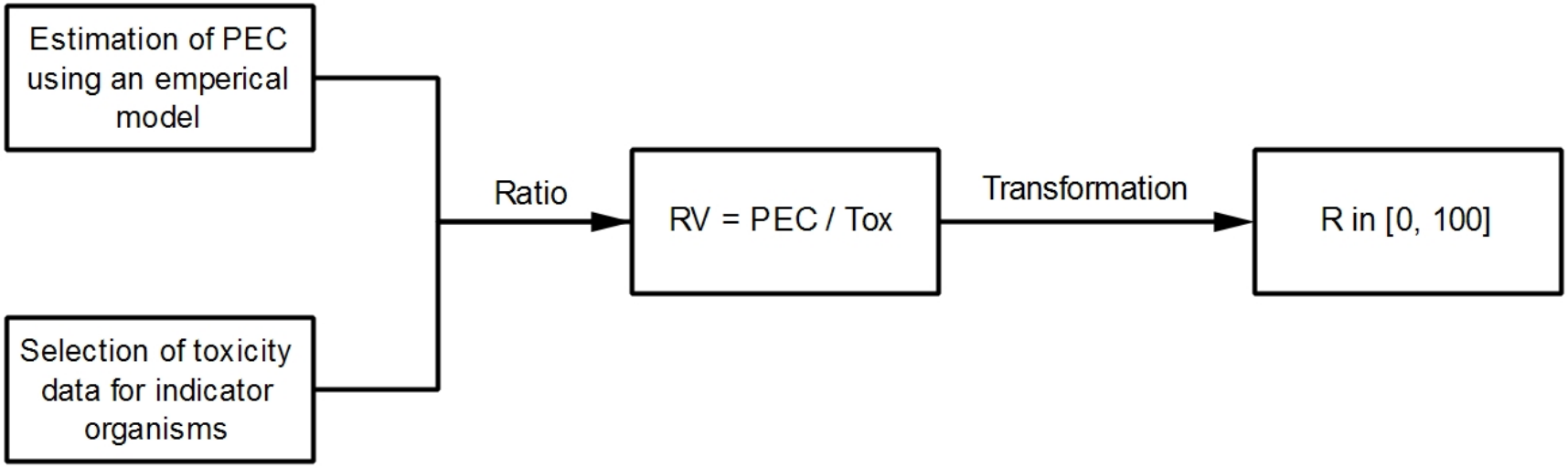
Main Data Sources



PURE Database Schema



Risk Score Calculation and Classification

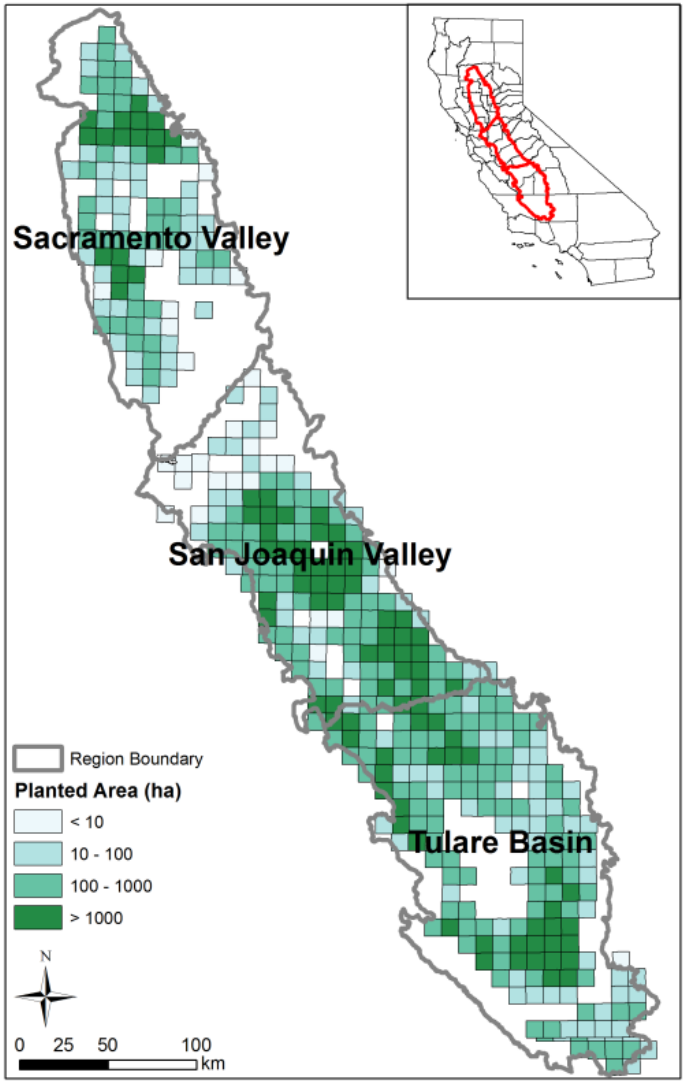


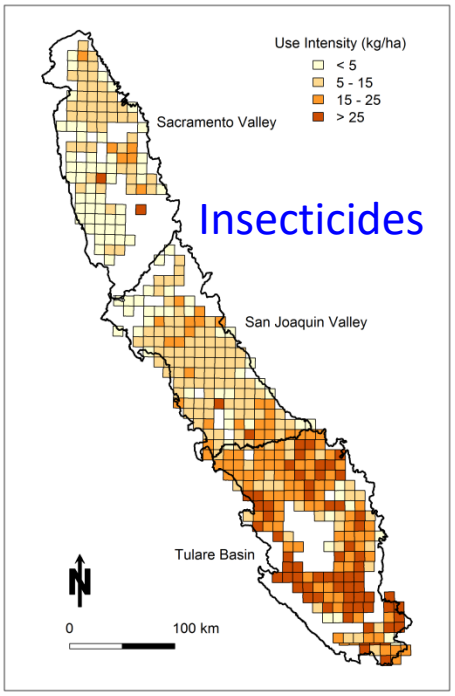
PEC: Predicted Environmental Concentration
Tox: Toxicity Value
RV: Risk Value
R: Risk Score

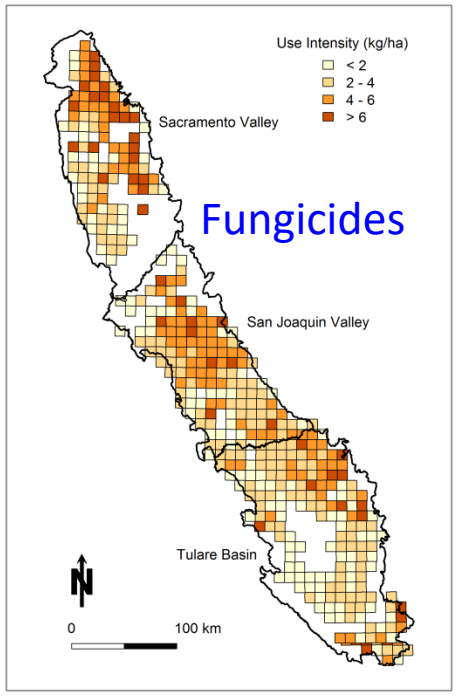
Risk Score	Risk Class
$0 \leq R \leq 25$	Low
$25 < R \leq 50$	Moderate Low
$50 < R \leq 75$	Moderate High
$75 < R$	High

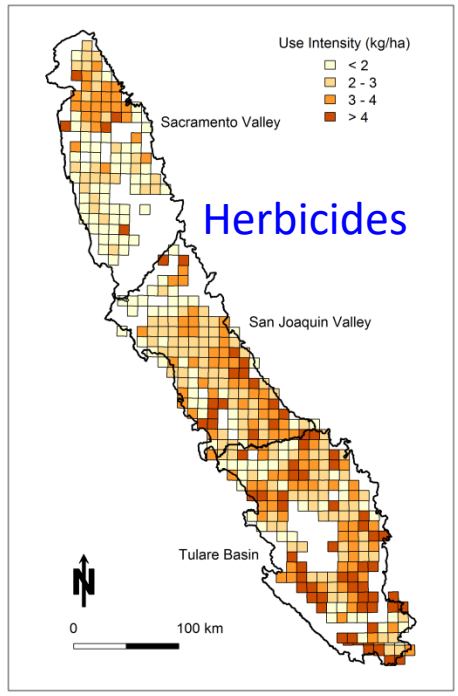
California Almonds

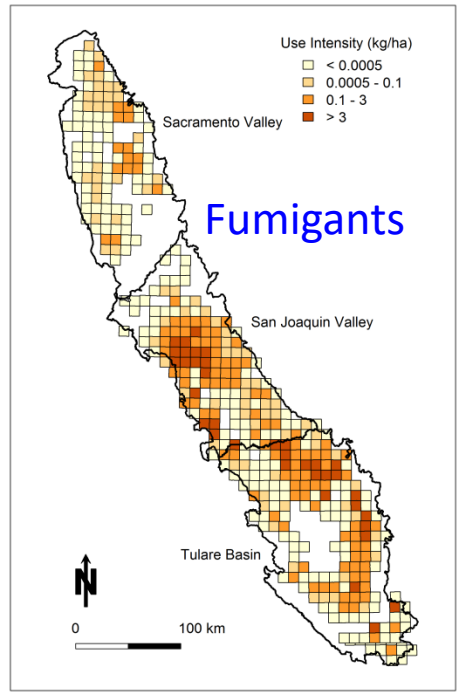
- Spatiotemporal patterns
  - Pesticide use intensity (*UI*; kg/ha)
  - Pesticide risk intensity (*RI*; R/ha)
- Period: 1996 – 2010
- Pesticide use categories:
  - Insecticides, Fungicides, Herbicides, Fumigants
- Statistical Methods:
  - Mann-Kendall test
  - Theil-Sen Slope

