FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT

SCIENTIFIC ADVISORY PANEL MEETING

A Set of Scientific Issues Being Considered by the Agency in Connection with Proposed Methods for Basin-scale Estimation of Pesticide Concentrations in Flowing Water and Reservoirs for Tolerance Reassessment

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Scientific Advisory Panel (SAP) has completed its review of the set of scientific issues being considered by the Agency in connection with Proposed Methods for Basin-scale Estimation of Pesticide Concentrations in Flowing Water and Reservoirs for Tolerance Reassessment. The review was conducted in an open meeting held in Arlington, Virginia, on July 29, 1998. The meeting was chaired by Dr. Ernest E. McConnell (ToxPath, Inc.). Other Panel Members present were: Dr. Janice Chambers (Mississippi State University); Dr. Rory Conolly (Chemical Industry Institute of Toxicology-CIIT); Dr. Michael Cunningham (National Institute of Environmental Health Sciences-NIEHS); Dr. Amira Eldefrawi (University of Maryland School of Medicine); Mr. James Fallon (U.S. Geological Survey); Dr. David Gaylor (National Center for Toxicological Research); Dr. Gordon Hard (American Health Foundation); Dr. Art Hornsby (University of Florida); Dr. Ronald J. Kendall (The Institute of Environmental and Human Health, Texas Tech University/Texas Tech University Health Sciences Center); Dr. Fumio Matsumura (University of California); Dr. Mark Nearing (U.S. Department of Agriculture-Purdue University); Dr. Christopher Portier (National Institute of Environmental Health Sciences-NIEHS); Dr. Mary Anna Thrall (Colorado State University); Dr. Harold Van Es (Cornell University); and Dr. John Wargo (Yale University).

Public Notice of the meeting was published in the Federal Register on June 19, 1998.

Oral statements were received from the following:
Dr. Robert Butz (Jellinek, Schwarz and Connolly, Inc.)
Dr. Summao Chen (Novartis Crop Protection)
Mr. Thomas Gilding (American Crop Protection Association)
Dr. David Gustafson (Acetochlor Registration Partnership)
Dr. Thomas Hoogheem (Monsanto Company)
Dr. Raymond Layton (DuPont Agricultural Products)
Dr. Nick Poletika (Dow Agrosciences)
Dr. Mark Russell (DuPont Agricultural Products)
Mr. John Sullivan (American Water Works Association)

No written statements were received.

Questions to the Scientific Advisory Panel

The Agency posed the following questions to the SAP regarding Proposed Methods for Basin-scale Estimation of Pesticide Concentrations in Flowing Water and Reservoirs for Tolerance Reassessment.

Index Reservoir Questions

1) Is the Index Reservoir a suitable interim replacement for the standard pond for screening-level drinking water assessments?

The Agency is commended for trying to develop more realistic reservoir scenarios. The index reservoir (IR) approach is an improvement over the farm pond scenario; however concerns exist about the IR results. The critical issue is how the IR scenario is used. The Panel is aware of the challenges associated with this work and believes that the Agency is definitely focusing on the correct issues. However, the Panel recognizes the complexity of the processes considered here and that the establishment of quantitative criteria based on watershed-reservoir scenarios requires a high degree of sophistication and site-specific information. Some factors, such as the location of the fields in a watershed and soil/crop management factors can be very important in determining the potential for reservoir contamination. Given the limitations of model simulations, the Agency should consider complementary monitoring as an important component of validation process of defining the IR approach.

Several Panel members provided specific remarks. A Panel member questioned the Agency presenters on whether tile drains are present in the Shipman reservoir. The Agency presenters stated that they were not aware of tile drainage in the watershed. Another Panel member commented that Hydrologic Groups A/D and C/D soils are, by definition, tile drained (i.e., artificially drained). Since soils in the Shipman reservoir are Hydrologic Groups A/D and C/D, then tile drainage is present in the Shipman reservoir. These points further reiterate the importance of appropriate site characterization when applying the IR approach.

2) Given that the Index Reservoir has a drainage area to normal capacity ratio that is greater than seventy percent of reservoir-based drinking water supplies, does the SAP believe that the Index Reservoir represents a conservative but reasonable scenario for screening level assessments for drinking water exposure?

Several Panel members concluded that they could not directly answer this question without knowing the impact of the model parameters. However, the Panel agreed that the Agency should move forward in utilizing the IR. Thus, the Panel encourages the Agency to seek further scientific peer review as additional refinements are made to the IR. Additional comments in response to this question are provided below.

The use of the ratio of drainage area-to-reservoir normal capacity (DA/NC) to characterize the drinking water scenario reservoir is an improvement in that it more realistically represents an actual water supply catchment. Having a DA/NC ratio for the farm pond scenario of 12 is a conservative value.

