CONCLUSIONS AND RECOMMENDATIONS

I. Conclusions

Advantages and disadvantages of modelling and risk assessment

Advantages

- Hazard/risk assessment systems are based on scientific principles.
- Hazard and risk assessment can be powerful tools in assessing consistently the behaviour, effect, hazard and risk of chemical substances with regard to man and the environment.
- Common language and terminology is provided between scientists, decision makers and the public.
- Risk assessment is a controllable process (GMP).
- Risk assessment is a possibility for comparison with other natural risks.
- Risk assessment is a decision support tool and can be used for registration of chemicals in the environment through estimation of limit values.

Disadvantages

Technical objections:

- inaccuracy of our knowledge concerning:
  - properties of pollutants;
  - magnitude and type of emission;
  - environmentally variable parameters;
- uncertainty in exposure assessment;
- different safety factors in ADI values.

Non-technical objections:

- numbers (risk values) are emphasized out of all proportion;
- risk values are simple for communication but complicated for understanding;
- overestimation of expertise might push in the background social, cultural factors and subjective observations.

Concluding remarks

- Continuous improvement and refinement and validation is essential;
- Hazard and risk assessment are supporting decision making but cannot replace independent scientific judgment;
- Taking the above into account modeling can be powerful tools in assessing risk.

Comparative assessment of models and their use in representative regions

- Comparisons should only be made if the models have the same purpose;
- Methodology:
  - compare models with measured data (model as a black-box);
  - compare the scientific background.
- Decision making:
  - a comparative assessment should be based on a considerable number of results;

- availability of input parameters is important (simple model with available data vs complex model without data);
- what to do with model B and C if the comparative assessment shows that model A is the most favourable?
  - recommend not to use B and C? Very difficult due to preferences of individuals and countries;
  - develop new model which combines the strengths of A, B and C? funding is a potential problem in developing new models.

II. Recommendations

Recommendations for the use of models for specific environmental compartments

- Priorities for use should be based on the areas of use.
- There are two major types of use for modelling – regulation and research.
- It is not possible to recommend one specific model but some areas can be highlighted.
- Regulatory models should be able to accurately predict concentrations in specific environmental compartments.
- Pesticide models are generally more advanced than models for industrial chemicals.
- The selection of appropriate model inputs is determined by the modelling objectives. Mean values provide "best estimates" while worst-case inputs provide "worst-case" estimates.
- Probabilistic modelling is useful but requires knowledge of the distributions of input paramaters. The statistics of extreme values is a specialized area of research.
- Fuzzy models could be used to estimate the range of uncertainty.
- Generally, the first priority in modelling is to represent the key processes. The second priority is to obtain distributions of input parameters.
- More development is needed for ecosystems, air (both short range and long range transport) and the terrestrial compartment.
- There needs to be international coordination of further development of key models. More cooperation is needed to develop internationally recognized models.
- The role of FOCUS is to recommend specific models for use in pesticide registration. These groups should continue to be supported.
- User support should be provided for models. More training is needed to build the expertise of regulators.
- Models should be updated based on current scientific developments.

Recommendations for future collaboration in the validation of models

- Validation is fitting model results with reality. One of the goals is to validate the inner structure of the model (i.e. the equations). Internal versus external validation:
  - input parameters should only be used with validated regression ranges

  - the user should ensure that the model is appropriate for the chemical being modelled
  - the theory used in modeling should be based on laboratory and/or field experiments
- The decision to accept or reject validation work should be based on the purpose of the modeling and the scientific consequence.
- Spatial and temporal resolution can be a problem. Quality criteria need to be developed for measured data
- Measured concentrations should be clearly defined. Are they representative of localized values or regional values? Are they mean or median values? What was the detection limit?
- Recommendations should be developed for determining the uncertainty in modeling results.
- Models require good measured values.
- Laboratories should have good quality control.
- It may be useful to develop a quality score for measurements.
- Databases are needed for environmental data, toxicity data and emission data.
- Typically, more data than just the concentration are needed for modeling. Additional parameters include, e.g. pH, temperature, location.
- There should be more collaboration on the validation status of certain models. Who should decide if a model is validated? Should it be expert judgment or up to an established group of modelers such as FOCUS? Perhaps NATO should establish an expert board for modelling.

