DEPARTMENT OF
PRIMARY INDUSTRIES

The thinking behind
our everyday essentials

Agrochemical residues in waterways: assessing and managing ecosystem risk in Victoria's catchments:

Research and Development Strategy 2007 onwards

Summary

80

Victoria
The Place To Be

Agrochemical residues in waterways: assessing and managing ecosystem risk in Victoria's catchments:

Research and Development Strategy 2007 onwards.

Adam Wightwick

Professor Keith Solomon (University of Guelph, Canada)

Dr Graeme Allinson

Primary Industries Research Victoria

Department of Primary Industries – Queenscliff

Funding for this strategy review was provided by the Department of Primary Industries' Agricultural Development Division, Program 1 – Integrating farming systems into landscapes.

Published by:
Department of Primary Industries
PO Box 114 Queenscliff Vic 3225
Ph: (03) 52580111
Fax: (03) 52580270

Introduction

Managing the effects of agrochemicals in Victorian waterways requires far more information than we (as scientists and/or managers) can afford to directly measure for all the places and all the times, and all the agrochemicals of interest. Strategies and/or tools are therefore required to focus monitoring and risk assessment programs in a cost-effective manner, and to predict agrochemical concentrations and effects in locations that have never been directly assessed (or inadequately assessed).

To assess the risk of agrochemicals to aquatic ecosystems, information is required on the environmental fate of particular chemicals, their concentrations in the environment (exposures) and toxicity to aquatic organisms (as illustrated by the ecological risk assessment framework shown in Figure 1). The overall ecological risk can then by determined based on the general principle that risk is a function of toxicity and exposure (or likelihood of an adverse effect).

During 2006/07, the project completed a review into existing information related to agrochemical residues in waterways within agricultural areas of Victoria, and liaised with key stakeholders to identify needs and concerns, and to prepare a strategy research plan/approach for addressing the issues.

The review has been completed, and has highlighted that there have been relatively few and isolated studies assessing agrochemical residues and risks within aquatic systems in Victoria, and that much of the information is now outdated (i.e. due to changes in agricultural production systems/practices and chemical use). The review identified the need for further, more current studies to assess the risks, and that this should by undertaken within a more strategic risk assessment framework using consistent approaches to allow comparisons across regions.