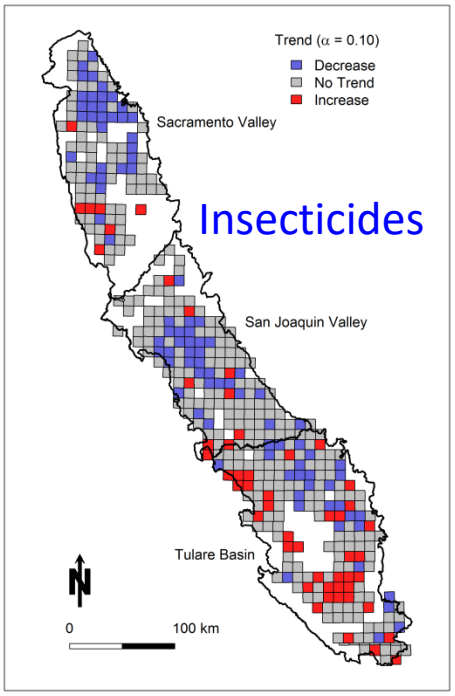


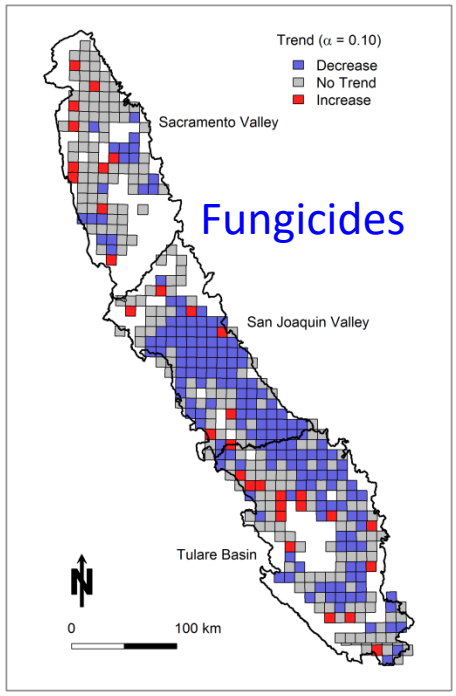

Use Intensity (kg/ha)
< 5
5 - 15
15 - 25
> 25
Sacramento Valley
San Joaquin Valley
Tulare Basin
Insecticides
0
100 km

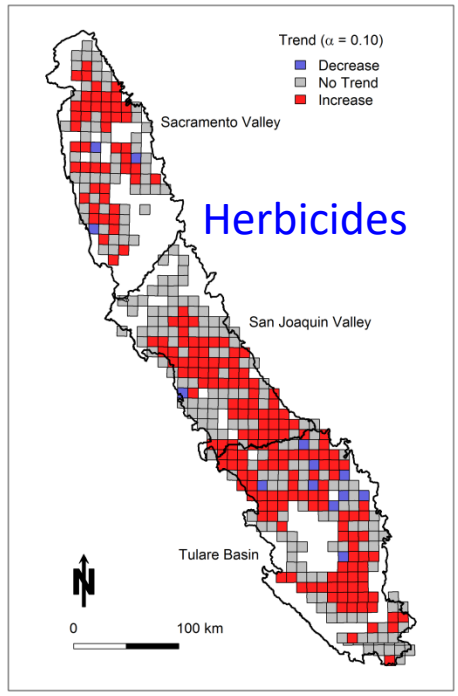

Use Intensity (kg/ha)
< 2
2 - 4
4 - 6
> 6
Sacramento Valley
San Joaquin Valley
Tulare Basin
Fungicides
0
100 km

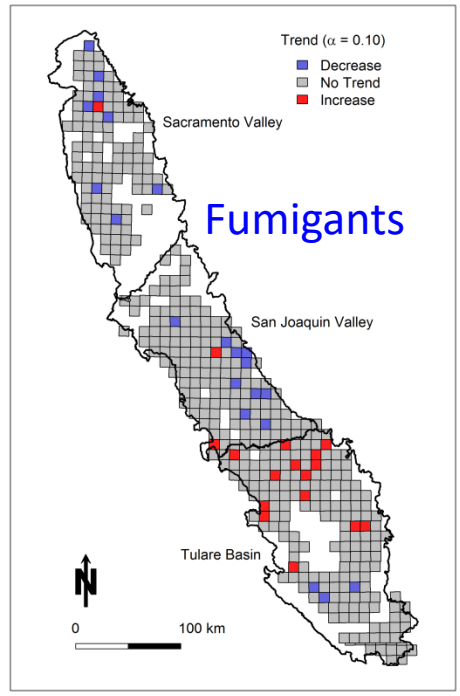

Use Intensity (kg/ha)
< 2
2 - 3
3 - 4
> 4
Sacramento Valley
San Joaquin Valley
Tulare Basin
Herbicides
0
100 km


Use Intensity (kg/ha)
< 0.0005
0.0005 - 0.1
0.1 - 3
> 3
Sacramento Valley
San Joaquin Valley
Tulare Basin
Fumigants
0
100 km


Trend (α = 0.10)
Decrease
No Trend
Increase
Sacramento Valley
San Joaquin Valley
Tulare Basin
Insecticides
0
100 km

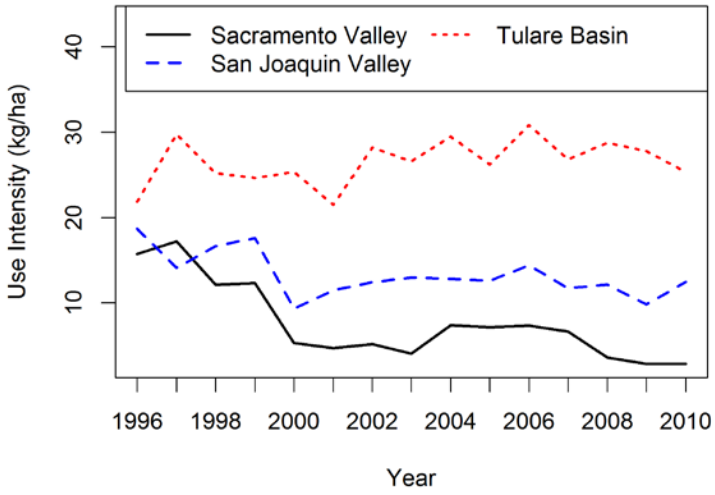

Trend (α = 0.10)
Decrease
No Trend
Increase
Sacramento Valley
San Joaquin Valley
Tulare Basin
Fungicides
0
100 km


Trend (α = 0.10)
Decrease
No Trend
Increase
Sacramento Valley
San Joaquin Valley
Tulare Basin
Herbicides
0
100 km

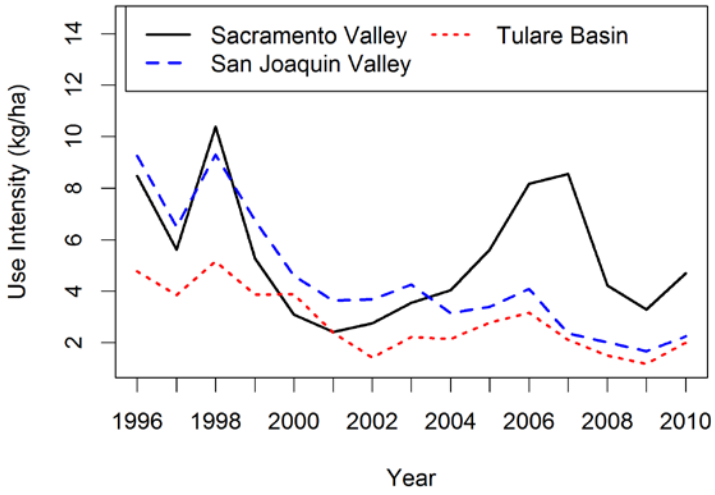

Trend (α = 0.10)
Decrease
No Trend
Increase
Sacramento Valley
San Joaquin Valley
Tulare Basin
Fumigants
0
100 km

Annual *UI* at Regional Level

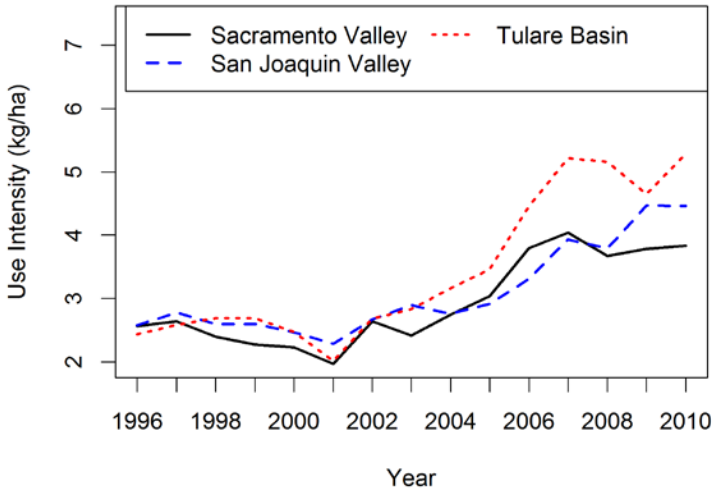
Insecticides



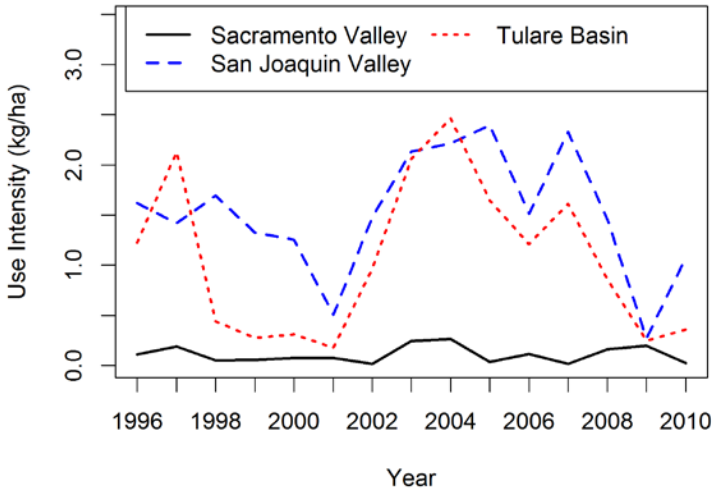
Fungicides



Herbicides



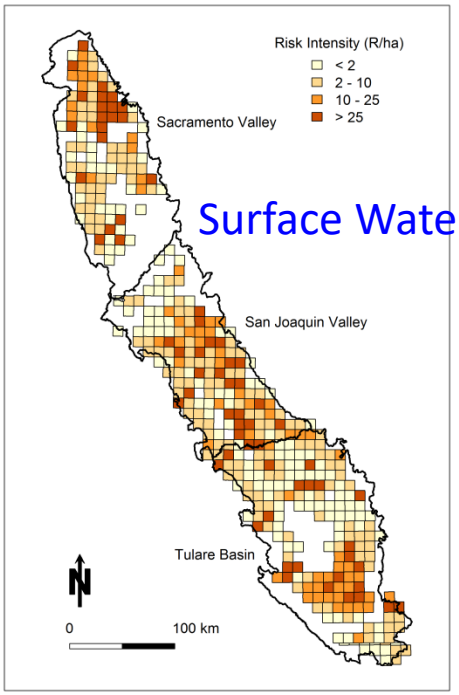
Fumigants

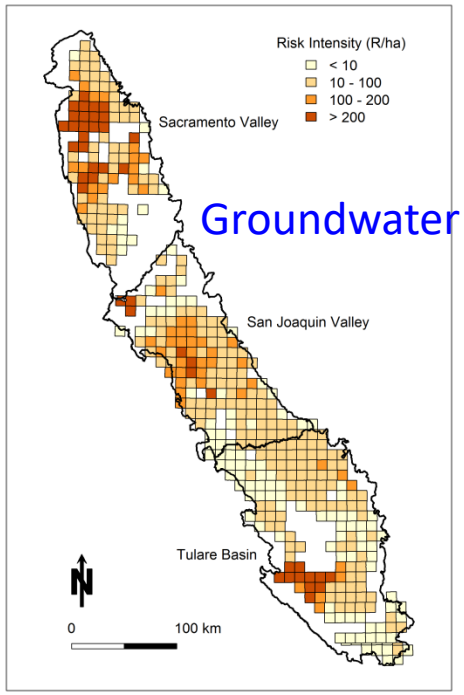


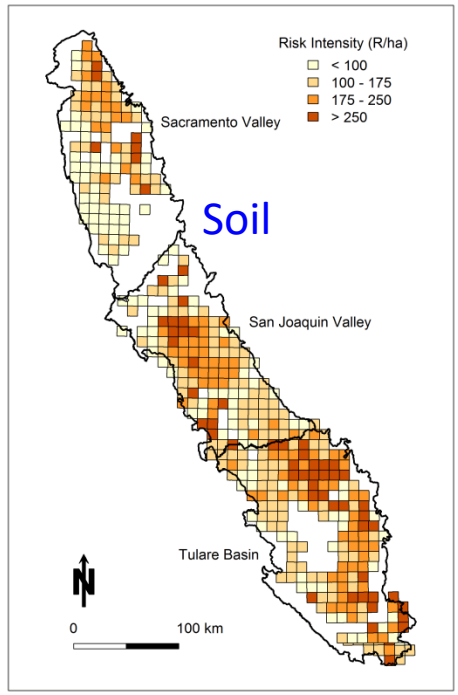
Top-five pesticides for each use category (kg/ha)