Even though 30 percent of the Nation's reservoirs pose a higher risk of drinking water contamination, this may be due to inadequate design of the reservoir. These reservoirs may require special protection measures and should not influence the appropriateness of chemical use in other watersheds. It is advisable to do a sensitivity analysis of the Exposure Analysis Modeling Systems (EXAMS) model for different DA/NC watersheds.

One Panel member favored larger rather than smaller reservoirs for modeling. The Panel member questioned whether the Agency considered large reservoirs or the percentage of populations served by large versus small reservoirs. Large reservoirs would minimize the effect of point source contamination as was expressed as a public comment concerning the Shipman reservoir.

The Panel also addressed acute and chronic concentrations of pesticide residues in reservoirs. A reservoir with a short residence time would have more of a problem with acute pesticide concentrations, whereas a reservoir with a long residence time would have concerns addressing chronic concentrations. As an example, in a large reservoir in Perry Lake, Kansas, triazine concentrations in the upstream end were as high as 20 ppb, while the downstream end concentrations were 5-6 ppb. Thus, residence time must be considered, indicating a need for minimum discharge data from the reservoir.

On a related note, a Panel member concluded that DA/NC may not accurately reflect the range in reservoirs and residence time. Of the 38 Midwestern reservoirs that are listed as used for Public Drinking Water Utilities (PDWU), little meaningful information exists for DA/NC. However, residence time is related to mean annual runoff. Of the 38 reservoirs stated above, those with longer residence time (regardless of DA/NC) tend to be located in the cornbelt west of the Mississippi River where evaporation exceeds or equals precipitation, whereas those with shorter residence times tend to be located east of the Mississippi River.

3) Do the process and criteria used to select the Index Reservoir represent a reasonable approach? Are there other criteria we should consider when we reassess the reservoir scenario in the future?

The approach of the selection of the IR is reasonable, but the important question is how representative it is and how it is used in model simulation efforts. Appropriate representation of processes and management factors is important. Tile drainage and tillage are probably very important factors in this case (especially for Hydrologic Groups C and D).

One Panel member disagreed with the Agency background document (page 18) that concluded reservoirs vulnerable to pesticide contamination tend to be small and shallow with small watersheds. The Panel member stated that large reservoirs may also be vulnerable. As an example, two large reservoirs in Kansas (Perry Lake and Tuttle Creek Lake), are at least 10 times larger than those in the Agency database. Yet these reservoirs have annual concentrations just as high, and peak concentrations that may be just as high, depending on where in the reservoir sampling occurs.

In the Agency's background document *Proposed Methods for Basin Scale Estimation of Pesticide Concentrations in Flowing Water and Reservoirs*, the Agency raised concern with EXAMS handling stratified pesticide concentrations. A Panel member commented that data from Perry Lake indicated that stratification had a significant effect on atrazine concentrations at selected times. Concern should also exist for longitudinal changes in concentration, especially with respect to where PDWU intakes reside. Concentrations vary longitudinally and vertically in the reservoir. The upstream ends of reservoirs have much greater ranges in concentrations than downstream ends or the outflow. These factors should be considered as well.

The method of estimating the flow rate (mean annual runoff/number of hours per year) will result in too much water flowing into the reservoir in the fall and winter, when actual flows and pesticide concentrations are typically low, and too little water flowing into the reservoir in the spring and summer, when actual flows and pesticide concentrations are typically highest. As a result, this method may significantly underestimate pesticide concentrations and loads.

4) OPP has discussed a number of possible refinements to the reservoir approach and its screening approach in general. Which of these refinements does the SAP believe would have the highest priority?

More emphasis should be placed on tracking patterns of chemical use and release (i.e., monitoring relative to model simulations). Concentration data in the water supply are necessary for exposure and risk assessment. Incorporation of factors that are important to the transport process such as variable soil, regional climatic conditions, different land use scenarios contributing to pesticide transport (e.g., forestry, residential, recreational), corridors (i.e., transportation and utilities) and institutional considerations are additional refinements for the Agency to consider.

A Panel member suggested that the Agency use Soil Survey Geographic Data Base (SSURGO) level soils maps and attribute data rather than State Soil Geographic Data Base (STATSGO). In addition, simulations should be made on all soils in the catchment and weighted for their areal extent, rather than using just on one or two soils for an assessment. The Agency should develop or use geographic information system (GIS) linked models (i.e., Pesticide Root Zone Model [PRZM3]-EXAMS or Soil and Water Assessment Tool [SWAT]) to perform risk assessments using SSURGO level soils information. If this is done for several appropriate scenarios, then the first and second level screening can be handled quickly.

Several statements were made during the session concerning the lack of monitoring data. However, a Panel member remarked that extensive monitoring data exist in the public domain for Perry Reservoir in Kansas.

