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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

POLICY BRIEF

Water resources and agricultural chemicals – what is the risk?

A recently completed Water Research Commission (WRC) project investigated the contamination of water resources by agricultural chemicals and the impact on environmental health.

Background

Agricultural activity is potentially a source of a number of hazardous chemicals in water resources. Concerns have been expressed that some of the pesticides used in agricultural practice, either through crop spraying and animal disease, control may enter and pollute the rivers and dams and cause detrimental effects in animals and humans that use the water for drinking and recreational purposes.

A number of WRC studies have identified different chemicals in different areas that are hazardous, including in water resources. Some of these chemicals have also been found to be endocrine disruptors. Endocrine disrupting effects have also been observed in some species of animals in and around contaminated water resources.

What are endocrine disruptors?

Endocrine disruptors are chemicals that, at certain doses, can interfere with the endocrine (or hormone) system in animals (and humans). These disruptions can cause cancerous tumors, birth defects, and other developmental disorders.

Most of these studies in South Africa have not specifically focused on the link between the chemicals used in agricultural practices and the impact on human health with water as a pathway. The main objective of this study, therefore, was to determine the extent and level of contamination by agricultural chemicals (including pesticides, herbicides and plant growth regulants) in South Africa.

Three study areas were selected, namely the Letsitele catchment, near Tzaneen, the Lomati catchment, near Komatipoort, and the Vals and Renoster catchments in the Free State, both of which enter the Vaal River.

Monitoring water and sediment for pesticides

Water and sediment samples in the three study areas were analysed for pesticides. Both surface water and groundwater samples were tested.

A wide variety of pesticides were detected within all study areas. The Letsitele catchment was found to have the lowest concentration of pesticides in water and sediment compared to the other two catchments.

A host of pesticides were detected in the samples from the Vals and Renoster catchments, including atrazine and terbuthylazine – both highly mobile pesticides which are used on maize.

The fact that these herbicides were detected constantly throughout the year (during the wet and dry season) indicates that they have essentially saturated the hydrological cycle and further detailed monitoring surveys targeting these specific herbicides would be warranted in future.

These two pesticides, as well as a host of other mobile pesticides were detected in samples in the Lomati catchment. Samples collected from a water purification works in Langloop had very similar concentrations of pesticides to those detected in the river from which water was sourced. This indicates that the treatment technology had very little effect on removing pesticides from drinking water. A number of samples collected in all study areas showed endocrine disrupting activity. It was, however, not possible to link this

activity to specific pesticides that were detected in the chemical analyses.

Contamination patterns for each of the pesticides detected in each of the study areas were generally well predicted by an index of mobility (so-called GUS index), with high and medium mobility pesticides being detected either more frequently or at higher concentrations than those in the low mobility category.

In addition to water and sediment sampling, an intensive air monitoring study was performed. Measured concentrations were compared with concentrations predicted by the AGDISP model and indicated that the model provides reliable estimates of airborne pesticide concentrations, highlighting its use for risk assessment studies in South Africa.

Pesticide Prioritisation

An Excel based risk indicator was developed that prioritises pesticide risks to human health via the water pathway, using data on toxicity, quantity of use and environmental mobility. The indicator can be used to identify priority pesticides at a national scale or per crop type.

Using pesticide use data and statistics on the distribution of important agricultural crops across the country it was possible to develop maps providing a spatial overview of the likely distribution of over 200 active ingredients used in crop protection (Figure 1). These maps are the first of their kind for South Africa and have a number of useful applications, particularly in the design of monitoring programmes, identifying priority source areas of pesticides of interest and as input into ecological and human health risk assessments.