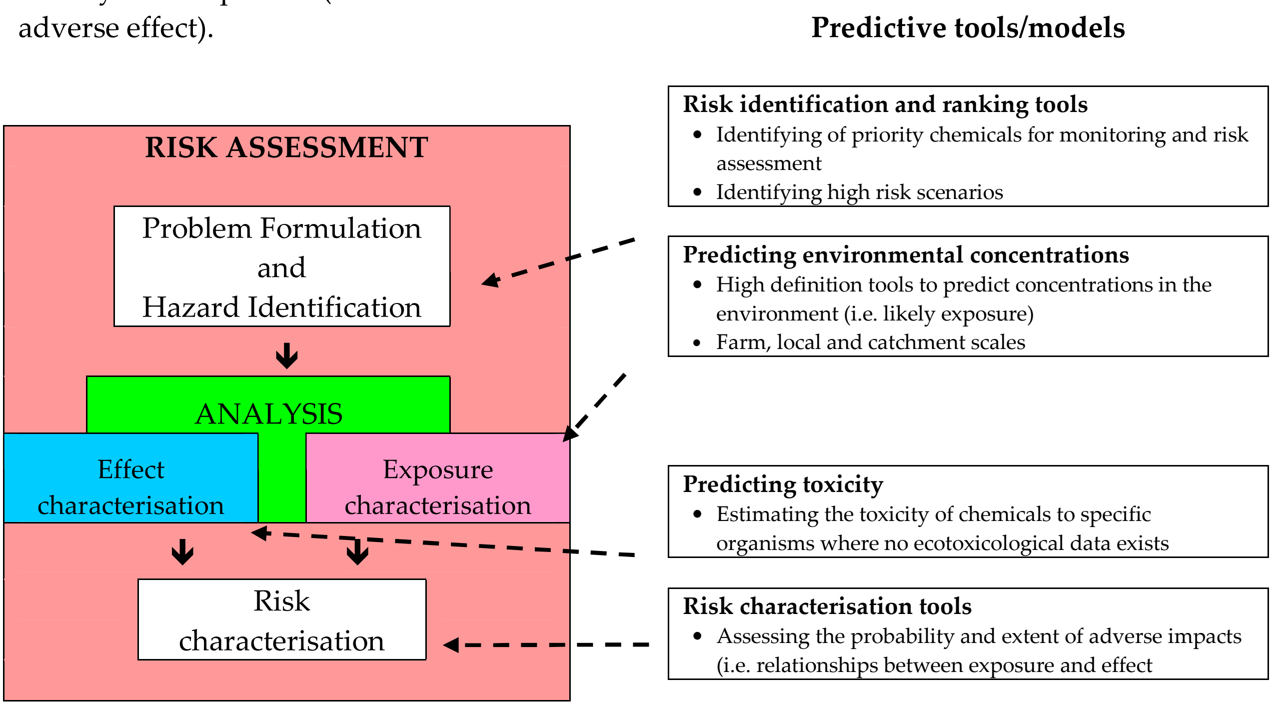

Figure 1 *The ecological risk assessment framework and the main types of predictive tools/models available to assist with the various levels of risk assessment*

During 2006/07, the project team liaised with key stakeholders to identify their needs and concerns with respect to agrochemical risks in Victorian waterways.

- Several of the CMA's and water authorities expressed a desire to assess agrochemical risks in their catchments, but were uncertain of the approach that they should be taking and were seeking assistance to design monitoring programs (i.e. which chemicals to monitor for and where).
- Meetings with Biosecurity Victoria Division's Chemical Standards Branch (CSB) highlighted their need to clarify and document the risk management response(s) to be taken if unacceptably high residues are detected in natural waters prior to conducting broad scale monitoring to assess agrochemical risks. This risk management response strategy needs to document the roles and responsibilities of the various government agencies and organisations in Victoria and the types of mitigation actions that could be taken if required. Completing such a risk management response strategy will provide for more efficient and effective risk management action if required, and provide assurance to the various responsible agencies that they were clear on their roles and responsibilities.

A stakeholder workshop was held at DPI-Queenscliff on the 8th of May 2007 to provide a forum for discussing information needs and concerns, the roles and responsibilities of Victorian agencies/ organisations, and future research and development directions.

- The workshop was attended by representatives from DPI, Biosecurity Victoria / CSB, CMA's, water authorities (both rural and urban), the Department of Sustainability and Environment (DSE), and the Victorian Environment Protection Authority (EPA).
- In addition, visiting eminent scientist Professor Keith Solomon from the University of Guelph, Ontario, Canada was in attendance to provide expert advice and input into the forum.

The key discussion points at the workshop included:

- A need for chemical use information to assist in identifying the priority high-risk agrochemicals to be targeted in monitoring programs and risk assessments.
- An interest in conducting regional studies (to begin with) to obtain a current snapshot of agrochemical concentrations and risks in key catchments/areas for use in identifying priority chemicals and as a baseline for which future studies could be compared.
- The general consensus that probabilistic risk assessment approaches should be utilised in studies assessing agrochemical risks in Victoria.

The 'Agrochemicals in waterways' project has been planned as an adaptive project, willing to respond to the needs of its stakeholders. Through the review and stakeholder liaison conducted during the first year of the project, and with input from Professor Keith Solomon, the project team has been able to identify areas of redirection, i.e. the project team have identified the key areas in which research and development is needed. As such, the purpose of this document is to outline and discuss the key strategic research pathways, which the 'Agrochemicals in waterways' project will adopt over the next 3 years and beyond.