<u>Model Evaluation Questions</u>

1) Is our current broad exploratory approach to selection of suitable models and methods appropriate at this stage? Or, does the SAP believe that we know enough now about the various approaches to make a decision to focus our efforts exclusively on one or two modeling approaches?

In the use and evaluation of any model, there are five basic properties to be addressed: (1) the purpose of the modeling exercise; (2) the mathematical forms used to derive numerical results from the model; (3) the computational tools used to derive numerical results from the model; (4) the data/theory/mechanistic understanding which provides support for the model and; (5) validation of the model. In answering the questions posed to the Panel, one must answer them in the context of these five basic properties.

Why is the Agency using a suite of screening models for pesticides? A carefully constructed model will provide insight into the potential for standard excedence of current and new pesticides in agricultural use. The Agency's approach is correct, considering the difficulties in monitoring water quality for the broad range of pesticides in use and the impossibility of doing this for new submissions. Models are cost-effective means of providing information for priority setting. In addition, a well developed model will provide insights into which information will be most crucial for monitoring exposure (i.e., sensitivity analyses), an important issue to consider in order to evaluate exposure.

The mathematical form used for modeling is one of the most confusing aspects of the exercise. The difference between simple linear models typically used for regression analyses, and more complicated nonlinear models based upon a mechanistic understanding of the endpoints of concern is a source of considerable confusion, most of which is due to the linkage between the data and the model. Most linear regression models are fully supported by a single data set and seldom use ancillary, mechanistic data. Mechanism-based nonlinear models use a wide variety of data and are subject to much more complicated methods of parameter estimation.

The mathematical formulation of the river flow reservoir model as discussed at this session is an excellent initial effort at developing a screening model for water quality from pesticide runoff. The model incorporates most of the easily obtainable parameters. The directions for improving the model were well articulated by the Agency, including relaxation of some of the steady-state assumptions, use of finer time frames for simulations and expansion to include GIS data, and the ability to consider probability distributions for key model parameters.

The computational tools currently used in applying the model are adequate; this is obvious since the model is actually used. The Agency is encouraged to consider alternative computational tools to improve the understanding of the model, flexibility in modifications plus use and ease in overall programming. Efforts to convert the existing code to higher level mathematical programming languages will, in the long run, be beneficial to the overall project. In addition, the Agency is encouraged to further expand its collaborations on these models.

Finally, as with most modeling efforts of this level of complexity, data paucity and gaps are the key problem areas. The Agency is encouraged to promote a strong linkage between data acquisition and modeling; this will improve both the efficiency of use of the resources needed to acquire key data. In addition, balance between data needed for model validation (e.g., monitoring data) versus those needed for model use and expansion (e.g., distribution of flows in a representative sample of reservoirs) should be carefully addressed.

The Agency's broad exploratory approach was very useful and pointed out that each model has its strengths and weaknesses. Thus, one model is not applicable for all scenarios. The Panel and the Agency have learned a lot from this exercise. Given the complexities of the modeling demands and the contrasting limitations and sub-models of the various models, more than one model should be selected for basin scale assessment purposes. This could, and preferably would, result in a system of two or more models under a single user interface. A side-by-side characterization of the available models is a necessary first step in selection of candidate models for use by the Agency.

The models generally address multiple contaminants, while the 1996 Food Quality Protection Act (FQPA) needs are only for pesticides. Given the importance of the FQPA requirements, it appears to make sense to develop a sophisticated tool just for this particular purpose. The best approach may be to select the most promising of these models and make the appropriate adjustments. This can be done fairly quickly while working with the model developers. Perhaps this can be done in concert with the regulated industry. It is very important to include all relevant features (e.g., tile drainage, preferential flow, conservation practices, crop development) in the model. It is also suggested to place more emphasis on model validation for "extreme" hydrologic events for the reasons of evaluating acute toxicity risks.

2) We have sketched out a potential tiering system for model use in a FQPA drinking water assessment. Is the level of effort required at each level and the degree of added sophistication appropriate in the proposed tiered system? Is the accuracy gained through the added sophistication of each modeling tier likely to be worth the added cost?

The majority of the Panel agreed with the Agency's tiering approach for drinking water assessment. The need for more than two tiers was questioned; two may be enough. Most of the tiering effort is related to establishing the simulation framework (weather, soils, land use scenarios, etc.) and the appropriate model validation. Once this has been completed, the actual simulations are perhaps of moderate time consumption. Thus, most of the effort of modeling is up front and needs to be done in a sophisticated matter.

However, a Panel member did not agree that a two-tiered approach is adequate and suggested a four tiered system. Utilization of such a tiering system would entail a cursory screen (first tier), detailed field screen (second tier), basin-scale evaluation (third tier), and monitoring (fourth tier), leading to greater accuracy for modeling drinking water exposure.

