USE-EXPOSURE RELATIONSHIP OF PESTICIDES FOR AQUATIC RISK ASSESSMENT

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Background

- Aquatic exposure to pesticide use is required in pesticide evaluations for surface water protection
- DPR surface water protection program is developing a more consistent and transparent method for evaluating registration packages
- Existing modeling approaches
  - Advanced models: require a large set of input data
  - Simple models: ignore spatial variability in climate, soil, crop, and/or topography

Objective

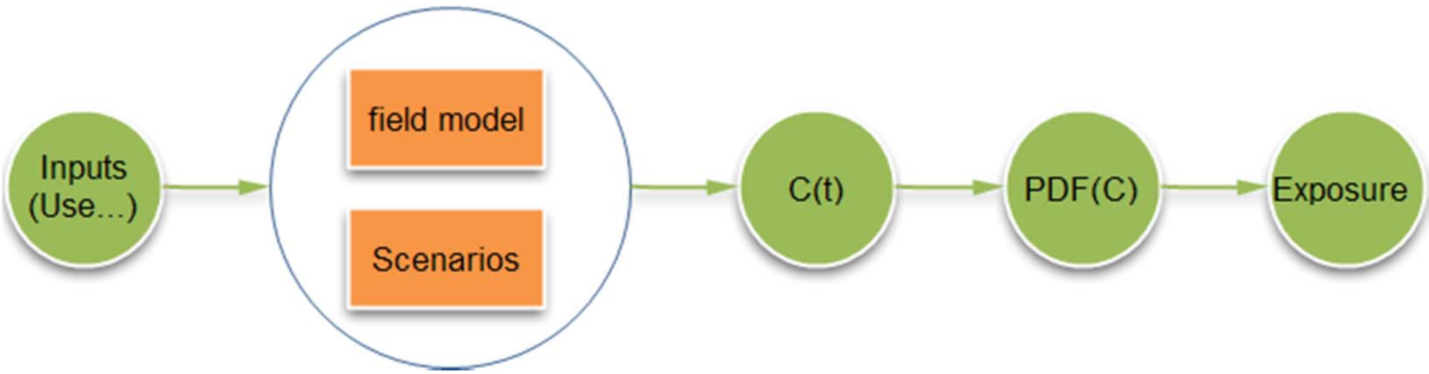
- To develop a simple model to estimate aquatic exposure to pesticides in California field conditions
- The model is designed as a screening tool of pesticide evaluation for surface water protection in the pesticide registration processes
- *Use-exposure relationship*: a statistical relationship as an abstraction, highlighting selected inputs/outputs of an *existing model*

Variables

- Use
  - What's used: chemical properties
  - Where used: use pattern/site (scenario)
  - How used: label rates and intervals
- Exposure
  - Peak concentration in a certain return period
  - Exposure Index (EI) from edge-of-field concentrations
    - Dissolved: 1-in-3 year return 4-day moving averages
    - Sediment-bound: 1-in-3 year return 10-day moving average

Conceptual model

- Regular modeling approach



- Use-exposure relationship
  - Direct linkage between input data to exposure
  - Exposure=***f***(label rate, chemical property)|<u>b</u>
  - where <u>b</u> is a set of *scenario*-specific coefficients

Development

- Select base model and scenarios
- Select chemical properties
  - Aerobic soil metabolism half-life (AERO), and organic carbon-normalized adsorption coefficient (KOC)
  - Log-normal distribution parameterized by ~200 common pesticides (Spurlock, 2008)
- Run stochastic simulations of the "regular approach"
- Save results as input-output (use-exposure)
- Perform regression analysis on the modeling results for the coefficient vector $\underline{b}$

Base model

- Pesticide Root-Zone Model (PRZM) is selected
  - Preference of its use by USEPA for pesticide risk assessment
  - Developed modeling *scenarios* for California
  - Uses in recent projects of risk assessments for California (e.g., OP cumulative risk study, red-legged frog study)
  - Continuous updates and supports

	Format	Inputs	Outputs
PRZM	FORTRAN program	Field conditions, chemical properties, applications	Daily concentrations
Use-exposure relationships	Regression equations	Modeling *scenarios*, registrant-submitted data	Exposure index

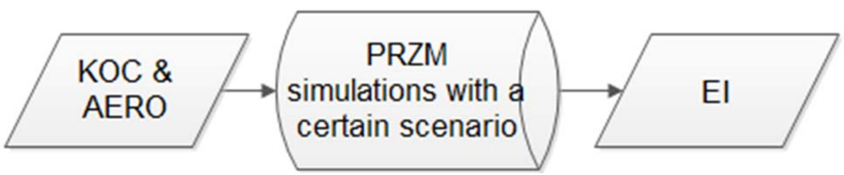
Modeling scenarios

- USEPA Tier 2 modeling scenarios for California
  - USEPA (2006). Organophosphate pesticides: revised cumulative risk assessment
  - USEPA (2008). USEPA Tier 2 crop scenarios for PRZM/EXAMS Shell
  - USEPA (2010). Effects Determinations for the California Red-legged Frog and other California Listed Species

