Characterization of Land Cover for Estimating Nitrogen and Salt Losses to Groundwater

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Why does land cover matter?

- Groundwater is applied, polluted, and recharged at or near the land surface
- Analyses of factors influencing groundwater conditions:
  - Are highly sensitive to how land cover is characterized
  - Must relate groundwater trends to corresponding trends in land use if they are to serve as a useful guide to future actions

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Why use process based models?

- Sources' significance depends on:
  - Concentration
  - Flow
  - Field and watershed context
    - Sensitivity of adjacent surface water and underlying groundwater
    - Additive effect with other concentrated and dilute sources
    - Climate, timing of release
    - Transport and transformation of the constituent

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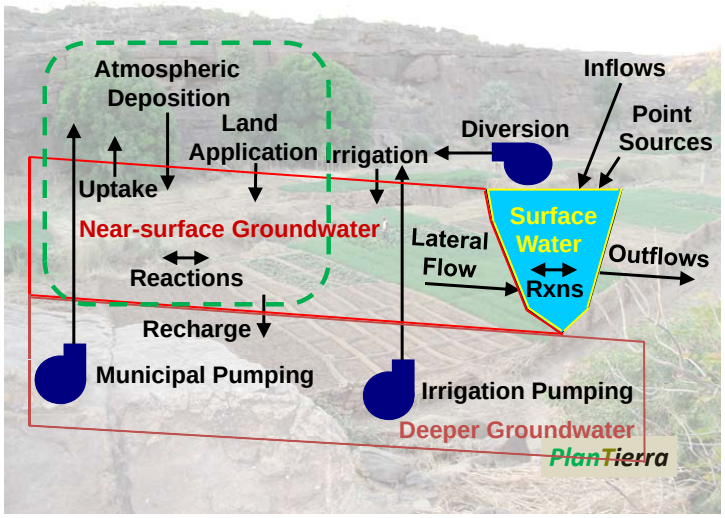

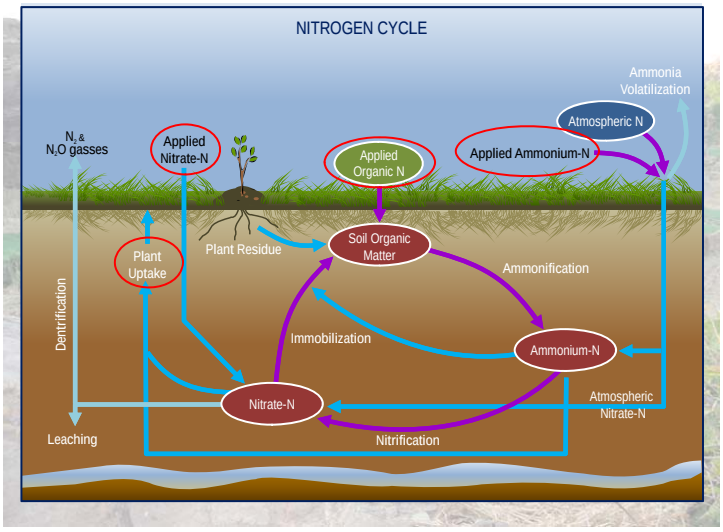

Land cover data input to models

- List of land cover ***classes***
  - Enough detail, but can group similar uses
- Land cover ***map***
  - The proportion of each analysis unit in each class
- ***Table*** of parameters
  - ET, runoff, % irrigated area, irrigation
  - N application and uptake, salt loading
  - Other significant factors (soils, newly reclaimed lands, drainage recycling)

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Topics

- Scale of analysis
- Classifying land cover (spatially, through time)
- Class parameters
- Sample land cover data set
- Approximations, when and where?
- Sample source analysis results
- Conclusions

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Using field-scale data to characterize sources within a watershed

Application	Scale of analysis		
	Field	Watershed	Admin unit
Production	x		
Field-level management	x		
Watershed-level performance		x	x
Watershed-level management	x	x	
Regulatory	x	x	

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Mapping field-level land cover (legend, locations)

Data source	Livestock operations	Agricultural	Urban	Other	Update frequency
National Land Cover Database				●	9 years
California Dept. Water Res.		●			7 years
Local planning			●		~5 years
Local agricultural commissioners	●	●			Annual
State regulatory data	●		●		~5 years

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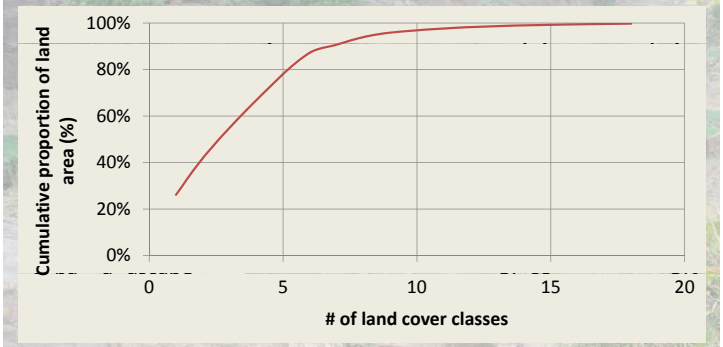
Sonoma county land cover classes