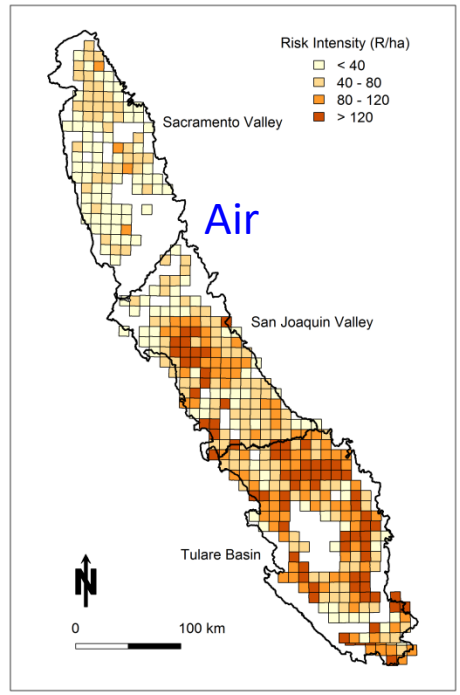
Use Category /	State		SAC		SJQ		TUL	
Pesticide	Mean	Slope	Mean	Slope	Mean	Slope	Mean	Slope
Insecticides	17.00	-0.22	7.63	-0.83**	13.28	-0.28·	26.54	0.26
petroleum oil, unclassified	10.03	-0.22*	2.81	-0.43**	6.79	-0.27*	17.98	-0.01
mineral oil	4.59	0.20*	2.60	-0.37**	4.70	0.13	5.28	0.43**
sulfur	0.47	0.00	0.96	0.11*	0.44	-0.04**	0.25	0.01
propargite	0.46	-0.06**	0.24	-0.01·	0.37	-0.05**	0.73	-0.12**
chlorpyrifos	0.45	-0.01	0.23	0.01*	0.37	-0.02**	0.67	-0.01
Fungicides	4.05	-0.28**	5.34	-0.05	4.46	-0.41**	2.83	-0.22**
ziram	0.95	-0.08**	2.06	-0.04	0.69	-0.09**	0.73	-0.08**
copper hydroxide	0.81	-0.08**	0.29	-0.02**	1.15	-0.11**	0.63	-0.04*
captan	0.48	-0.08**	0.64	-0.05*	0.58	-0.10**	0.25	-0.05**
sulfur	0.47	0.00	0.96	0.11*	0.44	-0.04**	0.25	0.01
maneb	0.35	-0.06**	0.54	-0.05*	0.37	-0.07**	0.22	-0.04**
Herbicides	3.21	0.17**	2.94	0.13**	3.10	0.14**	3.45	0.22**
glyphosate, isopropylamine salt	1.24	0.00	1.40	-0.01	1.21	0.02	1.21	-0.01
paraquat dichloride	0.46	0.03*	0.31	0.05**	0.37	0.02·	0.65	0.04*
glyphosate, potassium salt	0.26	0.04**	0.16	0.02*	0.20	0.04**	0.36	0.05**
oryzalin	0.23	-0.00	0.34	0.01·	0.24	-0.01	0.18	-0.01
oxyfluorfen	0.22	0.01*	0.15	0.01**	0.21	0.01*	0.26	0.01*
Fumigants	1.09	-0.02	0.11	2E-04	1.51	-0.01	1.06	-0.02
1,3-dichloropropene	0.77	0.07	0.05	0.00	1.06	0.09·	0.76	0.06*
methyl bromide	0.26	-0.04**	0.04	-0.01**	0.33	-0.06**	0.30	-0.04**
sodium tetrathiocarbonate	0.03	0.00	3E-3	0.00	0.06	0.00	7E-5	0.00
metam-sodium	0.02	-1E-3**	7E-6	0.00	0.03	-3E-3**	0.01	0.00
chloropicrin	0.01	-0.00	0.01	3E-4·	0.01	-0.00	4E-3	-0.00

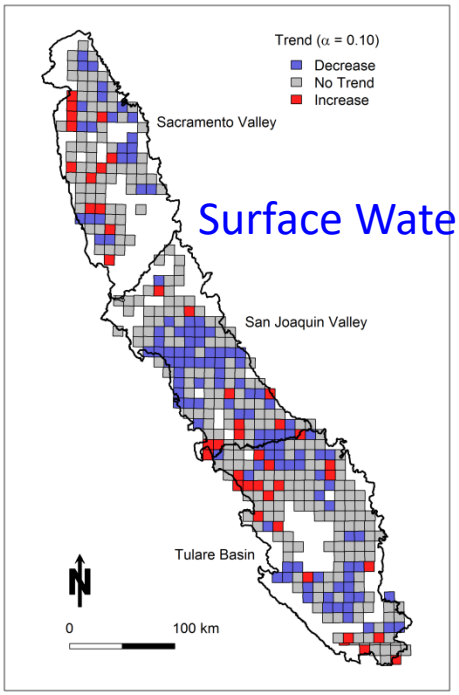
** $p<0.01$; * $p<0.05$; · $p<0.1$

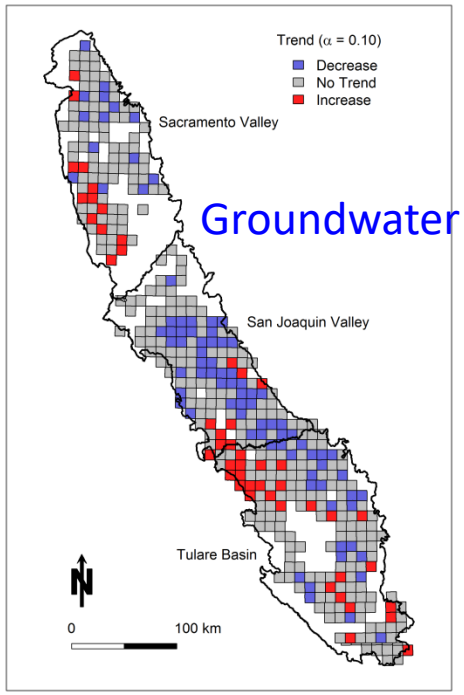

Risk Intensity (R/ha)
< 2
2 - 10
10 - 25
> 25
Sacramento Valley
San Joaquin Valley
Tulare Basin
Surface Water
0
100 km

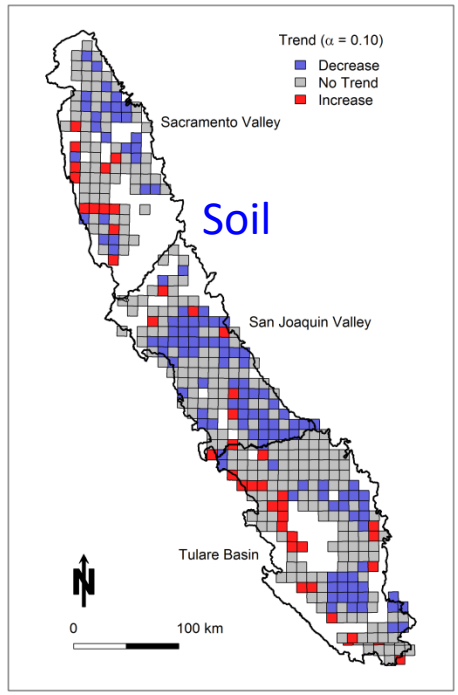

Risk Intensity (R/ha)
< 10
10 - 100
100 - 200
> 200
Sacramento Valley
San Joaquin Valley
Tulare Basin
Groundwater
0
100 km

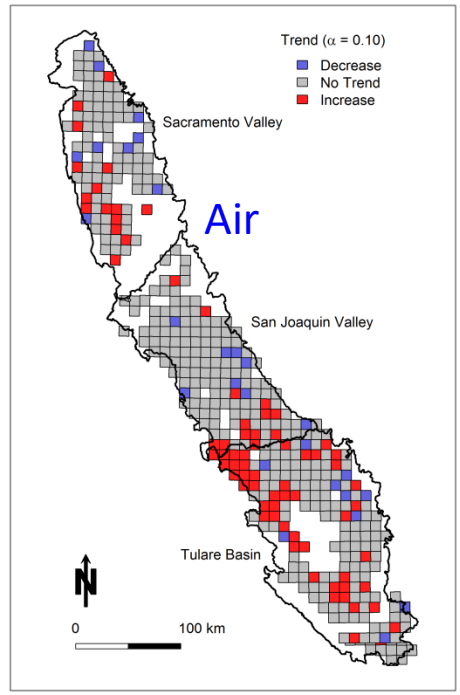

Risk Intensity (R/ha)
< 100
100 - 175
175 - 250
> 250
Sacramento Valley
San Joaquin Valley
Tulare Basin
Soil
0
100 km


Risk Intensity (R/ha)
< 40
40 - 80
80 - 120
> 120
Sacramento Valley
San Joaquin Valley
Tulare Basin
Air
0
100 km


Trend (α = 0.10)
Decrease
No Trend
Increase
Sacramento Valley
San Joaquin Valley
Tulare Basin
Surface Water
0
100 km