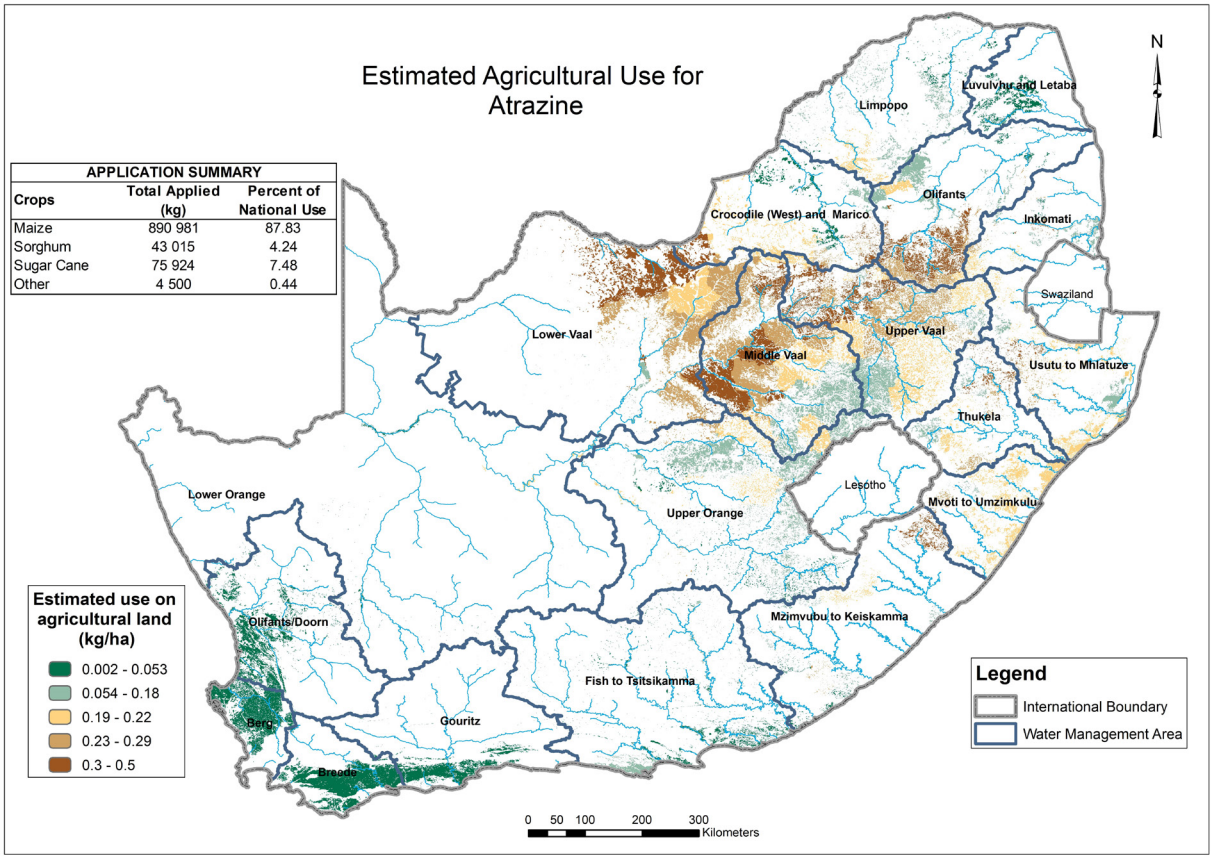

Figure 1. Map showing the estimated application rate of atrazine across the country, clearly identifying areas of high estimated use.

Animal health assessment

With regards to potential impacts of exposure to agricultural chemicals in the site key findings of the project were:

- Inorganic water quality constituents may represent a fundamentally greater potential hazard to various users compared to organic chemicals. This is largely due to the low concentrations of organic chemicals observed and the intermittent exposure to airborne pollutants.
- Commercial production animals present a viable low-cost means of obtaining representative clinical observations which can be used to determine if further human health investigations are indicated in a site-specific exposure scenario.
- Differentiating between inorganic constituents from naturally occurring geochemistry and those from agricultural chemicals is required to effectively formulate management objectives.
- A fundamental source, pathway and receptor approach is required in order to determine the potential hazards posed by, and safe use of, agricultural chemicals.
- For organic chemicals it also follows that site-specific factors, in terms of nutritional status and the presence of sensitive user groups, among others, may determine the potential hazard posed by animals and humans.
- For inorganic chemicals site-specific factors are also relevant, but the increased concentration ranges observed may imply that concentration alone plays a more significant role.

Human health risk assessment

A human health risk assessment of pesticides detected in water and sediment samples collected from sampling sites in each of the three study areas was conducted. Different exposure scenarios were used to predict possible human health risks, including a person making use of the surface water for their domestic use, a farmer using the water to irrigate produce, a person regularly eating fish from the area and a person making use of the water for recreational activities, such as swimming.

Modelled air distributions and depositions were also used to calculate potential risks based on spray-drift of applied pesticides.

In general, the study indicated that the present risk to human health in the study areas were low.

Despite the low hazards posed by pesticides detected in this study, the increased recognition of endocrine disrupting effects from exposure to low concentrations and complexities around concurrent exposure to multiple potential hazards via the water pathway, a precautionary approach is still justified.

Further reading:
To order the reports, *Investigation of the contamination of water resources by agricultural chemicals and the impact on environmental health Volume 1: Risk assessment of agricultural chemicals to human and animal health* (**Report No. 1956/1/15**) and *Volume 2: Prioritising human health effects and mapping sources of agricultural pesticides used in South Africa* (**Report No. TT 642/15**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.