Strategic outcomes and aims

Currently there is a lack of information and knowledge of the risks that agrochemicals pose to water in Victoria. Therefore the anticipated strategic outcomes of DPI's 'Agrochemicals in waterways' project are:

- Risks to water quality associated with the use of agrochemicals in Victorian agriculture are identified and defined, and strategies are being implemented to reduce the risks.
- DPI equipped with knowledge on the risks to water quality associated with agrochemical use, and are able to identify 'at risk' catchments on which to focus future research.

These outcomes can be achieved through conducting local and regional studies to assess the risk to waterways.

- This is best undertaken within a probabilistic risk assessment framework/context, i.e. problem formulation, risk analysis (effect and exposure characterisation), risk characterisation.

In achieving the above, DPI's role is to liaise with and assist key stakeholders through the process to facilitate practice change, rather than take complete ownership. Active input/ participation from key stakeholders (i.e. CAS, CMA's, water authorities) is also required to drive regional studies.

In line with the above, the overall strategic objective of DPI's current 'Agrochemicals in waterways' project is to:

- Facilitate an increase in monitoring/ studies assessing the risks of agrochemicals to waterways in Victoria, achieved by:

  - Produce guidance material and supporting information and tools to assist key stakeholders (e.g. CMA's, water authorities, EPA) to assess risks, such that consistent approaches to risk assessment and management are adopted across the state.
  - Provide independent scientific evaluation of information, tools, and approaches for use in risk assessment and management and prescribing recommendations to suit Victoria environments/situations.
  - Communicating with key stakeholders and conducting regular forums in which to discuss agrochemical risk assessment and management issues (thus giving greater assurance that consistent approaches will be adopted).

Specific discussion of the information and research needs required to support probabilistic risk assessments in Victoria follows, including recommendations for specific project activities.

Risk Assessment

One of the project's objectives is to consider the development of a catchment risk assessment tool, perhaps as a module in DPI's award winning CAT model. The review of risk assessment models undertaken by the project team in 2006/07, and subsequent discussions with stakeholders concludes:

- Many models are available to predict the fate of agrochemicals in the environment, although most relate to chemical behaviour at an individual site level.
- Models become complex and unreliable when scaled up for use at the catchment level.
- The CAT model can not assess the potential for contamination of waterbodies by agrochemicals at this time, since it does not have the capacity to cope with the complex behaviour of agrochemicals in the natural environment.
- Models can be data hungry and modification of existing models (e.g. CAT) to suit Victoria could easily become a time and resource consuming exercise, with questionable benefit.
- The project's stakeholders **see no need for complex models at this time**, preferring simpler approaches, since the perception is they require less technical expertise while being quite effective for prioritising the chemicals likely to pose the greatest risk in a particular area.

One of the major information needs identified by stakeholders is **chemical use data**.

- This is needed to assist with the problem formulation stage of the risk assessment process, and to aid in the design of monitoring programs.
- Currently in Victoria, there is very limited information publicly available regarding the types and volumes of agricultural chemicals used within particular areas. In other countries, chemical sales data is collected, averaged over each individual county and then mapped, e.g. within the United States Geological Survey's (USGS) program in the USA. This enables the higher use regions for particular chemicals to be identified and thus assists in targeting monitoring effort.
- Similar information is needed for Victoria, ideally at the catchment and sub-catchment scale (depending on which river basin one is looking at).

Water Quality Monitoring

There is a lack of state-wide general data on concentrations of pesticides in surface waters of Victoria. Collection of such data, as has been done in other jurisdictions, would offer very useful information to the state government, scientists, and regulators. A summary of current conditions would have the following advantages:

- Provide the data to test the (CSB) null hypothesis that current pesticide use practices in Victoria do not present a risk to the environment.
- Provide a baseline for future measurements that would allow the effects of changes in use-practices, changes in climate, and changes in land use patterns to be assessed.
- Allow the identification of pesticides and sites where concentrations exceed or are close to levels of concern. These sites could then be identified for continued monitoring and/or further assessed for the implementation of site-specific mitigation measures and other strategies for reducing exposure.