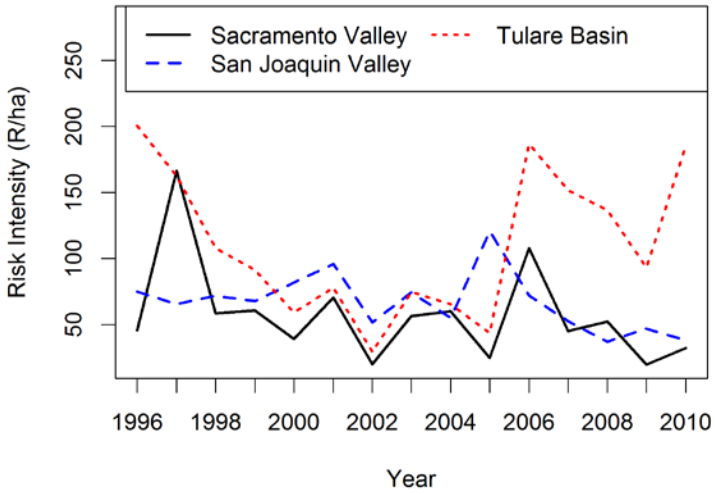

Trend (α = 0.10)
Decrease
No Trend
Increase
Sacramento Valley
San Joaquin Valley
Tulare Basin
Groundwater
0
100 km


Trend (α = 0.10)
Decrease
No Trend
Increase
Sacramento Valley
San Joaquin Valley
Tulare Basin
Soil
0
100 km

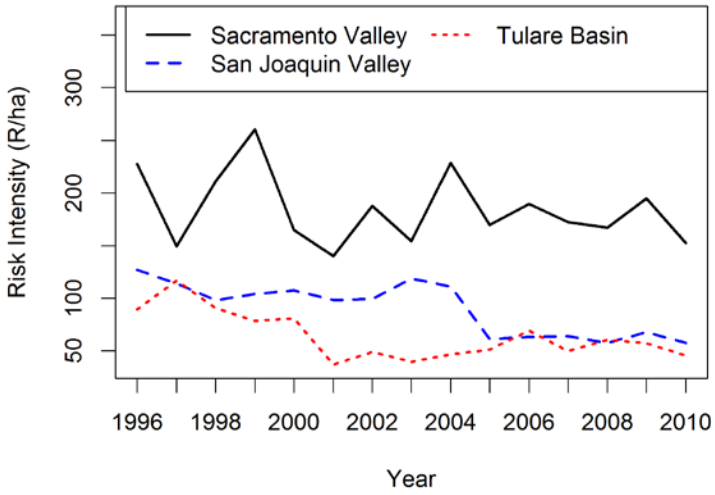

Trend (α = 0.10)
Decrease
No Trend
Increase
Sacramento Valley
San Joaquin Valley
Tulare Basin
Air
0
100 km

Annual *RI* at Regional Level

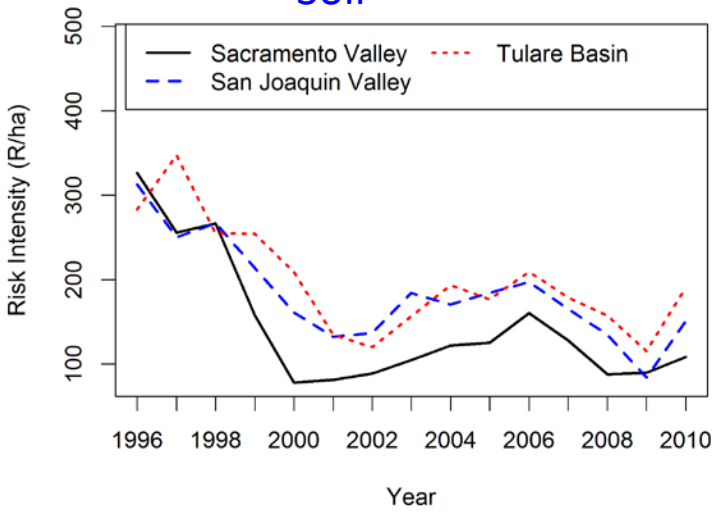
Surface Water



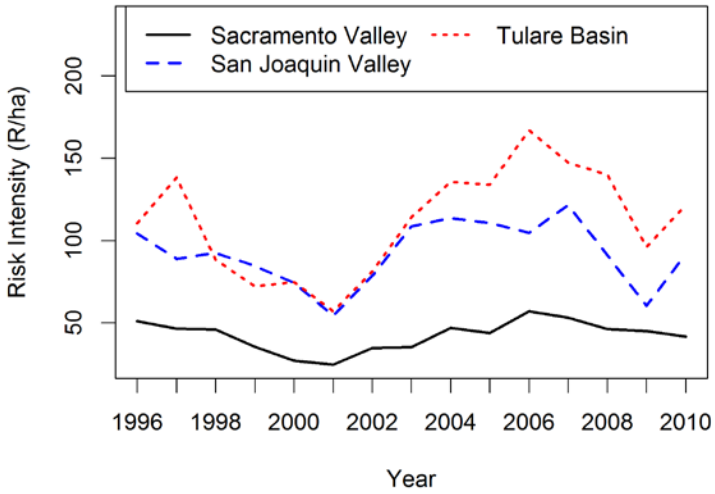
Groundwater



Soil



Air



Top-five pesticides for each risk type (R/ha)

Risk /	State		SAC		SJQ		TUL	
Pesticide	Mean	Slope	Mean	Slope	Mean	Slope	Mean	Slope
Surface water	81	-0.8	57	-2.0	67	-2.4·	111	-1.1
chlorpyrifos	31	1.2	9	-0.03	21	-0.7	54	2.3
copper hydroxide	18	-1.7**	10	-0.4**	22	-1.6*	18	-1.5·
ziram	7	-0.7*	19	-0.8	5	-0.7**	4	-0.3
permethrin	4	-0.3·	2	-0.01	4	-0.3*	6	-0.2
chloropicrin	4	-0.2	9	0.2*	5	-0.6**	1	-0.04·
Groundwater	98	-4.1**	185	-2.5	90	-4.5**	64	-3.0·
oxyfluorfen	37	1.0·	83	6.8**	18	0.3	39	-0.5
simazine	29	-1.9**	26	-1.6**	48	-2.8*	6	-0.5**
diazinon	7	-0.7**	32	-3.3**	1	-0.1*	1	-0.02**
norflurazon	6	-0.9**	7	-0.8**	8	-0.9**	3	-0.3**
propargite	5	-0.7**	12	-0.7	3	-0.4**	5	-0.9**
Soil	182	-9.8*	145	-7.1	183	-9.4*	199	-9.7*
copper hydroxide	22	-2.3**	8	-0.6**	31	-3.1**	17	-1.1*
1,3-dichloropropene	19	1.4*	1	0.03	25	2.0·	19	1.7*
ziram	17	-1.5**	39	-1.5	12	-1.6**	12	-1.6**
methidathion	15	-2.8**	11	-0.9**	9	-1.4**	25	-5.6**
mineral oil	9	0.1	6	-0.9**	9	0.03	10	0.7**
Air	90	1.7	42	0.2	92	0.6	112	3.0
1,3-dichloropropene	20	1.8	1	0.1	27	2.2·	20	1.7*
oxyfluorfen	12	0.5	9	0.7*	12	0.3	15	0.5
chlorpyrifos	12	-0.5	6	0.4·	10	-0.6*	17	-0.7
petroleum oil, unclassified	9	1.0**	1	-0.1*	6	0.6**	17	1.6**
methyl bromide	7	-1.0**	1	-0.1**	8	-1.4**	7	-0.9**

** $p<0.01$; * $p<0.05$; · $p<0.1$

PURE Website

Risk Assessment System for California Growers

County

Kern

Crop Type

Almond

Analysis Type

Past Performance in 2009

Future Decision Making

Operator ID (last 7 digits)

0000000 Verify

Field ID

Reset Submit

Past Performance Report - Field

High

Moderate High

Moderate Low

Low

County: Kern

Crop: Almond

Year: 2009

Operator ID: 0000000

Show all fields for this operator

Multiyear trends

Aggregate

Surface Water

Groundwater

Soil

Air

Back

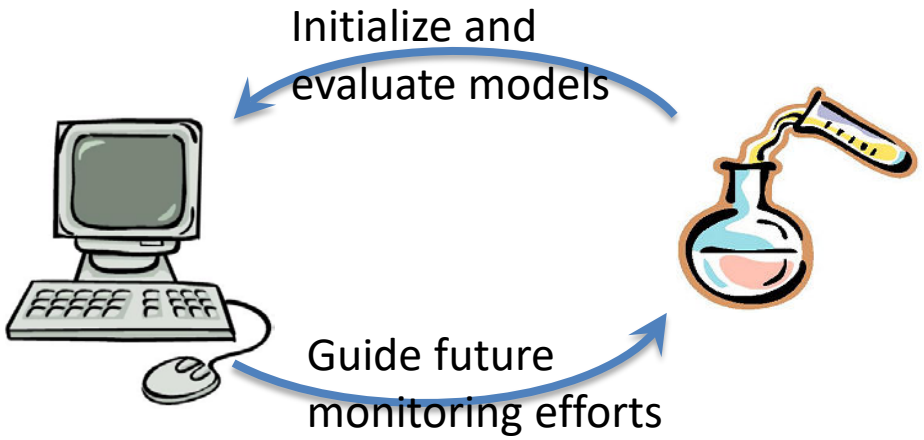
Field ID: 1 (320 acre) | Environmental Conditions | Show Chart

Date	Pesticide Product	Application Rate (lbs/acre)	Integrate	Surface Water	Ground Water	Soil	Air
2-5	Activate Plus	0.15	0	0	-	-	-
2-5	Gramoxone Inteon	1.80	55	0	0	55	52
3-7	Touchdown Total	0.84	43	34	0	39	43
4-13	Esteem Ant Bait	1.37	44	32	0	0	44
4-23	Goal 2Xl	0.08	44	40	36	6	44
4-23	Touchdown Total	0.61	40	31	0	36	40
5-7	Goal 2Xl	0.18	53	46	41	15	53
5-7	Roundup Powermax Herbicide	0.87	-	-	-	-	-
5-19	Pounce 1.5G Insecticide	0.0031	36	36	0	0	0
5-25	Roundup Powermax Herbicide	0.88	-	-	-	-	-
5-31	Whirlwind	3.27	100	100	0	68	82
6-13	Clinch Ant Bait	0.91	39	32	0	0	39
6-15	Mso Concentrate With Leci-Tech	0.55	-	-	-	-	-
6-15	Poast	0.76	70	44	30	14	70
7-9	Activate Plus	0.17	0	0	-	-	-
7-9	Gramoxone Inteon	2.06	53	43	0	46	53
7-21	Agrisolutions Cornerstone Plus Herbicide	2.29	47	33	0	47	0
10-2	Agrisolutions Cornerstone Plus Herbicide	3.33	52	36	0	52	0
10-2	Choice Weather Master	0.22	-	-	-	-	-
10-2	Goal 2Xl	0.42	62	51	47	24	62
2009 Field		-	82	82	2	50	63
2009 Operator		-	59	48	29	47	59
2009 Kern County Almond		-	58	43	26	58	57
2009 Statewide Almond		-	50	33	49	27	50

