US Environmental Protection Agency
Office of Pesticide Programs

Evaluation and Use of Water Monitoring Data in Pesticide Aquatic Exposure Assessments

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EVALUATION AND USE OF WATER MONITORING DATA IN PESTICIDE AQUATIC EXPOSURE ASSESSMENTS

The USEPA Office of Pesticide Programs (OPP) Environmental Fate and Effects Division (EFED) uses a tiered approach to risk assessment. The tiered approach screens out low-risk pesticides and focuses refined assessments and resources on pesticides most likely to pose a risk of concern. This approach utilizes modeling in conjunction with available water monitoring data from both surface water and groundwater to compensate for the fact that monitoring data for most pesticides is usually insufficient to estimate exposure to aquatic organisms under all potential use conditions and geographic scales.

Modeling begins at a national scale using assumptions about the predominant factors that influence pesticide concentrations in water (e.g., environmental fate characteristics, pesticide use, runoff and erosion vulnerability, leaching potential, climate) that together provide a conservative upper- bound estimate of potential pesticide concentrations. Pesticides that exceed screening (or Tier 1) levels of concern (LOC) for either human health or ecological effects are assessed at the next level of refinement using Tier II models and an evaluation of available monitoring data. Use of higher-tiered models to refine screening-level risk assessments is dependent on the need for more parameterization of the model and better characterization of the estimates of exposure in aquatic systems. As the tiers increase, the level of sophistication increases as does the spatial and temporal relevance to the estimated exposures.

Screening-level exposure estimates are derived from models intended to provide an upper-bound concentration, while monitored concentrations represent the conditions under which the data was collected. When monitoring data is compared to modeling results, it often appears that modeling over-predicts concentrations. EFED carefully considers these apparent differences, because the conditions under which monitoring data is collected and reported dictates its relevance for risk assessment.

The extent to which monitoring data can be used quantitatively in an exposure assessment for a specific chemical depends on how much is known about the data, the robustness of the dataset, and the extent to which the data represent areas of high pesticide use and runoff or leaching vulnerability. For example, the risk assessor considers how well the study was targeted to the chemical use, the frequency and number of years of sampling, and the adequacy of the ancillary data to correlate the detections with the pesticide use pattern being evaluated. Evaluation of monitoring data is critical because it provides context to the estimation of aquatic exposure from modeling. Monitoring data can provide information that is lacking in modeling, such as identifying vulnerable or non-vulnerable areas depending on the spatial extent of the data.

EVALUATION OF MONITORING DATA FOR QUANTITATIVE USE

Monitoring data provide snapshots of pesticide concentrations in time at specific locations. In order for OPP to make the best use of this data, we need supporting information that will allow us to put the results in context with the larger picture of pesticide exposures in the environment. The more likely the monitoring sites reflect areas that have a likelihood of pesticide occurrence in water (based on pesticide use as well as local runoff or leaching vulnerability), sampling

occurs during the time frame in which pesticides are expected to be used, and the sampling is frequent enough to estimate exposures for the endpoints of concern, the more likely OPP will be able to incorporate that data quantitatively.

Typically, monitoring data is screened at Tier I to identify any detection above the modeled values and is not evaluated in a comprehensive manner unless higher tiered assessments are needed. For higher-tiered assessments, when EFED uses monitoring data quantitatively it means that the data may be used as a direct measure of exposure in an ecological or human health dietary assessment. While submission of monitoring data with appropriate ancillary data is important, the quantitative use of monitoring data is highly dependent on the sampling frequency in the monitoring program. Monitoring data will typically underestimate actual exposure concentrations due to insufficient sampling frequency. While this is more of a concern for surface water monitoring, it can still be a consideration for groundwater monitoring. Therefore, monitoring data often are expected to provide a lower bound estimate of exposure for purposes of risk assessment. Statistical methods are being developed to address the uncertainty in estimating pesticide concentrations from monitoring data. Employment of these methods is expected to reduce the uncertainty in estimating upper bound pesticide concentrations from monitoring data.

In such cases, the monitoring data may be used in lieu of or in addition to modeled estimates. This is a high hurdle to clear because much of the monitoring data available are often not targeted to a particular use pattern or of sufficient frequency to capture durations of concern. However, with adequate ancillary data and study design/objectives, monitoring data can be used directly for risk assessment. Also, it is possible that while a data set may not be national in scope, it may provide a quantitative measure on a regional or local scale in which case it could be used for a local refinement to a national modeling exercise.

The occurrence of pesticides in waters varies with factors such as:

- Spatial pesticide use patterns, crop and management practices, soil and hydrologic vulnerabilities, and rainfall distribution;
- Intensity and timing of pesticide applications and coincidence of rainfall events;
- Year-to-year temporal patterns at any given location reflecting changes in cropping and pesticide use as well as variations in rainfall from year to year
- Extent of impervious surfaces in urban areas and hydrology of engineered urban stormwater systems

A well-designed, targeted water monitoring study takes into account both spatial and temporal patterns of exposure, focusing sampling on when and where the pesticide is used. Considerations for sampling frequency include the duration of toxicological concern, the pesticide properties and use patterns, expected interactions of the pesticide with the environment, and the aquifer and/or water body and watershed characteristics. Vulnerability to pesticide contamination is related to not only pesticide use but also the potential for runoff and leaching. However, there must also be a relevant temporal component to monitoring that must be considered when using the data quantitatively.