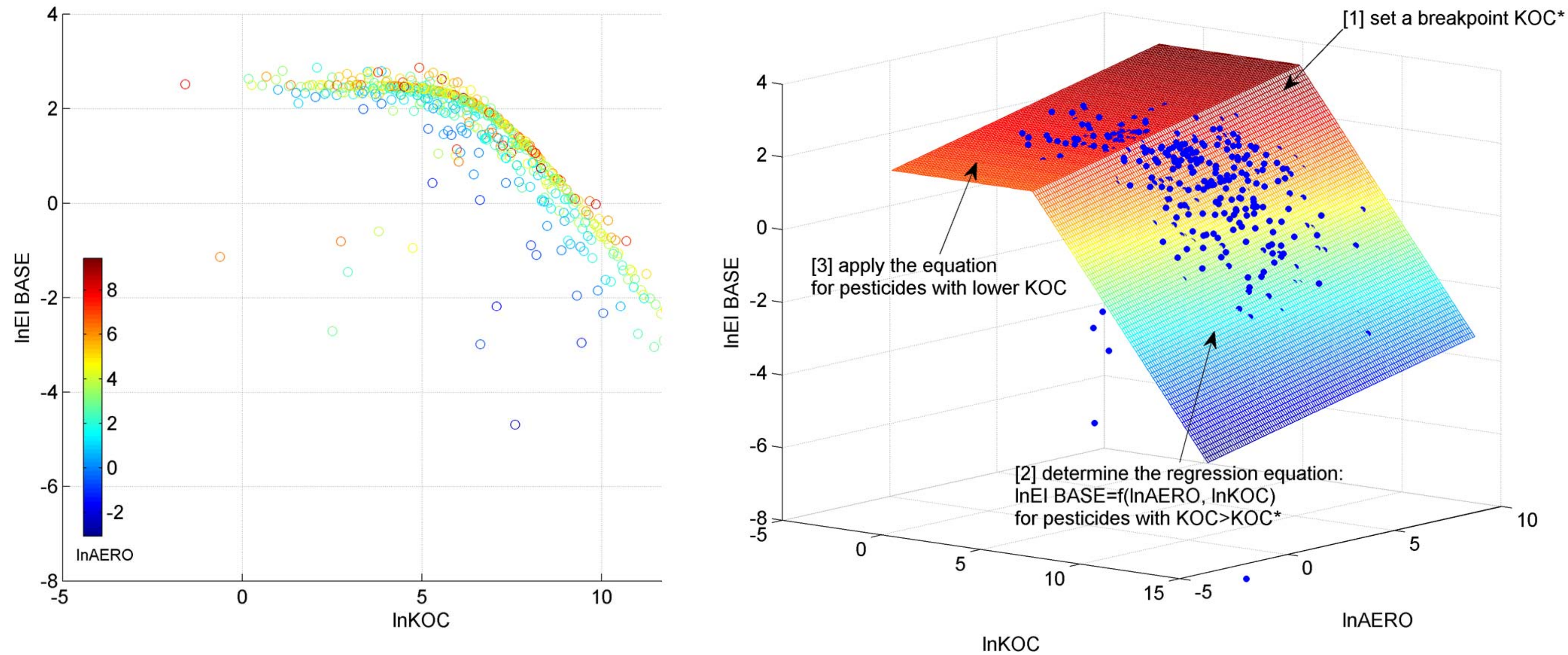
Crop scenario	Represented use pattern	Soil (hydrologic group)	Weather station
Alfalfa (OP)	Pasture, gravity irrigation	Sacramento clay (D)	Fresno
Almond (STD)	Dormant application	Manteca fine sandy loam (C)	Sacramento
Cotton (STD)	Field crop, gravity irrigation	Twisselman Clay (C)	Fresno
Sugar beet (OP)	Field crop, gravity irrigation	Ryde clay loam (C)	Fresno
Tomato (STD)	Tomato, gravity irrigation	Stockton clay (D)	Fresno
Turf (RLF)	Pre-emergent application	CapaySilty Clay Loam (D)	San Francisco
Wheat (RLF)	Grain, gravity irrigation	San Joaquin Loam (D)	Fresno

Processes

- Initialize PRZM model with one scenario
- Run stochastic simulations with random AERO and KOC
- Derive regression relationships between inputs and outputs



AERO	KOC	EI
AERO1	KOC1	EI1
AERO2	KOC2	EI2
…	…	…



KOC*: a breakpoint for KOC

EI: exposure index (i.e., peak concentration)