-: Not available due to missing pesticide properties

Pesticides in Surface Water

- Contamination of pesticides in water and sediment
- **Modeling vs. monitoring**
  - Continuous predictions
  - Not limited by site locations
  - Key processes/parameters
  - Scenario analysis



Model development

ArcGIS/ArcObjects	Transport simulation	Evaluation system
▪ Spatial framework ▪ Geo-database development ▪ Spatial analysis ▪ Input preparation ▪ Output visualization ▪ Web-GIS	▪ SWAT model (USDA) ▪ PRZM model (USEPA) ▪ Hydrology simulation ▪ Pesticide transport ▪ Management practices ▪ Weather generation ▪ Plant growth	▪ Statistical evaluation ▪ Stochastic simulation ▪ Model calibration ▪ Model validation ▪ Uncertainty and sensitivity analysis ▪ Scenario analysis

Modeling studies

Watershed model
- Model development
- Model evaluation

Field-scale model
- Linear routing
- Eco-system risk analysis

Structural BMPs
- Model sensitivity
- BMP representation

Human health risk
- Cumulative risk analysis for 13 OPs

IPM
- Integrated pesticide management

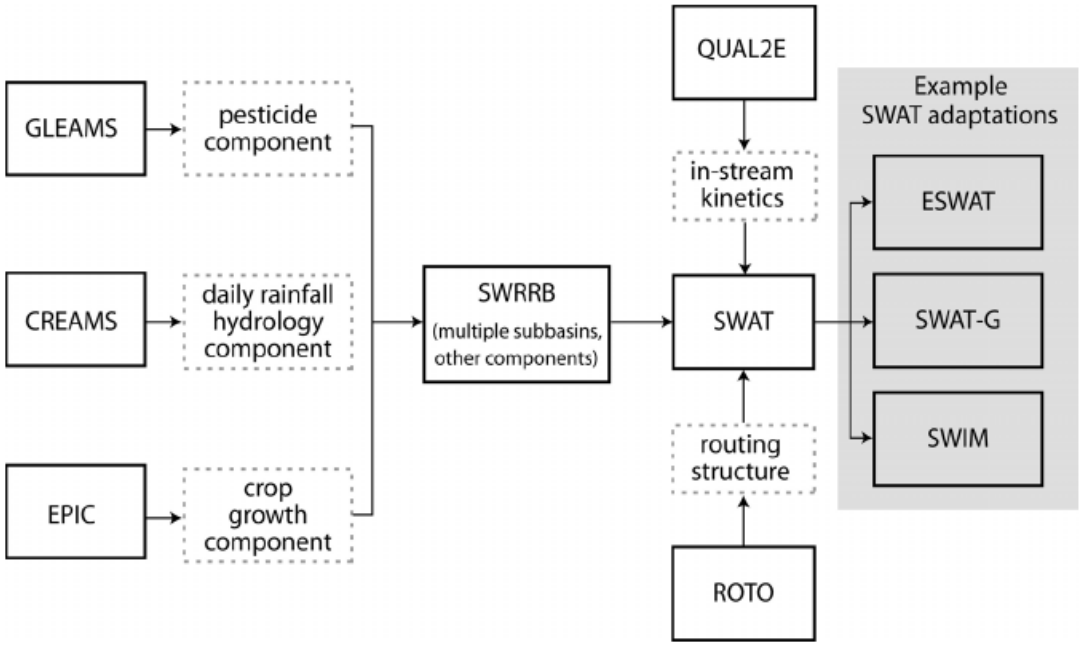
Climate change
- Hydrology
- Agricultural runoff

Soil property
- Soil data processing
- Impact on model performance

Scaling effects
- Spatial delineation
- Impact on model performance

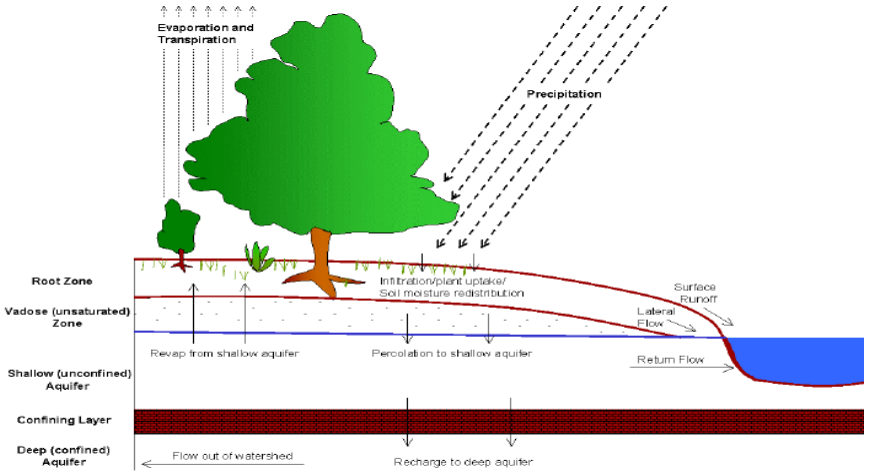
SWAT model overview

- Basin-scale, continuous time, daily step
- Predict the impact of management on water, sediment and agrochemicals
- USDA NRCS continuous improvement
- TMDL
- Efficacies of BMPs

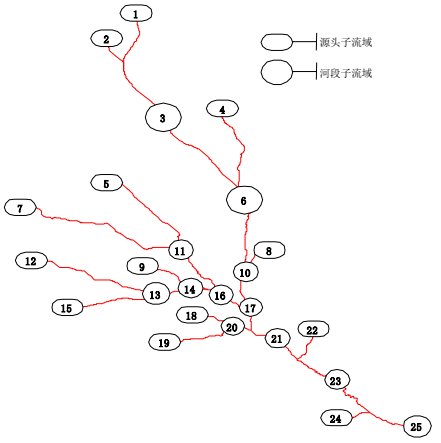


SWAT functions

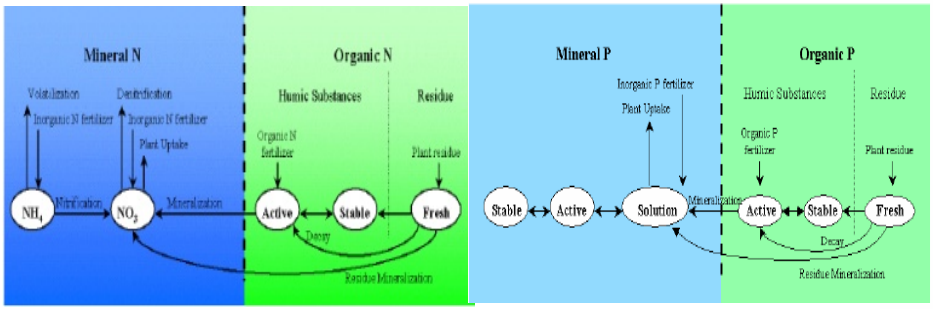
Water balance



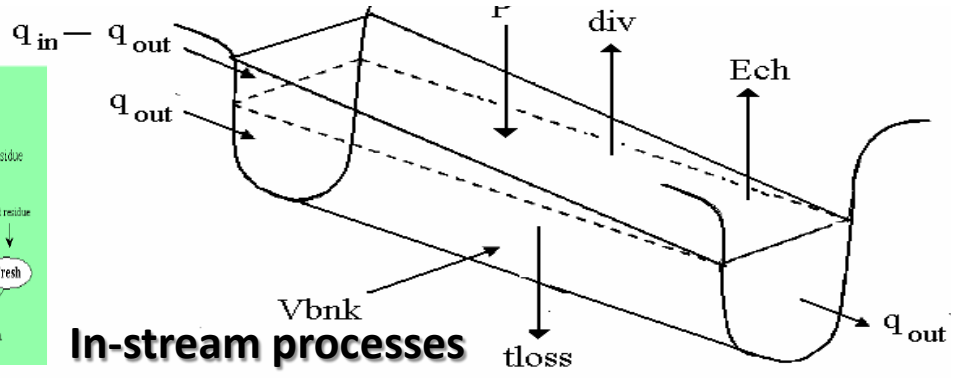
Spatially Distributed hydrologic simulation



Water quality



In-stream processes

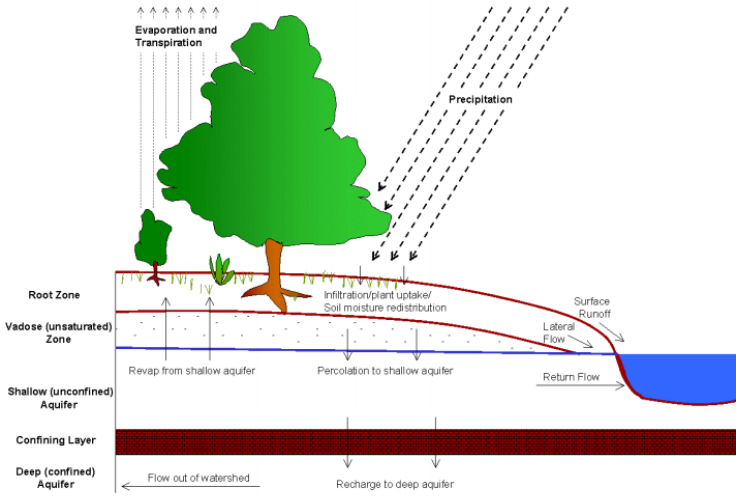


Reference: Neitsch *et al.* 2005

SWAT equations

- Soil water (SW) balance

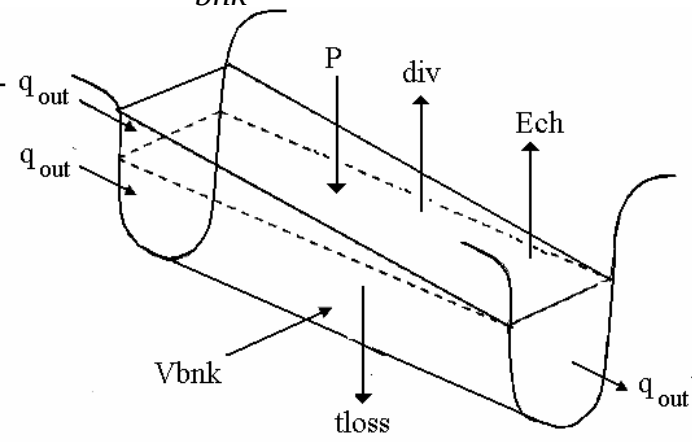
$$\Delta SW_t = \sum_{i=1}^{t} (R_{day} - Q_{surf} - Q_{later} - E_a - W_{seep} - Q_{gw})$$



