

# Environmental Statistics for the Agrichemical Industry



RTI International is a research development and technical services organization that has been providing model- and design-based environmental solutions for more than 30 years in support of the agricultural community. Our environmental statisticians collaborate with scientists and engineers from other disciplines to form a team that has a deep understanding of the environmental problems faced by modern agriculture.

## Overview

Our expertise helps industry solve problems related to the regulatory requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Toxic Substances Control Act. We provide statistical capabilities in support of work required by these regulations, including experimental design, sampling, simulation, and modeling. Focus areas include

- Epidemiological studies
- Geostatistical, spatial, and spatio-temporal modeling
- Risk assessment and exposure analysis
- Sampling and monitoring program design
- Toxicological modeling.

## Areas of Expertise

### Sampling and Monitoring Program Design

RTI develops probability-based sampling designs to make robust inferences regarding environmental variables that evolve in space and time. We also have developed sampling designs for collecting data on water and air quality and on human exposure to contaminants. RTI statisticians can apply a full suite of sampling methods specific to environmental monitoring, including

- Adaptive sampling
- Area sampling

- Capture-recapture designs
- Composite sampling
- Generalized random tessellation stratified designs
- Line transects and variable circular plot sampling
- Ranked-set sampling.

RTI statisticians can optimize sampling designs for monitoring programs by finding the smallest sample size and best sample allocation to achieve multiple precision constraints at minimum cost.

### Toxicological Modeling

RTI provides statistical consulting services for a variety of animal, plant, and eco toxicology studies conducted under the FIFRA good laboratory practice guidelines. We analyze safety assessment studies, including neurobehavioral, developmental toxicity and teratology, carcinogenicity, endocrine toxicity, avian toxicity, and acute studies for estimating LD50s (lethal dose 50%) and related parameters.

### Risk Assessment and Exposure Analysis

RTI's analytical chemists and statisticians have participated in more than 30 exposure field studies, with activities including sample survey design, estimation, modeling, database development, protocol development, in-field sampling, and laboratory-based analyses. Using

environmental exposure data, RTI statisticians apply parametric, nonparametric, and simulation techniques to evaluate whether a chemical's ambient concentrations are sufficiently high to cause health concerns, considering multimedia, multipathway, and multichemical exposures.

## Geostatistical, Spatial, and Spatio-Temporal Analysis

We use geostatistical, spatial, and spatio-temporal models to characterize environmental processes and to reliably predict measurements at locations where no data are available. We combine information from different GIS databases and field survey data, understanding change of support (upscale or downscale) and spatial resolution issues related to combination. We can also produce national, regional, county, state, and small-scale inferences as needed.

## Project Highlights

**National Human Exposure Assessment Survey (NHEXAS) Phase I Field Study.** We developed the sampling design for NHEXAS, the objective of which was the comprehensive evaluation of human exposure to multiple chemicals on a community and regional scale.

**Sampling Designs for Surface Water Monitoring.** In a post-registration study for a major nationally distributed pesticide, we identified best surface water sampling designs for the estimation of proposed regulatory quantities. Estimation approaches were evaluated using simulation and time-series methods.

**Estimation of Extreme Values in Historical Surface Water Monitoring Data.** Effective use of historical monitoring data can reduce the need for more extensive monitoring efforts. This project applied survey sampling techniques to find confidence intervals for upper percentiles of surface water pesticide concentration using large historical datasets with infrequent per-year sampling.

**Temporal Trends in Herbicide Surface Water Concentrations, 1990–2010.** Mixed-effect models were used to study the long-term trend in two annual concentration of pesticide concentrations using data from a monitoring

network. Our analysis provided an understanding of the effect of interventions, such as changing pesticide use patterns, increasing environmental stewardship efforts, and implementing best management practices.

**Technical Support for Evaluating PBPK/PD Models for Interpreting Biomarkers of Exposure to Assess Cumulative Risk.** We extended an existing PBPK/PD pesticide model to allow estimation of dose from observed levels of biomarkers of exposure. Our statistical analysis evaluated selected biomarkers of exposure for their utility in understanding pathways of exposure and dose.

**Endocrine Disruptor Screening and Testing Standardization and Validation Technical Support Services.** We applied mixed models to validate results obtained from several labs performing assays to detect endocrine-active chemicals by measuring body and organ weight changes, organ microscopic changes, and nine circulating hormones. The work was in compliance with regulatory agency guidelines, Good Laboratory Practices, and laboratory standard operating procedures.

**Toxicological Safety Assessments.** In this work for an agricultural chemical company, we provided rapid turnaround toxicological analyses for complex data situations—for example, nonlinear growth curves fitted to repeated measures data to estimate the dose-related time to recovery of cholinesterase activity after exposure to a carbamate. This work required an understanding of subchronic studies, neurotoxicology studies, teratology studies, and carcinogenicity studies in animals.

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## More Information

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