Recommendations on future research needs on modelling

- Announce a small workshop to plan further research on modelling.
- Inform officials in EU 5th framework program of the decisions from this workshop and to help in the future development of future research programs.
- Most leaching models simulate either the top 1-2 meters of the soil profile or the entire unsaturated zone. The capabilities of these models should be extended into the saturated zone.
- Additional models are needed for specific problems such as rice, algal bloom control and forestry.
- Actions are needed to promote use of modelling in various countries, training of users, correct use by decision makers.
- Model(s) are needed for indoor air quality and formation and decline of metabolites in the environment. Also pharmacokinetic modeling is needed to translate external exposures into internal doses to more accurately assess risk.
- Pesticide exposure models need to be adapted and validated to address EU conditions. Additional site-specific scenarios should be defined and characterized to represent a wide range of geographic settings.
- Should introduce concept of a model passport which would make models more understandable. More training should be provided to ensure correct understanding

and application of models. Model developers should distinguish between dynamic and state variables and clearly state how parameters are validated and updated. The exchange formats for I/O files should be standardized to facilitate coupling of models and future refinement.

- Use more experience from ecological modelling.
- Uncertainty of model outputs should be expressed by using probabilistic approaches. Output values should be expressed scientifically (with ranges). Safety factors should not be incorporated into concentration predictions but kept separate to clearly indicate the scientific and regulatory contributions to the predicted values.
- The capabilities of time-dependent sorption and depth dependence of degradation should be added to leaching models.
- Not enough is known about how sorption and degradation influences movement via preferential flow.
- Need to improve the accuracy of estimating potential and actual evapotranspiration since these values dramatically affect recharge.
- Models deal reasonably well with chemicals, which are deliberately spread in the environment. We need to improve our knowledge of the environmental distribution of industrial chemicals.
- Scenarios should be developed for a wide range of geographic settings. Some countries have well developed modelling capabilities and scenarios while others have low capability but also significant pollution problems.
- Need to organize some means of information exchange on modelling.
- There is a research need to improve modelling capabilities of simulating simultaneous exposure from soil, water and atmosphere. Risk assessments should consider multiple contaminants and possible synergism.
- Fundamental research must be increased with a focus on more appropriate environmental measurements and how to express uncertainty.
- There is a lack of information in the EU on appropriate tiered assessment schemes for toxicology and ecotoxicology.
- More research is needed on methods for model validation. Formal methods need to be developed to assess model accuracy.
- Need for develop standardized scenarios for southern and northern Europe.
- Validation studies should be performed at a local level.
- More training needs to be provided for model users to ensure correct understanding and use of models.
- Model users would like to find a standardised package of validated and common models for use in exposure assessment and risk assessment.
- Support should be provided to countries that do not currently have internal modelling capabilities including training, making models flexible enough to accept regionally appropriate inputs and providing assistance on the consequences of regulatory decisions based on modelling results.

- To stimulate additional thought concerning interpretation of modeling results, training should be organized at an advanced institute in which young researchers are invited to collaborate and begin using modeling to address specific needs.
- Some parameters are used in models which are not part of pesticide registration packages. More research is needed to clarify the needs for additional data.
- Need to develop more geographically-referenced (site specific) modeling.
- Need for better understanding and tools to assess chronic air exposure for human health.

General recommendations

- Need to develop ways to express uncertainty in the results of models. Need to provide a more systematic way to understand consequences of uncertainty in input parameters.
- Need to develop improved approaches to validate models.
- Need to address how to handle simultaneous exposures from multiple chemicals and simultaneous routes of exposure (probably less important). The current assumption is that multiple simultaneous contamination pathways are possible but exposure is generally dominated via one chemical and via one pathway.

Specific recommendations

- Need more site-specific scenarios. Some data layers have been developed for all of EU and may be usable for pesticide modelling. In air acidification modeling, RIVM provides a common EU model for all countries which is adapted to various national and regional assessments. Countries should defend locally appropriate parameters rather than specific models. Would also help to address uncertainty or variability if a reasonable range of representative scenarios were available in each country.
- Probabilistic modelling developed and used to reduce the use of safety factors.
- To obtain the benefits available through modelling, steps should be taken to promote training, develop standardized scenarios, use of websites and exchange of software.
- More specialized workshops are needed to provide information and training in the use of modelling. Web sites could be provided to provide technical assistance and to distribute models.

What can we do to push these conclusions?

- A short course on environmental risk assessment and modelling will be offered in early 2000 in the UK focussed primarily on pesticide fate modelling using MACRO and PELMO.
- Mailing lists are available for some types of models.
- Country-specific scenarios are important for human exposure to pesticides because practices vary with each country. External exposure varies with country. However, internal distribution is constant with humans. Risk tolerance can vary regionally. Co-pollutants also vary regionally and affect human response.