- Channel routing

$$V_{stored,2} = V_{stored,1} + V_{in} - V_{out} - tloss - E_{ch} - div + V_{bnk}$$

$$Q_{out,2} = C_1 \cdot Q_{in,2} + C_2 \cdot Q_{in,1} + C_3 \cdot Q_{out,1}$$



Landscape characterization

- **Simulation domain**

Northern San Joaquin Valley watershed

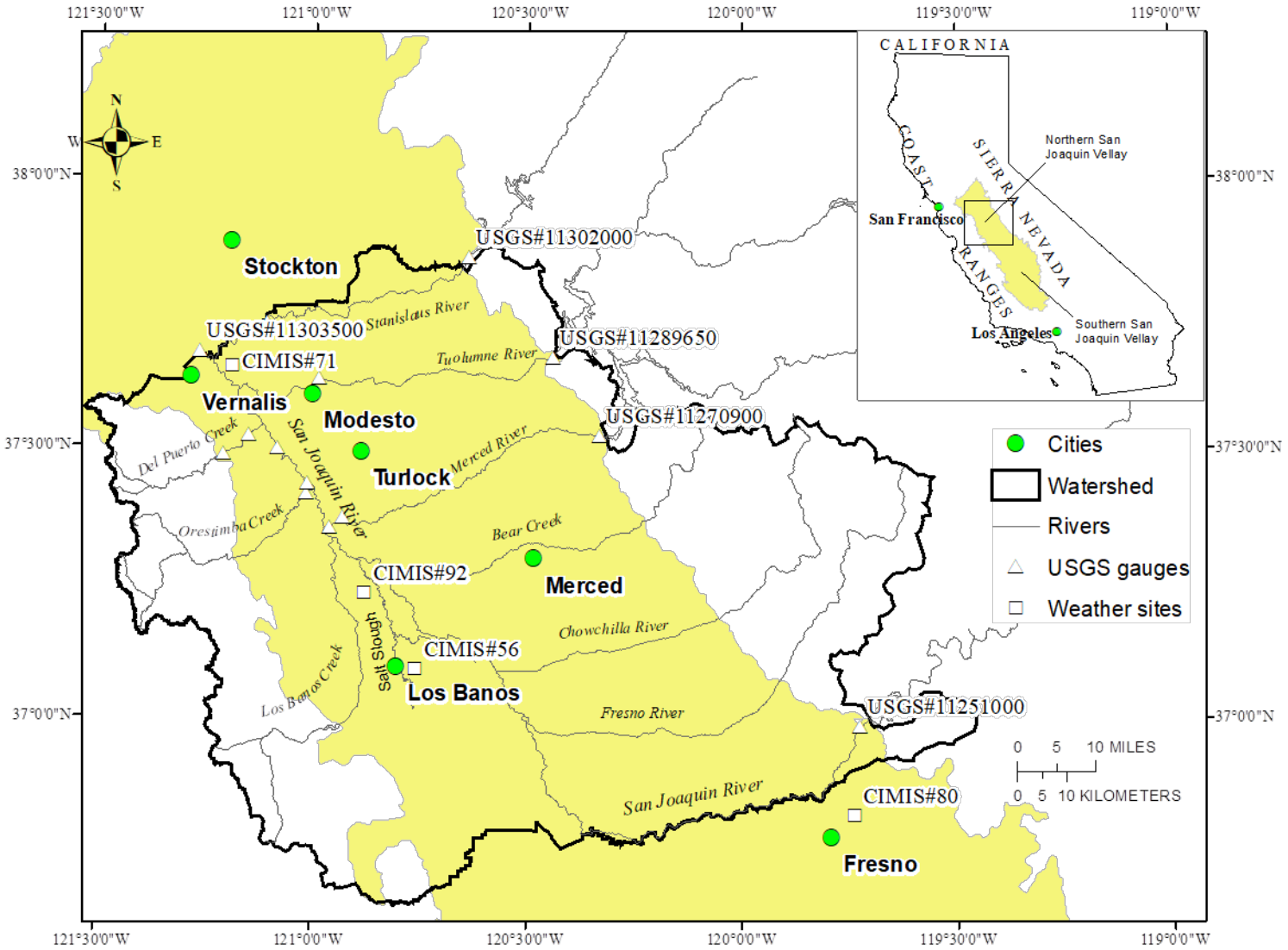
- **Watershed delineation**

15 sub-basins following CVRWQCB

- **HRU (Hydrologic Response Unit) distribution**

Overlaying land use and soil maps

Simulation domain



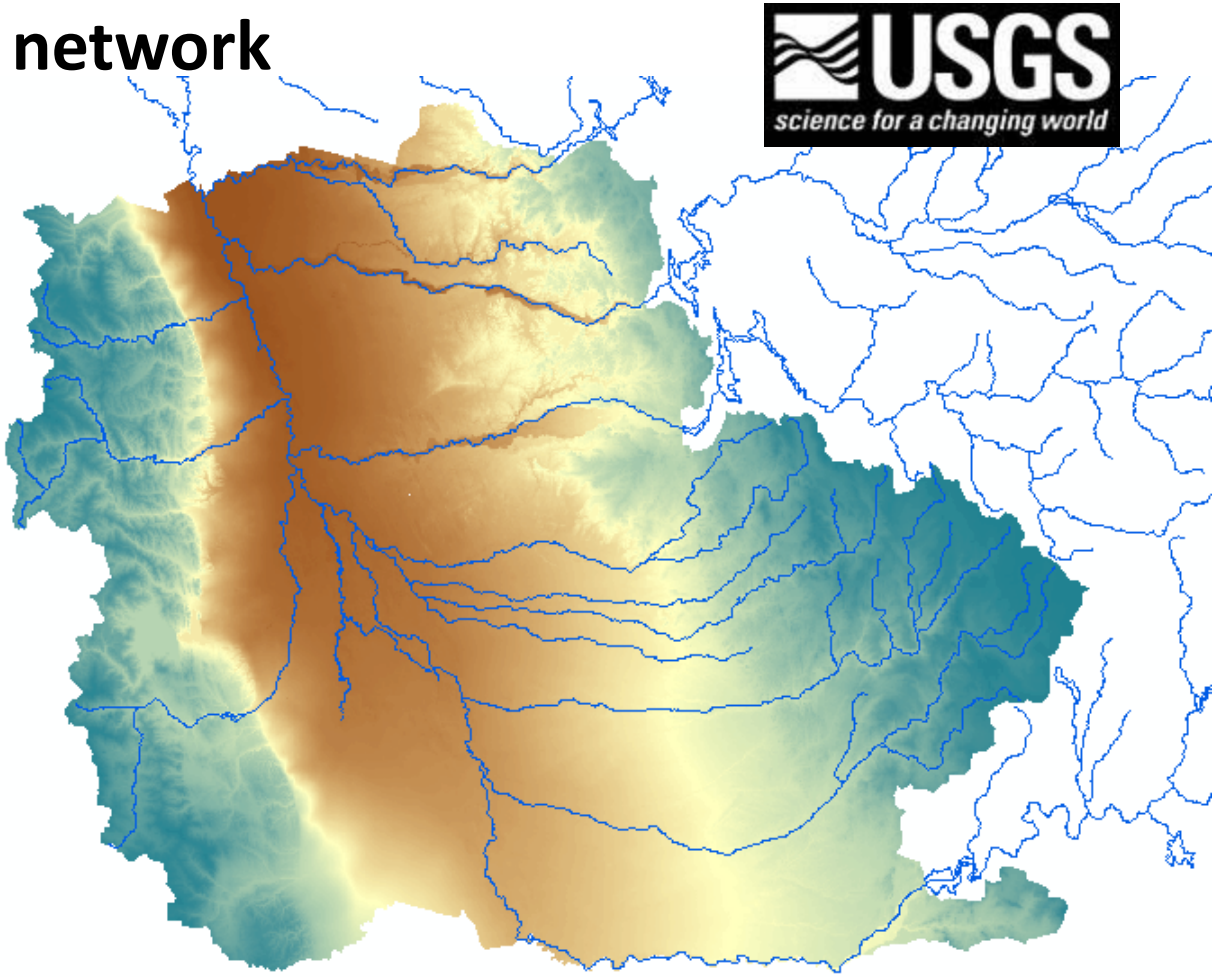
Reference: Luo et al., 2008

GIS databases

- National Elevation Data (USGS)
- National Hydrography Dataset (USGS)
- Land use survey data (CDWR)
- Soil Survey Geographic (SSURGO) database (USDA)
- Weather data (CIMIS)
- Pesticide use data (CDPR PUR)
- Monitoring data for streamflow rate and water quality (USGS and CDPR)