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Class parameters

Data source	Applied water, ET	Fertilization	Other salts	N uptake & removal	Update frequency
CIMIS, Agrimet, etc.	●				Daily; use monthly, long-term averages
Sales & delivery records, recommendations, industry	●	●	●		Annual (sales); use representative years
Local agricultural commissioners				●	Annual (sales); use representative years
Agronomic and plant analysis literature				●	Varies

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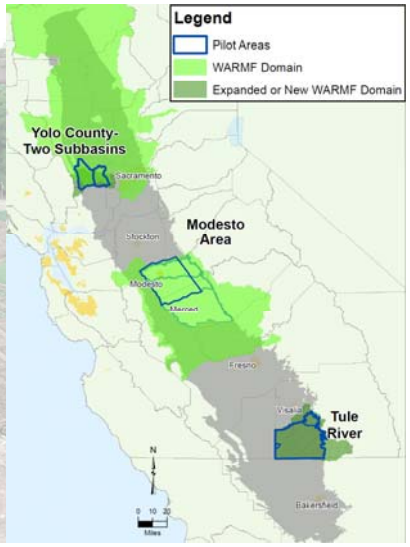
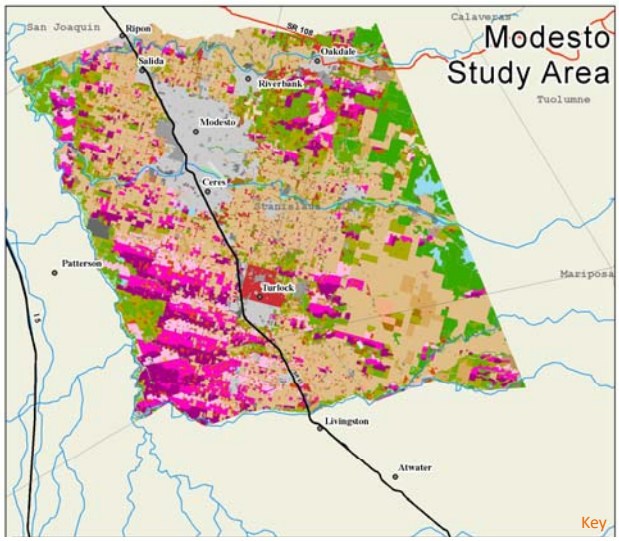
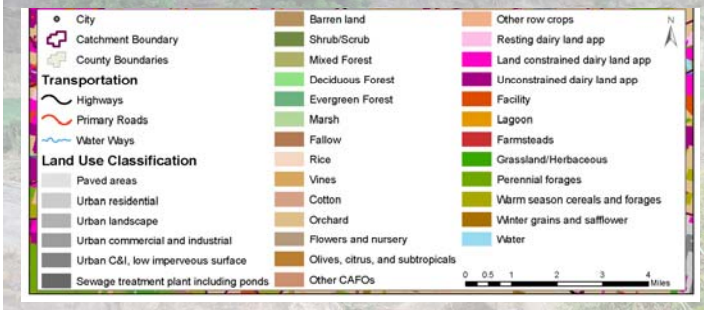




CV-SALTS Land Cover Classes



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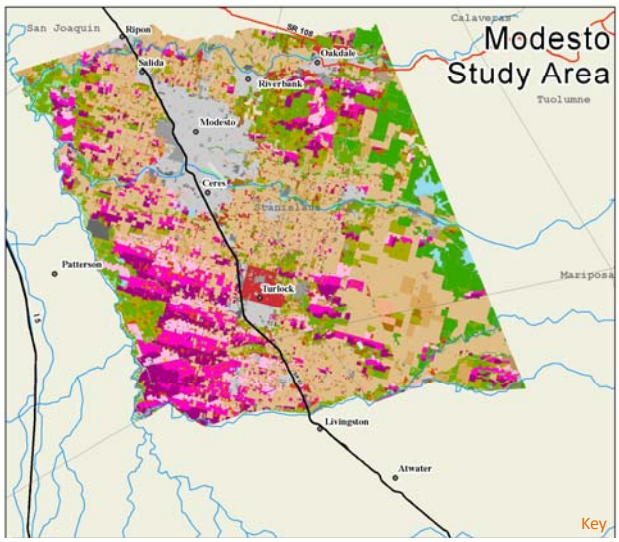
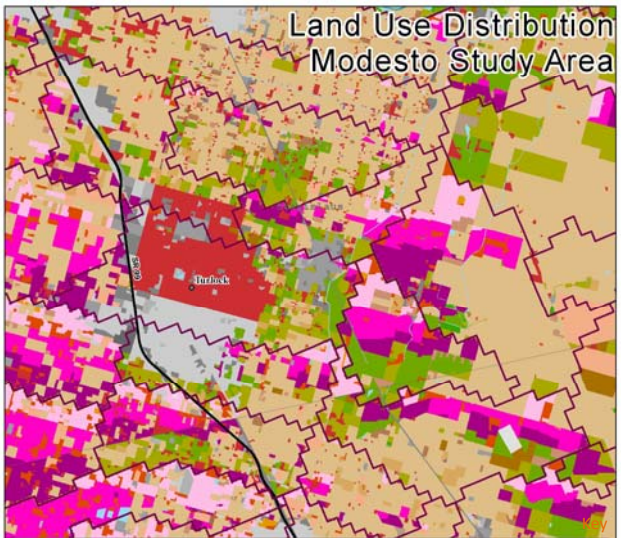
Close-up Yolo Modesto Tule





Approximations, when and where?