The National Water Quality Monitoring Council (NWQMC) developed a set of minimum data elements for evaluating and comparing water quality data (NWQMC, 2006). The data elements are not required information but are "recommended as a means to help data collectors more easily consider the most important WQDE (i.e., Water Quality Data Element) needed to assess data comparability." These data elements include point of contact, date/time of collection, sampling location, reasons for sampling, and information on collection, processing, analysis, and quality assurance/quality control (QA/QC) of samples. Information such as sample frequency, type of sample (grab vs. composite), number of samples, and analytical detection limits all influence the appropriate use of the data. OPP, EPA's Office of Water (OW), other federal agencies (e.g., United States Geological Survey) and some states use variations on this guidance for establishing reportable data elements that are generally consistent. For a specific example, see OW's Water Quality Exchange (WQX)[1] or the USGS National Water-Quality Assessment (NAWQA) Program data warehouse[2], which have schema for reporting data similar to this methodology.

More specifically, the key elements to consider when deciding if monitoring data is useful as a quantitative measure of exposure are:

- For agricultural areas, were the samples collected from sites where the pesticide was used?
- For urban areas, were the samples collected from sites receiving surface water runoff via stormwater conveyances?
- For groundwater, is there a pathway between the use site and the aquifer sampled?
- Were the samples collected at a time when runoff and spray drift were likely?
- What were the rainfall patterns before, during, and after pesticide application?
- How does runoff and/or leaching vulnerability at the sampling sites compare to the overall pesticide use area?
- Were the samples collected frequently enough to estimate the desired duration of exposure, and was it a grab or composite sample?
- Was the water body sampled relevant to the habitats of concern in the assessment?
- Was the groundwater well from confined or unconfined aquifers?
- How deep was the well and at what depth was it screened?
- Is the well used for drinking water or is it for ambient monitoring?
- Are the detection limits and limits of quantitation reported and were method recoveries reported and sufficient to have confidence in the results?

EVALUATION OF MONITORING DATA FOR QUALITATIVE USE

The discussion above does not mean that data not meeting these elements are not useful for risk assessment. Available monitoring data that has some but not all of the elements described above may still be valuable in adding context to the exposure assessments. For instance, detections of a given pesticide can provide a measure of a lower bound of exposure. While the data may not be robust enough to ensure a high-end exposure has been observed, the detections do indicate that transport has occurred in the study. At a minimum, qualitative data can provide a balance

[1] http://www.epa.gov/storet/wqx/index.html
[2] http://cida.usgs.gov/nawqa_public/apex/f?p=136:1:0

against modeled estimates and can be useful for characterization of risk conclusions. For example, refinements to modeling sometimes use alternative assumptions that may reduce predicted concentrations. However, if these predicted concentrations approach or are lower than those in monitoring then this may call into question the appropriateness of the refinement.

A key factor in incorporating monitoring data into a risk assessment is the relationship of the monitoring locations both temporally and spatially to the use pattern of the chemical. The number and timing of analysis within the data set is often determined by a sampling objective, which may not match the needs of the pesticide risk assessment. Often, sampling frequency and location are limiting factors in comparing monitoring results to modeling or in using monitoring data quantitatively. For instance, a recent study by Stehle, et. al (2012) concluded that current sampling methods based on fixed intervals are not suitable for adequately characterizing occurrence and concentrations of insecticides that are applied only in the case of insect infestations.

Careful consideration needs to be given to the robustness of the monitoring data. Often, monitoring data complements modeling by providing a lower bound on exposure, but the spatial and temporal limitations preclude the use of monitoring data as exposure endpoints. An important factor not usually considered in the monitoring study design is the toxicological endpoint being considered. Is it an acute or chronic issue? Studies have shown that less frequent sampling may provide a better estimate of annual average concentrations than of acute or peak concentrations.[3]

The USGS NAWQA data is a perfect example of data suitable for qualitative use. Typically, OPP will use that type of data in several ways. First, the data provides a ground truth on our modeled estimates. Comparisons of both peak and long term exposure can give us a sense of how representative our modeling is of ambient conditions. Second, situations where peak or long term exposures estimated from monitoring exceed modeled estimates suggest the need for reevaluation of whether the modeling approach is sufficiently protective.[4]

DATA WITH INSUFFICIENT DETAILS

Finally, monitoring data that provides no context on where samples were taken, what the study objectives were, what analytical methods were used or what the detection limits were are

[3] Recently, OPP solicited feedback from the FIFRA Scientific Advisory Panel (SAP) on methods of interpreting monitoring data sampled at various frequencies in order to use the results in quantitative exposure assessments (USEPA, 2010a, 2010b, 2011). The SAP provided recommendations on the use of bias factors and other interpolation methods, including models, in order to estimate potential exposures for various durations of toxicological concern based on varying sampling intervals. While these efforts focused on atrazine, the lessons learned and tools developed may be valuable for other pesticides as well.

[4] As a matter of routine, EFED typically checks and reviews the following sources for pesticide monitoring including USGS NAWQA; EPA STORET (short for STOrage and RETrieval) Data Warehouse ; United States Department of Agriculture Pesticide Data Program (PDP) Drinking Water Monitoring. Additional monitoring data may be available from industry/registrant studies, state and tribal monitoring programs, or other government or research programs. These should be considered on a pesticide-specific basis.

examples of data that can be described but typically cannot be used as either a quantitative or qualitative measure of exposure.

REFERENCES

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