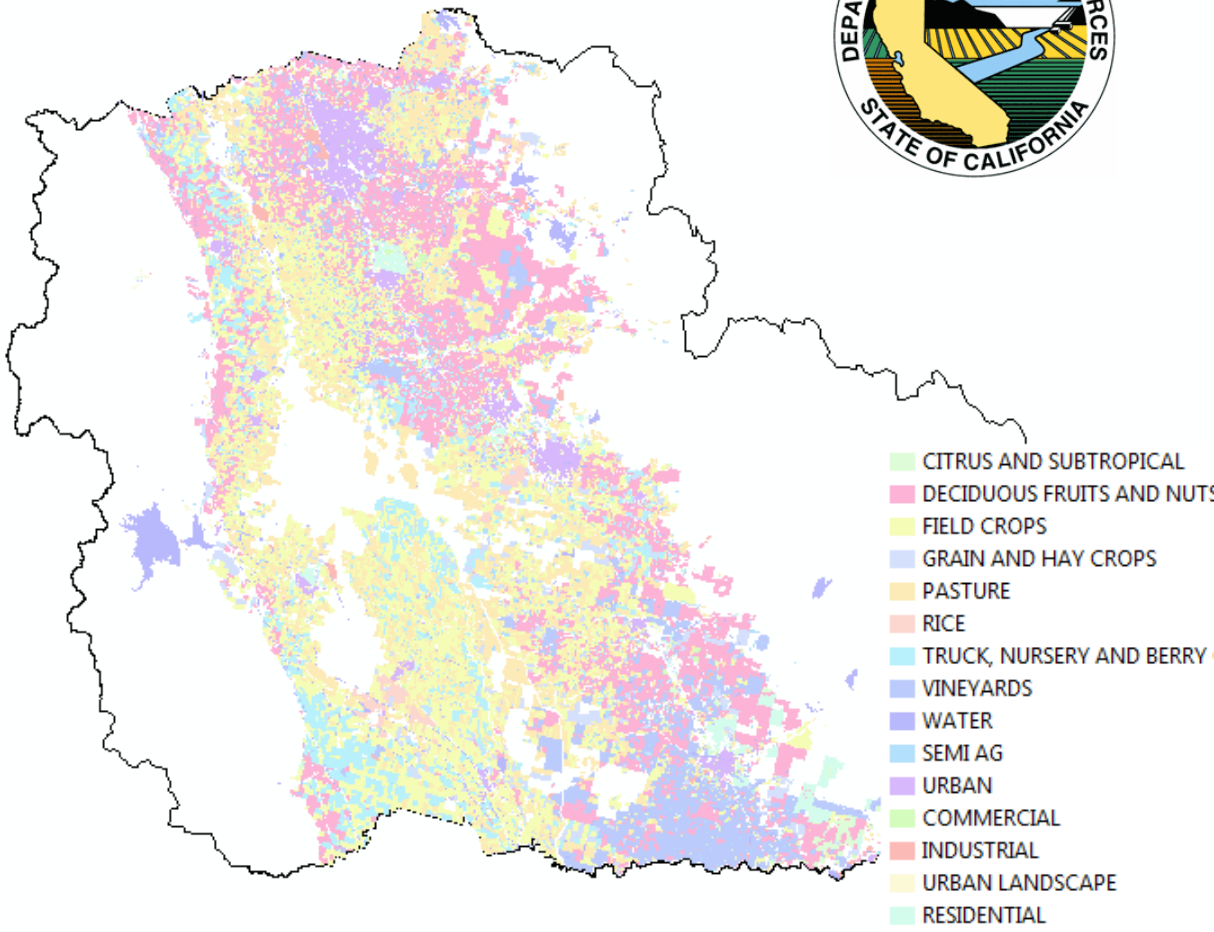
GIS databases

- **DEM and stream network**



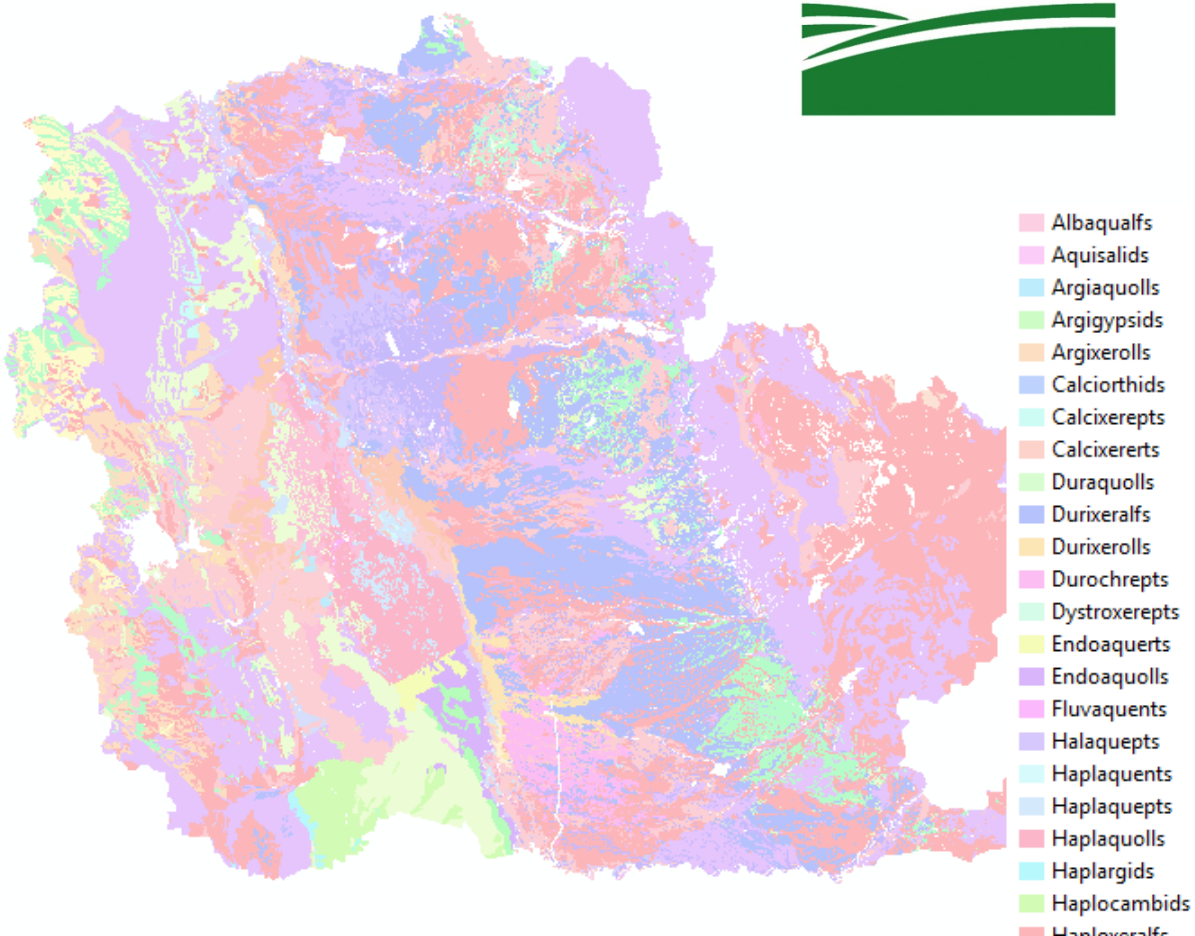
GIS databases

- DEM and stream network
- **Land use**



GIS databases

- DEM and stream network
- Land use
- **Soil**



Simulation scenario

- Model initialization and parameterization
- Test agents: diazinon and chlorpyrifos
- Daily simulations during 1990 though 2005
- Model calibration
  - Hydrology (stream flow), and
  - Water quality (sediment, nutrients, and pesticides)

Model evaluation

- Nash-Sutcliffe (NS) coefficient

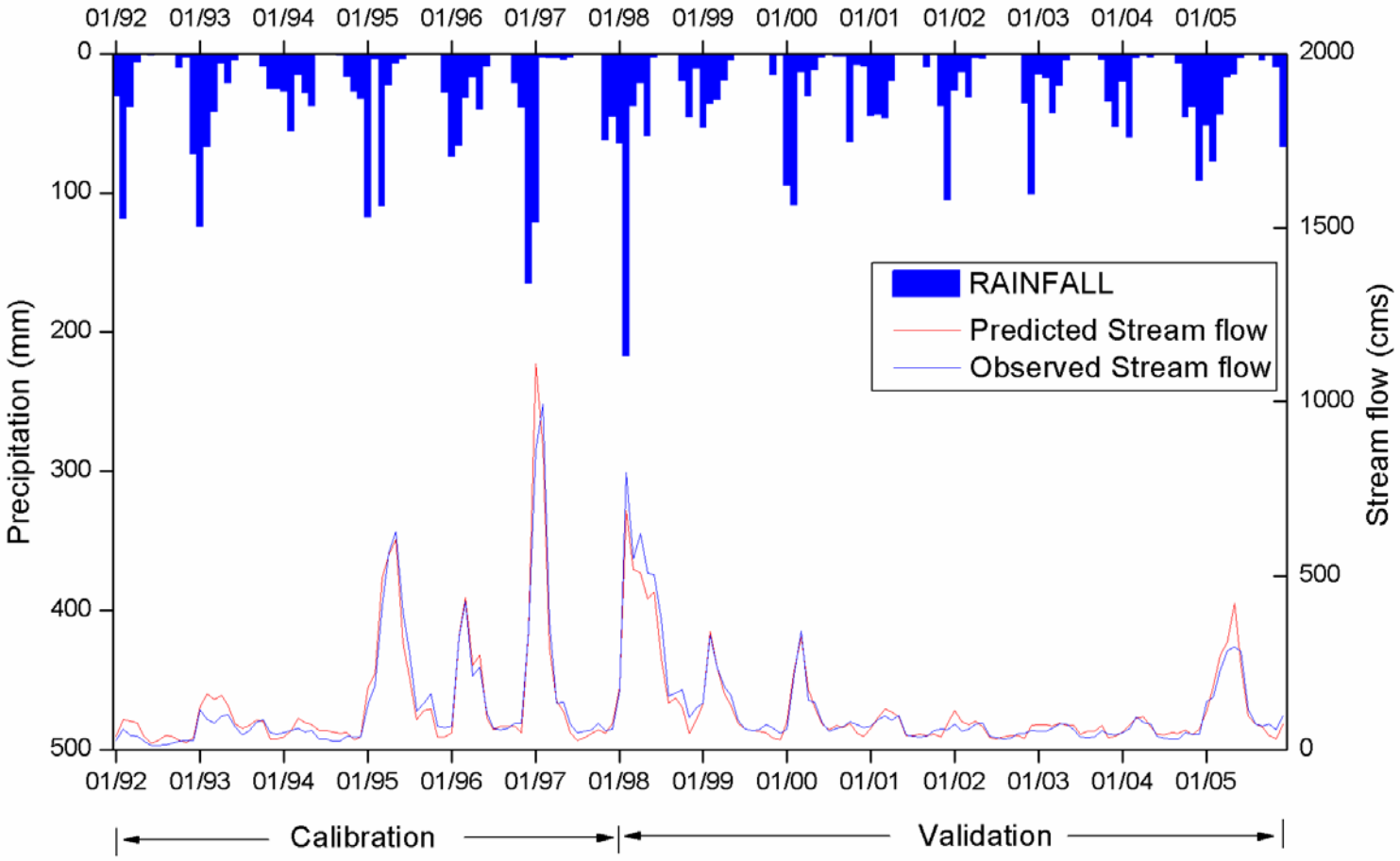
$$NS = 1 - \frac{\sum_j (O_j - P_j)^2}{\sum_j (O_j - \overline{O})^2}$$

- Sensitivity index (S)

$$S_I = \frac{\partial P}{\partial I} \frac{I}{P(I)} = \frac{P(I + \Delta I) - P(I - \Delta I)}{2\Delta I} \frac{I}{P(I)}$$