Condition	*Yes*	*No*
Rapidly evolving land cover?	Use time series	Use an average year
Field performance highly sensitive to soils, landscape, or locale?	Segregate by soil, landscape position, or locale	Consolidate soils, landscape positions, and locales
Potentially dominant source?	Refine parameters	Approximate parameters
Highly variable performance within class?	Segregate class	Consolidate class

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Sample results

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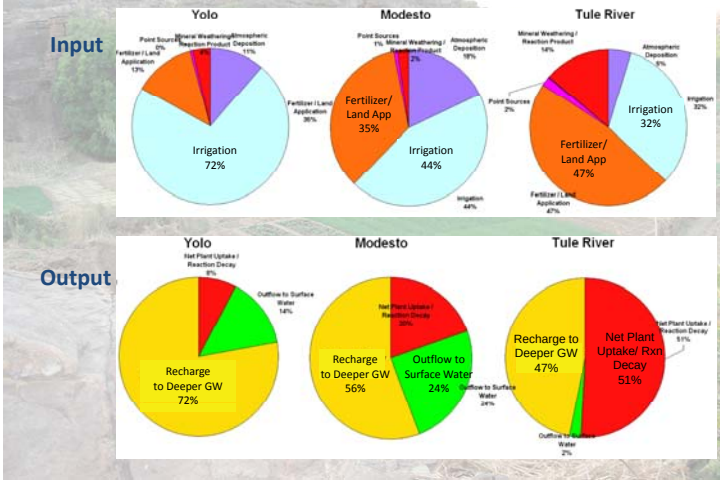
Near-Surface GW Loading to Surface Water by Land Use Class – Modesto

Land Use / Source[1]	TDS		Nitrate-N	
	lb/d	lb/ac/yr	lb N/d	lb N/ac/yr
Orchard	155,000	653	1,710	3.6
Perennial forages	115,000	1,420	406	2.49
Other row crops	93,900	1,440	2,490	19.1
Warm season cereals/forages	60,000	817	3,220	21.9
Farmsteads	32,200	919	302	4.32
Grassland/Herbaceous	12,200	322	4.41	0.058
Winter grains & safflower	6,460	443	344	11.8
Urban landscape	4,060	427	52.9	2.78
Land constrained dairy land application	3,680	55.9	12.7	0.097
Unconstrained dairy land application	2,540	38.6	4.56	0.035
Urban residential	2,290	28.9	4.67	0.03
Total	**486,000**		**8,600**	

[1] Top 11 land use sources

Mass Balance – Near-Surface Groundwater TDS



Conclusions

- Process-based watershed models require an up-front modeling of landscape conditions
- Pollutant source analysis is highly sensitive to land cover characterization
- Combine data from multiple sources, drawing on the strengths of each
- Need to address landscape variability that influences transport:
  - Within classes, between polygons
  - Within polygons
  - Temporal

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Related work

- Booth, M.S. and C. Campbell. 2007. Spring Nitrate Flux in the Mississippi River Basin: A Landscape Model with Conservation Applications. Environ. Sci. Technol. 41, 5410-5418
- Flay, R.F. undated. Modeling Nitrates and Phosphates in Agricultural Watersheds with the Soil and Water Assessment Tool. http://www.waterscape.org/pubs/tech_swat/SWAT_Review.doc.
- Gowda, P. H., B. J. Dalzell, and D. J. Mulla, 2007. Model Based Nitrate TMDLs for Two Agricultural Watersheds of Southeastern Minnesota. Journal of the American Water Resources Association (JAWRA) 43(1):254-263.
- Larry Walker Associates; Luhdorff & Scalmanini Consulting Engineers; Systech Water Resources, Inc.; NewFields Agricultural and Environmental Resources, LLC; Department of Land, Air, and Water Resource, UC Davis. Salt and nitrate sources pilot implementation study report. 2010. Report to CV-SALTS, posted at http://www.cvsalinity.org/.
- Ruddy, B.C., D.L. Lorenz, and D.K. Mueller. 2006. County-Level Estimates of Nutrient Inputs to the Land Surface of the Conterminous United States, 1982–2001. USGS Scientific Investigations Report 2006–5012.
- Schmid, W., R.T. Hanson, T. Maddock, and S.A. Leake. 2006. User Guide for the Farm Process (FMP1) for the U.S. Geological Survey's Modular Three-Dimensional Finite-Difference Ground-Water Flow Model, MODFLOW-2000. U.S. Geological Survey, Reston, Virginia.

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