Off-site transport of contaminants in the form of nutrients, sediment and pesticides from agricultural practices is of concern to landholders, regulatory agencies and the general public. The presence of contaminants in waterways can cause eutrophication, ecotoxicological effects on aquatic organisms and may increase the cost of water treatment for potable water.

This study aims to minimise the transport of contaminants, from an apple, cherry and grape site which eventually drain into the Onkaparinga River and then Mt Bold reservoir. The Centre for Natural Resource Management (CNRM), Australian Centre for International Agricultural Research (ACIAR) and the National Landcare Program (NLP) are jointly funding our research.

Methods being used

The apple and cherry sites are in the Cock Creek subcatchment and the grape site is in the Charleston subcatchment. The cherry site is an 8 ha catchment with cherries and native vegetation; the apple site is a 64 ha catchment with apples, broadscale and intensive grazing and the grape site is a 307 ha catchment with grapes, broadscale and intensive grazing. All three sites eventually drain to the Onkaparinga River and then into the Mt Bold reservoir.

Water level loggers were installed in July 2006 to measure the volume of water off each site (Fig. 1). Automated samplers were installed to regularly collect this water based on a flow weighted sampling strategy (Fig 2). In other words, after a pre-designated volume of water has passed, a 1-2 L volume of water is collected and these water samples are analysed back in our CLW laboratories for nitrogen, phosphorus, carbon, sediment and selected pesticides. These concentrations are then converted to loads based on the total volume of water per time period.
Prior to commencing the sampling the three growers involved with the study were interviewed about pesticide usage on their farms. The pesticide data and environmental information about each site were utilised in the predictive risk assessment tool, Pesticide Impact Rating Index (PIRI), to determine the likelihood of the pesticides being transported off-site. This data was also used for determining which pesticides would be analysed in the study.

In addition over 20 growers involved with apple, cherry, grape and pear production have been interviewed and their data about pesticide usage was assessed using PIRI to produce “Chemical Reference Cards” about the likely risk of off-site transport of the chemicals to surface water. These will enable growers to make informed choices about different herbicides, fungicides and insecticides that are available with respect to their likely risk of moving off-site.

**Initial results**

The apple site is the only location where water has flowed regularly since 2006. There was no substantial flow of water from the cherry site until late April 2007 and only one runoff event from the grape site in 2006, because of very low rainfall in 2006. Figure 5 shows monthly rainfall at the Lenswood weather station in 2006 compared to the 30 year average. Lenswood is 5-10 km from the monitoring sites. The total rainfall and runoff from three sites is given in Table 1.

Table 1. Total rainfall and runoff from monitoring sites between July 2006 and July 2007.

<table>
<thead>
<tr>
<th>Site</th>
<th>Rainfall (mm)</th>
<th>Runoff (mm)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apples</td>
<td>609</td>
<td>38</td>
<td>6</td>
</tr>
<tr>
<td>Cherries</td>
<td>739</td>
<td>184</td>
<td>25</td>
</tr>
<tr>
<td>Grapes (upper)</td>
<td>413</td>
<td>46</td>
<td>11</td>
</tr>
<tr>
<td>Grapes (lower)</td>
<td>413</td>
<td>26</td>
<td>6</td>
</tr>
</tbody>
</table>

Preliminary data show that 6 to 25% of the rainfall which fell in the catchments runs off, with the highest runoff from the cherry site.
Nutrient loads of total nitrogen (TN), total phosphorus (TP) and total organic carbon (TOC) from the land uses between July 2006 and July 2007 are shown in Table 2. The grapes site generated the largest loads, followed by cherries and then apples.

Table 2. Nutrient loads of total nitrogen (TN), total phosphorus (TP) and total carbon (TOC) from the three land uses between July 2006 and July 2007.

<table>
<thead>
<tr>
<th>Site</th>
<th>TN (kg/ha)</th>
<th>TP (kg/ha)</th>
<th>TOC (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apples</td>
<td>0.65</td>
<td>0.03</td>
<td>1.61</td>
</tr>
<tr>
<td>Cherries</td>
<td>11.0</td>
<td>0.12</td>
<td>21.5</td>
</tr>
<tr>
<td>Grapes (upper)</td>
<td>21.7</td>
<td>1.19</td>
<td>111</td>
</tr>
<tr>
<td>Grapes (lower)</td>
<td>8.1</td>
<td>0.41</td>
<td>36.8</td>
</tr>
</tbody>
</table>

All water samples were analysed as unfiltered (i.e. total load composed of chemicals in solution and those attached to colloidal material) and as filtered samples passed through a 1.2 µm filter for the pesticides and total suspended solid (TSS) measurements or a 0.45 µm filter for the nutrients (representing contaminants in the solution phase). Examples of concentrations of a fungicide (fenarimol) and an insecticide (chlorpyrifos) detected in water samples collected in April 2007 in water leaving the apple site are given in Fig. 4. While the fenarimol was transported mainly in the solution phase approximately 50% of the chlorpyrifos was transported attached to colloidal material. The loads of the selected pesticides analysed that were transported off-site ranged from <0.01% to 2% of the applied active ingredient. Very low concentrations of pesticides were detected in water leaving the grapes site so no loads have been calculated for this site.

In summary the pesticides detected to date in the water samples have been:
- carbaryl, fenarimol and chlorpyrifos from the apples site;
- very low concentrations of penconazole, cyprodinil, myclobutanil, and fludioxonil from the grapes site; and
- procymidone, propiconazole and pirimicarb from the cherries site.

Outcomes from project

The main outcomes from this ongoing project:
- A two to three year detailed dataset of concentrations and loads of selected pesticides, nutrients and sediment moving to surface water from apple, cherry and grape production in the Mt Lofty Ranges. This data can be used to determine the severity of environmental impact of the three landuses.
- An understanding of the behaviour of pesticides, nutrients and sediment moving to surface water from apple, cherry and grape production. This data can be used to develop a set of recommendations for the horticultural industry to minimise the environmental impact of the three landuses.
- The reference cards, which are to be distributed to growers in the Mt Lofty Ranges, will outline the relative risk of pesticides to be transported to surface water as assessed by PIRL. This information will allow growers to make informed decisions about choice of chemical and timing of application with regard to their relative impact on surface water.
- The concentrations of pesticides detected in the water transported off-site will be compared with regulatory guidelines for pesticide concentrations in surface waters to provide a context for the level of contamination.
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