National Exposure Research Laboratory

Pesticide Exposure

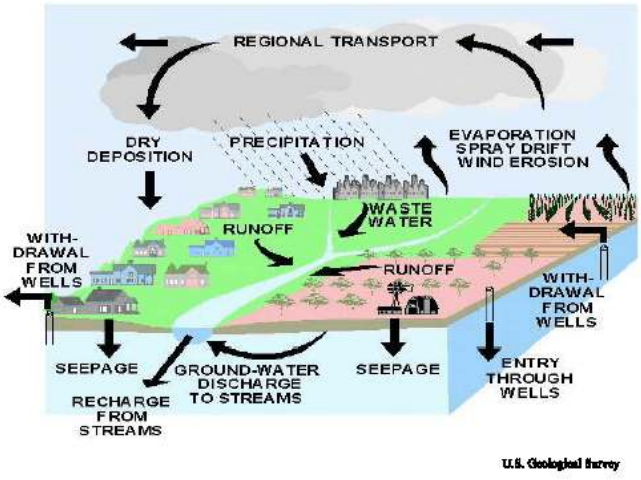
Responsible and Safe Pesticide Use

Pesticides in the Environment

Pesticides are important for keeping American agriculture productive, free from pest infestations and disease, and economically viable. Many pesticides are also toxic to wildlife and consumers, so EPA and industry work together to write careful instructions for their safe and responsible use. In creating these instructions – the pesticide "label" – industry first studies the chemistry and toxicology of their products in the laboratory and submits the data to EPA. EPA then has the responsibility to use the data to predict how much chemical would escape into natural ecosystems, and how long the chemical would remain in food chains and natural reservoirs. "Exposure" is then combined with toxicological "effects" data, the likelihood of accidental damage to ecosystems is evaluated, and the pesticide "label" is written to minimize these dangers and risks.

From the Laboratory to Fields and Streams in the Agricultural Landscape

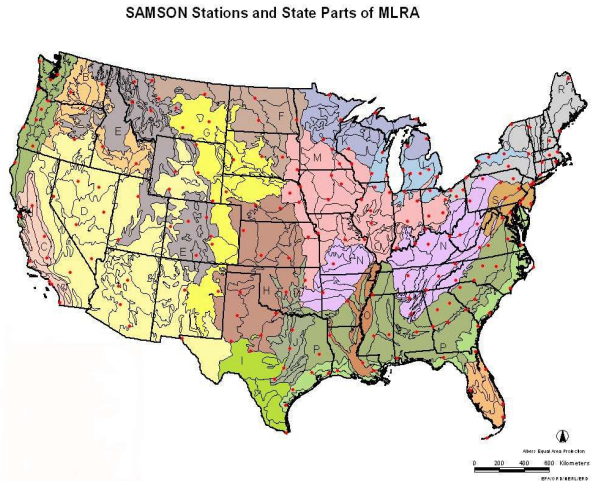
Pesticides are used throughout the country, so using a pesticide experimentally in one or a few areas does not tell us enough about how it will behave when subject to the vagaries of wind, sun and rain in other areas. For this, an understanding of environmental processes – the basic chemical and physical mechanisms of pesticide transport and degradation in the real world – is needed. This knowledge has accumulated over the past five decades, and, although much remains to be done, serves as the basis for the laboratory experiments required of industry, and the means by which EPA predicts the environmental behavior of pesticides allowed into general use. The implications of our knowledge of processes are captured by creating and testing mathematical expressions that describe the interaction of chemistry and environment. This mathematics is then molded into computer algorithms, which are imbedded in a larger computerized "decision-support system" that serves the information needs of the risk assessor. When making safety decisions, the uncertainties in models, errors in chemical data, year-to-year changes in weather patterns, and the range of soils, slopes, and cropping practices used by farmers all enter into the probabilistic and uncertain nature of the risk equation.



Research Objectives

Ecological risk assessment of pesticides relies on "fate and transport" models that make direct use of industry study results to predict exposure. These models, developed from basic physical and chemical process sciences, are tested in "validation" studies so their uncertainties can be known. By design, they capture the uncertainties of weather and the heterogeneous soils of farmers' fields in probabilistic exposure estimates, and so require high-quality nation-wide databases of climate, soil properties, and farming practices.

Research Summary



This research has developed models of the atmospheric drift of pesticides (*AgDisp*), pesticide persistence, runoff, and erosion in agricultural fields (*PRZM*), transport and fate in aquatic environments (*EXAMS*), and food chain contamination (*BASS*). The models have been tested by comparing their predictions to real-world studies where one or another of the model processes is most important, so that each part of the model can be critically evaluated. In this way the process algorithms have been continually strengthened over time. Many of these studies have been published in the scientific literature and summarized in the models' user manuals. The models, their manuals, the computer source codes, and supporting databases are available at EPA's Center for Exposure Assessment Modeling (CEAM) web site at http://www.epa.gov/ceampubl/ceamhome.htm. A national-scale database is currently being developed to provide a unified, high-quality single source of input environmental data for all the models. The State divisions of Major Land Resource Areas (MLRA) were chosen as a fundamental mapping unit, to facilitate access to soils and agricultural land use data from the National Resources Inventory of the United States Department of Agriculture. The database includes solar radiation data from the National Weather Service's SAMSON (Solar and Meteorological Surface Observation Network) project, hourly rainfall, wind, and weather data, and evaporation data developed as a combination of weather observations and FAO (Food and Agricultural Organization of the United Nations) standardized methods for estimating crop water requirements. This database includes 239 U.S. stations, giving 30 years of data for comparable high-quality studies throughout the country..

Participants

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Selected Publications from this Research

Teske, M.E., Bird, S.L., Esterly, D.M., Curbishley, T.B., Ray, S.L., and Perry, S.G. 2002. AgDrift: A model for estimating near-field spray drift from aerial applications. Environm. Toxicol. Chem. (in press).

Burns, L.A. 2001. Probabilistic Aquatic Exposure Assessment for Pesticides. I: Foundations. EPA/600/R-01/071. U.S. Environmental Protection Agency, National Exposure Research Laboratory, Ecosystems Research Division, Athens, Georgia. 43 pp.

Burns, L.A. 2000. Exposure Analysis Modeling System (EXAMS): User Manual and System Documentation. EPA/600/R-00/081. U.S. Environmental Protection Agency, National Exposure Research Laboratory, Ecosystems Research Division, Athens, Georgia. 197 pp.

Burns, L.A. 1995. PIRANHA – A computer-based system for chemical risk assessment. pp. 305-315 In: M. L. Leng, E.M.K. Leovey, and P.L. Zubkoff (Eds.) Agrochemical Environmental Fate: State of the Art. CRC Press, Boca Raton.

Burns, L. A. 1983. Fate of chemicals in aquatic systems: process models and computer codes. pp. 25-40 In: R.L. Swann and A. Eschenroeder (Eds.) Fate of Chemicals in the Environment: Compartmental and Multimedia Models for Predictions (ACS Symposium Series 225). American Chemical Society, Washington, D.C.