The Panel expressed concern about the use of tiered screening models (including Surface Water Mobility Index) based only on Koc and half-life information, as in the case of very toxic chemicals. Recent research has shown that relatively immobile chemicals may still leach (through preferential flow) or run off in significant quantities during extreme hydrologic events. A relatively immobile pesticide with high toxicity may therefore still pose a significant risk. Highly toxic compounds should perhaps automatically go to an advanced tier.

Complexity and sophistication do not necessarily equate to more accurate predictions in natural resource modeling. Factors in this case, however, call for the more sophisticated approach. The tiered system outlined for the pesticide evaluation system calls for an increase in accuracy with each tier level, but it also calls for a different type of model. Specifically, the basin-scale methods call for consideration of a larger spatial-scale (river basin) which involves processes not represented in the lower tier models. In addition, integration of the models with site-specific GIS data, in many cases, will enhance the reliability and repeatability of the simulations.

3) We have selected two sub-basins of the White River watershed in Indiana for a preliminary model evaluation and comparison effort. Can data from these watersheds provide a reasonable evaluation given model capabilities and watershed characteristics?

The two sub-basins identified in the White River watershed may provide a reasonable first step in validation for that region due to the vast amount of data available as part of the NAWQA program plus the diversity of soils and land uses. The data from the White River study can and should be used for model evaluation; however, it is not sufficient as an end point. The natural, unexplained variability in water quality measurements is enormous. Two sets of data from a single geographic location are not sufficient to justify a complete validation. Thus, the basin-scale models selected for use in the basin scale tier should be chosen with an emphasis on the amount and breadth of validation that has been conducted on the model. The major effort of developing water quality assessment technology is not the creation of the model, but rather the validation and testing which occurs at the back end of the project.

Particular aspects of the White River data should be recognized during model validation. First, the measured pesticide concentrations were, according to the USGS report, among the highest in the nation. Secondly, the data showed an unusual relationship between soil type (i.e., drainage characteristics) and pesticide runoff. The more permeable watersheds, with a greater percentage of sandy soils, exhibited greater pesticide runoff than the less permeable watersheds. This result runs counter to expectations and data from other sites, such as the data from the Lake Erie Basin studies.

The White River tributaries appear to be well suited for a reasonable evaluation of the preliminary model, at least for the Midwest. The types and ranges in land use, soils, cropping patterns, and climate are typical of much of the Midwestern cornbelt, although not the western and southern United States.

It is good that two types of soils are represented: permeable sandy soils with good natural drainage and impermeable clay soils with artificial drainage via tile drains. White River data show that pesticide concentrations were two times higher in the basin with permeable soils. Furthermore, the tile drains were found to play a major role in the transport of pesticides in poorly drained soils, especially during wet growing seasons. These points reinforce earlier concerns that the basin models must have a tile-drain component. Without such a component, the contributions of impermeable soils to pesticide concentrations in streams will most likely be underestimated.

4) Is the Panel aware of any inaccuracies or mischaracterizations of model features or capabilities in our evaluation?

The Panel was of general consensus that there were no inaccuracies of model features or capabilities in the Agency's evaluation. In general, it is important to recognize the limitations of the model simulation approach. Even with extensive efforts, the models will provide uncertain results. Over-reliance on models should therefore be guarded against. The Panel also provided several general remarks.

Both Hydrologic Simulation Program for Fortran (HSPF) and SWAT now have an Arcview interface, which should allow for SWAT to be linked with Better Assessment in Science Integrating for Point and Non-Point Sources (BASINS) along with HSPF. HSPF and SWAT could be linked under BASINS, driven by ArcView, and the input and output processors could be shared in common. Also, common databases could be linked to both. Both models could then be evaluated under BASINS, with common data sets. These data should represent as wide a range of conditions for climate, soil, geologic setting, crop, crop management, and topography.

Annual Agricultural Non-Point Source (AnnAGNPS) is not a sufficiently mature technology for use as an assessment or regulatory tool. It has not had the amount of validation and testing that is sufficient for pesticide evaluations in the short term. In the longer term, AnnAGNPS may be a powerful technology for these types of evaluations.

Regression models in natural resources modeling applications generally under-predict the upper range (i.e., higher values) of the measured data; they do not predict the peaks. Specialized regression methods should be utilized to avoid this problem.

The past 30-year weather record is, from a historical perspective, a particularly calm period relative to variability and extreme events of rainfall. There is some evidence that our weather is again becoming more variable. The use of statistically based weather generators would help extend and amend the weather record.

FOR THE CHAIRPERSON:

Certified as an accurate report of findings:

Paul I. Lewis

Designated Federal Official

FIFRA/Scientific Advisory Panel

DATE:____________________