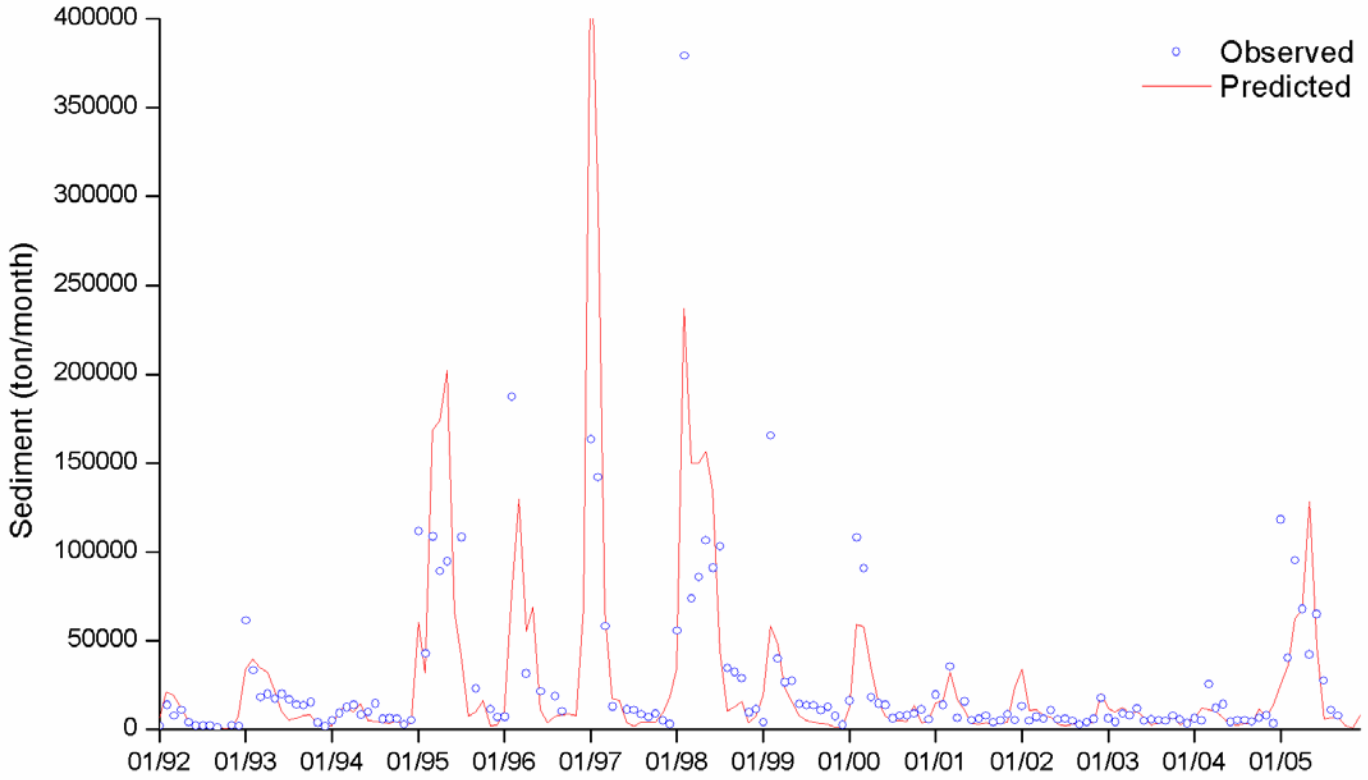
I : Model input
O: Observation
P: model prediction

Model results: stream flow



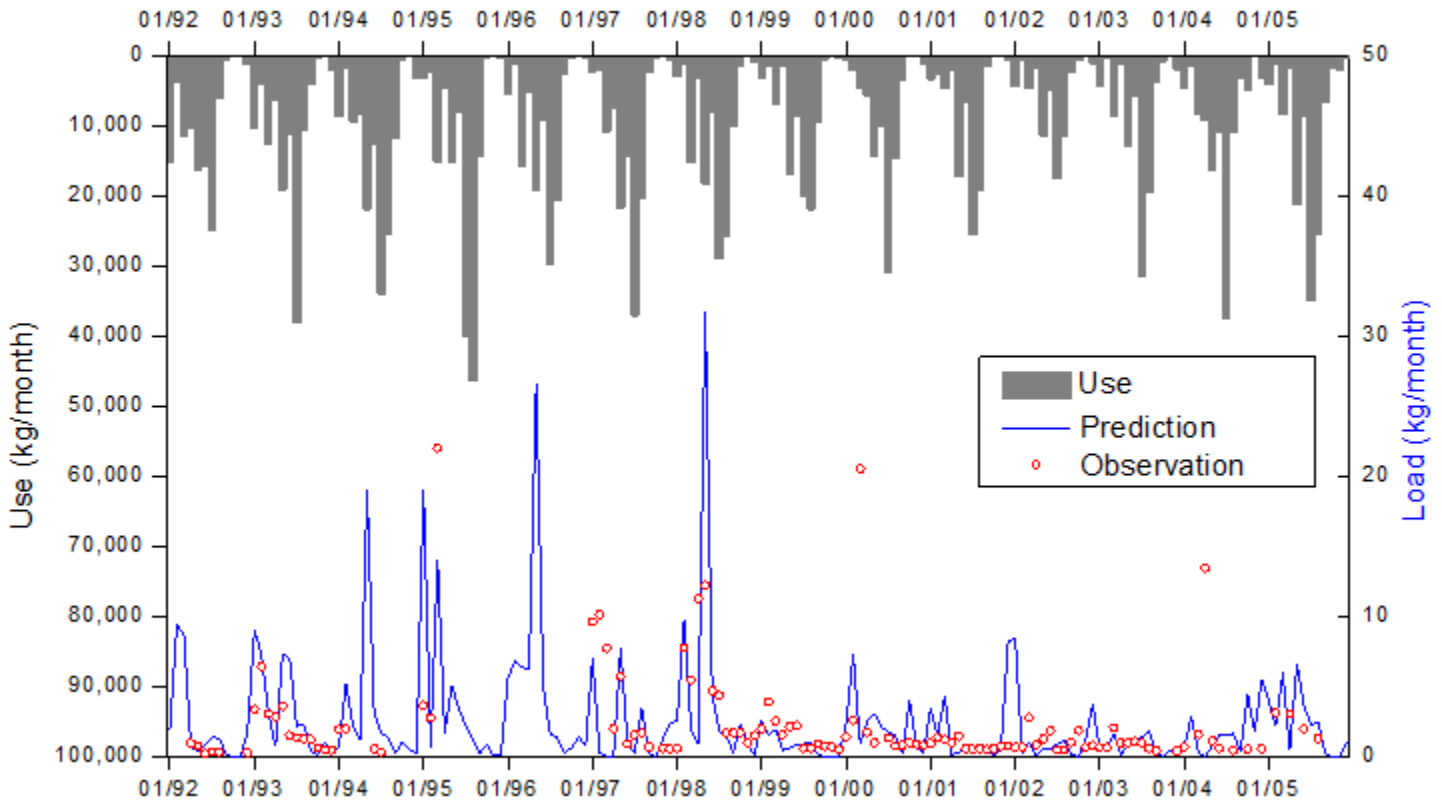
Predicted and observed **stream flow** (m^3/s) in the San Joaquin River at Vernalis during 1992-2005 (Reference: Luo et al., 2008)

Model results: sediment



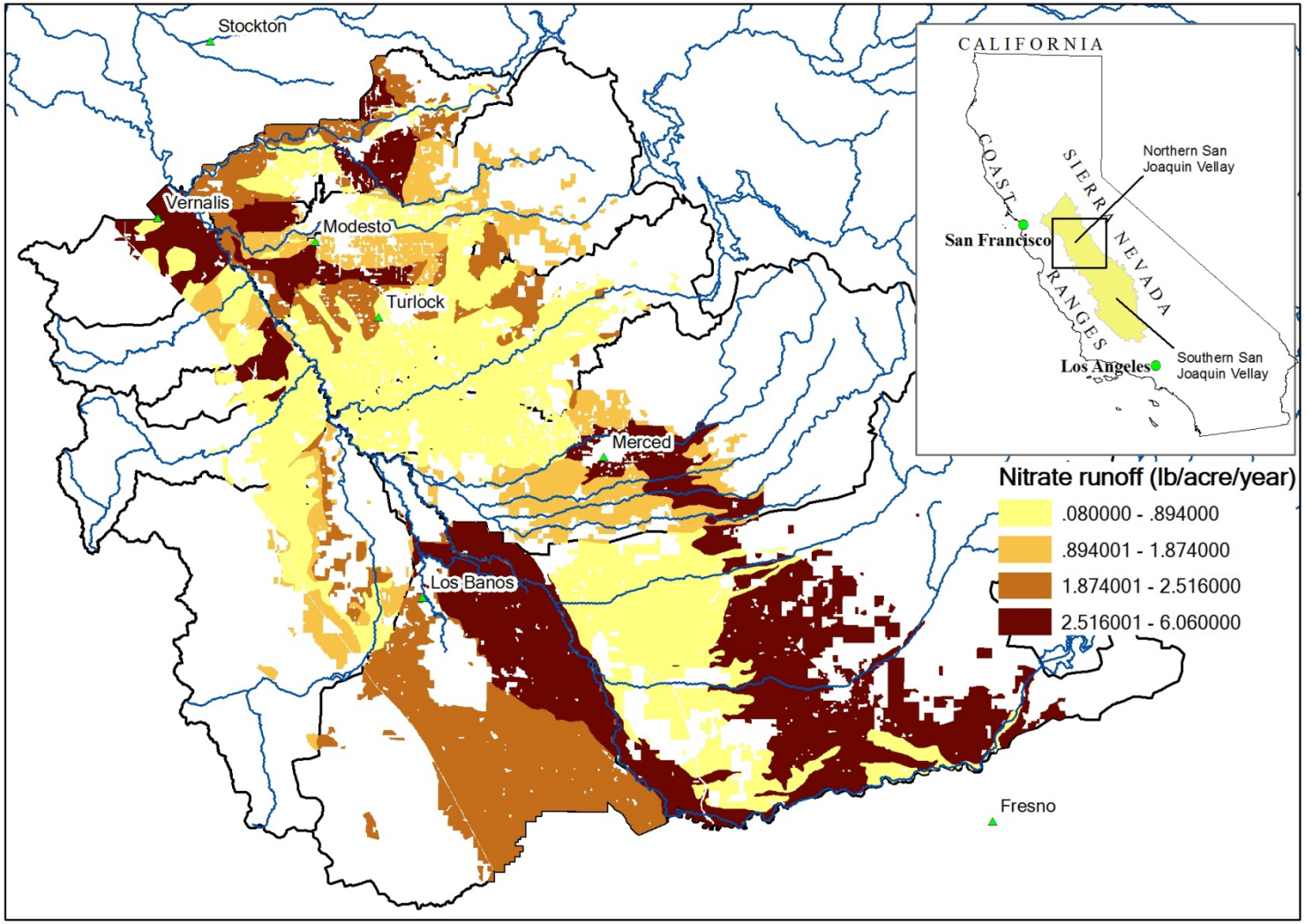
Predicted and observed **sediment load** (kg/mon) in the San Joaquin River at Vernalis during 1992-2005 (Reference: Luo et al., 2008)

Model results: pesticide



Dissolved chlorpyrifos loads (kg/mon) in the San Joaquin River at Vernalis during 1992-2005 (Reference: Luo et al., 2008)

Spatial distribution



Summary

- **PUR**: a valuable data source on pesticide use
- **PURWebGIS**: a user-friendly query tool
- **PURE**: an integrated pesticide environmental risk assessment system
- **SWAT**: a reliable model to simulate pesticide surface water concentrations

Acknowledgement

- California Department of Pesticide Regulation
- California Water Quality Control Board
- Coalition for Urban/Rural Environmental Stewardship (CURES)
- All colleagues in the AGIS lab @ UCD
  - http://agis.ucdavis.edu


请各位老师批评指正！