- Allow verification of information from pesticide use maps for watershed and catchments. For example, identify unreported pesticide use or suggest that local conditions in soil etc. may mitigate the movement of pesticides that are extensively used in the catchment.

The perception (often correct) is that measurement of agrochemicals in waters and soils is expensive, which inhibits monitoring, resulting in increased risk to agriculture and the wider, natural environment. A range of alternative tools are available for water quality monitoring which may improve this situation. One of these is:

- **Integrative sampling with passive samplers**. This method of sampling has some advantages in that the samplers need little attention apart from deployment and collection. They also integrate and average exposures over time, thus enabling identification of events that may be missed by grab sampling. The disadvantage of these methods is that concentration data from the sampler is not directly compatible to toxicity data (water concentrations) and have to be extrapolated to the water matrix through the use of calibration factors, few of which are available. In addition, some pesticides may be missed, as they are not readily portioned into the sampler.
- One way passive integrative samplers could be used is as a screening tool to identify which pesticides are found in a waterway, thus targeting analytes for further analysis by statistically valid grab sampling regimes. They could also be used to check for the presence of unexpected residues that may not be part of routine screening via grab samples.

Overall, however, passive integrative samplers are not judged to be appropriate for use in hazard or probabilistic risk assessment at this time. For this purpose, **instantaneous sampling via grab samples** is still recommended.

- Grab samples are commonly used to characterise residues in surface waters. The advantage is that the matrix itself is analysed and concentrations can be easily related to trigger values, as well as used for probabilistic risk assessment. The disadvantage of grab samples is that they may miss a peak if they are taken too infrequently.
- If grab samples are the chosen method, they should be taken at regular intervals. In its sampling program, the United States Geological Survey generally samples at time intervals of the order of two weeks. Similar intervals may be appropriate for some surface waters in Victoria but would depend on resources.

Sampling of sediments for pesticide residues is useful for two major reasons;

- Sediment is the exposure pathway for benthic organisms and these concentrations are therefore useful for hazard and risk assessment purposes.
- Sediments also act as integrative passive samplers for pesticides that partition onto clays or organic matter in sediments. Thus, they can allow the identification of pesticides that may be present less frequently in the water column and thus be missed in grab samples taken over longer time intervals.

In line with the overall strategic objective of DPI's current 'Agrochemicals in waterways' project, stakeholders and the project's expert reviewer recommend:

- Undertaking a risk snap shot, in a small pilot catchment, in collaboration with a water authority and/or CMA, using a most likely worst case scenario as the criterion for site selection.
- Further development of passive water samplers as a screening tool, including;
  - Refinements to capture wider groups of chemicals (i.e. more polar chemicals).
  - Calibration of passive water samplers for key high-risk chemicals (but need to weigh up cost of work to calibrate samplers *vs*. the cost of collecting and analysing lots of grab samples).
- Develop guidance material on standard sampling strategies/programs for use by stakeholders (i.e. CMA's, water authorities), so that a consistent approach is used across different regions. Document to include, criteria for selecting monitoring sites, how to decide what to monitor for, sampling techniques to use and when, QA/QC.
- Undertake regional monitoring / risk assessments in conjunction with CMA's, water authorities, and other stakeholders.

Monitoring with rapid biological methods

One of the challenges for scientists and waterway managers is to derive threshold concentrations for contaminants below which biodiversity and the functional attributes of natural systems are protected.
- In other words, what concentration is dangerous to the ecosystem in question?

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality provide trigger values that indicate the potential toxicity of a range of chemicals to aquatic organisms, and which can be used to assist with characterising the likely ecological effects.
- But, water quality trigger values have only been prescribed for 28 agrochemicals, due to a lack of toxicity data.