BASE: base application rate, used to normalized the predictions

RATE: equivalent application rate based on label rates and intervals

Model: $\ln(EI\_BASE)=b_1+b_2\ln(AERO)+b_3\ln[\max(KOC,KOC^*)]$

$EI=EI\_BASE^*(RATE/BASE)$

Coefficients

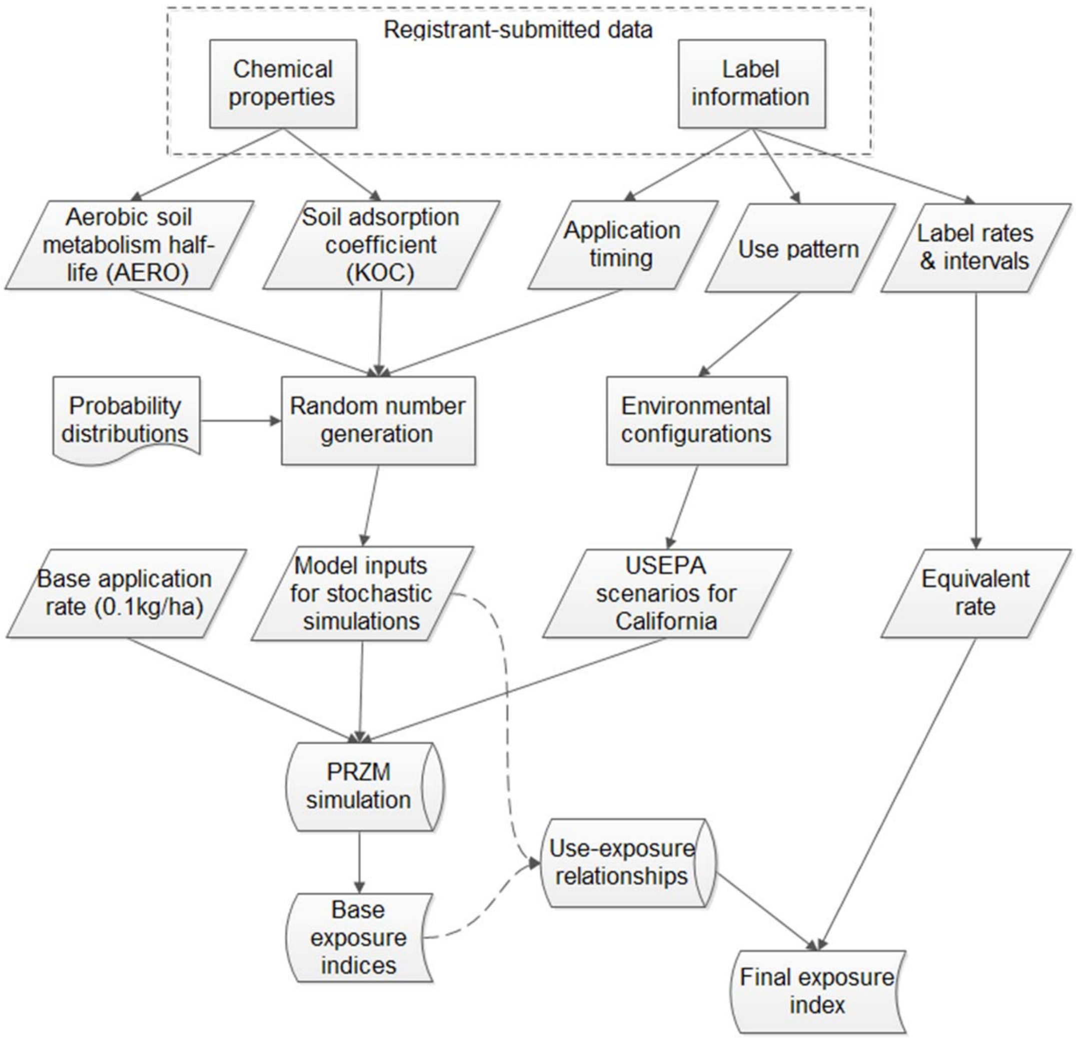
Scenarios	Coefficients			R2	lnKOC*
	b1	b2	b3		
Alfalfa	5.2156	0.1907	−0.8288	0.9494	3.5
Almond	4.8131	0.1869	−0.7467	0.9335	4.5
Cotton	6.3173	0.1467	−0.7662	0.9102	5.5
Sugar beet	4.9105	0.2412	−0.8377	0.9193	3.0
Tomato	5.9979	0.1785	−0.7844	0.8970	4.0
Turf	3.3647	0.2821	−0.8248	0.9546	0.5
Wheat	6.0764	0.1853	−0.7954	0.9487	5.0
Tomato_FL	4.9362	0.2531	−0.8063	0.9422	4.0

Note: "Tomato_FL" denotes the standard USEAP crop scenario for tomato in Florida, which is provided as an example of the crop scenarios in other states.
doi:10.1371/journal.pone.0018234.t005

Discussions and future studies

- Selection of the base model
- Modeling scenarios
- Receiving water bodies

Thank you!



Reference:

Luo et al., 2011. *PLoS ONE*, 6(4): e18234

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