There are now a number of standardised biological tests offered by a range of agencies around the world, and although using a standard species helps achieve comparable results, there are some specific criticisms often raised by stakeholders:
- Are the standard species representative of, and appropriate for Australian conditions?
- Test organisms are often in-bred to some degree, so do test groups adequately encompass the genetic variability found in wild populations?
- Test organisms are often picked to be as uniform as possible, so do test groups adequately reflect the variation in organisms' response produced by age, sex, nutritional status, reproductive status, genetics, or interactions with other organisms, e.g. predators, prey and parasites?
- Most aquatic toxicology tests are conducted using single chemicals at concentrations significantly higher than those found in the natural environment, so how relevant are they to the lower concentrations of chemicals in complex mixtures wild organisms are exposed to?
- Most tests are short term and use mortality as the only end point, so how relevant are they to the long term and developmental impacts chemicals can elicit on aquatic organisms?

How can we predict what concentration of agrochemical is harmful to a waterway if there is little, or no, toxicity data for local species?

- Cautiously use overseas data. Chemical sensitivity does vary between species, but it is the taxonomic composition of species used in the assessment of risk that is most significant, not the habitat and geographical distribution of the species.
- Use a species sensitivity distribution (SSD), a statistical distribution estimated from a sample of toxicity data and visualised as a cumulative distribution function.

In line with the overall strategic objective of DPI's current 'Agrochemicals in waterways' project, stakeholders and the project's expert reviewer recommend:

- Collecting and collating existing ecotoxological data for agrochemicals registered for use in Victoria.
- Utilising the existing ecotoxological data to generate SSD's for commonly used agrochemicals for both water and sediment.
- Use the SSD approach to ascertain whether salinity, and/or dissolved oxygen, is likely to alter toxicity (i.e. are marine and freshwater data points separate or intermingled?).

Specific project activities for year 2 of the agrochemicals project (07/08)

Based on stakeholder and expert advisor recommendations, activities during 07/08 will be centred around three key areas:

1. **Risk management response strategy**. In recognition of the risk to government and regulators associated with the use of any tool that encourages monitoring of waterways for agrochemicals, the project will scope scenarios that will help waterway managers address the 'what do we do now?', if inconvenient truths of agrochemicals are found in waterways. The project will do this through two complementary activities, namely:
    - Reviewing the discovery-action scenarios used by authorities overseas.
    - Expert workshops.

    The above will provide broad consultation required to assure stakeholders that the project should continue in its current, or modified form, or that the risks to government and regulators are such that there is no gain in proceeding with the project in its current format.

2. **Development or validation of tools** required for cost-effective monitoring of Victoria's waterways for agrochemicals
    - Calibration of passive samplers for the most commonly discovered agrochemicals in Victoria's waterways (where such data does not exist).
    - Characterisation of the toxicity of agrochemicals used in Victoria. We anticipate that this will be achieved through collaboration with university departments (e.g. RMIT University), at Honours or PhD project level. Such post-graduate projects are a cost-effective manner in which to obtain data that will assist in the selection of analytes for routine analysis.
    - Further independent assessments of rapid assessment and biomonitoring tools.

3. Catchment Assessment tool. The **project's stakeholders see no need for complex models at this time**, preferring simpler approaches, since

the perception is they require less technical expertise while being quite effective for prioritising the chemicals likely to pose the greatest risk in a particular area. The project will therefore create:

- A statewide chemical use map. This map will be used to highlight high / higher risk areas, and facilitate targetted monitoring by water authorities, CMAs, researchers etc.
- Utilise chemical use mapping and risk scoring to come up with priority chemicals for particular catchments (such as Gippsland).
- Further independent assessments of pesticide risk scoring/ranking, and probabalisitic risk assessment approaches.

For further information contact:

Dr Graeme Allinson, or
Adam Wightwick

Department of Primary Industries – Queenscliff Centre

Ph: (03) 52580111

Email:
graeme.allinson@dpi.vic.gov.au
adam.wightwick@dpi.vic.gov.au